



PROGRAM BOOK

101st Annual Meeting

Featuring Aortic Symposium and Mitral Conclave

A Virtual Learning Experience



April 30-May 2, 2021

President
Marc R. Moon

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Since 1917, when it was founded as the first organization dedicated to thoracic surgery, the American Association for Thoracic Surgery (AATS) has evolved significantly. Today, it is an international organization consisting of more than 1,500 of the world's foremost cardiothoracic surgeons representing 41 countries. Its members are selected based on their proven records of distinction within the cardiothoracic surgical field and their meritorious contributions to the existing knowledge of cardiothoracic disease and its surgical treatment. AATS continues to strengthen its commitment to science, education, and research through the Annual Meeting, research grants and awards, educational symposia and courses, and the AATS official journal, *The Journal of Thoracic and Cardiovascular Surgery*.

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Learning Objectives

At the conclusion of this activity, participants will be able to:

- ☐ Identify the latest techniques and current research specifically related to adult cardiac surgery, congenital heart disease, general thoracic surgery, and perioperative care;
- ☐ Select appropriate surgical procedures and other interventions for their own patients based upon results presented;
- ☐ Incorporate the basic science developments and emerging technologies and techniques across the spectrum of cardiothoracic surgery;
- ☐ Communicate current practice management necessary for the effective and safe delivery of patient care;
- ☐ Translate expanded knowledge into practice for the improvement of patient outcomes and satisfaction.

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The American Association for Thoracic Surgery designates this other activity (live and recorded sessions) for a maximum of **166.75 AMA PRA Category 1 Credits™**.

Physicians should only claim credit commensurate with the extent of their participation in the activity.

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To claim credit for this event:

- Attend the sessions in full for which credit is sought;
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SCIENTIFIC PROGRAM

FRIDAY MORNING, APRIL 30, 2021

9:00AM–10:45AM

KEY

- ADULT CARDIAC
- CONGENITAL
- MULTI-SPECIALTY
- PERIOPERATIVE
- THORACIC

ADULT CARDIAC Simultaneous Scientific Sessions

AORTIC SYMPOSIUM 1: Root/Ascending

Moderator: Edward P. Chen, *Duke University*

Panelists: Ruggero De Paulis, *Unicamillus, European Hospital*
Hans-Joachim Schäfers, *UKS Saarland*
Nicholas T. Kouchoukos, *Washington University*
Emmanuel Lansac, *Institut Mutualiste Montsouris*
Tirone E. David, *University of Toronto, Toronto General Hospital*
John A. Elefteriades, *Yale School of Medicine, Yale New Haven Hospital*
Duke E. Cameron, *Harvard University, Massachusetts General Hospital*

1. Systematic Screening Strategy for Genetic Aortopathy

Jihoon Kim¹, Jae Suk Yoo², Hee-Jung Kim³, Ho Jin Kim⁴, Joon Bum Kim⁴, Suk Jung Choo⁴
¹Kangnam Sacred Heart Hospital, Seoul, Republic of Korea; ²Sejong General Hospital, Bucheon, Gyeonggi-do, Republic of Korea; ³Korea University Anam Hospital, Seoul, Republic of Korea; ⁴Asan Medical Center, Seoul, Republic of Korea

2. Modeling Aortic Wall Stress from CT- and Echo-Derived Biomechanical Parameters for Clinical Risk Prediction

Lauren V. Huckaby¹, Ronald N. Fortunato¹, Leonid Emerel¹, Tara Richards¹, Jennifer Hill¹, Marie Billaud², Julie Phillippi¹, David Vorp¹, Spandan Maiti¹, Thomas Gleason²
¹University of Pittsburgh, Pittsburgh, PA; ²Brigham and Women's Hospital, Boston, MA

3. Redo Aortic Surgery—Does One versus Multiple Affect Outcomes?

Kanika Kalra, LaRonica McPherson, Bradley G. Leshnow, Edward P. Chen
Emory University, Atlanta, GA

4. Should We Operate on Thoracic Aortic Aneurysm of 5.0–5.5 cm in Bicuspid Aortic Valve Disease Patients?

Katelyn Monaghan¹, Felix Orelaru², Aroma Neema¹, Xiaoting Wu¹, Bo Yang¹
¹University of Michigan, Ann Arbor, MI; ²St. Joseph Mercy Hospital, Ann Arbor, MI

5. Valsalva Prosthesis and Straight Tube Graft Offer Similar Short- and Long-Term Outcomes in Valve Sparing Aortic Root Replacement

N. Bryce Robinson¹, Woodrow J. Farrington^{1,2}, Mohamed Rahouma¹, Jeremy Leonard¹, Katia Audisio¹, Giovanni Soletti¹, Christopher Lau¹, Erin M. Iannacone¹, Mario Gaudino¹, Leonard N. Girardi¹

¹NewYork-Presbyterian, New York, NY; ²Emory University School of Medicine, Atlanta, GA

HOW I DO IT VIDEO: Root/Ascending

G. Chad Hughes, *Duke University*

MITRAL CONCLAVE INTERACTIVE VIDEO: Session 1

Video Case Presentation

Moderators: David H. Adams, *Mount Sinai Health System*
Anelechi C. Anyanwu, *Mount Sinai Health System*

Panelists: Joanna Chikwe, *UCLA, Cedars-Sinai*
Gilles D. Dreyfus, *Paris University Pierre et Marie Curie, Institut Montsouris Paris France*
Marc Gillinov, *Cleveland Clinic*
Y. Joseph Woo, *Stanford University, Stanford Hospital*

HOCM AND LV REMODELING

Moderators: Juan B. Grau, *University of Ottawa, The Valley Hospital*
David A. Bull, *University of Arizona, Banner Medical Center*

Evaluation, Diagnosis, and Therapeutic Indications in HOCM

Victoria Parikh, *Stanford University*

6. Disparities in Outcomes of Septal Myectomy for Hypertrophic Obstructive Cardiomyopathy: Impact of Race, Sex, Socio-Economic Status

Sri Harsha Patlolla, Hartzell V. Schaff, Rick A. Nishimura, John M. Stulak, Jeffrey B. Geske, Steve R. Ommen, Joseph A. Dearani
Mayo Clinic, Rochester, MN

Invited Discussant: Joseph D. Schmoker

7. Left Ventricular Remodeling Following Septal Myectomy in Hypertrophic Obstructive Cardiomyopathy

Tsuyoshi Yamabe¹, Jonathan Ginns², Vijay Vedula³, Jay S. Leb¹, Yuichi J. Shimada¹, Shepard D. Weiner¹, Hiroo Takayama¹

¹Columbia University Medical Center, New York, NY; ²Heart Hospital of Austin, Austin, TX;

³Columbia University, New York, NY

Invited Discussant: Nicholas G. Smedira

TransAortic Ventricular Septal Myomectomy

Nicholas G. Smedira, Cleveland Clinic

Transapical Ventricular Septal Myomectomy

Hartzell V. Schaff, Mayo Clinic

PANEL DISCUSSION

IMPACT OF COVID-19 ON CARDIOTHORACIC SURGERY

Moderators: Kevin D. Accola, Advent Health Orlando
Robert J. Cerfolio, NYU Langone Health

8. The Effect of COVID-19 on Surgical Volume and Its Associated Costs

Edgar Aranda-Michel¹, Arman Kilic¹, Derek Serna-Gallegos¹, James A. Brown¹, Yancheng Dai¹, George Arnaoutakis², Courtenay Dunn-Lewis¹, Ibrahim Sultan¹
¹University of Pittsburgh, Pittsburgh, PA; ²University of Florida, Gainesville, FL

Invited Discussant: Michael J. Reardon

COVID-19: An Update for Cardiothoracic Surgeons

Robin Varghese, Icahn School of Medicine at Mount Sinai, Mount Sinai Health System

9. A Multi-Centre Analysis of Clinical Decision Making for Non-Elective Cardiac Surgery Referrals During the COVID-19 Pandemic

Damian C. Balmforth¹, Martin T. Yates¹, Bilal H. Kirmani², Mayzar Kanani³, Alex Cale⁴, Metesh Acharya⁵, Reuben Jeganathan⁶, Indu Deglurkar⁷, Julie Sanders¹, Aung Oo¹
¹St. Bartholomew's Hospital, London, United Kingdom; ²London Heart and Chest Hopsital, Liverpool, United Kingdom; ³James Cook University Hospital, Middlesbrough, United Kingdom; ⁴Hull and East Yorkshire Hospitals, Hull, United Kingdom; ⁵University Hospital Leicester, Leicester, United Kingdom; ⁶Royal Victoria Hospital, Belfast, United Kingdom; ⁷University Hospital of Wales, Cardiff, United Kingdom

Invited Discussant: Kevin D. Accola

Ethical and Systems Considerations in ECMO for COVID

Alain Combes, Sorbonne Paris, Pitié Salpetriere Paris

Technical Considerations and Results of ECMO for COVID

Scott C. Silvestry, AdventHealth

LB1. Long-Term Recovery of COVID-19 Survivors Is Not Negatively Impacted by ECMO: A Multi-Center Study from the ORACLE Group

Lauren J. Taylor¹, Chintan Ramani², Shoaib Fakhri¹, Kirby P. Mayer³, Eric W. Etchill⁴, Matthew F. Mart⁵, Sarah E. Jolley¹, Alexandra Kadl², Skyler Peterson¹, Ashley A. Montgomery-Yates³, Ann M. Parker⁴, Carla Sevin⁵, Kathryn Colborn¹, Nicholas Teman², Jordan Hoffman⁵, Kyle Enfield², Karsten Bartels¹, Bo Soo Kim⁴, Sung-Min Cho⁴, Joseph Hippensteel¹, Glenn J.R. Whitman⁴, Joseph B. Zwischenberger³, Jessica Y. Rove¹
¹University of Colorado, Aurora, CO; ²University of Virginia, Charlottesville, VA; ³University of Kentucky, Louisville, KY; ⁴Johns Hopkins University, Baltimore, MD; ⁵Vanderbilt University, Nashville, TN

Invited Discussant: TBD

Lung Transplant

Marcelo Cypel, University of Toronto, Toronto General Hospital

TRANSCATHETER MITRAL VALVE REPAIR

Moderators: Gilbert H.L. Tang, Icahn School of Medicine at Mount Sinai, Mount Sinai Health System
Vinod H. Thourani, Piedmont Heart Institute

Surgeons Need to Learn Percutaneous Edge-to-Edge Device Repair Implantation Techniques

Gorav Ailawadi, University of Michigan

PANEL DISCUSSION

10. Five-Year Outcomes of Microinvasive Transapical Mitral Valve Repair Through Neochordae Implantation

Augusto D'Onofrio¹, Matteo Nadali¹, Alessandro Fiocco¹, Florinda Mastro¹, Patrizia Aruta², Giuseppe Evangelista¹, Lorenzo Longinotti¹, Giorgio Pittarello³, Gino Gerosa¹
¹Division of Cardiac Surgery, University of Padova, Padova, Italy; ²Division of Cardiology, University of Padova, Padova, Italy; ³Division of Anesthesiology, University of Padova, Padova, Italy

Invited Discussant: Andrea Colli

11. Impact of Preoperative Tricuspid Regurgitation and Right Ventricular Dysfunction on Outcomes of Mitral Valve Surgery After Edge-to-Edge Transcatheter Mitral Valve Repair: From the CUTTING-EDGE Registry

Tsuyoshi Kaneko¹, Syed Zaid², Sameer A. Hirji¹, Ketii Vitanova³, Rudiger Lange³, Markus Krane³, Francesco Maisano⁴, Maurizio Taramasso⁴, Tom Nguyen⁵, Gorav Ailawadi⁶, Marissa Donatelle⁶, Robert Smith⁷, John Squiers⁷, Timothy George⁷, Kelley Hutcheson⁷, Michael DiMaio⁷, Pinak Shah¹, Matthew Romano⁸, Jessica Oakley⁸, Walid Ben Ali⁹, Phillipe Demers⁹, Basel Ramlawi¹⁰, Newell Robinson¹¹, Lin Wang¹¹, Len Conradi¹², Oliver Bhadra¹², Lionel Leroux¹³, Michael Chu¹⁴, Rodrigo Bagur¹⁴, Muhanad Algadheeb¹⁵, Marco Gennari¹⁶, Antonio Bartorelli¹⁶, Moritz Wyler von Ballmoos¹⁷, Michael Reardon¹⁷, Marvin Atkins¹⁷, Augusto Donofrio¹⁸, Arnar Geirsson¹⁹, Ryan Kaple¹⁹, Francesco Massi²⁰, Michele Triggiani²⁰, Marco Di Eusanio²¹, Filippo Capestro²⁰, Roi Estevez²², Paul Grayburn⁷, Tamim Nazif²³, Michael Mack⁷, Vinayak Bapat²³, Thomas Modine¹³, Paolo Denti²⁴, Gilbert Tang²
¹Brigham and Women's Hospital, Allston, MA; ²Mount Sinai Hospital, New York, NY; ³German Heart Center Munich, Munich, Germany; ⁴Zurich Heart Center, Zurich, Switzerland; ⁵University of Texas Houston, Houston, TX; ⁶University of Virginia, Charlottesville, VA; ⁷Baylor, Scott & White, Plano, TX; ⁸University of Michigan, Ann Arbor, MI; ⁹Montreal Heart Institute, Montreal, QC, Canada; ¹⁰Valley Health Winchester, Winchester, VA; ¹¹St. Francis Hospital, Roslyn, NY; ¹²University of Hamburg, Hamburg, Germany; ¹³CHU Bordeaux, Bordeaux, France; ¹⁴London Health Sciences Center, London, ON, Canada; ¹⁵London Health Sciences Center, London, QC, Canada; ¹⁶Monzino Hospital, Milan, Italy; ¹⁷Houston Methodist, Houston, TX; ¹⁸Padova Italy, Padova, Italy; ¹⁹Yale University, New Haven, CT; ²⁰Ospedale Mazzini, Teramo, Italy; ²¹Ancona Ospedali Riuniti di Ancona Italy, Ancona, Italy; ²²Hospital Alvaro Cunqueiro Vigo Spain, Vigo, Spain; ²³Columbia University, New York, NY; ²⁴Milan San Raffaele, Milan, Italy

Invited Discussant: Joon Bum Kim

Guidelines for TMVR/r Program Development

Patrick T. O'Gara, Harvard University Medical School, Brigham and Women's Hospital

12. Incidence, Characteristics, and Outcomes of Reintervention After Failed Transcatheter Mitral Valve Repair Procedures: A National Representative Analysis

Tsuyoshi Kaneko¹, Paige Newell¹, Sang Gune Yoo², Sameer Hirji¹, Sarah Nisivaco³, Hechuan Hou⁴, Gorav Ailawadi², Michael Thompson²
¹Brigham and Women's Hospital, Boston, MA; ²Michigan Medicine, Ann Arbor, MI;
³Harvard Medical School, Boston, MA; ⁴University of Michigan, Ann Arbor, MI

Invited Discussant: Andrea Colli

PANEL DISCUSSION

10:45AM–11:00AM **BREAK**

FRIDAY MORNING, APRIL 30, 2021
11:00AM–12:45PM

ADULT CARDIAC
Simultaneous Scientific Sessions

AORTIC SYMPOSIUM 2: Arch/Cerebral Protection

Moderator: David Spielvogel, New York Medical College, Westchester Medical Center
Panelists: Davide Pacini, University of Bologna, S. Orsola Hospital
Hitoshi Ogino, Tokyo Medical University, Tokyo Medical University Hospital
T. Brett Reece, University of Colorado, University of Colorado Hospital
Marek P. Ehrlich, University of Vienna, AKH Vienna
Thomas G. Gleason, Harvard Medical School, Brigham and Women's Hospital

25. Long-Term Outcomes of Total Arch Replacement and Frozen Elephant Trunk for Chronic Type I Aortic Dissection

Wei-Guo Ma^{1,2}, Yu Chen¹, Wei Zhang¹, Fang-Fang Cao², Jun Zheng^{1,2}, Yong-Min Liu^{1,2}, Jun-Ming Zhu^{1,2}, Li-Zhong Sun^{1,2}
¹Beijing Anzhen Hospital, Beijing, China; ²Fu Wai Hospital, Chinese Academy of Medical Sciences, Beijing, China

26. Multicenter Prospective Comparative Study of Japanese Frozen Elephant Trunk Device for Open Aortic Arch Repairs

Hitoshi Ogino¹, Yutaka Okita², Naosato Uchida³, Masaaki Kato⁴, Shinji Miyamoto⁵, Hitoshi Matsuda⁶, Michikazu Nakai⁶, Shinichi Higashiue⁷, Matsui Matsui⁸, Kenji Minatoya⁹, Yoshikatsu Saiki¹⁰, Hideyuki Shimizu¹¹, Norihiko Shiya¹², Kazuo Yamanaka¹³, Kenji Okada¹⁴
¹Tokyo Medical University, Tokyo, Japan; ²Takatsuki Hospital, Takatsuki, Japan; ³Yao Tokushukai Hospital, Yao, Japan; ⁴Morinomiya Hospital, Osaka, Japan; ⁵Oita University, Oita, Japan; ⁶National Cerebral and Cardiovascular Center, Osaka, Japan; ⁷Kishiwada Tokushukai Hospital, Kishiwada, Japan; ⁸Hanaoka Seishu Memorial Hospital, Sapporo, Japan; ⁹Kyoto University, Kyoto, Japan; ¹⁰Tohoku University, Sendai, Japan; ¹¹Keio University, Tokyo, Japan; ¹²Hamamatsu University School of Medicine, Hamamatsu, Japan; ¹³Nara Prefecture General Medical Center, Nara, Japan; ¹⁴Kobe Univesity, Kobe, Japan

27. Implications of Significant Intraoperative Neurophysiological Monitoring Changes in Aortic Surgery

Derek Serna-Gallegos, Thomas Gleason, Parthasarathy D. Thirumala, Jeffrey R. Balzer, James A. Brown, Stephanie Paras, Cara Fleseriu, Donald J. Crammond, Katherine M. Anetakis, Arman Kilic, Forozan Navid, Ibrahim Sultan
University of Pittsburgh, Pittsburgh, PA

28. Impact of Insufficient Cerebral Hemisphere Compensation Mechanism on Postoperative Cognitive Function in Patients with Circulatory Arrest Using Selective Antegrade Cerebral Perfusion

Tae-Hoon Kim¹, Suk-Won Song¹, Ha Lee¹, Myeong Su Kim¹, Jooyoung Oh², Jae-Jin Kim², Kyung-Jong Yoo¹, Bum-koo Cho³
¹Department of Cardiovascular Surgery, Gangnam Severance Hospital, Seoul, Republic of Korea; ²Department of Psychiatry, Gangnam Severance Hospital, Seoul, Republic of Korea; ³The Korea Heart Foundation, Seoul, Republic of Korea

HOW I DO IT VIDEO: Arch/Cerebral Protection

Malakh Shrestha, Hannover Medical School

MITRAL CONCLAVE LIVE CASE: Session 1

Mitral Valve Repair from OR 25 at Mount Sinai

Moderators: Anelechi C. Anyanwu, Mount Sinai Health System
Y. Joseph Woo, Stanford University, Stanford Hospital
Surgeons: David H. Adams, Mount Sinai Health System
Ahmed Mahmoud El-Eshmawi, Mount Sinai Health System
Panelists: Rebecca T. Hahn, Columbia University
Tirone E. David, University of Toronto, Toronto General Hospital
Randolph P. Martin, Emroy University
Gilles D. Dreyfus, Paris University Pierre et Marie Curie, Institut Montsouris Paris France
Marc Gillinov, Cleveland Clinic
Y. Joseph Woo, Stanford University, Stanford Hospital

CARDIOTHORACIC SURGERY TRAINING AND CAREER DEVELOPMENT

Moderators: Craig J. Baker, *University of Southern California, Keck Hospital of USC*
Andrea J. Carpenter, *University of Texas Health Science Center, San Antonio, University Hospital*

LB4. The Thoracic Surgery Medical Student Association: Understanding the Needs of Medical Students Pursuing Cardiothoracic Surgery in the United States

Edgar Arsanda-Michel¹, Eleanor F. Gerhardt², Lena Trager³, Connor Magural⁴, Jason Han⁵, HelenMari L. Merritt-Genorel⁶, Jules Lin⁷, Elizabeth David⁸, Betty Tong⁹, Rishindra Reddy⁷, Marc Moon¹⁰, Ibrahim Sultan¹
¹University of Pittsburgh, Pittsburgh, PA; ²The George Washington University School of Medicine and Health Sciences, Washington, DC; ³University of Minnesota, Minneapolis, MN; ⁴Geisinger Commonwealth School of Medicine, Hershey, PA; ⁵Hospital of the University of Pennsylvania, Philadelphia, PA; ⁶Nebraska Methodist Health System, Omaha, NE; ⁷University of Michigan, Ann Arbor, MI; ⁸University of Southern California, Los Angeles, CA; ⁹Duke, Durham, NC; ¹⁰Washington University in St. Louis, St. Louis, MO

Invited Discussant: Abe DeAnda, Jr.

30. Traits of the Current Traditional-Track Cardiothoracic Surgery Training Pool: Results of a Cross-Sectional Study

Mara B. Antonoff¹, Nathaniel Deboever², Erin M. Corsini¹, Ara A. Vaporciyan¹
¹University of Texas MD Anderson Cancer Center, Houston, TX; ²University of Texas at Houston, Houston, TX

Invited Discussant: Timothy J. Gardner

31. The Utilization and Impact of Educational Resources Published by the Thoracic Surgery Residents Association

Alexander A. Brescia¹, Clauden Louis², Jessica G.Y. Luc³, Garrett N. Cohan⁴, Jason J. Han⁵, David Blitzer⁶, Fatima G. Wilder⁷, Curtis S. Bergquist¹, J. Hunter Mehaffey⁸
¹University of Michigan, Ann Arbor, MI; ²University of Rochester, Rochester, NY; ³University of British Columbia, Vancouver, BC, Canada; ⁴University of Pittsburgh Medical Center, Pittsburgh, PA; ⁵University of Pennsylvania, Philadelphia, PA; ⁶Columbia University, New York, NY; ⁷Johns Hopkins University, Baltimore, MD; ⁸University of Virginia, Charlottesville, VA

Invited Discussant: Craig J. Baker

App-Based Residency Tools

Edward M. Bender, *Stanford University, Good Samaritan Regional Medical Center*

32. A Systematic Review of the Quality of Abstracts Reporting on Randomized Controlled Trials Presented at Major International Cardiothoracic Conferences

Savannah Gysling¹, Amreen Khan², Edward J. Caruana³
¹University Hospitals of Derby and Burton, Derby, United Kingdom; ²Nottingham University Hospitals NHS Trust, Nottingham, United Kingdom; ³University Hospitals of Leicester NHS Trust, Leicester, United Kingdom

Invited Discussant: Richard D. Weisel

LB5. Characteristics in the Integrated Cardiothoracic Surgery Match: Trends in Positions, Gender, Race, and Qualifications Among Applicants When Compared with Those of Other Surgical Subspecialties

Lauren Bougioukas¹, Alyssa Heiser¹, Adrian Berg¹, Marek Polomsky², Chris Rokkas², Fuyuki Hirashima²
¹Larner College of Medicine at The University of Vermont, Burlington, VT; ²Department of Surgery, Division of Cardiothoracic Surgery, University of Vermont Medical Center, Burlington, VT

Invited Discussant: Ara A. Vaporciyan

33. Greater Publication Count and Research Impact During a National Institutes of Health R01 Funding Cycle Are Associated with Successful Grant Renewal Among Cardiothoracic Surgeons

Hanjay Wang, Simar S. Bajaj, Joseph C. Heiler, Aravind Krishnan, Kiah M. Williams, Y. Joseph Woo, Jack H. Boyd
Stanford University, Palo Alto, CA

Invited Discussant: Frank W. Sellke

INTERNATIONAL CORONARY CONGRESS 1: The Evolving Evidence Base for CABG and Arterial Grafting in 2021

Moderators: John D. Puskas, *Icahn School of Medicine at Mount Sinai, Mount Sinai Morningside (St. Luke's)*
Marc R. Moon, *Washington University School of Medicine/ Division of CT, Barnes Jewish Hospital*
Panelists: Joseph F. Sabik, III, *University Hospital Cleveland Medical Center*
Marc Ruel, *University of Ottawa, University of Ottawa Heart Institute*
David Glineur, *Ottawa University, Ottawa Heart Institute*
Faisal G. Bakaeen, *Cleveland Clinic*
Mario F.L. Gaudino, *Weill Cornell, NewYork-Presbyterian Hospital*
Sanghoon Jheon, *Seoul National University Hospital, Seoul National University Hospital Bundang*
Stephen E. Fremes, *University of Toronto, Sunnybrook*

The Rationale and Role of Coronary Surgery in 2020: What the Surgeon Needs to Know

Marc Ruel, *University of Ottawa, University of Ottawa Heart Institute*

Only CABG Prolongs Life and Prevents MI in Stable Coronary Artery Disease

Faisal G. Bakaeen, *Cleveland Clinic*

How to Improve Vein Graft Patency

Stephen E. Fremes, *University of Toronto, Sunnybrook*

The Evidence for BITA, Multiple and Total Arterial Grafting

David P. Taggart, *Oxford University, Oxford University Hospitals*

The Evidence for RA Grafting: When and When Not?
Mario F.L. Gaudino, *Weill Cornell, NewYork-Presbyterian Hospital*

Competitive Flow and Other Pitfalls to Avoid in Arterial Grafting
David Glineur, *Ottawa University, Ottawa Heart Institute*

PANEL DISCUSSION

ISCHEMIC CARDIOMYOPATHY

Moderators: Ahmet Kilic, *The Johns Hopkins Hospital*
Philippe Menasché, *University of Paris, Hopital Europeen Georges Pompidou*

34. Incidence and Predictors of Lethal Ventricular Arrhythmias Following Coronary Artery Bypass Grafting in Patients with Ischemic Cardiomyopathy
Masaro Nakae, Satoshi Kainuma, Koichi Toda, Shigeru Miyagawa, Daisuke Yoshioka, Takuji Kawamura, Ai Kawamura, Noriyuki Kashiya, Takayoshi Ueno, Toru Kuratani, Yoshiki Sawa
Osaka University Graduate of Medicine, Suita, Japan

Invited Discussant: William L. Holman

Clinical Utility of Stem Cell Sheet Technology
Yoshiki Sawa, *Osaka University Graduate School of Medicine, Osaka University Hospital*

Clinical Potential of Angiogenic and Cellular Reprogramming Therapies
Todd K. Rosengart, *Baylor College of Medicine, Baylor St. Luke's Medical Center*

35. Extracellular Vesicle Therapy Improves Diastolic Performance and Reduces Perivascular Fibrosis in a High Fat Fed Porcine Model of Chronic Myocardial Ischemia
Ahmed Mohamed Aboulgheit, Catherine Karbasiafshar, Laura A. Scrimgeour, Zhiqi Zhang, Guangbin Shi, Mohamed Sabra, Aja Tucker, Neil Sodha, M.Ruhul Abid, Frank W. Sellke
Rhode Island Hospital, Providence, RI

Invited Discussant: Pavan Atluri

Combined Revascularization, Mitral Repair, and Variable Ventricular Restraint will Supercede Cellular Therapies for Ischemic Cardiomyopathy
Frederick Y. Chen, *Tufts University School of Medicine, Tufts Medical Center*

LB6. Improved Survival Associated with Mitral Valve Annuloplasty over Replacement in Patients with Ischemic Heart Disease Undergoing Concomitant Coronary Artery Bypass Grafting
John J. Squiers, J. Michael Dimaio, Jasjit K. Banwait, Paul A. Grayburn, Michael J. Mack, Justin M. Schaffer

Baylor Scott & White The Heart Hospital, Plano, TX

Invited Discussant: Robert Michler

PANEL DISCUSSION

TRANSCATHETER MITRAL VALVE REPLACEMENT

Moderator: Volkmar Falk, *Charite Berlin, ETH Zürich, German Heartcenter Berlin*

Transseptal MV Replacement Devices
Pradeep Yavav, *Piedmont Heart Institute*

Transapical MV Replacement Devices
Vinod H. Thourani, *Piedmont Heart Institute*

36. Should Embolic Protection Devices Be Used in Transcatheter Mitral Valve-in-Valve Replacement?
Liza M. Rosenbloom, Alexander A. Brescia, Gorav Ailawadi, Steven F. Bolling, Matthew A. Romano
Frankel Cardiovascular Center, Ann Arbor, MI

Invited Discussant: Isaac George

Is There a Role for Ring Fracture in the Mitral Position?
Richard Lee, *Medical College of Georgia at Augusta University, Augusta University Medical Center*

Transcatheter Valve in Ring
Mayra E. Guerrero, *Mayo Clinic College of Medicine, Mayo Clinic Rochester*

Mitral Annular Calcification: Hybrid Transcatheter Options
Tom C. Nguyen, *University of California San Francisco*

PANEL DISCUSSION

12:45PM–1:00PM	BREAK
1:00PM–1:50PM	LUNCH
1:50PM–2:05PM	BREAK

ADULT CARDIAC Simultaneous Scientific Sessions

AORTIC SYMPOSIUM 3: Dissection

Moderator: Joseph E. Bavaria, *University of Pennsylvania, Hospital of the University of Pennsylvania*

Panelists: Steven L. Lansman, *New York Medical College, Westchester Medical Center*
Himanshu J. Patel, *Michigan Medicine*
Bradley G. Leshnower, *Emory University Hospital*
S. Chris Malaisrie, *Northwestern University, Northwestern Memorial Hospital*
Nimesh D. Desai, *University of Pennsylvania, Hospital of the University of Pennsylvania*
D. Craig Miller, *Stanford University, Stanford University Medical Center*
Yutaka Okita, *Kobe University, Takatsuki General Hospital*

45. Aortic Septotomy to Optimize Landing Zones During Thoracic Endovascular Aortic Repair for Chronic Type B Aortic Dissection: Results and Clinical Implications

Shinichi Fukuhara¹, Chan Tran N. Nguyen¹, Himanshu J. Patel¹, David Williams¹, Xhorlina Marko¹, Minhaj Khaja², Bo Yang¹, Karen M. Kim¹

¹University of Michigan, Ann Arbor, MI; ²University of Virginia, Charlottesville, VA

46. Early Results of TEVAR for the Management of Acute Uncomplicated Type B Aortic Dissection

Xiaoying Lou, Edward P. Chen, Yazan Duwayri, William D. Jordan, Bradley G. Leshnower
Emory University, Atlanta, GA

47. Early and Long Term Outcomes of Type A Acute Aortic Dissection with Common Carotid Artery Involvement

Taishi Inoue, Atsushi Omura, Kenji Okada
Kobe University, Kobe, Japan

48. Aortic Root and Valve Management During Acute Type A Aortic Syndromes

Parth Mukund Patel¹, Andy Dong¹, Edward Chiou¹, Jane Wei², Jose Binongo², Bradley G. Leshnower¹, Edward P. Chen¹

¹Emory University School of Medicine, Atlanta, GA; ²Rollins School of Public Health, Atlanta, GA

49. Acute Ascending Aortic Dissection As a Complication of Transfemoral Transcatheter Aortic Valve Replacement

Julie W. Doberne, Adam Z. Banks, J. Kevin Harrison, Adam R. Williams, Jeffrey Gaca, G. Chad Hughes, Ryan Plichta
Duke University Hospital, Durham, NC

HOW I DO IT VIDEO: Dissection

Eric E. Roselli, *Cleveland Clinic*

MITRAL CONCLAVE LIVE CASE: Session 2

Mitral Valve Repair from OR 25 at Mount Sinai

Moderators: Anelechi C. Anyanwu, *Mount Sinai Health System*
Marc R. Moon, *Washington University School of Medicine/ Division of CT, Barnes Jewish Hospital*

Surgeons: David H. Adams, *Mount Sinai Health System*
Percy Boateng, *Mount Sinai Health System*

Panelists: Tirone E. David, *University of Toronto, Toronto General Hospital*
Gilles D. Dreyfus, *Paris University Pierre et Marie Curie, Institut Montsouris Paris France*
Marc Gillinov, *Cleveland Clinic*
Randolph P. Martin, *Emory University*
Marc A. Miller, *Mount Sinai Health System*

INTERNATIONAL CORONARY CONGRESS 2: Complex Techniques in Surgical Coronary Revascularization

Moderator: David P. Taggart, *Oxford University, Oxford University Hospitals*

Management of Diffuse CAD, Including Coronary Endarterectomy and Stentectomy for Full Metal Jacket

Shuichiro Takanashi, *International University of Health and Welfare, Kawasaki Saiwai Hospital*

Coronary Surgery in Women: How Can We Improve Outcomes?

Jennifer S. Lawton, *Johns Hopkins*

OPCAB: Surgical Principles

John D. Puskas, *Icahn School of Medicine at Mount Sinai, Mount Sinai Morningside (St. Luke's)*

Anaortic OPCAB: Why, When and How?

Michael Vallely, *Ohio State University*

Robotic MIDCAB, TECAB and Hybrid Coronary Revascularization

Husam H. Balkhy, *University of Chicago Medicine, University of Chicago Medical Center*

CABG and Concomitant Ablation of Atrial Fibrillation

Marc Gillinov, *Cleveland Clinic*

PANEL DISCUSSION

Closing Remarks & Announcement of ICC 2021

John D. Puskas, *Icahn School of Medicine at Mount Sinai, Mount Sinai Morningside (St. Luke's)*

David P. Taggart, *Oxford University, Oxford University Hospitals*

MECHANICAL CIRCULATORY SUPPORT 1

Moderators: Pavan Atluri, *University of Pennsylvania, Hospital of the University of Pennsylvania*
Jan Schmitto, *Hannover Medical School*

The New Cardiopulmonary Arrest and Resuscitation Guidelines

Joel Dunning, *Teeside University, James Cook University Hospital*

Minimally Invasive LVAD Implantation Tips

William Hiesinger, *Stanford University, Stanford Medical Center*

Impact of LV Unloading During Cardiac Surgery on Low EF Patients

Daniel Goldstein, *Albert Einstein College of Medicine, Montefiore Medical Center*

Adjunctive Mesenchymal Stem Cell Therapy During LVAD

Terrence M. Yau, *University of Toronto, Toronto General Hospital, University Health Network*

50. Contemporary Outcomes Following Total Artificial Heart Implantation As Bridge to Transplant in the United States

Shinobu Itagaki, Nana Toyoda, Erick Sun, Timothy Lee, Percy Boateng, Donna Mancini, David H. Adams, Anelechi C. Anyanwu
Mount Sinai Hospital, New York, NY

Invited Discussant: Danny Ramzy

Heartmate 6 Is the New TAH

Mani A. Daneshmand, *Emory University, Emory University Hospital*

PANEL DISCUSSION

MITRAL ANNULOPLASTY RING DESIGN AND SELECTION

Moderators: Thierry G. Mesana, *University of Ottawa, University of Ottawa Heart Institute*
Eugene A. Grossi, *NYU*

Flexible Bands Are All You Need

Spencer J. Melby, *Washington University in St. Louis, Barnes Jewish Hospital*

Complete Semi-Rigid Is Best

Taweesak Chotivatanapong, *Central Chest Institute of Thailand*

Rigid Posterior Band Always Works

Aubrey C. Galloway, *NYU School of Medicine, NYU Langone Health*

Integrated Neochord Tying Adjunctive Guide

Song Wan, *The Chinese University of Hong Kong, Prince of Wales Hospital, Hong Kong*

Docking Station for Future TMVR-in-Ring

Vinayak N. Bapat, *Abbott Northwestern Hospital*

51. First in Man Experience with the Physio Flex Mitral Annuloplasty Ring

Ahmed El-Eshmawi, Erick Sun, Percy Boateng, Chartaroon Rimsukcharoenchai, Dimosthenis Pandis, Anelechi Anyanwu, David H. Adams
Mount Sinai Medical Center, New York, NY

Invited Discussant: Steven F. Bolling

LB9. Impact of Extra-Cardiac Support of the Cardiac Base Impacts on Functional Mitral Regurgitation and Left Ventricular Size

Jaishankar Raman¹, Chandrashekar Padmanabhan², Richard Saldanha³, Marek A. Deja⁴, Jan Hraelishka⁵, Radim Brot⁶, Vivek Rao⁷, Milind Hote⁸, Erwan Salaun⁹, Jeremy Bernard⁹, Philippe Pibarot⁹

¹University of Melbourne, Melbourne, Australia; ²GKNM Hospital, Coimbatore, India; ³KLE Hospital, Belagavi, India; ⁴Independent Public Clinical Hospital No. 7 of the Medical University of Silesia in Katowice, Katowice, Poland; ⁵Clinic for Heart, Thoracic Diseases, University of Frankfurt, Frankfurt, Germany; ⁶University Hospital Ostrava, Ostrava, Czech Republic; ⁷University of Toronto Hospital, Toronto, ON, Canada; ⁸All India Institute of Medical Sciences, New Delhi, India; ⁹Quebec Heart and Lung Institute, Quebec, QC, Canada

Invited Discussant: Fredrick Y. Chen

PANEL DISCUSSION

TRANSCATHETER AORTIC VALVE REPLACEMENT/SAVR 1

Moderators: Vinod H. Thourani, *Piedmont Heart Institute*
Hersh Maniar, *Washington University School of Medicine, Barnes Jewish Hospital*

Deep Dive on the Low Risk Trials

Martin B. Leon, *Columbia University Medical Center, NewYork-Presbyterian*

Are the Low Risk TAVR versus SAVR Trials Comparing Apples and Oranges

Eugene H. Blackstone, *Cleveland Clinic*

TAVR in Aortic Regurgitation: Outcomes and Implications for Surgeons

Torsten Peter Vahl, *Columbia University, NewYork-Presbyterian Hospital*

52. Did Ethno-Racial Disparities in Access to Transcatheter Aortic Valve Replacement Change Over Time?

Brian D. Cohen¹, Nathan Aminpour², Haijun Wang³, Waddah B. Al-Refaie⁴, Afshin Ehsan⁵
¹MedStar Georgetown/Washington Hospital Center, Washington, DC; ²Georgetown University, Washington, DC; ³MedStar Health Research Institute, Hyattsville, MD; ⁴MedStar Georgetown University Hospital, Washington, DC; ⁵Brown University Medical School/Rhode Island Hospital, Providence, RI

Invited Discussant: Danny Chu

SAVR+CABG versus TAVR+PCI

Ko Bando, *The Jikei University School of Medicine, Jikei University Hospital*

Incidence and Outcomes of Thrombus on Transcatheter and Surgical Valves: Is HALT Real?

Susheel Kodali, *Columbia University, NewYork-Presbyterian Hospital*

TAVR in Bicuspid Patients: Appropriate Use or Foolish?

Alan Zajarias, *Washington University, Barnes Jewish Hospital*

3:50PM–4:05PM

BREAK

ADULT CARDIAC Simultaneous Scientific Sessions

AORTIC SYMPOSIUM 4: Descending/Thoracoabdominal

- Moderator:** Joseph S. Coselli, Baylor College of Medicine, Baylor St. Luke's Medical Center Hospital
- Panelist:** Anthony L. Estrera, McGovern Medical School at UT Health, Memorial Hermann Heart and Vascular Institute
- Maral Ouzounian, University of Toronto, Toronto General Hospital
- Scott A. LeMaire, Baylor College of Medicine, Baylor St. Luke's Medical Center
- Christian D. Etz, University of Leipzig, Heart Center Leipzig
- Ourania Preventza, Baylor College of Medicine, Houston, Texas Heart Institute, Baylor St. Luke's Medical Center
- Wilson Y. Szeto, University of Pennsylvania, University of Pennsylvania Medical Center
- Lars G. Svensson, Heart, Vascular, and Thoracic Institute, Cleveland Clinic

57. Endovascular Treatment of Penetrating Atherosclerotic Ulcers of the Arch and Thoracic Aorta: A Contemporary 20-Years Experience

Giacomo Murana, Luca Di Marco, Mariafrancesca Fiorentino, Luigi Lovato, Gregorio Gliozzi, Francesco Buia, Alessandro Leone, Davide Pacini
S. Orsola Hospital, Bologna, Italy

58. Elephant Trunk Simplifies Extent I and II Thoracoabdominal Aortic Aneurysm Repair Without Impacting Operative Risk

Erin M. Iannacone, N. Bryce Robinson, Mohamed Rahouma, Katia Audisio, Giovanni Soletti, Christopher Lau, Mario Gaudino, Leonard N. Girardi
NewYork-Presbyterian, New York, NY

59. Early Results of Dissection Petticoat Stents for Acute and Chronic Residual Type B Aortic Dissection

Patrick R. Vargo, Christopher L. Tarola, Christopher Smollock, Francis Caputo, Eric E. Roselli
Cleveland Clinic, Cleveland, OH

60. Early and Late Outcomes of Surgical Treatment of Mycotic Aortic Aneurysm and Pseudoaneurysm: A 30-Year Experience

William C. Frankel, Waleed Ageedi, Susan Y. Green, Hiruni S. Amarasekara, Vicente Orozco-Sevilla, Ourania Preventza, Scott A. LeMaire, Joseph S. Coselli
Baylor College of Medicine, Houston, TX

61. Tailored Treatment Modality in Acute Type A Intramural Hematoma: The Importance of Aortopathy in Descending Aorta As a Clue to Find Origin of Acute Type A Intramural Hematoma

Myeong Su Kim¹, Ha Lee¹, Tae-Hoon Kim¹, Suk-Won Song¹, Kyung-Jong Yoo², Byung-Chul Chang³, Bum-Koo Cho⁴

¹Department of Thoracic and Cardiovascular Surgery, Gangnam Severance Hospital, Yonsei University College of Medicine, Seoul, Republic of Korea; ²Department of Thoracic and Cardiovascular Surgery, Cardiovascular Hospital, Severance Hospital, Yonsei University College of Medicine, Seoul, Republic of Korea; ³CHA Bundang Medical Center, CHA University College of Medicine, Seongnam, Republic of Korea; ⁴The Korean Heart Foundation, Seoul, Republic of Korea

HOW I DO IT VIDEO: Descending/Thoracoabdominal

Leonard N. Girardi, Weill Cornell Medicine

MITRAL CONCLAVE INTERACTIVE VIDEO: Session 2

Video Case Presentation

- Moderators:** David H. Adams, Mount Sinai Health System
Anelechi C. Anyanwu, Mount Sinai Health System
- Panelists:** Gorav Ailawadi, University of Virginia
Vinay Badhwar, West Virginia University
Khalil Fattouch, Policlinco University
Ahmed Mahmoud El-Eshmawi, Mount Sinai Health System

AATS/ACC/AHA/SCAI/STS 2020 VALVE GUIDELINES MAJOR PRACTICE IMPACTS

- Moderators:** Rick A. Nishimura, Mayo Clinic
Y. Joseph Woo, Stanford University, Stanford Hospital

The Evolving Impact of Valvular Disease Systems of Care and Heart Teams

Patrick T. O'Gara, Harvard University Medical School, Brigham and Women's Hospital

Aortic Stenosis Therapy Timing and Intervention Choice Guidelines

Rick A. Nishimura, Mayo Clinic

Valve Prosthesis Choices in AVR and MVR

Thoralf M. Sundt, III, Harvard University, Massachusetts General Hospital

Mitral Regurgitation Therapy Timing and Intervention Choice Guidelines

Blase Carabello, East Carolina, Vidant Medical Center

Recommended Approaches to Atrial Fibrillation Management

Thoralf M. Sundt, III, Harvard University, Massachusetts General Hospital

PANEL DISCUSSION

MECHANICAL CIRCULATORY SUPPORT 2

Moderators: Kenneth K. Liao, *Baylor College of Medicine, Baylor CHI St. Luke's Medical Center*
John Stulak, *Mayo Clinic*

Bacteriophage Therapy for VAD Infection

Evgenij V. Potapov, *Charite, DHZB*

Patient Selection: Predicting When the Right Ventricle Will Pose a Major Problem

Akinobu Itoh, *Washington University, Barnes and Jewish Hospital*

RV Dysfunction Is Best Managed with TAH

Nahush A. Mokadam, *The Ohio State University Wexner Medical Center*

Can CardioMems Be Used to Guide VAD Flow Optimization

Jeff Teuteberg, *Stanford*

PANEL DISCUSSION

TRANSCATHETER AORTIC VALVE REPLACEMENT/SAVR 2

Moderator: Michael J. Reardon, *Cornell, Houston Methodist Hospital*

SAVR and TAVR Economics in the USA

Joseph E. Bavaria, *University of Pennsylvania, Hospital of the University of Pennsylvania*

Amyloid Aortic Stenosis

Andrew Kates, *Washington University*

TAVR Valves Allowing Cusp Alignment

Gilbert H.L. Tang, *Icahn School of Medicine at Mount Sinai, Mount Sinai Health System*

TAVR Valve-in-Valve: Future Implications for the Surgeon

Samir Kapadia, *Cleveland Clinic Foundation*

62. Widening Volume and Persistent Outcome Disparity in Valve Operations: New York Statewide Analysis 2005–2016

Michael Shang, Makoto Mori, Geliang Gan, Yanhong Deng, Cornell Brooks, II, Gabe Weininger, Aminah Sallam, Prashanth Vallabhajosyula, Arnar Geirsson
Yale University, New Haven, CT

Invited Discussant: Frederick Y. Chen

CV3. Infected TAVR with Severe Invasion, Atrial Fistula, Mitral Extension, and Embolization Treated with Modified Hemi-Commando Homograft

Eric E. Roselli, Gosta Pettersson
Cleveland Clinic, Cleveland, OH

PANEL DISCUSSION

FRIDAY MORNING, APRIL 30, 2021

9:00AM–10:45AM

CONGENITAL Simultaneous Scientific Sessions

BENCH TO BEDSIDE: TRANSLATIONAL DISCOVERIES

Moderators: David Kalfa, *Columbia University, NYP-CHONY*
Peter J. Gruber, *Yale University, Yale New Haven Hospital*

Integrating Novel Physiologic Data in Decision Making in Congenital Heart Surgery

Osami Honjo, *The Hospital for Sick Children*

14. Contact Factors As a Potential Therapeutic Target in the Management of Extracorporeal Membrane Oxygenation: Results from In Vitro and In Vivo Experiments

Mousa Kharnaf¹, Leah Rosenfeldt¹, Duaa Mureb¹, Alexey Revenko², Brett Monia³, Karthik Thangappan¹, Kyle Riggs¹, Farhan Zafar¹, Joseph Palumbo¹, James Tweddell¹
¹Cincinnati Children's Hospital Medical Center, Cincinnati, OH; ²Ionis Pharmaceuticals, Inc., Carlsbad, CA

Invited Discussant: David M. McMullan

15. Cyclosporin A Preserves Multimer Assembly Following Neonatal Myocyte Arrest Using Del Nido Cardioplegia

Bartholomew V. Simon, II, Michael F. Swartz, Gisela Beutner, Robin Westcott, Jeff Wyatt, Karen L. Jones, Shuichi Yoshitake, George M. Alfieri, George A. Porter, Jr.
University of Rochester, Rochester, NY

Invited Discussant: Sachin Talwar

Stem Cell Therapy for Single Ventricle

Sunjay Kaushal, Ann & Robert H. Lurie Children's Hospital of Chicago

16. A Biomimetic Patch Designed for Heart Valve Repair Displays a Better Anisotropy and Tensile, Flexural, and Anti-Tearing Properties Compared to Commercial Patches

Mingze Sun¹, Lei Shi², Giovanni Ferrari¹, Emile Bacha³, Kristin Myers², David Kalfa^{1,3}
¹Department of Surgery and Biomedical Engineering, Columbia University Medical Center, New York, NY; ²Department of Mechanical Engineering, Columbia University, New York, NY; ³Division of Cardiac, Thoracic and Vascular Surgery, Section of Pediatric and Congenital Cardiac Surgery, New-York-Presbyterian Morgan Stanley Children's Hospital, Columbia University Medical Center, New York, NY

Invited Discussant: William M. DeCampi

LB2. Donor Fraction Cell-Free DNA and Rejection in Pediatric and Adult Heart Transplantation

Marc E. Richmond¹, Shriprasad R. Deshpande², Steven D. Zangwill³, David P. Bichell⁴, Steven J. Kindel⁵, Jacob N. Schroder⁶, Mark A. Wigger⁴, Kenneth R. Knecht⁷, Elfrieda Pahl⁸, Nunzio A. Gaglianella⁹, William T. Mahle¹⁰, Huan ling Liang⁹, Pippa M. Simpson⁵, Mahua Dasgupta⁵, Liyun Zhang⁶, Paula E. North⁵, Aoy Tomita Mitchell¹¹, Michael E. Mitchell¹²
¹Columbia University, New York, NY; ²Children’s National Hospital, Washington, DC; ³Phoenix Children’s Hospital, Phoenix, AZ; ⁴Vanderbilt University, Nashville, TN; ⁵Children’s Hospital of Wisconsin, Medical College of Wisconsin, Milwaukee, WI; ⁶Duke University, Durham, NC; ⁷Arkansas Children’s Hospital, Little Rock, AR; ⁸Lurie Children’s Hospital, Chicago, IL; ⁹Medical College of Wisconsin, Milwaukee, WI; ¹⁰Emory University, Children’s Healthcare of Atlanta, Atlanta, GA; ¹¹Herma Heart Institute, Medical College of Wisconsin, Milwaukee, WI; ¹²Herma Heart Institute, Children’s Hospital of Wisconsin, Medical College of Wisconsin, Milwaukee, WI

Invited Discussant: Dilip Nath

LB3. Composite Analysis of Nuclear and Mitochondrial Cell Free DNA Predicts Death After Infant Cardiac Surgery

John (Jake) P. Scott¹, Justinn Tanem¹, Aoy T. Mitchell¹, George M. Hoffman¹, Karl Stamm², Pippa Simpson¹, Rob A. Niebler¹, Paula North¹, Huan-Ling Liang², Michael E. Mitchell¹
¹Children’s Wisconsin, Medical College of Wisconsin, Milwaukee, WI; ²Medical College of Wisconsin, Milwaukee, WI

Invited Discussant: TBD

HEART FAILURE/MECHANICAL SUPPORT

Moderators: Mark D. Rodefeld, *Indiana University, Riley Children’s*
Francis Fynn-Thompson, *Harvard Medical School,*
Boston Children’s Hospital

Mechanical Support for the Failing Single Ventricle Prior to Fontan
Iki Adachi, *Baylor College of Medicine, Texas Children’s Hospital*

17. The Outdated Practice of Using Oversized Organs for Recipients with Elevated PVR

Karthik Thangappan, Farhan Zafar, Russel Hirsch, Clifford Chin, David Lehenbauer, Alan ODonnell, James S. Tweddell, David L.S. Morales
Cincinnati Children’s Hospital Medical Center, Cincinnati, OH
Invited Discussant: Bahaaldin Alsoufi

Mechanical Support for the Failing Single Ventricle After Fontan Palliation
David L. Morales, *University of Cincinnati, Cincinnati Children’s Hospital*

18. Heart-Kidney Listing Is Better Than Isolated Heart Listing for Pediatric Heart Transplant Candidates with Significant Renal Insufficiency

Alia Dani, Nina Price, Karthik Thangappan, Thomas D. Ryan, David Hooper, David S. Cooper, David G. Lehenbauer, Clifford Chin, Farhan Zafar, David L.S. Morales
Cincinnati Children’s Hospital Medical Center, Cincinnati, OH
Invited Discussant: Osami Honjo

Mechanical Circulatory Support for the Failing Systemic Right Ventricle in Adults

Edward Hickey, *Texas Children’s Hospital*

19. Multicenter US Experience with Trans-Septal Left Atrial VAD Cannulation Technique for Small Left Ventricles in the Pediatric Population

Katsuhide Maeda¹, Iki Adachi², Ming-Sing Si³, David M. Peng³, Teimour Nasirov¹, Michael Ma¹, David N. Rosenthal¹, Chris S. Almond¹, John C. Dykes¹
¹Stanford University, Stanford, CA; ²Texas Heart Institute, Texas, TX; ³University of Michigan, Ann Arbor, MI

Invited Discussant: Ronald K. Woods

13. Low Parental Socioeconomic Position Results in Longer Post-Norwood Length of Stay

Zachary A. Spigel, Alyssa B. Kalustian, Jessica A. Zink, Ziyad M. Binsalamah, Christopher A. Caldarone
Texas Children’s Hospital, Houston, TX

Invited Discussant: Tara B. Karamlou

10:45AM–11:00AM **BREAK**

FRIDAY MORNING, APRIL 30, 2021

11:00AM–12:45PM

CONGENITAL
Simultaneous Scientific Sessions

CHALLENGES IN SINGLE VENTRICLE PHYSIOLOGY

Moderators: Harold M. Burkhart, *University of Oklahoma, OUMC*
Kirk R. Kanter, *Emory University, Children’s Healthcare of Atlanta at Egleston*

37. Combined Norwood and Cavopulmonary Shunt As the First Palliation in Late Presenters with Hypoplastic Left Heart Syndrome and Its Variants
Osman O. Al-Radi^{1,2}, Ahmed Elmahrouk², Mohamed Ismail³, Amr Arafat³, Ahmed Domain¹, Jameel Al-Ata^{1,2}, Mohamed Shihata², Ahmed Jamjoom²
¹King Abdulaziz University, Jeddah, Saudi Arabia; ²King Faisal Specialist Hospital and Research Center – Jeddah, Jeddah, Saudi Arabia; ³Tanta University, Tanta, Egypt

Invited Discussant: Christopher E. Mascio

Criteria for BiV Conversion in Fontan
Ram Kumar Subramanyan, *University of Southern California, Children’s Hospital, Los Angeles*

38. Outcomes of Risk-Adjusted Decision Making Using the Hybrid Strategy in Neonates with Ductal Dependent Systemic Circulation and Multiple Risk Factors

Nicolle M. Ceneri, Aybala Tongut, Manan H. Desai, Syed M. Burkhari, Karthik Ramakrishnan, Mahmut Ozturk, Syed M. Peer, Mary T. Donofrio, Gil Wernovsky, Joshua Kanter, Richard A. Jonas, Pranava Sinha, Can Yerebakan

Children's National Hospital, The George Washington University School of Medicine and Health Sciences, Washington, DC

Invited Discussant: Mark E. Galantowicz

39. Inherent Risk of Non-Cardiac and Secondary Cardiac Diagnoses Associated with Stage 1 Palliation for Hypoplastic Left Heart Syndrome—How Bad Is It?

Emily R. Backes¹, Natasha S. Afonso¹, Danielle Guffey¹, James S. Tweddell², Sarah Tabbutt³, Nancy A. Rudd⁴, Ginny O'Harrow⁴, Silvana M. Molossi¹, George M. Hoffman⁴, Garick D. Hill², Jeffrey S. Heinle¹, Priya Bhat¹, Jeffrey B. Anderson², Nancy S. Ghanayem^{1,5}

¹Baylor College of Medicine and Texas Children's Hospital, Houston, TX; ²Cincinnati Children's Hospital Medical Center, Cincinnati, OH; ³University of California San Francisco and Benioff Children's Hospital, San Francisco, CA; ⁴Medical College of Wisconsin and Children's Hospital of Wisconsin, Milwaukee, WI; ⁵University of Chicago and Comer Children's Hospital, Chicago, IL

Invited Discussant: Aaron Eckhauser

Coronary Anomalies in Single Ventricle Patients—When to Offer Single Ventricle Palliation

James S. Tweddell, *University of Cincinnati, Cincinnati Children's Hospital Medical Center*

40. Stage 2 Palliation After Ductal Stenting for Ductal Dependent Pulmonary Blood Flow

Srujan Ganta¹, John Artrip^{1,2}, Jessica Haley^{1,2}, Rohit Rao^{1,2}, Tara Karamlou³, Shylah Haldeman¹, Ratnayaka Kanishka^{1,2}, John Moore^{1,2}, Howaida EL-Said^{1,2}, John J. Nigro^{1,2}

¹Rady Children's Hospital, San Diego, CA; ²UC San Diego School of Medicine, San Diego, CA; ³Cleveland Clinic, Cleveland, OH

Invited Discussant: Andrew Glatz

12:45PM–1:00PM BREAK

1:00PM–1:50PM LUNCH

1:50PM–2:05PM BREAK

FRIDAY AFTERNOON, APRIL 30, 2021
2:05PM–3:50PM

CONGENITAL
Simultaneous Scientific Sessions

CLINICAL CHALLENGES IN CHD

Moderators: David M. Overman, *Mayo Medical School, Children's Minnesota*
Kristine J. Guleserian, *HCA Healthcare, Medical City Children's Hospital*

Borderline HLHS: When to Abandon Bi-Ventricle Conversion

Sitaram M. Emani, *Harvard Medical School, Boston Children's Hospital*

CV2. Intraoperative Conduction Mapping in Complex Congenital Heart Surgery

Eric N. Feins, Edward O'Leary, David Hoganson, Noah Schulz, Emily Eickhoff, John K. Friedman, Pedro J. del Nido, Elizabeth DeWitt, Sitaram Emani
Boston Children's Hospital, Boston, MA

Invited Discussant: Carl L. Backer

53. Early Cyanosis After Bidirectional Cavopulmonary Shunt in Patients with Functional Single Ventricle: Etiology, Outcome, and Risk Factors

Caecilia Euringer, Takashi Kido, Janez Vodiskar, Martina Strbad, Melchior Burri, Bettina Ruf, Julie Cleuziou, Alfred Hager, Peter Ewert, Jürgen Hörer, Masamichi Ono
German Heart Center Munich, Munich, Germany

Invited Discussant: Osami Honjo

54. Incidence, Diagnosis and Natural History of Vocal Cord Palsy After Congenital Cardiac Surgery: A Prospective Implementation Study

Louise A. Kenny^{1,2}, Amy McIntosh¹, Karen Jardine¹, Jessica Suna³, Kathryn Versluis¹, Mary Wilson¹, Greg Merlo⁴, Tristan Reddan^{1,5}, Robert Justo¹, Jennifer Powell^{1,6}, Nicola Slee¹, Prem Venugopal^{1,7}, Nelson Alphonso^{1,8}

¹Queensland Children's Hospital, Brisbane, Australia; ²School of Clinical Medicine, University of Queensland, Brisbane, Australia; ³School of Clinical Medicine, Children's Health Queensland Clinical Unit, University of Queensland, Brisbane, Australia; ⁴Primary Care Clinical Unit, University of Queensland, Brisbane, Australia; ⁵School of Clinical Sciences, Faculty of Health, Queensland University of Technology, Brisbane, Australia; ⁶University of Queensland, Brisbane, Australia; ⁷School of Clinical Medicine, Children's Health Queensland Clinical Unit, University of Queensland, Brisbane, Australia; ⁸School of Clinical Medicine, Children's Health Queensland Clinical Unit, University of Queensland, Brisbane, Australia

Invited Discussant: Christian Pizarro

55. Re-Operation After Vascular Ring Repair to Correct Symptomatic Airway Compression and Tracheobronchomalacia

Daniel F. Labuz, Ali Kamran, Russell W. Jennings, Christopher W. Baird
Boston Children's Hospital, Boston, MA

Invited Discussant: Roosevelt Bryant, III

56. Potts Shunt As an Effective Palliation for Patients with End-Stage Pulmonary Arterial Hypertension
Smruti Ranjan Mohanty, Prashant Bobhate, Tanuja Karande, Kamlesh Tailor, Hari Bipin Radhakrishnan, Simran Kundan, Harsh Seth, Shankar Kadam, Keyoor Bhavsar, Nilesh Bohra, Snehal Kulkarni, Suresh Rao
Kokilaben Dhirubhai Ambani Hospital, Mumbai, India
Invited Discussant: Emre Belli

LB10. Status of Women in Congenital Cardiac Surgery—Results from a National Survey
Raina Sinha¹, Katherine W. Herbst¹, Jennifer Romano²
¹Connecticut Children’s Medical Center, Hartford, CT; ²C.S. Mott Children’s Hospital, Ann Arbor, MI
Invited Discussant: Karla Christian
3:50PM–4:05PM **BREAK**

FRIDAY AFTERNOON, APRIL 30, 2021
4:05PM–5:50PM

CONGENITAL Simultaneous Scientific Sessions
COMPLEX HEART DISEASES IN NEONATES AND INFANTS
Moderators: Richard G. Ohye, *University of Michigan, C.S. Mott Children’s Hospital*
James M. Hammel, *University of Nebraska Medical Center, Children’s Hospital & Medical Center*

DEBATE: Replacement of the Mitral Valve Under One Year of Age
Mechanical Valves Should Be Used
James S. Tweddell, *University of Cincinnati, Cincinnati Children’s Hospital Medical Center*
Mechanical Valves Should Not Be Used
Yves d’Udekem, *Georges Washington University, Children’s National Hospital*

CV4. En-Bloc Double Root Translocation in Transposition of the Great Arteries with Pulmonary Valve Stenosis
Karthik Thangappan, Alan ODonnell, Awais Ashfaq, Ryan Moore, Nicholas Szugye, David L.S. Morales, James S. Tweddell
Cincinnati Children’s Hospital Medical Center, Cincinnati, OH
Invited Discussant: Victor Morell

63. Fontan Palliation in 159 Patients with Heterotaxy Syndrome: A Five Decade Experience
Gabriel Graham, Elizabeth H. Stephens, Joseph A. Dearani, Frank Cetta, Jr., Naiz Talha
Mayo, Rochester, MN
Invited Discussant: J. William Gaynor

64. Cardiovascular Surgical Outcomes of Patients with Heterotaxy Syndrome and Predictors of Mortality in the Current Era
Nicolle M. Ceneri¹, Manan H. Desai¹, Steven J. Staffa², David Zurakowski², Zaenab Dhari¹, David Schidlow², Pranava Sinha¹, Richard A. Jonas¹, Can Yerebakan¹
¹Children’s National Hospital, The George Washington University School of Medicine and Health Sciences, Washington, DC; ²Boston Children’s Hospital, Harvard Medical School, Boston, MA
Invited Discussant: Joseph A. Dearani

65. Pulmonary Atresia with Intact Ventricular Septum (PAIVS): Intervention Strategy and Long-Term Outcomes
Amrita Sukhvasi, Sara McHugh-Grant, Andrew Glatz, Antara Mondal, Heather Griffis, Nancy Burnham, J. William Gaynor, Christopher E. Mascio, Jonathan Chen, Thomas L. Spray, Stephanie M. Fuller
Children’s Hospital of Philadelphia, Philadelphia, PA
Invited Discussant: Richard Mainwaring

LB12. Cardiac Surgery in Children with Trisomy 13 or Trisomy 18—How Safe Is It?
Kirk R. Kanter, Fawwaz Shaw, Subhadra Shashidharan, Joshua Rosenblum, Paul Chai
Emory University, Atlanta, GA
Invited Discussant: Pirooze Eghtesady

FRIDAY MORNING, APRIL 30, 2021
9:00AM–10:45AM

MULTI-SPECIALTY Simultaneous Scientific Sessions
C. WALTON LILLEHEI FORUM
Moderators: Nahush A. Mokadam, *The Ohio State University Wexner Medical Center*
Arjun Pennathur, *University of Pittsburgh Medical Center*

L1. Correlation Between Aortic Valve Protein Expression and Vector Flow Mapping of Wall Shear Stress and Oscillatory Shear Index in Patients Supported with Continuous-Flow Left Ventricular Assist Devices
Serge S. Kobsa¹, Koichi Akiyama², Samantha K. Nemeth¹, Paul A. Kurlansky¹, Yoshifumi Naka¹, Koji Takeda¹, Hiroo Takayama¹
¹Columbia University Medical Center, New York, NY; ²Yodogawa Christian Hospital, Osaka, Japan
Invited Discussant: Gabriel Loor

L2. Toll-Like Receptor 4 Mediates Reflux-Induced Inflammatory Responses in a Murine Reflux Model
Anna K. Gergen, Michael J. Jarrett, Keval R. Tilva, Helen J. Madsen, Anqi Li, Xianzhong Meng, David A. Fullerton, Michael J. Weyant
University of Colorado Anschutz Medical Campus, Denver, CO
Invited Discussant: David T. Cooke

L3. Association of BAP1 Expression with Immune Microenvironment in Malignant Pleural Mesothelioma
Benjamin J. Wadowski¹, David T. Severson¹, Yin P. Hung², Lucian R. Chiriac¹, William G. Richards¹, Raphael Bueno¹, Assunta De Rienzo¹
¹Brigham and Women's Hospital, Boston, MA; ²Massachusetts General Hospital, Boston, MA
Invited Discussant: Bryan M. Burt

L4. Cardioprotective Effects of Glucagon-Like Peptide-1 Analogue Exenatide on the Donation After Circulatory Death Heart Model in Juvenile Pigs
Sachiko Kadowaki¹, Ahsan Siraj², Weidan Chen¹, Jian Wang¹, Kyle Runeckles³, Steve Fan³, Christoph Haller¹, Mansoor Husain², Osami Honjo¹
¹The Hospital for Sick Children, Toronto, ON, Canada; ²Toronto General Hospital, Toronto, ON, Canada; ³University of Toronto, Toronto, ON, Canada
Invited Discussant: Ashish Shah

L5. Heart-Derived Extracellular Vesicles Activate Regulatory T Cells and Attenuate Experimental Autoimmune Myocarditis
Akbarshakh Akhmerov, Geoffrey de Couto, Jackelyn Valle, Liang Li, Russell Rogers, Ahmed Ibrahim, Lizbeth Sanchez, Rui Zhang, Yen-Nien Lin, Weixin Liu, Eduardo Marbán
Cedars-Sinai Medical Center, Los Angeles, CA
Invited Discussant: Ram Kumar Subramanyan

L6. Rodent Survival Model of Cardiopulmonary Bypass Demonstrates Systemic and Organ-Specific Inflammation
Aimee Y. Zhang, Nathan S. Haywood, Dustin T. Money, Matthew R. Byler, Hari P. Osuru, William Z. Chancellor, Jared P. Beller, Victor E. Laubach, J. Hunter Mehaffey, Mark E. Roeser, Jennifer R. Charlton, Nadia Lunardi, Irving L. Kron, Nicholas R. Teman
University of Virginia Medical Center, Charlottesville, VA
Invited Discussant: Ravi K. Ghanta

L7. Recellularization of Xenograft Heart Valves Reduces the Xenoreactive Immune Response in an In-Vivo Rat Model
Sabin J. Bozzo, Ryaan EL-Andari, Lin Fu Zhu, Benjamin Adam, Michael C. Moon, Darren H. Freed, Jayan Nagendran, Jeevan Nagendran
University of Alberta, Edmonton, AB, Canada
Invited Discussant: Sunjay Kashual

12:45PM–1:00PM **BREAK**
1:00PM–1:50PM **LUNCH**
1:50PM–2:05PM **BREAK**

**MULTI-SPECIALTY
Simultaneous Scientific Sessions**
CARDIOTHORACIC CAREERS COLLEGE 1: Early Career
Moderators: Douglas E. Wood, *University of Washington*
Amy Fiedler, *University of Wisconsin, UW Health Hospital and Clinics*

Introduction
Joanna Chikwe, *UCLA, Cedars-Sinai*
How to Maximize Your Educational Experience in the OR
Aaron Weiss, *Cleveland Clinic*
Why and How to Choose a Super-Fellowship
Heidi Reich, *Central California Heart and Lung Surgery*

DEBATE: Rapid Fire
Early Niche (Pro)
Tom C. Nguyen, *University of California San Francisco*
Early Niche (Con)
Andrew Brownlee, *Stanford University, Stanford Hospital and Clinics*
Veterans Affairs Healthcare System Palo Alto

PANEL DISCUSSION
Essential Tips for a Successful Job Search
Elizabeth H. Stephens, *Mayo Clinic*
How Do You Evaluate a New Job?
Andrew B. Goldstone, *University of Pennsylvania, Hospital of the University of Pennsylvania*
How to Negotiate
Thomas K. Varghese, Jr., *University of Utah, Huntsman Cancer Institute*

PANEL DISCUSSION
How Do You Build a Practice?
Ismail El-Hamamsy, *Icahn School of Medicine at Mount Sinai, Mount Sinai Hospital*
How Do You Deal with a Bad Outcome?
TBD
Effective Use of Social and Online Media
Amy Fiedler, *University of Wisconsin, UW Health Hospital and Clinics*
PANEL DISCUSSION
When Is the Right Time for a Family?
Jennifer S. Lawton, *Johns Hopkins*

DEBATE: Rapid Fire

Why Private Practice?

Vinod H. Thourani, *Piedmont Heart Institute*

Why Academic Practice?

Douglas E. Wood, *University of Washington*

PANEL DISCUSSION

PATIENT SAFETY IN THE OPERATING ROOM

Moderator: Thoralf M. Sundt, III, *Harvard University, Massachusetts General Hospital*

Leadership Behaviors That Improve Performance of the Team

Sarah Henrickson Parker, *Virginia Tech, Carilion Clinic*

Unconscious Bias and Communications in the OR

Leah Backhus, *Stanford University, Stanford Hospital and Clinics/Veterans Affairs Healthcare System Palo Alto*

What Is Unique to Pediatric Practice and Broadly Acceptable Across Cardiac and Thoracic Surgery?

Robert D.B. Jaquiss, *UT Southwestern Medical Center, Children's Medical Center*

Three Things I Have Learned in the NIH Study

Francis D. Pagani, *University of Michigan, Michigan Medicine – University of Michigan*

What Do Cardiac Surgeons Need to Know About the World of Perfusion to Make Them Better Communicators?

Kenneth Shann, *Massachusetts General Hospital*

Ether and the Environment: Patient Safety from the Other Side of the Drape

James H. Abernathy, III, *Johns Hopkins University, Johns Hopkins*

PANEL DISCUSSION

3:50PM–4:05PM

BREAK

FRIDAY AFTERNOON, APRIL 30, 2021

4:05PM–5:50PM

MULTI-SPECIALTY Simultaneous Scientific Sessions

CARDIOTHORACIC CAREERS COLLEGE 2

Moderators: Lauren C. Kane, *LCMC Health, Children's Hospital New Orleans*
Ashish Shah, *Vanderbilt University, Vanderbilt University Medical Center*

How Do I Get Promoted?

Joanna Chikwe, *UCLA, Cedars-Sinai*

How Do I Get Resources to Start Research?

Asishana A. Osho, *Harvard Medical School, Massachusetts General Hospital*

How Do I Teach Effectively in the OR?

Thoralf M. Sundt, III, *Harvard University, Massachusetts General Hospital*

PANEL DISCUSSION

How Search Committees Work

Todd K. Rosengart, *Baylor College of Medicine, Baylor St. Luke's Medical Center*

DEBATE: Rapid Fire

Early Chief Job (Pro)

Shanda H. Blackmon, *Mayo Clinic*

Early Chief Job (Con)

Leonard N. Girardi, *Weill Cornell Medicine*

PANEL DISCUSSION

How Do You Deal with Burnout?

David A. Fullerton, *University of Colorado, University of Colorado Hospital*

How Do You Deal with Bias?

David Tom Cooke, *UC Davis, UC Davis Medical Center*

How Do You Deal with a Bully?

Lauren C. Kane, *LCMC Health, Children's Hospital New Orleans*

PANEL DISCUSSION

Getting on Podiums, Trials and Editorial Boards

Gorav Ailawadi, *University of Michigan*

How Do I Start a Start-Up?

James S. Gammie, *University of Maryland Medical Center*

How Do I Get My Research Funded?

Yolonda L. Colson, *Massachusetts General Hospital*

PANEL DISCUSSION

FRIDAY MORNING, APRIL 30, 2021

9:00AM–10:45AM

PERIOPERATIVE CARE Simultaneous Scientific Sessions

SPECIFIC TARGETS FOR ERAS

Moderators: Daniel T. Engelman, *University of Massachusetts, Baystate Medical Center*
George Justison, *University of Colorado*

Prophylaxis and Prevention of Postoperative Atrial Fibrillation 5

J. Mauricio Del Rio, *Duke University School of Medicine*

Perfusion Related Approaches to Blood Conservation

David C. Fitzgerald, *MUSC*

Reducing Wound Infections in High-Risk Patients

V. Seenu Reddy, *Centennial TriStar*

Novel Multi-Modal Opioid-Sparing Approaches to Postoperative Pain Relief

Michael C. Grant, *Johns Hopkins University, Johns Hopkins Medical Institutions*

Brain Recovery and Reducing Postoperative Delirium

Charles Brown, *Johns Hopkins University School of Medicine, Johns Hopkins*

It Takes a Village: Early Postoperative Mobilization

Kelly Codispodi, *University of Manitoba, St. Boniface Hospital*

10:45AM–11:00AM

BREAK

FRIDAY MORNING, APRIL 30, 2021

11:00AM–12:45PM

PERIOPERATIVE CARE Simultaneous Scientific Sessions

THE IMPLEMENTATION OF ERAS

Moderators: Thomas M. Beaver, *University of Florida College of Medicine, Shands*
HelenMari Merritt Genore, *University of Nebraska Medical Center, Methodist Health Systems*

Adapting ERAS to the Pandemic

Alexander J. Gregory, *University of Calgary, Foothills Medical Centre*

Intra and Perioperative Prevention of Air Leaks

Stephen R. Broderick, *Johns Hopkins University School of Medicine*

Avoiding Pitfalls

Amanda Eilers, *UTSCSA*

Can We Integrate the ERAS Movement to the Adult Cardiac Databases?

TBD

LB7. Enhanced Recovery After Cardiac Surgery Protocol Significantly Reduces Postoperative Opioid Use

Chelsea M. Loria, Zainab Faiza, Kirsten Zborek, Matthew P. Anderson, James B. Millward, Cynthia M. Richardson, Niharika Namburi, Lava R. Timsina, Lawrence S. Lee
Indiana University School of Medicine, Indianapolis, IN

Invited Discussant: Michael C. Grant

LB8. Effects of Pulmonary Rehabilitation Based ERAS Program (PREP) on Postoperative Pulmonary Complications in Patients Undergoing Lung Cancer Surgery: Primary Results from the Phase III Multicenter Randomized Controlled Clinical Trial

Yu Zheng¹, Mao Mao¹, Fang Li², Lu Wang¹, Xintong Zhang¹, Xiu Zhang¹, Haiming Wang³, Huiqing Zhou⁴, Meifang Ji⁵, Yulong Wang⁶, Liang Liu⁷, Jan D. Reinhardt⁸, Quan Zhu², Xiao Lu¹
¹Department of Rehabilitation Medicine, the First Affiliated Hospital of Nanjing Medical University, Nanjing, China; ²Department of Thoracic Surgery, the First Affiliated Hospital of Nanjing Medical University, Nanjing, China; ³Department of Rehabilitation Medicine, the First Affiliated Hospital of Zhengzhou University, Zhengzhou, China; ⁴Department of Rehabilitation Therapy, Taizhou Enze Medical Center, Enze Hospital, Taizhou, China; ⁵Department of Rehabilitation Therapy, the Second Affiliated Hospital of Hainan Medical University, Haikou, China; ⁶Department of Rehabilitation Medicine, Shenzhen Dapeng New District Nan'ao People's Hospital, Shenzhen, China; ⁷Department of Rehabilitation Medicine, Nanjing Drum Tower Hospital, the Affiliated Hospital of Nanjing University Medical School, Nanjing, China; ⁸Institute for Disaster Management and Reconstruction of Sichuan University and Hong Kong Polytechnic University, Chengdu, China

Invited Discussant: Amanda Eilers

DEBATE: ERAS

Is It Worth It? (Pro)

Kenton J. Zehr, *Wayne State University, DMC Heart Hospital*

Is It Worth It? (Con)

Daniel T. Engelman, *University of Massachusetts, Baystate Medical Center*

12:45PM–1:00PM

BREAK

1:00PM–1:50PM

LUNCH

1:50PM–2:05PM

BREAK

FRIDAY AFTERNOON, APRIL 30, 2021

2:05PM–3:50PM

PERIOPERATIVE CARE Simultaneous Scientific Sessions

TOP ABSTRACTS

Moderators: Percy Boateng, *Icahn School of Medicine at Mount Sinai, Mount Sinai Medical Center, New York*

Andra E. Duncan, *Cleveland Clinic Lerner College of Medicine, Cleveland Clinic*

66. Optimization of an Established Enhanced Recovery After Thoracic Surgery Protocol: Aiming for Schedule II Opioid-Free Pain Control Following Robotic Surgery

Karishma Kodia, Joanne Szewczyk, Joy Stephens-McDonnough, Nestor R. Villamizar, Dao M. Nguyen

University of Miami, Miami, FL

Invited Discussant: Linda W. Martin

67. Intermediate Term Functional Outcomes After Extracorporeal Membrane Oxygenation (ECMO)

Heather Rossong

University of Manitoba, Winnipeg, MB, Canada

Invited Discussant: HelenMari Merritt Genore

68. Five-Minutes Bleeding Counting to Prevent Postcardiotomy Resternotomy

Shingo Kunioka, Hideki Isa, Masahiko Narita, Ryo Okubo, Keisuke Shibagaki, Daisuke Takeyoshi, Yuta Kikuchi, Wakabayashi Naohiro, Tomonori Shirasaka, Natsuya Ishikawa, Hiroyuki Kamiya

Asahikawa Medical University, Asahikawa, Japan

Invited Discussant: Victor A. Ferraris

69. Ambulatory Chest Drainage with Advanced Nurse Practitioner-Led Follow-Up Facilitates Early Discharge Following Thoracic Surgery

Oliver J. Harrison, Victoria Schoeman, Justin Pahelga, Charlotte Bartlett, Xiaohui Liu, Vicki Richardson, Maria Elena Vilar-Alvarez, Abdul Badran, Alessandro P. Tamburrini, Khalid M. Amer, Aiman Alzetani

University Hospital Southampton, Southampton, United Kingdom

Invited Discussant: Stephen C. Yang

70. Early Trends of Extracorporeal Membrane Oxygenation Mortality Among Vulnerable Populations May Have Predicted the Beginning of the COVID-19 Pandemic

J.W. Awori Hayanga, Jeffrey Jacobs, Heather Kaiser Hayanga, Paul McCarthy, Benjamin Reed, Kalee Vincent, Vinay Badhwar

West Virginia University, Morgantown, WV

Invited Discussant: Tom C. Nguyen

71. Diagnosing Sepsis After Cardiac Surgery: The Predictive Validity of the Systemic Inflammatory Response Syndrome, Quick Sepsis Related Organ Failure Assessment and New Early Warning Scores

Savannah Gysling¹, Selvaraj Shanmuganathan², Adam Szafraneck², Edward J. Caruana³

¹University Hospitals of Derby and Burton, Derby, United Kingdom; ²Nottingham University Hospitals NHS Trust, Nottingham, United Kingdom; ³University Hospitals of Leicester NHS Trust, Leicester, United Kingdom

Invited Discussant: Keki Balsara

3:50PM–4:05PM

BREAK

FRIDAY AFTERNOON, APRIL 30, 2021

4:05PM–5:50PM

PERIOPERATIVE CARE Simultaneous Scientific Sessions

PATIENT SAFETY, TEAMWORK, AND QUALITY

Moderator: Bo Soo Kim, *Johns Hopkins University*

Team Members Roles in the CVICU

Rakesh C. Arora, *University of Manitoba, St. Boniface Hospital*

An Implementation Science Approach to Handoff

Tracy R. Geoffrion, *University of Texas Southwestern Medical Center*

How Do You Assess High-Performing Teams in the CVICU?

Marco A. Zenati, *Harvard Medical School, U.S. Department of Veterans Affairs, Veterans Affairs Boston Healthcare System*

Automating the Bedside Sitter in 2021

Marijana Zubrinic, *University of Toronto, Toronto General Hospital*

DEBATE

Night-Time Consultants/Intensivist in the CVICU (Pro)

Jay G. Shake, *University of Mississippi, University of Mississippi Medical Center*

Night-Time Consultants/Intensivist in the CVICU (Con)

Ken Shelton, *Harvard Medical School, Massachusetts General Hospital*

FRIDAY MORNING, APRIL 30, 2021

9:00AM–10:45AM

GENERAL THORACIC Simultaneous Scientific Sessions

LUNG CANCER 1

Moderators: Betty C. Tong, *Duke University, Duke University Medical Center*
Benjamin D. Kozower, *Washington University St. Louis, Barnes-Jewish Hospital*
Boris Sepesi, *MD Anderson Cancer Center*

Anatomic Variations in Lung Surgery

Dominique Gossot, *Paris V, IMM*

20. Lymph Node Assessment During Segmentectomy for Stage I Non-Small Cell Lung Cancer in the National Society of Thoracic Surgery Database: A Propensity Score Adjusted Comparison of the Robotic-, Vats and Open Approach

Peter J. Kneuert^z, Desmond M. D'Souza, Jing Zhao, Mahmoud Abdel-Rasoul, Susan D. Moffatt-Bruce, Robert E. Merritt
The Ohio State University, Columbus, OH

Invited Discussant: Daniel P. Raymond

DEBATE T1-A NSCLC: Wedge versus Segmentectomy

Alan D.L. Sihoe, *Gleneagles Hong Kong Hospital*
Nasser K. Altorki, *Weill Cornell Medicine, NewYork-Presbyterian*

21. Relationship Between Delayed Surgery and Oncologic Outcomes in Clinical Stage I Non-Small Cell Lung Cancer

Brendan T. Heiden¹, Daniel B. Eaton², Su-Hsin Chang^{1,2}, Yan Yan^{1,2}, Bryan F. Meyers¹, Benjamin D. Kozower¹, Varun Puri^{1,2}, Kathryn E. Engelhardt¹

¹Washington University School of Medicine, St. Louis, MO; ²VA St. Louis Health Care System, St. Louis, MO

Invited Discussant: Michael Lanuti

22. Reconsidering the AJCC 8th Edition TNM Classifications for T2b/T3 Non-Small Cell Lung Cancer

Arvind Kumar¹, Shivee Gilja¹, Alexandra Potter², Vignesh Raman³, Ashok Muniappan⁴, Douglas Liou⁵, Chi-fu Jeffrey Yang⁴

¹Icahn School of Medicine at Mt. Sinai, New York, NY; ²University of California, Berkeley, CA; ³Duke University Medical Center, Durham, NC; ⁴Massachusetts General Hospital, Boston, MA; ⁵Stanford University Medical Center, Stanford, CA

Invited Discussant: Frank C. Detterbeck

23. Statin Use Is Associated with Reduced Recurrence of Early-Stage NSCLC Treated by Lobectomy Only in Overweight/Obese Patients

Santosh Patnaik, Cara Petrucci, Eric Kannisto, Sai Yendamuri
Roswell Park Comprehensive Cancer Center, Buffalo, NY

Invited Discussant: Dennis Wigle

24. A Risk Model to Predict the Ability to Start Adjuvant Chemotherapy Following Lung Resection in Patients with Pathologically Positive Lymph Nodes

Miriam Patella¹, Alessandro Brunelli², Laura Adams³, Stefano Cafarotti¹, Lorena Costardi⁴, Paul De Leyn⁵, Herbert Decaluwé⁶, Marta Fuentes⁶, Marcelo Jimenez⁶, Sunanda Karri⁷, Johnny Moons⁵, Pierluigi Novellis⁸, Enrico Ruffini⁴, Yaron Shargall⁷, Giulia Veronesi⁸, Emanuele Voulaz⁸, Kevin Franks³

¹San Giovanni Hospital, Bellinzona, Switzerland; ²St. James's University Hospital, Leeds, United Kingdom; ³St. James's Institute of Oncology, Leeds, United Kingdom; ⁴University of Torino, Città della Salute e della Scienza, Torino, Italy; ⁵University Hospitals Leuven, Leuven, Belgium; ⁶Salamanca University Hospital, Salamanca, Spain; ⁷McMaster University, St. Joseph's Healthcare Hamilton, Hamilton, ON, Canada; ⁸Humanitas Clinical and Research Center, Milano, Italy

Invited Discussant: Mara B. Antonoff

Definition and Assessment of High-Risk Patients Considered for Lobectomy for Stage I Non-Small Cell Lung Cancer

Scott J. Swanson, *Brigham and Women's Hospital*

10:45AM–11:00AM

BREAK

FRIDAY MORNING, APRIL 30, 2021

11:00AM–12:45PM

GENERAL THORACIC Simultaneous Scientific Sessions

OTHER THORACIC MALIGNANCIES

Moderators: Chadrick E. Denlinger, *Indiana University*
Raphael Bueno, *Harvard Medical School, Brigham and Women's*

41. Outcomes of Pleurectomy Decortication in Biphasic Mesothelioma

Moshe Lapidot¹, Emanuele Mazzola², Raphael Bueno¹

¹Brigham and Women's Hospital, Harvard Medical School, Boston, MA; ²Dana Farber Cancer Institute, Boston, MA

Invited Discussant: Olaf Mercier

DEBATE: EPP versus PD

Raja M. Flores, *Mount Sinai School of Medicine, Mount Sinai Hospital*
Marc de Perrot, *University of Toronto, Toronto General Hospital*

42. The (Facilitates Chromatin Transcription) Complex Is a Novel Therapeutic Target in Mesothelioma

Anand Singh, Roma Pahwa, Nathanael Pruett, Shivani Dixit, David S. Schrupp, Chuong D. Hoang

National Cancer Institute – NIH, Bethesda, MD

Invited Discussant: Matthew J. Bott

43. A Randomized Trial of Neoadjuvant PD-L1 versus PD-L1 Plus CTLA-4 Blockade in Patients with Malignant Pleural Mesothelioma

Bryan Burt, Maheshwari Ramineni, Hee-Jin Jang, Daniela Ramos, Taylor Splawn, Monica Espinoza, Michelle Almarez, R. Taylor Ripley, Daniel Y. Wang, Hyun-Sung Lee

Baylor College of Medicine, Houston, TX

Invited Discussant: Harvey I. Pass

44. PET/CT Effectively Differentiates Resectable Thymoma from Anterior Mediastinal Lymphoma

Catherine T. Byrd, Winston L. Trope, Prasha Bhandari, Harrison B. Konsker, Natalie S. Lui, Douglas Liou, Leah M. Backhus, Mark F. Berry, Joseph B. Shrager

Stanford University School of Medicine, Stanford, CA

Invited Discussant: James Huang

CV1. Thymectomy with Angioplasty Through Subxiphoid Approach with Double Elevation of the Sternum in Masaoka III Stage Thymoma

Xing Wang, Tongkai Xu, Jiang Fan

Shanghai Pulmonary Hospital, Shanghai, China

Invited Discussant: Kenneth A. Kesler

Robotic Resection of Mediastinal Castleman’s Disease After Induction Therapy

Monisha Sudarshan, Cleveland Clinic

12:45PM–1:00PM	BREAK
1:00PM–1:50PM	LUNCH
1:50PM–2:05PM	BREAK

FRIDAY AFTERNOON, APRIL 30, 2021
2:05PM–3:50PM

**GENERAL THORACIC
Simultaneous Scientific Sessions**

SURGICAL COMPLICATIONS: Avoidance and Management

Moderators: Sandra L. Starnes, University of Cincinnati College of Medicine, University of Cincinnati Medical Center
Diego Gonzalez Rivas, Tongji University, Shanghai Pulmonary Hospital

Space Management and Intraoperative Air Leak
Sebastien Gilbert, University of Ottawa, The Ottawa Hospital

IntraOperative Gastric Conduit Assessment

Rishindra M. Reddy, University of Michigan

Late Gastric Conduit Dysfunction

Bryan F. Meyers, Washington Univeristy in St. Louis, Barnes Jewish Hospital

How to Avoid Bleeding in Lung Resection

Varun Puri, Washington University School of Medicine, Barnes-Jewish Hospital

LB11. Joint 2021 European Society of Thoracic Surgeons (ESTS) and American Association for Thoracic Surgeons (AATS) Guidelines for the Prevention of Cancer-Associated Venous Thromboembolism in Thoracic Surgery

Virginia R. Litle¹, Yaron Shargall², Alessandro Brunelli³, Sudish C. Murthy⁴, Wayne L. Hofstetter⁵, Jules Lin⁶, Hui Li⁷, Lori A. Linkins², James D. Douketis², Marc Crowther², Gian Paolo Morgano², Finn Schunemann⁸, Giovanna Muti-Schunemann², Holger J. Schunemann², Wojtek Wiercioch²
¹Boston Medical Center, Boston, MA; ²McMaster University, Hamilton, ON, Canada; ³St. James University Hospital, Leeds, United Kingdom; ⁴Cleveland Clinic, Cleveland, OH; ⁵MD Anderson, Houston, TX; ⁶University of Michigan, Ann Arbor, MI; ⁷Capital Medical University, Beijing, China; ⁸Albert-Ludwigs-Universitat Freiburg, Freiburg, Germany

Invited Discussant: Shanda H. Blackmon

PANEL DISCUSSION

3:50PM–4:05PM **BREAK**

FRIDAY AFTERNOON, APRIL 30, 2021
4:05PM–5:50PM

**GENERAL THORACIC
Simultaneous Scientific Sessions**

HOW I DO IT VIDEOS

Moderators: Robert B. Cameron, UCLA, Ronald Reagan UCLA Medical Center
Scott J. Swanson, Harvard Medical School, Brigham and Women’s Hospital

Endoscopic Management for an Anastomotic Leak

Richard K. Freeman, Loyola University/Stritch School of Medicine, Loyola University Medical Center

72. Initiative Double Sleeve Lobectomy Is Superior in Left Upper Lobe Non-Small Cell Lung Cancer Patients with Severe Main Bronchus Invasion

Honglei Xu, Xing Wang, Jiang Fan
Shanghai Pulmonary Hospital, Shanghai, China

Invited Discussant: Enrico A. Rendina

73. A New Sealing Test Method Using Indocyanine Green Aerosol

Naoya Yokota, Tetsuhiko Go, Noriyuki Misaki, Sung Soo Chang, Hiroyasu Yokomise
Kagawa University, Miki-cho, Kita-gun, Kagawa, Japan

Invited Discussant: Jules Lin

MIE Anastomosis

Inderpal S. Sarkaria, *University of Pittsburgh School of Medicine, University Pittsburgh Medical Center*

Robotic Tracheal Resection with VV ECMO

Sudish C. Murthy, *Case Western Reserve, Cleveland Clinic*
Robert James Cerfolio, *NYU Langone Health, NYU Langone Health*

Minimally Invasive Esophagectomy—The Beijing Way

Ke-Neng Chen, *Peking University, Beijing Cancer Hospital*

CV5. Right Transthoracic Approach for the Robotic Left Main Stem Bronchus Sleeve Resection

Facundo Iriarte, Stacey Su, Roman Petrov, Abbas El-Sayed Abbas
Fox Chase Cancer Center, Philadelphia, PA

Invited Discussant: Harmik J. Soukiasian

CV6. Robotic Repair of Redundant Conduit and Para-Conduit Hernias Following Esophagectomy

Ammara A. Watkins¹, Cameron T. Stock², Syed M. Quadri³, Elliot L. Servais³
¹*Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, MA;*
²*Lahey Hospital Medical Center, Tufts Medical School, Burlington, MA;* ³*Lahey Health Medical Center, Tufts Medical School, Burlington, MA*

Invited Discussant: Robert E. Merritt

PANEL DISCUSSION

SATURDAY MORNING, MAY 1, 2021

9:00AM–10:45AM

ADULT CARDIAC Simultaneous Scientific Sessions

aMAZEing ATRIAL FIBRILLATION SURGERY

Moderators:

Harold G. Roberts, Jr., *West Virginia University, J.W. Ruby Memorial Hospital*
James Cox, *Northwestern University, Bluhm Cardiovascular Institute Northwestern Memorial Hospital*

Hybrid VATS Maze

Anson M. Lee, *Stanford University, Stanford Hospital*

A Perfect Mitral Repair Will Usually Resolve Paroxysmal Afib

Michael Argenziano, *Columbia University, NewYork-Presbyterian/Columbia*

Cox Maze IV: What Lesions and Why?

Ralph J. Damiano, Jr., *Washington University School of Medicine, Barnes Jewish Hospital*

Is a Full Cox Maze IV Necessary?

Patrick M. McCarthy, *Northwestern University, Northwestern Memorial Hospital*

74. Predictors of Recurrent Atrial Fibrillation After Surgical Ablation

Charles F. Laurin¹, Emilia Bagiella², A. Marc Gillinov³, Samantha Raymond², Annetine C. Gelijns², Alan J. Moskowitz², Wendy Taddei-Peters⁴, Patrick T. O’Gara⁵, Eugene Blackstone³, Michael Argenziano⁶, Pierre Voisine¹

¹*Institut Universitaire de Cardiologie et de Pneumologie de Québec (IUCPQ), Québec, QC, Canada;* ²*Icahn School of Medicine at Mount Sinai, New York, NY;* ³*Cleveland Clinic, Cleveland, OH;* ⁴*National Heart, Lung, and Blood Institute, Bethesda, MD;* ⁵*Brigham and Women’s Hospital, Boston, MA;* ⁶*Columbia University Medical Center, New York, NY*

Invited Discussant: James Cox

75. The Long-Term Impact of Postoperative Atrial Fibrillation After Cardiac Surgery

Valentino J. Bianco, Arman Kilic, Derek Serna-Gallegos, Edgar Aranda-Michel, Yisi Wang, Forozan Navid, Ibrahim Sultan
University of Pittsburgh Medical Center, Pittsburgh, PA

Invited Discussant: James R. Edgerton

PANEL DISCUSSION

AORTIC ROOT AND ASCENDING AORTIC REPLACEMENT 1

Moderators: Maral Ouzounian, *University of Toronto, Toronto General Hospital*
Joseph S. Coselli, *Baylor College of Medicine, Baylor St. Luke's Medical Center Hospital*

Partial Sternotomy or Right Anterior Thoracotomy for Ascending Aortic and Arch Surgery

Eric E. Roselli, *CCLCM, Cleveland Clinic*

76. To Bentall, or Not to Bentall, That Is the Question

Busra Cangut, Kevin L. Greason, Vishal Khullar, Arman Arghami, Gabor Bagameri, Prasad Krishnan, Phillip Rowse, Juan A. Crestanello, Richard C. Daly, Joseph A. Dearani, Alberto Pochettino, John M. Stulak, Hartzell V. Schaff
Mayo Clinic, Rochester, MN

Invited Discussant: Mohamed Ezani Md Taib

Biovalved Aortic Root Conduits

Leonard N. Girardi, *Weill Cornell Medicine*

77. Open Proximal Aortic Aneurysm Repair in Contemporary Era

Tsuyoshi Yamabe¹, Yanling Zhao¹, Casidhe-Nicole R. Bethancourt², Christian A. Pearsall², Ilya Kim², Diane Hu², Joshua Bergsohn¹, Paul A. Kurlansky¹, Virendra Patel¹, Isaac George¹, Craig R. Smith¹, Hiroo Takayama¹

¹Columbia University Medical Center, New York, NY; ²Columbia University Vagelos College of Physicians and Surgeons, New York, NY

Invited Discussant: Maral Ouzounian

Aortic Root Surgery for the Marfan Patient—Special Considerations

Duke E. Cameron, *Harvard University, Massachusetts General Hospital*

78. Towards an Aortic Risk Calculator: Using Machine Learning to Predict Adverse Ascending Aortic Events

Nicolai P. Ostberg^{1,2}, Mohammad A. Zafar², Bulat A. Ziganshin², Sandip K. Mukherjee², Prashanth Vallabhajosyula², John A. Eleftheriades²

¹New York University Grossman School of Medicine, New York, NY; ²Yale University School of Medicine, New Haven, CT

Invited Discussant: Yuichi Ueda

PANEL DISCUSSION

CABG VERSUS PCI

Moderators: Timothy J. Gardner, *University of Pennsylvania, Hospital of University of Pennsylvania*
Roxana Mehran, *Icahn School of Medicine at Mount Sinai, Mount Sinai Hospital*

Can Wire FFR and Virtual FFR Guidance Help to Decide?

William Fearon, *Stanford University, Stanford*

LB13. Association Between Sternal Wound Complications and 10-Year Mortality Following Coronary Artery Bypass Grafting in the Arterial Revascularization Trial

Mario Gaudino¹, Katia Audisio¹, Mohamed Rahouma¹, N. Bryce Robinson¹, Giovanni Jr. Soletti¹, Gianmarco Cancelli¹, Stephen Gerry², Umberto Benedetto³, Marcus Flather⁴, David P. Taggart²

¹Weill Cornell, New York, NY; ²University of Oxford, Oxford, United Kingdom; ³University of Bristol, Bristol, United Kingdom; ⁴University of East Anglia, Norwich, United Kingdom

Invited Discussant: TBD

79. Real-World, Propensity-Matched Analysis of Surgical versus Percutaneous Revascularization for Left Main Coronary Disease

Lauren V. Huckaby, Ibrahim Sultan, Francis D. Ferdinand, Suresh Mulukutla, Saloni Kapoor, Floyd Thoma, Yisi Wang, Arman Kilic
University of Pittsburgh, Pittsburgh, PA

Invited Discussant: David Kandzari

PCI Treats Flow Limiting Lesions While CABG Provides “Surgical Collateralization”

Torsten Doenst, *Friedrich Schiller University Jena, Germany, Jena University Hospital, Jena, Germany*

Multivessel CAD PCI Is Superior to CABG

Roxana Mehran, *Icahn School of Medicine at Mount Sinai, Mount Sinai Hospital*

Multivessel CAD CABG Is Superior to PCI

David P. Taggart, *Oxford University, Oxford University Hospitals*

PANEL DISCUSSION

IN THE YOUNG PATIENT, OPTIMIZING TRANSCATHETER AND OPEN SURGERY THERAPEUTIC SEQUENCE TO REACH OLD AGE

Moderators: Patrick T. O’Gara, MD, *Harvard University Medical School, Brigham and Women’s Hospital*
Vinod H. Thourani, *Piedmont Heart Institute*

Aortic: SAVR Then TAVR Valve-in-Valve

Craig R. Smith, *Columbia University, Columbia University Irving Medical Center of NewYork-Presbyterian Hospital*

Aortic: TAVR Then SAVR

Martin B. Leon, *Columbia University Medical Center, NewYork-Presbyterian/Columbia University Medical Center*

Mitral: MVRr Then TMVR

Joanna Chikwe, *UCLA, Cedars-Sinai*

PANEL DISCUSSION

MECHANICAL CIRCULATORY SUPPORT 3

Moderators: Ranjit John, *University of Minnesota, University of Minnesota Hospital*
Anelechi C. Anyanwu, *Mount Sinai Medical Center*

Mitral and Aortic Valve Surgery During LVAD Implantation

Pavan Atluri, *University of Pennsylvania, Hospital of the University of Pennsylvania*

Innovations in Implant Technique

Jasmin S. Hanke, *Hannover Medical School*

Converting Among ECMO, Temporary BiVAD, and Permanent VADs

Bryan A. Whitson, *The Ohio State University, Ross Heart Hospital*

80. A Novell Intra-Pericardial Pulsatile Device for Individualized, Biventricular Circulatory Support Without Direct Blood Contact—The Impact of Electro-Mechanical Synchronization

Stephan W. Schueler¹, Christopher Bowles², Rabea Hinkel³, Johannes Fischer⁴, Robert Wohlfarth⁵, Stephen Wildhirt⁶, Hassiba Smail², Ulrich A. Stock²

¹Freeman Hospital, Newcastle, United Kingdom; ²Harefield Hospital, Harefield, United Kingdom; ³German Primate Center, Department of Laboratory Animal Science, Germany;

⁴Center of Preclinical Research, Technical University of Munich, Munich, Germany;

⁵Mechanics & High Performance Computing Group, Technical University of Munich, Munich, Germany; ⁶AdjuCor GmbH, Munich, Germany

Invited Discussant: David D. Yuh

PANEL DISCUSSION

PRIMARY MITRAL REGURGITATION REPAIR TECHNIQUES 1

Moderators: Tohru Asai, *Juntendo University, Juntendo University Hospital*
Alfredo Trento, *UCLA, Cedars-Sinai Medical Center*

Neochords Freehand Technique and Length Determination

Patrick Perier, *Herz und Gefass Klinik*

Neochords Preformed Loop Technique

Volkmar Falk, *Charite Berlin, ETH Zürich, German Heartcenter Berlin*

81. Biomechanical Engineering Analysis of Standard Interrupted, Running, and Loop Neochord Mitral Valve Repair Techniques

Mateo Marin-Cuartas^{1,2}, Annabel M. Imbrie-Moore^{1,3}, Yuanjia Zhu^{1,4}, Matthew H. Park^{1,3}, Robert Wilkerson¹, Michael A. Borger², Y. Joseph Woo^{1,4}

¹Department of Cardiothoracic Surgery, Stanford University, Stanford, CA; ²University Department of Cardiac Surgery, Leipzig Heart Center, Leipzig, Germany; ³Department of Mechanical Engineering, Stanford University, Stanford, CA; ⁴Department of Bioengineering, Stanford University, Stanford, CA

Invited Discussant: Matthew A. Romano

Automated Neochord Implantation Device

Thierry-Pierre Carrel, *University Zürich, University Hospital Zürich*

Transapical Edge Neochords

Andrea Colli, *University of Pisa, Italy, Azienda Ospedaliera-Universitaria Pisana*

PANEL DISCUSSION

10:45AM–11:00AM

BREAK

PRESIDENTIAL PLENARY

11:00AM–12:45PM

Moderator: David R. Jones, *Memorial Sloan Kettering*

A Conversation with Condoleezza Rice

Condoleezza Rice, *66th US Secretary of State*

Introduction of the 101st AATS President

Shaf Keshavjee, *University of Toronto, Toronto General Hospital*

PRESIDENTIAL ADDRESS: Is This an Adventure?

Marc R. Moon, *101st AATS President*

Washington University School of Medicine/Division of CT, Barnes Jewish Hospital

12:45PM–1:00PM

BREAK

1:00PM–1:50PM

LUNCH

1:50PM–2:05PM

BREAK

SATURDAY AFTERNOON, MAY 1, 2021

2:05PM–3:50PM

ADULT CARDIAC Simultaneous Scientific Sessions

AATS/WTS JOINT SESSION: Contemporary Valvular Disease Therapy

Moderators: Lauren C. Kane, *LCMC Health, Children's Hospital New Orleans*
Ourania Preventza, *Baylor College of Medicine, Houston,*
Texas Heart Institute, Baylor St. Luke's Medical Center

SPECIAL LECTURE

1:45PM–3:30PM

Guest Lecturer: Dipti Itchhaporia, *Jeffrey M. Carlton Heart & Vascular Institute*
Panelists: Steven F. Bolling, *University of Michigan, Michigan Medicine*
Marc R. Moon, *Washington University School of Medicine/*
Division of CT, Barnes Jewish Hospital

93. The Ross Procedure—10-Year Experience in 472 Consecutive Patients Using Contemporary Techniques

Ismail El-Hamamsy¹, Vincent Chauvette², Ismail Bouhout², Laurence Lefebvre², Raymond Cartier², Philippe Demers², Nancy Poirier²

¹Mount Sinai Hospital, New York, NY; ²Montreal Heart Institute, Montréal, QC, Canada

Invited Discussant: Emile A. Bacha

94. The Contemporary Status of Socioeconomic Based Disparities in Cardiac Surgery: Are We Closing the Disparities Gap?

Paige C. Newell¹, Sainath Asokan², Anagha Prasanna³, Sameer Hirji¹, Morgan Harloff¹, Edward Percy¹, Mariam Kerolos¹, Tsuyoshi Kaneko¹

¹Brigham and Women's Hospital, Boston, MA; ²Boston University School of Medicine, Boston, MA; ³Harvard Medical School, Boston, MA

Invited Discussant: Jennifer S. Lawton

95. Aortic Valve Reintervention After Transcatheter Aortic Valve Replacement: Repeat Transcatheter Therapy Is Not Guaranteed

Shinichi Fukuhara, Chan Tran N. Nguyen, George Michael Deeb, Karen M. Kim, Bo Yang, Gorav Ailawadi, Himanshu J. Patel

University of Michigan, Ann Arbor, MI

Invited Discussant: Elaine E. Tseng

96. Classic Surgical Risk Prediction Fails for Isolated Tricuspid Valve Surgery—What Is the Impact of Liver Dysfunction?

Gloria Faerber¹, Jonas Marx¹, Christoph Sponholz², Michael Bauer³, Sven Moebius-Winkler⁴, Torsten Doenst¹

¹Friedrich Schiller University Jena, University Hospital, Department of Cardiothoracic Surgery, Jena, Germany; ²Friedrich Schiller University Jena, University Hospital, Department of Anesthesiology and Critical Care Medicine, Jena, Germany; ³Friedrich-Schiller-University Jena, University Hospital, Department of Anesthesiology and Critical Care Medicine, Jena, Germany; ⁴Friedrich Schiller University Jena, University Hospital, Department of Internal Medicine I/Cardiology, Jena, Germany

Invited Discussant: David H. Adams

97. Long-Term Outcomes of Mitral and Concomitant Tricuspid Valve Repair for Degenerative Mitral Valve Prolapse

Percy Boateng, Shinobu Itagaki, Nana Toyoda, Ahmed E-Eshmawi, Anelechi Anyanwu, Hannah Adams, Jason Storch, Dimosthenis Pandis, David H. Adams

Icahn School of Medicine at Mount Sinai, New York, NY

Invited Discussant: Adanna Akujuo

AORTIC ROOT AND ASCENDING AORTIC REPLACEMENT 2

Moderators:

Munir Boodhwani, University of Ottawa Heart Institute,
Scott A. LeMaire, Baylor College of Medicine,
Baylor St. Luke's Medical Center

Marfan Considerations: Medical Aspects

Alan C. Braverman, Washington University School of Medicine, Barnes-Jewish Hospital

AVR Plus Ascending Aortic Replacement Is Sufficient and Optimal for BAV Aortopathy

John S. Ikonomidis, UNC at Chapel Hill, UNC Medical Center

Bentall BAV Root Replacement Is Needed to Avoid Future Root Dilatation

Abe DeAnda, Jr., UTMB-Galveston

98. Reoperations on the Ascending Aorta and Aortic Arch: A Retrospective Series of 479 Patients

Davide Pacini, Giacomo Murana, Gregorio Gliozzi, Daniela Votano, Alessandro Leone, Giulio Giovanni Cavalli, Antonio Loforte, Sofia Martin Suarez, Luca Di Marco

S. Orsola Hospital, Bologna, Italy

Invited Discussant: Ourania Preventza

99. Ex-Vivo Biaxial Load Testing Analysis of Aortic Biomechanics Demonstrates Variation in Energy Distribution Across Aortic Zone Zero: Early Results from the Matadors Trial

Emily Durbak¹, Emidio Germano¹, Frank Cikach¹, Callan Gillespie¹, Robert Borden², Samar Tarraf³, Benjamin Kramer¹, Kelly Emerton⁴, Jennifer Hargrave¹, Robb Colbrunn¹, Chiara Bellini³, Eugene Blackstone¹, Eric Roselli¹

¹Cleveland Clinic, Cleveland, OH; ²Stanford University, Stanford, CA; ³Northeastern University, Boston, MA; ⁴CryoLife, Inc., Cleveland, OH

Invited Discussant: Scott A. LeMaire

100. Single-Cell Analysis Reveals Paradoxical TGF-Beta Signaling and Increased Expression of Elastin-Associated Genes in the Aortic Wall That Is Specific to Ascending Aortic Aneurysms in Patients with Marfan Syndrome

Ashley Dawson¹, Yanming Li¹, Chen Zhang¹, Hernan Vasquez¹, Pingping Ren¹, Waleed Ageedi¹, Alon Azares², Aladdein Mattar¹, Hong S. Lu³, Lisa A. Cassis³, Joseph S. Coselli^{1,2}, Alan Daugherty³, Ying H. Shen^{1,2}, Scott A. LeMaire^{1,2}

¹Baylor College of Medicine, Houston, TX; ²Texas Heart Institute, Houston, TX;

³University of Kentucky, Lexington, KY

Invited Discussant: Thomas G. Gleason

PANEL DISCUSSION

AORTIC VALVE REPAIR TECHNIQUES

Moderators: Gébrine El Khoury, *UCL, Cliniques Universitaires St-Luc*
Edward P. Chen, *Duke University*

Cusp Repair Techniques in Bicuspid and Tricuspid Aortic Valves

Y. Joseph Woo, *Stanford University, Stanford Hospital*

Quantitative Assessment of Commisural Geometry and Cusp Fusion Guides Bicuspid Aortic Valve Repair

Laurent De Kerchove, *Université Catholique de Louvain (UCL), Cliniques Universitaires Saint-Luc*

Novel Suture Commissuroplasty and Commissural Elevation Techniques

Lars G. Svensson, *Heart, Vascular, and Thoracic Institute, Cleveland Clinic*

Aortic Suture and Ring Annuloplasty Techniques

Hans-Joachim Schäfers, *UKS Saarland, UKS Saarland*

Aortic Valve Repair Is Best Supported with Reimplantation Valve Sparing Aortic Root Replacement

Tirone E. David, *University of Toronto, Toronto General Hospital*

101. Predictors of Long-Term Stenosis in Bicuspid Aortic Valve Repair

Cristiano Spadaccio¹, Arnaud Henkens¹, Antonio Nenna², Stefano Mastrobuoni¹, Emiliano Navarra¹, Guillaume Lemaire¹, Alain Poncelet¹, David Vancraenest¹, Parla Astarci¹, Gebrine El Khoury¹, Laurent De Kerchove¹

¹Cliniques Universitaires Saint-Luc (UCLouvain), Bruxelles, Belgium; ²University Campus Bio-Medico of Rome, Rome, Italy

Invited Discussant: Emmanuel Lansac

PANEL DISCUSSION

CABG IS STILL ONE OF THE MOST COMMONLY PERFORMED MAJOR OPERATIONS IN THE USA

Moderators: Joseph F. Sabik, III, *University Hospital Cleveland Medical Center*
Mario F.L. Gaudino, *Weill Cornell, NewYork-Presbyterian Hospital*

Guidelines: CABG in Low EF

Faisal G. Bakaeen, *Cleveland Clinic*

CABG Is the More Appropriate Use Therapy in Most Scenarios

Jennifer S. Lawton, *Johns Hopkins*

LIMA and Two Veins Saves Many Lives

Craig R. Smith, *Columbia University, Columbia University Irving Medical Center of New York-Presbyterian Hospital*

Multiarterial Grafting Strategies

James Tatoulis, *University of Melbourne, Royal Melbourne Hospital*

102. Saphenous Vein versus Right Internal Thoracic Artery As a Y-Composite Graft: Ten-Year Angiographic and Long-Term Clinical Results of the SAVE RITA Trial

Ki-Bong Kim¹, Min-Seok Kim², Se Jin Oh³, Ho Young Hwang¹, Jun Sung Kim⁴

¹Seoul National University Hospital, Seoul, Republic of Korea; ²Severance Cardiovascular Hospital, Seoul, Republic of Korea; ³SMG-SNU Boramae Medical Center, Seoul, Republic of Korea; ⁴Seoul National University Bundang Hospital, Seongnam, Republic of Korea

Invited Discussant: Xin Chen

103. Secondary Prevention Medication with Statins and Major Adverse Events After Coronary Artery Bypass Grafting—A Population-Based Study from the Swedeheart Registry

Emily Pan¹, Susanne J. Nielsen^{2,3}, Ari Mennander⁴, Erik Björklund⁵, Andreas Martinsson⁶, Martin Lindgren⁶, Emma C. Hansson⁶, Aldina Pivodic^{3,7}, Anders Jeppsson⁶

¹Central Finland Central Hospital, Jyväskylä, Finland; ²Göteborg University, Gothenburg, Sweden; ³Sahlgrenska Academy, Gothenburg, Sweden; ⁴Tampere University Hospital, Tampere, Finland; ⁵South Alvsborg Hospital, Borås, Sweden; ⁶Sahlgrenska University Hospital, Gothenburg, Sweden; ⁷Statistiska Konsultgrupp, Gothenburg, Sweden

Invited Discussant: Paul Kurlansky

PANEL DISCUSSION

ECMO EVOLUTION

Moderators: Benjamin Sun, *Abbott Northwestern*
Alexander Iribarne, *Dartmouth College, Dartmouth-Hitchcock Medical Center*

104. Utilization of Extracorporeal Life Support Therapies at Urban Teaching Hospitals: Trend Analysis Using ICD 9 and ICD 10 Data

Muhammad F. Masood, Margaret A. Olsen, Akinobu Itoh, Kunal D. Kotkar, Katelin Nickel, Matt R. Keller, Marci Damiano, Ralph J. Damiano, Jr., Marc R. Moon
Washington University in St. Louis, Saint Louis, MO

Invited Discussant: Tomasz A. Timek

Ambulating Patients During ECMO

Yih-Shang Chen, *National Taiwan University, National Taiwan University Hospital*

Mixed Venovenous-Arterial ECMO and Other Parallel Circuits

David James Kaczorowski, *University of Pittsburgh, University of Pittsburgh Medical Center*

LV Unloading Tactics on ECMO

Hermann Reichenspurner, *University of Hamburg, University Heart & Vascular Center Hamburg*

105. Cerebral and Vascular Access Site Complications of Postcardiotomy Extracorporeal Life Support: Focus on Peripheral Cannulation Strategies

Anne-Kristin Schaefer, Klaus Distelmaier, Julia Riebandt, Georg Goliasch, Martin Bernardi, Thomas Haberl, Johann Horvat, Guenther Laufer, Daniel Zimpfer, Dominik Wiedemann
Medical University of Vienna, Vienna, Austria

Invited Discussant: Christian Andres Bermudez

129. Primary Cardiac Sarcomas: Treatment Strategies from an Institutional Experience of 121 Resections

Edward Y. Chan¹, Areeba Ali¹, Vinod Ravi², Edward A. Graviss¹, Duc T. Nguyen¹, Sergio H. Ibarra¹, Oz Shapira³, Thomas E. MacGillivray¹, Michael J. Reardon¹

¹Houston Methodist Hospital, Houston, TX; ²MD Anderson Cancer Center, Houston, TX;

³Hadassah Medical Center, Jerusalem, Israel

Invited Discussant: Leora B. Balsam

PRIMARY MITRAL REGURGITATION REPAIR TECHNIQUES 2

Moderators: Phan Van Nguyen, *Heart Institute Ho Chi Minh City*
Jeswant Dillon, *National Heart Institute Kuala Lumpur*

Bileaflet Prolapse, Fibrosis, and Malignant Arrhythmogenicity As a New Operative Indication

David H. Adams, *Mount Sinai Health System*

106. Racial Disparities in Mitral Valve Surgery: A Statewide Analysis

Michael Pienta¹, Patty Theurer², Melissa Clark², Chang He², Edward Murphy³, Daniel Drake⁴, Kenton Zehr⁵, Steven Bolling¹, Matthew Romano¹, Donald Likosky¹, Richard Prager¹, Michael P. Thompson¹, Gorav Ailawadi¹

¹University of Michigan, Ann Arbor, MI; ²Michigan Society of Thoracic and Cardiovascular Surgeons, Ann Arbor, MI; ³Spectrum Health Medical Group, Grand Rapids, MI; ⁴Munson Medical Center, Traverse City, MI; ⁵Detroit Medical Center, Detroit, MI

Invited Discussant: Dawn Hui

Extended Applications of Edge-to-Edge Repair

Ottavio R. Alfieri, *San Raffaele University Hospital*

107. Survival After Mitral Valve Repair, Replacement, or Clip in Octogenarians with Non-Ischemic Mitral Regurgitation

Meghan O. Kelly, Samuel Perez, Nadia H. Bakir, Martha M.O. McGilvray, Christian Zemlin, Marc R. Moon, Ralph J. Damiano, Spencer J. Melby
Barnes Hospital, Saint Louis, MO

Invited Discussant: Matthew A. Romano

Mitral Annular Calcification Resection

Didier Loulmet, *NYU, NYU Langone Health*

Rheumatic Leaflet Peeling

Taweesak Chotivatanapong, *Central Chest Institute of Thailand*

Treating and Avoiding Mitral Stenosis in Rheumatic Repair: Tips and Tricks

Thitipong Tepsuwan, *Chiang Mai University, Chiang Mai University Hospital*

3:50PM–4:05PM

BREAK

SATURDAY AFTERNOON, MAY 1, 2021
4:05PM–5:50PM

ADULT CARDIAC
Simultaneous Scientific Sessions

ADVANCED APPROACHES TO SAVR

Moderator: J. Michael DiMaio, *The Heart Hospital Baylor Plano*

CV7. A “Y” Incision and Rectangular Patch to Enlarge the Aortic Annulus by Two—Three Valve Sizes

Bo Yang
University of Michigan, Ann Arbor, MI

Techniques and Outcomes of Pulmonary Autograft Root Inclusion
Vaughn A. Starnes, *University of Southern California, Keck Medical Center*

122. The Ross Procedure Provides Superior Outcomes in Young Adults: A Statewide Propensity-Matched Analysis

Ismail El-Hamamsy, Nana Toyoda, Shinobu Itagaki, Natalia Egorova, Robin Varghese, Elbert E. Williams, Paul Stelzer, David H. Adams
Icahn School of Medicine at Mount Sinai, New York, NY

Invited Discussant: Peter D. Skillington

123. Ex Vivo Biomechanical Analysis of the Ross Procedure Using the Modified Inclusion Technique in a 3D-Printed Left Heart Simulator

Yuanjia Zhu, Mateo Marin-Cuartas, Matthew H. Park, Annabel M. Imbrie-Moore, Robert J. Wilkerson, Sarah Madira, Danielle M. Mullis, Y. Joseph Woo
Stanford University, Stanford, CA

Invited Discussant: Pedro J. del Nido

Technical Tips on Redo AVR and Redo AVR After TAVR
Byung Chul Chang, *CHA University, CHA Bundang Medical Center*

124. Efficacy of Del Nido Cardioplegia in Adult Cardiac Procedures with Prolonged Aortic Cross Clamp Time

Holliann Willekes¹, Jessica Parker², Jere Neill, Jr.¹, Gabriel Augustin¹, Justin Fanning², Stephane Leung², David Spurlock², Edward Murphy², Theodore Boeve², Marzia Leacche², Charles Willekes², John Heiser², Tomasz Timek²
¹Michigan State University, Grand Rapids, MI; ²Spectrum Health, Grand Rapids, MI

Invited Discussant: David A. Bull

PANEL DISCUSSION

EMERGING SOLUTIONS TO COMPLEX ARCH AND THORACOABDOMINAL AORTIC DISEASE

Moderators: Bradley G. Leshnower, Emory, Emory University Hospital
Martin Czerny, University Heart Center Freiburg – Bad Krozingen,

125. Hybrid Frozen Elephant Trunk Device for Transverse Aortic Arch Replacement: One-Year Results from a US IDE Trial

Joseph S. Coselli¹, Ourania Preventza¹, S. Chris Malaisrie², Allan Stewart³, Paul Stelzer⁴, Eric E. Roselli⁵, Himanshu J. Patel⁶, Thomas G. Gleason⁷, Edward P. Chen⁸, Anthony L. Estrera⁹, Joseph E. Bavaria¹⁰, Hiroo Takayama¹¹, Leonard Girardi¹², Michael Fischbein¹³, Scott A. LeMaire¹

¹Baylor College of Medicine, Houston, TX; ²Northwestern University Feinberg School of Medicine, Chicago, IL; ³Baptist Health South Florida, Miami, FL; ⁴Mount Sinai Medical Center, New York, NY; ⁵Cleveland Clinic, Cleveland, OH; ⁶University of Michigan Health System, Ann Arbor, MI; ⁷University of Pittsburgh Medical Center, Pittsburgh, PA; ⁸Emory University School of Medicine, Atlanta, GA; ⁹The University of Texas, McGovern Medical Center, Houston, TX; ¹⁰University of Pennsylvania, Philadelphia, PA; ¹¹Columbia University Medical Center, New York, NY; ¹²NewYork-Presbyterian Weill Cornell Medical Center, New York, NY; ¹³Stanford University School of Medicine, Stanford, CA

Invited Discussant: Axel Haverich

Total Arch Replacement Simplified for Reproducibility

Leonard N. Girardi, Weill Cornell Medicine

Novel Arch Graft Configurations

Thomas G. Gleason, Harvard Medical School, Brigham and Women's Hospital

Integrated Arch/Frozen Elephant Trunk Grafts

Malakh Shrestha, Hannover Medical School

126. Nitric Oxide Administered Through the Oxygenator During Selective Cerebral Perfusion Improve Neuroprotection in an Experimental Model of Hypothermic Circulatory Arrest

Daniele Linardi¹, Romel Mani², Angela Murari², Maddalena Tessari², Ilaria Decimo³, Sissi Dolci³, Giovanni Battista Luciani², Giuseppe Faggian², Alessio Rungtatscher²

¹Cardiac Surgery Department – Ospedale Civile Maggiore – Borgo Trento, Verona, Italy;

²Cardiac Surgery Department – University of Verona, Verona, Italy; ³Pharmacology Department – University of Verona, Verona, Italy

Invited Discussant: T. Brett Reece

Should All Uncomplicated Type B Aortic Dissections Undergo TEVAR?

Edward P. Chen, Duke University

Abdominal Debranching Hybrid TAAA Repair versus Snorkeled EVAR

Anthony L. Estrera, McGovern Medical School at UT Health, Memorial Hermann Heart and Vascular Institute

INNOVATIONS IN VALVE TECHNOLOGY AND PROSTHESIS DESIGN

Moderators: Kevin L. Greason, Mayo Clinic
Tirone E. David, University of Toronto, Toronto General Hospital

Designing Rings for Future TMVR

Paul G. Bannon, Sydney, Royal Prince Alfred

127. Early Results of Geometric Ring Annuloplasty for Bicuspid Aortic Valve Repair During Aortic Aneurysm Surgery: A Multi-Institutional Analysis

Marc W. Gerdtsch¹, Brett T. Reece², Marc R. Moon³, Richard S. Downey⁴, Vinay Badhwar⁵, Lawrence M. Wei⁵, Geoffrey B. Blossom⁶, Reed D. Quinn⁷, Joshua N. Baker⁸, Alfredo Trento⁹, Joanna Chikwe⁹, Hiroo Takayama¹⁰, Michael P. Robich⁷, Alexander Kraev¹¹, J. Alan Wolfe¹², Ming-Sing Si¹³, Kentaro Yamane¹⁴, Peter S. Downey¹⁵, Joseph W. Turek¹⁵, J. Scott Rankin⁵, G. Chad Hughes¹⁵

¹Franciscan St. Francis Heart Center, Indianapolis, IN; ²University of Colorado, Aurora, CO; ³Washington University Medical Center, St. Louis, MO; ⁴University of Michigan, Muskegon, MI; ⁵West Virginia University, Morgantown, WV; ⁶Ohio Health Riverside Methodist Hospital, Columbus, OH; ⁷Maine Medical Center, Portland, ME; ⁸Missouri Baptist Hospital, St. Louis, MO; ⁹Cedars Sinai Medical Center, Los Angeles, CA; ¹⁰Columbia Presbyterian Medical Center, New York, NY; ¹¹Billings Clinic, Billings, MT; ¹²Northeast Georgia Medical Center, Gainesville, GA; ¹³University of Michigan, Ann Arbor, MI; ¹⁴Pennsylvania State University, Hershey, PA; ¹⁵Duke University Medical Center, Durham, NC

Invited Discussant: Hans-Joachim Schäfers

CV8. Remodeling Valve-Sparing Aortic Root Replacement with Bicuspid Valve Repair Using Rigid Internal Geometric Ring Annuloplasty, Repair of Aorto-Atrial Fistula, and VSD Closure in a 16-Year-Old with Marfan Syndrome

Peter S. Downey, Julie W. Doberne, Andrew Vekstein, Joseph Turek, G. Chad Hughes
Duke University, Durham, NC

Novel Anti-Calcification Updates in Aortic and Mitral Bioprostheses

Bart Meuris, Leuven

LB20. Mitral Valve Replacement Using a Pericardial Valve with RESILIA Tissue

David Heimansohn¹, John Puskas², Mubashir Mumtaz³, Vaughn Starnes⁴, Evelio Rodriguez⁵, Francois Dagenais⁶, David Talton⁷, Hiroo Takayama⁸, Spencer Melby⁹, Abeel Mangi¹⁰, Bartley Griffith¹¹, Leonard Girardi¹², Jeffrey Lyons¹³, Kevin Accola¹⁴, David Adams²
¹Ascension/St. Vincent Heart Center of Indiana, Indianapolis, IN; ²Mount Sinai Health System, New York, NY; ³UPMC, Pittsburgh, PA; ⁴University of Southern California, Los Angeles, CA; ⁵Ascension St. Thomas Health, Nashville, TN; ⁶Institut Universitaire de Cardiologie et de Pneumologie De Quebec, Quebec, QC, Canada; ⁷North Mississippi Medical Center, Tupelo, MS; ⁸Presbyterian Hospital Columbia University Medical Center, New York, NY; ⁹Washington University, St. Louis, MO; ¹⁰Yale University, New Haven, CT; ¹¹University of Maryland, Baltimore, MD; ¹²Weill Cornell Medicine, New York, NY; ¹³Ohio Health Research Institute, Columbus, OH; ¹⁴Advent Health, Orlando, FL

Invited Discussant: Gabriel S. Aldea

LB21. Early and Mid Term Results from the Resilia Aortic Tissue Valve Italian Registry (RES-ITA)

Erica Manzan¹, Filippo Prestipino¹, Riccardo D'Ascoli¹, Francesco Musumeci², Mattia Glauber³, Marco Di Eusanio⁴, Germano Di Credico⁵, Giovanni Troise⁶, Severino Iesu⁷, Gianluca Polvani⁸, Maurizio Merlo⁹, Andrea Colli¹⁰, Giuseppe Faggian¹¹, Michele Portoghesi¹², Giampaolo Luzi¹
¹Aor San Carlo Di Potenza, Potenza, Italy; ²Azienda Ospedaliera San Camillo, Roma, Italy; ³Istituto Clinico Sant'Ambrogio, Milano, Italy; ⁴AOU Ospedali Riuniti di Ancona, Ancona, Italy; ⁵Ospedale di Legnano, ASST Ovest Milanese, Legnano, Italy; ⁶Fondazione Poliambulanza Istituto Ospedaliero, Brescia, Italy; ⁷Ospedale San Giovanni di Dio e Ruggi d'Aragona, Salerno, Italy; ⁸Istituto Centro Cardiologico Monzino, Milano, Italy; ⁹Azienda Ospedaliera Papa Giovanni XXIII, Bergamo, Italy; ¹⁰Azienda Ospedaliera Universitaria Pisana, Pisa, Italy; ¹¹Azienda Ospedaliera Universitaria di Verona, Verona, Italy; ¹²Ospedale SS Annunziata, Sassari, Italy

Invited Discussant: Robert J. Klautz

Lower INR Mechanical Valves

John D. Puskas, *Icahn School of Medicine at Mount Sinai, Mount Sinai Morningside (St. Luke's)*

MECHANICAL CIRCULATORY SUPPORT 4

Moderators: Hari R. Mallidi, *Harvard University, Brigham and Women's Hospital*
Ashish Shah, *Vanderbilt University, Vanderbilt University Medical Center*

128. Mechanical Cardiac Support Using a New Implantable Cardiac Compression Device

George V. Letsou¹, Boris Leschinsky², Erica Hord², Christina Bolch², John Criscione³
¹Baylor College of Medicine, Houston, TX; ²CorInnova, Inc, Houston, TX; ³Texas A&M School of Medicine, College Station, TX

Invited Discussant: Michael E. Jessen

Subcostal versus Resternotomy Approaches for VAD Exchange

David A. D'Alessandro, Jr., *Harvard Medical School, Massachusetts General Hospital*

Optimal LVAD Duration in Bridge to Transplantation

Craig H. Selzman, *University of Utah*

VAD Recovery and Technical Aspects of Explant

Gloria Faerber, *Friedrich Schiller University Jena, University Hospital Jena*

Implantable RVAD Technical Tips

Evgenij V. Potapov, *Charite, DHZB*

Ventricular Recovery After LVAD

Vivek Rao, *Toronto, Toronto General*

MINIMALLY INVASIVE CORONARY ARTERY SURGERY

Moderators: Rosemary F. Kelly, *University of Minnesota, University of Minnesota Medical Center*
Mario F.L. Gaudino, *Weill Cornell, NewYork-Presbyterian Hospital*

Multivessel MIDCAB without a Robot

Marc Ruel, *University of Ottawa, University of Ottawa Heart Institute*

Robotic and Non-Robotic Approaches to MIDCAB

Piroze M. Davierwala, *University of Leipzig, Heart Center, Leipzig*

130. Multi-Spectrum Robotic Cardiac Surgery: Early Outcomes in 1000 Cases from a Single Institution

Husam Balkhy, Sarah Nisivaco, Gianluca Torregrossa, Hiroto Kitahara, Brooke Patel, Kaitlin Grady, Mackenzie McCrorey, Charocka Coleman
University of Chicago Medicine, Chicago, IL

131. Peripheral ECMO Support Expands the Application of Robotic-Assisted Coronary Artery Bypass

Vivek Patel, Zach Gray, Mahboob Alam, Guilherme Vianna Silva, Leo Simpson, Kenneth Liao
Baylor College of Medicine, Houston, TX

Invited Discussant: Paul W.M. Fedak

Myocardial Bridge UnRoofing

Jack H. Boyd, *Stanford Medicine*

LB22. One Year Results of a Pivotal Study of a Second Generation Low-Profile Endograft in Subjects with Thoracic Aortic Aneurysm and Ulcer Pathologies

Wilson Y. Szeto¹, Prashanth Vallabhajosyula², Hitoshi Matsuda³, Sina Moainie⁴, Mel Sharafuddin⁵, Joel Corvera⁶, Christopher Smolock⁷, Shinji Miyamoto⁸, Thomas Naslund⁹, Venkatesh Ramaiah¹⁰

¹University of Pennsylvania, Philadelphia, PA; ²Yale University, New Haven, CT; ³National Cerebral and Cardiovascular Center, Suita, Japan; ⁴St. Vincent Heart Center, Indianapolis, IN; ⁵University of Iowa, Iowa City, IA; ⁶Indiana University, Indianapolis, IN; ⁷Cleveland Clinic, Cleveland, OH; ⁸Oita University Hospital, Yufu, Oita, Japan; ⁹Vanderbilt University, Nashville, TN; ¹⁰Arizona Heart Institute, Phoenix, AZ

Invited Discussant: G. Chad Hughes

PANEL DISCUSSION

PRIMARY MITRAL REGURGITATION REPAIR TECHNIQUES 3

Moderators: Filip P. Casselman, *OLV Clinic Aalst*
Y. Joseph Woo, *Stanford University, Stanford Hospital*

Deep Clefts: To Close or Not to Close

Francis C. Wells, *Cambridge, Royal Papworth Hospital NHS Trust*

Targeted Triangular Resections

Marc Gillinov, *Cleveland Clinic*

Native Chordal Transfer or Neochords?

Gilles D. Dreyfus, *Paris University Pierre et Marie Curie, Institut Montsouris Paris France*

Barlow Repair

Clifford W. Barlow, *Southampton, Southampton General*

Leaflet Folding Approaches

Minoru Tabata, *Keio University/Kyorin University/Jikei University/St. Marianna University, Tokyo Bay Urayasu Ichikawa Medical Center/Toranomon Hospital*

LB23. Operative Outcomes of Mitral Surgery for Failed Transcatheter Edge-to-Edge Repair (TEER) in the United States

Joanna Chikwe¹, Patrick O'Gara², Stephen Fremes³, Thoralf Sundt⁴, Robert Habib⁵, Georgina Rowe¹, George Gill¹, James Gammie⁶, Mario Gaudino⁷, Vinay Badhwar⁸, Michael Acker⁹, Marc Gillinov¹⁰, Andrew B. Goldstone⁹, Thomas Schwann¹¹, Annetine Gelijns¹², Natalia N. Egorova¹², Raj Makkar¹, Alfredo Trento¹, Michael Mack¹³, David H. Adams¹²

¹Cedars-Sinai, Beverly Hills, CA; ²Brigham and Women's Hospital, Boston, MA;

³Sunnybrook Health Sciences Center, University of Toronto, Toronto, ON, Canada;

⁴Massachusetts General Hospital, Boston, MA; ⁵The Society of Thoracic Surgeons Research Center, Chicago, IL; ⁶University of Maryland, Baltimore, MD; ⁷Weill Cornell, New York, NY; ⁸West Virginia University, Morgantown, WV; ⁹University of Pennsylvania, Philadelphia, PA; ¹⁰Cleveland Clinic, Cleveland, OH; ¹¹Baystate Health, Springfield, MA;

¹²Icahn School of Medicine at Mount Sinai, New York, NY; ¹³Baylor Health Care System, Plano, TX

Invited Discussant: Patrick M. McCarthy

PANEL DISCUSSION

SATURDAY MORNING, MAY 1, 2021

9:00AM–10:45AM

CONGENITAL Simultaneous Scientific Sessions

ATRIOVENTRICULAR VALVES

Moderators: Christopher A. Caldarone, *Baylor College of Medicine, Texas Children's Hospital*
S. Adil Husain, *University of Utah Health, Primary Children's Hospital*

82. Tailored Strategy to Match Anatomy and Physiology with Intervention Can Improve Outcomes of Symptomatic Neonates with Ebstein Anomaly and Tricuspid Valve Dysplasia

Christian Pizarro, Majeed Bhat, Deborah Davis, Daniel Duncan, Glenn Pelletier, Claude Beaty, Paul Anisman, Gina Baffa
Alfred I duPont Hospital for Children, Wilmington, DE

Invited Discussant: Richard G. Ohye

Tricuspid Repair in Hypoplastic Left Heart Syndrome: Indications, Techniques, Outcomes, and When to Abandon the Fontan Track

Jeffrey S. Heinle, *Baylor College of Medicine, Texas Children's Hospital*

83. Force Profiles of Single Ventricle Atrioventricular Leaflets in Response to Annular Dilation

Sumanth Kidambi¹, Stephen Moye¹, Edward Brandon Strong¹, Teaghan Cowles¹, Annabel Imbrie-Moore², Rob Wilkerson¹, Michael Paulsen¹, Y. Joseph Woo^{1,3}, Michael Ma¹
¹Department of Cardiothoracic Surgery, Stanford University, Palo Alto, CA; ²Department of Mechanical Engineering, Stanford University, Palo Alto, CA; ³Department of Bioengineering, Stanford University, Palo Alto, CA

Invited Discussant: Tain-Yen Hsia

84. Prosthesis-Patient Mismatch Due to Somatic Growth After Mechanical Mitral Valve Replacement in Small Children: Predictor and Outcomes of Reoperation

Yuji Nakamura¹, Hoashi Takaya¹, Motoki Komori¹, Naoki Okuda¹, Kenta Imai¹, Kenichi Kurosaki², Isao Shiraishi², Hajime Ichikawa¹

¹Department of Pediatric Cardiovascular Surgery, National Cerebral and Cardiovascular Center, Suita, Osaka, Japan; ²Department of Pediatric Cardiology, National Cerebral and Cardiovascular Center, Suita, Osaka, Japan

Invited Discussant: Christopher A. Caldarone

Management of the Complex Valve Problems in Atrioventricular Septal Defect: How and When to Repair or Replace

Glen Scott Van Arsdell, University of California, Los Angeles, UCLA Ronald Reagan Medical Center

85. Contemporary Outcome After Pulmonary Artery Banding in Complete Atrioventricular Septal Defect: How the Band Tightness Affect the Outcome?

Mi Jin Kim, Seulgi Cha, Jae Suk Baek, Eun Seok Choi, Bo Sang Kwon, Tae-Jin Yun, Chun Soo Park

Asan Medical Center, Seoul, Republic of Korea

Invited Discussant: Paul J. Chai

2021 The American Association for Thoracic Surgery (AATS) Congenital Cardiac Surgery Working Group Consensus Document on a Comprehensive Perioperative Approach to Enhanced Recovery Following Pediatric Cardiac Surgery

Stephanie Fuller¹, S. Ram Kumar², Nathalie Roy³, William T. Mahle⁴, Susan Nicolson⁵, Jennifer C. Romano⁶, Jennifer S. Nelson^{7,8}, James M. Hammel⁹, Michiaki Imamura¹⁰, Haibo Zhang¹¹, Stephen E. Fremes¹², Sara McHugh-Grant¹³

¹Division of Cardiothoracic Surgery, Department of Surgery, The Children’s Hospital of Philadelphia and Perelman School of Medicine at the University of Pennsylvania, Philadelphia, PA; ²Division of Cardiac Surgery, Department of Surgery, and Department of Pediatrics, Keck School of Medicine of the University of Southern California, Heart Institute, Children’s Hospital Los Angeles, Los Angeles, CA; ³Department of Cardiac Surgery, Boston Children’s Hospital, Department of Surgery, Harvard Medical School, Boston, MA; ⁴Division of Cardiology, Department of Pediatrics, Emory University, Children’s Healthcare of Atlanta, Atlanta, GE; ⁵Division of Cardiothoracic Anesthesiology, Department of Anesthesiology and Critical Care Medicine, The Children’s Hospital of Philadelphia, Perelman School of Medicine at the University of Pennsylvania, Philadelphia, PA; ⁶Departments of Cardiac Surgery and Pediatrics, University of Michigan, Ann Arbor, MI; ⁷Division of Cardiovascular Surgery, Division of Cardiovascular Services, Nemours Children’s Hospital, Orlando, Florida; ⁸Department of Surgery, University of Central Florida College of Medicine, Orlando, FL; ⁹Department of Cardiothoracic Surgery, Children’s Hospital and Medical Center of Omaha, Omaha, NE; ¹⁰Division of Congenital Heart Surgery, Texas Children’s Hospital, Houston, TX; ¹¹Department of Cardiothoracic Surgery, Shanghai Children’s Medical Center, Shanghai Jiao Tong University School of Medicine, Shanghai, China; ¹²Division of Cardiac Surgery, Department of Surgery, Schulich Heart Centre, Sunnybrook Health Sciences Centre, University of Toronto, Toronto, Ontario, Canada; ¹³Division of Cardiothoracic Surgery, Children’s Hospital of Philadelphia, Philadelphia, PA

10:45AM–11:00AM

BREAK

PRESIDENTIAL PLENARY
11:00AM–12:45PM

Moderator: David R. Jones, Memorial Sloan Kettering

A Conversation with Condoleezza Rice
Condoleezza Rice, 66th US Secretary of State

Introduction of the 101st AATS President
Shaf Keshavjee, University of Toronto, Toronto General Hospital

PRESIDENTIAL ADDRESS: Is This an Adventure?
Marc R. Moon, 101st AATS President
Washington University School of Medicine/Division of CT, Barnes Jewish Hospital

12:45PM–1:00PM

BREAK

1:00PM–1:50PM

LUNCH

1:50PM–2:05PM

BREAK

SATURDAY AFTERNOON, MAY 1, 2021
2:05PM–3:50PM

CONGENITAL
Simultaneous Scientific Sessions

AORTA AND PULMONARY VALVES 1

Moderators: Pirooz Eghtesady, Washington University, St. Louis Children’s Hospital
Stephanie Fuller, University of Pennsylvania, Children’s Hospital of Philadelphia

Surgical Management of Complex Aortic Valve in the Neonates
Pedro J. del Nido, Harvard Medical School, Boston Children’s Hospital

108. The Ross/Konno Procedure in Infancy Is a Safe and Durable Solution for Aortic Stenosis
Jack Luxford^{1,2}, Julian Ayer^{1,2}, Yishay Orr¹, Gananjay Salve¹, Gary Sholler^{1,2}, Philip Roberts¹, David Winlaw^{1,2}
¹The Children’s Hospital at Westmead, Sydney, Australia; ²The University of Sydney, Sydney, Australia

Invited Discussant: Victor T. Tsang

109. Valve-Sparing Root Replacement After the Ross Procedure
Reilly D. Hobbs, Richard G. Ohye, Edward Bove, Ming-Sing Si
University of Michigan, Ann Arbor, MI

Invited Discussant: Jennifer S. Nelson

110. Valve-Sparing Aortic Root Reconstruction in Children and Adults: A Dual-Center Experience

Karthik Thangappan¹, Sharadhi Madhusudhana², Lorelei Robinson¹, Farhan Zafar¹, Garick Hill¹, Salil Ginde², Michael G. Earing², James S. Tweddell¹, Michael E. Mitchell²
¹Cincinnati Children's Hospital Medical Center, Cincinnati, OH; ²Children's Hospital of Wisconsin, Milwaukee, WI

Invited Discussant: Edward Hickey

111. Long-Term Outcomes of Aortic Valve Repair for Isolated Congenital Aortic Stenosis in Children

Fraser R.O. Wallace, Edward Buratto, Michael Zhu, Tyson A. Fricke, Christian P. Brizard, Igor E. Konstantinov
Royal Children's Hospital, Melbourne, Parkville, Australia

Invited Discussant: Ming Si

112. Long-Term Surgical Outcomes of Primary Supravalvular Aortic Stenosis Repair with Modified Simple Sliding Aortoplasty

Eun Seok Choi, Chun Soo Park, Bo Sang Kwon, Tae-Jin Yun
Asan Medical Center, Seoul, Republic of Korea

Invited Discussant: Dilip Nath

LB17. Outcomes of the Ross Procedure for Young Patients with Aortic Valve Disease in the Third Decade of Follow-up

Giovanni B. Luciani, Gianluca Cullurà, Antonio Segreto, Andrea Ardigo¹, Stiljan Hoxha, Mara Pilati, Lucia Rossetti, Maria A. Prioli, Giuseppe Faggian
University of Verona, Verona, Italy

Invited Discussant: TBD

3:50PM–4:05PM

BREAK

SATURDAY AFTERNOON, MAY 1, 2021
4:05PM–5:50PM

CONGENITAL
Simultaneous Scientific Sessions

SURGICAL MANAGEMENT OF TRANSPOSITION OF GREAT ARTERIES

Moderators: Emile A. Bacha, Columbia University, New York-Presbyterian
James A. Quintessenza, Johns Hopkins, All Children's Hospital

133. Outcomes of Patients with Inverted Coronary Anatomy After the Arterial Switch Operation

Kaushik Thungathurthi, Tyson Alexander Fricke, Edward Buratto, Christian Brizard, Igor Konstantinov
Royal Children's Hospital, Melbourne, Australia

Invited Discussant: Glen Scott Van Arsdell

ccTGA: Routine Anatomic Repair versus Alternative Approaches?
Pirooz Eghtesady, Washington University, St. Louis Children's Hospital

134. A Simplified Approach to Predicting Reintervention in the Arterial Switch Operation

Gananjay G. Salve¹, Kim Betts², Julian G. Ayer^{1,3}, Richard B. Chard^{1,3}, Ian A. Nicholson^{1,3}, Yishay Orr^{1,3}, David S. Winlaw^{1,3}

¹The Children's Hospital at Westmead, Sydney, Australia; ²School of Public Health, Curtin University, Perth, Australia; ³Faculty of Medicine and Health, The University of Sydney, Sydney, Australia

Invited Discussant: Yasuhiro Kotani

135. Branch Pulmonary Artery Stenosis After Arterial Switch Operation: The Impact of Preoperative Anatomic Factors on Reoperation

Shuhua Luo¹, Martui Haranal², Mimi xiaoming Deng², Jaymie Varenbut², Kyle Runeckles², Steve Chun-po Fan², Osami Honjo²

¹West China Hospital, Chengdu, China; ²The Hospital for Sick Children, Toronto, ON, Canada

Invited Discussant: Robert D.B. Jaquiss

136. Outcomes of the Arterial Switch Operation in Patients with Taussig-Bing Anomaly and Aortic Arch Obstruction

Tyson A. Fricke, Kaushik Thungathurthi, Edward Buratto, Christian Brizard, Igor E. Konstantinov
The Royal Children's Hospital, Melbourne, Australia

Invited Discussant: Jeffrey S. Heinle

The Systemic Right Ventricle: How Does It Compare to Late Fontan
Stephanie Fuller, University of Pennsylvania, Children's Hospital of Philadelphia

VIDEO SESSION: How I Do It—Controversies

Moderators: Edward Hickey, Texas Children's Hospital
Hani K. Najm, Case Western, Cleveland Clinic

CV9. Tricuspidization of a Regurgitant Quadricuspid Truncal Valve: A Versatile Adaptation for Aortic Valve Repair

Anthony L. Zaki, Tara Karamlou, Munir Ahmad, Gosta Pettersson, Hani Najm
Cleveland Clinic Foundation, Cleveland, OH

Invited Discussant: Igor E. Konstantinov

CV10. Da Silva Cone Repair in Double Orifice Ebstein's Malformation Tricuspid Valve

Luciana Da Fonseca da Silva, Jose Pedro da Silva, Melita Viegas, Mario Castro-Medina
UPMC Children's Hospital of Pittsburgh, Pittsburgh, PA

Invited Discussant: Christopher J. Knott-Craig

CV11. Customized Aortic Valve Reconstruction in Children

Ignacio G. Berra¹, Pablo A. Takeuchi², Alfredo Irusta², Pablo García Delucis¹, Adalberto Yamil Guglielmone¹, Javier Cornelis¹, Laura Zenobi¹, María Sol De Los Santos¹, Ramiro Goldman¹, Carin Vandoorn³, Sebastián Berra⁴

¹Hospital Nacional de Pediatría J.P. Garrahan, Buenos Aires, Argentina, Ciudad Autónoma de Buenos Aires, Argentina; ²Lew Insumos e Innovaciones, Morón, Argentina; ³Leeds Children's Hospital, Leeds, United Kingdom; ⁴Universidad de Buenos Aires, Facultad de Ingeniería, Cátedra de Control, Ciudad Autónoma de Buenos Aires, Argentina

Invited Discussant: Christopher W. Baird

CV12. Bicuspid Neoaortic Insufficiency Following Single Ventricle Palliation: Repair with a Rigid Annuloplasty Ring

Kellianne C. Kleeman, Aishwarya Ramaswami, Richard G. Ohye, Ming-Sing Si
University of Michigan, Ann Arbor, MI

Invited Discussant: Joseph W. Turek

CV13. 3D Visualization of Cardiac Fibromas for Prospective Planning and Intraoperative Guidance

Emily Eickhoff, Noah Schulz, Rebecca Beroukhim, Tal Geva, Peter Hammer, David Hoganson, Pedro del Nido
Boston Children's Hospital, Boston, MA

Invited Discussant: Jennifer C. Romano

CV14. Norwood Modification for Hypoplastic Left Heart with Right Aortic Arch

Ralph Mosca, David Williams, Joshua Scheinerman, Sunil Saharan, Michelle Ramirez, Michael Argilla, T.K. Susheel Kumar
New York University Langone Health, New York, NY

Invited Discussant: Ram Kumar Subramanyan

SATURDAY MORNING, MAY 1, 2021

11:00AM–12:45PM

PRESIDENTIAL PLENARY

11:00AM–12:45PM

Moderator: David R. Jones, Memorial Sloan Kettering

A Conversation with Condoleezza Rice

Condoleezza Rice, 66th US Secretary of State

Introduction of the 101st AATS President

Shaf Keshavjee, University of Toronto, Toronto General Hospital

PRESIDENTIAL ADDRESS: Is This an Adventure?

Marc R. Moon, 101st AATS President

Washington University School of Medicine/Division of CT, Barnes Jewish Hospital

SATURDAY AFTERNOON, MAY 1, 2021

4:05PM–5:50PM

**MULTI-SPECIALTY
Simultaneous Scientific Sessions**

WELLNESS SESSION

Moderator: Ross Bremner, Norton Thoracic Institute

Introduction and Results of the Wellness Survey

Ross Bremner, Norton Thoracic Institute

Recognizing the Emotive Response to the Pandemic

Heather Rabin, Orion Solutions

Resilience in the Time of COVID

Michael Maddaus, University of Minnesota Medical Center

Differences Between Diagnostic and Procedural Specialists: Implications for Understanding and Remediating Professionalism Lapses

Betsy Williams, Professional Renewal Center

Invited Discussant: G. Alexander Patterson, Washington University

COVID As a Patient and a Caregiver—Perspectives and Insights for the Rest of Us

Ross Ungerleider, Oregon Health and Sciences

Andrea Wolf, Mt. Sinai

Jamie Dickey Ungerleider, Oregon Health and Sciences

SATURDAY MORNING, MAY 1, 2021

9:00AM–10:45AM

**PERIOPERATIVE CARE
Simultaneous Scientific Sessions**

CARDIOTHORACIC CRITICAL CARE 1

Moderators: Bo Soo Kim, *Johns Hopkins University, JHH*
Sean van Diepen, *University of Alberta, University of Alberta Hospital*

DEBATE

Preoperative Beta Blocker Should Be a Quality Measure (Pro)

J. Michael DiMaio, *The Heart Hospital Baylor Plano*

Preoperative Beta Blocker Should Be a Quality Measure (Con)

Stephen E. Fremes, *University of Toronto, Sunnybrook*

DEBATE

Routine Cardiac Surgery Is Done Better with a Swan Ganz and a TEE (Pro)

Kevin W. Lobdell, *Wake Forest University, Atrium Health*

Routine Cardiac Surgery Is Done Better with a Swan Ganz and a TEE (Con)

Nathalie Roy, *Harvard, Boston Children's Hospital*

DEBATE

**Patients Should Be Extubated in the Operating Room After
Routine Cardiac Surgery (Pro)**

Vinay Badhwar, *West Virginia University, WVU Heart and Vascular Institute*

**Patients Should Be Extubated in the Operating Room After
Routine Cardiac Surgery (Con)**

Robin Varghese, *Icahn School of Medicine at Mount Sinai, Mount Sinai Health System*

DEBATE

Recurrent Episodes of Afib Requires Anticoagulation (Pro)

Thomas Stephen Metkus, Jr., *Johns Hopkins University, Johns Hopkins Hospital*

Recurrent Episodes of Afib Requires Anticoagulation (Con)

Ann Gage, *Centennial Heart Hospital*

DEBATE

Late versus Early CRRT in Post-Op Cardiac Surgery (Late)

TBD

Late versus Early CRRT in Post-Op Cardiac Surgery (Early)

HelenMari Merritt Genore, *University of Nebraska Medical Center, Methodist Health Systems*

**LB14. Negative Pressure Wound Dressings in Diabetic Patients Undergoing
LITA Harvest—A Randomised Control Trial**

Sam Jenkins¹, Mohamed Komber², Kavitha Mattam², Norman Briffa²

¹University of Sheffield, Sheffield, United Kingdom; ²Sheffield Teaching Hospitals NHS Foundation Trust, Sheffield, United Kingdom

Invited Discussant: TBD

10:45AM–11:00AM

BREAK

PRESIDENTIAL PLENARY

11:00AM–12:45PM

Moderator: David R. Jones, *Memorial Sloan Kettering*

A Conversation with Condoleezza Rice

Condoleezza Rice, *66th US Secretary of State*

Introduction of the 101st AATS President

Shaf Keshavjee, *University of Toronto, Toronto General Hospital*

PRESIDENTIAL ADDRESS: Is This an Adventure?

Marc R. Moon, *101st AATS President*

Washington University School of Medicine/Division of CT, Barnes Jewish Hospital

12:45PM–1:00PM

BREAK

1:00PM–1:50PM

LUNCH

1:50PM–2:05PM

BREAK

SATURDAY AFTERNOON, MAY 1, 2021

2:05PM–3:50PM

**PERIOPERATIVE CARE
Simultaneous Scientific Sessions**

CARDIOTHORACIC CRITICAL CARE 2

Moderators: Lynelle Jolliff, *Washington University School of Medicine, Barnes Jewish Hospital*

Andra E. Duncan, *Cleveland Clinic Lerner College of Medicine, Cleveland Clinic*

ARDS in the Cardiothoracic Patient: Optimal Management to Prevent ECMO

Bo Soo Kim, *Johns Hopkins University, JHH*

Controversies in Mechanical Ventilation: Recruitment and Tracheostomy

J.W. Awori Hayanga, *West Virginia University*

How to Overcome the Failure to Progress Syndrome

TBD

PANEL DISCUSSION

Myocardial Infarction After CABG: When to Cath, When to Intervene

George Dangas, Mount Sinai

Failure-to-Rescue As a Quality Indicator

Donald Likosky, University of Michigan

Prolonged Vasoplegia and Autonomic Dysfunction After Cardiac Surgery: Treatment Strategies

Subhasis Chatterjee, Baylor College of Medicine, Baylor St. Lukes Medical Center

3:50PM–4:05PM

BREAK

SATURDAY AFTERNOON, MAY 1, 2021

4:05PM–5:50PM

PERIOPERATIVE CARE
Simultaneous Scientific Sessions

ECMO/ECPR

Moderators: J.W. Awori Hayanga, West Virginia University
HelenMari Merritt Genore, University of Nebraska Medical Center, Methodist Health Systems

ECPR for in and Out of Hospital Cardiac Arrest: Where, How, and When to Say “No”

Chris C. Cook, West Virginia University, J.W. Ruby Memorial Hospital

Optimizing Outcomes in eCPR

Nicholas R. Teman, University of Virginia, University of Virginia Health System

Mitigating Neurologic Complications

Sung-Min Cho, Johns Hopkins University, Johns Hopkins Hospital

ECMO Essentials: The Perfusionist’s Perspective

Desiree Bonadonna, Duke University, Duke Health

ECMO and the End of Life

Peter Barrett, Piedmont Heart Institute, Piedmont Atlanta Hospital

SATURDAY MORNING, MAY 1, 2021

9:00AM–10:45AM

GENERAL THORACIC
Simultaneous Scientific Sessions

ACADEMIC PUBLICATIONS

Moderators: Richard D. Weisel, University of Toronto, Toronto General Hospital
G. Alexander Patterson, Washington University

Best Fit for a Submission

David R. Jones, Memorial Sloan Kettering

Statistics and Analytics

Eugene H. Blackstone, Cleveland Clinic

Abstract Preparation

Thomas A. D’Amico, Duke University

Manuscript Preparation (Discussion and How to Conclude)

Gaetano Rocco, Weill Cornell Medical College, Memorial Sloan Kettering Cancer Center

What Your Review Means and How to Respond?

Sudish C. Murthy, Cleveland Clinic

How to Review for JTCVS

Robert B. Cameron, UCLA, Ronald Reagan UCLA Medical Center

ESOPHAGEAL CANCER

Moderators: Haiquan Chen, Fudan University, Fudan University Shanghai Cancer Center
Ikenna Okereke, University of Texas Medical Branch
Yaron Shargall, McMaster University

Endoscopic Therapy for T1b: Where Do We Stand?

Thomas J. Watson, Georgetown University, MedStar Georgetown University Hospital

86. Peri-Operative Outcomes Following Esophagectomy Between Older and Younger Adults with Esophageal Cancer

Aaron R. Dezube¹, Lisa Cooper¹, Emanuele Mazzola², Daniel Dolan¹, Daniel N. Lee¹, Suden Kucukak¹, Luis E. De Leon¹, Clark Dumontier¹, Bayonle Ademola¹, Emily Polhemus¹, Abby White¹, Scott J. Swanson¹, Michael T. Jaklitsch¹, Laura Frain¹, Jon O. Wee¹
¹Brigham and Women’s Hospital, Boston, MA; ²Dana Farber Cancer Institute, Boston, MA

Invited Discussant: Joshua R. Sonett

Esophageal Sparing Therapy for Locally Advanced Disease Identifying Candidates and Late Outcomes

Wayne L. Hofstetter, The University of Texas MD Anderson Cancer Center

87. The Impact of Weight Loss on the Regression of Barrett’s Esophagus After Roux-en-Y Gastric Bypass As an Anti-Reflux Operation

Dongning Zhang¹, James D. Luketich¹, Omar Awais¹, William Gooding², Arjun Pennathur¹
¹University of Pittsburgh Medical Center, Pittsburgh, PA; ²University of Pittsburgh, Pittsburgh, PA

Invited Discussant: Moishe Liberman

88. Patients with Diabetes Are Less Likely to Achieve Pathologic Complete Response Rate After Neoadjuvant Chemoradiation Therapy for Esophageal Cancer: A Multi-Institutional Analysis

Christine E. Alvarado¹, Kevin C. Kapcio², Michal Lada², Katelynn C. Bachman¹, Philip A. Linden¹, Christopher W. Towe¹, Stephanie G. Worrell¹

¹Case Western Reserve University/University Hospitals Cleveland Medical Center, Cleveland, OH; ²University of Rochester Medical Center, Rochester, NY

Invited Discussant: Shawn S. Groth

DEBATE: MIE versus Open

Bryan F. Meyers, Washington Univeristy in St. Louis, Barnes Jewish Hospital
James D. Luketich, University of Pittsburgh, UPMC

LB15. The Contemporary Significance of Venous Thromboembolism [Deep Venous Thrombosis (DVT) and Pulmonary Embolus (PE)] in Patients Undergoing Esophagectomy: A Prospective, Multicenter Cohort Study to Evaluate the Incidence and Clinical Outcomes VTE After Major Esophageal Resections

Yaron Shargall¹, Sudish Murthy², Jules Lin³, Gail Darling⁴, Richard Malthaner⁵, Biniam Kidane⁶, Andrew Seely⁷, Hui Li⁸, Mark Crowther¹, Lori-Ann Linkins¹, Esther Lau¹, Laura Schneider¹, Wael C. Hanna¹, Christian Finley¹, John Agzarian¹, James Douketis¹

¹McMaster University, Hamilton, ON, Canada; ²Cleveland Clinic, Cleveland, OH; ³University of Michigan, Ann Arbor, MI; ⁴University of Toronto, Toronto, ON, Canada; ⁵University of Western Ontario, London, ON, Canada; ⁶University of Manitoba, Winnipeg, MB, Canada; ⁷University of Ottawa, Ottawa, ON, Canada; ⁸Beijing Chao-Yang Hospital, Capital Medical University, Beijing, China

Invited Discussant: Donald E. Low

LB16. Preoperative Pembrolizumab Combined with Chemoradiotherapy for Oesophageal Squamous Cell Carcinoma: Trial Design of a Multicenter Single-Arm Study (PALACE-2)

Hecheng Li, Chengqiang Li, Yuyan Zheng

Ruijin Hospital, Shanghai Jiaotong University, School of Medicine, Shanghai, China

UNDERSTANDING SURGICAL CANDIDACY

Moderators: Donald E. Low, University of Washington, Virginia Mason Medical Center
Alessandro Brunelli, University of Leeds, Leeds Teaching Hospitals
Varun Puri, Washington University St. Louis

89. Impact of COVID-19 on the Delivery of Care for Thoracic Surgery Patients

Joanne B. Szewczyk, Karishma Kodia, Joy Stephens-McDonnough, Nestor R. Villamizar, Dao M. Nguyen

University of Miami Miller School of Medicine, Miami, FL

Invited Discussant: James M. Isbell

90. Safety of Lung Cancer Surgery During COVID-19 in a Pandemic Epicenter

Jonathan Villena-Vargas, Evan Lutton, J. Nathan Mynard, Abu Nasar, Roger Zhu, Francesca Voza, Oliver Chow, Benjamin Lee, Sebron Harrison, Brendon M. Stiles, Jeffrey L. Port, Nasser Altorki

Department of Cardiothoracic Surgery, Weill Cornell Medicine, NewYork-Presbyterian Hospital, New York, NY

Invited Discussant: Michael Zervos

Risk Stratification for Lobectomy: What Tests Are Essential

Mark K. Ferguson, University of Chicago

Frailty

Andrew Tang, Cleveland Clinic Foundation

Prehabilitation for Lung Cancer Surgery

Peter Mazzone, Cleveland Clinic

Patient Reported Outcomes

Shanda H. Blackmon, Mayo Clinic

91. Association Between the Frailty and Outcomes Following Elective Lobectomy

Bryce Bludevich, Isabel Emmerick, Mark Maxfield, Karl Uy, Jennifer Baima, Arlene Ash, Feiran Lou

UMASS Medical School, Worcester, MA

Invited Discussant: John Howington

92. Long-Term Assessment of Efficacy with a Novel Thoracic Survivorship Program for Patients with Lung Cancer

Hari B. Keshava, Kay See Tan, Joseph Dycoco, James Huang, Prasad Adusumilli, Manjit Bains, Matthew Bott, Robert J. Downey, Danelia Molena, Bernard J. Park, Gaetano Rocco, Smita Sihag, David R. Jones, Valerie W. Rusch

Memorial Sloan Cancer Center, New York, NY

Invited Discussant: Paula A. Ugalde

PANEL DISCUSSION

10:45AM–11:00AM BREAK

PRESIDENTIAL PLENARY

11:00AM–12:45PM

Moderator: David R. Jones, *Memorial Sloan Kettering*

A Conversation with Condoleezza Rice

Condoleezza Rice, *66th US Secretary of State*

Introduction of the 101st AATS President

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Washington University School of Medicine/Division of CT, Barnes Jewish Hospital

12:45PM–1:00PM

BREAK

1:00PM–1:50PM

LUNCH

1:50PM–2:05PM

BREAK

SATURDAY AFTERNOON, MAY 1, 2021

2:05PM–3:50PM

GENERAL THORACIC Simultaneous Scientific Sessions

AATS/WTS JOINT SESSION

Moderators: DuyKhanh Pham Ceppa, *Indiana University School of Medicine, Indiana University Hospital/Simon Cancer Center, Roudebush VA Medical Center*
Daniela Molena, *Weill Cornell, Memorial Sloan Kettering Cancer Center*

113. Subsolid Lesions Exceeding 3 cm: Do the Ground-Glass Opacity Components Still Matter?

Fanfan Fan
Shanghai Cancer Center, Shanghai, China

Invited Discussant: Robert E. Merritt

114. Complete Lymphadenectomy for Clinical Stage I Lepidic Adenocarcinoma of the Lung: Is It Justified?

Giulio Maurizi, Antonio D'Andrilli, Anna Maria Ciccone, Mohsen Ibrahim, Claudio Andreetti, Camilla Vanni, Simone Maria Tierno, Federico Venuta, Erino Angelo Rendina
Sapienza University of Rome, Rome, Italy

Invited Discussant: Allison J. McLarty

HOW I DO IT: Robotic Esophagectomy

M. Blair Marshall, *Harvard Medical School, Brigham & Women's Hospital*

115. Pattern and Impact of Nodal Metastases After Neoadjuvant and Surgical Treatment in Esophageal Adenocarcinoma

Caitlin A. Harrington, Rebecca Carr, Smita Sihag, Prasad Adusumilli, Manjit Bains, Matthew Bott, James Isbell, Bernard Park, Gaetano Rocco, Valerie Rusch, David Jones, Daniela Molena

Memorial Sloan Kettering Cancer Center, New York, NY

Invited Discussant: Harmik J. Soukiasian

116. The Optimal Extent of Lymphadenectomy for Patients with Esophageal Squamous Cell Carcinoma: Results from Two Randomized Clinical Trials

Bin Li
Fudan University Shanghai Cancer Center, Shanghai, China

Invited Discussant: Cherie P. Erkmén

HOW I DO IT: Intentional Segmentectomy for Early Stage NSCLC

Isabelle Opitz, *University of Zurich, University Hospital Zurich*

PANEL DISCUSSION

LUNG CANCER 2

Moderators: Elizabeth A. David, *University of Southern California, Keck Hospital*
Thomas A. D'Amico, *Duke University*
Biniam Kidane, *Max Rady College of Medicine/University of Manitoba*

SBRT, Limited Resection, Ablation for Early Stage Lung Cancer: A Comprehensive Review

Eric Lim, *Imperial College London, Royal Brompton Hospital*

Robotic Lung Cancer Ablation—Where Are We?

Luis J. Herrera, *Orlando Health*

117. Comparative Effectiveness of Primary Radiation Therapy versus Surgery for Stage I Lung Cancer in Otherwise Healthy Patients: An Instrumental Variable Analysis

Michael J. Littau, Jr.¹, Richard Freeman², Wickii Vigneswaran², James Lubawski², Fred A. Luchette^{2,3}, Marshall S. Baker^{2,3}, Wissam Raad², Tyler Grenda⁴, Zaid M. Abdelsattar^{1,2}, Maria Lucia L. Madariaga⁵

¹Stritch School of Medicine – Loyola University Chicago, Maywood, IL; ²Loyola University Medical Center, Maywood, IL; ³Edward Hines Jr. VA Hospital, Hines, IL; ⁴Thomas Jefferson University Hospital, Philadelphia, PA; ⁵University of Chicago Medical Center, Chicago, IL

Invited Discussant: Harvey I. Pass

118. Endobronchial Ultrasound-Guided Bipolar Radiofrequency Ablation for Lung Cancer: A First-in-Human Clinical Trial

Tsukasa Ishiwata¹, Hideki Ujii¹, Terunaga Inage¹, Yamato Motooka¹, Kosuke Fujino¹, Masato Aragaki¹, Zhenchian Chen¹, Tomonari Kinoshita¹, Alexander Gregor¹, Andrew Effat¹, Nicholas Bernards¹, Laura Donahoe¹, Jonathan Yeung¹, Marcelo Cypel¹, Marc De Perrot¹, Andrew Pierre¹, Gail Darling¹, Thomas Waddell¹, Shaf Keshavjee¹, Prodipto Pal², Kazuhiro Yasufuku¹

¹Division of Thoracic Surgery, Toronto General Hospital, University Health Network, Toronto, ON, Canada; ²Department of Laboratory Medicine and Pathobiology, University Health Network, Toronto, ON, Canada

Invited Discussant: Thomas Gildea

119. The Feasibility Study of a Novel Localization Technique Using Radiofrequency Identification Marker for Deeply Located Small Lung Lesions

Yojiro Yutaka¹, Toshihiko Sato², Satona Tanaka¹, Soh Miyahara², Akinori Iwasaki², Hiroshi Date¹

¹Kyoto University Hospital, Kyoto, Japan; ²Fukuoka University Hospital, Fukuoka, Japan

Invited Discussant: Anthony W. Kim

120. Clinical Validation of the Canada Lymph Node Score for Endobronchial Ultrasound

Richard He¹, Danielle A. Hylton², Eric L.R. Bédard¹, Scott Johnson¹, Bryce Laing¹, Azim Valji¹, Wael C. Hanna², Simon R. Turner¹

¹University of Alberta, Edmonton, AB, Canada; ²McMaster University, Hamilton, ON, Canada

Invited Discussant: Joseph B. Shrager

121. Bilateral Ultrasound-Guided Erector Spinae Plane Block for Postoperative Pain Management After Surgical Repair of Pectus Excavatum: A Retrospective Study

Silvia Fiorelli, Cecilia Menna, Claudio Andreetti, Valentina Peritore, Domenico Massullo, Monica Rocco, Erino Angelo Rendina, Mohsen Ibrahim

Sant'Andrea Hospital, Rome, Italy

Invited Discussant: Linda Martin

LB18. Extended Resections for Advanced Stages T3/T4 NSCLC Including N2 Disease After Neoadjuvant Treatment: Results and Conclusions of SAKK Pooled Analysis (16/96, 16/00, 16/01)

Katarzyna Furrer¹, Walter Weder¹, Daniel Betticher², Miklos Pless³, Roger Stupp⁴, Thorsten Krueger⁵, Jean Yannis Perentes⁵, Ralph A. Schmid⁶, Didier Lardinois⁷, Markus Furrer⁸, Martin Frueh⁹, Solange Peters⁵, Alessandra Curioni-Fontecedro¹, Rolf A Stahel¹, Sacha Rothschild⁷, Eric Innocents Eboulet¹⁰, Stephanie Hayoz¹⁰, Sandra Thierstein¹⁰, Christine Biaggi¹⁰, Isabelle Opitz¹

¹University Hospital Zurich, Zurich, Switzerland; ²Cantonal Hospital Freiburg, Freiburg, Switzerland; ³Cantonal Hospital Winterthur, Winterthur, Switzerland; ⁴Northwestern University Feinberg School of Medicine, Chicago, IL; ⁵University Hospital Lausanne, Lausanne, Switzerland; ⁶Bern University Hospital, Bern, Switzerland; ⁷University Hospital Basel, Basel, Switzerland; ⁸Cantonal Hospital Graubunden, Chur, Switzerland; ⁹Cantonal Hospital St. Gallen, St. Gallen, Switzerland; ¹⁰Swiss Group for Clinical Cancer Research (SAKK) Coordinating Center, Bern, Switzerland

Invited Discussant: Michael Lanuti

PANEL DISCUSSION

3:50PM–4:05PM

BREAK

SATURDAY AFTERNOON, MAY 1, 2021
4:05PM–5:50PM

**GENERAL THORACIC
Simultaneous Scientific Sessions**

MY BEST THORACIC ROBOTIC CASE

Moderators: Mark R. Dylewski, *Institute for Thoracic Surgery, South Miami, FL*
James M. Wudel, *Cleveland Clinic Foundation*

Resection of Central Mediastinal Adenoma

Richard S. Lazzaro, *Hofstra, Lenox Hill Hospital*

Robotic Belsey

Abbas El-Sayed Abbas, *Lewis Katz School of Medicine at Temple University, Temple University Hospital and Fox Chase Cancer Center*

Bisegmentectomy and Intraoperative Imaging

Samuel S. Kim, *Northwestern University School of Medicine, Chicago, IL*

Intrathoracic Tissue Flaps

Usman Ahmad, *Cleveland Clinic Case Western Reserve Medical School, Cleveland Clinic*

Chest Wall Resection

Lana Y. Schumacher, *Harvard Medical School, Massachusetts General Hospital*

Pancoast Tumor

Laurence Spier, *NYU Langone Medical Center*

Right Upper Lobe Sleeve Resection

Michael Zervos, *New York University Medical Center, New York, NY*

PANEL DISCUSSION

SUNDAY MORNING, MAY 2, 2021

9:00AM–10:45AM

ADULT CARDIAC Simultaneous Scientific Sessions

ADVANCED OPCAB TECHNIQUES

Moderators: John D. Puskas, *Icahn School of Medicine at Mount Sinai, Mount Sinai Morningside (St. Luke's)*
Tohru Asai, *Juntendo University, Juntendo University Hospital*

Current Status of OPCAB Adoption

Mario F.L. Gaudino, *Weill Cornell, NewYork-Presbyterian Hospital*

Does OPCAB Require Specialized Advanced Training?

Michael E. Halkos, *Emory University, Emory Healthcare*

137. Comparison of On- versus Off-Pump Revascularization for Left Main Disease: Insights from the Excel Trial

Craig M. Jarrett¹, Marc Pelletier¹, Yasir Abu-Omar¹, Cristian Baeza¹, Yakov Elgudin¹, Alan Markowitz¹, Zhipeng Zhou², Ovidiu Dressler², Arie Pieter Kappetein³, Patrick W. Serruys^{4,5}, Gregg W. Stone^{2,6}, Joseph F. Sabik, III¹

¹University Hospitals Cleveland Medical Center, Cleveland, OH; ²Cardiovascular Research Foundation, New York, NY; ³Erasmus Medical Center, Rotterdam, Netherlands; ⁴Imperial College of Science, Technology and Medicine, London, United Kingdom; ⁵National University of Ireland, Galway, Ireland; ⁶Icahn School of Medicine at Mount Sinai, New York, NY

Invited Discussant: Rosemary F. Kelly

Equivalent Graft Patency When Performed by Off-Pump Experts

David P. Taggart, *Oxford University, Oxford University Hospitals*

Creative Sequential and Composite Grafting Tricks to Revascularize All Territories

David Glineur, *Ottawa University, Ottawa Heart Institute*

Off-Pump Coronary Endarterectomy

Shuichiro Takanashi, *International University of Health and Welfare, Kawasaki Saiwai Hospital*

PANEL DISCUSSION

ARRHYTHMIA SURGERY AND LEFT ATRIAL APPENDAGE SURGERY DEVICES

Moderators: Ko Bando, *The Jikei University School of Medicine, Jikei University Hospital*
Piotr Suwalski, *Center of Postgraduate Medical Education, Central Clinical Hospital of Ministry of Interior and Administration*

LAA Closure: Transitioning from Oversewing to Clip Devices

Vinay Badhwar, *West Virginia University, WVU Heart and Vascular Institute*

138. Improved Stroke-Free Survival with Routine Left Atrial Appendage Closure During Mitral Repair

Joanna Chikwe¹, Amy Roach¹, Dominic Emerson¹, Achille Peiris¹, Georgina Rowe¹, George Gill¹, Asma Hussaini¹, Danny Ramzy¹, Wen Cheng¹, Natalia Egorova², Alfredo Trento¹

¹Cedars-Sinai Medical Center, Los Angeles, CA; ²Icahn School of Medicine at Mount Sinai, New York, NY

Invited Discussant: Ralph J. Damiano, Jr.

139. Surgical Ablation for Atrial Fibrillation Is Efficacious in Patients with Large Left Atria

Martha M.O. McGilvray, Nadia H. Bakir, Meghan O. Kelly, Laurie A. Sinn, Hersh S. Maniar, Christian W. Zemlin, Richard B. Schuessler, Marc R. Moon, Spencer J. Melby, Ralph J. Damiano, Jr.

Washington University School of Medicine, St. Louis, MO

Invited Discussant: Marc Gillinov

140. Impact of Atrial Fibrillation Duration on Pacemaker Implantation After Cryomaze Procedure for Persistent Atrial Fibrillation

Takashi Kakuta, Satsuki Fukushima, Kimito Minami, Tetsuya Saito, Naonori Kawamoto, Naoki Tadokoro, Ayumi Ikuta, Tomoyuki Fujita

National Cerebral and Cardiovascular Research Center, Suita, Japan

Invited Discussant: Hersh Maniar

Ablation Energy Sources: Cryo

Niv Ad, *University of Maryland, Adventist White Oak Medical Center*

Ablation Energy Sources: RF

Marc W. Gerdisch, *Loyola University Chicago, Franciscan Health Heart Center*

PANEL DISCUSSION

MINIMALLY INVASIVE AND ROBOTIC APPROACHES TO MITRAL VALVE SURGERY

Moderators: Joseph Lamelas, *University of Miami, University of Miami Hospital*
Gloria Faerber, *Friedrich Schiller University Jena, University Hospital Jena*

Sternotomy Is the Gold Standard

Anelechi C. Anyanwu, *Mount Sinai Medical Center*

Partial Sternotomy Is Best

Vincent Gaudiani, *El Camino Hospital*

Right Thoracotomy Is Best

Kazuma Okamoto, *Akashi Medical Center*

Robotic Is Best

Aubrey Almeida, *Monash Medical Centre*

Should We Always Use Percutaneous Access and Closure of the Femoral Artery?

T. Sloane Guy, IV, *Thomas Jefferson University, Thomas Jefferson University Hospital*

Transthoracic Aortic Cross Clamping Is Optimal

W. Randolph Chitwood, Jr., *East Carolina University, Vidant Medical Center*

Intra-Aortic Balloon Occlusion Is Optimal

W. Clark Hargrove, III, *University of Pennsylvania, Penn/Presbyterian Medical Center*

Perfused Beating Heart Has Its Role

Hirokuni Arai, *Tokyo Medical and Dental University, Tokyo Medical and Dental University Medical Hospital*

PANEL DISCUSSION

REIMPLANTATION VALVE SPARING AORTIC ROOT REPLACEMENT GRAFT SELECTION AND CONFIGURATION

Moderators: Duke E. Cameron, *Harvard University, Massachusetts General Hospital*
Y. Joseph Woo, *Stanford University, Stanford Hospital*

Valsalva Graft Provides Optimal Neosinuses

Ruggero De Paulis, *Unicamillus, European Hospital*

Annular and SinoTubular Junction Plication

Gébrine El Khoury, *UCL, Cliniques Universitaires St-Luc*

Neosinus Creation via the Stanford Modification

D. Craig Miller, *Stanford University, Stanford University Medical Center*

141. Single-Center 25-Years Experience with Valve-Sparing Aortic Root Replacement Using a Straight Tube Graft (David I Procedure)

Malakh Shrestha, Erik Beckmann, Tim Kaufeld, Heike Krueger, Andreas Martens, Axel Haverich

Hannover Medical School, Hannover, Germany

Invited Discussant: Tirone E. David

142. Long-Term Outcomes Following Valve Sparing Root Replacement with Concomitant Mitral Valve Repair

Maral Ouzounian¹, Myriam Lafreniere-Roula², Carolyn David¹, Jennifer C.Y. Chung¹, Tirone E. David¹

¹Toronto General Hospital, Toronto, ON, Canada; ²University of Toronto, Toronto, ON, Canada

Invited Discussant: Laurent De Kerchove

CV15. Bicuspid Aortic Valve Repair with Valve-Sparing Root Replacement

John J. Kelly¹, Christopher Mehta², Brittany J. Cannon¹, Nimesh Dilip Desai¹, Joseph E. Bavaria¹

¹University of Pennsylvania, Philadelphia, PA; ²Northwestern University, Chicago, IL

PANEL DISCUSSION

TRICUSPID VALVE REPAIR

Moderators: Song Wan, *The Chinese University of Hong Kong, Prince of Wales Hospital, Hong Kong*
Patrick M. McCarthy, *Northwestern University, Northwestern Memorial Hospital*

Indications, Timing, and ECHO Parameters in Surgery for Tricuspid Regurgitation

Rebecca T. Hahn, *Columbia University, The New York Hospital*

Moderate Tricuspid Regurgitation: Repair or Not?

Gilles D. Dreyfus, *Paris University Pierre et Marie Curie, Institut Montsouris Paris France*

Tricuspid Leaflet Repair Techniques

Phan Van Nguyen, *Heart Institute Ho Chi Minh City*

Pacemaker Lead Impingement: Repair or Replace?

Michele De Bonis, *Vita-Salute San Raffaele University, IRCCS San Raffaele Hospital, Milan, Italy*

Clip Repairs of TR

Rahul Sharma, *Stanford University, Stanford Hospital*

Transcatheter Annuloplasty Devices

Thomas Modine, *Bordeaux University Hospital, Hôpital Haut leveque*

Transcatheter TV Replacement

Hendrik Treede, *Rheinische Friedrich-Wilhelms-University Bonn, University Hospital Bonn*

TYPE A AORTIC DISSECTION 1

Moderators: Steven L. Lansman, *New York Medical College, Westchester Medical Center*
Eric E. Roselli, *CCLCM, Cleveland Clinic*

KEYNOTE LECTURE

Insight into Novel Mechanisms of Aorto and Atherosclerosis—Is Aortic Dissection a Disease of the Vaso Vasorum?
Axel Haverich, *Hannover Medical School*

143. Surgical Management and Outcomes in Patients with Acute Type A Aortic Dissection and Cerebral Malperfusion—Insights from a Multicenter Study
Igor Vendramin¹, Daniela Piani¹, Francesco Onorati², Stefano Salizzoni³, Augusto D’Onofrio⁴, Luca Di Marco⁵, Giuseppe Gatti⁶, Giuseppe Faggian², Mauro Rinaldi³, Gino Gerosa⁴, Davide Pacini⁵, Aniello Pappalardo⁶, Ugolino Livi¹
¹University Hospital of Udine, Udine, Italy; ²Azienda Ospedaliero-Universitaria di Verona, Verona, Italy; ³Azienda Ospedaliero-Universitaria di Torino, Torino, Italy; ⁴Azienda Ospedaliera-Università di Padova, Padova, Italy; ⁵Azienda Ospedaliera-Università di Bologna, Bologna, Italy; ⁶Azienda Sanitaria Universitaria Giuliana Isontina, Trieste, Italy
Invited Discussant: Mohamad Bashir

Type A Dissection with Distal Malperfusion: Repairing the Type A Will Usually Correct the Malperfusion
Arnar Geirsson, *Yale, Yale New Haven Hospital*

Type A Dissection with Distal Malperfusion: Correct the Malperfusion First Then Repair the Type A
Himanshu J. Patel, *Michigan Medicine*

Type A Dissection with Neurologic Injury: Should We Operate on All, Including Coma?
Yutaka Okita, *Kobe University, Takatsuki General Hospital*

Type A Dissection with Cerebral Malperfusion: Carotid Perfusion First
Thomas G. Gleason, *Harvard Medical School, Brigham and Women’s Hospital*

CV16. Fenestrated Frozen Elephant Trunk Repair of Type A Aortic Dissection
Yuting Chiang, Isaac George, Hiroo Takayama
Columbia University Irving Medical Center, New York, NY

PANEL DISCUSSION

10:45AM–11:00AM **BREAK**

SUNDAY MORNING, MAY 2, 2021
11:00AM–1:20PM

SUGARBAKER MEMORIAL LECTURE
11:00AM–11:30AM

The von Hippel-Lindau Hereditary Cancer Syndrome: Insights into Oxygen Sensing and Cancer
Guest Lecturer: William G. Kaelin, Jr., *2019 Nobel Laureate*
Howard Hughes Medical Institute, Dana-Farber Cancer Institute

ADULT CARDIAC
11:30AM–12:35PM

PLENARY

Moderators: Joanna Chikwe, *UCLA, Cedars-Sinai*
Y. Joseph Woo, *Stanford University, Stanford Hospital*

155. CABG Public Star Ratings and Program Performance: The Intersection Between Statistics, Perceptions, and Reality
Hiba Ghandour¹, Ozgun Erten¹, Mario Gaudino², Edward Soltesz¹, Tara Karamlou¹, Aaron Weiss¹, Eric Roselli¹, A. Marc Gillinov¹, John Puskas³, Todd Rosengart⁴, Danny Chu⁵, Husam Balkhy⁶, John Stulak⁷, Deepak Bhatt⁸, Bradley Taylor⁹, Anthony Warmuth¹, Marco Zenati¹⁰, Eugene Blackstone¹, Lars Svensson¹, Faisal Bakaeen¹
¹Cleveland Clinic, Cleveland, OH; ²Weill Cornell, NewYork-Presbyterian Hospital, New York, NY; ³Icahn School of Medicine at Mount Sinai, New York, NY; ⁴Baylor College of Medicine, Houston, TX; ⁵University of Pittsburgh, Pittsburgh, PA; ⁶University of Chicago, Chicago, IL; ⁷Mayo Clinic, Rochester, MN; ⁸Brigham and Women’s Hospital and Harvard Medical School, Boston, MA; ⁹University of Maryland, Baltimore, MD; ¹⁰VABHCS and Brigham and Women’s Hospital, Harvard Medical School, Boston, MA
Invited Discussant: Anelechi C. Anyanwu

156. Impact of Aortic Valve Effective Height Following Valve-Sparing Root Replacement on Postoperative Insufficiency and Reoperation
Puja Kachroo, Meghan O. Kelly, Nadia H. Bakir, Catherine Cooper, Nicholas T. Kouchoukos, Marc R. Moon
Barnes Hospital, Saint Louis, MO
Invited Discussant: Tirone E. David

157. Delineating the Optimal Circulatory Arrest Temperature for Aortic Hemiarch Replacement with Antegrade Cerebral Perfusion Strategy: An Analysis of the Society of Thoracic Surgeons National Database

Laura Seese¹, Edward Chen², Vinay Badhwar³, Jeffrey Jacobs⁴, Vinod Thourani⁵, Faisal Bakaeen⁶, Dylan Thibault⁷, Sean O'Brien⁷, Oliver Jawitz⁷, Brittany Zwischenberger⁸, Thomas Gleason⁹, Ibrahim Sultan¹, Arman Kilic¹, Joseph Coselli¹⁰, Lars Svensson⁶, Robert Habib¹¹, Joanna Chikwe¹², Danny Chu¹

¹University of Pittsburgh School of Medicine, Pittsburgh, PA; ²Emory University, Atlanta, GA; ³West Virginia University, Morgantown, WV; ⁴University of Florida, Gainesville, FL; ⁵Piedmont Heart Institute, Atlanta, GA; ⁶Cleveland Clinic Foundation, Cleveland, OH; ⁷Duke Clinical Research Institute, Durham, NC; ⁸Duke University, Durham, NC; ⁹Brigham and Women's Hospital/Harvard Medical School, Boston, MA; ¹⁰Baylor College of Medicine, Houston, TX; ¹¹Society of Thoracic Surgeons, Chicago, IL; ¹²Cedars-Sinai Medical Center Smidt Heart Institute, Los Angeles, CA

Invited Discussant: Joseph E. Bavaria

158. Surgical Explantation After Transcatheter Aortic Valve Replacement (TAVR) Failure: Midterm Outcomes from the Explant-TAVR International Registry

Vinayak N. Bapat¹, Syed Zaid², Shekhar Saha³, Christian Hagl³, Ketii Vitanova⁴, Michael Mack⁵, Paolo Denti⁶, Thomas Modine⁷, Tsuyoshi Kaneko⁸, Gilbert Tang⁹

¹Minneapolis Heart Institute, Minneapolis, MN; ²Westchester Medical Center, Valhalla, NY; ³LMU Klinikum, Munich, Germany; ⁴Germany Heart Center, Munich, Germany; ⁵Baylor Scott & White Health, Plano, TX; ⁶San Raffaele Hospital, Milan, Italy; ⁷CHU Bordeaux, Bordeaux, France; ⁸Brigham and Women's Hospital, Boston, MA; ⁹Mount Sinai Hospital, New York, NY

Invited Discussant: Vinod H. Thourani

12:35PM–12:50PM

LB25. The Impact of Receiving an Award from the American Association for Thoracic Surgery Foundation

Edgar Aranda-Michel¹, James D. Luketich¹, Rashmi Rao¹, Victor O. Morell¹, George J. Arnaoutakis², Arman Kilic¹, Courtenay Dunn-Lewis¹, Ibrahim Sultan¹

¹University of Pittsburgh, Pittsburgh, PA; ²University of Florida, Gainesville, FL

Invited Discussant: Mehmet C. Oz

LEGACY LECTURE

12:50PM–1:20PM

Spirit and Legacy of Innovation

W. Randolph Chitwood, Jr., East Carolina University, Vidant Medical Center

1:20PM–1:35PM

BREAK

1:35PM–2:35PM

LUNCH

2:35PM–2:50PM

BREAK

SUNDAY AFTERNOON, MAY 2, 2021

2:50PM–4:35PM

**ADULT CARDIAC
Simultaneous Scientific Sessions**

ENDOCARDITIS

Moderators: Pierre Voisine, Laval University, Quebec Heart and Lung Institute
Joseph C. Cleveland, Jr., University of Colorado Anschutz Medical Center, University of Colorado Hospital

The Opioid Epidemic, Endocarditis, and Early Surgery

Arnar Geirsson, Yale, Yale New Haven Hospital

Repair Strategies for Endocarditis

Rudiger S. Lange, TUM, German Heart Center Munich

167. Mitral Valve Endocarditis: Observing the Impact of Patient Factors, Echocardiographic Parameters and Operative Findings on Surgical Outcomes

Ryan Moore, Raphaelle Chemtob, James Witten, Ashley Lowry, A. Marc Gillinov, Lars Svennson, Eugene Blackstone, Gosta Pettersson, Per Wierup
Cleveland Clinic Foundation, Cleveland, OH

Invited Discussant: James E. Davies, Jr.

CV17. The Operative Management of an Acquired Gerbode Ventricular Septal Defect Due to Infective Endocarditis

David Williams, Jonathan Hyde, Eddie Louie, Stanley Schrem, Deane Smith, Aubrey Galloway

New York University Langone Health, New York, NY

CV18. Tricuspid Valve Repair with Pericardial Leaflet Reconstruction for Infective Endocarditis

Timothy S. Lancaster, Rachel Lee, Puja Kachroo, Marc R. Moon

Washington University, Saint Louis, MO

Aortic Root Abscess—Homograft or Biovalve Conduit?

Arminder Jassar, Harvard University, Massachusetts General Hospital

How to Reconstruct the Destroyed AortoMitral Junction and LVOT

Gosta B. Petterson, Case Western, Cleveland Clinic

PANEL DISCUSSION

HEART TRANSPLANT ADVANCES

Moderators: Sara J. Shumway, *University of Minnesota, University of Minnesota Medical Center*
Ashish Shah, *Vanderbilt University, Vanderbilt University Medical Center*

Ex Vivo Organ Preservation Systems

Carmelo A. Milano, *Duke University, Duke University Medical Center*

168. Impact of UNOS Listing Policy Changes on Utilization and Outcomes of Patients Bridged to Heart Transplant with Intra-Aortic Balloon Pump

Gillian O'Connell, Andrew Melehy, Paul Kurlansky, Yuming Ning, Veli Topkara, Farhana Latif, Maryjane A. Farr, Gabriel Sayer, Nir Uriel, Yoshifumi Naka, Koji Takeda
Columbia University Medical Center, New York, NY

Invited Discussant: Robert S. Higgins

169. Left Ventricular Oversizing > +50% Is Associated with Poorer Outcomes After Heart Transplantation

Andre Critsinelis¹, Taylor Nordan², Camille Hironaka², Yong Zhan², Frederick Y. Chen², Gregory S. Couper², Masashi Kawabori²

¹Mount Sinai Medical Center, Miami Beach, FL; ²Tufts Medical Center, Brookline, MA

Invited Discussant: Shu S. Lin

LB26. The First Clinical Heart Transplantation in The United States from Donation After Cardiac Death (DCD) Using Normothermic Regional Perfusion (NRP)

Deane E. Smith, Zachary N. Kon, Julius A. Carillo, Claudia G. Gidea, Greta L. Piper, Amy L. Friedman, Jennifer Pavone, Alex Reyentovich, Robert Montgomery, Aubrey C. Galloway, Nader Moazami
NYU Langone, New York, NY

Invited Discussant: Carmelo A. Milano

171. Should Hearts from Hepatitis C NAT+ Donors Continue to Be Transplanted? A UNOS Registry Analysis

Yu Xia, William Ragalie, Nathan Airhart, Joanna Schaeman, Abbas Ardehali
UCLA, Los Angeles, CA

Invited Discussant: Ashish Shah

Extended Applications for Heart-Lung Transplantation

Yasuhiro Shudo, *Stanford University School of Medicine, Stanford University Hospital*

172. Cardiac Xenotransplantation from Genetically Modified Swine with Growth Hormone Knockout and Multiple Human Transgenes Prevents Accelerated Diastolic Graft Failure

Corbin Goerlich^{1,2}, Bartley Griffith¹, Avneesh Singh¹, Mohamed Abdullah¹, Shreya Singireddy¹, Irina Kolesnik¹, Billela Lewis¹, Ivan Tatarov¹, Alena Hershfild¹, Tianshu Zhang¹, Patrick Odonkor¹, Erik Strauss¹, Brittney Williams¹, Ali Tabatabai¹, Adnan Bhutta¹, David Ayares³, David Kaczorowski¹, Muhammad Mohiuddin¹

¹University of Maryland School of Medicine, Baltimore, MD; ²Johns Hopkins School of Medicine, Baltimore, MD; ³Revivacor, Blacksburg, VA

Invited Discussant: Ravi K. Ghanta

INNOVATIONS IN CABG

Moderators: Ari A. Mennander, *Tampere University Finland, Tampere University Heart Hospital*
Clifford W. Barlow, *Southampton, Southampton General*
Panelists: Craig M. Jarrett, *Case Western Reserve University, University Hospitals Cleveland Medical Center*
Carlo M. Rosati, *Mount Sinai, Mount Sinai Morningside*
Sigrid E. Sandner, *Medical University of Vienna, Vienna General Hospital*
Kevin Hodges, *Cleveland Clinic*

Intraoperative Graft Patency Assessment

George Tolis, Jr., *Harvard Medical School, Massachusetts General Hospital*

174. Factors Determining Perfect Vein Graft Patency at 2 Years After Coronary Artery Bypass Grafting

Sigrid E. Sandner¹, T. John Donovan², Cha Rajakaruna³, Umberto Benedetto³, Joseph Zacharias⁴, Leonid Ladyshenskij⁵, Ravi De Silva⁶, Nikolaos Bonaros⁷, Gil Bolotin⁸, Stephan Jacobs⁹, Matthias Thielmann¹⁰, Yeong-Hoon Choi¹¹, Sunil Ohri¹², Philipp Angleitner¹, Ivar Friedrich², David P. Taggart¹³

¹Medical University of Vienna, Vienna, Austria; ²Krankenhaus der Barmherzigen Brüder Trier, Trier, Germany; ³University Hospital Bristol, Bristol, United Kingdom; ⁴Blackpool Victoria Hospital, Blackpool, United Kingdom; ⁵Immanuel Klinikum Bernau Herzzentrum Brandenburg, Bernau, Germany; ⁶Papworth Hospital, Cambridge, United Kingdom; ⁷Medical University of Innsbruck, Innsbruck, Austria; ⁸Rambam Medical Center, Rambam, Israel; ⁹German Heart Center Berlin, Berlin, Germany; ¹⁰University Hospital Essen, Essen, Germany; ¹¹Kerckhoff Heart Center, Bad Nauheim, Germany; ¹²University Hospital Southampton, Southampton, United Kingdom; ¹³University of Oxford, John Radcliffe Hospital, Oxford, United Kingdom

Invited Discussant: Thomas A. Burdon

CV19. Stentectomy/Endarterectomy for Left Anterior Descending Coronary Artery “Full Metal Jacket” with In-Stent Restenosis

Carlo M. Rosati¹, Minh Quan Vu¹, Maroun Yammine¹, Aarti Patil¹, Samin K. Sharma², John D. Puskas¹

¹Mount Sinai Morningside, New York, NY; ²Mount Sinai Health System, New York, NY

CV20. Massive Left Main Coronary Artery Aneurysm Treated with In-Situ Reconstruction + Mitral Repair

Eric E. Roselli, Gosta Pettersson
Cleveland Clinic, Cleveland, OH

PANEL DISCUSSION

PRESIDENTIAL MASTER CLASS

Moderators: Vaughn A. Starnes, *University of Southern California, Keck Medical Center*
Marc R. Moon, *Washington University School of Medicine/ Division of CT, Barnes Jewish Hospital*

All Arterial CABG

Craig R. Smith, *Columbia University, Columbia University Irving Medical Center of New York-Presbyterian Hospital*

Transaortic Ventricular Septal Myomectomy for HOCM

Hartzell V. Schaff, *Mayo Clinic*

Complex Barlow MV Repair

David H. Adams, *Mount Sinai Health System*

Aortic Annular Enlargement Options

Pedro J. del Nido, *Harvard Medical School, Boston Children's Hospital*

Valve Sparing Aortic Root Replacement

Duke E. Cameron, *Harvard University, Massachusetts General Hospital*

Sundt Calcified Homograft

Thoralf M. Sundt, III, *Harvard University, Massachusetts General Hospital*

Type 2 TAAA Repair

Joseph S. Coselli, *Baylor College of Medicine, Baylor St. Luke's Medical Center Hospital*

SECONDARY MITRAL REGURGITATION REPAIR TECHNIQUES AND OUTCOMES

Moderators: Steven F. Bolling, *University of Michigan, Michigan Medicine*
Robert E. Michler, *Albert Einstein College of Medicine, Montefiore Medical Center*

175. Surgical Strategy and Outcomes for Atrial FMR: All FMR Is Not the Same!

Catherine M. Wagner, Alexander A. Brescia, Tessa M.F. Watt, Liza M. Rosenbloom, Nicolas N. Ceniza, Grace E. Markey, Gorav Ailawadi, Matthew A. Romano, Steven F. Bolling
University of Michigan, Ann Arbor, MI

Invited Discussant: Song Wan

Subvalvular Repair Techniques in Secondary MR

Hermann Reichenspurner, *University of Hamburg, University Heart & Vascular Center Hamburg*

176. Mitral Valve Repair with Bilateral Papillary Muscle Relocation in the Direction of the Anterior Mitral Annulus Improves the Long-Term Outcomes for Functional Mitral Regurgitation

Keiji Oi, Hirokuni Arai, Tomohiro Mizuno, Eiki Nagaoka, Masafumi Yashima, Tatsuki Fujiwara, Kiyotoshi Oishi, Masashi Takeshita, Yoshun Sai, Tomoki Tahara
Tokyo Medical and Dental University, Tokyo, Japan

Invited Discussant: Song Wan

177. Comparative Effects of Papillary Muscle Apical-Basal Hoisting and Papillary Muscle Lateral Approximation on Mitral Valve Hemodynamics and Kinematics in Functional Mitral Regurgitation

Elorm J. Agra, Kirthana Suresh, Qi He, Daisuke Onohara, Muralidhar Padala
Emory University, Atlanta, GA

Invited Discussant: Spencer J. Melby

Initial Clinical Experience with Mitral Valve Translocation

James S. Gammie, *University of Maryland Medical Center*

Mitral Valve Replacement Is the Most Durable Solution for Secondary MR

Michael A. Acker, *Hospital of the University of PA, CT Surgery, Hospital of the University of PA*

178. Mitral Valve Replacement in Patients 50–70 Years of Age—A Propensity Matched Cohort

Dror B. Leviner, Barak Zafrir, Shirel Yossefi, Walid Saliba, Erez Sharoni
Carmel Medical Center, Haifa, Israel

Invited Discussant: Joanna Chikwe

TYPE A AORTIC DISSECTION 2

Moderators: Thomas M. Beaver, *University of Florida College of Medicine, Shands*
Prashanth Vallabhajosyula, *Yale University, Yale New Haven Hospital*

Aortic Dissection Guidelines

S. Chris Malaisrie, *Northwestern University, Northwestern Memorial Hospital*

Central Cannulation Is Safe, Effective, and Efficient

John Frederick, *University of Pennsylvania Medical School*

When Are Bentall and Total Arch Indicated in Type A Dissection?

Michael P. Fischbein, *Stanford University, Stanford University Medical Center*

Who and When Should Receive Valve Sparing Aortic Root Replacement in Type A Dissection

Michael A. Borger, *University of Leipzig, Leipzig Heart Center*

179. The Role of False Lumen Area Ratio on Late Aortic Events After Open Repair of Non-Syndromic Acute Type I Aortic Dissection

Jung-Hwan Kim, Seung Hyun Lee, Sak Lee, Young-Nam Youn, Kyung-Jong Yoo, Hyun-Chel Joo

Yonsei University College of Medicine, Seoul, Republic of Korea

Invited Discussant: R. Scott Mitchell

CV21. Valve-Sparing Root Replacement with Zone 2 Arch for Type A Dissection

Nimesh D. Desai, John J. Kelly, Christopher K. Mehta, Brittany Cannon, Joseph E. Bavaria
University of Pennsylvania, Philadelphia, PA

PANEL DISCUSSION

LB28. 27 Year Odyssey with T. David Valve-Sparing Aortic Root Replacement in 577 patients

Elizabeth H. Stephens¹, Andrea R. Witte², David H. Liang², R. Scott Mitchell²,
Christiane Haeffele², Christine O. Keskwa², Michael P. Fischbein², D. Craig Miller²
¹Mayo Clinic, Rochester, MN; ²Stanford University, Stanford, CA

Invited Discussant: S. Chris Malaisrie

SUNDAY MORNING, MAY 2, 2021

9:00AM–10:45AM

**CONGENITAL
Simultaneous Scientific Sessions**

AORTA AND PULMONARY VALVES 2

Moderators: Robert D.B. Jaquiss, *UT Southwestern Medical Center, Children's Medical Center*

David J. Barron, *University of Toronto, Hospital for Sick Children*

Surgical Management of Complex Aortic Valve Disease in Young Adults: Repair, Replace, Ozaki, TAVR, Ross

Emile A. Bacha, *Columbia University, NewYork-Presbyterian*

144. Optimizing Evaluation and Predictive Utility in Pediatric Marfan Syndrome: Novel Longitudinal Metrics to Track Growth of Aortic Structures

Salima Bhimani, Abdelrahman Rahmy, Justin Jin, Rukmini Komarlu, Kenneth Zahka, Suzie Kim, Vidyasagar Kalahasti, Lars G. Svensson, Milind Desai, Eric Roselli, Hani K. Najm, Gosta Pettersson, Jeevanatham Rajeswaran, Amol Pande, Tara B. Karamlou
Cleveland Clinic, Cleveland, OH

Invited Discussant: Luca A. Vricella

145. Predictors of Left Ventricular Outflow Tract Obstruction Following Neonatal Arch Repair: Role of Computed Tomography

Dong-Hee Kim¹, Eun Seok Choi¹, Bo Sang Kwon¹, Tae-Jin Yun¹, Dong Hyun Yang²,
Chun Soo Park¹

¹Division of Pediatric Cardiac Surgery, Department of Thoracic and Cardiovascular Surgery, University of Ulsan College of Medicine, Asan Medical Center, Seoul, Republic of Korea; ²Department of Radiology, University of Ulsan College of Medicine, Asan Medical Center, Seoul, Republic of Korea

Invited Discussant: Ronald K. Woods

146. One Year Results of a Novel PTFE-Based Pulmonary Valved Conduit in a Pediatric Patient Population

Pedro J. del Nido¹, Mark Galantowicz², Carl Backer³, Christopher Baird¹

¹Boston Children's Hospital, Boston, MA; ²Nationwide Children's Hospital, The Ohio State University College of Medicine, Columbus, OH; ³UK HealthCare Kentucky Children's Hospital, University of Kentucky, Lexington, KY

Invited Discussant: James A. Quintessenza

147. Risk Factors of Early Adverse Outcomes After Right Ventricular Outflow Tract Reconstruction with Bovine Jugular Vein Conduit

Dong-Hee Kim, Young Kern Kwon, Eun Seok Choi, Bo Sang Kwon, Chun Soo Park, Tae-Jin Yun

Division of Pediatric Cardiac Surgery, Department of Thoracic and Cardiovascular Surgery, University of Ulsan College of Medicine, Asan Medical Center, Seoul, Republic of Korea

Invited Discussant: Max B. Mitchell

148. Handmade Tri-leaflet ePTFE Conduits versus Homograft for RVOT Reconstruction: An Institutional Experience

Guanxi Wang, Sr., Kai Ma, Sr., Rui Liu, Shoujun Li
Fuwai Hospital, Beijing, China

Invited Discussant: Christoph Haller

LB24. A Novel Tri-Cuspidalization Technique to Reconstruct Neo-aortic Valve in Children: Early Results in Single Center

Huifeng Zhang, Bing Jia
Children's Hospital of Fudan University, Shanghai, China

Invited Discussant: Yves d'Udekem

10:45AM–11:00AM **BREAK**

SUNDAY MORNING, MAY 2, 2021
11:00AM–1:20PM

SUGARBAKER MEMORIAL LECTURE
11:00AM–11:30AM

The von Hippel-Lindau Hereditary Cancer Syndrome: Insights into Oxygen Sensing and Cancer

Guest Lecturer: William G. Kaelin, Jr., 2019 Nobel Laureate
Howard Hughes Medical Institute, Dana-Farber Cancer Institute

CONGENITAL
11:30AM–12:35PM

PLENARY

Moderators: Christopher A. Caldarone, *Baylor College of Medicine, Texas Children's Hospital*
Luca A. Vricella, MD, *Advocate Children's Hospital; University of Chicago Medicine*

159. Staged Ventricular Recruitment and Biventricular Conversion Following Single-Ventricle Palliation in Unbalanced Atrioventricular Canal Defects

Nicholas A. Oh¹, Ilias P. Doulamis², Alvise Guariento³, Breanna Piekarski², Gerald R. Marx², Pedro J. del Nido², Sitiram Emani²

¹Cleveland Clinic Foundation, Cleveland, OH; ²Boston Children's Hospital, Boston, MA; ³Hospital for Sick Children, Toronto, ON, Canada

Invited Discussant: David M. Overman

160. Ventriculo-Septoplasty for Hypertrophic Obstructive Cardiomyopathy in Children

Edward Buratto, Igor E. Konstantinov, Christian P. Brizard
Royal Children's Hospital, Melbourne, Parkville, Australia

Invited Discussant: Joseph A. Dearani

161. Atrial Fenestration During Atrioventricular Septal Defect Repair Is Associated with Increased Mortality

Connor P. Callahan¹, Anusha Jegatheeswaran¹, David J. Barron¹, Osami Honjo¹, Pirooz Eghtesady², David M. Overman³, Eugene H. Blackstone⁴, Jeevanantham Rajeswaran⁴, Karthik Ramakrishnan⁵, Adil Husain⁶, Jeffrey P. Jacobs⁷, Jennifer S. Nelson⁸, Anastasios Polimenakos⁹, Christopher A. Caldarone¹⁰, Stephanie M. Fuller¹¹, Robert J. Dabal¹², James K. Kirklin¹², Tharini Paramananthan¹, Alistair Phillips¹³, William M. DeCamp¹⁴, Brian W. McCrindle¹

¹The Hospital for Sick Children, Toronto, ON, Canada; ²St. Louis Children's Hospital, St. Louis, MO; ³The Children's Heart Clinic, Minneapolis, MN; ⁴Cleveland Clinic, Cleveland, OH; ⁵Children's National Health System, Washington, DC; ⁶Primary Children's Medical Center, Salt Lake City, UT; ⁷University of Florida, Gainesville, FL; ⁸Nemours Children's Hospital, Orlando, FL; ⁹Children's Hospital of Georgia, Augusta, GA; ¹⁰Texas Children's Hospital, Houston, TX; ¹¹Children's Hospital of Philadelphia, Philadelphia, PA; ¹²University of Alabama at Birmingham, Birmingham, AL; ¹³Cleveland Clinic Children's, Cleveland, OH; ¹⁴Arnold Palmer Hospital for Children, Orlando, FL

Invited Discussant: Jennifer C. Romano

162. Delayed Strategy of Total Anomalous Pulmonary Venous Connection Repair Improves Survival to Achieve Fontan Completion in Right Atrial Isomerism

Eiri Kisamori, Yasuhiro Kotani, Yosuke Kuroko, Takuya Kawabata, Shingo Kasahara
Okayama University Hospital, Okayama, Japan

Invited Discussant: Rachel D. Vanderlaan

12:35PM–12:50PM

LB25. The Impact of Receiving an Award from the American Association for Thoracic Surgery Foundation

Edgar Aranda-Michel¹, James D. Luketich¹, Rashmi Rao¹, Victor O. Morell¹, George J. Arnaoutakis², Arman Kilic¹, Courtenay Dunn-Lewis¹, Ibrahim Sultan¹

¹University of Pittsburgh, Pittsburgh, PA; ²University of Florida, Gainesville, FL

Invited Discussant: Mehmet C. Oz

LEGACY LECTURE

12:50PM–1:20PM

Spirit and Legacy of Innovation

W. Randolph Chitwood, Jr., East Carolina University, Vidant Medical Center

1:20PM–1:35PM

BREAK

1:35PM–2:35PM

LUNCH

2:35PM–2:50PM

BREAK

SUNDAY AFTERNOON, MAY 2, 2021

2:50PM–4:35PM

**CONGENITAL
Simultaneous Scientific Sessions**

TETRALOGY OUTCOMES

Moderators: Jennifer C. Romano, University of Michigan

John W. Brown, Indiana University, Riley Children's Hospital at IU Health

180. Long-Term Outcomes of Tetralogy of Fallot Repair: Impact of Right Ventriculotomy in Pulmonary Valve Sparing Procedures

Yoshikazu Ono, Takaya Hoashi, Kenta Imai, Naoki Okuda, Kenichi Kurosaki, Hajime Ichikawa

National Cerebral and Cardiovascular Center, Suita, Japan

Invited Discussant: Joseph B. Clark

Transcatheter Approaches to Palliation for Tetralogy of Fallot

Athar Mahmood Qureshi, Baylor College of Medicine, Texas Children's Hospital

181. Late Outcomes of Surgical Reconstruction of Peripheral Pulmonary Arteries: More Than a Decade Experience

Abdulaziz Al-Khaldi¹, Ahmad D. Abuzaid¹, Omar Tamimi², Atif Alsahari¹, Abdulmajeed Alotay¹, Tarek Momenah¹, Juan J. Alfonso¹

¹Prince Sultan Cardiac Center, Riyadh, Saudi Arabia; ²King Fahad Medical City, Riyadh, Saudi Arabia

Invited Discussant: Elisabeth Martin

182. The Impact of Pulmonary Artery Coarctation on Pulmonary Artery Growth in Patients Undergoing Modified Blalock-Taussig Shunt

Yasuhiro Kotani, Sachiko Kadowaki, Yasuyuki Kobayashi, Eiri Kisamori, Junko Kobayashi, Takuya Kawabata, Yosuke Kuroko, Shingo Kasahara

Okayama University, Okayama, Japan

Invited Discussant: James M. Hammel

How and When Should Tetralogy Be Palliated Prior to Complete Repair?

David J. Barron, University of Toronto, Hospital for Sick Children

183. Pulmonary Artery Growth Patterns Following Neonatal Intervention for Variants of Tetralogy of Fallot

Michael O. Murphy, Alain Fraisse, Olivier Ghez, Andreas Hoschtitzky, Guido Michielon, Royal Brompton Hospital, London, United Kingdom

Invited Discussant: S. Adil Husain

LB29. Midterm Results of Clinical Application of In Vivo Tissue-Engineered Vascular Graft for Pulmonary Artery Plasty and Aortic Valve Augmentation

Hisayuki Hongu¹, Masaaki Yamagishi¹, Yoshinobu Maeda¹, Keiichi Itatani¹, Hiroki Nakatsuji¹, Jyunya Nabeshima¹, Takashi Nagase¹, Hitoshi Yaku²

¹Department of Pediatric Cardiovascular Surgery, Children's Medial Center, Kyoto Prefectural University of Medicine, Kamigyo-Ku, Kyoto-Shi, Japan; ²Department of Cardiovascular Surgery, Kyoto Prefectural University of Medicine, Kamigyo-Ku, Kyoto-Shi, Japan

Invited Discussant: Toshiharu Shinoka

SUNDAY MORNING, MAY 2, 2021

9:00AM–10:45AM

**MULTI-SPECIALTY
Simultaneous Scientific Sessions**

**CARDIOTHORACIC ETHICS FORUM: MEASURING SURGICAL
COMPETENCE—WHY, WHEN, HOW, AND WHAT TO DO
ABOUT IT**

Moderators: John W. Entwistle, III, *Thomas Jefferson University,
Thomas Jefferson University Hospital*
Robert M. Sade, *Medical University South Carolina,
Medical University Hospital*

Introduction

Robert M. Sade, *Medical University South Carolina, Medical University Hospital*

Evaluation of Surgical Capabilities Must Be Mandatory

Andrea J. Carpenter, *University of Texas Health Science Center, San Antonio,
University Hospital*

Independent Practice Requires Board Certification

David H. Adams, *Mount Sinai Health System*

Early and Late Career Surgeon Deficiencies in Complex Cases

Marc R. Moon, *Washington University School of Medicine/Division of CT, Barnes Jewish Hospital*

Intermittent Surgeon Evaluation Is Needed from Career's Beginning to End

Christopher M. Feindel, *University of Toronto, Toronto General Hospital*

Declining Surgical Skills: Planning for Transition

Todd K. Rosengart, *Baylor College of Medicine, Baylor St. Luke's Medical Center*

PANEL DISCUSSION

10:45AM–11:00AM

BREAK

SUNDAY MORNING, MAY 2, 2021

11:00AM–1:20PM

SUGARBAKER MEMORIAL LECTURE

11:00AM–11:30AM

**The von Hippel-Lindau Hereditary Cancer Syndrome: Insights into Oxygen
Sensing and Cancer**

Guest Lecturer: William G. Kaelin, Jr., 2019 Nobel Laureate
Howard Hughes Medical Institute, Dana-Farber Cancer Institute

12:35PM–12:50PM

**LB25. The Impact of Receiving an Award from the American Association for
Thoracic Surgery Foundation**

Edgar Aranda-Michel¹, James D. Luketich¹, Rashmi Rao¹, Victor O. Morell¹,
George J. Arnaoutakis², Arman Kilic¹, Courtenay Dunn-Lewis¹, Ibrahim Sultan¹
¹University of Pittsburgh, Pittsburgh, PA; ²University of Florida, Gainesville, FL

Invited Discussant: Mehmet C. Oz

LEGACY LECTURE

12:50PM–1:20PM

Spirit and Legacy of Innovation

W. Randolph Chitwood, Jr., *East Carolina University, Vidant Medical Center*

1:20PM–1:35PM

BREAK

1:35PM–2:35PM

LUNCH

2:35PM–2:50PM

BREAK

SUNDAY MORNING, MAY 2, 2021

9:00AM–10:45AM

**PERIOPERATIVE CARE
Simultaneous Scientific Sessions**

CONTROVERSIES IN ECMO

Moderators: Robin Varghese, *Icahn School of Medicine at Mount Sinai, Mount Sinai Health System*
Nathalie Roy, *Harvard, Boston Children's Hospital*

PCS ECMO: Peripheral or Central?

William Hiesinger, *Stanford University, Stanford Medical Center*

Immediate versus Watchful Waiting for VA ECMO Venting

Yoan Lamarche, *Université de Montréal, Montreal Heart Institute*

Mobilizing Patients on ECMO

Meghan Hudock, *Washington University, Barnes Jewish Hospital*

Weaning VA ECMO: Evaluation of Recovery and Weaning

Daniel W. Johnson, *University of Nebraska Medical Center*

ECMO As a Bridge to Transplant

Gabriel Loor, *Baylor College of Medicine, Baylor St. Luke's Medical Center*

ECMO with RV Support in ARDS (in the COVID-19 Patient)

Antone J. Tatoes, *Christ Hospital & Medical Center*

10:45AM–11:00AM

BREAK

SUNDAY MORNING, MAY 2, 2021

11:00AM–1:20PM

SUGARBAKER MEMORIAL LECTURE

11:00AM–11:30AM

The von Hippel-Lindau Hereditary Cancer Syndrome: Insights into Oxygen Sensing and Cancer

Guest Lecturer: William G. Kaelin, Jr., *2019 Nobel Laureate*
Howard Hughes Medical Institute, Dana-Farber Cancer Institute

PERIOPERATIVE CARE

11:30PM–12:35PM

YEAR IN REVIEW

Moderators: J.W. Awori Hayanga, *West Virginia University*
Donald Likosky, *University of Michigan*

Panelists: Rakesh C. Arora, *University of Manitoba, St. Boniface Hospital*
Glenn J. Whitman, *John Hopkins Hospital*

Arrest Trial: Yannopoulos D, Bartos J, Raveendran G, et al. Advanced Reperfusion Strategies for Patients with Out-of-Hospital Cardiac Arrest and Refractory Ventricular Fibrillation (ARREST): A Phase 2, Single Centre, Open-Label, Randomized Controlled Trial. Lancet 2020; Nov 13: [Epub ahead of print].

Joel Dunning, *MD, Teeside University, James Cook University Hospital*

Does the Full-Time Presence of an Intensivist Lead to Better Outcomes in the Cardiac Surgical Intensive Care Unit?

Sean van Diepen, *University of Alberta, University of Alberta Hospital*

Association of Earlier Extubation and Post-Operative Delirium After Coronary Artery Bypass Grafting

Bryan A. Whitson, *The Ohio State University, Ross Heart Hospital*

Predictors of New Persistent Opioid Use After Coronary Artery Bypass Grafting

Kimberly Holst, *Mayo Clinic*

PANEL DISCUSSION

12:35PM–12:50PM

LB25. The Impact of Receiving an Award from the American Association for Thoracic Surgery Foundation

Edgar Aranda-Michel¹, James D. Luketich¹, Rashmi Rao¹, Victor O. Morell¹, George J. Arnaoutakis², Arman Kilic¹, Courtenay Dunn-Lewis¹, Ibrahim Sultan¹
¹University of Pittsburgh, Pittsburgh, PA; ²University of Florida, Gainesville, FL

Invited Discussant: Mehmet C. Oz

LEGACY LECTURE

12:50PM–1:20PM

Spirit and Legacy of Innovation

W. Randolph Chitwood, Jr., *East Carolina University, Vidant Medical Center*

1:20PM–1:35PM

BREAK

1:35PM–2:35PM

LUNCH

2:35PM–2:50PM

BREAK

SUNDAY AFTERNOON, MAY 2, 2021

2:50PM–4:35PM

PERIOPERATIVE CARE
Simultaneous Scientific Sessions

AORTIC EMERGENCIES

Moderators: Subhasis Chatterjee, *Baylor College of Medicine, Baylor St. Lukes Medical Center*
Wilson Y. Szeto, *University of Pennsylvania, University of Pennsylvania Medical Center*

Transfusion Triggers and Blood Conservation in Aortic Surgery: Are They Different?

Eric E. Roselli, *CCLCM, Cleveland Clinic*

Management of Delayed Paraplegia After TAAA Repair

George J. Arnaoutakis, *University of Florida, University of Florida Health*

Medical or Endovascular Management of Acute Type B Aortic Dissection

Ourania Preventza, *Baylor College of Medicine, Houston, Texas Heart Institute, Baylor St. Luke's Medical Center*

Vocal Cord Complications After Aortic Surgery

TBD

Regional Systems of Care

Venugopal Menon, *Cleveland Clinic*

DEBATE

Routine Use of Spinal Drains (Pro)

George J. Arnaoutakis, *University of Florida, University of Florida Health*

Routine Use of Spinal Drains (Con)

Maral Ouzounian, *University of Toronto, Toronto General Hospital*

SUNDAY MORNING, MAY 2, 2021

9:00AM–10:45AM

GENERAL THORACIC
Simultaneous Scientific Sessions

BUILDING AN ACADEMIC CAREER—ROUNDTABLE

Moderators: Andrea S. Wolf, *The Icahn School of Medicine at Mount Sinai, The Mount Sinai Hospital*
Yolonda L. Colson, *Harvard Medical School, Massachusetts General Hospital*

Early Academic Career

Min P. Kim, *Weill Cornell Medicine, Houston Methodist Hospital*
Lisa M. Brown, *MAS, University of California, Davis, UC Davis Health*

Middle Academic Career

Virginia R. Litle, *Boston University SOM, Boston Medical Center*
Dennis Wigle, *Mayo Clinic*

Late Academic Career

Malcolm M. DeCamp, Jr., *University of Wisconsin, University of Wisconsin Hospitals and Clinics*
John Howington, *University of Tennessee Health Sciences, Ascension Saint Thomas*

PANEL DISCUSSION

LUNG CANCER 3

Moderators: Jessica S. Donington, *University of Chicago, University of Chicago Medicine*
Gaetano Rocco, *Weill Cornell Medical College, Memorial Sloan Kettering Cancer Center*
Kazuhiro Yasufuku, *University Health Network*

149. Intraoperative Opioid Exposure Is Associated with Survival Differences Relative to the Tumor Genomic Profile in Early-Stage Lung Adenocarcinoma Patients: An Exploratory Analysis

James G. Connolly, Kay See Tan, Brooke Mastrogiamomo, Joseph Dycoco, Patrick J. McCormick, Francisco Sanchez-Vega, Prasad S. Adusumilli, Gaetano Rocco, James M. Isbell, Daniela Molena, Matthew J. Bott, Gregory W. Fischer, David R. Jones, Joshua S. Mincer

Memorial Sloan Kettering Cancer Center, New York, NY

Invited Discussant: Mark Onaitis

150. The Role of Surgery versus Immunotherapy in Stage IIIA/N2 Non-Small Cell Lung Cancer Following Chemoradiation

Susan Ansley Smith, Jaimin R. Trivedi, Matthew C. Black, Victor H. van Berkel, Matthew P. Fox

University of Louisville, Louisville, KY

Invited Discussant: Linda W. Martin

151. Establishment and Validation of Primary Non-Small Cell Lung Cancer Organoids As In Vitro Lung Cancer Models

Raphael S. Werner¹, Sylvia Hoeller², Michaela B. Kirschner¹, Isabelle Oplitz¹

¹University Hospital Zurich, Department of Thoracic Surgery, Zurich, Switzerland;

²University Hospital Zurich, Department of Pathology, Zurich, Switzerland

Invited Discussant: Christopher W. Seder

IIIA Induction Immunotherapy NSCLC—Where We Were, Where We Are and Where We Are Going to Be

Valerie W. Rusch, Cornell University Medical College, Memorial Sloan Cancer Center

152. Perioperative Outcomes of Video-Assisted Thoracoscopic Surgery After Neoadjuvant Pembrolizumab and Chemotherapy in Patients with Resectable Non-Small Cell Lung Cancer

Deping Zhao, Long Xu, Junqi Wu, Dong Xie, Yuming Zhu, Gening Jiang, Chang Chen

Tongji University Affiliated Shanghai Pulmonary Hospital, Shanghai, China

Invited Discussant: Ke-Neng Chen

153. Intersectional Discrimination in Lung Cancer Screening

Michael R. Poulson, Alaina Geary, Virginia Litle, Kei Suzuki

Boston Medical Center, Boston, MA

Invited Discussant: Bryan M. Burt

154. Objective Performance Indicators Are Associated with Bleeding Events During Robotic-Assisted Lobectomy by Cardiothoracic Surgery Residents

John F. Lazar¹, Ariana Metchick¹, Kristen Brown², Sadia Yousaf³, Anthony Jarc², Jonathon Nesbitt⁴, Desmond D'Souza⁵, Manu Sancheti⁶, Jules Lin⁷, Richard Feins⁸, Stephen Yang⁹, Daniel Oh¹⁰

¹MedStar Georgetown University Hospital, Washington, DC; ²Intuitive Surgical, Sunnyvale, CA; ³Intuitive Surgical, Washington, CA; ⁴Vanderbilt, Nashville, TN; ⁵The Ohio State University, Columbus, OH; ⁶Emory University, Atlanta, GA; ⁷University of Michigan, Ann Arbor, MI; ⁸University of North Carolina, Chapel Hill, NC; ⁹Johns Hopkins Medical Institutions, Baltimore, MD; ¹⁰University of Southern California, Los Angeles, CA

Invited Discussant: Bernard J. Park

Multifocal NSCLC

David R. Jones, Memorial Sloan Kettering

PANEL DISCUSSION

10:45AM–11:00AM

BREAK

SUNDAY MORNING, MAY 2, 2021

11:00AM–1:20PM

SUGARBAKER MEMORIAL LECTURE

11:00AM–11:30AM

The von Hippel-Lindau Hereditary Cancer Syndrome: Insights into Oxygen Sensing and Cancer

Guest Lecturer: William G. Kaelin, Jr., 2019 Nobel Laureate
Howard Hughes Medical Institute, Dana-Farber Cancer Institute

GENERAL THORACIC

11:30AM–12:35PM

THORACIC PLENARY

Moderators: Sudish C. Murthy, Case Western Reserve, Cleveland Clinic
Benjamin D. Kozower, Washington University
St. Louis, Barnes-Jewish Hospital

163. Randomized Trial of Segmentectomy Compared to Lobectomy in Small-Sized Peripheral Non-Small Cell Lung Cancer

Hisao Asamura¹, Morihito Okada², Hisashi Saji³, Masahiro Tsuboi⁴, Ryu Nakajima⁵, Kenji Suzuki⁶, Keiju Aokage⁴, Masashi Wakabayashi⁷, Kenichi Nakamura⁷, Haruhiko Fukuda⁷, Shinichiro Nakamura⁸, Tetsuya Mitsudomi⁹, Shun-ichi Watanabe¹⁰

¹Division of Thoracic Surgery, Keio University School of Medicine, Tokyo, Japan; ²Department of Surgical Oncology, Hiroshima University Hospital, Hiroshima, Japan; ³Department of Chest Surgery, St. Marianna University School of Medicine, Kawasaki, Japan; ⁴Department of Thoracic Surgery, National Cancer Center Hospital East, Chiba, Japan; ⁵Department of Thoracic Surgery, Osaka City General Hospital, Osaka, Japan; ⁶Department of Thoracic Surgery, Juntendo University School of Medicine, Tokyo, Japan; ⁷Japan Clinical Oncology Group Data Center/Operations Office, National Cancer Center Hospital, Tokyo, Japan; ⁸West Japan Oncology Group (WJOG) Data Center Division, Osaka, Japan; ⁹Thoracic Surgery, Kinki University Faculty of Medicine, Osaka, Japan; ¹⁰Department of Thoracic Surgery, National Cancer Center Hospital, Tokyo, Japan

Invited Discussant: Nasser K. Altorki

164. Outcome After Pulmonary Endarterectomy for Segmental Chronic Thromboembolic Pulmonary Hypertension: A Canadian National Cohort Study

Marc de Perrot¹, Laura Donahoe¹, Karen McRae¹, John Thenganatt¹, Jakov Moric¹, Jason Weatherald², Naushad Hirani³, Mitesh Thakrar², Doug Helmersen², John Swiston³, Nathan Brunner³, Robert Levy³, Sanjay Mehta⁴, Ali Kapasi⁵, Dale Lien⁵, Evangelos Michelakis⁵, Paul Hernandez⁶, Kristina Kemp⁷, Andrew Hirsch⁸, David Langleben⁸, Nathan Hambly⁹, Punginathn Dorasamy¹⁰, Christine D'Arsigny¹¹, George Chandy¹², David Christiansen¹³, George Fox¹⁴, Karen Laframboise¹⁵, Steeve Provencher¹⁶, John Granton¹

¹Toronto General Hospital, Toronto, ON, Canada; ²Peter Lougheed Centre, Calgary, AB, Canada; ³Vancouver General Hospital, Vancouver, BC, Canada; ⁴London Health Science Centre, London, ON, Canada; ⁵University of Alberta Hospital, Edmonton, AB, Canada; ⁶Queen Elizabeth II Health Sciences Centre, Halifax, NS, Canada; ⁷The Moncton Hospital, Moncton, NB, Canada; ⁸Jewish General Hospital, Montreal, QC, Canada; ⁹St. Joseph's Healthcare Hamilton, Hamilton, ON, Canada; ¹⁰Hamilton General Hospital, Hamilton, ON, Canada; ¹¹Kingston General Hospital, Kingston, ON, Canada; ¹²Ottawa Heart Institute, Ottawa, ON, Canada; ¹³University of Winnipeg, Winnipeg, MB, Canada; ¹⁴Eastern Health General Hospital, St. John's, NL, Canada; ¹⁵Royal University Hospital, Saskatoon, SK, Canada; ¹⁶Institut universitaire de cardiologie et de pneumologie de Québec, Quebec City, QC, Canada

Invited Discussant: Cameron D. Wright

165. Long-Term Patient-Reported Outcomes Following Non-Small Cell Lung Cancer Resection

Brendan T. Heiden¹, Melanie P. Subramanian, Jingxia Liu, Angela Keith, Bryan F. Meyers, Varun Puri, Benjamin D. Kozower
Washington University School of Medicine, St. Louis, MO

Invited Discussant: Ara A. Vaporciyan

166. A Comparison of Robotic versus Laparoscopic Heller Myotomy: Are We Ready to Switch?

Saurav Adhikari, Sudish Murthy, Prashanti Thota, Scott Gabbard, Mark Baker, Jesse Rappaport, Usman Ahmad, Eugene H. Blackstone, Siva Raja
Cleveland Clinic Foundation, Cleveland Ohio, OH

Invited Discussant: Steven R. DeMeester

12:35PM–12:50PM

LB25. The Impact of Receiving an Award from the American Association for Thoracic Surgery Foundation

Edgar Aranda-Michel¹, James D. Luketich¹, Rashmi Rao¹, Victor O. Morell¹, George J. Arnaoutakis², Arman Kilic¹, Courtenay Dunn-Lewis¹, Ibrahim Sultan¹
¹University of Pittsburgh, Pittsburgh, PA; ²University of Florida, Gainesville, FL

Invited Discussant: Mehmet C. Oz

LEGACY LECTURE

12:50PM–1:20PM

Spirit and Legacy of Innovation

W. Randolph Chitwood, Jr., East Carolina University, Vidant Medical Center

1:20PM–1:35PM

BREAK

1:35PM–2:35PM

LUNCH

2:35PM–2:50PM

BREAK

SUNDAY AFTERNOON, MAY 2, 2021

2:50PM–4:35PM

**GENERAL THORACIC
Simultaneous Scientific Sessions**

BENIGN ESOPHAGUS

Moderators:

Thomas J. Watson Georgetown University,
MedStar Georgetown University Hospital
Brian E. Louie, Swedish Cancer Institute
Matthew G. Hartwig, Duke University

DEBATE: POEM versus Heller Dor

Dennis Wigle, Mayo Clinic
Siva Raja, Lerner College of Medicine at the CaseWestern School of Medicine,
Cleveland Clinic Foundation

Ask the Experts: GPEH in the Obese Patient

Shaina Eckhouse, Washington University
Matthew J. Schuchert, University of Pittsburgh Medical Center, UPMC Presbyterian

DEBATE: PEH to Lengthen or Not?

Richard S. Lazzaro, Hofstra, Lenox Hill Hospital
Stephen D. Cassivi, Mayo Clinic College of Medicine and Science, Mayo Clinic

PANEL DISCUSSION

LUNG TRANSPLANT

Moderators: Christine L. Lau, *University of Maryland, University of Maryland Medical Center*
Varun Puri, *Washington University School of Medicine, Barnes-Jewish Hospital*
Usman Ahmad, *Cleveland Clinic Foundation*

Where We Started

Joel D. Cooper, *University of Pennsylvania, Hospital of The University of Pennsylvania*

184. Waiting List Death and ECMO Bridge to Lung Transplant—A National Registry Analysis

Leonid Emerel, John Ryan, Takashi Harano, James Luketich, Pablo G. Sanchez
UPMC, Pittsburgh, PA

Invited Discussant: Stephanie Chang

185. Long-Term Outcome of Living-Donor Lobar Lung Transplantation Performed More Than 16 Years Ago

Hiroshi Date¹, Seiichiro Sugimoto², Kentaroh Miyoshi², Shinji Otani², Megumi Ishihara², Masaomi Yamane², Shinichi Toyooka²

¹Kyoto University, Kyoto, Japan; ²Okayama University, Okayama, Japan

Invited Discussant: Walter Klepetko

How We Got Better

G. Alexander Patterson, *Washington University*

186. Clinical Features and Outcomes of Unplanned Single Lung Transplants

Yuriko Terada, Tsuyoshi Takahashi, Ruben G. Nava, Ramsey R. Hachem, Chad A. Witt, Derek E. Byers, Rodrigo Vazquez Guillaumet, Benjamin D. Kozower, Bryan F. Meyers, Hrishikesh S. Kulkarni, Michael K. Pasque, G. Alexander Patterson, Daniel Kreisel, Varun Puri

Washington University in St. Louis, Saint Louis, MO

Invited Discussant: Victor H. van Berkel

187. Effect of Mode of Support on Primary Graft Dysfunction (PGD): Analysis of an International Multicenter Registry on Extracorporeal Life Support (ECLS) in Lung Transplantation

Gabriel Loo¹, Stephen Huddleston², Matthew Hartwig³, Brandi Bottiger³, Daoud Daoud¹, Qi Wei¹, Fabio Ius⁴, Gregor Warnecke⁵, Mauricio Villavicencio⁶, Briana Tirabassi⁶, Tiago Machuca⁷, Dirk Van Raemdonck⁸, Anna Elizabeth Frick⁸, Arne Neyrinck⁸, Yoshiya Toyoda⁹, Mohammed A. Kashem⁹, Michelle Landeweer², Satish Chandrashekar⁷

¹Baylor College of Medicine, Houston, TX; ²University of Minnesota Medical School, Minneapolis, MN; ³Duke University Health System, Durham, NC; ⁴Hannover Medical School, Hannover, Germany; ⁵Heidelberg University Hospital, Heidelberg, Germany; ⁶Massachusetts General Hospital, Boston, MA; ⁷University of Florida, Gainesville, FL;

⁸University Hospitals Leuven, Leuven, Belgium; ⁹Temple University School of Medicine, Philadelphia, PA

Invited Discussant: Stephanie Chang

Where We Are Going

Shaf Keshavjee, *University of Toronto, Toronto General Hospital*

LB30. Safe Avoidance of Overnight Lung Transplantation Using 10°C Cold Static Preservation: A Prospective Multi-Center Proof-of-Concept Clinical Trial

Marcelo Cypel¹, Aadil Ali¹, Konrad Hoetzenecker², Tiago Machuca³, Zachary Kon⁴, Stefan Schwarz², Julius Carillo⁴, Jonathan Yeung¹, Laura Donahoe¹, Kazuhiro Yasufuku¹, Andrew Pierre¹, Marc de Perrot¹, Thomas Waddell¹, Shaf Keshavjee¹

¹University of Toronto, Toronto, ON, Canada; ²Medical University of Vienna, Vienna, Austria; ³University of Florida, Gainesville, FL; ⁴NYU-Langone Medical Center, New York, NY

Invited Discussant: Stephanie Chang

PANEL DISCUSSION

ABSTRACTS

1. Systematic Screening Strategy for Genetic Aortopathy

Jihoon Kim¹, Jae Suk Yoo², Hee-Jung Kim³, Ho Jin Kim⁴, Joon Bum Kim⁴, Suk Jung Choo⁴
¹Kangnam Sacred Heart Hospital, Seoul, Republic of Korea; ²Sejong General Hospital, Bucheon, Gyeonggi-do, Republic of Korea; ³Korea University Anam Hospital, Seoul, Republic of Korea; ⁴Asan Medical Center, Seoul, Republic of Korea

Objective: Genetic aortopathy leads to aortic catastrophe in majority of affected individuals if left untreated. We sought to develop a proactive, systematic screening and management protocol through an institutional genetic aortopathy registry.

Methods: From August 2016 to September 2020, patients with aortopathy defined as aortic root aneurysm (Z score ≥ 2) or aortic dissection, and the first-degree relatives of confirmed genetic aortopathy patients were enrolled in the prospective registry. The subject individuals underwent systematic genetic testing (single gene test, and/or multi-gene panel tests) according to their clinical presentations (Figure 1). The multi-gene panel test has been set to exam well-established genetic aortopathy that included ACTA2, COL3A1, FBN1, MAT2A, MYH11, MYLK, NOTCH1, PRKG1, SKI, SLC2A10, SMAD3, SMAD4, TGFB2, TGFB3, TGFB1 and TGFB2.

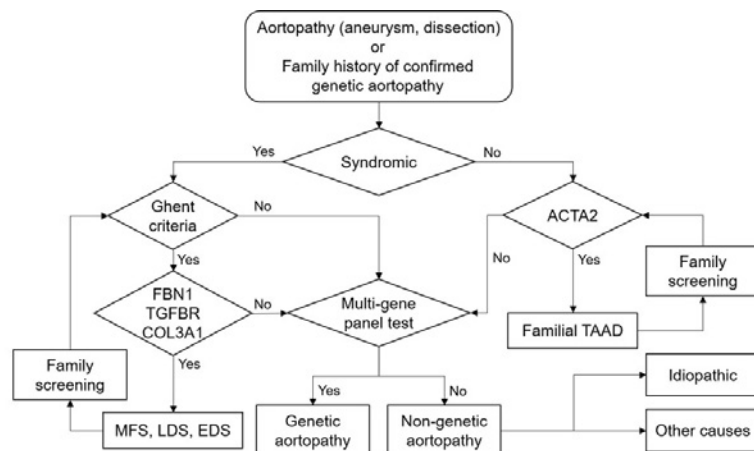


Figure 1 The systematic screening protocol for genetic aortopathy. *MFS*, Marfan syndrome; *LDS*, Loews-Dietz syndrome; *EDS*, Ehlers-Danlos syndrome type IV; *TAAD*, thoracic aortic aneurysm/dissection.

Results: Among 575 eligible individuals, 346 (60.2%; mean age 42.4 ± 14.9 years; male 217) finally finished confirmative genetic testing. Of these, primary triggers for the enrollment were aortic aneurysm in 205, aortic dissection in 199 and syndromic features in 26, and among these relevant gene mutations were identified in 143 patients (33.2%): 35.1% (72/205) in aneurysm, 25.6% (51/199) in dissection and 76.9% (20/26) in syndromic features. With the extension to family screening, 70.3% ($n = 102$) out of 145 screened individuals showed positive gene mutation finally ($P = 0.001$ as compared to other categories). The most frequently mutated gene was FBN1 (Marfan syndrome; $n = 200$, 34.8%) followed by COL3A1 (Ehlers-Danlos syndrome type IV, $n = 13$, 2.3%), TGFB1/2 (Loeys-Dietz syndrome; $n = 9$, 1.6%), and ACTA2 (non-syndromic familial thoracic aortic aneurysm/dissection, $n = 9$, 1.6%). Among all eligible individuals ($n = 575$), a total of 500 aortic surgeries were performed on 375 patients (65.2%), while 54.3% patients (133/245) with confirmed genetic aortopathy underwent aortic surgery ($P = 0.003$). Overall surgical mortality rate was 0.2% ($n = 1$).

Conclusions: Genetic aortopathy has been identified in a considerable proportion (25–35%) of patients presenting with aortic aneurysm or dissection by the systematic gene screening. The extension of the screening to family members accounted for 71.3% (102/143) more patients with diagnostic confirmation of genetic aortopathy. This strategy is encouraged for the timely detection, accurate diagnosis, and subsequent proactive management including early surgery.

2. Modeling Aortic Wall Stress from CT- and Echo-Derived Biomechanical Parameters for Clinical Risk Prediction

Lauren V. Huckaby¹, Ronald N. Fortunato¹, Leonid Emerel¹, Tara Richards¹, Jennifer Hill¹, Marie Billaud², Julie Phillippi¹, David Vorp¹, Spandan Maiti¹, Thomas Gleason²
¹University of Pittsburgh, Pittsburgh, PA; ²Brigham and Women's Hospital, Boston, MA

Objective: Our prior work revealed overlap between intimal tear location and predicted high longitudinal tensile stress in pre-dissection CT angiography (CTA) scans from type A aortic dissection patients. We sought to estimate imaging-derived aortic stiffness and correlate regional wall tensile stress, extracellular matrix (ECM) architecture, and cellular biology to improve upon diameter-based aortic surgery guidelines.

Methods: We calculated aortic stiffness from transthoracic echocardiogram (TTE)-derived diameters. Electrocardiogram (ECG)-gated CTA was utilized to model regional aortic wall biomechanical properties. Using an established constitutive model, we derived wall tensile stress and strain heat maps from CTAs of patients who underwent ascending aortic replacement for aneurysmal disease. We quantitatively and qualitatively assessed ECM microarchitecture, matrix metalloproteinase (MMP) activity, and aortic smooth muscle cell (SMC) behavior in regions of low and high biaxiality ratio (B, defined as the ratio of longitudinal to circumferential tensile stress). Patients with a tricuspid aortic valve (TAV) and bicuspid aortic valve (BAV) were considered separately.

Results: Patients experiencing dissection uniformly exhibited aortic stiffness index >5 (mean 7.3 ± 1.7 ; $n = 29$); stiffness was similar between aortic valve morphotypes for non-dissected patients (tricuspid aortic valve [TAV]: 4.3 ± 0.9 ; bicuspid aortic valve [BAV]: 3.9 ± 0.6 ; $p = 0.348$; $n = 15$ and $n = 19$, respectively) (Figure). A total of 17 patients underwent pre-operative mapping (8 TAV, 9 BAV). Gated CTAs demonstrated heterogeneous aortic wall strain. Regions of high B exhibited disarrayed elastin fibers and localized ECM degeneration. MMP activity was significantly increased in regions of high vs low B ($p = 0.029$). SMCs isolated from regions of high B exhibited significantly decreased viability in response to oxidative stress ($p = 0.016$). There were no differences in SMC contractility or expression of SMC phenotypic markers in regions of low and high B.

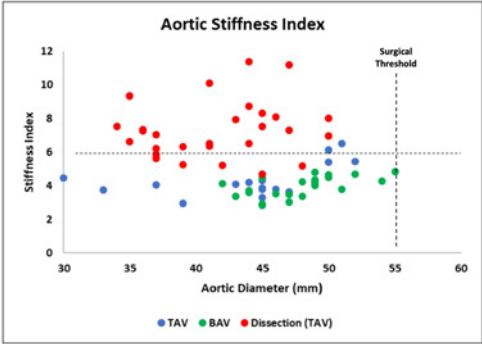


Figure 1. Aortic stiffness index measured from transthoracic echocardiogram data in tricuspid aortic valve (TAV), bicuspid aortic valve (BAV), and dissection patients (based on pre-dissection imaging). An aortic stiffness index ≥ 6 was demonstrated a sensitivity of 91.67% and specificity of 87.5% for development of aortic dissection.

Conclusions: Non-invasive mapping of longitudinal stress corresponds with ECM and cellular disruption and improves our understanding of aortic wall biomechanics in ascending aortic disease. This, combined with interrogatories of dynamic imaging (i.e. echo and gated-CTA), will contribute to tailored risk adjudication for thoracic aortic aneurysm.

3. Redo Aortic Surgery—Does One versus Multiple Affect Outcomes?

Kanika Kalra, LaRonica McPherson, Bradley G. Leshnowar, Edward P. Chen
Emory University, Atlanta, GA

Objective: Complexity associated with redo aortic surgery is multifactorial from mediastinal adhesions with potential injury to the aorta as well as other vital structures, previously implanted prostheses, presence of infection leading to increased risk of bleeding, conduction abnormalities, and overall increased morbidity and mortality. In a quality metrics driven reimbursement environment, establishing bench-marking data and expectations for these difficult clinical scenarios is critically important. In this study, we investigated the differences in peri-procedural and short-term outcomes in patients undergoing aortic surgery after a single previous cardiac surgery versus multiple previous operations.

Methods: Between 2004 and 2019, a total of 444 patients were identified who underwent aortic surgery after a previous cardiac surgery. Patients were classified into two

groups: aortic surgery after one previous surgery (FREDO, $n = 370$), and aortic surgery after ≥ 2 previous cardiac surgeries (MREDO, $n = 74$). All available pre-operative, procedural and post-operative data were tabulated, retrospectively analyzed, and compared.

Characteristics		First Redo (n=370)	Multiple Redo (n=74)	P value
Age (yrs), mean +/- std		57 +/- 14	49 +/- 15	6.43
Male, n(%)		264 (71%)	49 (66%)	0.37
Preoperative diagnoses	Cerebrovascular Disease, n(%)	51 (13.7%)	25 (33.7%)	3.04
	Chronic lung disease, n(%)	32 (8.6%)	18 (24.3%)	9.85
	Diabetes, n(%)	60 (16.2%)	6 (8%)	0.07
	Dyslipidemia, n(%)	223 (60.2%)	37 (50%)	0.10
	Hypertension, n(%)	313 (84.5%)	53 (71.6%)	0.007
	Renal Failure/Dialysis, n(%)	6 (1.62%)	1 (1.3%)	0.86
	Prior MI, n(%)	44 (11.9%)	9 (12%)	0.94
	Ejection Fraction (%), mean +/- std	54 +/- 14.6	54 +/- 9	0.80
	Smoking n(%)	94 (25.4%)	10 (13.5%)	0.02
	NYHA class I-II, n(%)	111 (30%)	20 (27%)	0.60
	NYHA Class III-IV, n(%)	119 (32.1%)	20 (39%)	0.38
	CABG, n(%)	75 (20.2%)	7 (9.4%)	0.02
Previous Surgery	Aortic surgery, n(%)	152 (41%)	29 (39%)	0.76
	AVR, n(%)	209 (56.4%)	56 (75.6%)	0.002
	MVR, n(%)	25 (6.75%)	9 (12%)	0.11
	Other, n(%)	31 (8.3%)	14 (18.9%)	0.006
	CABG, n(%)	75 (20.2%)	7 (9.4%)	0.02
Operative details	CPB (mins), mean +/- std	215.7 +/- 61.5	243 +/- 71	0.002
	Cross clamp time (mins), mean +/- std	177.3 +/- 54.6	205 +/- 56	0.0009
	Circulatory arrest, n(%)	22 (60%)	43(58%)	4.77
	Axillary Cannulation, n(%)	192 (51.8%)	43(58%)	0.32
	Antegrade and Retrograde cardioplegia, n(%)	69 (18.6%)	16 (21.6%)	0.55
	Antegrade Cerebral Perfusion, n(%)	187 (50.5%)	34 (45.9%)	0.47
	Retrograde cerebral perfusion, n(%)	18 (4.86%)	3 (4%)	0.76
	IABP, n(%)	88 (23.7%)	23 (31%)	0.18
	Aortic valve repair, n(%)	12 (3.24%)	2 (2.7%)	0.80
	Mechanical valve, n(%)	38 (10.2%)	19 (25.6%)	0.0002
	Bioprosthetic valve, n(%)	178 (48.1%)	30 (40.5%)	0.23
	Ascending replacement, n(%)	215 (58.1%)	44 (59.4%)	0.82
	Aortic Root replacement, n(%)	243 (65.6%)	57 (77%)	0.05
	Hemi-arch replacement, n(%)	141 (38.1%)	35 (47.2%)	0.14
	Total arch replacement, n(%)	24 (6.4%)	4 (5.4%)	0.72
	Stage I Elephant trunk, n(%)	34 (9.1%)	1 (1.35%)	0.02
	CABG, n(%)	77 (20.8%)	15 (20.2%)	0.91
	Descending Thoracic Aneurysm repair, n(%)	8 (2.1%)	2 (2.7%)	0.77
	Re-entry Injury, n(%)	30 (8%)	9 (12%)	0.26
Post Operative outcomes	Re-exploration for haemorrhage, n(%)	42 (11.3%)	8 (10.8%)	0.89
	CVA, n(%)	12 (3.24%)	4 (5.4%)	0.36
	New renal failure, n(%)	40 (10.8%)	13 (17.5%)	0.10
	New dialysis, n(%)	26 (7%)	10 (13.5%)	0.06
	Post-operative arrhythmias, n(%)	100 (27%)	26 (35.1%)	0.15
	Postoperative pneumonia, n(%)	25 (6.75%)	3 (4%)	0.38
	Blood transfusion, n(%)	318 (85.9%)	73 (98.6%)	0.002
	Length of stay (days), mean +/- std	10.3 +/- 9	10.2 +/- 8.9	0.93
	ICU stay (hours), mean +/- std	143 +/- 191	156 +/- 205	0.60
	30-day mortality, n(%)	32 (11.3%)	16 (21.6%)	0.001

Results: Pre-operative characteristics, operative details and post-operative outcomes are listed in Table 1. Both groups had similar age and sex distribution. Patients in the FREDO group had higher incidences of hypertension (84.5% vs 71.6%, $p = 0.007$) and smoking (25.4% vs 13.5%, $p = 0.02$). Patients in FREDO group were more likely to have had a CABG in the past whereas, patients in the MREDO groups were more likely to have had aortic valve replacements in the past. The incidence of previous aortic surgery was similar. Circulatory arrest along with antegrade and retrograde cerebral perfusion were used with similar frequencies, however bypass (243 ± 71 mins vs 215 ± 61 mins, $p = 0.002$) and cross

clamp times (205 ± 56 mins vs 177 ± 54 mins, $p = 0.0009$) were lower in FREDO group. The incidence of re-entry injury and balloon pump insertion were similar. Rate of intra-operative blood transfusion was expectedly higher in the MREDO group. Post-operative complications occurred at similar rates except new renal failure requiring dialysis being more common in MREDO group (13.5% vs 7%, $p = 0.06$). ICU hours and total length of stay were similar. 30-day mortality was significantly lower, and almost half in the FREDO group compared to the MREDO group (11.3% vs 21.6%, $p = 0.001$).

Conclusions: Redo aortic procedures, in the setting of prior cardiac surgery, can be done with acceptable morbidity and mortality. These are often long operations involving complex etiologies like pseudoaneurysms, endocarditis and graft infections. Operative risk increases with increasing number of previous cardiac operations and is associated with higher need for intra-operative blood transfusion and post-operative renal failure requiring dialysis.

4. Should We Operate on Thoracic Aortic Aneurysm of 5.0–5.5 cm in Bicuspid Aortic Valve Disease Patients?

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Objective: The AATS guidelines favor aortic repair when the proximal thoracic aortic diameter is ≥ 5.5 cm in patients without significant risk factors. However, data from the international registry of aortic dissection (IRAD) showed that majority of acute dissection occurs at diameter < 5.5 cm. Our study aims to determine the long-term survival outcome and rate of re-operation among BAV patients with aorta diameter of 5–5.5 cm who underwent immediate surgical repair or surveillance between 1993–2019 at our institution.

Methods: A total of 150 BAV patients with aortic aneurysm measuring 5–5.5 cm were identified between 1993 to 2019. Patients were categorized into two groups: immediately operated ($n = 91$), versus watched group ($n = 59$) who were monitored until either symptomatic, aortic diameter ≥ 5.5 cm or operated at surgeons' discretion/patient preference. Imaging studies were reviewed for the measurements of the aorta diameter during follow-up. Data was retrieved from the surgical BAV registry and the STS data warehouse. The primary outcomes of the study were differences in long-term survival and reoperations between BAV patients who had immediate intervention at aorta diameter of 5–5.5 cm compared to those who were watched.

Results: The watched group had significant lower number of males compared to the immediately operated [45/59 (76%) vs 86/91 (95%)], otherwise there was no significant difference in demographics data between groups. Mean size of proximal thoracic aorta, including aortic root, ascending, and arch, for the immediately operated was 52.1 ± 1.62 mm and 52.7 ± 1.83 mm in the watched group, $p = 0.052$. The initial operation rate for the watched group during 10-year follow-up was 85%. There was no significant difference in postoperative complications in the operated patients between two groups. The operative mortality in both groups was 0%. There was no significant difference in 10-year survival between the immediately operated group 96.5% (95% CI: 86.3%, 99.1%) vs watched group 94.3% (95% CI: 79.1%, 98.6%); $p = 0.96$. Lastly, the 10-year reoperation rate between groups was similar with 7.0% (95% CI: 2.83%–13.8%) in the watched group vs 8.0% (95% CI: 2.50%–17.8%) in the immediately operated group; $p = 0.65$.

Conclusions: Our study showed that there was no survival benefit of immediate surgical aortic aneurysm repair in asymptomatic BAV patients with aortic diameter of 5–5.5 cm. Also, the rate of re-operation was similar between groups. Asymptomatic BAV patients with TAA of 5–5.5 cm without family history of aortic dissection could be safely watched until they became symptomatic or larger than 5.5 cm.

5. Valsalva Prosthesis and Straight Tube Graft Offer Similar Short- and Long-Term Outcomes in Valve Sparing Aortic Root Replacement

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Objective: Valve sparing root replacement was classically performed using straight tube grafts at our institution and we transitioned to Valsalva prostheses in 2017. We aim to present short-term echocardiographic and clinical outcomes of patients undergoing valve-sparing replacement of the ascending aorta with either a Valsalva prosthesis or straight tube graft.

Methods: Our institutional database was retrospectively reviewed to identify consecutive patients with ascending aortic aneurysms who underwent valve sparing root replacement between December 2014 and March 2020. Patients were stratified into two groups: replacement with Valsalva prosthesis or replacement with straight tube graft. All patients were repaired with an exclusion technique and button reimplantation of coronary arteries. The primary endpoint was degree of aortic insufficiency (AI) on postoperative transesophageal echocardiography. Secondary endpoints were AI on follow-up echocardiography, operative mortality, myocardial infarction, cerebrovascular accident, tracheostomy, new dialysis, and re-exploration for hemorrhage.

Results: A total of 202 patients were included in the final analysis, 101 (50.0%) Valsalva prosthesis and 101 (50.0%) straight tube graft. Patients in the straight tube group presented with larger aneurysms (5.4 cm [IQR: 5.3–5.7] vs 5.3 cm [IQR: 5.1–5.6], $p = 0.005$). All other preoperative characteristics were similar between groups. Patients in the straight tube had shorter CPB (126 min [IQR: 118–138] vs 134 min [IQR: 125–149], $p = 0.001$) and cross clamp times (108 min [IQR: 101–118] vs 114 min [IQR: 107–127], $p = 0.001$). There were no differences in the need for valve leaflet repair, use of hypothermic circulatory arrest, or postoperative coaptation height. There was no difference in degree of AI on postoperative transesophageal echocardiography (Table 1). Two patients (2.0%) in the straight tube group and 3 (3.0%) in the Valsalva group required re-exploration for bleeding. One patient in the straight graft group required aortic valve replacement four years following the index operation. There were no other adverse events reported in either group. Follow-up echocardiography showed no difference in the degree of AI between groups and little progression in the severity of AI overall.

Conclusion: Valve-sparing replacement of ascending aortic aneurysms can be performed safely with excellent durability using either a straight tube graft or Valsalva prosthesis. There is no difference in AI immediately or on late follow-up echocardiography.

Table 1: Intraoperative and postoperative outcomes

Variable	Overall (n = 202)	Straight Tube (n = 101)	Valsalva Prosthesis (n = 101)	P-Value
Leaflet cusps	–	–	–	–
–2	42 (20.8)	18 (17.8)	24 (23.8)	0.39
–3	160 (79.2)	83 (82.2)	77 (76.2)	0.39
Coaptation height, cm (median [IQR])	0.90 [0.80–1.10]	0.95 [0.89–1.10]	0.90 [0.80–1.00]	0.05
CPB time, min (median [IQR])	132 [121–142]	126 [118–138]	134 [125–149]	0.001
Cross clamp time, min (median [IQR])	111 [104–121]	108 [101–118]	114 [107–127]	0.001
HCA used	20 (9.9)	9 (8.9)	11 (10.9)	0.81
HCA time, min (median [IQR])	23 [21–36]	23 [22–26]	35 [15–53]	1.00
Concomitant AV repair	26 (12.9)	11 (10.9)	15 (14.9)	0.53
Degree AI on postoperative TEE	–	–	–	0.55
None	80 (40.0)	43 (43.0)	37 (37.0)	–
Trace	116 (58.0)	55 (55.0)	61 (61.0)	–
Mild	3 (1.5)	2 (2.0)	1 (1.0)	–
Moderate	1 (0.5)	0 (0.0)	1 (1.0)	–
Degree of AI on follow up TTE	–	–	–	0.33
None	43 (35.5)	19 (32.2)	24 (38.7)	–
Trace	59 (48.8)	27 (45.8)	32 (51.6)	–
Mild	15 (12.4)	10 (16.9)	5 (8.1)	–
Moderate	2 (1.7)	2 (3.4)	0 (0.0)	–
Severe	2 (1.7)	1 (1.7)	1 (1.6)	–
Mean AV gradient on postoperative TTE (median [IQR])	4.30 [3.00–6.20]	4.30 [3.00–6.10]	4.20 [3.10–6.30]	0.99

6. Disparities in Outcomes of Septal Myectomy for Hypertrophic Obstructive Cardiomyopathy: Impact of Race, Sex, Socio-Economic Status

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Invited Discussant: Joseph D. Schmoker

Objective: Information on the impact of race, sex, and socioeconomic status on the utilization and early outcomes of septal myectomy (SM) for obstructive hypertrophic cardiomyopathy (HOCM) is limited.

Methods: Using the National Inpatient Sample from January 2012 through December 2017, we identified all adult admissions with a primary diagnosis of HOCM and those undergoing SM. Race was classified as White versus Non-White (Black, Hispanic, Asian, others); socioeconomic status as lowest income quartile vs higher-income quartiles. A

hierarchical multivariable logistic regression model was used to identify independent predictors of receiving SM. Multivariable logistic regression analysis incorporating age, sex, race, primary payer, income quartile, hospital characteristics, Charlson comorbidity index, pacemaker implantation, concomitant procedure, ventricular arrhythmias, atrial fibrillation, ischemic stroke, elective vs non-elective admission, calendar year was performed to evaluate associations with in-hospital mortality.

Results: Among a total of 13,445 HOCM admissions, septal myectomy was utilized in 3,940 (29.3%). Non-white admissions (adjusted OR [AOR] 0.77, 95% CI 0.69–0.87, P < 0.001), and those belonging to the lowest income quartile (AOR 0.77, 95% CI 0.69–0.86, P < 0.001) were less likely to receive SM, while female admissions were associated with higher odds of receiving a SM (AOR 1.15, 95% CI 1.04–1.26, P = 0.004). Among admissions receiving SM, in-hospital mortality was significantly higher for non-white admissions (non-white versus white; 3.4% vs 1.6%, AOR 2.29, 95% CI 1.30–4.03, P = 0.004), and female admissions (female vs male; 2.5% vs 1.1%, AOR 1.95, 95% CI 1.08–3.51, P = 0.03). In-hospital mortality was comparable between admissions belonging to the lowest income quartile and higher-income quartiles (1.8% vs 2.0%, AOR 0.75, 95% CI 0.38–1.48, P = 0.40). Compared to white admissions, non-whites had longer lengths of in-hospital stay, higher hospitalization costs, higher rates of blood transfusion, prolonged mechanical ventilation, cardiac arrest, and acute kidney injury. Compared to men, women had higher rates of blood transfusions, prolonged mechanical ventilation, and ischemic stroke (all P < 0.001). A concomitant major cardiac procedure was associated with significantly higher in-hospital mortality (AOR 3.65, 95% CI 2.10–6.3, P < 0.001).

Conclusions: This study documents disparities in utilization and outcomes of SM in the United States. Racial minorities and lowest income hospitalizations were less likely to receive a septal myectomy. Importantly, we found that female sex, non-white race, and concomitant cardiac operation were associated with significantly higher in-hospital mortality. Further studies are necessary to understand whether these disparities are related to phenotypic/pathophysiologic characteristics or patterns of care.

7. Left Ventricular Remodeling Following Septal Myectomy in Hypertrophic Obstructive Cardiomyopathy

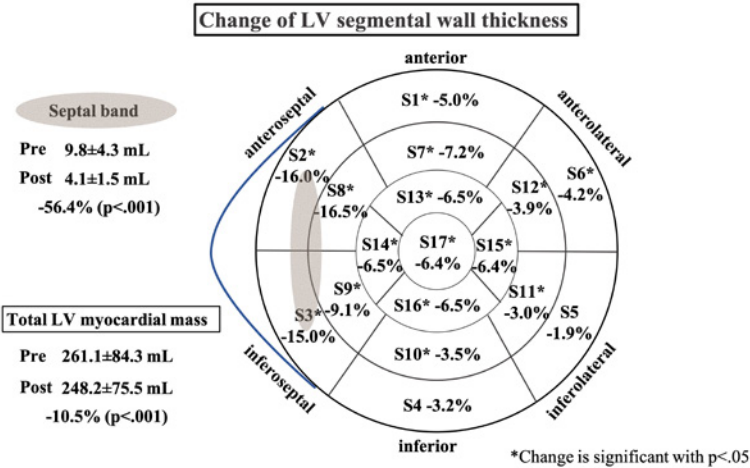
Tsuyoshi Yamabe¹, Jonathan Ginns², Vijay Vedula³, Jay S. Leeb¹, Yuichi J. Shimada¹, Shepard D. Weiner¹, Hiroo Takayama¹
¹Columbia University Medical Center, New York, NY; ²Heart Hospital of Austin, Austin, TX; ³Columbia University, New York, NY

Invited Discussant: Nicholas G. Smedira

Objective: While septal myectomy (SM) remains the gold standard therapy for hypertrophic obstructive cardiomyopathy (HOCM), the procedure has been determined subjectively by the operator. We have introduced virtual myectomy (VM)-guided SM, in which the extent and volume of resection are objectively planned using 3-dimensional reconstruction of gated cardiac computed tomography (CT) prior to surgery. VM-guided SM aims to resect a “septal band”, a 3D-CT identified hypertrophic septal structure ranging from the left trigone area to the base of the posterolateral papillary muscle. We investigated the utility of VM-guided SM, the changes in the septal band volume and left ventricular segmental myocardial thickness after SM.

Methods: We retrospectively reviewed 50 patients with HOCM who underwent SM along the septal band guided by preoperative VM at our institution between March 2016 and July 2020. Recent consecutive 19 patients underwent postoperative gated cardiac CT angiogram in addition to preoperative CT. In these patients, thickness of 17 left ventricular myocardial segments and volumes of the septal band were measured to determine the changes after SM. Postoperative CT was done at a median of 2.5 months [Interquartile range, IQR 1.8–3.4 months] after surgery.

Results: Mean age was 55.0 ± 14.8 years, and 50% were female. VM-predicted resection volume was 6.7 ± 3.3 mL and the actual resection volume was 6.4 ± 2.7 mL. In-hospital mortality was 0. Moderate or greater mitral regurgitation (MR) and systolic anterior motion (SAM) of the mitral valve decreased from 56% and 86% to 10% and 4%, respectively. Mean preoperative peak LV outflow tract gradient at rest and ventricular septal wall thickness decreased from 73.3 ± 41.3 mmHg and 20.0 ± 4.4 mm to 11.0 ± 6.8 mmHg and 13.8 ± 2.8 mm, respectively (both p < .001).



Postoperative CT confirmed a reduction of the septal band volume by 56.4% [IQR, 46.9–63.2%] (4.8 mL [IQR, 3.2–8.0 mL]) with a strong correlation between the actual resection volumes and the changes of septal band volumes ($R = 0.82$, $p < .001$). The total LV myocardial volume was decreased by 10.5% [IQR, 2.7–14.7%] (25.8 mL [IQR, 7.1–40.2 mL]), exceeding the volume reduction in the resected septal band. All segments, except for the basal inferior and basal inferolateral segments, showed a significant decrease in wall thickness by a median of 6.4% [IQR, 3.9–7.2%].

Conclusions: Preoperative VM provided an objective tool for successful SM. Properly performed SM may induce remodeling of the entire left ventricle, not just the resected area.

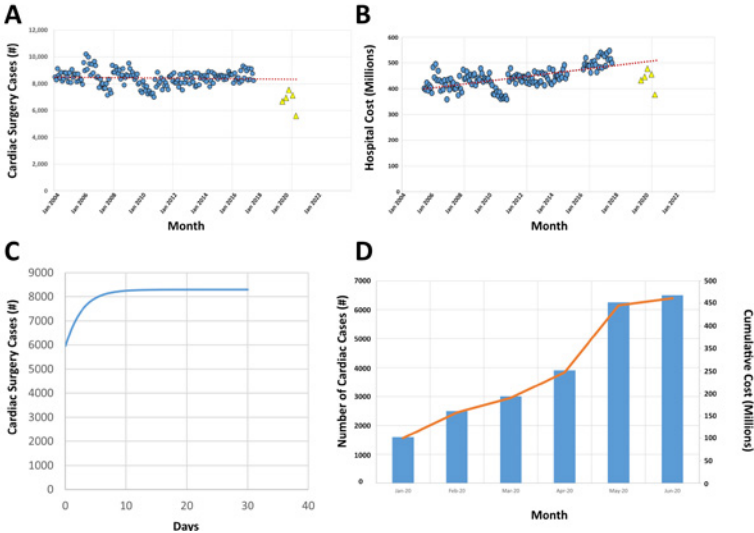
8. The Effect of COVID-19 on Surgical Volume and Its Associated Costs

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Invited Discussant: Michael J. Reardon

Objective: COVID-19 has had a drastic effect on the medical community and hospital systems by reducing caseloads and potentially decreasing hospital revenue. We aimed to estimate these effects on a national scale.

Methods: The national inpatient sample, which represents 20% of national discharges, was queried for all cardiac surgery cases between 2004–2017. The clinical classifier software was used to change ICD9 and ICD10 codes to manageable categories. Those that were included are: open heart valve procedures, coronary artery bypass grafting, Other OR heart procedures, and aortic resections and replacement. Total procedures were summed for each month and a linear trendline was drawn as the available data does not extend to 2020. Hospital charges were assessed by using the total hospital charge and converting with each hospital's cost to charge ratio for that specific year. The hospital charges, in dollars, were adjusted for inflation to 2019. This was additionally plotted and another trendline drawn. Local institutional data were used to estimate a decrease in operative volume and subsequent recovery. The estimated deleterious effect was extended to the entire database. The recovery of cases was fit to a Gompertz function, which is used to model growth in populations. Cumulative backlog of cases as well as lost hospital costs were assessed over the duration from initial case load decrease to full recovery.



Results: Operative volume was relatively constant throughout the study period, with over 8,000 cases occurring each month (Figure 1A). Differing from this, the hospital costs have been increasing throughout the study period, with costs increasing 590,000 dollars per month (Figure 1B). The yellow triangles in each of these graphs represent the estimated decreased caseload and revenue from COVID. There was a 19% decrease in cases at the end of January, which increase to a 28% decrease by May. However, there was a rapid recovery (estimated at 41% growth) that occurred between May and June (Figure 1C). Note that day 0 corresponds with the end of May and day 30 with the end of June. Despite the rapid recovery, a new cumulative backlog of 6,000 patients and decreasing hospital charges of around 450 million occurred over this time (Figure 1D).

Conclusions: COVID-19 has had an undeniable and deleterious effect on cardiac surgery, with volume decreased by over 25%. While this increased the backlog of patients and led to lost hospital charges, it is promising that recovery occurred rapidly. This is likely due to the acuity of most cardiac surgery procedures as well as the general patient population served. Nevertheless, these data can be beneficial not only to inform the current situation but to guide policies in the unfortunate cases of future outbreaks.

9. A Multi-Centre Analysis of Clinical Decision Making for Non-Elective Cardiac Surgery Referrals During the COVID-19 Pandemic

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Invited Discussant: Kevin D. Accola

Objectives: The COVID-19 pandemic caused significant disruption to the provision of cardiac surgery in the United Kingdom. Elective surgery was largely postponed and some centres were also unable to provide urgent surgery. The aim of this study is to assess the patterns of referrals to cardiac surgery and clinical decision making through the peak of the pandemic.

Methods: This multicentre prospective study collated data on all patients referred for cardiac surgery between 1st March to 1st August 2020. Demographic and outcome data were obtained at each centre from local electronic records, anonymised, and transferred securely for analysis by the lead centre. This study received clinical effectiveness approval at each centre.

Results: In total, 1175 patients were referred for urgent/emergency cardiac surgery from 122 hospitals to 7 cardiac centres in the UK. Data was complete for 97.7% of patients. Mean age was 65 years and 878 (74.7%) were male. Diagnosis was coronary artery disease (CAD) in 661 (56%), valve disease in 240 (20%), valve + CAD in 92 (8%), aortovascular disease in 104 (9%) and other pathology in 49 (4%). Treatment was open surgery in 841 (72%), percutaneous in 87 (7.4%), optimal medical therapy (OMT) in 172 (14.6%) and elective surgical clinic review in 48 (4.1%). Sixteen patients (1.4%) died prior to intervention. Of these outcomes, 978 (80%) concurred with the original plan on referral. Trends in treatment

modality over time are shown in Figure 1. As time progressed away from the peak of the pandemic, the proportion of patients undergoing surgery increased and the number of patients undergoing non-surgical treatment (OMT and percutaneous) decreased.

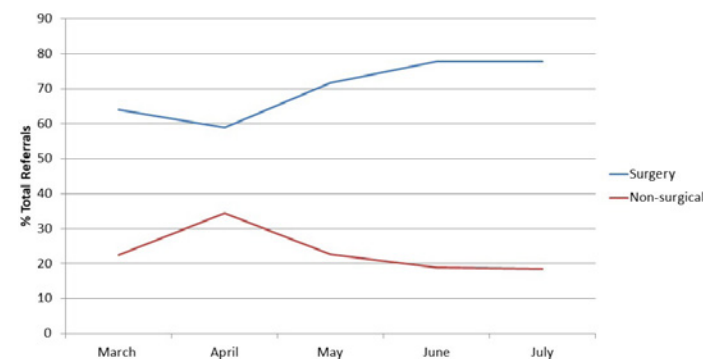


Figure 1. Outcomes of referrals over time

Conclusions: We describe the first multicentre analysis of clinical decision making in referrals for inpatient cardiac surgery during the COVID-19 pandemic. The provision of cardiac surgery was maintained throughout however not surprisingly the proportion of patients undergoing surgery increased and those undergoing percutaneous therapy or medical therapy decreased as the national lockdown eased.

10. Five-Year Outcomes of Microinvasive Transapical Mitral Valve Repair Through Neochordae Implantation

Augusto D'Onofrio¹, Matteo Nadali¹, Alessandro Fiocco¹, Florinda Mastro¹, Patrizia Aruta², Giuseppe Evangelista¹, Lorenzo Longinotti¹, Giorgio Pittarello³, Gino Gerosa¹

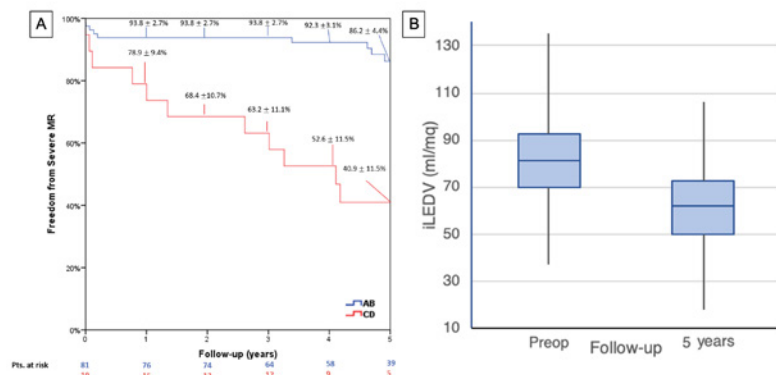
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Invited Discussant: Andrea Colli

Objective: Transapical, microinvasive off-pump, beating heart mitral valve repair with neochordae implantation (NC) showed promising early results in patients with degenerative mitral regurgitation (MR). Aim of this single-center study was to evaluate 5-year outcomes of patients undergoing NC.

Methods: Clinical and echocardiographic data of all patients undergoing NC at our institution were prospectively collected. For this study, we retrospectively analyzed data of patients who underwent NC from November 2013 to March 2016. Patients were preoperatively classified in type A, isolated P2 scallop prolapse/flail; type B, posterior multi-segment prolapse/flail; type C, anterior or bi-leaflet prolapse/flail; type D, paracommissural prolapse/flail or significant leaflet/annular calcification. Clinical and echocardiographic follow-up was performed after 1, 3, 6, 12 months and on a yearly basis thereafter. Outcomes were defined according to MVARC criteria.

Results: One-hundred consecutive patients were treated with NC during the study period (37 anatomical type A; 44 type B; 11 type C and 8 type D). Median age was 68 years (IQR 58–76) and median EuroScore II was 1.40% (IQR 0.67–2.25). Successful repair was achieved in 98% of patients, resulting in absent/trivial residual MR at the end of the procedure. Median operative time was 142 minutes (IQR 110–155) and 3 to 5 neochordae were implanted in 87% of patients. Two more patients underwent early in-hospital failure and were reoperated traditionally. At discharge, MR was mild or less in 95 of 96 patients (99%). Median follow-up was 5.1 years and it was 99% complete. Thirteen patients (13.5%) underwent conventional redo surgery due to late MR recurrence. Seventy-two patients (75%) were alive and free from reoperation, 12 (12.5%) were alive after reoperation; 15 patients (10.4%) died (cardiovascular death in 8); 1 patient was lost at FU. Five-year echocardiography was available in 64 patients. Trivial MR was found in 2 patients (3.1%); mild MR in 38 (59.4%); moderate MR in 14 (21.9%) and severe MR in 10 (15.6%). Kaplan-Meier estimated freedom from severe MR at 5-year was $76.9 \pm 4.7\%$ for all patients and $86.2 \pm 4.4\%$ for isolated posterior mitral leaflet disease (A-B type) with a significant difference if compared with types C and D (Figure 1A). We observed a significant reduction of left ventricular end-diastolic volume (81 vs 62 ml/m²; $p < 0.001$; Figure 1B) and of systolic pulmonary artery pressure (33 vs 25 mmHg; $p < 0.001$) between baseline and 5-year follow-up.



Conclusions: Transapical, microinvasive off-pump, beating heart mitral valve repair with neochordae implantation provides good 5-year clinical and hemodynamic outcomes in patients with degenerative MR. Patient selection plays a crucial role for good outcomes. Further data from ongoing randomized multi-center studies will help understand better this new approach to MV repair.

11. Impact of Preoperative Tricuspid Regurgitation and Right Ventricular Dysfunction on Outcomes of Mitral Valve Surgery After Edge-to-Edge Transcatheter Mitral Valve Repair: From the CUTTING-EDGE Registry

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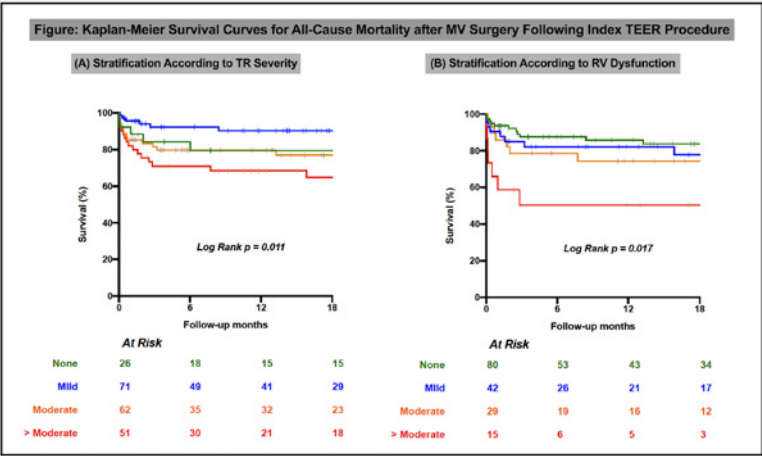
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Invited Discussant: Joon Bum Kim

Objective: More than 100,000 Transcatheter Edge-to-Edge mitral valve Repair (TEER) procedures have been performed globally, and consequently, mitral valve (MV) surgery after TEER is increasing. The aim of this study is to assess the impact of preoperative tricuspid regurgitation (TR) grade and right ventricular (RV) dysfunction on outcomes of MV surgery after TEER.

Methods: Data from the multicenter, international CUTTING-EDGE registry of patients who underwent MV surgery after TEER were retrospectively reviewed. Surgical indications and median interval from TEER to surgery was evaluated. Valve Academic Research Consortium-2 outcomes at 30 days and 1 year were evaluated. TR grade or RV dysfunction was classified as either none, mild, moderate or > moderate based on echocardiography. Actuarial cumulative survival was assessed using Kaplan-Meier survival analysis. The overall median follow-up was 30.5 months (IQR: 10.3–43.7) from TEER.

Results: From 7/2005 to 7/2020, 228 patients across 24 centers with mean age of 73 ± 10.4 years were enrolled. Median STS risk at initial TEER was 5.0% (IQR: 2.4–7.9%), and 47.3% were at least high or extreme surgical risk. The proportion of degenerative MR and functional MR patients was 44.3% and 42.1%, respectively. Majority of patients (91.2%) underwent MV replacement, while concomitant TV repair was performed in 41.4% of patients. The main surgical indications included partial/total leaflet detachment (34.2%), recurrent MR (39.7%), residual MR (29%), mitral stenosis (15.2%), and partial leaflet detachment (19.2%); The median interval from TEER to surgery was 4.8 months (IQR: 0.6–11.1). The 30-day and 1-year mortality was 13.4% and 25.5%, respectively. Preoperative TR grade and RV dysfunction of moderate and at least moderate-to-severe was prevalent in 30.8% and 24.8%, and 17.6% and 9.7% of patients prior to MV surgery. On Kaplan-Meier analysis, there was a significant difference in cumulative survival according to preoperative TR grade severity (Figure A) and RV dysfunction (Figure B). However, on multivariable analysis, only TR severity pre-surgery remained a risk factor of in-hospital mortality after MV surgery (OR 1.75, 95% CI: 1.14–2.69).



Conclusions: In this CUTTING-EDGE global registry, preoperative TR grade and RV dysfunction severity appear to impact cumulative survival after MV surgery following TEER significantly. This first report suggests that aggressive reintervention before interval development of TR or RV dysfunction following TEER may improve patient outcomes.

12. Incidence, Characteristics, and Outcomes of Reintervention After Failed Transcatheter Mitral Valve Repair Procedures: A National Representative Analysis

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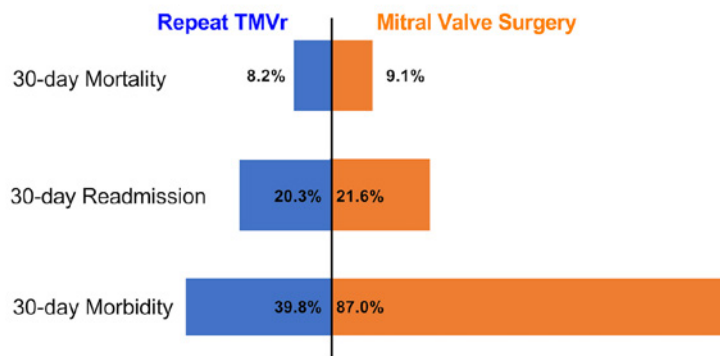
Invited Discussant: Andrea Colli

Objective: Transcatheter mitral valve repair (TMVr) is increasingly performed on patients not suitable for surgery. However, with its increasing use, reintervention after failed TMVr by way of repeat TMVr or mitral valve surgery (MVS: repair or replacement) is being performed. This nationally representative study examines the incidence, characteristics, and outcomes of reintervention after the index TMVr.

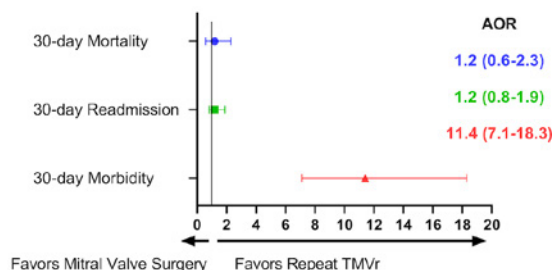
Methods: Between July 2013 and 2017, we reviewed 11,426 patients who underwent an index TMVr procedure using Medicare inpatient claims and beneficiary summary files. These patients are prospectively tracked and classified as having no reintervention, repeat TMVr, or MVS. Primary outcomes included 30-day mortality, 30-day readmission, and a 30-day morbidity composite outcome of stroke, acute kidney injury, permanent pacemaker implantation, major bleeding, and cardiac arrest. Multivariate logistic regression and inverse propensity weighting techniques were used to adjust for differences between patients, which accounted for patient comorbidities and claims-based Charlson Comorbidity Indexes.

Results: Among 11,426 patients, 548 patients (4.8%) required reintervention with a median time to reintervention of 4.5 months [IQR 2.1, 10.7]. Overall 30-day mortality was 8.6%, 30-day readmission was 20.9%, and 30-day composite morbidity was 61.7%. Examining by reintervention type, 294 (53.7%) underwent repeat TMVr, 11 (2.0%) underwent MV repair, and 243 (44.3%) underwent MV replacement. The MVS cohort had a significantly shorter time to reintervention (4.2 vs 5.0 months, $p < 0.01$) than the TMVr cohort. Patients who underwent MVS were more likely to be younger (78.7 vs 81.6 years) and female (46.9% vs 36.4%) compared to the repeat TMVr cohort. There were no significant differences in Charlson Comorbidity Index at the time of reintervention between these two cohorts (56.3% vs 57.8%). The MVS cohort had significantly more concomitant procedures, including concomitant surgical aortic valve replacement and tricuspid valve surgery ($p < 0.01$). Adjusted outcomes demonstrated that there were no significant differences in 30-day mortality (AOR 1.2 [0.6, 2.3]) or 30-day readmission (AOR 1.2 [0.8, 1.9]), but MVS was associated with higher 30-day morbidity (AOR 11.4 [7.1, 18.3]) compared to repeat TMVr. The outcomes were similar when employing an inverse probability weighting adjustment approach.

Unadjusted Outcomes for Repeat Intervention After TMVr



Adjusted Outcomes by Multivariate Analysis



Conclusions: Repeat intervention after index TMVr procedure is a high-risk procedure that carries a significant mortality burden. Both TMVr and MVS had equally high 30-day mortality and readmission, with MVS having a higher rate of 30-day morbidity. This highlights the importance of ensuring appropriate patient selection and procedural success for index TMVr procedures.

13. Low Parental Socioeconomic Position Results in Longer Post-Norwood Length of Stay

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Texas Children's Hospital, Houston, TX

Invited Discussant: Tara B. Karamlou

Objective: Length of stay (LOS) has been proposed to be used as a quality metric in congenital heart surgery; however, LOS may be influenced by parental socioeconomic position (SEP). We aimed to examine post-Norwood LOS as an effect of parental SEP.

Methods: Patients undergoing a Norwood procedure from 2008–2018 for hypoplastic left heart syndrome (HLHS) from a single institution, who were discharged alive prior to second stage palliation, were included. SEP was defined by area deprivation index (ADI), distance from hospital, insurance status, and immigration status. The ADI is a validated measure for ranking census blocks by socioeconomic disadvantage using domains such as income, education, employment, and housing quality. A directed acyclic graph identified confounders for the effect of SEP on LOS, which included gestational age, race/ethnicity, HLHS subtype, post-operative cardiac arrest, reoperations, and ventilator days. A negative binomial model was used to assess effect of SEP on LOS.

Results: In total, 98 patients were discharged alive at a median 37 days (15th–85th percentile 26–72). The majority of patients were children of United States citizens and permanent residents (n = 89, 91%). Private insurance covered 54 (55%), with 44 (45%) covered by Medicaid or Tricare. Median area deprivation index was 54 (25–87). Median distance travelled was 72 miles (17–469). For every 10 percentile increase in area deprivation index, LOS increased 4% (IRR 1.04, 95% CI 1.003–1.075, p = 0.023). Insurance type, immigration status, and distance travelled did not affect post-operative length of stay.

Conclusions: To consider length of stay as a quality indicator is to trivialize social determinants of health and penalize hospitals providing complex care for all patients.

14. Contact Factors As a Potential Therapeutic Target in the Management of Extracorporeal Membrane Oxygenation: Results from In Vitro and In Vivo Experiments

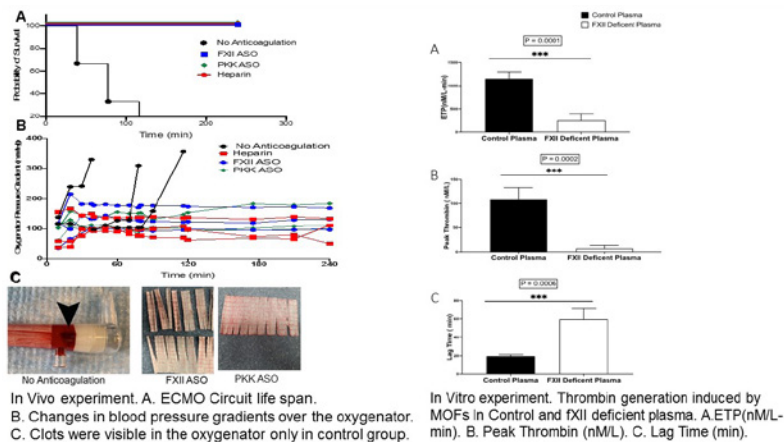
Mousa Kharnaf¹, Leah Rosenfeldt¹, Duaa Mureb¹, Alexey Revenko², Brett Monia², Karthik Thangappan¹, Kyle Riggs¹, Farhan Zafar¹, Joseph Palumbo¹, James Tweddell¹

¹Cincinnati Children's Hospital Medical Center, Cincinnati, OH; ²Ionis Pharmaceuticals, Inc., Carlsbad, CA

Invited Discussant: David M. McMullan

Objective: Suppression of the contact activation system (CAS) of coagulation has shown promise in animal models of extracorporeal membrane oxygenation (ECMO) support. The goal of this study was to evaluate whether upstream targeting of factor XII (fXII) or prekallikrein (PKK) could prevent clotting and improve circuit life in a rabbit model of ECMO.

Methods: In Vitro experiment: Thrombin generation (TG) in the absence or presence of membrane oxygenator fibers (MOFs) was quantified in fXII deficient plasma and normal plasma controls. In Vivo experiment: The clinical applicability of targeting fXII or PKK was investigated using antisense oligonucleotides (ASO) targeting these proteases. A total of 12 New Zealand white rabbits (3 with no anticoagulation, 3 heparin treated, 3 fXII ASO treated, 3 PKK ASO treated), were placed on ECMO via direct abdominal aorta and inferior vena cava cannulation. Circuit life, pressure across the oxygenator and presence of clot were compared.



Results: MOFs significantly promoted TG in normal control plasma in the absence of any other trigger. FXII deficient plasma significantly attenuated the degree of thrombin generation observed in the presence of MOFs relative to control (FXII-sufficient) plasma. In the rabbit ECMO model, elimination of fXII or PKK was as efficient as unfractionated heparin (UFH) in preventing clot formation and maintaining ECMO circuit life (Figure). Both the fXII and PKK depleted groups were maintained on ECMO for the entire 4-hour experimental timeframe without any visible thrombi in the circuit. In contrast, none of the non-anticoagulated control rabbits were able to reach the 4 hr mark on bypass. Of the three non-anticoagulated cases, clots were visible in the oxygenator in two cases while the third case was stopped due to pre-membrane pressures >400 mmHg.

Conclusions: Targeting fXII or PKK can limit thrombus formation and improve circuit life in ECMO, presumably without incurring any bleeding risk. Consistent with this, MOFs induced thrombin generation was attenuated in fXII depleted plasma. Contacted factor targeted suppression of CAS needs to be studied in the presence of varying degree of extrinsic activation of coagulation to better understand its clinical utility in extracorporeal life support.

15. Cyclosporin A Preserves Multimer Assembly Following Neonatal Myocyte Arrest Using Del Nido Cardioplegia

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Invited Discussant: Sachin Talwar

Objective: The efficiency of myocyte ATP production is increased by the assembly of monomer protein units into multimer units that include tetramers, synthasomes, and respirasomes. Following ischemia, multimer proteins are often disassembled into monomers, reducing myocyte ATP supply and left ventricular function. We hypothesized that cyclosporin A (CsA), which preserves multimer assembly during hypoxia, would also preserve multimer assembly in a neonatal large animal model of myocyte arrest with del Nido cardioplegia.

Methods: Neonatal lambs (*Ovis aries*) were placed on cardiopulmonary bypass and underwent myocyte arrest for approximately 40 minutes using single dose antegrade del Nido cardioplegia. Animals were given CsA 10 mg/kg or vehicle 30 min after reperfusion and every 24 h afterward. Left and right ventricular biopsies were taken at 72 h postoperatively or at the time of expiration. Protein complexes were separated on clear native gels and the monomer to multimer (tetramer, synthasome, or respirasome) ratio quantified by immunoblot. Serum troponin was measured at approximately 4 h following ischemia. Echocardiograms assessed change in left ventricular ejection function (LVEF) from baseline to protocol completion.

Results: Of eight neonatal lambs, 4 received CsA and 4 received vehicle. Within each group, two animals survived to study completion and two expired during the early post-operative period from cardiorespiratory failure. There were no significant differences in baseline age, weight, gender, LVEF, cardiopulmonary bypass, or cross clamp times between groups. Troponin levels were also similar between groups. Although the right ventricular tetramer ratio (0.37 ± 0.10 veh vs 0.36 ± 0.05 CsA, $P = 0.81$) was not significant between groups, the respirasome ratio (0.63 ± 0.02 veh vs 0.77 ± 0.02 CsA, $P < 0.001$) was significantly higher in the CsA group. All left ventricular multimer levels including tetramers, synthasomes, and respirasomes were significantly greater within the CsA group (Figure 1). Qualitatively, the LVEF decreased in all vehicle treated animals and increased in all CsA treated animals. In addition, there was a direct relationship between the change in LVEF and left ventricular tetramer ratio ($R^2 = 0.61$, $p = 0.1$).

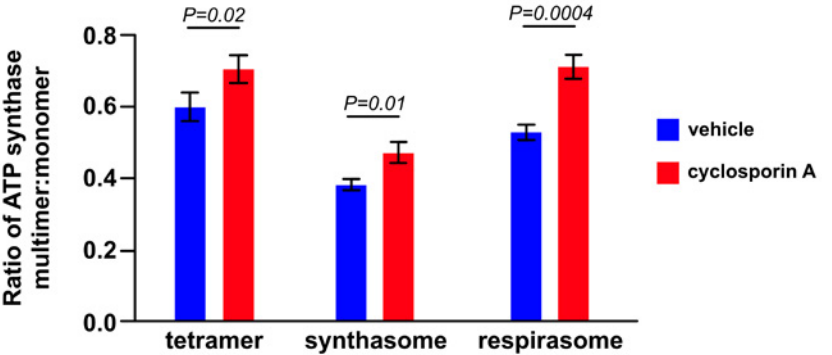


Figure 1: Bar graph illustrating energy producing multimers (tetramers, synthasomes, and respirasomes) in left ventricular muscle following cardioplegic arrest and treatment with vehicle solution ($n = 4$) vs. cyclosporin A ($n = 4$). Assembly of energy producing multimers after cardioplegic arrest was significantly preserved in animals treated with cyclosporin A.

Conclusions: This demonstrates for the first time in a large animal model that CsA preserves multimer assembly following the ischemia and reperfusion of cardioplegic arrest, and may be a viable alternative to increase myocyte ATP availability following neonatal cardiac surgery.

16. A Biomimetic Patch Designed for Heart Valve Repair Displays a Better Anisotropy and Tensile, Flexural, and Anti-Tearing Properties Compared to Commercial Patches

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¹Department of Surgery and Biomedical Engineering, Columbia University Medical Center, New York, NY; ²Department of Mechanical Engineering, Columbia University, New York, NY; ³Division of Cardiac, Thoracic and Vascular Surgery, Section of Pediatric and Congenital Cardiac Surgery, New-York-Presbyterian Morgan Stanley Children's Hospital, Columbia University Medical Center, New York, NY

Invited Discussant: William M. DeCamp

Objective: A “biomimetic” patch based on biostable polymers was developed to replicate the three-layer architecture and anisotropic mechanical properties of a native leaflet in order to achieve a better durability *in vivo*. We aimed to test the mechanical properties of this new generation patch and compare it to commercial patches and native tissues.

Methods: A polycarbonate polyurethane (PCU)-based patch, with aligned fibers and foams, was fabricated via solution casting, electrospinning, and lyophilization methods. The biomimetic composite patch (BCP) has a designed Film-Foam-Film structure (Figure 1A, 1B) that mimics the three-layered architecture of native human aortic leaflet (HAV). In vitro mechanical tests including uniaxial tensile tests, bulge flexural tests, and suture retention tests were performed to evaluate the mechanical performance of different products and compare our BCP to FDA-approved commercial cardiac patches and HAVs.

Results: Compared to commercial patches, our BCPs exhibited an anisotropic behavior and tensile modulus [circumferential tensile modulus (cEM): 6.20 ± 1.83 MPa, and radial tensile modulus (rEM): 1.80 ± 0.21 MPa] much closer to HAV [cEM: 16.34 ± 0.42 MPa, and rEM: 0.03 ± 0.01 MPa] (Figure 1C). The flexural bulge test unveiled a similar flexural modulus between our BCP and HAV (2.70–3.55 MPa), while commercial patches had very rigid flexural properties (4.52–17.58 MPa) (Figure 1D). The tensile and flexural test showed an anisotropic performance of the BCP (similar to HAV) while commercial patches displayed a concentric stress distribution at a near-physiological pressure, which demonstrates their inherent isotropic behavior. (Figure 1E). Our BCP showed thickness-normalized suture retention strength (TN-SRS) similar to FDA-approved cardiac patches (Figure 1F), with an improved toughness (Figure 1G), defined as the integration of the area under the TN-SRS curve.

Conclusions: The biomimetic composite patch displays mechanical properties that are much closer to human aortic leaflets compared to commercial ones, including tensile property, flexural property, and anti-tearing property. It paves the way for a new clinical-grade biomaterial designed for a better durability when implanted in a valve leaflet position.

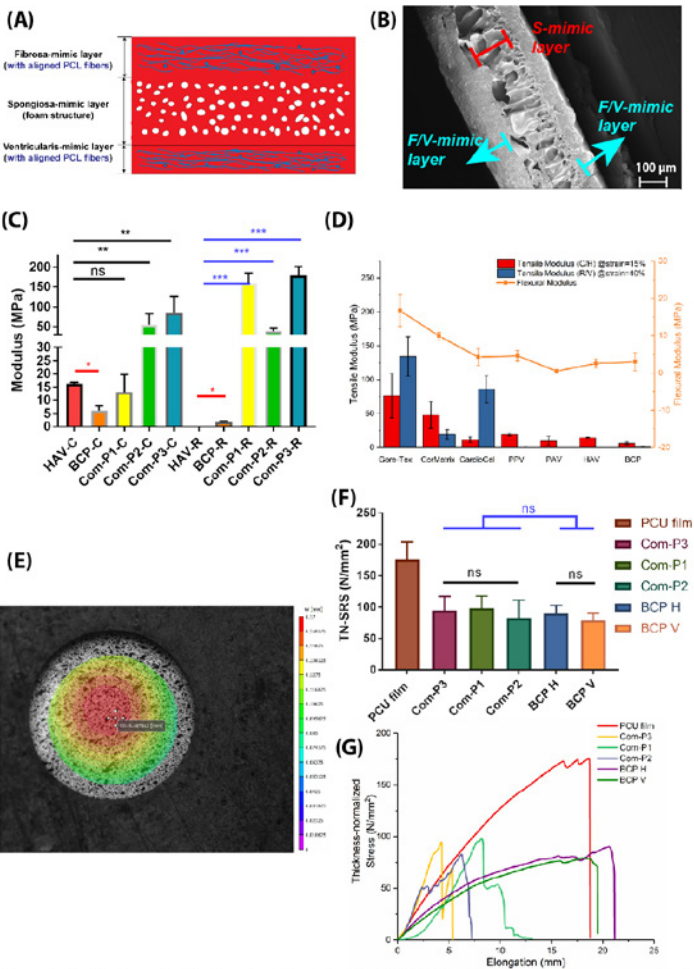


Figure 1: Architecture of the biomimetic customized patch (BCP) (A). The SEM image of the cross-section of the BCP (B). A comparison of tensile modulus illustrated the significant difference in mechanical stiffness in two different directions (circumferential direction-C and radial direction-R) among human aortic valve (HAV), BCP, and commercial patches (Com-P1, P2 & P3) (* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ and ns=no significant difference, t-test) (C). Tensile Modulus and Flexural Modulus show that commercial patches have much stiffer performance compared to HAV while our BCP displays a mechanical performance similar to the HAV. Both of them have similar trend in accordance (orange line vs red bar) (D). Commercial patches have shown a concentric stress distribution at a near-physiological pressure, which demonstrates its inherent isotropic behavior (E). BCPs exhibit a similar TN-SRS as other commercial patches (ns=no significant difference, t-test & one-way ANOVA) (F). TN-SRS curves unveiled the higher elongation of BCP than commercial patches, inferring BCP's higher toughness and potential to resist tearing (G).

17. The Outdated Practice of Using Oversized Organs for Recipients with Elevated PVR

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Cincinnati Children's Hospital Medical Center, Cincinnati, OH
Invited Discussant: Bahaaldin Alsoufi

Objective: Elevated pulmonary vascular resistance (PVR) continues to pose challenges in heart transplantation, but does the common belief that implanting a larger organ when the PVR is high actually affect outcomes? The purpose of this study is to assess post-transplantation outcomes in recipients with increased PVR in relation to donor organ size.

Methods: The United Network for Organ Sharing (UNOS) database was used to identify patients ages 0–18 years at time of listing who underwent transplantation between 2010 and 2019 and for whom cardiac catheterization and donor-recipient weight data was available. Patients were divided by listing PVR into <3, 3–6, and >6 Wood units. Donor-Recipient weight ratio was categorized as undersized (≤ 0.80), mid-size (0.81–1.2), and oversized (>1.2). Subgroup analysis was done with an additional supersized group (>2.0).

Results: 1491 patients met study criteria. Median age (years [IQR]) 10 (3–15) and 45% female. 4% of heart transplantation cases used undersized, 45% used mid-size, and 51% used oversized organs. More patients with PVR >6 were transplanted with an oversized organ compared to patients with PVR <3 [59% (148/252) vs 48% (430/894), $p = 0.003$]. There was no difference in survival between the organ size groups regardless of PVR; this includes patients with PVR >6 at listing who were transplanted with an oversized organ versus those transplanted with an undersized ($p = 0.359$) or mid-sized ($p = 0.956$) organ. In subgroup analysis, even in patients transplanted with a supersized organ, there was no survival difference noted regardless of PVR.



Figure 1: Kaplan-Meier survival over time for patients with PVR >6 Wood units who underwent heart transplantation with different donor-recipient weight ratio organs

Conclusions: Despite a persistent practice pattern to transplant high PVR patients with oversized organs, there remains no difference in post-transplantation survival between these patients and those transplanted with smaller organs. Therefore, transplants in patients with high PVR should not be delayed by waiting for larger organs.

18. Heart-Kidney Listing Is Better Than Isolated Heart Listing for Pediatric Heart Transplant Candidates with Significant Renal Insufficiency

Alia Dani, Nina Price, Karthik Thangappan, Thomas D. Ryan, David Hooper, David S. Cooper, David G. Lehenbauer, Clifford Chin, Farhan Zafar, David L.S. Morales
Cincinnati Children's Hospital Medical Center, Cincinnati, OH
Invited Discussant: Osami Honjo

Objective: Renal insufficiency is prevalent in patients with end-stage heart failure and is identified as a risk factor for post-transplantation mortality in pediatric heart transplant (HTx) recipients. The outcomes of simultaneous heart-kidney transplantations (HKTx) in pediatric patients are promising. This study evaluates HKTx outcomes compared to isolated HTx for pediatric candidates with significant renal insufficiency (SRI).

Methods: The United Network for Organ Sharing (UNOS) HTx database was searched for pediatric candidates from January 1987 to March 2020 who were either simultaneously listed for a kidney anytime during the waitlist period (HKTx listing) or were listed for isolated HTx and had SRI at the time of listing. SRI was defined as needing dialysis and/or having a low GFR (<40 mL/min). Most centers do not perform kidney transplants in patients weighing less than 10 kg, hence they were excluded. Comparison of descriptive characteristics and post-transplant outcomes, including survival rates using Kaplan-Meier analysis, were obtained.

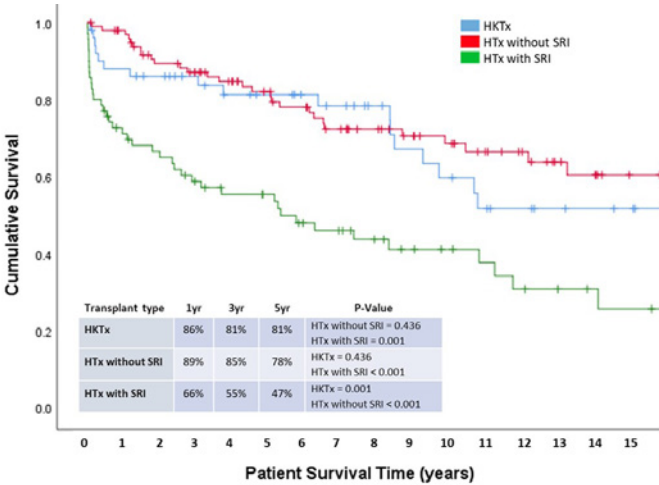


Figure. Post-transplant patient survival outcomes for 3 transplant groups: Heart-Kidney Transplantation (HKTx), Heart Transplantation with Significant Renal Insufficiency (HTx with SRI) and Heart transplantation without SRI at time of transplant (HTx without SRI), at 1-year, 3-year and 5-year post-op

Results: A total of 427 cases were identified: 26% ($n = 109$) were HKTx listings (36% on dialysis [$n = 39$], 46% with GFR <40 [$n = 50$]), and 74% ($n = 318$) were listed for HTx alone (39% on dialysis [$n = 124$] and 61% with GFR <40 [$n = 194$]). Median number of days on the waitlist was 145 (39–334) for HKTx listings compared to 22 (6–51.5) and 30 days (12–85.25)

for HTx patients on dialysis or with a low GFR, respectively ($p < 0.001$). Of all HKTx listings, 66% ($n = 71$) received a transplant (HTx $n = 16$, HKTx $n = 51$, or Kidney Tx $n = 1$), whereas 54% ($n = 173$) of HTx alone listings with SRI received a transplant ($p = 0.005$). At 1-year after listing, 69% of HKTx listed patients were alive (either transplanted or not), compared to 51% of patients listed for heart alone ($p = 0.029$). HKTx recipients had significantly better 1-year post-transplant survival rates (86%) than HTx recipients who had SRI at transplant (66%) ($p = 0.001$). There was no significant difference in the 1- and 5-year survival of HTx recipients listed with SRI who had no SRI at time of transplant (89% and 78%) and HKTx recipients (86% and 81%) ($p = 0.436$) (Figure).

Conclusions: Pediatric heart transplant candidates with significant renal insufficiency listed for HKTx have superior waitlist and post-transplantation outcomes, despite spending more days on the waitlist, compared to those listed for isolated HTx. Patients with significant renal insufficiency should be listed for Heart-Kidney transplantation. However, if their renal function improves significantly, isolated heart transplantation is judicious.

19. Multicenter US Experience with Trans-Septal Left Atrial VAD Cannulation Technique for Small Left Ventricles in the Pediatric Population

Katsuhide Maeda¹, Iki Adachi², Ming-Sing Si³, David M. Peng³, Teimour Nasirov¹, Michael Ma¹, David N. Rosenthal¹, Chris S. Almond¹, John C. Dykes¹

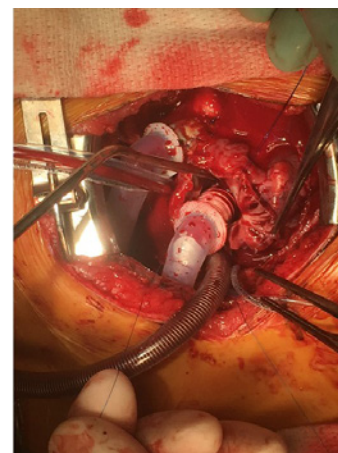
¹Stanford University, Stanford, CA; ²Texas Heart Institute, Texas, TX; ³University of Michigan, Ann Arbor, MI

Invited Discussant: Ronald K. Woods

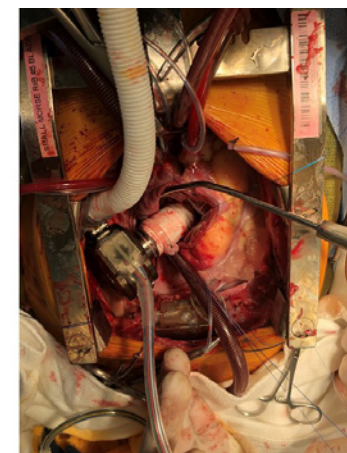
Objective: Left ventricular assist device (LVAD) outcomes for children with a small left ventricular (LV) cavity, such as those with hypertrophic (HCM)/restrictive cardiomyopathy (RCM) are unsatisfactory. While the LV apical cannulation often results in inadequate drainage, the standard left atrial (LA) cannulation has high incidence of stroke. To address this issue, we developed a modified LA cannulation technique in which the left atrium is drained via the trans-atrial chimney graft connected to a created atrial septal defect.

Methods: Retrospective review of multicenter US experience with the modified technique for LVAD/BiVAD implantation in patients with small LV cavity from October 2016 to August 2020. Outcomes following implantation were analyzed, including subsequent interventions, quality of VAD support, as well as patient survival and complications.

Results: In total, 9 patients underwent LVAD implantation with the modified LA cannulation techniques (HCM = 5 patients, RCM = 1, others = 3, age ranging from 15 days old to 10-year-old, 3.6 to 35 kg). Six patients received Berlin Heart LVAD, 1 received a Berlin Heart BiVAD, 1 patient received PediMag BiVADs, and 1 patient received a Heartware LVAD. Total support days were 640 days. Five patients underwent successful heart transplant after 275, 111, 62, 45 and 31 days of support. One neonate with HCM died from sepsis 27 days after PediMag BiVAD placement. One RCM patient died 10 days after Berlin Heart BiVAD placement following extracorporeal membrane oxygenation due to ARDS. Two patients are still on VAD support, awaiting transplant. Total survival rate is 78%, including those on continuing support. One patient developed severe bleeding, and hemolysis. All survivors did not manifest any neurological deficits or complications related to thrombus.



Berlin Heart LVAD inflow through atrial septum



Heartware LVAD inflow through atrial septum

Conclusions: This trans-septal left-atrial LVAD cannulation strategy is an alternative cannulation technique for patients with a small left ventricular cavity including HCM/RCM. This technique can be applied to a variety of pediatric and adult devices in patients ranging from infants to adults.

20. Lymph Node Assessment During Segmentectomy for Stage I Non-Small Cell Lung Cancer in the National Society of Thoracic Surgery Database: A Propensity Score Adjusted Comparison of the Robotic-, Vats and Open Approach

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The Ohio State University, Columbus, OH

Invited Discussant: Daniel P. Raymond

Objective: To assess the quality of lymph node assessment during segmentectomy by robotic-assisted (RATS), video-assisted thoracoscopic (VATS), and open thoracotomy approach for clinical stage I non-small cell lung cancer (NSCLC).

Methods: The national STS General Thoracic Database was queried for patients who had undergone segmentectomy as the primary procedure for clinical stage I NSCLC between years 2012–2018. Patients without PET scan, carcinoid tumors, unavailable pathologic nodal status and those undergoing preoperative therapy were excluded. Propensity score adjustment by inverse probability of treatment weighting (IPTW) was used to match baseline characteristics between the three operative approaches. Primary endpoint was pathologic lymph node upstaging.

Results: A total of 2,800 patients were analyzed. The majority of patients underwent thoracoscopic segmentectomy by either RATS ($n = 563$, 20.1%) or VATS ($n = 1775$, 63.4%) approach, and 462 (16.5%) underwent an open thoracotomy. The groups were adequately

balanced following IPTW adjustments. Ten or more lymph nodes were recorded in 42.6% of RATS, 31.5% of VATS and 28.6% of open segmentectomy procedures ($p < 0.001$). Similarly, six or more lymph node stations (N1 + N2) were reported in the minority of cases (RATS 34.0%, VATS 14.8%, Open 16.7%, $p < 0.001$). The IPTW adjusted rate of overall pathologic lymph nodal upstaging (pN1/pN2) was 5.7%, and was slightly higher in the thoracotomy group (RATS 5.5%, vs VATS 5.1% vs Open 8.0%, $p = 0.049$). Frequencies of mediastinal pN2 upstaging were similar between groups (RATS 2.1% vs VATS 1.9% vs Open 2.8%, $p = 0.18$). On multivariate analysis, when adjusting for IPTW, patient factors, tumor stage, location, and preoperative invasive staging procedure there was no significant differences in lymph node upstaging between RATS or VATS as compared to the open segmentectomy approach (Table).

TABLE:

Multivariate Binary Logistic Regression Analysis of Nodal Upstaging Comparing Surgical Approaches for Segmentectomy for Stage I NSCLC*			
	Odds Ratio	97.5% Confidence Interval	P-value
Overall Upstaging			
Open Thoracotomy	Reference	Reference	
Robotic	0.586	0.282 – 1.220	0.154
VATS	0.754	0.396 – 1.436	0.390
N1 Upstaging			
Open Thoracotomy	Reference	Reference	
Robotic	0.759	0.309 – 1.866	0.548
VATS	0.861	0.389 – 1.905	0.712

*Model adjusted for IPTWs, country, gender, race, COPD, ASA class, use of invasive mediastinal staging (EBUS, mediastinoscopy, VATS), reoperation, tumor stage, tumor location, and margin status.

Conclusions: National data from the STS database indicate that only the minority of patients undergoing segmentectomy met the quality standards set for a complete lymph node evaluation. The frequency of pathologic nodal upstaging following segmentectomy for stage I NSCLC however is notable, with no significant differences between the robotic, VATS and the conventional open operative approach in a carefully adjusted analysis.

21. Relationship Between Delayed Surgery and Oncologic Outcomes in Clinical Stage I Non-Small Cell Lung Cancer

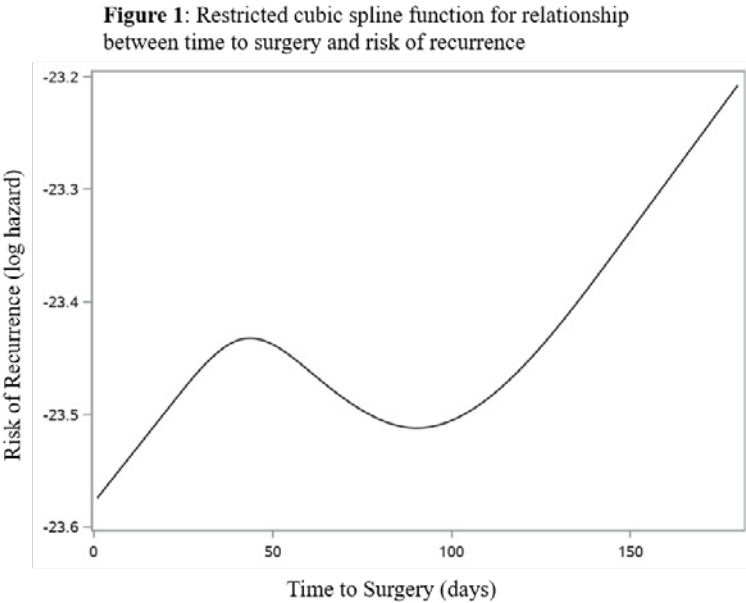
Brendan T. Heiden¹, Daniel B. Eaton², Su-Hsin Chang^{1,2}, Yan Yan^{1,2}, Bryan F. Meyers¹, Benjamin D. Kozower¹, Varun Puri^{1,2}, Kathryn E. Engelhardt¹
¹Washington University School of Medicine, St. Louis, MO; ²VA St. Louis Health Care System, St. Louis, MO

Invited Discussant: Michael Lanuti

Objective: The COVID-19 pandemic has imposed unprecedented delays in surgical care. The impact of delayed surgery on lung cancer outcomes is poorly understood as prior studies, including those by our group, have used imprecise definitions for the date of cancer diagnosis. Using the United States Veterans Health Administration (VA) system, we employed a uniform method to quantify surgical delay and examined its association with oncologic outcomes.

Methods: Traditionally, VA and other large databases allow coders to record date of diagnosis based on either clinical, radiologic, or pathologic diagnosis. In a cohort of Veterans undergoing clinical stage I lung cancer resection between 10/2006 and 09/2016, time to surgery (TTS) was uniformly defined as the period between the computed-tomography scan prompting thoracic surgery intervention and surgery. We performed multivariable regression analysis to examine factors influencing pathologic upstaging, positive surgical margins, and recurrence. We evaluated the relationship between TTS and these outcomes using restricted cubic spline functions.

Results: The study included 10,447 patients. The mean (SD) TTS through our radiologic method was 70.1 (38.6) days; the previously documented TTS in the VA dataset, by contrast, was 0 days in more than 25% of patients. Pathologic upstaging occurred in 1,423 (13.7%) patients and positive surgical margins were found in 338 (3.2%) patients. Factors associated with upstaging included younger age (OR 0.985, 0.975–0.995), higher grade (I vs II, OR 2.503, 1.879–3.335), larger tumor size (<10 mm vs 30–40 mm, OR 1.762, 1.271–2.444), higher number of lymph nodes examined (<10 vs >10, OR 1.511, 1.305–1.749), and pneumonectomy (OR 3.393, 2.332–4.936). Factors associated with positive surgical margins included wedge resection (OR 2.501, 1.866–3.352) and larger tumor size (<10 mm vs 31–40 mm, OR 1.848, 1.026–3.329). TTS was not associated with increased risk of upstaging or positive margins. With median follow-up of 4.92 years, recurrence was detected in 4,422 (44.3%) patients with median time-to-recurrence of 1.24 years (IQR, 0.43, 2.76). Factors associated with recurrence included younger age (HR 0.991, 0.986–0.996), higher Charlson comorbidity index (HR 1.056, 1.039–1.074), higher grade (I vs. II, HR 1.249, 1.120–1.392), segmentectomy (HR 1.292, 1.126–1.482) or wedge resection (HR 1.246, 1.146–1.355), readmission (HR 1.115, 1.009–1.233), and longer TTS with increasing risk after 12 weeks (Figure 1, HR 1.003, $p = 0.033$).



Conclusions: Using a more precise definition for the date of diagnosis, surgeries delayed more than 12 weeks were associated with higher risk of recurrence. This suggests that clinical stage I lung cancer patients should continue to undergo expedient resection, although short delays for additional workup following suspicious imaging may have a relatively modest biologic penalty.

22. Reconsidering the AJCC 8th Edition TNM Classifications for T2b/T3 Non-Small Cell Lung Cancer

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Invited Discussant: Frank C. Detterbeck

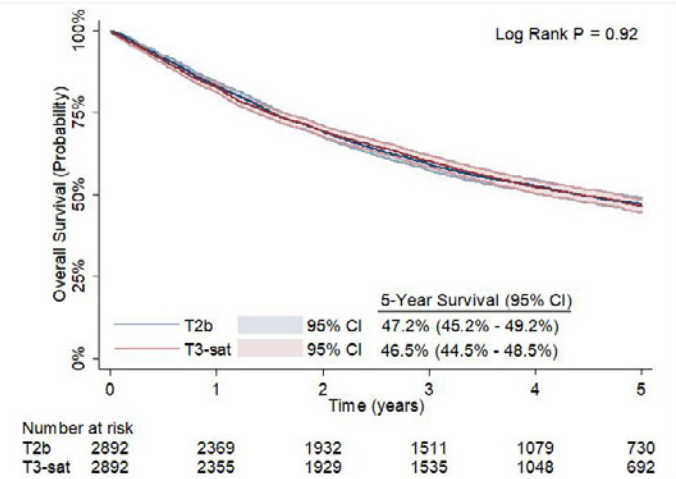
Objective: According to the American Joint Commission on Cancer (AJCC) 8th edition TNM stage classifications for non-small-cell lung cancer (NSCLC), a primary tumor associated with separate tumor nodule(s) in the same lobe is classified as “T3” (T3-sat). This classification is based on data from the International Association for the Study of Lung Cancer (IASLC). Of note, analysis of the IASLC database showed a trend in improved survival with T3-sat tumors when compared to other types of T3 tumors. The objective of this study was to assess whether patients with T3-sat tumors have worse survival than patients with T2b NSCLC.

Methods: Patients with cT2b No-N3 Mo or cT3 No-N3 Mo NSCLC (with only a single T3 descriptor of “T3-sat” or “T3-size” [tumors >5 cm but ≤7 cm in greatest dimension]), according to the AJCC 8th edition, in the National Cancer Data Base from 2010–2015 were included. Other types of T3 tumors were not included because of unavailable data. Overall survival was evaluated using multivariable Cox proportional hazards modeling and propensity-score matching.

Results: Of the 30,364 patients that met study inclusion criteria, there were 4,867 (16.0%) T2b patients, 7,067 (23.3%) T3-sat patients, and 18,430 (60.7%) T3-size patients. Multivariable-adjusted analysis demonstrated that when compared to T3-size, T3-sat was associated with improved overall survival (HR: 0.85, 95% CI: 0.82–0.88, $p < 0.001$). When compared to T2b, T3-sat was associated with similar survival in multivariable analysis (HR: 1.02, 95% CI: 0.95–1.08, $p = 0.62$). A propensity score-matched analysis of 2,892 cT2b and 2,892 T3-sat patients who were well matched by 16 common prognostic covariates including co-morbidities, N-status, and treatment type (i.e., surgery, chemotherapy and/or radiation) also yielded no significant differences in 5-year survival between the T2b and T3-sat groups (47.2% vs 46.5%, $p = 0.92$) (Figure 1).

Conclusions: In this national analysis of patients with cT2b and cT3 NSCLC, as classified by AJCC 8th edition criteria, T3-sat tumors were associated with improved overall survival when compared to T3-size tumors. In addition, both T2b and T3-sat tumors had similar overall survival, even in multivariable-adjusted and propensity-score matched analyses accounting for N-status, co-morbidities and specific treatment types. These findings suggest that multiple tumor nodules in the same, ipsilateral lobe, which are currently classified as T3, should be reconsidered as T2b.

Figure 1. Overall Survival of Patients with cT2b and cT3 (associated separate tumor nodule(s) in the same lobe as primary) NSCLC: Propensity Score-Matched Analysis



23. Statin Use Is Associated with Reduced Recurrence of Early-Stage NSCLC Treated by Lobectomy Only in Overweight/Obese Patients

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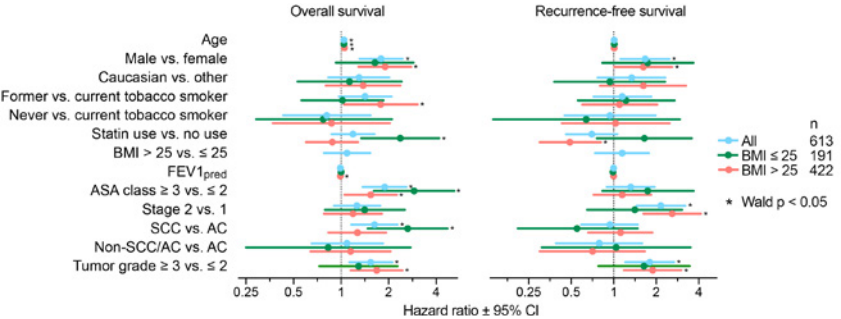
Invited Discussant: Dennis Wigle

Objective: Statins, used for their lipid-lowering activity, have anti-inflammatory properties as well. Recent epidemiologic and laboratory investigations suggest that these commonly used drugs also have an anti-cancer effect. In this study we examined this potential benefit of statin use in patients with non-small cell lung cancer (NSCLC).

Methods: All patients (n = 613) with pathologic stage I/II NSCLC undergoing lobectomy without neoadjuvant therapy at our institution during 2008–2015 were included in the study. To avoid time-interval bias, patients were considered exposed to statins only if they were prescribed statins prior to surgery. Cox proportional hazards regression was used to examine the association between statin use and overall (OS) and recurrence-free survival (RFS). Multivariable models were used to control for age, sex, race (Caucasian or other), stage, grade (≤2 or ≥3), histology, ASA (American Society of Anesthesiology) physical status class (≤2 or ≥3), smoking history (current, former, or never), and forced expiratory volume at 1 second (FEV1, % predicted). Analyses were also independently performed for the 422 overweight/obese (body mass index [BMI] ≥25) and the 191 other patients of the cohort. Standard t and Fisher exact tests were used for other group comparisons.

Results: Patients exposed to statins (n = 261; 42.6%) were older (mean ± SD = 69.7 ± 8.9 years vs 65.6 ± 10.5; $p < 0.01$) and more likely to be male (48% vs 38%; $p = 0.02$), and had higher BMI (29.1 ± 5.7 vs 26.7 ± 5.6; $p < 0.01$) and ASA class ($p < 0.01$). Univariate analyses did not demonstrate an association of statin use with OS but showed a trend toward benefit

in RFS, with hazard ratio (HR) = 1.19 and 0.70 (Wald p = 0.28 and 0.09), respectively. The trend toward RFS benefit was maintained in multivariable analysis (HR = 0.68; p = 0.07). In subgroup analyses, the benefit of statin use was seen only in overweight/obese patients (209 using statins), with univariate and multivariable HR of 0.49 and 0.46 (p = 0.005 and 0.002), respectively, but not in patients with BMI < 25 (52 using statins; univariate HR = 1.65; p = 0.21). The associations between variables and OS and RFS for the entire cohort and for subsets with BMI ≥25 and <25 are shown in Figure 1 (* denotes statistically significant associations; higher HR indicates increased risk of death or recurrence).



Conclusions: Statin use is associated with improved RFS of overweight/obese patients undergoing lobectomy for early-stage NSCLC. This is the first study to suggest that BMI modulates the beneficial effect of statins in lung cancer and it will help inform the conduct of clinical trials of statins in lung cancer.

24. A Risk Model to Predict the Ability to Start Adjuvant Chemotherapy Following Lung Resection in Patients with Pathologically Positive Lymph Nodes

Miriam Patella¹, Alessandro Brunelli², Laura Adams³, Stefano Cafarotti¹, Lorena Costardi⁴, Paul De Leyn⁵, Herbert Decaluwé⁶, Marta Fuentes⁶, Marcelo Jimenez⁶, Sunanda Karri⁷, Johnny Moons⁵, Pierluigi Novellis⁸, Enrico Ruffini⁴, Yaron Shargall⁷, Giulia Veronesi⁸, Emanuele Voulaz⁸, Kevin Franks³

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Invited Discussant: Mara B. Antonoff

Objective: To investigate factors associated with the ability to receive adjuvant chemotherapy in patients with pathological N1 (pN1) and N2 (pN2) stage after anatomic lung resections for non-small cell lung cancer (NSCLC) in a real-world setting.

Methods: Multicenter retrospective analysis on prospectively maintained clinical databases from 5 international centers. All 707 patients who underwent upfront anatomical lung resection for NSCLC (2014–2019) and were found to have pN1 or pN2 disease post-surgery were used as the derivation set. Multiple imputation logistic regression was used

to identify factors associated with adjuvant chemotherapy and to develop a model to predict the probability of starting adjuvant treatment. The model was externally validated in a population of 253 patients coming from 2 different centers.

Results: In the derivation set, 442 patients were pN1 and 265 pN2. 58% of patients received at least one cycle of adjuvant chemotherapy. The variables significantly associated with the probability of starting chemotherapy after multivariable regression analysis were younger age (p < 0.0001), higher Body Mass Index (BMI) (p = 0.031), higher Forced Expiratory Volume in 1 second (FEV1) (p = 0.037), better performance status (PS) (p < 0.0001), absence of chronic kidney disease (CKD) (p = 0.016), resection lesser than pneumonectomy (p = 0.010). The logit of the final prediction model was 6.58 -0.112 × age + 0.039 × BMI + 0.009 × FEV1 -0.650 × PS -1.388 × CKD -0.550 × pneumonectomy. In the validation set 143 patients (37.5%) were pN1 and 110 (43.5%) were pN2. 149 patients (59%) were able to receive adjuvant chemotherapy. The risk model was tested in the validation set showing a ROC AUC of 0.78; Hosmer-Lemeshow goodness of fit p value was 0.30, and the predicted rate of adjuvant chemotherapy administered was 59.2% (p = 0.87).

Table: Overview of Postoperative Chemotherapy Indication and Course

CHT no	400 (41.7%)
Reason for not having CHT	
Patients choice	88 (22%*)
Poor PS	112 (28%*)
Comorbidities	176 (44%*)
Not known	24 (6%*)
CHT yes	560 (58.3%)
CHT completed (≥3 cycles)	395 (70.7%§)
CHT interrupted (<3 cycles)	93 (16.6%§)
CHT completeness not known	72 (12.7%§)
CHT-related complications	252 (45%§)
Grade 1–2	85
Grade 3	59
Grade 4	20
Death	5
Unknown	83
Hospital admission during CHT	88

CHT: chemotherapy. (*): percentage referred to number of patients who did not have adjuvant chemotherapy; (§): percentage referred to number of patients who had adjuvant chemotherapy

Conclusions: Our study identified several preoperative factors associated with the probability of starting adjuvant chemotherapy after lung resection in node-positive patients. These findings support the role of accurate preoperative lymph node staging, including hilar lymph nodes, as high-risk patients, unlikely to receive adjuvant chemotherapy, might benefit of preoperative treatment. Cancer centers applying the policy of upfront surgery in resectable N2 disease may remodel the timing of systemic treatment over surgery. Our model may inform the multidisciplinary discussion and patient counseling to assist the decision-making process in this cohort of subjects needing multimodality treatment.

25. Long-Term Outcomes of Total Arch Replacement and Frozen Elephant Trunk for Chronic Type I Aortic Dissection

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Objective: The use of frozen elephant trunk (FET) and total arch replacement (TAR) in chronic type I aortic dissection (CTIAD) is limited by the scarcity of long-term follow-up data in large series. We seek to evaluate the long-term outcomes of FET + TAR and identify the risk factors for late adverse events in 508 patients over 17 years.

Methods: Data were analyzed for 508 patients with CTIAD (age 46.6 ± 10.8 years; 78.5% men) undergoing FET + TAR from 2003 to 2013. Hypertension was seen in 348 (68.5%), Marfan syndrome (MFS) in 66 (13.0%), ischemic heart disease in 40 (7.9%), prior cerebrovascular disease in 20 (3.9%), and prior heart surgery in 97 (19.1%). Malperfusion syndrome occurred in 62 cases (12.2%), including limb in 35 (6.9%), brain in 23 (4.5%), and kidney and spinal cord in 2 each (0.4%). Bentall operation was done in 174 (34.3%), uni- or bi-Yacoub remodeling in 40 (7.9%), aortic valve resuspension in 14 (2.8%), coronary artery bypass grafting (CABG) in 39 (7.7%), extra-anatomic bypass (EAB) in 27 (5.3%), and mitral valve replacement (MVR) in 13 (2.6%).

Results: Early mortality was 5.3% (27/508). Paraplegia occurred in 13 patients (2.6%), stroke in 6 (1.2%), acute kidney injury (AKI) in 23 (4.5%), reexploration for bleeding in 19 (3.7%), visceral or limb ischemia in 8 (1.6%), ventilation > 48 hours in 40 (7.9%), and distal new entry which was treated with thoracic aortic endovascular repair (TEVAR) in 3 (0.6%).

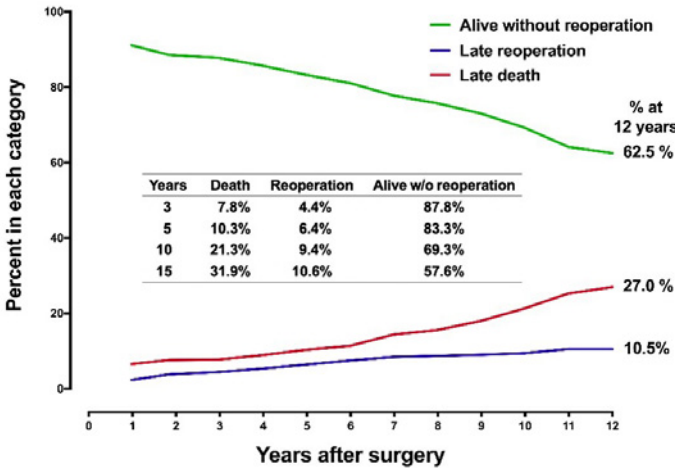
Risk factors for early death were time from onset to surgery (day) (odds ratio [OR] 1.001, *P* < .001), concomitant CABG (OR 5.457, *P* = .001) and EAB (OR 5.525, *P* = .002).

By October 2020, follow-up was complete in 98.5% (474/481) at mean 9.7 ± 3.3 years (range, 0.1–17.5), exceeding 10 years in 202 (42.6%) and 12 years in 113 patients (23.8%). Late death occurred in 108 patients. Confirmed causes included distal aortic rupture in 19, stroke in 7, sepsis in 3, acute heart failure in 2, lung cancer in 1, and liver cirrhosis in 1. Late reoperation was performed in 44 patients, including thoracoabdominal aortic repair in 16, TEVAR in 15, anastomotic leak repair in 6, abdominal aortic replacement in 4, EAB in 1, AVR in 1 and Bentall in 1.

At 10 and 15 years, survival were 75.4% and 63.9%, and freedom from reoperation were 90.6% and 89.4%, respectively. Competing outcomes analysis showed that at 12 years, mortality was 27%, 10.5% underwent reoperation, and 62.5% were alive without reoperation (Figure).

Risk factors for late death were MFS (hazard ratio [HR] 2.549, *P* < .001), prior heart surgery (HR 1.705, *P* = .022), concomitant MVR (HR, 4.584, *P* < .001) and ventilation > 48 hours (HR 3.062, *P* < .001). MFS (HR, 2.436; *P* = .012) and AKI after FET (HR 4.901, *P* = .009) were predictors of late reoperation.

Competing Risks of Late Death and Reoperation



Conclusions: The FET + TAR technique achieved excellent long-term survival and freedom from reoperation in this large series. These results argue favorably for use of this extensive approach in the management of chronic type I aortic dissection.

26. Multicenter Prospective Comparative Study of Japanese Frozen Elephant Trunk Device for Open Aortic Arch Repairs

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Objective: Recently, frozen elephant trunk (FET) procedures have been applied frequently to the open aortic arch repairs for aortic dissection or aneurysm. Since 2014, a new FET device has been commercially available in Japan. We performed a multicenter prospective comparative study to determine the impact of a Japanese FET device on the total arch replacement (TAR) and its outcome compared with that of conventional TAR without it.

Methods: Between 2016 and 2019, a total of 684 patients (TAR with FET; n = 369, conventional TAR; n = 315) from 41 institutions were enrolled. The two procedures were selected according to each center's strategy. The early outcomes (mortality and morbidity) are compared between the two procedures.

Results: TAR with FET was applied more for aortic dissection, whereas conventional TAR was predominantly performed for aneurysms. In TAR with FET, the incidences of emergent or urgent ($P < 0.001$) and redo ($P = 0.037$) surgeries were significantly higher. Regarding the FET size, the majorities were 9 and 12 cm in length and 25, 27, and 29 mm in diameter. The landing levels of the FET distal end were almost above the T8 level, except for seven patients (1.0%): T9 in six and T12 in one. With FET, corporeal hypothermic circulatory arrest time for the open distal anastomosis of TAR was reduced among the intraoperative parameters. There were no significant differences in the 30-day and in-hospital mortality rates (0.8% and 1.6%, respectively, for the TAR with FET vs 0.3% and 0.6%, respectively, for conventional TAR). However, in TAR with FET, the neurological complication rates were significantly higher in stroke (5.7% vs 2.2%; $P = 0.022$) and paraplegia (1.6% vs 0%; $P = 0.023$). In the propensity score matching analyses using five categories (age, gender, aortic dissection, emergency, and Stanford classification type A), in 84 patients each, statistical significance disappeared in the differences for mortality and neurological morbidity rates; a 30-day mortality rate of 1.2% for TAR with FET and 0% for conventional TAR ($P = 0.32$), an in-hospital mortality rate of 1.2% and 0% ($P = 0.32$), a stroke rate of 6.0% and 1.2% ($P = 0.096$) and a paraplegia rate of 1.2% and 0% ($P = 0.32$). In the further individual analyses on acute aortic dissection or aneurysm, there were no significant differences in the mortality and neurological morbidity rates between the two procedures, although the incidences were slightly higher in TAR with FET. In the propensity score matching analyses, similar findings with smaller differences were observed.

Conclusions: The early outcome of TAR with FET was acceptable despite its higher prevalence of emergency or redo surgery, which was comparable with that of the conventional TAR. TAR with FET had higher rates of spinal cord injury than the conventional TAR, which is a disadvantage of this approach.

27. Implications of Significant Intraoperative Neurophysiological Monitoring Changes in Aortic Surgery

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Objective: To evaluate the predictive ability of significant intraoperative neurophysiological monitoring (IONM) changes during aortic arch reconstruction with hypothermic circulatory arrest to detect adverse neurologic events (stroke or transient ischemic attack [TIA]) and mortality.

Methods: Patients undergoing aortic arch surgery requiring hypothermic circulatory arrest from 2010–2018 were retrospectively reviewed. Patients were actively monitored with electroencephalogram (EEG) and somatosensory evoked potential (SSEP). Baseline characteristics and outcomes of patients who had a significant IONM change were compared with those who did not experience any IONM changes. A significant IONM change was defined as any acute variation in SSEP or EEG monitoring compared to baseline. Multivariable logistic regression was used to evaluate the association with mortality and adverse neurologic events (ANE) which included stroke or transient ischemic attack.

Results: A total of 547 patients underwent aortic arch reconstruction under circulatory arrest with IONM. Of these, 117 (21.4%) patients had a significant IONM change while 430 (78.6%) did not. There was no difference in baseline characteristics (age, sex, cerebrovascular disease, dissection vs aneurysm) between patients who had a significant IONM change versus those who did not. Of the 117 patients with IONM changes, 104 (86.7%) had a significant SSEP event and 60 (50.4%) had a significant EEG event. An ANE (Stroke or TIA) occurred in 12 (10.3%) patients who had an IONM change and 20 (4.7%) patients who did not experience an IONM change ($p = 0.022$). Thirty-day mortality occurred in 18 (4.2%) patients who did not have an IONM change and in 27 (23.1%) patients who experienced an IONM change ($p < 0.001$). On multivariable logistic regression, intraoperative SSEP change was significantly associated with an adverse neurologic event [OR 4.30 (1.37,13.49) $p = 0.01$] while intraoperative EEG change was not. On multivariable analysis, increase in age, intraoperative EEG and SSEP change and decreasing BMI were all significantly associated with operative mortality (Table).

Table: Multivariable Logistic Regression Model for Operative Mortality (STS Definition: In-Hospital or 30 Day Mortality), Assessing Baseline Abnormality or Intraoperative Change for SSEP or EEG

Variable	Odds Ratio	95% CI	P-Value
SSEP baseline abnormality	0.73	0.29, 1.87	0.511
EEG baseline abnormality	1.01	0.36, 2.87	0.983
Significant SSEP intraoperative change	4.54	1.57, 13.14	0.005
Significant EEG intraoperative change	3.22	1.14, 9.06	0.027
Age (years)	1.05	1.01, 1.10	0.028
Sex (female)	1.01	0.37, 2.75	0.992
Caucasian race	0.47	0.13, 1.64	0.235
Body mass index (kg/m2)	0.91	0.84, 0.99	0.023
Diabetes mellitus	1.72	0.49, 6.01	0.395
Cerebrovascular disease	0.95	0.34, 2.63	0.921
Preoperative hematocrit (%)	0.98	0.90, 1.07	0.709
Congestive heart failure (≤ 14 days)	3.31	0.66, 16.53	0.145
Redo sternotomy	0.86	0.26, 2.77	0.794
Surgical status (ref: elective): Urgent	0.88	0.17, 4.48	0.882
Surgical status (ref: elective): Emergent/salvage	3.13	0.96, 10.26	0.060

Abbreviations: IONM, Intraoperative neurophysiological monitoring; SSEP, Somatosensory evoked potential; EEG, Electroencephalography.

Conclusions: Abnormal IONM events during aortic arch reconstruction with hypothermic circulatory arrest portend worse outcomes with respect to stroke and mortality. Intraoperative SSEP monitoring is a more sensitive modality than EEG monitoring for predicting adverse neurologic events, but derangements in either monitoring modality predicts increased mortality.

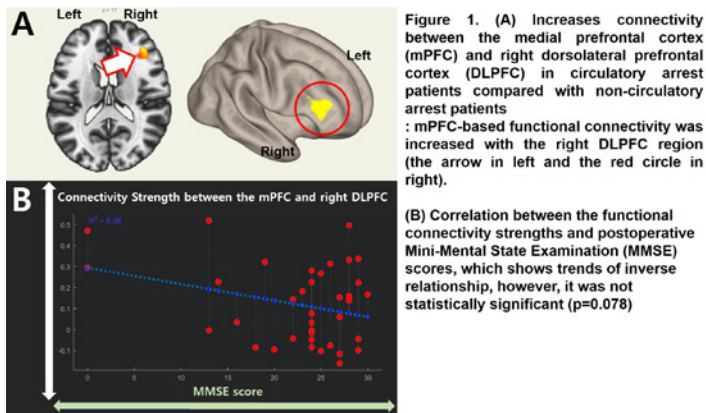
28. Impact of Insufficient Cerebral Hemisphere Compensation Mechanism on Postoperative Cognitive Function in Patients with Circulatory Arrest Using Selective Antegrade Cerebral Perfusion

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Objective: Aortic surgery is one of the most challenging type of surgeries that frequently involves circulatory arrest, and it may be related to adverse events including postoperative delirium and cognitive sequelae. Herein, the authors aimed to investigate the changes in resting-state functional connectivity associated with intraoperative circulatory arrest (CA) in patients who underwent the aortic surgery, while also exploring the effects of altered connectivity on their cognitive functions.

Methods: Total 38 patients (14 patients with CA, 24 patients without CA) participated in this study. All the patients completed a resting-state functional magnetic resonance imaging (fMRI) scan after 5 days from surgery date. Among them, 21 patients had experienced delirium, so that they took fMRI scans after the resolution of delirium. After preprocessing of the raw image data, we assessed the differences in functional connectivity across groups (circulatory arrest versus no circulatory arrest), by examining the seed-to-voxel connectivity strengths. The default mode network (DMN) regions including the posterior cingulate cortex and medial prefrontal cortex were considered as the seed regions. We also investigated correlation between the functional connectivity strengths and cognitive functions after surgery, as assessed by Mini-Mental State Examination (MMSE).



Results: The occurrence of delirium was not statistically different between the patients with and without circulatory arrest during aortic surgery. In terms of the brain network connectivity, the patients with circulatory arrest show increased connectivity between the medial prefrontal cortex and right dorsolateral prefrontal cortex compared to the patients without circulatory arrest (Figure 1A). There was also a statistical trend in the relationship between this increase in local connectivity and the decrease in postoperative MMSE score (Figure 1B).

Conclusions: Our findings suggest that circulatory arrest induces increased local brain connectivity including DMN hyperconnectivity as a compensatory mechanism for a disruption in normal brain networks after acute brain insults. If this compensation works properly, and people with high brain reserves may not develop delirium, however, excessive activation of this mechanism due to low brain reserves seems to eventually lead to postoperative cognitive deficits. Long term follow-up studies are needed to verify whether this damage will remain as sequelae.

30. Traits of the Current Traditional-Track Cardiothoracic Surgery Training Pool: Results of a Cross-Sectional Study

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Invited Discussant: Timothy J. Gardner

Objective: As new paradigms for cardiothoracic surgery (CTS) training emerged in recent years, the traditional 2-year program persists as an option for trainees completing general surgery residencies. While the applicant pool for 6-year integrated (I-6) CTS training programs has been superficially explored, little data exist characterizing those applicants to the traditional CTS pathway and the impact of I-6 expansion on the traditional applicant pool. We sought to describe CTS applicants in the modern era and to evaluate for any trends over the last 6 years.

Methods: We reviewed materials from 2015–2020 from candidates applying to a single 2-year CTS training program, which consistently received applications from a majority of NRMP-registered applicants each year. We included applicants to both our general thoracic and cardiothoracic tracks. Information was recorded regarding presentations; manuscripts, book chapters, and other articles published; authorship positions on scholarly work; letters of recommendation; and in-service scores. Descriptive analyses were performed as well as comparative analytics over the years of study.

Results: During the years 2015–2020, we received 571 applications, accounting for 72% of the total NRMP applicant pool (Table). We saw no significant year-to-year trends in numbers of peer-reviewed publications or presentations in terms of total numbers, nor was a change over time observed with regard to first authorship positions. Over the years of study, the average trainee had >5 peer-reviewed manuscripts, with >2 as first author, and >3 oral presentations as the presenting first author. There was a minimal year-to-year increase in number of first-authored posters, 2.04 in 2015 to 2.13 in 2020 ($p = 0.008$). Online publications, book chapters, and other publications were stable throughout the study period. Applicants consistently provided approximately 3.6 letters of recommendation, with about 1.9 letters from CTS faculty. Average in-service score percentile was stable at around 54th percentile for applicants throughout the study years.

	2015	2016	2017	2018	2019	2020	P-value, 2015 vs 2020
Applicants to program	104	67	94	97	88	171	
National applicants	138	130	140	122	121	146	
Percent of pool	75%	52%	67%	80%	73%	83%	
Peer-review publications	5.20	6.72	5.82	5.96	5.83	7.07	0.0877
Peer-reviewed publications, 1st author	2.02	2.81	2.55	2.09	2.30	2.64	0.1963
Other articles	1.05	1.06	1.07	1.02	1.02	1.03	0.0451
Other articles, 1st author	0.51	0.52	0.53	0.54	0.54	0.55	0.0181
Book chapters	0.56	0.57	0.58	0.62	0.62	0.63	0.2990
Book chapters, 1st author	0.38	0.38	0.39	0.42	0.42	0.42	0.4068
Posters	3.51	3.55	3.55	3.65	3.64	3.63	0.0540
Posters, 1st author	2.04	2.08	2.08	2.12	2.11	2.13	0.0081
Oral presentations	4.44	4.56	4.54	4.53	4.55	4.58	0.1212
Oral presentations, 1st author	3.29	3.39	3.38	3.38	3.38	3.41	0.1296
Peer-reviewed online publications	0.11	0.11	0.11	0.11	0.10	0.10	0.0601
Peer-reviewed online publications, 1st author	0.06	0.06	0.06	0.06	0.05	0.05	0.0843
Other online articles	0.34	0.34	0.34	0.34	0.34	0.34	0.2504
Other online articles, 1st author	0.29	0.29	0.29	0.29	0.29	0.29	0.7236
LORs	3.65	3.64	3.63	3.63	3.64	3.64	0.4241
LOR from CTS faculty	1.95	1.93	1.93	1.91	1.93	1.92	0.2196
Average ABSITE Percentile	54.42	54.28	54.51	54.75	54.53	54.37	0.6231

LOR – Letters of Recommendation, CTS – Cardiothoracic Surgery, ABSITE – American Board of Surgery In-training Exam

Conclusions: Despite the growth of the I-6 pathway to CTS in recent years, we have seen no substantial year-to-year changes in the scholarly activity, academic achievements, or letters of recommendation for our applicants to a traditional training program. While this study is limited by potential bias in terms of the candidates who choose to apply to this single program, confounders are minimized by the high volume of applicants, representing nearly $\frac{3}{4}$ of the national applicant pool. Findings from this cohort suggest that the CTS applicant pool continues to be comprised of a stable group of highly productive trainees. Future initiatives in candidate selection should emphasize interview strategies to highlight aspects of grit, emotional intelligence, and team dynamics.

31. The Utilization and Impact of Educational Resources Published by the Thoracic Surgery Residents Association

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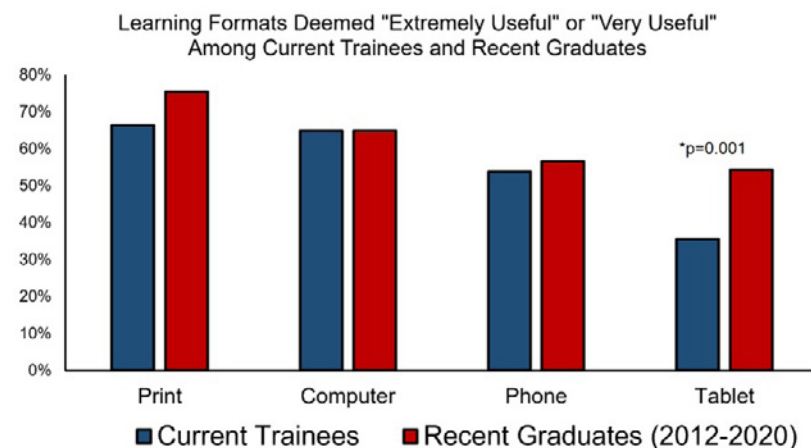
³University of British Columbia, Vancouver, BC, Canada; ⁴University of Pittsburgh Medical Center, Pittsburgh, PA; ⁵University of Pennsylvania, Philadelphia, PA; ⁶Columbia University, New York, NY; ⁷Johns Hopkins University, Baltimore, MD; ⁸University of Virginia, Charlottesville, VA

Invited Discussant: Craig J. Baker

Objective: The Thoracic Surgery Residents Association (TSRA) is the leading cardiothoracic surgery resident-led organization in North America with a mission to provide peer-based resources and support for residents to succeed throughout training and launch successful careers. In fulfilling this role, the TSRA has published numerous educational resources. However, the utility and effectiveness of these resources in meeting the needs of residents remains unknown.

Methods: Separate surveys constructed by the authors and validated by the TSRA Executive Committee were sent via e-mail and social media to 527 current cardiothoracic trainees (12 questions) and to 780 recent 2012–2019 graduates (16 questions). The surveys recorded respondent demographics and assessed exposure to TSRA educational resources and the effectiveness of these resources in preparing trainees for clinical practice as well as in-training and board certification examinations. Responses to common questions were compared between survey groups with chi-square tests.

Results: In total 143 (27%) current trainees and 180 (23%) recent graduates provided responses. A higher proportion of recent graduates compared to current trainees identified as female (83% [149/180] vs 66% [95/143], $p = 0.001$). Recent graduate respondents predominantly graduated from 2- or 3-year traditional training programs (81% [145/180]), whereas more current trainees than recent graduates were in integrated training programs (49% [70/143] vs 8% [14/180]; $p < 0.001$) and the proportion in a 4 + 3 pathway did not differ (recent graduates: 11% [19/180] vs current trainees: 10% [14/143]; $p = 0.82$). The most common uses of TSRA resources for current trainees included preparation for the in-training exam (75% [107/143]) and operative preparation (73% [104/143]), whereas the most common for recent graduates were ABTS oral and/or written board preparation (92% [165/180]) and preparation for the in-training exam (89% [161/180]). The highest number of respondents ranked TSRA Clinical Scenarios as the most beneficial TSRA resource (121/323, 37%), followed by the TSRA Review (102/323, 32%). Among recent graduates who passed the ABTS oral board exam on the first attempt, 82% (97/118) used TSRA resources to prepare, versus only 40% (25/63) of recent graduates who passed after multiple attempts, failed, have not taken the exam, or preferred not to answer ($p < 0.001$). Print format was deemed “extremely useful” or “very useful” by the highest proportion of respondents for both current trainees and recent graduates (Figure).



Conclusions: Both current cardiothoracic trainees and recent graduates have utilized TSRA educational resources extensively in both clinical practice and test preparation. As the TSRA continues to develop content, the organization should continue to use both print and digital formats to disseminate educational resources to trainees.

32. A Systematic Review of the Quality of Abstracts Reporting on Randomized Controlled Trials Presented at Major International Cardiothoracic Conferences

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Invited Discussant: Richard D. Weisel

Objectives: Conference proceedings are widely available and may represent the only accessible report of given research. Poor reporting of randomised controlled trials (RCTs) in conference abstracts may impede interpretability. In 2008, the Consolidating Standards of Reporting Trials (CONSORT) group published guidance on the minimum standards for reporting of RCTs in conference abstracts. We sought to evaluate the reporting quality of abstracts presented at the annual meetings of major international cardiothoracic societies.

Methods: Published abstracts were retrieved for the annual meetings of five cardiothoracic societies, over three subsequent years (2016 to 2018): American Association for Thoracic Surgery (AATS), Australian & New Zealand Society of Cardiac & Thoracic Surgeons (ANZSCTS), European Society of Thoracic Surgeons (ESTS), The Society of Thoracic Surgeons (STS), and The World Society of Cardio-vascular and Thoracic Surgeons (WSCTS). Abstracts for the European Association of Thoracic Surgery (EACTS) and The Asian Society for Cardiovascular and Thoracic Surgery (ASCVTS) meetings were not available online or on request. Abstracts were screened for inclusion, and those reporting on RCTs were scored by two independent reviewers against the 17-item CONSORT checklist. Conflict was resolved by a senior reviewer. The primary endpoint was the total number of checklist criteria reported in an individual abstract. Statistical analysis was performed using Stata SE v16.

Results: 3323 abstracts were screened, revealing 103 (3.1%) RCTs (Table 1). On average, 35% (median 6/17, range 2 to 15) of checklist items were reported in individual abstracts. Funding disclosures (n = 3, 2.9%), details of the randomisation process (n = 5, 4.8%) and comprehensive results (n = 8, 7.8%) were the least-frequently reported. There was no difference between conferences (p = 0.07) or subsequent years (p = 0.06) in terms of reporting quality, or between oral and poster sessions (p = 0.76). Multicentre trials (MD 1.44, p = 0.03), and those registered in trial registries (MD 1.50, p < 0.001) scored better. A better-structured conference abstract was not associated with successful publication of a full-text journal article within two years (p = 0.33).

Table 1

Annual Meeting	Abstracts (n)	RCTs (n, %)	CONSORT Checklist Score (Mean ± SD)
AATS	546	25 (4.6%)	6.48 ± 1.90
ANZSCTS	602	8 (1.3%)	4.60 ± 1.02
ESTS	800	41 (5.1%)	6.41 ± 2.28
STS	656	15 (2.3%)	6.06 ± 1.77
WSCTS	719	14 (1.9%)	4.86 ± 2.32

Conclusions: The reporting quality of abstracts of RCTs accepted for presentation at international cardiothoracic society annual meetings remains poor, when benchmarked against the CONSORT standards. This highlights an area for targeted quality improvement.

33. Greater Publication Count and Research Impact During a National Institutes of Health Ro1 Funding Cycle Are Associated with Successful Grant Renewal Among Cardiothoracic Surgeons

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Invited Discussant: Frank W. Sellke

Objective: Cardiothoracic (CT) surgeons who receive a National Institutes of Health (NIH) Ro1 grant subsequently face a highly competitive renewal process at the end of the funding cycle. The factors contributing to successful renewal have not been studied. We hypothesized that greater publication count and research impact during an Ro1 funding cycle are associated with successful grant renewal.

Methods: Using a database of all CT surgeons (n = 992) who were faculty at an accredited United States CT surgery training program in 2018, we identified Ro1 grants awarded to a CT surgeon as principal investigator (PI) since 1985. All data were obtained from publicly-available online sources (NIH RePORTER, Scopus, institutional webpages, CTSNet). The relative citation ratio (RCR), developed by the NIH and calculated as citations for an article benchmarked to other Ro1-funded publications in the same field, was calculated using the NIH iCite database. RCR 1.0 represents equal impact, and RCR 2.0 indicates twice the impact. Continuous data are presented as median [interquartile range] and analyzed using the Mann-Whitney test. Categorical data are analyzed using the Chi-square test.

Results: 98 Ro1 grants were awarded to 54 surgeons (5.4%) in our database. While 28 grants were renewed (28.6%), 70 were not (71.4%). Renewed and non-renewed grants had a similar start year (2006 [1997–2011] vs 2003 [2000–2009], p = 0.634), similar 2020 inflation-adjusted award per year (\$458,655 [425,609–583,258] vs \$473,733 [402,045–563,377], p = 0.807), and were disbursed over a similar funding period (4 [4–5] years each, p = 0.942). The CT surgeon PI of renewed versus non-renewed grants exhibited similar surgeon type (16/28 [57.1%] vs 42/70 [60.0%] adult cardiac, p = 0.814), gender (27/28 [96.4%] vs 64/70 [91.4%] male, p = 0.385), year started as an attending (1990 [1985–2000] vs 1991 [1986–1999], p = 0.905), PhD degree (5/28 [17.9%] vs 12/70 [17.1%], p = 0.933), previous Ro1 funding (16/28 [57.1%] vs 31/70 [44.3%], p = 0.250), career publications at grant expiration (151.5 [110.3–217.5] vs 134.5 [85.3–207.0], p = 0.295), and faculty status at a top 25 NIH-funded institution (19/28 [67.9%] vs 40/70 [57.1%], p = 0.328).

During the grant cycle prior to renewal, the number of Ro1-funded manuscripts published in total (11.0 [5.3–23.8] vs 6.0 [2.0–13.0], p = 0.010, Figure 1A) and per year (2.5 [1.5–4.8] vs 1.2 [0.4–2.9], p = 0.002, Figure 1B) were significantly greater for renewed grants. In addition, the median RCR (0.9 [0.6–1.3] vs 0.6 [0.3–1.0], p = 0.012, Figure 1C) and maximum RCR (3.1 [2.0–5.9] vs 1.3 [0.6–4.4], p = 0.009, Figure 1D) among the Ro1-funded manuscripts published during the grant cycle were also significantly greater for renewed grants.

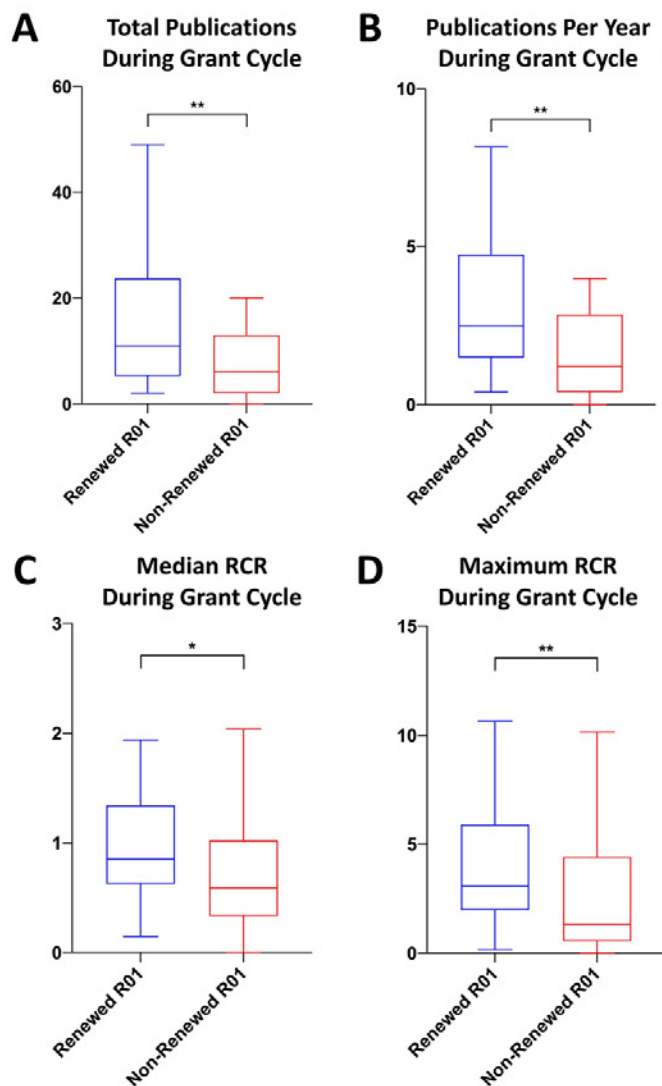


Figure 1. Renewed R01 grants exhibited greater (A) total publications, (B) publications per year, (C) median relative citation ratio (RCR), and (D) maximum RCR during the grant cycle compared to non-renewed R01 grants. * indicates $p < 0.05$, ** indicates $p < 0.01$.

Conclusion: Among R01 grants awarded to CT surgeons, greater publication count and research impact during the funding cycle is associated with successful grant renewal.

34. Incidence and Predictors of Lethal Ventricular Arrhythmias Following Coronary Artery Bypass Grafting in Patients with Ischemic Cardiomyopathy

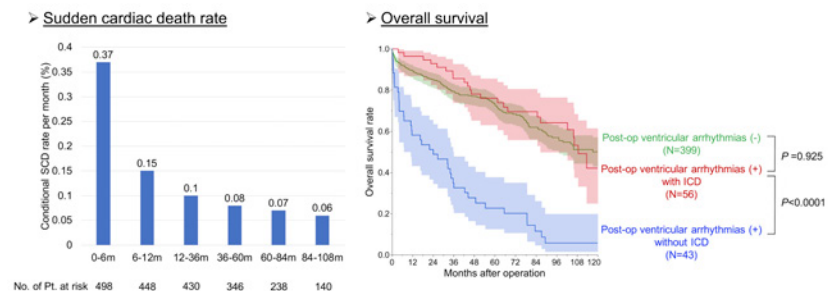
Masaro Nakae, Satoshi Kainuma, Koichi Toda, Shigeru Miyagawa, Daisuke Yoshioka, Takuji Kawamura, Ai Kawamura, Noriyuki Kashiya, Takayoshi Ueno, Toru Kuratani, Yoshiki Sawa

Osaka University Graduate of Medicine, Suita, Japan

Invited Discussant: William L. Holman

Objective: For patients with severe left ventricular (LV) dysfunction who are undergoing coronary artery bypass grafting (CABG), the prevention of sudden cardiac death with implantable cardioverter-defibrillator (ICD) might be deferred as CABG can improve LV function, thereby rendering ICD unnecessary. However, how risk of sudden cardiac death changes over time following CABG is uncertain. We determined the magnitude of sudden cardiac death risk over time, predictors of ventricular arrhythmias and the impact of ICD on survival among patients who developed ventricular arrhythmias following CABG.

Methods: Five hundred and four patients with LV ejection fraction $\leq 40\%$ (mean, $30 \pm 7\%$) underwent CABG from 1993 to 2015. Of them, 6 patients who had implanted ICD prior to CABG were excluded and finally 498 patients were enrolled. Conditional sudden cardiac death rates per month for different intervals during follow-up were evaluated from the cumulative incidence rate of sudden cardiac death. Cox proportional hazard model was used to identify predictors of postoperative ventricular arrhythmias defined as sudden cardiac death, ventricular fibrillation, and sustained or non-sustained ventricular tachycardia.



Results: During a median follow-up of 58.4 months, 212 patients (43%) died of either sudden cardiac death ($n = 40$, 8%) or other causes ($n = 172$, 35%). The sudden cardiac death rate was the highest during the first 6 months with a monthly sudden cardiac death rate of 0.37% (Figure, left panel). Multivariate analysis showed previous ventricular arrhythmias (hazards ratio [HR] 3.52; 95% confidence interval [CI] 2.17–5.71; $p < 0.0001$), LV end-systolic dimension ≥ 55 mm (HR 2.10; 95% CI 1.33–3.32; $p = 0.002$), and prior myocardial infarction in the left anterior descending artery (LAD) territory (HR 1.69; 95% CI 1.07–2.65; $p = 0.024$) were independent predictors for postoperative ventricular arrhythmias. Among 99 patients who developed postoperative ventricular arrhythmias, absence of ICD implantation significantly increased the risk of overall mortality (HR 4.96; 95%

CI 2.95–8.33; $p < 0.0001$). Notably, the patients with postoperative ventricular arrhythmias who received ICD implantation obtained the comparable overall survival with those who did not develop postoperative ventricular arrhythmias (log-rank $p = 0.925$) (Figure, right panel). The degree of LV function recovery was greater in patients who did not develop postoperative ventricular arrhythmias than those who developed them, irrespective of ICD implantation (P for interaction < 0.0001).

Conclusions: In patients with ischemic cardiomyopathy undergoing CABG, sudden cardiac death occurred in 8% and its most frequent timing was within postoperative 6 months. In order to prevent sudden cardiac death, early ICD implantation should be indicated for high-risk patients who presents with scars in LAD territory and excessive LV remodeling.

35. Extracellular Vesicle Therapy Improves Diastolic Performance and Reduces Perivascular Fibrosis in a High Fat Fed Porcine Model of Chronic Myocardial Ischemia

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Invited Discussant: Pavan Atluri

Objective: Cardiovascular disease continues to be the leading cause of death globally. The burden of mortality and morbidity is attributed to maladaptive changes in the ischemic myocardium, including substantial fibrosis, which is accelerated by coexisting risk factors such as diabetes and hypertension. In previous studies, we observed improved signaling events and functional effects in models of myocardial ischemia with extracellular vesicle (EV) treatment. Furthermore, we found that a high fat diet (HFD) produces metabolic derangement with resultant paradoxical signaling events that impede EV treatment. This study aims to evaluate the effect of EV therapy on myocardial fibrosis and diastolic function in the setting of high fat diet and chronic myocardial ischemia.

Methods: Fourteen male Yorkshire swine were administered a high fat diet (500 g/day) consisting of 4% cholesterol, 17.2% coconut oil, 2.3% corn oil, and 1.5% sodium cholate. At eleven weeks of age, they underwent placement of an ameroid constrictor on their left circumflex coronary artery. The animals were then divided into two groups; controls received injection of vehicle saline (HFD-C, $n = 6$), whereas subjects in the treatment group received injection of extracellular vesicles (EVs) into the ischemic territory; (HFD-EV $n = 8$). Five weeks later hemodynamic parameters, collagen density, and selected protein expression were evaluated.

Results: The HFD resulted in dyslipidemia and impaired glucose tolerance. End diastolic pressure volume relationship (EDPVR), was significantly improved by EV treatment ($p = 0.002$). HFD nor EV therapy significantly altered ischemic myocardial perivascular nor interstitial collagen density independently. However, when studied with previous normal diet cohorts, EV therapy together with HFD exhibit a significant interactive effect; that is, a reduction in perivascular collagen density in ischemic myocardial tissue, ($p = 0.048$). Interestingly, ischemic myocardial tissue lysates in the treatment cohort found a significant rise in osteopontin 2 ($p = 0.021$) whereas the expression of tumor necrosis factor- α (TNF- α), NADPH-oxidase 4 (NOX4), NOX2, and lysyl oxidase 4 (LOX4) were unaffected by EV treatment.

Conclusions: EV treatment augmented diastolic function in the ischemic myocardium subject to metabolic stress. Interestingly, this was associated with EV-mediated reduction in perivascular but not interstitial fibrosis seen as an interaction between EVs and HFD. The expression of osteopontin2, a pro-fibrotic protein, was induced by EVs. This may indicate that EV treatment directed inherent pathways of cardiac remodeling to produce a positive functional outcome, while steering away from maladaptive pathology.

36. Should Embolic Protection Devices Be Used in Transcatheter Mitral Valve-in-Valve Replacement?

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Invited Discussant: Isaac George

Objective: Transcatheter mitral valve-in-valve (MVIV) replacement has been increasingly used to replace degenerated bioprosthetic mitral valves in patients that are prohibitively high risk to undergo reoperative cardiac surgery. Embolic stroke from this type of procedure can result in devastating complications and is well documented for patients undergoing transcatheter aortic valve replacement (TAVR). Embolic protection devices have been approved for use in TAVR procedures with evidence of smaller cerebral infarct volume. In this study, we report the use of a transradial artery cerebral protection system during transcatheter MVIV procedures.

Methods: We retrospectively reviewed 48 consecutive patients who successfully underwent a transcatheter MVIV procedure at a single institution between June 2016–September 2020. The decision to use the cerebral protection system was based on device availability and patient anatomy and was successfully placed in 48% ($n = 23$) of the procedures. The patients were divided into two groups: those who received the cerebral protection system and control. The primary outcome measure was post-intervention stroke. The secondary outcomes included hospital mortality, readmission, and all cause long-term mortality.

Results: Mean age was 65 ± 15 years and 60% ($n = 29$) of the patients were female. Patients in each group did not differ in terms of preoperative left ventricular ejection fraction, treated endocarditis, previous stroke, or number of prior operations or cardiac interventions (Table). The raw STS PROM score was 7.6% for the control group and 8.0% for the cerebral protection group ($p = 0.86$). Post-intervention stroke occurred in none of the cerebral protection device patients but did occur in 8% ($n = 2$) of the control group ($p = 0.16$). Overall, 96% ($n = 46$) of patients treated with MVIV were alive at discharge including one death in each group. The overall readmission rate was 54% ($n = 21$) and did not differ between groups. Long-term mortality was 8% and did not differ between groups. The mean follow-up time was 15 months (95% CI 11–18).

Table 1.

	Cerebral Protection Group (n=23)	Control Group (n=25)	p-value
Preoperative Characteristics			
Age, years \pm SD	65 \pm 15	58 \pm 14	0.010
Ejection fraction, % \pm SD	58 \pm 10	59 \pm 11	0.670
LVIDd, cm \pm SD	49.5 (8)	49.2 (7)	0.885
Number of previous cardiac interventions			
One, n (%)	10 (21)	21 (29)	0.287
Two, n (%)	10 (21)	21 (29)	0.287
Three, n (%)	0 (0)	3 (4)	0.287
Treated Endocarditis, n (%)	18 (38)	30 (30)	1.00
Congestive heart failure, n (%)	36 (75)	39 (81)	0.459
Arrhythmia, n (%)	40 (83)	30 (65)	0.044
Postoperative Outcomes			
Stroke, n (%)	3 (6)	12 (15)	0.149
Late mortality, n (%)	3 (13)	1 (4)	0.257

*Left ventricular internal diameter at end-diastole (LVIDd).

Conclusions: Although stroke was lower in the cerebral protection device group in this study, it did not reach statistical significance, and this may be due to the small study size. Interestingly, particulate matter was seen in the protection device in all 23 patients that had a cerebral protection device. While larger studies are necessary, the data here suggest that use of a cerebral protection system should be considered during transcatheter MVIV procedures to mitigate the risk of embolic stroke.

37. Combined Norwood and Cavopulmonary Shunt As the First Palliation in Late Presenters with Hypoplastic Left Heart Syndrome and Its Variants

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Invited Discussant: Christopher E. Mascio

Background: The use of Blalock Taussig (BT) shunt and Right Ventricle to Pulmonary Artery (RVPA) shunt as part of the Norwood palliation for Hypoplastic Left Heart Syndrome (HLHS) and its variants is well described. In such patients with delayed presentation there may be a third option of doing a primary Cavo-Pulmonary Shunt (CPS) as a component of the initial Norwood palliation. We presented our initial experience with this approach in carefully selected patients with unrestricted pulmonary blood flow and low pulmonary vascular resistance.

Methods: The study included 16 patients between April 2011 and December 2017. The median age was 141 days (range 49 to 366), and 9 (56%) patients were female. The preoperative diagnosis was HLHS in 3 (18%) patients, double inlet left ventricle with coarctation in 5 (31%) patients, double outlet right ventricle with mitral atresia in 4 (25%) patients, tricuspid atresia or stenosis with transposition of the great arteries in 3 (18%) patients, and

unbalanced atrioventricular septal defect with hypoplastic aortic arch in 1 (6%) patient. All patients had unrestricted pulmonary blood flow evidenced by calculated pulmonary to systemic blood flow (Qp/Qs) ratio. All patients underwent a Norwood palliation consisting of atrial septectomy, Damus-Kay-Stansel connection and arch augmentation in addition to the CPS as the initial palliation. No patients had preoperative pulmonary artery banding or interventions.

Results: The median preoperative Qp/Qs ratio on room air and with 100% oxygen was 5.2 and 8.7, respectively. The median Pulmonary Vascular Resistance (PVR) on room air and with 100% oxygen was 5 and 1.8 Wood units, respectively. Delayed chest closure was needed in 12 patients and six patients required postoperative inhaled nitric oxide. One patient underwent takedown of the CPS and construction of RVPA conduit. The median ICU stay was 15 days (range 2 to 60). There was one in-hospital death and two post-discharge deaths, one of which was due to hepatoblastoma with brain metastases. Seven patients have undergone the Fontan completion successfully and six patients await further surgery.

Conclusions: The use of the CPS as the source of pulmonary blood flow in the Norwood operation is feasible and may be safe in carefully selected patients with HLHS and its variants who present late and have evidence of low or reactive PVR and a high left to right shunt.

38. Outcomes of Risk-Adjusted Decision Making Using the Hybrid Strategy in Neonates with Ductal Dependent Systemic Circulation and Multiple Risk Factors

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Invited Discussant: Mark E. Galantowicz

Objective: Neonates with hypoplastic left heart syndrome or its variants are treated using a classic surgical pathway at most institutions. The hybrid strategy showed the potential to improve outcomes in high-risk patients. Our aim is to evaluate outcomes of the hybrid strategy for ductal dependent systemic circulation consisting of bilateral pulmonary artery banding (BPAB) with or without ductal stenting followed by either delayed Norwood-type palliation or comprehensive stage II (CSII) procedure in high-risk neonates.

Methods: Between December 2017 and October 2020, 27 high-risk neonates with hypoplastic left heart syndrome or its variants underwent bilateral pulmonary artery banding. Nineteen patients (70%) underwent full hybrid palliation with BPAB and ductal stenting. Thirteen patients (48%) were born premature. Eleven patients (41%) had a birth weight less than 2.5 kg; six (22%) weighed less than 2.0 kg. By echocardiography, twelve patients (44%) had aortic atresia, six (22%) had an ascending aorta with diameter less than 2 mm, and four (15%) had preoperative cardiac dysfunction. Genetic syndrome was confirmed in six patients (22%); 2 are undergoing evaluation for suspicious features. Preoperative inotropic support and intubation were required in twenty-two (81%) and twenty patients (74%), respectively. Median preoperative lactate was 5 (1.3–19.8). Median number of

preoperative risk factors per patient was 4 (1–7). CSII operation was performed electively at 4–6 months of age, except in two patients who required early procedure with body weight of 3.2 kg and 3.4 kg, respectively.

Results: Median age and body weight of patients at hybrid stage I were 2 days (0–43) and 2.7 kg (1.2–4.2), respectively. Seven patients underwent CSII operation, while nine were bridged to a delayed Norwood operation. Operative mortality for hybrid stage I was 4% (1/27). One patient died in the interstage period and two received comfort care. There was 100% survival after delayed Norwood operation (9/9); one patient died following completion of bidirectional Glenn operation in this group. Two patients in the cohort received orthotopic heart transplantation and three patients received a biventricular repair with 100% survival. Overall survival in the cohort was 76% (19/25) at a median follow-up time of 11 months (0–32). Survival after hybrid stage I, CSII, and Fontan completion was 96% (26/27), 86% (6/7), and 100% (1/1), respectively. Five patients are awaiting stage II and eight are awaiting Fontan completion.

Conclusions: High-risk neonates with hypoplastic left heart syndrome or its variants and ductal dependent systemic circulation can be successfully palliated using a hybrid strategy for bridging to a delayed Norwood or CSII operation. Early results of this strategy as an alternative to the conventional algorithm in neonates with multiple preoperative risk factors are promising at our center.

39. Inherent Risk of Non-Cardiac and Secondary Cardiac Diagnoses Associated with Stage 1 Palliation for Hypoplastic Left Heart Syndrome—How Bad Is It?

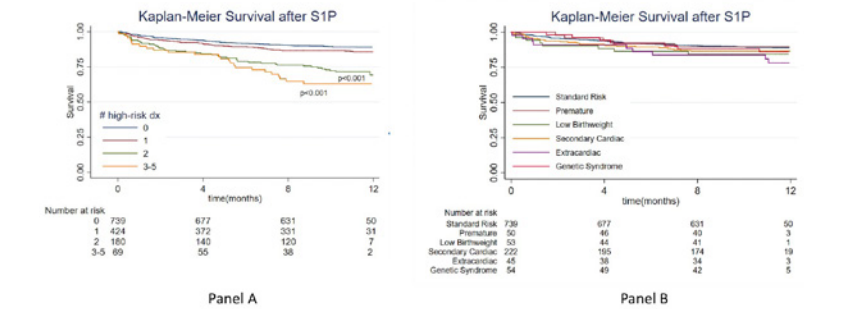
Emily R. Backes¹, Natasha S. Afonso¹, Danielle Guffey¹, James S. Tweddell², Sarah Tabbutt³, Nancy A. Rudd⁴, Ginny O’Harrow⁴, Silvana M. Molossi¹, George M. Hoffman⁴, Garick D. Hill², Jeffrey S. Heinle¹, Priya Bhat¹, Jeffrey B. Anderson², Nancy S. Ghanayem^{1,5}
¹Baylor College of Medicine and Texas Children’s Hospital, Houston, TX; ²Cincinnati Children’s Hospital Medical Center, Cincinnati, OH; ³University of California San Francisco and Benioff Children’s Hospital, San Francisco, CA; ⁴Medical College of Wisconsin and Children’s Hospital of Wisconsin, Milwaukee, WI; ⁵University of Chicago and Comer Children’s Hospital, Chicago, IL

Invited Discussant: Aaron Eckhauser

Objective: Prematurity, low birth weight, genetic and extracardiac diagnoses, and secondary cardiac diagnoses are considered high-risk for early mortality following stage 1 palliation (S1P) for hypoplastic left heart syndrome and variants. Granular reports of the impact of these high-risk features on survival following S1P are lacking, thus limiting evidence-based perinatal and preoperative counseling. We herein report the impact of these high-risk conditions on outcomes after S1P from a prospective multicenter improvement collaborative.

Methods: The National Pediatric Cardiology Quality Improvement Collaborative Phase II registry was queried. Standard-risk and high-risk participants were compared to determine odds of transplant-free survival to stage 2 palliation (S2P) and the first birthday (1-year survival). Comparisons were made with individual and collective high-risk categories using Chi-square test, logistic regression, and Cox regression.

Results: Of the 1421 participants from 58 centers who had S1P and a known status at 1 year, 48% (681) had at least one high-risk condition. Having multiple high-risk conditions resulted in lower 1-year survival compared to having none or a single high-risk condition (p < 0.001, Panel A). In a subanalysis of those with a single high-risk condition compared to the standard risk group, extracardiac diagnosis was the only high-risk condition associated with reduced odds of survival at 1 year (p = 0.039, Panel B). In multivariable analysis of the entire cohort, post-S1P extracorporeal membrane oxygenator (ECMO) use and cardiac reoperation were identified as risk factors for reduced survival to S2P (p < 0.001 and 0.017, respectively). Multivariable factors associated with reduced survival to 1 year included ECMO after S1P, cardiac reoperation, and any post-operative complication (p < 0.001, 0.047, and 0.013 respectively).



Conclusions: With the exception of an extracardiac diagnosis, the presence of a single risk factor was not associated with decreased transplant-free survival at 1 year. Cumulative high-risk factors decreased odds of 1-year transplant-free survival as did post-operative complications, the need for ECMO after S1P, and cardiac reoperation. Further patient accrual is needed to evaluate the impact of specific high-risk diagnoses within each diagnostic category. Additionally, disentanglement of the collinearity of risk factors and center-specific treatment strategies on outcome remain problematic and require further study.

40. Stage 2 Palliation After Ductal Stenting for Ductal Dependent Pulmonary Blood Flow

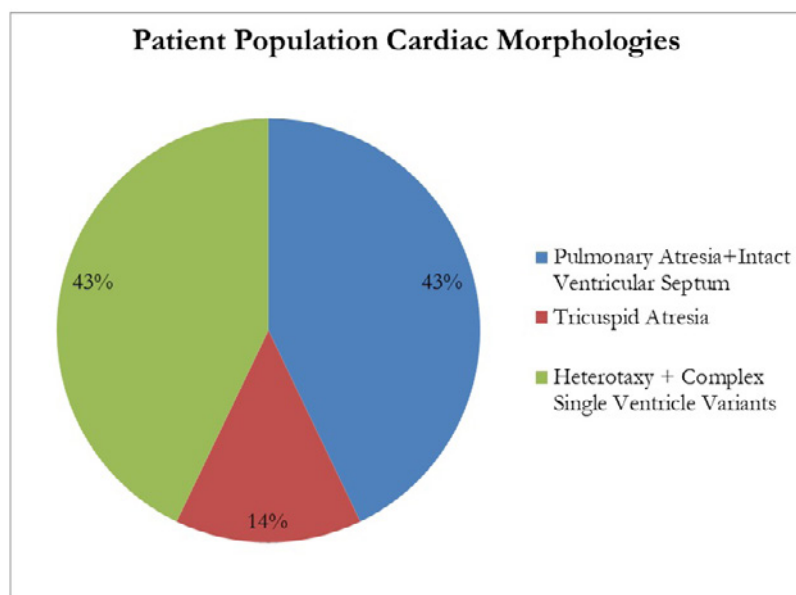
Srujan Ganta¹, John Artrip^{1,2}, Jessica Haley^{1,2}, Rohit Rao^{1,2}, Tara Karamlou³, Shylah Haldeman¹, Ratnayaka Kanishka^{1,2}, John Moore^{1,2}, Howaida EL-Said^{1,2}, John J. Nigro^{1,2}
¹Rady Childrens Hospital, San Diego, CA; ²UC San Diego School of Medicine, San Diego, CA; ³Cleveland Clinic, Cleveland, OH

Invited Discussant: Andrew Glatz

Objective: Evolution of patent ductus arteriosus stenting (PDAS) for ductal dependent pulmonary blood-flow (DDPBF) has provided a new paradigm for managing some neonates with single ventricle (SV) morphology. Although short-term results appear promising, there is little data for subsequent stages of palliation of these patients. We aimed to report our experience with inter-stage care and stage 2 (S2) conversion for patients with DDPBF who underwent PDAS.

Methods: Retrospective chart review of all patients with DDPBF who had PDAS with DDPBF at our center from 3/1/2017–10/1/2020 identified 32 patients. Of these, 15 had SV morphologic features that required palliation and the remaining were candidates for septation. Patient demographics, cardiac morphologies, operative notes, imaging and information regarding clinical course were collected and analyzed for patients routed into the SV pathway. Paired t-tests compared pulmonary artery growth (pre- vs post-PDAS).

Results: All 15 patients progressing through the SV pathway were discharged home after PDAS and enrolled in inter-stage surveillance. There were no cardiac arrests post PDAS or during inter-stage. One PDAS was converted to a modified Blalock Taussig shunt prior to S2. S2 was completed in 14 patients with 1 awaiting surgery. Cardiac morphologies for the study patients are in Figure 1. Patients were a median of 4.7 months old (IQR 3.8–6.7) and 5.8 kg (IQR 5.3–6.3) at stage 2 representing a median weight for age z-score of -1.23. Inter stage median increase in weight and Nakata index were 2.8 kg (IQR 2.2–3.1) and 94.7 mm²/m² (IQR 55.2–163, $p < 0.0001$) between stages respectively. The pulmonary artery symmetry score was 0.85 ± 0.08 (SD) at S2. Inter-stage re-intervention rate was 7/14 (50%). S2 was completed in 8 (57%) patients without cardiopulmonary bypass (CPB). Pulmonary arterioplasty was performed during S2 in 7 patients with 4 of these completed in the group without CPB. There was one post S2 mortality (1/14, 7.1%) due to neurologic injury. The remaining patients are alive at a median of 12.9 months (IQR 3.7–21) follow-up.



Conclusions: PDAS has changed SV palliation paradigms for patients with DDPBF at our center. Initial PDAS has provided for excellent pulmonary artery growth, inter-stage survival, progression along multistage single ventricle palliation and post Glenn physiology. The majority of these patients can be transitioned through 2 stages of palliation without CPB.

41. Outcomes of Pleurectomy Decortication in Biphase Mesothelioma

Moshe Lapidot¹, Emanuele Mazzola², Raphael Bueno¹

¹Brigham and Women's Hospital, Harvard Medical School, Boston, MA; ²Dana Farber Cancer Institute, Boston, MA

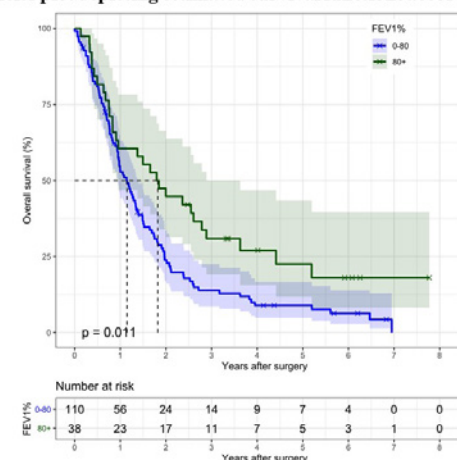
Invited Discussant: Olaf Mercier

Objective: There are limited small single-institution observational studies examining the role of surgery in biphase mesothelioma. Herein we report a series of 149 consecutive patients with biphase mesothelioma treated over 11 years in a high-volume single institution with intended pleurectomy decortication.

Methods: All patients with biphase mesothelioma from 2007–2017 who underwent pleurectomy decortication (PDC) in our institution were included and clinical, pathologic, and surgical information was retrieved. Kaplan-Meier estimators and log-rank test were used to compare the overall survival and logistic regression models were used.

Results: There were 119 males (80%), 100 right sided operations (67%), and median age was 70 y (36–86). Macroscopic Complete Resection (MCR) was achieved in 128 (86%). Neoadjuvant therapy was given to 37 (25%) and 109 (73%) received intraoperative heated chemotherapy (IOHC). Tumors were assigned to stages IA (27, 18.1%), IB (66, 44.3%) II (16, 10.7%), IIIA (19, 12.8%), IIIB (20, 13.4%), and IV (1, 0.7%) according to the 8th Tumor, Node, Metastasis (TNM) edition. The 30 and 90-day mortality were 1.3% and 6.0%. Median/Five-year survival were 14.6 months/12.5% in the intent-to-treat cohort and 21.7 months/20.7% in patients <70 y. In a Univariate analysis, factors that were found to be associated with patient overall survival included age ($p = 0.002$), pre-operative percentage forced expiratory volume in 1 second ($p = 0.01$), MCR ($p < 0.001$), IOHC ($p = 0.001$), adjuvant therapy ($p < 0.001$) and T stage IV versus I ($p = 0.008$). No correlation was found between sex, neoadjuvant therapy, and nodal status to overall survival.

Kaplan-Meier plot depicting estimated survival functions according to FEV1 status



Conclusions: In selected patients with biphase mesothelioma and favorable prognostic factors prolonged survival after PDC is expected.

42. The (Facilitates Chromatin Transcription) Complex Is a Novel Therapeutic Target in Mesothelioma

Anand Singh, Roma Pahwa, Nathanael Pruett, Shivani Dixit, David S. Schrupp, Chuong D. Hoang

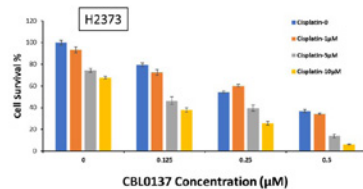
National Cancer Institute – NIH, Bethesda, MD

Invited Discussant: Matthew J. Bott

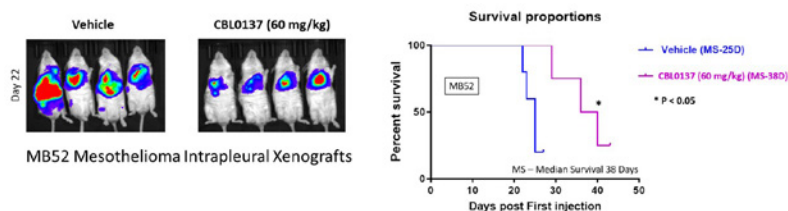
Objective: Malignant pleural mesothelioma (MPM) has unique molecular features such as preserved wild type p53 and aberrantly activated NF- κ B. Effective drug therapy remains elusive yet is a mainstay of multimodality treatment. We propose to use a novel small molecule (CBL0137) that simultaneously suppresses NF- κ B and activates tumor suppressor p53 via targeting Facilitates Chromatin Transcription (FACT) complex, a histone chaperone critical for DNA repair in cancers.

Methods: We employed in-silico, *in-vitro* and *in-vivo* MPM models and patient tumor specimens to characterize CBL0137 efficacy in MPM. Drug effects were assessed in a panel of cell lines by proliferation, foci formation, invasion, flow cytometry, and cell cycle assays. Drug-specific mechanisms were verified in certain transcripts and proteins using appropriate molecular assays. Both monotherapy and combinatorial regimens were tested to evaluate the optimal deployment of CBL0137 in comparison to several controls including standard chemotherapy. Various mouse models with different genetic backgrounds and types of ectopic and orthotopic tumor grafts were treated. Survival was analyzed by Kaplan-Meier and log-rank test.

A. CBL0137 and Cisplatin Additive Effects in Mesothelioma



B. CBL0137 Treatment of Mesothelioma Improves Survival



Results: We observed that transcript and protein levels of SSRP1 and SPT16, subunits of the FACT complex, were significantly upregulated in our collection of MPM compared to normal specimens. The Cancer Genome Atlas database revealed that overexpression of these FACT subunits was associated with worse survival ($p < 0.05$). CBL0137 treatment suppressed MPM cell proliferation, invasiveness, and colony foci formation by

inducing both apoptosis (activate p53 tumor suppressor) and cell cycle arrest (inhibit NF- κ B-dependent survival). An interesting consequence was immunogenic tumor cell death, suggesting additive effects if CBL0137 is combined with immune checkpoint inhibitors. All these molecular mechanisms provided rationale to test synergistic pairings. For example, in combination with cisplatin, CBL0137 exhibited additive anti-tumor activity in much lower dose ranges compared to monotherapy (Figure 1A). Additionally, CBL0137 effects synergized with different classes of agents like microRNA-215, a MPM tumor suppressor via triggering p53 secondary to MDM2 transcript regulation. In-vitro treatments (mono- and combinatorial) were confirmed with *in-vivo* models. For example, CBL0137 monotherapy controlled pleural tumor progression that translated to improved survival (Figure 1B).

Conclusions: MPM is dependent on FACT for tumor progression since higher levels of SSRP1 and SPT16 are poorly prognostic. This MPM vulnerability can be leveraged to identify novel therapeutic paradigms. Targeting this MPM dependency by CBL0137 (dual effects on NF- κ B and p53) alone or in various combinations with different classes of drugs holds great promise for improved outcomes regardless of histotype.

43. A Randomized Trial of Neoadjuvant PD-L1 versus PD-L1 Plus CTLA-4 Blockade in Patients with Malignant Pleural Mesothelioma

Bryan Burt, Maheshwari Ramineni, Hee-Jin Jang, Daniela Ramos, Taylor Splawn, Monica Espinoza, Michelle Almaraz, R. Taylor Ripley, Daniel Y. Wang, Hyun-Sung Lee
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Invited Discussant: Harvey I. Pass

Objective: Preoperative immune checkpoint blockade can result in dramatic pathologic responses in melanoma, lung, and colorectal cancer. We conducted a single institution, investigator-initiated randomized controlled trial to determine whether neoadjuvant PD-L1 or combination PD-L1 and CTLA-4 blockade is associated with favorable alterations of the tumor-immune microenvironment in patients with malignant pleural mesothelioma (MPM).

Methods: Resectable patients with clinical stage I-III MPM were randomized to anti-PD-L1 (durvalumab 15 mg/kg once), or anti-PD-L1 (durvalumab 1500 mg once) plus anti-CTLA-4 (tremelimumab 75 mg once). Two to six weeks after infusion, patients underwent resection by extrapleural pneumonectomy (EPP) or pleurectomy/decortication (P/D). The primary objective was alteration of the ratio of intratumoral CD8 to regulatory T cells (CD8/Treg). Pathologic response was determined by H&E in multiple regions of the resected tumor by a clinical pathologist. Pathologic response was defined as $<80\%$ viable tumor, and major pathologic response was defined as $<20\%$ viable tumor. Multiplexed quantitative imaging mass cytometry (IMC) with a panel of 35 antibodies was performed to interrogate changes in the tumor-immune contexture.

Results: In the anti-PD-L1 group, 5 patients underwent P/D, 2 underwent EPP, and 1 was unresectable. In the combination therapy group, 6 patients underwent P/D, 1 underwent EPP, and 1 was unresectable. Thirty-day operative mortality was 0%. Intratumoral CD8 T cells increased significantly after treatment in both groups, and there was a tendency towards a higher increase in CD8 T cells in the combination therapy group (Figure 1A). No differences in Treg or CD8/Treg were seen after either treatment. Patients in the

combination therapy group had significantly extended overall survival compared to patients that received anti-PD-L1 alone (Figure 1B). Major pathologic was seen in 1 patient in the anti-PD-L1 group and in 1 patient in the combination therapy group. Intratumoral tertiary lymphoid structures (aggregates of B cells and T cells that are emerging as important predictors and potential mediators of response to checkpoint blockade) increased in density following therapy with anti-PD-L1 and combination therapy (Figure 1C-D), and were highly correlated with the presence of pathologic response (Figure 1E).

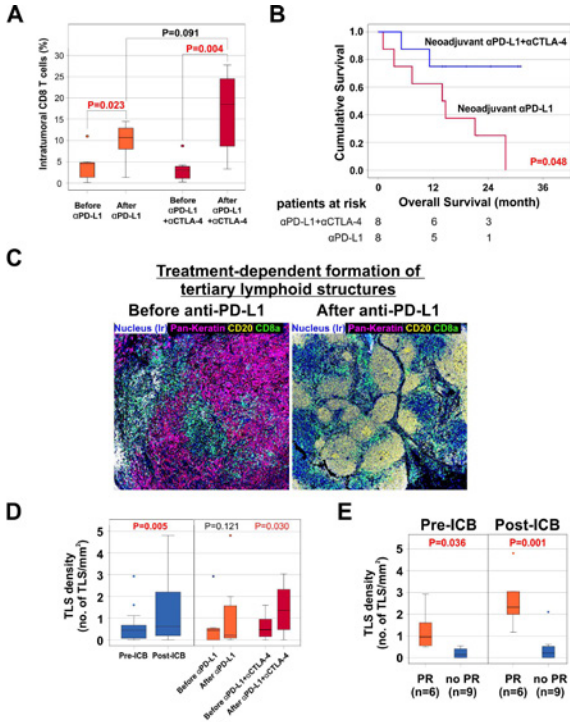


Figure 1. Neoadjuvant PD-L1 versus PD-L1 plus CTLA-4 blockade in patients with malignant pleural mesothelioma. **A**, Comparison of infiltration of intratumoral CD8 T cells in the same tumors before and after therapy (paired T tests). **B**, Overall survival is compared between the neoadjuvant PD-L1 group and the neoadjuvant PD-L1 plus CTLA-4 blockade group. **C**, Representative imaging mass cytometry of a tumor before and after receiving a single dose of anti-PD-L1, showing formation of tertiary lymphoid structures after therapy. **D**, Tertiary lymphoid structures (TLS) form as a result of immune checkpoint blockade (ICB). **E**, Higher TLS density in patients with any pathologic response (PR; <80% residual viable tumor).

Conclusions: In patients with MPM, a single cycle of neoadjuvant PD-L1 or PD-L1 plus CTLA-4 checkpoint blockade results in striking alterations of the tumor-immune contexture, including formation of tertiary lymphoid structures. Considering the limited number of patients in this window-of-opportunity study, combination therapy resulted in a strong survival signal compared with anti-PD-L1 single agent therapy.

44. PET/CT Effectively Differentiates Resectable Thymoma from Anterior Mediastinal Lymphoma

Catherine T. Byrd, Winston L. Trope, Prasha Bhandari, Harrison B. Konsker, Natalie S. Lui, Douglas Liou, Leah M. Backhus, Mark F. Berry, Joseph B. Shrager
Stanford University School of Medicine, Stanford, CA

Invited Discussant: James Huang

Objective: Thoracic surgeons often see patients with a discrete anterior mediastinal mass likely to represent either thymoma (T) or lymphoma (L). Treatment of L is non-surgical and requires biopsy, while non-invasive T is ideally resected without biopsy, given evidence that biopsy may potentiate pleural metastases. Clinical criteria to separate these diagnoses are likely unreliable. We thus set out to determine if PET/CT can reliably differentiate between T and L, guiding the decision between direct surgery vs. biopsy.

Methods: We retrospectively evaluated 286 anterior mediastinal T (n = 176) and L (n = 110) treated at our institution (1999–2019). Among these, 48 T and 29 L had available pre-treatment PET/CT and met our inclusion criteria denoting “resectability”—a solitary mass without clear invasion or metastases. We compared the reliability of clinical criteria (age and presence of B symptoms) with PET/CT SUVmax in differentiating T and L. Two-tailed Independent Samples t test and Pearson’s chi-square test were applied to continuous and categorical variables, respectively. ROC curve analysis was performed to find the SUVmax value providing best separation and to explore sensitivity and specificity.

Results: To evaluate the predictive value of clinical criteria, subjects were dichotomized into groups according to ages associated with T (40–70 years) vs L (<40 and >70) and according to presence/absence of B symptoms. There was a non-significant trend associating tumor type with anticipated age group: 29/48 (60.4%) of T patients and 13/29 (44.8%) of L patients were 40–70 years of age (p = 0.183). Thymoma patients were far less likely to report B symptoms: T 2/48 (4.2%) and L 10/29 (34.5%), p < 0.001, but absence of B symptoms had only a 70.7% positive predictive value (PPV) for T and was thus unreliable to rule out L. The mean SUVmax of T and L differed dramatically: T 5.13 ± 2.62 (range 0.00–12.70) and L 19.17 ± 7.19 (range 7.50–37.60), p < 0.001. By ROC analysis, SUVmax 12.85 was the ideal threshold. SUVmax <12.85 predicted T with 100% sensitivity, 79.3% specificity, 88.9% PPV, and 100% negative predictive value (NPV). On the most clinically important issue—whether any SUVmax can predict T with 100% accuracy and thus allow safe decision for direct resection without biopsy—there were no Ls with an SUVmax <7.50. SUVmax <7.50 thus had 100% PPV for T. 41/48 (85.4%) thymomas were below this cut-off.

		Thymoma (n = 48)	Lymphoma (n = 29)	Total	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Optimal ROC Threshold to Predict Thymoma	SUVmax ≤12.85	48	6	54	100.0	79.3	89.9	100.0
	SUVmax >12.85	0	23	23				
Optimal Clinical Threshold to Predict Thymoma	SUVmax <7.5	41	0	41	85.4	100.0	100.0	80.6
	SUVmax ≥7.5	7	29	36				

Conclusions: PET/CT is a highly reliable tool to achieve the goal of operating without biopsy on the vast majority of resectable T (avoiding spillage from unnecessary biopsy), while avoiding the error of resecting L. Discrete, non-invasive anterior mediastinal masses with SUVmax < 7.50 are essentially always T and are appropriately resected without biopsy. Tumors with SUVmax > 12.85 are essentially always L and are appropriately biopsied. SUVmax 7.50–12.85 is an ambiguous range in which biopsy is also indicated.

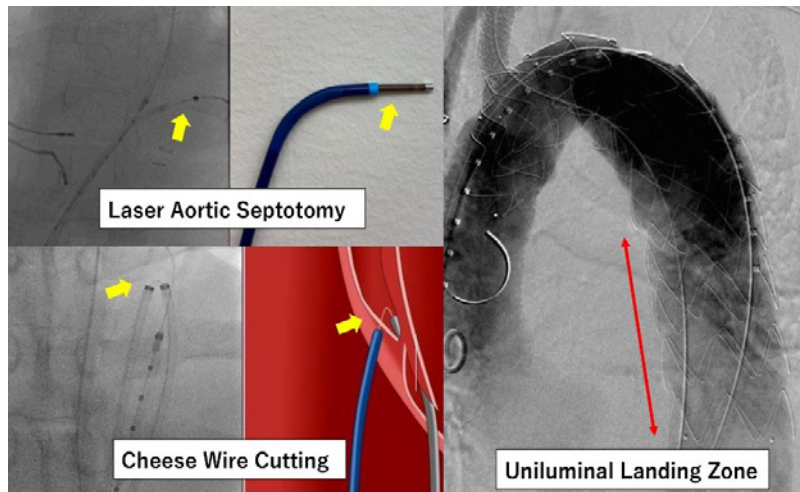
45. Aortic Septotomy to Optimize Landing Zones During Thoracic Endovascular Aortic Repair for Chronic Type B Aortic Dissection: Results and Clinical Implications

Shinichi Fukuhara¹, Chan Tran N. Nguyen¹, Himanshu J. Patel¹, David Williams¹, Xhorlina Marko¹, Minhaj Khaja², Bo Yang¹, Karen M. Kim¹

¹University of Michigan, Ann Arbor, MI; ²University of Virginia, Charlottesville, VA

Objective: The role of thoracic endovascular aortic repair (TEVAR) in the management of chronic type B aortic dissection (cTBAD) remains controversial. Persistent false lumen perfusion due to a thick stiff aortic septum is a known significant contributor to treatment failure. We describe our experience with TEVAR that has evolved over the 12-year period.

Methods: Between 2008 and 2020, 87 patients with cTBAD and degenerative aortic aneurysm underwent a TEVAR, consisting of 36 (41%) with de novo and 51 (59%) with residual cTBAD following hemiarch (n = 31), partial (n = 12) and total arch repair (n = 8). Routine aortic septotomy (Figure) to create landing zones was started in 2018 and 30 (35%) had an endovascular aortic septotomy to prepare the proximal (3/30; 10%) and distal (30/30; 100%) landing zones. The aortic septotomy techniques comprised 15 (50%) longitudinal “cheese wire” cutting with or without upfront needle septal fenestration and 15 (50%) laser aortic septotomy.



Results: The mean age was 63 ± 11 and 73% were male. The median time interval between aortic dissection occurrence and TEVAR was 1.2 years (interquartile range [IQR] 0.5–5.9). Technical success of aortic septotomy was achieved in 97% (30/31). Reverse aortic remodeling, defined by a ≥5 mm reduction in maximal aortic diameter, occurred by 6 months in 90% and 39% in the aortic septotomy and non-septotomy group, respectively (p < 0.001). Among the 57 patients without aortic septotomy, 17 (30%) aorta-related or sudden deaths were observed at a median follow-up period of 3.5 years (IQR 1.4–6.1), whereas none in patients with aortic septotomy at a median 0.8 years (IQR 0.3–1.2). Furthermore, among patients without aortic septotomy, composite outcome rates of aortic re-interventions, aorta-related or sudden deaths were significantly higher in patients without aortic remodeling compared with patients with positive aortic remodeling (63% vs 23%; p = 0.003). In contrast, among the 30 patients with aortic septotomy landing zone preparation, elimination of retrograde false lumen flow was achieved in all cases, while persistent antegrade false lumen flow at various degree was intraoperatively evident in 2 (7%) patients, of which one required false lumen embolization procedure 3 months post-TEVAR. Both were post-hemiarch patients with a thick aortic arch dissection flap present.

Conclusions: Clinical outcomes of TEVAR for cTBAD pathology remain unfavorable in patients without reverse aortic remodeling. Conversely, optimization of landing zones using aortic septotomy techniques resulted in a high reverse aortic remodeling rate early after TEVAR. Although long-term follow-up in this subgroup is yet available, this strategy may positively impact the overall outcomes of TEVAR for cTBAD. In contrast, post-hemiarch residual aortic septum within the aortic arch presents a significant challenge despite landing zone optimization.

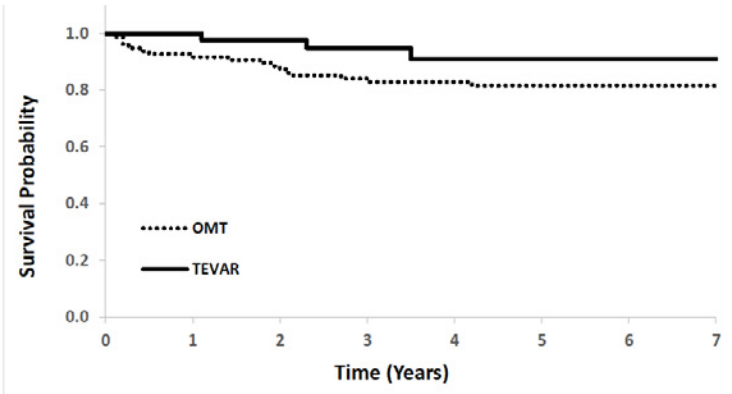
46. Early Results of TEVAR for the Management of Acute Uncomplicated Type B Aortic Dissection

Xiaoying Lou, Edward P. Chen, Yazan Duwayri, William D. Jordan, Bradley G. Leshnowar
Emory University, Atlanta, GA

Objective: Historically, optimal medical therapy (OMT) has been the primary therapy for acute uncomplicated type B aortic dissection (auTBAD). However, recent data suggest that OMT leads to poor long-term results and that aortic remodeling with thoracic endovascular aortic repair (TEVAR) may improve survival. There has been resistance to performing TEVAR for auTBAD due to the procedural risks of morbidity and mortality. This study compares adverse events and survival among auTBAD patients receiving either TEVAR or OMT at the index hospitalization.

Methods: A retrospective analysis of a U.S. academic database identified 146 consecutive auTBAD patients presenting to a single institution between 1/2012–10/2020. Patients were divided into two groups based upon whether they received TEVAR (n = 50) or OMT (n = 96) at index hospitalization. Major morbidity and survival were compared between groups.

Results: Among the entire cohort, 66% of patients presented with DeBakey IIIB aTBD with a maximum descending aortic diameter of 3.9 cm (IQR: 3.6,4.3). Over a median follow-up of 3.7 ± 1.9 years, 35% of patients in the OMT group failed medical therapy and underwent intervention (n = 23 TEVAR, n = 11 open surgery). An additional 13 medically managed patients died for an OMT failure rate of 49%. The composite incidence of renal failure, stroke, and spinal cord ischemia was similar between groups (TEVAR: 7% vs OMT: 5%, p = 0.77). In-hospital mortality was 0% with TEVAR and 2% with OMT. Kaplan-Meier analysis demonstrated a trend towards improved survival among the TEVAR group at 1 and 3 years but no difference in overall survival between groups (HR: 0.38, 95% CI: 0.15–0.98) (Figure). Estimated five-year survival was 91% with TEVAR and 82% with OMT. Over the course of follow-up, complete elimination of thoracic aorta FL flow was achieved in 89% in the TEVAR group and 34% in the OMT group (p < 0.001).



		1 Year	3 Years	5 Years	7 Years
Survival (%)	OMT (N = 96)	91.7 (88)	83.0 (73)	81.6 (44)	81.6 (16)
	TEVAR (N = 50)	100.0 (42)	94.9 (31)	91.0 (14)	91.0 (5)
p-value (by log-rank test)		0.044	0.055	0.112	0.112

Conclusions: There is a high rate of failure of OMT for aTBD. In experienced centers, there is no increase in mortality in the treatment of aTBD with TEVAR compared to OMT. TEVAR provides superior aortic remodeling to OMT in aTBD and will likely translate into improved long-term survival.

47. Early and Long Term Outcomes of Type A Acute Aortic Dissection with Common Carotid Artery Involvement

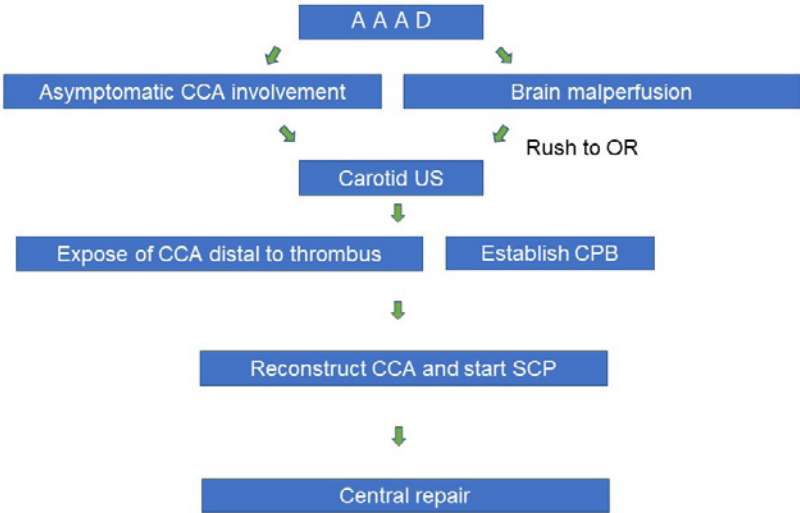
Taishi Inoue, Atsushi Omura, Kenji Okada
Kobe University, Kobe, Japan

Objective: Acute type A aortic dissection (ATAAD) complicated by cerebral malperfusion is highly challenging emergency. However, the relation between asymptomatic common carotid artery (CCA) dissection secondary to aortic dissection and postoperative neurological outcome is unclear. The objective is to demonstrate our strategy and short and long-term outcomes of ATAAD with common carotid artery involvement.

Methods: From 2006, our strategy for ATAAD with symptomatic CCA involvement was early direct reperfusion to CCA. From 2018, we performed early direct CCA reperfusion before central repair and direct reconstruction for symptomatic/asymptomatic patients with CCA involvement.

Results: Among 474 patients who underwent surgical repair for ATAAD from September 1999 to September 2020, 106 (22.4%) patients had CCA dissection diagnosed by pre-operative computed tomography or carotid ultrasonography. Of these, 51 patients presented with neurological deficits (persistent neurological disorder 34 patients, Coma 17 and hemiplegia 13). CCA early direct reperfusion was done in 17 patients, and current strategy was in 9 patients. The patients reperfused within less than 4.5 hours or less than 6 hours were 16 and 36 patients. Fifty-five patients underwent total arch replacement. Concomitant procedure was performed in 19 patients (root repair 7 patients, CABG 10, others 2). In-hospital mortality and in-hospital mortality including death after transfer (in-all hospital death) were found in 22 (20.8%) and 33 (31.1%) patients. Persistent neurological deficit was found in 41 (38.7%) patients (coma 16 patients, hemiplegia 17). Multivariate analysis showed age, operation length and preoperative coma as the risk factor for in-all hospital mortality. In-all hospital death in current strategy group was 1 (11%) patient, however, current strategy was not significant predictor of in-all hospital death (odds ratio 0.31, 95% CI 0.04–2.62, P value 0.281). The cumulative survival rate at 5 and 10 years were 64.2% and 56.8%.

Our current strategy



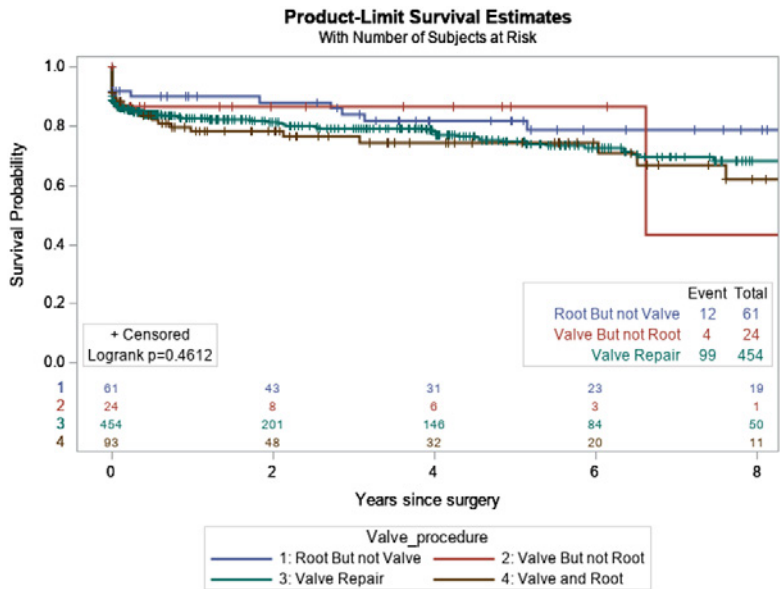
Conclusions: We reviewed surgical outcomes of acute aortic dissection with common carotid artery involvement. The risk factors of in-all hospital death are age, operation time preoperative coma. Current strategy seemed to improve the neurological outcome, however it was not statistically significant predictor of in all hospital death. Further study is necessary to evaluate the efficacy of current strategy.

48. Aortic Root and Valve Management During Acute Type A Aortic Syndromes

Parth Mukund Patel¹, Andy Dong¹, Edward Chiou¹, Jane Wei², Jose Binongo², Bradley G. Leshnower¹, Edward P. Chen¹
¹Emory University School of Medicine, Atlanta, GA; ²Rollins School of Public Health, Atlanta, GA

Purpose: Limited data exists regarding optimal management of the aortic valve during acute type A aortic syndrome repair. Possible options include aortic valve resuspension, aortic valve replacement, and aortic root replacement, with and without valve-sparing techniques. In this report, clinical outcomes following the various interventions were studied and compared.

Methods: From 2005 to 2020, 634 patients underwent acute type A aortic syndrome repair. Patients were divided into 4 groups: Valve Repair (n = 456), Valve Replacement only (n = 24), Valve and Root Replacement (n = 93), and Valve Sparing Root (n = 61). Acute type A aortic syndromes were defined as either acute type A aortic dissection or type A intramural hematoma. Mean age at operation was 57 ± 13, 65 ± 13, 51 ± 14, and 44 ± 13 years respectively, p < 0.01. Primary endpoints were mortality and reoperation and multivariable risk factor analysis was performed. Secondary endpoints were early and late complications.



Results: Mean cardiopulmonary bypass time (p < 0.01) and mean length of stay (p = 0.05) was longest for the valve sparing root group at 283 ± 61 minutes and 20 ± 48 days respectively. Valve and Root Replacement patients more often required reoperation for bleeding at 17% (16), p < 0.01. There was no difference late stroke, renal failure, heart block, and late bleeding, p > 0.05 for all. Early mortality was 13%, 8%, 12% and 7% for the Valve Repair, Valve Only, Valve and Root Replacement, and Valve Sparing Root groups, p = 0.35. Five-year

survival was 76%, 87%, 75%, and 83% for the Valve Repair, Valve Only, Valve and Root Replacement, and Valve Sparing Root groups respectively, p = 0.46. (Figure 1) At late follow up, the Valve Only and Valve and Root Replacement patients had higher mean gradient at 9.5 mmHg (IQR 6–14) and 9.0 mmHg (IQR 7–13) respectively versus the Valve Repair and Valve Sparing Root patients 4.0 mmHg (IQR 3–6) and 4.3 mmHg (IQR 3–9) respectively (p < 0.0001). For the total cohort, risk factors for late mortality included preoperative peripheral vascular disease (HR 2.3, 95% CI 1.2–4.4, p = 0.009) and preoperative dialysis (HR 2.8, 95% CI 1.3–6.1, p = 0.01).

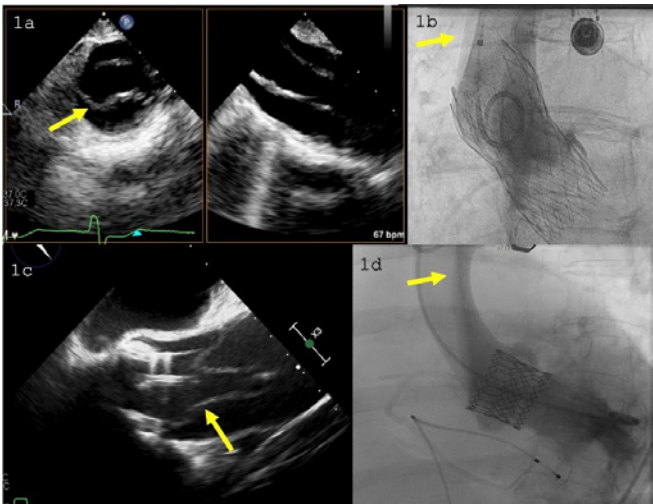
Conclusion: Clinical outcomes following acute type A aortic dissection is not independently associated with a specific aortic valve intervention. No significant difference in late mortality was observed between different valve interventions. Native valve preservation leads to more optimal late valve hemodynamics and is the preferred therapy in this emergent clinical setting.

49. Acute Ascending Aortic Dissection As a Complication of Transfemoral Transcatheter Aortic Valve Replacement

Julie W. Doberne, Adam Z. Banks, J. Kevin Harrison, Adam R. Williams, Jeffrey Gaca, G. Chad Hughes, Ryan Plichta
 Duke University Hospital, Durham, NC

Objective: Iatrogenic acute ascending aortic dissection (IAAAD) is a rare, catastrophic complication of transcatheter aortic valve replacement (TAVR). Scant details exist in the literature on the perioperative context and management of IAAAD.

Methods: We describe a case series of patients who experienced IAAAD during transfemoral (TF) TAVR. Five cases of IAAAD out of a total 1,227 TAVRs (0.004%) from a prospectively maintained single-institution TAVR database 2014–2020 were identified.



Results: Four out of five patients were octogenarians, the fifth was 68. All four octogenarians had trileaflet aortic valves; the 68-year-old had a bicuspid valve. Four were female, all were Caucasian. Four of five cases were deemed extreme risk. All of the cases were done via the TF approach. Angle of deployment ranged from 48.2 to 54.8 degrees and two out of five patients had heavy arch calcification. Two of our five patients were actively or recently on chemotherapy, including one who had recently finished a course of cisplatin which has previously been reported as associated with spontaneous aortic dissection. Four out of five cases used the CoreValve Evolut R; one used the Sapien S3 valve. All but one of the dissections were associated with technical issues related to wire positioning or valve “pop-out.” All IAAADs were diagnosed intraoperatively via aortic root angiography or TEE (Figure 1), except for one which was diagnosed on autopsy. All cases were managed non-operatively. The mortality rate was 60%; all deaths occurred within 3 days of TAVR. The other two have had relatively normal postoperative courses, including one which recovered from subsequent surgical replacement.

Conclusions: This is the largest case series in the literature on IAAAD. We conclude that IAAAD can be due to clinical, anatomic, or technical risk factors (Table). The high mortality rate has broader implications, particularly for low-risk TAVR patients. Examination of existing data on medical management for Type A aortic dissections shows that those patients with more proximal involvement should be considered for open or endovascular intervention given the poor outcome with medical management (Figure Legend 1a). Intraoperative TEE demonstrating dissection in ascending aorta (1b). Root angiogram demonstrating focal dissection just above the Evolut R valve. Arrow indicates false lumen with dissection flap (1c). Intraoperative TEE demonstrating dissection flap in ascending aorta (1d). Root angiogram demonstrating large ascending aortic dissection flap.

50. Contemporary Outcomes Following Total Artificial Heart Implantation As Bridge to Transplant in the United States

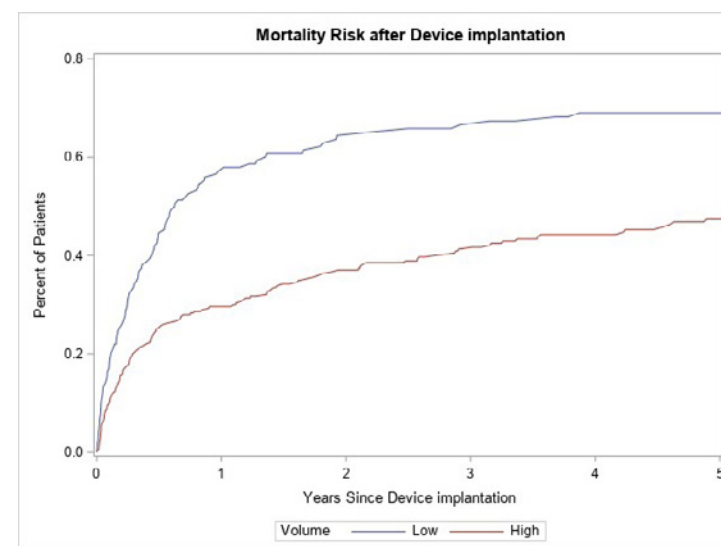
Shinobu Itagaki, Nana Toyoda, Erick Sun, Timothy Lee, Percy Boateng, Donna Mancini, David H. Adams, Anelechi C. Anyanwu
Mount Sinai Hospital, New York, NY

Invited Discussant: Danny Ramzy

Objective: The SynCardia temporary Total Artificial Heart (TAH) was approved as a bridge to heart transplantation (BTT) in 2004 in the United States. Although indications, techniques and management strategies are now well defined, the adoption remains low such that in most centers TAH is not a standard option for biventricular BTT. This study was designed to characterize the current utilization and outcomes of patients listed for transplantation following TAH.

Methods: The thoracic main file and the mechanical circulatory support device file in the United Network of Organ Sharing Standard Transplant Analysis and Research File were queried to identify patients who underwent TAH implantation in the United States between 2005 and 2018.

Results: During the study period, 465 patients (mean 49 years old, 88% male) underwent TAH implantation. Of 161 centers in the data set, 61 (38%) implanted at least one TAH. Only 11 (7%) centers had cumulative experience of 10 or more implants. Successful bridge to transplantation was achieved in 319 (69%) patients after a median duration of 3.8 months TAH support. Concomitant renal transplantation was performed in 49 (15%). The remaining 146 (31%) died on the device after a median duration of 1.9 months. Multi-organ failure was the leading cause of death on the device. The cumulative incidence of mortality on TAH at 6 months and 1 year were 25.1% and 28.4%. The cumulative incidence of transplant at 6 months and 1 year post TAH were 49.0% and 60.4%. After the transplantation, the mortality rate at 1 year and 2 years was 20.0% and 25.8% respectively. Age at implantation (HR 1.03, 95% CI 1.01–1.04, $P < 0.001$), congenital etiology for heart failure (HR 2.9, 95% CI 1.3–6.9, $P < 0.011$), and center experience [TAH implantation 10 or more] (HR 0.42, 95% CI 0.29–0.59, $P < 0.001$) were predictive of mortality on the device after TAH implantation. Center experience was also associated with the post-transplant mortality risk (HR 0.64, 95% CI 0.42–0.99, $P = 0.049$). In aggregate, comparing centers that performed less than 10 versus 10 or more implants, the one year mortality after TAH (including post-transplant phase) was 57% (95% CI 49–67%) versus 30% (95% CI 25–35%) (Adjusted $P < 0.001$).



Conclusions: TAH utilization remains low, but it remains a viable option for biventricular bridge to transplant with acceptable bridge to transplant and post-transplant survival rates, especially in higher volume centers. The observation of significantly worse outcomes in lower volume centers raises questions as to whether targeted training, center certifications, and minimum volume requirements could improve outcomes for patients requiring this therapy.

51. First in Man Experience with the Physio Flex Mitral Annuloplasty Ring

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Invited Discussant: Steven F. Bolling

Objective: Mitral annular stabilization remains a mainstay to ensure durability of a mitral valve repair. The Physio Flex Annuloplasty ring is a new generation incomplete ring with novel features that may make it suitable for annular remodeling in a variety of anatomical circumstances resulting from different etiologies of mitral valve disease. Key features include progressive anterior and posterior saddle shaping and in-plane flexibility that increase across annular size. This report summarizes the first in man experience with the novel Physio Flex annuloplasty ring.

Methods: From 3/20 to 7/20 we implanted the Physio Flex ring in 46 consecutive patients with mitral valve regurgitation due to a variety of different etiologies. Prospectively collected data was later reviewed for baseline characteristics, operative variables, and early outcomes in patients receiving the Physio Flex ring.

Table. Patient characteristics, operative variables, and early outcomes of patients undergoing Physio Flex ring implantation

	N = 46
Age, years ± std	69.9 ± 11.3
Female, n (%)	12 (26%)
Valve Disease Etiology	
Degenerative, n (%)	30 (65.2%)
Functional, n (%)	13 (28.3%)
Endocarditis, n (%)	2 (4.3%)
Congenital, n (%)	1 (2.2%)
Preoperative Mitral Regurgitation Grade	
Severe, n (%)	24 (52%)
Moderate-Severe, n (%)	22 (48%)
Procedure	
Resection Techniques, n (%)	29 (63%)
Nonresection Techniques, n (%)	17 (37%)
Concomitant Procedures, n (%)	43 (93%)
Tricuspid Valve Repair, n (%)	41 (89%)
Cryo-Maze, n (%)	12 (26%)
Aortic Valve Replacement, n (%)	9 (20%)
Cardiopulmonary Bypass Time, minutes, median (IQR)	111 minutes (IQR 93 to 158 minutes)
Cross-Clamp Time, minutes, median (IQR)	86 minutes (IQR 74 to 134 minutes)
Hospital Length of Stay, median (IQR)	7 days (IQR 6 to 10 days)
Postoperative Mitral Regurgitation Grade	
None or Trace, n (%)	41 (89%)
Mild, n (%)	5 (11%)
Hemolysis, n (0%)	0 (0%)
Paravalvular Regurgitation, n (0%)	0 (0%)
Ring Dehiscence, n (0%)	0 (0%)
Systolic Anterior Motion, n (0%)	0 (0%)

Results: The study cohort included 12 females and 34 males, with a mean age of 69.9 ± 11.3 years. The primary valve etiology was degenerative in 30 patients (65%) (fibroelastic deficiency in 13 patients, forme fruste in 8 patients, and Barlow’s disease in 9 patients),

functional mitral regurgitation in 13 patients (28.3%), endocarditis in 2 patients (4.3%), and congenital in 1 patient (2.2%). All patients had severe or moderate-to-severe regurgitation with ACC/AHA Class I or II triggers for intervention. Leaflet resection techniques were used in 29 patients (63%), while 17 patients (37%) underwent non-resection repair. There were 41 patients (89%) who underwent concomitant tricuspid valve repair. Median Physio Flex ring size was 32 (IQR 30 to 34). Median cross-clamp time and cardiopulmonary bypass time were 86 minutes (IQR 74 to 134 minutes) and 111 minutes (IQR 93 to 158 minutes), respectively. Median intensive care unit length of stay was 2 days (IQR 1 to 4 days), median total hospital length of stay was 7 days (IQR 6 to 10 days). Pre-discharge trans-thoracic echocardiography revealed grade 0 or trace mitral regurgitation in 41 patients (89%) and mild regurgitation in 5 patients (11%), with a mean mitral valve gradient of 3.8 ± 1.6 mmHg. There were no patients with postoperative evidence of hemolysis, ring dehiscence, para-valvular regurgitation, or systolic anterior motion. No patients had significant complications.

Conclusion: We report the first in man experience with the novel Physio Flex annuloplasty ring. Our initial experience demonstrates this prosthesis can facilitate mitral valve repair across a spectrum of mitral valve disease etiologies with excellent safety and valve repair outcomes.

52. Did Ethno-Racial Disparities in Access to Transcatheter Aortic Valve Replacement Change Over Time?

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Invited Discussant: Danny Chu

Objective: Limited dissemination of transcatheter aortic valve replacement (TAVR) among ethno-racial minorities (non-whites) has been well-documented. The objectives of this study are to 1) evaluate whether disparate use of TAVR among this vulnerable population has decreased over time, and 2) examine whether unequal access to TAVR is driven by unequal access to high-volume hospitals where this new technology was initially available.

Methods: From 2013–2017, we utilized State Inpatient Databases across 8 states (AZ, CO, FL, MD, NC, NM, NV, WA) to identify 51,232 patients who underwent TAVR vs surgical aortic valve replacement (SAVR). This population included only Medicare beneficiaries in order to maximize the cohort of patients eligible for TAVR and eliminate any confounding effects of payor status on access. To analyze the effects of hospital volume, we categorized hospitals as low- (<50/year), medium- (50–100/year), or high-volume (>100/year) by total valve procedures (TAVR + SAVR). Patient and hospital characteristics were compared for TAVR vs SAVR. Multivariable logistic regression models with interactions were performed to determine the impact of race, time, and hospital volume on the utilization of TAVR.

Results: Nearly 13% of our overall sample are non-white. The proportions of TAVR vs SAVR was 39% and 61%, respectively. The distribution of all procedures by hospital volume was 16% at low-, 29% at medium-, and 55% at high-volume hospitals. When looking only at TAVR, 5%, 28%, and 67% were performed at low-, medium-, and high-volume hospitals, respectively. Non-white patients were more likely to be younger, multi-morbid, and undergo non-elective surgery (for all, $p < 0.05$). While utilization of TAVR is increasing over time (OR = 1.73, 95% CI [1.73,1.80]), non-white patients were less likely to receive TAVR than white patients (OR 0.77, 95% CI [0.71, 0.83]). However, we observed a significantly accelerated rate of TAVR use in non-whites vs whites by 6% per year (OR = 1.06, 95% CI [1.00, 1.12]) over time (time* race interaction, $p = 0.034$). Further, an adjusted volume-stratified time trend analyses showed accelerated utilization of TAVR at high-volume hospitals among non-whites vs. whites of 8.6% per year (OR = 1.09, 95% CI [1.01, 1.16]) (Table).

Table: Time Trend by Race/Ethnicity Stratified on Hospital Volume

Race	Low-Volume	Medium-Volume	High-Volume
White	3.79 [3.39,4.24]	2.01 [1.94,2.09]	1.56 [1.53,1.60]
Non-white	3.61 [2.74,4.76]	1.83 [1.68,1.99]	1.70 [1.59,1.81]
Trend difference	0.95 [0.71,1.28]	0.91 [0.83,0.99]	1.09 [1.01,1.16]

Conclusions: This large, multi-state analysis demonstrates initially low rates of TAVR utilization among non-white patients followed by an acceleration of access over time. This decreasing inequity was likely driven by increased TAVR utilization by non-white patients at high-volume hospitals. As more patients become eligible for this technology, future investigations should identify actionable mechanisms behind these narrowing disparities.

53. Early Cyanosis After Bidirectional Cavopulmonary Shunt in Patients with Functional Single Ventricle: Etiology, Outcome, and Risk Factors

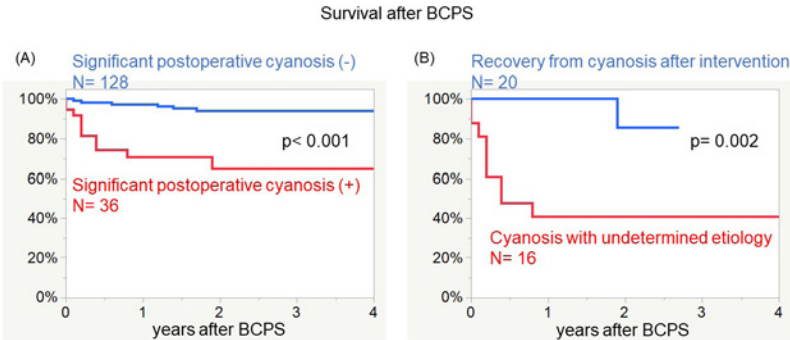
Caecilia Euringer, Takashi Kido, Janez Vodiskar, Martina Strbad, Melchior Burri, Bettina Ruf, Julie Cleuziou, Alfred Hager, Peter Ewert, Jürgen Hörer, Masamichi Ono
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Invited Discussant: Osami Honjo

Objective: Severe cyanosis in the early postoperative period after bidirectional cavopulmonary shunt (BCPS) is a critical complication. We aimed to evaluate the clinical outcomes in patients who demonstrated early postoperative severe cyanosis after BCPS, focused on its etiology and risk factors.

Methods: The medical records and serial early postoperative hemodynamic variables (SaO₂, PO₂, PCO₂, and PAP) were collected in patients who underwent BCPS at our center between 2013 and 2018. Early postoperative severe cyanosis was defined as requirement of interventions for cyanosis during the hospital stay after BCPS. Predicted hemodynamic variables were analysed. The cause and the risks of early postoperative cyanosis was analysed and its impact on mortality was determined.

Results: A total of 164 patients were included in this study. Median age and weight at BCPS procedure was 3.8 (Interquartile range, 3.0–5.6) months and 5.1 (4.5–6.1) kg. Seventy-one (43.3%) patients had a diagnosis of hypoplastic left heart syndrome. There were 2 early deaths (1.2%), 5 hospital deaths (3.0%), and 7 late deaths (4.3%). Estimated survival at 1 year following BCPS was 91.6%. Analysis using early hemodynamic variables after BCPS revealed that SaO₂ at 12 hours after extubation was an independent predictor for mortality ($p = 0.003$, HR = 0.991). Thirty-six patients (22%) presented with severe cyanosis in early postoperative period and underwent interventions at median 10 days after BCPS (range, 0–35 days). These patients showed lower survival rate after BCPS (log rank: $p < 0.001$, Figure A). Twenty patients (54%) recovered from cyanosis after interventions: coil embolization for veno-venous collaterals in 11 patients, stent implantation in left pulmonary artery in 6, and others in 3. In the remaining 16 patients (46%), etiology of severe cyanosis could not be determined and the persistent cyanosis resulted in hospital death in 4 patients and partial take down (additional aortopulmonary shunt and septation of pulmonary artery between BCPS and aortopulmonary shunt) in 9. In a subset of 36 patients with significant cyanosis after BCPS, 16 patients with undetermined etiology showed lower survival rate after BCPS (log rank: $p = 0.002$, Figure B). Multivariate logistic regression analysis revealed that ventricular end-diastolic pressure before BCPS was an independent risk factor for severe cyanosis with undetermined etiology ($p = 0.016$, OR = 1.226).



Conclusions: Low SaO₂ at 12 hours after extubation is a predictor for mortality following BCPS. Among 36 patients who demonstrated severe cyanosis in early postoperative period, 16 patients with undetermined etiology had worse outcome, and preoperative high ventricular end-diastolic pressure was identified as an independent risk factor. Earlier decision-making and subsequent intervention might improve the outcome in such cyanotic patients.

54. Incidence, Diagnosis and Natural History of Vocal Cord Palsy After Congenital Cardiac Surgery: A Prospective Implementation Study

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Invited Discussant: Christian Pizarro

Objective: 1) To determine the incidence and natural history of vocal cord palsy (VCP) in children undergoing a cardiac surgical procedure with potential risk of injury to the recurrent laryngeal nerves and; 2) to compare the sensitivity and specificity of ultrasound (US, non-invasive) to flexible direct laryngoscopy (FDL, invasive, gold standard) for diagnosing VCP.

Methods: We implemented a prospective VCP diagnostic and feeding pathway for all children aged 0–10 years undergoing at-risk cardiac surgery between September 2019–October 2020. Patients underwent post-operative assessment with US and FDL in addition to examination by a speech pathologist. Patients with VCP were followed up at 3-months with US and clinical examination and at 6-month intervals with FDL and ENT review.

Results: 88 patients were eligible for inclusion. Median age was 28.5 days (IQR 11, 111). Median weight was 3.6 kg (IQR 3.1, 5.5). VCP occurred in 29 (33%) patients [n = 17 (59%) neonates]. Left VCP occurred in 26 (90%), right VCP in 2 (7%) and bilateral VCP occurred in 1 patient (vascular ring with pre-existing abnormal movement of both vocal cords). VCP was symptomatic (hoarse cry, feeding difficulty) in 25 (86%) while 4 (14%) were asymptomatic. 53 (60%) patients underwent US and FDL. 33 (38%) patients did not undergo FDL due to COVID restrictions. Combined clinical examination and US yielded a sensitivity of 91% (95% CI 71–99); and a specificity 81% (95% CI 63–93)] for the diagnosis of VCP. Median follow-up was 92.5 days (IQR 81, 158). 19 patients (66%) have undergone follow-up imaging. 4 (14%) were lost to follow up and 6 (20%) are awaiting follow-up imaging. Of the 19 patients, 12 (63%) had complete resolution of VCP after a median of 92.5 days (IQR 82, 101). 7 patients (37%) continue to have persistent VCP on US or FDL (4 symptomatic, 3 asymptomatic) at a median follow up of 150 days (IQR 69, 188). Patient characteristics and outcomes are compared in Table 1.

Two patients were readmitted with respiratory complications potentially related to VCP. 1 patient with VCP required a tracheostomy for multilevel airway obstruction related to 22 q11 deletion. No patient required a percutaneous endoscopic gastrostomy (PEG).

Table 1: Characteristics and outcomes for patients with VCP (n=29) compared to those without VCP (n=59)

	With VCP n=29	Without VCP n=59	p value
Characteristics			
Age days, median (IQR)	18 (11-212)	34 (12-111)	0.84
Weight kg, median (IQR)	3.8 (3-8)	3.5 (3.1-5.4)	0.51
Operations			
Operation performed, n(%)			
PDA ligation primary procedure	3 (10)	2 (3)	
PDA ligation secondary procedure	6 (21)	33 (56)	
Coarctation repair	6 (21)	14 (24)	***
Arch reconstruction	8 (28)	3 (5)	
Vascular ring	5 (17)	5 (8)	
Norwood procedure	1 (3)	2 (3)	
Outcomes			
ICU days, median (IQR)	5 (2-7)	4 (1-7)	0.79
Hospital days post op, median (IQR)	15 (9-27)	10 (6-20.8)	0.08
NG feeding days, median (IQR)	27 (15-71)	17.5 (7-30)	0.10
Full oral feeds, n (%)	12 (41%)	39 (66%)	0.03
>50% oral feeds; < 50% NG* top up, n(%)	9 (31%)	15 (25%)	0.61
<50% oral feeds; > 50% NG top up, n(%)	8(28%)	5(9%)	0.02
PEG** feeding, n(%)	0	0	-
Tracheostomy, n(%)	1	1	-

*NG – nasogastric; **PEG – percutaneous endoscopic gastrostomy, *** - small numbers preclude meaningful statistical analysis

Conclusions: VCP occurs in one-third of patients undergoing cardiac surgical procedures with potential risk of injury to the recurrent laryngeal nerves and is silent in up to 15% of children. US in conjunction with speech pathology examination is a reliable non-invasive screening tool for the diagnosis of VCP and reduces the need for invasive FDL. VCP resolves completely in over half of patients by 3 months. VCP has a significant impact on feeding but it is not a contraindication to oral feeding and does not delay discharge from hospital. A structured management pathway facilitates establishment of oral nutrition in all children. Over a third do not require any nasogastric support. PEG feeding is not necessary in children with VCP.

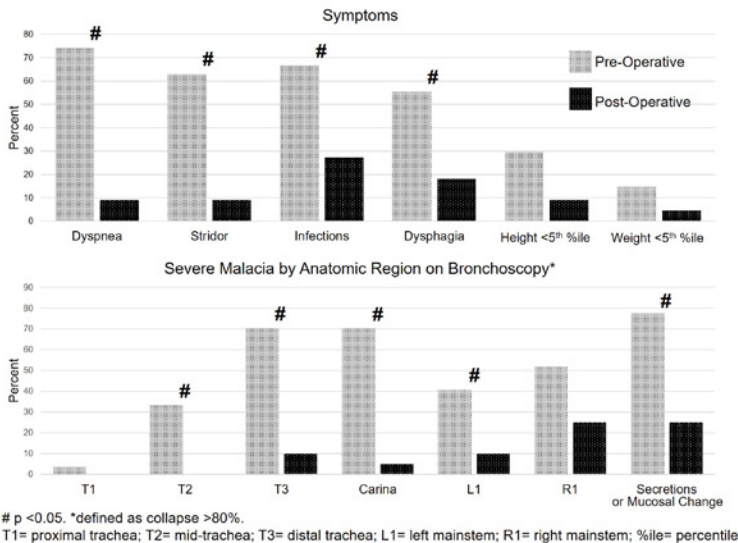
55. Re-Operation After Vascular Ring Repair to Correct Symptomatic Airway Compression and Tracheobronchomalacia

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Invited Discussant: Roosevelt Bryant, III

Objective: Vascular rings can cause external compression of the airway, resulting in symptomatic airway narrowing. Although vascular ring release can relieve the external airway compression, residual tracheobronchomalacia (TBM) and/or cartilage malformation can be the reason for persistent and long-standing respiratory symptoms. We review our surgical experience using a combined vascular and tracheobronchial approach in patients with persistent respiratory symptoms following a prior vascular ring operation.

Methods: Our institutional database identified all patients who had a prior vascular ring operation, were referred to our multidisciplinary clinic for symptomatic airway narrowing, and were re-operated on between January 2014 and December 2019. Charts were reviewed for initial operation, symptoms, surgical approach, clinical results, along with bronchoscopic evaluation pre- and post-surgical repair. Data were analyzed by Fischer's exact test for comparison between groups with significance at $p < 0.05$.



Results: Of the 61 total vascular ring patients operated on over the 6-year period, 27 (44%) had been referred for recurrent airway symptoms. Median age was 4.5 months at initial operation and 4 years at re-operation. Initial anatomy was most commonly double aortic arch (n = 12) or right arch (n = 12) while 13 patients had a diverticulum of Kommerell (2 were resected at first operation). During re-operation, patients required division of ductal/scar tissue (n = 11), division of an aberrant left subclavian (n = 8), aortic uncrossing procedure (n = 4), resection of a Kommerell diverticulum (n = 7), and aortopexy (n = 22). During all re-operations, bronchoscopic guidance was used to identify and address residual TBM and/or cartilage deformation: 26 patients had a tracheopexy (25 posterior, 17

anterior) and 20 required bronchopexy to maintain an open airway after ring release. Five patients needed a subsequent operation for revisional anterior tracheal or bronchial pexy with persistent airway symptoms. Follow-up was available in 22 patients at a median of 1 year (range, 2 months–2.4 years): symptoms of dyspnea resolved in 15/17 (88%), stridor in 14/16 (88%), recurrent infections in 10/16 (63%), and dysphagia in 8/11 (73%). On bronchoscopy, severe tracheomalacia (>80% luminal collapse) resolved in 16/18 (89%) while severe bronchomalacia resolved in 7/13 (54%) (Figure).

Conclusions: Recurrent or persistent respiratory symptoms following vascular ring repair can be successfully treated using a combined vascular and direct airway approach. In addition to relieving the external airway compression caused by the vascular ring, concurrent tracheobronchial procedures to address the residual TBM and/or cartilage deformation may also be required to prevent reoperation and achieve optimal airway outcomes.

56. Potts Shunt As an Effective Palliation for Patients with End-Stage Pulmonary Arterial Hypertension

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Invited Discussant: Emre Belli

Objective: Potts shunt has been suggested as an effective palliative therapy for patients with pulmonary artery hypertension (PAH) not associated with congenital heart disease.

Methods: This is a prospective single-center study performed to assess outcomes of Potts shunt in patients with PAH who are in functional class III or IV.

Results: 52 patients in functional class III/IV with pulmonary arterial hypertension without significant intra or extracardiac shunt on maximal medical therapy were evaluated and counseled for undergoing Potts shunt/patent ductus arteriosus (PDA) stenting. 19/52 patients (16 females) consented for the procedure; 17 patients underwent surgical creation of Potts, and 2 underwent transcatheter stenting of PDA, which physiologically acted like a Potts shunt. Standard medical therapy was continued in patients who did not consent for the procedure. 15/19 patients survived the procedure. Patients who did not survive the procedure were older, with severe right ventricular systolic dysfunction, and functional class IV. Patients who survived the procedure were followed up in the pulmonary hypertension clinic. The Median follow-up was 17 (1–40 months). 13/15 patients discharged after the operation showed sustained clinical, echocardiographic, and biochemical improvement, which reduced pulmonary vasodilator therapy in 12/15 patients. There was one death in the follow-up period 16 months post-surgery due to lower respiratory tract infection.

Conclusions: Potts shunt is feasible in patients with PAH without significant intra or extracardiac shunts. It can be done safely with an acceptable success rate. Patient selection, preoperative stabilization, and meticulous postoperative management are essential. It should be performed at the earliest sign of clinical, echocardiographic, or laboratory deterioration for optimal outcomes. Long-term follow-up is required to see a sustained improvement in functional class and the need for a lung transplant in the future.

57. Endovascular Treatment of Penetrating Atherosclerotic Ulcers of the Arch and Thoracic Aorta: A Contemporary 20-Years Experience

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Objective: Thoracic endovascular aortic repair (TEVAR) is the treatment of choice for acute and chronic diseases of the thoracic aorta. Penetrating aortic ulcer (PAU) is a chameleonic disease often triggering other acute aortic syndromes. The objective of this study was to analyze the results of TEVAR for the treatment of PAU in our population.

Methods: From January 1999 to January 2019, 830 patients with acute and chronic type B aortic syndromes were treated with TEVAR in our institution. Of these, we selected 73 patients treated for a PAU, both in emergency setting and in elective-one. In-hospital mortality and follow up mortality are reported and compared.

Results: Mean age of our population was 72 ± 8 years, 86.3% suffered from hypertension and 5.6% had a positive familiar history for aortic events. Symptoms onset was variable even if the most frequent presentation was pain (chest pain 19.2% and infrascapular pain 15.7%). Eleven patients (15.6%) had a previous surgery on the thoracic aorta. The 20.5% (15patients) were treated in an emergency setting. Proximal landing zone was in arch zone 2 in 18 patients (25%) with 17 carotid-subclavian bypass, while for the rest of the population (75%) it was the descending thoracic aorta. A mean of 1.53 ± 0.7 stent graft was used for each procedure. In-hospital mortality was 6.8%, 1 patient suffered from spinal cord injury and 5 patients suffered from acute kidney injury (3 dialysis). On the univariate analysis, the only pre-operative factors capable of influencing in-hospital mortality were the presence of infrascapular pain (p = 0.001) and the emergency setting of the procedure (p < 0.001). The arch zone 2 delivery of the prosthesis (with carotid-subclavian bypass) didn't result as a risk factor for mortality (p = 0.383).

Survival at 1, 3, and 5 years was 84.0%, 76.6%, and 73.6%, respectively, with no statistically significant difference between elective and emergency patients (Log rank 0.09) or according to the proximal landing zone (arch zone 2 vs descending thoracic aorta [Log Rank 0.125]). Freedom from reoperation at 1, 3, and 5 years was 92.4%, 80.9%, and 71.9%, respectively.

Conclusions: The use of TEVAR for treatment of aortic PAU is a safe procedure, with acceptable mortality and morbidity if performed in an elective setting. Proximal landing zone (arch vs. descending thoracic aorta) doesn't affect outcomes. Clinical presentation with infrascapular pain, and above all the emergency regimen can influence in-hospital mortality.

58. Elephant Trunk Simplifies Extent I and II Thoracoabdominal Aortic Aneurysm Repair Without Impacting Operative Risk

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Objective: During operative repair of the aortic arch, reconstruction with an elephant trunk (ET) technique aids in obtaining proximal control of the aorta during subsequent thoracoabdominal aneurysm (TAAA) repair if required. Additionally, the presence of an ET may reduce operative times and complication rates as the need for dissection in the aorto-pulmonary window is avoided. In this analysis, we aim to compare outcomes of TAAA repair in patients with an elephant trunk compared to those without.

Table: Intraoperative and Postoperative Outcomes

Variable	Overall (n = 469)	No ET (n = 431)	ET (n = 38)	P-Value
Crawford extent	–	–	–	–
Extent I	345 (73.6)	315 (73.1)	30 (78.9)	0.55
Extent II	124 (26.4)	116 (26.9)	8 (21.1)	0.55
Urgent or emergent procedure	230 (49.0)	218 (50.6)	12 (31.6)	0.04
Use of bypass	244 (52.0)	234 (54.3)	10 (26.3)	0.02
Femoral–femoral	9 (1.9)	9 (2.1)	0 (0.0)	–
LA–distal aortic	192 (41.1)	183 (42.7)	9 (23.7)	–
LA–femoral	40 (8.6)	39 (9.1)	1 (2.6)	–
Traditional CPB	3 (0.6)	3 (0.7)	0 (0.0)	–
Bypass time, min (median [IQR])	17 [0.0–28]	20 [0.0–28]	0.0 [0.0–9.0]	<0.001
Cross clamp time, min (median [IQR])	41 [31–52]	42 [32–52]	30 [25–39]	<0.001
PRBC transfused, units (median [IQR])	3 [2–5]	3 [2–5]	2 [1–3]	0.01
MAE	76 (16.5)	72 (17.0)	4 (11.1)	0.50
Operative mortality	26 (5.6)	24 (5.6)	2 (5.4)	1.00
Recurrent laryngeal nerve injury	26 (5.5)	26 (6.0)	0 (0.0)	0.24
Permanent neurologic deficit	2 (0.4)	2 (0.5)	0 (0.0)	1.00

Methods: Our institutional database was retrospectively reviewed to identify patients with Crawford extent I or II aneurysms who underwent repair between September 1997 and October 2020. Patients were stratified into two groups: ET vs. no ET. The primary outcome was major adverse events (MAE) defined as a composite of operative mortality, myocardial infarction, permanent neurologic deficit, need for tracheostomy, and new need for dialysis. Secondary outcomes included each component of MAE and recurrent laryngeal nerve injury.

Results: A total of 469 patients were included, 38 (8.1%) in the ET group and 431 (91.9%) in the no ET group. A majority of the patients (n = 345, 73.6%) presented with Crawford extent I aneurysms. There were no differences in baseline characteristics. Patients in the no ET group were more likely to undergo an urgent or emergent operation (50.6% vs 31.6%, $p = 0.04$). Partial or complete bypass was used more frequently in the no ET group (54.3% vs 26.3%, $p = 0.02$). Left atrial to distal aortic bypass was the most commonly used strategy overall. Cardiopulmonary bypass (20 min [IQR: 0.0–28] vs 0.0 min [IQR: 0.0–9.0], $p < 0.001$) and aortic cross clamp (42 min [IQR: 32–52] vs 30 min [25–39], $p < 0.001$) times were significantly lower in the ET group. There was no difference in rates of MAE between groups. Operative mortality was 5.6% in the no ET group and 5.4% in the ET group ($p = 1.00$). No patients in the ET group had a recurrent laryngeal nerve injury, while 26 (6.0%) in the no ET group had an injury, but this was not significantly different ($p = 0.24$). On multivariable regression analysis a history of peripheral vascular disease (Odds Ratio [OR]: 2.11, 95% Confidence Interval [CI]: 1.15–3.85, $p = 0.02$), renal dysfunction (OR: 2.23, 95% CI: 1.23–4.04, $p = 0.008$), and longer circulatory arrest times (OR: 1.07, 95% CI: 1.03–1.11, <0.001) were independent predictors of increased MAE. Notably, the presence of an ET was not a predictor of MAE (OR: 1.08, 95% CI: 0.35–3.39, $p = 0.89$).

Conclusion: Completion elephant trunk in patients with Crawford extent I and II aneurysms can be performed safely in a tertiary referral center with shorter bypass and cross-clamp times. The presence of a prior ET does not increase the operative risk for TAAA.

59. Early Results of Dissection Petticoat Stents for Acute and Chronic Residual Type B Aortic Dissection

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Objective: Type A Aortic Dissection is frequently complicated by extension along the thoracoabdominal aorta, and in the absence of mesenteric, limb, and spinal complications, management is prioritized to the ascending aorta. Over the long term, the thoracoabdominal aorta in these patients often degenerates requiring endovascular or open repair. The purpose of this investigation is to determine the early clinical outcome on aortic morphology by managing the abdominal aorta with the Cook Zenith Dissection Stent system in patients with acute and chronic primary or residual Type B Aortic Dissection.

Methods: We retrospectively reviewed the clinical outcomes of adult patients ≥ 18 with primary or residual Type B aortic dissection who simultaneously underwent endovascular stent graft repair of the thoracic aorta and repair of the abdominal aorta using an uncovered dissection stent system. We identified 26 patients between April 2019 and April 2020 who met this criterion, and compared their pre-operative to post-operative and follow-up (3 month) CT scans.

Results: In this study population, 9 patients (35%) were female, and mean [SD] age and BMI were 60.3 [11] years and 30.1 [5] kg/m², respectively. Twenty (79%) patients had a previously repaired type A aortic dissection and were presenting for management of chronic residual type B dissection. Two (8%) patients underwent surgery for acute type B aortic dissection (time to surgery ≤ 14 days), 1 patient (4%) was treated in the subacute period (15–30 days), and median [IQR] time to surgery was 715 [140, 2050] days. All patients

underwent simultaneous endovascular repair of the thoracic aorta prior to placement of the dissection stent: 23 (88%) patients had a 180 cm stent placed, and 5 (19%) had a 46 mm stent placed. Mean [SD] procedure time was 185 [81] minutes. Mortality was 4% (1 patient). No patients suffered post-operative stroke, paraparesis, or mesenteric/limb ischemia. On post-operative and follow-up CT scans, there was a significant increase in true lumen area ($p < 0.005$) in all aortic zones. This coincided with a significant reduction in the area of the false lumen and whole aorta in most aortic zones ($p < 0.05$) at the time of follow-up (Figure 1). Stent placement, however, did not impact thrombosis of the false lumen in the abdominal aorta.

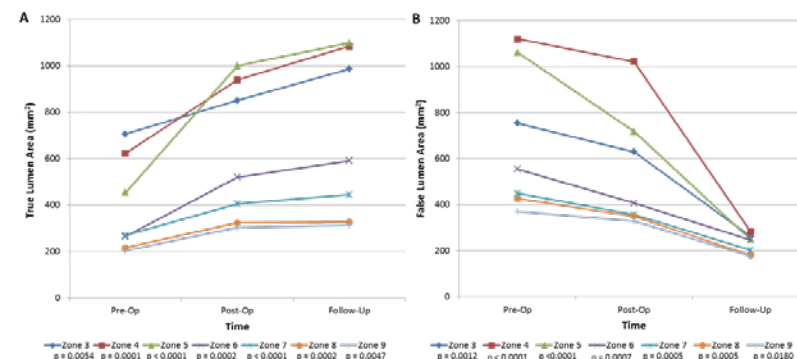


Figure 1: A. Increase in true lumen area and, B. Reduction in false lumen area over time. *p-values compare pre-op to follow-up.

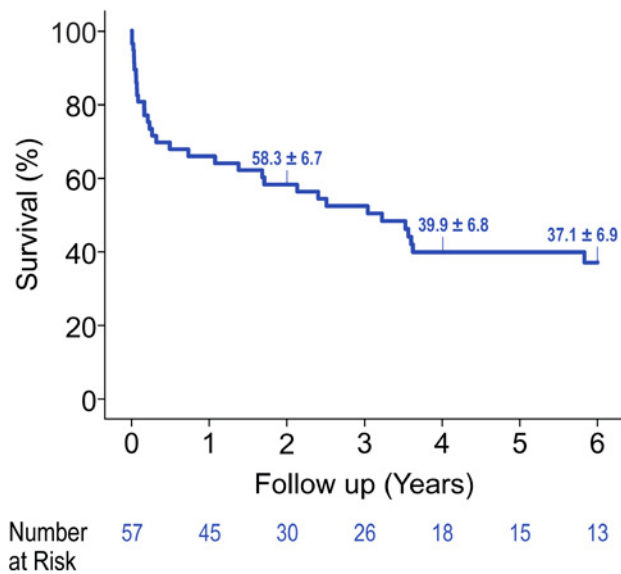
Conclusions: Altering the course of aortic remodeling, as evidenced by true lumen expansion and false lumen regression/thrombosis, may predict long-term success in dissection management. This investigation demonstrates that placement of a dissection stent in the abdominal aorta simultaneously with thoracic aortic repair may help promote true lumen re-expansion and reduce false lumen size. Further follow-up is necessary to determine the long-term outcome of stent placement on aortic morphology.

60. Early and Late Outcomes of Surgical Treatment of Mycotic Aortic Aneurysm and Pseudoaneurysm: A 30-Year Experience

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Objective: Mycotic aortic aneurysm and pseudoaneurysm are associated with significant morbidity and mortality. On top of their virulence, the optimal medical and surgical management of these conditions remains unclear, and there is a paucity of data regarding outcomes after surgical repair. In this study, we examined the early and late outcomes of repair of mycotic aortic aneurysm at our center.

Methods: Clinical data from patients with mycotic aortic aneurysm or pseudoaneurysm were abstracted from our clinical database with supplemental adjudication from paper and electronic charts as needed. Aortic infection was confirmed through clinical, radiographic, operative, pathological, and/or treatment evidence.



Results: A total of 57 consecutive patients were treated surgically for mycotic aortic aneurysm or pseudoaneurysm at our center between 1990 and 2019. The majority of patients (91%) underwent open aortic repair, usually on an urgent or emergency basis (84%), and 18 patients (32%) presented with rupture. Infection-specific adjunct techniques included pedicled omentum flaps (n = 22), rifampin-soaked grafts (n = 10), and antibiotic irrigation catheters (n = 7). The most common organisms isolated from aortic wall cultures were *Staphylococcus species* (n = 8), *Streptococcus species* (n = 6), and Gram negative organisms (n = 6), however, 30% of specimens yielded negative cultures (n = 17). There were 14 early deaths (25%), including 10 among the 18 patients who presented with rupture (56%). In addition, 7 patients (12%) developed fulminant sepsis and 7 patients (12%) developed multiple organ failure. Persistent stroke, paraplegia or paraparesis, and renal failure necessitating dialysis in operative survivors were uncommon (each ≤5%). Median intensive care unit and overall length of stay were 6 and 16 days, respectively. The majority of patients (70%) were discharged on antibiotics, and 14 patients (25%) were prescribed lifelong suppressive antibiotic therapy. Kaplan-Meier estimated survival rates at 2, 4, and 6 years were 58 ± 7%, 40 ± 7%, and 37 ± 7%, respectively (Figure).

Conclusions: Patients with mycotic aortic aneurysm and pseudoaneurysm generally require urgent or emergency repair. Early mortality and complications are common, especially for patients who present with rupture, and the probability of long-term survival is low.

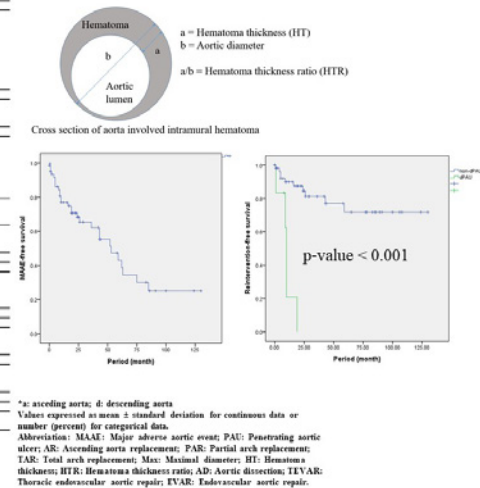
61. Tailored Treatment Modality in Acute Type A Intramural Hematoma: The Importance of Aortopathy in Descending Aorta As a Clue to Find Origin of Acute Type A Intramural Hematoma

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Objectives: In acute type A intramural hematoma (ATAIMH), it is often hard to know its origin, however, most of the surgery is performed on the proximal aorta. Reviewing major adverse aortic event (MAAE) after ATAIMH surgery, like a tear-oriented treatment in aortic dissection considered well-established and mainstay strategy, we thought there should be a treatment modality tailored according to the origin.

Baseline characteristics			
variables	MAAE (2) (n=25)	MAAE (3) (n=32)	p-value
Age (year)	62.37 ± 11.33	66.69 ± 11.61	0.171
Male (n)	15 (60.0%)	14 (43.8%)	0.415
Smoking (n)	9 (36.0%)	12 (37.5%)	0.667
Hypertension (n)	19 (76.0%)	20 (62.5%)	0.067
Intact aortic regurg (n)	21 (84.0%)	29 (90.6%)	0.106
Maximal diameter (mm)	42.6 (2.5)	42.0 (2.5)	0.556
Maximal thickness (mm)	11.2 (2.3)	11.8 (2.3)	0.173
Maximal thickness ratio (HTR)	7.0 (2.5)	7.0 (2.5)	0.108
Hemorrhagic aortic (n)	11 (44.0%)	9 (28.1%)	0.104
Surgical extent			
AR (n)	12 (48.0%)	4 (12.5%)	0.080
PAR (n)	12 (48.0%)	16 (50.0%)	0.789
TAR (n)	4 (16.0%)	16 (50.0%)	0.213
Measurement of aorta			
Ascending (mm)	48.11 ± 4.58	48.17 ± 7.50	0.809
Maximal (mm)	10.86 ± 3.88	12.17 ± 4.29	0.224
Maximal thickness ratio (HTR)	0.22 ± 0.07	0.25 ± 0.08	0.239
Descending (mm)	37.28 ± 4.27	37.37 ± 7.70	0.938
Maximal (mm)	11.48 ± 3.59	9.17 ± 4.10	0.018
Maximal thickness ratio (HTR)	0.31 ± 0.10	0.24 ± 0.08	0.024
Maximal thickness ratio (HTR)	1.82 ± 0.44	1.82 ± 0.47	0.908
Proximal aortic (mm)	17.21 ± 4.17	24.59 ± 4.09	0.177
Proximal aortic thickness ratio (HTR)	1.99 ± 3.24	6.23 ± 3.06	0.012
Proximal aortic thickness ratio (HTR)	0.12 ± 0.05	0.12 ± 0.05	0.178
Maximal thickness ratio (HTR)	18.04 ± 3.26	12.17 ± 3.26	0.008
Maximal thickness ratio (HTR)	18.04 ± 3.26	14.44 ± 3.74	0.141
Maximal thickness ratio (HTR)	18.04 ± 3.26	18.04 ± 3.26	0.008
Multivariate analysis of MAAE			
Variables	OR	95% CI	p-value
Maximal thickness ratio (HTR)	2.49	1.016 to 6.002	0.044
Maximal thickness ratio (HTR)	1.016	1.016 to 1.016	0.044
Maximal thickness ratio (HTR)	1.016	1.016 to 1.016	0.012
Maximal thickness ratio (HTR)	1.016	1.016 to 1.016	0.012
Adverse outcome			
MAAE profile			
PAU (n)	13 (52.0%)		
AD (n)	4 (16.0%)		
Dissection (n)	11 (44.0%)		
Reoperation profile			
TEVAR (n)	11 (44.0%)		
TEVAR (n)	1 (4.0%)		
Embolectomy (n)	1 (4.0%)		
Multivariate analysis of reoperation			
Variables	OR	95% CI	p-value
Maximal thickness ratio (HTR)	2.49	1.016 to 6.002	0.044
Maximal thickness ratio (HTR)	1.016	1.016 to 1.016	0.044
Maximal thickness ratio (HTR)	1.016	1.016 to 1.016	0.012
Maximal thickness ratio (HTR)	1.016	1.016 to 1.016	0.012



Methods: We retrospectively analyzed 60 patients (mean age: 64.77 ± 11.58; 29 male sex) with ATAIMH who underwent surgery from 2008 to 2019. Patients with Marfan syndrome, malignancy and visible flap in the CT were excluded. We grouped according to the occurrence of MAAE and reviewed preoperative CT to find the origin. The maximal thickness of the hematoma (HT), the maximal diameter of aorta, and the hematoma thickness (HT) ratio (HTR [hematoma thickness/aortic diameter]) were measured at the ascending and descending aorta. For the descending aorta, measurements were taken at the level of pulmonary artery bifurcation. MAAE defined as penetrating aortic ulcer (PAU) enlargement, aortic dissection, rupture, aneurysmal growing and aortic surgery.

Results: Of the total patients, 28 were in the MAAE (+) group, and 15 (53.5%) of them required reintervention. The 10-year survival and MAAE-free survival rates were 89.8% and 25.1%, respectively. The average time to the occurrence of MAAE was 26 months (range, 0 to 85). Median follow up duration was 52 months (range, 5 to 135). The 10-year reintervention-free survival rate was 64.8%. In 83% of total patients (n = 50), we could not find its origin in initial CT scan. PAU was found in a 10 of total patients, of which the number of patient with PAU in descending aorta (dPAU) was significantly higher in the MAAE group. HT of the descending aorta (dHT), HTR of the descending aorta (dHTR)/HTR of ascending aorta (aHTR) and dHTR were significantly larger in MAAE (+) group. The number of the patients with dHT >9.53 mm and dHTR/aHTR > 1.15 was significantly higher in MAAE (+) group. dHT > 9.53 mm, dHTR/aHTR > 1.15, dHT and dHTR/aHTR were independent predictors of MAAE in the multivariate analysis. Subsequently, a multivariate analysis was performed on the requirement of reintervention, dPAU and dHT > 9.53 mm came out as independent predictors. The patients with dPAU showed significantly worse reintervention-free survival rate than patients without dPAU.

Conclusions: In our study, the aortopathy of descending aorta such as the HT, HTR and PAU was found to be a predictor of MAAE or reintervention after ATAIMH surgery. So we thought there were many cases of MAAE related to not properly treating the origin. We think it is important to find the origin and treat it, and aortopathy in descending aorta will be an important clue in finding the origin. With the above policy, we could consider tailored treatment modality such as medical treatment or timely surgery in addition to emergent surgery.

62. Widening Volume and Persistent Outcome Disparity in Valve Operations: New York Statewide Analysis 2005–2016

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Invited Discussant: Frederick Y. Chen

Objectives: Volume concentration of complex non-cardiac operations to high-volume centers has been observed, but whether this is also occurring in cardiac surgery is unknown. We examined the relationship between volume concentration and mortality rates for valve surgery and CABG between 2005–2016 in New York State.

Methods: We analyzed publicly available, hospital-level case volume and risk-adjusted mortality rates from 2005–2016 for isolated coronary artery bypass graft and isolated or concomitant valve operations performed in New York. Data were aggregated into 3-year increments. We identified hospitals in the top and bottom volume quartiles for each procedure type and compared changes in percent market share and risk-adjusted mortality rate (RAMR) for each quartile. Generalized linear mixed models were used to evaluate the statistical significance of the temporal trends in volume and outcome.

Results: Among 36 centers, total CABG procedure volume performed across all hospitals decreased by 27.9% (33,139 to 23,898 triannual cases) across the study period while valve cases increased by 2.8% (20,302 to 20,873 triannual cases). Percent market share of the top volume quartile increased for valve cases from 54.4% to 59.4%, while CABG share increased from 41.4% to 44.3%. No significant changes were noted in market share of the

bottom quartile for either procedure type. Average RAMR for valve procedures decreased between 2005–2007 and 2014–2016 from 5.02% to 2.95% in the top volume quartile (p = 0.001) and from 6.62% to 4.52% in the bottom volume quartile (p = 0.24). The top volume quartile demonstrated significant trends in improving outcomes over the study period for both valve procedures (RAMR: -0.261%/year, p < 0.001) and CABG (RAMR: -0.071%/year, p = 0.018). No significant trends were noted in the bottom quartile for either procedure.

Conclusions: In NY, over the last decade, highest-volume hospitals increased their market share for valve operations while maintaining lower mortality rates than lowest-volume hospitals. This trend was not observed for CABG procedures. Valve volume is regionalizing in the setting of a persistent outcome gap between the highest- and lowest-volume hospitals, suggesting that volume-based referrals for specialized cardiac procedures may improve surgical mortality.

63. Fontan Palliation in 159 Patients with Heterotaxy Syndrome: A Five Decade Experience

Gabriel Graham, Elizabeth H. Stephens, Joseph A. Dearani, Frank Cetta, Jr., Naiz Talha
Mayo, Rochester, MN

Invited Discussant: J. William Gaynor

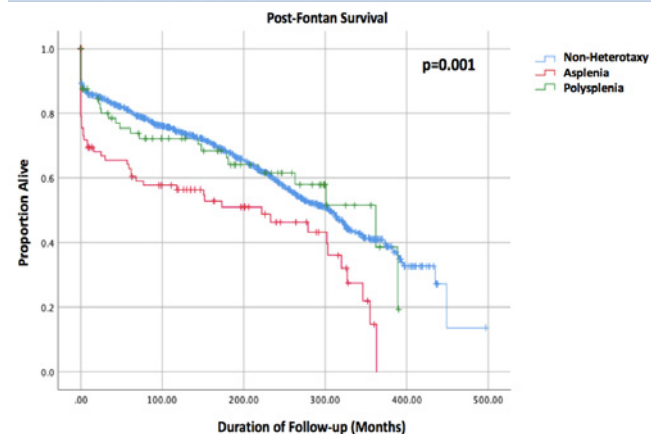
Objective: Patients with heterotaxy syndrome are at high risk of poor outcomes after surgical single ventricle palliation. However, the long-term outcomes and specific parameters associated with poor outcomes are incompletely understood.

Methods: A review was performed of all heterotaxy syndrome patients who had a Fontan operation at our institution from 1973 to present. Standard demographic, as well as pre-, peri-, and postoperative parameters were collected. Features and outcomes of patients with polysplenia were compared to those with asplenia. Outcomes were also analyzed for an era effect: (1973–1984), (1985–1994), (1995–2004), and (2005–2020). Multi-variate analysis was performed to determine factors associated with transplant-free survival. Transplant-free survival after Fontan of the heterotaxy group were compared to the non-heterotaxy cohort. Data are presented as median (interquartile range) for non-normally distributed data and mean ± standard deviation for normally distributed data.

Results: All 1176 patients who had a Fontan procedure from 1973–2020 were identified, including 159 (13.5%) with heterotaxy syndrome. These were then stratified by polysplenia and asplenia. Median age at time of Fontan was 8 (9) years and 55% were male. Details of anatomy and Fontan procedure are shown in the Table. Early mortality was 20%, and was higher in the asplenia group compared to polysplenia (27% vs 12%, p = 0.019). Survival improved over the eras with early mortality of 61% in era 1, 13% in era 2, and 7–10% in the most recent eras (p < 0.001). Similarly, long-term transplant-free survival improved with era (88% at 10 years in the most recent era vs 20% at 10 years in the oldest era, p < 0.001). At median follow up of 10 (20) years, 51% were alive, and 4.4% had undergone transplant. Transplant-free survival was significantly less in the asplenia group than the polysplenia group (p = 0.011). Heterotaxy patients overall had lower survival than the non-heterotaxy patients (p = 0.008), largely due to the asplenia group (Graph, p < 0.001). Parameters associated with improved survival by multi-variate analysis included prior Glenn (p = 0.001), azygous continuation of the inferior vena cava (p = 0.03), and left ventricular morphology (p = 0.001).

	Total Cohort (n=159)	Polysplenia (n=73)	Asplenia (n=86)	p-value
Age at Fontan (Years)	8 (9)	8 (8)	7 (9.5)	0.693
AV valve Anatomy				0.003
Concordant	23 (14.5%)	15 (20.5%)*	8 (9.3%)*	
Discordant	2 (1.3%)	1 (1.4%)	1 (1.2%)	
Double inlet	10 (6.3%)	9 (12.3%)*	1 (1.2%)*	
Other	124 (78%)	48 (65.8%)*	76 (88.4%)	
Ventricular Morphology				0.479
Two Vent.	20 (20.9%)	6 (8.6%)	14 (16.5%)	
LV	22 (14.2%)	12 (17.1%)	10 (11.8%)	
RV	93 (60%)	43 (61.4%)	50 (58.8%)	
Common	16 (10.3%)	8 (11.4%)	8 (9.4%)	
Intermediate	4 (2.6%)	1 (1.4%)	3 (3.5%)	
Pulmonary venous connection				<0.001
Normal	57 (36.3%)	37 (50.7%)*	20 (23.8%)*	
TAPVR	65 (41.4%)	12 (16.4%)*	53 (63.1%)*	
PAPVR	35 (22.3%)	24 (32.9%)*	11 (13.1%)*	
Fontan Type				<0.001
Other	19 (12.7%)	18 (23.3%)*	1 (1.2%)*	
AP	32 (21.3%)	13 (19.7%)	19 (22.6%)	
Lateral Tunnel	79 (52.7%)	30 (45.5%)	49 (58.3%)	
Extra Cardiac	20 (13.3%)	5 (7.6%)	15 (17.9%)	
Fenestration	18 (12.2%)	7 (10.4%)	11 (13.6%)	0.374
Valve Work	48 (30.2%)	21 (28.8%)	27 (31.4%)	0.427

AV-atrioventricular, LV-left ventricle, RV-right ventricle, TAPVR-total anomalous pulmonary venous return, PAPVR-partial anomalous venous return, AP-atrio-pulmonary connection



Conclusion: Patients with heterotaxy, particularly asplenia, demonstrate worse transplant-free survival than non-heterotaxy patients. Early mortality and long-term transplant-free survival have improved in more recent eras. Left ventricular morphology, azygos continuation of the inferior vena cava anatomy and prior Glenn are associated with improved survival.

64. Cardiovascular Surgical Outcomes of Patients with Heterotaxy Syndrome and Predictors of Mortality in the Current Era

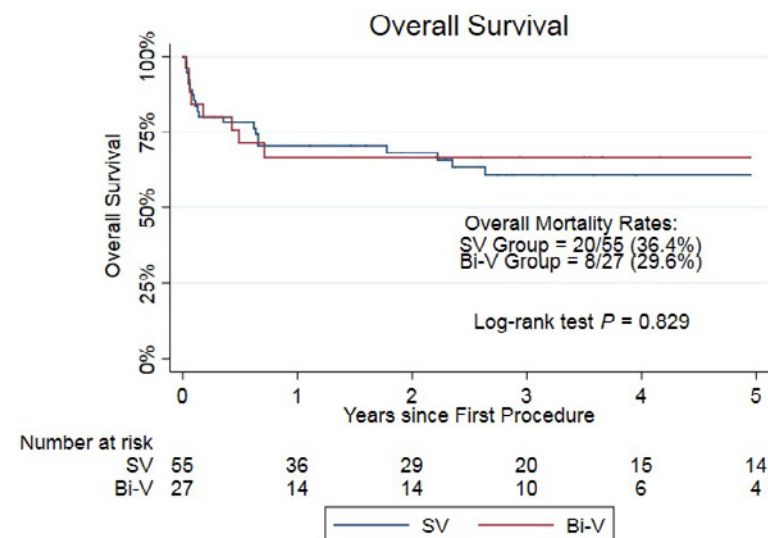
Nicolle M. Ceneri¹, Manan H. Desai¹, Steven J. Staffa², David Zurakowski², Zaenab Dhari¹, David Schidlow², Pranava Sinha¹, Richard A. Jonas¹, Can Yerebakan¹

¹Children's National Hospital, The George Washington University School of Medicine and Health Sciences, Washington, DC; ²Boston Children's Hospital, Harvard Medical School, Boston, MA

Invited Discussant: Joseph A. Dearani

Objective: Heterotaxy syndrome may be defined as a spectrum of abnormally discordant organ situs resulting from aberrant left-right axis determination in the thoracic and abdominal cavities. The abnormal degree of thoracic and abdominal visceral symmetry is associated with complex intracardiac abnormalities. Our aim is to analyze outcomes of patients with heterotaxy syndrome undergoing cardiovascular surgical repair, with a focus on univentricular palliation vs full biventricular repair, and to determine predictors of mortality.

Methods: A single-center, 10-year retrospective review of all patients diagnosed with heterotaxy syndrome who underwent cardiovascular surgical repair from January 2008 to December 2017. Diagnosis of heterotaxy syndrome was based upon evaluation of thoracoabdominal situs by echocardiography. Patients were classified as either single ventricle (SV) or biventricular (BV) according to their functional anatomy after repair.



Results: Eighty-two patients with heterotaxy syndrome met inclusion criteria. Fifty-five patients (67%) underwent SV palliation and twenty-seven (33%) underwent complete BV repair. Patient mortality in the entire cohort was 34% (28/82) including 36% (20/55) for SV palliation and 30% (8/27) for BV repair. Interstage mortality among SV patients was 29% after stage 1 (12/46), 17% after stage 2 (7/42), and 4% after stage 3 (1/23). Among all

heterotaxy patients, independent risk factors for mortality included pre- or post-operative ECMO (HR = 10.4; 95% CI: 4.3–25.4; $P < 0.001$), TAPVR (HR = 4.3; 95% CI: 1.7–10.8; $P = 0.002$), and body weight <2500 g (HR = 2.4; 95% CI: 1.0–5.4; $P = 0.041$). Among patients undergoing SV palliation, significant multivariable risk factors for mortality included both ECMO (HR = 11.0; 95% CI: 3.6–34.2; $P < 0.001$) and TAPVR (HR = 7.0; 95% CI: 2.3–21.7; $P = 0.001$). Pulmonary vein stenosis was a significant univariate predictor of mortality among all heterotaxy patients (HR = 3.0; 95% CI: 1.4–6.4; $P = 0.005$) and in the subgroup of SV patients (HR = 4.0; 95% CI: 1.7–9.7; $P = 0.002$). Overall survival of all heterotaxy patients was 66% (54/82) at a median follow-up time of 2.2 years (0.4–4.1) from the first operation (Figure 1).

Conclusions: Regardless of the cardiac operative pathway, there was comparable observed survival after the first procedure in patients with heterotaxy syndrome. Overall long-term survival was higher in those who received complete biventricular repair. Significant risk factors for mortality in cardiovascular surgical patients with heterotaxy syndrome include body weight <2500 g, TAPVR, and ECMO. Pulmonary vein stenosis is a significant predictor of mortality in patients with heterotaxy syndrome, irrespective of functional cardiac anatomy.

65. Pulmonary Atresia with Intact Ventricular Septum (PAIVS): Intervention Strategy and Long-Term Outcomes

Amrita Sukhvasi, Sara McHugh-Grant, Andrew Glatz, Antara Mondal, Heather Griffiths, Nancy Burnham, J. William Gaynor, Christopher E. Mascio, Jonathan Chen, Thomas L. Spray, Stephanie M. Fuller

Children's Hospital of Philadelphia, Philadelphia, PA

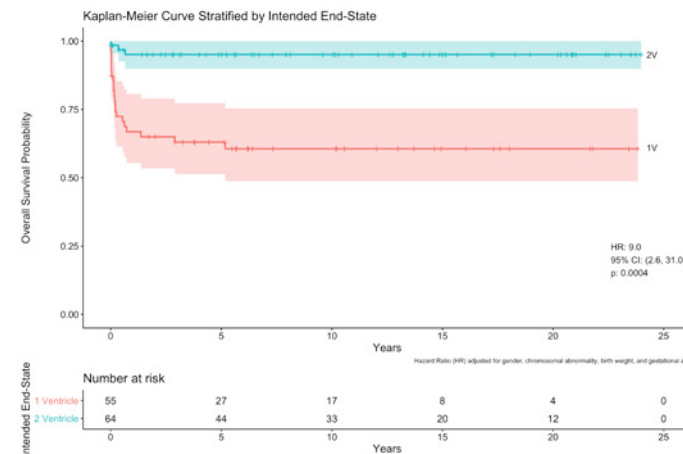
Invited Discussant: Richard Mainwaring

Objective: Pulmonary Atresia with Intact Ventricular Septum (PAIVS) has a wide spectrum of morphologic presentations. Neonatal intervention strategy is based on the degree of tricuspid valve (TV) hypoplasia and presence of right ventricle dependent coronary circulation (RVDCC). We sought to evaluate associations between baseline patient characteristics and long-term outcomes comparing patients suitable for biventricular (BiV) versus single ventricle (SV) repair.

Methods: Retrospective review was performed of 119 subjects diagnosed with PAIVS from 1995 to 2018. Patients who underwent right ventricle decompression at first intervention were classified as intended for BiV repair. Descriptive statistics summarized patient characteristics and a multivariable Cox survival model was used to compare intended BiV to SV repair, adjusted for other patient factors.

Results: Of 119 patients, 62 (52.1%) were male and 13 (10.9%) had a chromosomal abnormality. BiV repair was pursued in 53.8% (64/119) with a median (IQR) TV z-score of -1.59 (-3.03, 0.21) and single ventricle (SV) repair in 46.2% (55/119) with a median TV z-score of -5.12 (-5.60, -4.06). Presence of RVDCC was confirmed in 27.4% (31/113) patients, all except one of whom were treated with SV approach. The median age at first intervention was 3 (2, 5) days. The median follow-up duration was 6 (2, 15) years. Overall survival at 1, 3 and 5 years was 82% (98/119), 81% (96/119) and 80% (95/119), respectively. End-states include (n = 119): BiV (defined as no residual shunts, no cavopulmonary connection, and arterial oxygen saturation $\geq 95\%$) in 36 patients (30.2%), SV in 33 patients (27.7%), alive

without having achieved definitive end-state in 22 patients (18.5%), death before end-state in 21 patients (17.6%), 1.5V in 4 patients (3.4%), and transplant in 3 patients (2.5%). No SV were converted to BiV repair whereas 4/64 (6.3%) BiV repairs were converted to SV. After adjusting for gender, presence of chromosomal abnormalities, gestational age and birth weight, patients intended for SV pathway were found to have a significantly higher risk of mortality ($p < 0.001$) [HR 9.0 (95% CI, 2.6–31.0)] (Figure). Of the 24 deaths, 10 (41.7%) occurred during the initial hospitalization. Mortality was found to be higher in those with RVDCC (41.9%, 13/31) in comparison to those without RVDCC (7.3%, 6/82).



Conclusions: PAIVS remains a rare and highly lethal condition, particularly during infancy, in those patients on the SV treatment pathway, and for those with RVDCC. Prediction of end-state based on morphologic characteristics is critical to determining treatment pathway and potentially altering mortality risk. Larger, multicenter studies will be necessary to compare catheter based versus surgical palliation outcomes.

66. Optimization of an Established Enhanced Recovery After Thoracic Surgery Protocol: Aiming for Schedule II Opioid-Free Pain Control Following Robotic Surgery

Karishma Kodla, Joanne Szewczyk, Joy Stephens-McDonnough, Nestor R. Villamizar, Dao M. Nguyen

University of Miami, Miami, FL

Invited Discussant: Linda W. Martin

Objective: An essential component of enhanced recovery after surgery (ERAS) protocols is periodic auditing and modification of care components to achieve more optimal outcomes. Our ERATS (Enhanced Recovery After Thoracic Surgery) protocol was implemented on 2/1/2018 and became well established after a 5-month transition period. We implemented modifications to our care pathway on 1/1/2020 and aimed to further reduce the need for opioids in the operative period. This study aims to evaluate the impact of such efforts on the clinical outcomes and the use of both schedule II and schedule IV opioids following robotic thoracoscopic procedures.

Methods: An Institutional Review Board-approved retrospective analysis of a prospectively maintained thoracic surgery database was performed on all patients undergoing elective robotic procedures from 7/1/2019 to 9/14/2020. The main pain management component of ERATS included opioid-sparing analgesics, infiltration of liposomal bupivacaine long-acting local anesthetic 1:1 v/v dilution with normal saline to intercostal space and surgical wounds, scheduled tramadol administration and tailoring post-discharge opioid dispenses based on type and amount of opioid consumed inpatient. Protocol modifications included replacing saline diluent with 0.25% bupivacaine and switching tramadol to PRN. Demographics, type of robotic procedures, postoperative outcomes (30-day complications, length of hospital stay, subjective pain levels), in-hospital and post-discharge opioids prescribed and dispensed were obtained from the electronic medical record. Opioid consumption was reported as total MME (milligram of morphine equivalent) at discharge or as daily MME (total MME divided by length of hospital stay—LOS).

Results: 279 patients met the inclusion criteria (159 in the original ERATS and 120 in the optimized ERATS protocol). The two cohorts were comparable with respect to demographics, types of robotic procedures, and final pathologic diagnosis. Data analysis was performed based on robotic procedure stratification. There was no difference in postoperative complications, LOS or re-admission (Table 1). There was a significant reduction of in-hospital (due to the elimination of scheduled tramadol) and post-discharge opioid consumption (particularly for schedule II opioids with addictive tendency) in the optimized ERATS cohort (Table 1 and Figure 2). The optimized ERATS patients had lower incidences of opioid prescriptions filled and refilled after discharge, an indicator of adequate initial pain control. Subjective pain levels were similar between two cohorts (Figure 1).

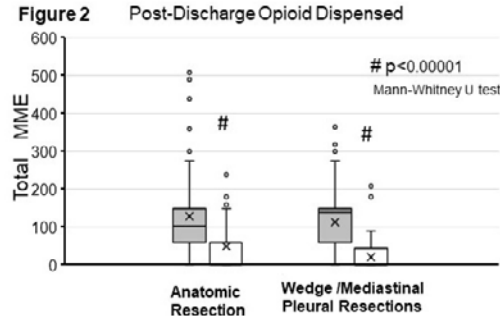
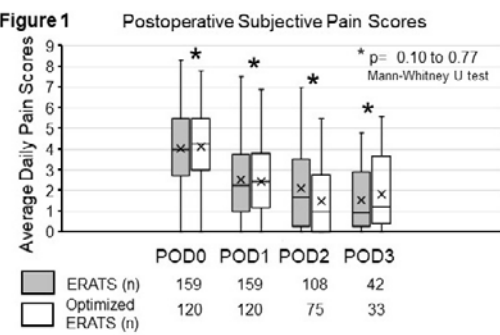


Table 1: Postoperative Outcomes

	ERATS (n=159)	Optimized ERATS (n=120)	p - value
Anatomic Resections (n)			
Complications (Clavien - Dindo)			
0	83 (80.8%)	59 (90.8%)	0.7774
1-2	11 (14.1%)	4 (6.1%)	
3-4	4 (5.1%)	2 (3.1%)	
5	0	0	
LOS (Median [IQR])	2.0 [2.0 - 3.0]	2.0 [2.0 - 3.0]	0.19
Re-admissions (n, %)	3/78 (4.5%)	1/65 (1.8%)	0.51
In-hospital Opioid Use (MME/LOS) (Median [IQR])	21.0 [12.9 - 26.4]	9.2 [4.7 - 23.6]	0.00024
Discharge Opioid Use (MME)	105.0 [60.0 - 150.0]	60.0 [0 - 60.0]	< 0.00001
% Opioid filled	88.9%	55.4%	0.00005
% Opioid refilled	10.2%	6.1%	0.41
Schedule II (Median; Mean)	90.0 [0 - 90.0]; 68.2	0 [0-0]; 15.2	< 0.00001
Schedule IV (Median; Mean)	60 [50 - 60]; 58.9	0 [0 - 60]; 31.6	0.00162
Wedge /Mediastinal-Pleural Resections (n)			
Complications (Clavien - Dindo)			
0	76 (93.8%)	55(100%)	0.3658
1-2	4 (4.8%)	0	
3-4	1 (1.2%)	0	
5	0	0	
LOS (Median [IQR])	1.0 [1.0 - 2.0]	1.0 [1.0 - 2.0]	0.6924
Re-admissions	1 (1.2%)	0	0.87
In-hospital Opioid Use (MME/LOS)	19.0 [12.7 - 23.6]	7.5 [1.5 - 23.0]	0.00016
Discharge Opioid Use (MME)	140.0 [60.0 - 150.0]	0 [0 - 33.7]	< 0.00001
% Opioid filled	80.2%	25.4%	<0.00001
% Opioid refilled	4.6%	1.8%	0.04
Schedule II (Median; Mean)	90.0 [0 - 90.0]; 70.4	0 [0 - 0]; 7.8	< 0.00001
Schedule IV (Median; Mean)	60.0 [50.0 - 60.0]; 56.4	0 [0 - 0]; 11.7	< 0.00001

IQR: Interquartile Range; MME: Milligram Morphine Equivalent; LOS: Length of Hospital Stay

Conclusions: Small modifications to our ERATS protocol for better pain management is safe and leads to a significant reduction of postoperative schedule II opioid requirements inpatient and subsequently after discharge.

67. Intermediate Term Functional Outcomes After Extracorporeal Membrane Oxygenation (ECMO)

Heather Rossong
University of Manitoba, Winnipeg, MB, Canada

Invited Discussant: HelenMari Merritt Genore

Objective: Extracorporeal membrane oxygenation (ECMO) survivors often experience complications which can have effects long after hospital discharge. However, the long-term health-related quality of life (HRQoL) of ECMO patients is poorly studied. This study examined the 5-year survival of patients treated with VA- or VV-ECMO and the health-related quality of life (HRQoL) of ECMO survivors.

Methods: A single-center retrospective chart review was conducted on all ECMO patients from December 2007 until June 2019. Prospective telephone-based assessments of HRQoL amongst ECMO survivors was performed using eight standardized questionnaires, including Activities of Daily Living (ADLs), Instrumental Activities of Daily Living (IADLs), EuroQoL-5D-5L, EQ-VAS, Post-Traumatic Stress Disorder (PTSD) Checklist and Decision Regret Scale. Survival was analyzed separately for the VA- and VV-ECMO cohorts using the Kaplan Meier method.

Results: 370 consecutive ECMO patients were reviewed, including 288 (78%) placed on VA-ECMO and 82 (22%) placed on VV-ECMO. The most common indications for VA-ECMO and VV-ECMO were cardiogenic shock (183, 64%) and ARDS (65, 79%), respectively. VA- and VV-ECMO patients were followed to a median of 4.2 and 5.7 years post-ECMO initiation. Overall estimated survival at 5 years was 33% for the VA-ECMO cohort and 36% for the VV-ECMO cohort, as per the Kaplan Meier survival curves. However, among patients that survived at least 30 days after initiation of VA- or VV-ECMO, estimated 5-year survival rates were 73% and 71%, respectively. 60 out of 108 (56%) surviving patients had a HRQoL assessment with 48 patients previously on VA-ECMO and 12 patients previously on VV-ECMO. 14 (29%) VA-ECMO patients and 9 (75%) VV-ECMO patients reported difficulty with at least 1 ADL while 13 (27%) VA-ECMO patients and 8 (67%) VV-ECMO patients reported difficulty with at least 1 IADL. The median EQ-VAS scores were 80/100 and 63/100 for VA- and VV-ECMO patients, respectively. 11 (23%) VA-ECMO patients reported a PTSD score ≥ 40 , indicating the presence of significant PTSD symptoms, while 7 (58%) VV-ECMO patients reported the same. The median decision regret score was 0/100 for the VA-ECMO cohort and 5/100 for the VV-ECMO cohort, suggesting minimal regret of the decision to initiate ECMO among survivors.

Conclusions: The overall 5-year survival of ECMO patients is low. However, a large number of mortalities occurred early in treatment and patients that survived the initial 30 days had a good probability of survival to at least 5 years. Among ECMO survivors, HRQoL concerns including difficulties with ADLs/IADLs and mental health concerns were apparent highlighting the need for long-term care in this patient population. This highlights the importance of optimizing patient selection and providing post-discharge follow-up for ECMO patients.

68. Five-Minutes Bleeding Counting to Prevent Postcardiotomy Resternotomy

Shingo Kunioka, Hideki Isa, Masahiko Narita, Ryo Okubo, Keisuke Shibagaki, Daisuke Takeyoshi, Yuta Kikuchi, Wakabayashi Naohiro, Tomonori Shirasaka, Natsuya Ishikawa, Hiroyuki Kamiya

Asahikawa Medical University, Asahikawa, Japan

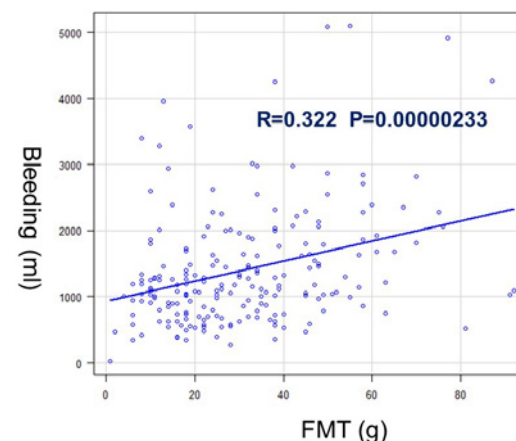
Invited Discussant: Victor A. Ferraris

Objective: Postcardiotomy cardiac tamponade is one of the life-threatening condition due to pericardial accumulation of intrapericardial bleeding and requires expedient management to prevent unfavorable outcomes, so we developed the five-minutes test (FMT); counting the amount of pericardial bleeding for five minutes before sternal closure, to reduce postcardiotomy resternotomy due to intrapericardial bleeding and tamponade. This study aims to evaluate the effectiveness of the FMT in patients undergoing general cardiac surgery and investigate the relationship between the FMT and postcardiotomy bleeding.

Methods: Medical records were retrospectively reviewed for 573 patients with underwent adult cardiac surgery from January 2016 to December 2019. Patients were divided into two groups; the FMT group consists of patients who underwent general cardiac surgery from January 2018 to December 2019 (N = 278), the control group is composed of patients from January 2016 to December 2017 (N = 297). The rate of postcardiotomy resternotomy due to intrapericardial bleeding or cardiac tamponade within a week after

the operation and the amount of bleeding until two days after the surgery were compared with two groups. We started the FMT in January 2018. The FMT procedure is that packing 4–6 surgical gauze sheets into pericardial sac for five minutes and counting the amount of them and exclude the weight of the gauze sheets. The sternal closure is performed when the amount of FMT under 100 g.

Results: The FMT group had a significantly lower incidence of postcardiotomy resternotomy (FMT: 1.5% vs control: 5.7%, $p = 0.00695$) and a lower amount of bleeding after cardiac surgery (median, FMT: 1165 ml, 756.2–1743.8 vs control: 1440 ml, 825.0–2130.0, $p = 0.00397$). There was significant correlation between the weight of FMT gauze sheets and postcardiotomy bleeding ($R = 0.322$, $P = 0.0000233$, Figure).



Conclusions: The FMT is an effective tool for preventing postcardiotomy resternotomy and reducing the bleeding after cardiac surgery and this test has a correlation with the amount of bleeding after cardiac surgery.

69. Ambulatory Chest Drainage with Advanced Nurse Practitioner-Led Follow-Up Facilitates Early Discharge Following Thoracic Surgery

Oliver J. Harrison, Victoria Schoeman, Justin Pahelga, Charlotte Bartlett, Xiaohui Liu, Vicki Richardson, Maria Elena Vilar-Alvarez, Abdul Badran, Alessandro P. Tamburrini, Khalid M. Amer, Aiman Alzetani

University Hospital Southampton, Southampton, United Kingdom

Invited Discussant: Stephen C. Yang

Objective: The UK National Lung Cancer Audit published January 2020 recognized our institution as having the shortest median length of stay following major lung cancer resection in the country (median 4 days). Rapid and safe discharge following thoracic surgery has never been more important than in the wake of the COVID-19 pandemic. Our objective was to demonstrate the safety and feasibility of enhanced discharge with ambulatory chest drains for management of prolonged air leak and excessive fluid drainage with outpatient follow-up led by Advanced Nurse Practitioners (ANPs).

Methods: All patients discharged with ambulatory chest drain bags (Rocket® Ambulatory Bag, Rocket Medical PLC, UK) following thoracic surgery (including anatomical and non-anatomical lung resections, empyema debridement, pneumothorax surgery, lung volume reduction and others) between January 2017 and December 2019 were retrospectively reviewed. Patients were discharged with an ambulatory chest drain bag when air leak or excessive fluid output was deemed manageable in patients who were medically fit for discharge. Patients were reviewed weekly in the outpatient clinic by ANPs, a highly skilled cohort of nurses with physician support available. Operative procedure, post-operative length of stay, presence and duration of air or fluid leak, duration of ANP-led clinic follow-up and post-discharge complications were recorded. Analysis was performed with SPSS statistics (IBM; version 26).

Results: Key results are displayed in Table 1. Two-hundred patients were identified during the study period amounting to 368 ANP-led clinic episodes. Median age was 68 (± 13) years and 119 (60%) were male. 137 (69%) patients underwent anatomical lung resection. For comparison, a total of 917 patients underwent anatomical lung resection at our institution during the study period, equating to a discharge with ambulatory bag rate of 14.9% in this group. Overall median post-operative length of stay was 6 (± 3) days and 176 (88%) were discharged with air leak versus 24 (12%) with excessive fluid drainage. Median time to chest drain removal was 12 (± 11) days. Complications occurred in 16 patients (8%) of which most were infection related. Twelve patients (6%) required readmission. An estimated 2156 inpatient days were saved over the study period with the associated benefit for the patients and cost saving.

Table 1 Key study results (n=200). Data are given as median \pm IQR

Age (years)	68 \pm 13
Gender (n; M:F)	119:81
Procedure performed (n; %)	
Lobectomy	94 (47%)
Wedge resection	25 (12.5%)
Pleural effusion	22 (11%)
Pneumothorax surgery	16 (8%)
Segmentectomy	9 (4.5%)
Bilobectomy	9 (4.5%)
Empyema debridement	6 (3%)
Trauma (pneumothorax)	4 (2%)
LVRS	4 (2%)
Bedside pleurodesis	3 (1.5%)
Decortication	3 (1.5%)
Post-surgical readmission requiring drain	3 (1.5%)
Other	2 (1%)
Reason for clinic review (n; %)	
Air leak	176 (88%)
Excessive fluid	24 (12%)
Post-operative length of stay (days)	6 \pm 3
Number of clinics attended (n)	2 \pm 1
Time to post-discharge drain removal (days)	12 \pm 11
Complications post-discharge (n; %)	
Total complications	16 (8%)
Required readmission	12 (6%)
Infection (LRTI or chest drain site)	10 (5%)
Pain	3 (1.5%)
Drain fell out	2 (1%)
Drain blocked	1 (0.5%)

Conclusions: Patients with air leak or excessive fluid drainage can safely be discharged with ambulatory chest drains allowing them to return to their familiar home environment safely and quickly. ANP-led outpatient clinics are a robust and cost-effective follow-up strategy. This approach is associated with an acceptable complication rate and may help reduce patient anxiety as well as maintaining hospital inpatient capacity and reducing the associated cost burden of prolonged hospital admission.

70. Early Trends of Extracorporeal Membrane Oxygenation Mortality Among Vulnerable Populations May Have Predicted the Beginning of the COVID-19 Pandemic

J.W. Awori Hayanga, Jeffrey Jacobs, Heather Kaiser Hayanga, Paul McCarthy, Benjamin Reed, Kalee Vincent, Vinay Badhwar
West Virginia University, Morgantown, WV

Invited Discussant: Tom C. Nguyen

Objective: To evaluate whether trends in mortality by state among vulnerable populations requiring Extracorporeal Membrane Oxygenation (ECMO) during the first quarter of 2020 may have predicted the SARS-Cov-2 pandemic in the United States.

Methods: We analyzed 5% Medicare claims from the first quarter of 2019 and 2020 (the latter being the pandemic year), pertaining specifically to Medicare Severity-Diagnosis Related Group (MS-DRG) codes for ECMO. Claims pertaining to ECMO and cardiology volume were analyzed by state, MS-DRG, and hospital. Association between case volume and in-hospital mortality was evaluated using Pearson's correlation and the change in mortality was calculated using Wilcoxon signed-rank test. Subgroup analyses were conducted for high prevalence MS-DRG codes.

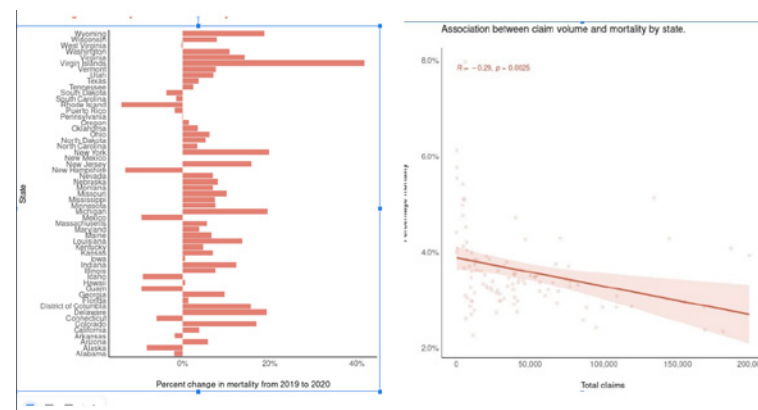


Figure: Percent change in mortality from 2019 to 2020 by state.

Results: The study cohort comprised 4,787,544 cases, 2,503,359 from 2019 and 2,284,185 for 2020, distributed across 306 hospitals. A total of 84 MS-DRGs procedures were performed. The overall mortality for our sample was 3.35% (160,532 deaths). Mortality rates increased by 7% between 2019 and 2020 ($p < 0.01$). New York state presented the largest increase in mortality (20%), while Rhode Island had the largest decrease (14%). States

with the highest volumes presented the lowest mortality rates ($r = -0.29$; $p < 0.01$). ECMO (MS-DRGs 003) was associated with the highest increase in mortality rate (from 16.4% to 22.4%, a 37% increase) between 2019 and 2020. In addition, high mortality increases between 2019 and 2020 were detected for pneumonia (33%).

Conclusion: During the first quarter of the 2020, there was an unprecedented excess mortality among patients undergoing ECMO or having pneumonia. Mortality was lower in centers with higher volumes. Sharing prospective data in real time may elicit trends predictive of pandemics and can better guide resource distribution in the future.

71. Diagnosing Sepsis After Cardiac Surgery: The Predictive Validity of the Systemic Inflammatory Response Syndrome, Quick Sepsis Related Organ Failure Assessment and New Early Warning Scores

Savannah Gysling¹, Selvaraj Shanmuganathan², Adam Szafrank², Edward J. Caruana³

¹University Hospitals of Derby and Burton, Derby, United Kingdom; ²Nottingham University Hospitals NHS Trust, Nottingham, United Kingdom; ³University Hospitals of Leicester NHS Trust, Leicester, United Kingdom

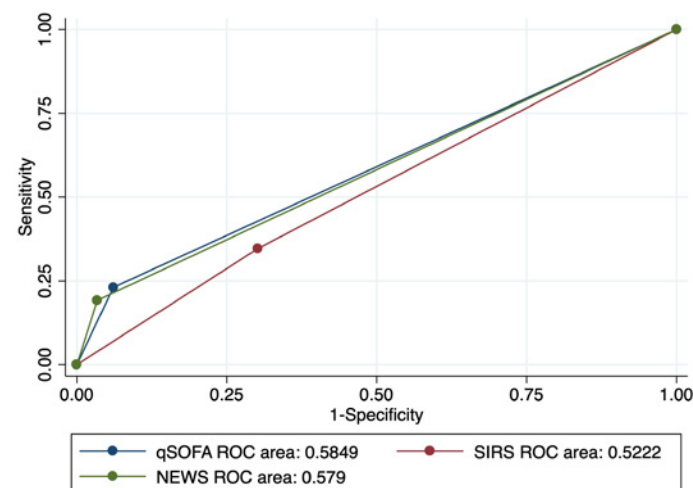
Invited Discussant: Keki Balsara

Objectives: ‘Sepsis 3’—the third international consensus definition of sepsis—was published in 2016. It recommended the replacement of ‘Systemic Inflammatory Response Syndrome’ (SIRS) with ‘quick Sepsis Related Organ Failure Assessment’ (qSOFA) as a bedside screening tool to identify patients with suspected infection who are at high risk of deterioration and poor outcome. The National Health Service (NHS) in the United Kingdom (UK) makes use of the National Early Warning Score (NEWS) 2 for this purpose. We sought to assess the predictive validity of the NEWS, SIRS and qSOFA scores in identifying post-operative, ward-level cardiac surgical patients at risk of poor short-term outcomes.

Methods: All adult patients who underwent cardiac surgery at our institution between November 2014 and October 2017 were identified from a prospectively-populated departmental database. Data for bedside observations, haematological parameters and microbiology test requests were obtained from electronic hospital records. Survival data was acquired from a national registry. Statistical analysis was performed in Stata[®] v14.

Results: 1,622 patients met the inclusion criteria. 1,189 (72%) were male, with an average age of 67 ± 11 years. The logistic euroSCORE was 7.2 ± 9.0 , with 1,048 (63%) elective and 541 (33%) emergency procedures. 67% of all patients were (1,114) screened for infection at some stage post-operatively. The overall mortality was 2.0% at 30 days and 3.1% at 90 days. NEWS, SIRS and qSOFA demonstrated a predictive accuracy of 95.3% (95% CI 94.1 to 96.3), 70.5% (68 to 73) and 92.7% (91.3 to 93.9) respectively for 30-day mortality; and of 94.5% (93.2 to 95.5), 70.8% (68.5 to 72.9) and 92.1% (90.7 to 93.4) at 90 days. Sensitivity was ubiquitously low, ranging from 14.6% to 39.2% across all scores.

Conclusions: Currently-available scoring systems show a low predictive validity in cardiac surgical patients; despite extensive validation in general surgical and medical cohorts.



72. Initiative Double Sleeve Lobectomy Is Superior in Left Upper Lobe Non-Small Cell Lung Cancer Patients with Severe Main Bronchus Invasion

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Shanghai Pulmonary Hospital, Shanghai, China

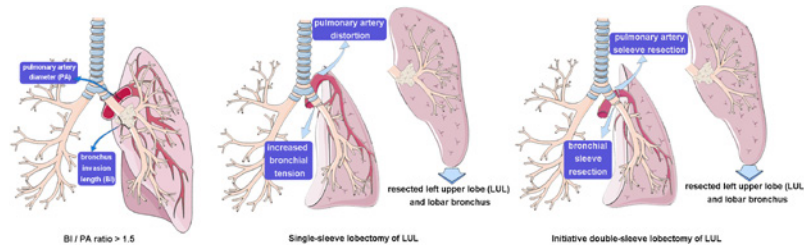
Invited Discussant: Enrico A. Rendina

Objective: Sleeve lobectomy is commonly used in advanced Non-small-cell lung cancer (NSCLC), including single sleeve lobectomy (SSL) and double sleeve lobectomy. However, increased bronchial tension or pulmonary artery distortion was usually noted in single sleeve lobectomy with severe bronchus invasion. This study aims to explore the prognostic factors for left upper lobe sleeve lobectomy, and evaluate the efficacy and safety of an “initiative double sleeve lobectomy (IDSL)” in left upper lobe NSCLC patients with only severe bronchus invasion.

Methods: A total of 812 patients of left upper lobe sleeve lobectomy in our institution from Apr 2014 to Jun 2020 were included in the study. Univariate and multivariate survival analysis were performed to assess the prognostic factors for the surgical results. In patients with severe main bronchus invasion (diagnostic criterion: bronchus invasion length/pulmonary artery diameter ≥ 1.5), IDSL was performed since Apr 2017 when surgeons were required to perform initiative pulmonary artery resection and anastomosis along with bronchus reconstruction, and the surgical outcomes were compared with SSL.

Results: In total, 166 cases (20%) were confirmed as left upper lobe sleeve lobectomy and included in data analysis. Complete resection was achieved in all patients. Univariate survival analysis showed that the prognosis of males ($P = 0.003$), squamous cell carcinoma ($P < 0.001$) and the full course postoperative adjuvant chemotherapy ($P < 0.001$) may benefit after underwent operation in long terms. The multivariate analysis showed that

the gender ($P = 0.038$) and pathological type ($P = 0.044$) were independent risk factors for postoperative recurrence. Of the 166 cases, 58 (35%) were diagnosed as severe main bronchus invasion according to the criterion, 26 of SSL and 32 of IDSL were performed respectively before and after Apr 2017. It was found that the IDSL patients had a shorter thoracic drainage time (days, the same below, 4.72 ± 0.89 vs 7.42 ± 5.52 , $P = 0.020$), post-operative hospital stays (5.44 ± 0.88 vs 7.35 ± 3.30 , $P = 0.008$) and fewer postoperative complications ($P = 0.031$), compared to those SSL patients. And there was no significant difference in overall survival time between two groups ($P = 0.242$).



Conclusions: Squamous cell carcinoma, non-N2 and male patients with locally advanced left upper lobe lung cancer had superior outcome. For patients with severe bronchial invasion, we first introduced an initiative double sleeve lobectomy with less postoperative complication and shorter postoperative hospital stay.

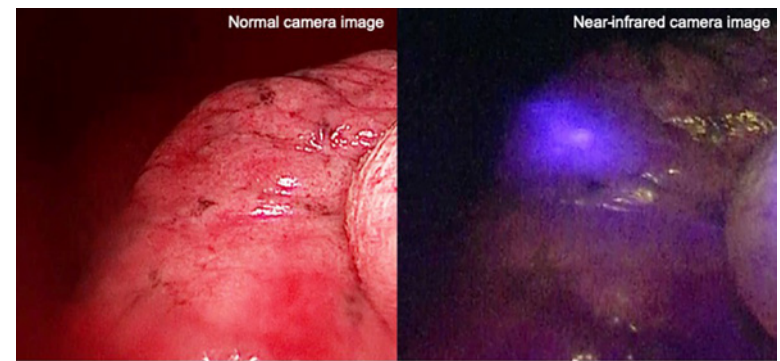
73. A New Sealing Test Method Using Indocyanine Green Aerosol

Naoya Yokota, Tetsuhiko Go, Noriyuki Misaki, Sung Soo Chang, Hiroyasu Yokomise
Kagawa University, Miki-cho, Kita-gun, Kagawa, Japan

Invited Discussant: Jules Lin

Objective: We developed a new sealing test method that involves the administration of aerosolized indocyanine green (ICG) into the airway. This study aims to confirm whether this method could identify air leak points caused by pulmonary resection surgery.

Methods: A total of 43 patients (36 video-assisted thoracoscopic surgeries [VATS] and seven thoracotomies) were included in this study. After pulmonary resection, a conventional sealing test was performed, and the ICG sealing test was performed thereafter. The first conventional sealing test was performed under continuous airway pressure of 20 cmH₂O to confirm the presence of air bubbles in the fluid. In the ICG sealing test, ICG aerosol was administered under intermittent ventilation at a maximum airway pressure of 20 cmH₂O. Using a pediatric jet nebulizer kit, 1 mL of 2.5 mg/mL aerosolized ICG solution was administered into the lungs through a catheter placed in the main bronchus on the surgical side. The fluorescent site was identified using a near-infrared thoracoscope under one-lung ventilation. The conventional sealing test was re-performed on the fluorescent sites where bubbles were not confirmed in the first conventional sealing test. The point where the bubbles were confirmed, including the re-performed conventional sealing test, was defined as the air leak point.



An air leak point identified with the ICG sealing test.
Bubbles were confirmed in the re-performed conventional sealing test.

Results: In VATS, 33 air leak points were identified, and the ICG sealing test and conventional sealing test were completely matched in 23 cases. Overlooked air leak points were identified in nine cases using the ICG sealing test in VATS. In thoracotomy, nine air leak points were identified, and each sealing test was completely matched in all cases. A total of 42 air leak points were confirmed, of which 32 points were identified with the conventional sealing test and 41 points with the ICG sealing test. The sensitivity of each test was 71.4% for the conventional sealing test and 97.6% for the ICG sealing test ($p = 0.002$). In the ICG sealing test, no air leaks were confirmed in five fluorescent sites (false positive), and one air leak point could not be identified (false negative). No complications attributable to ICG aerosol were encountered.

Conclusions: The ICG sealing test identified air leak points that were overlooked in the conventional sealing test. The ICG sealing test can be a valid test for the screening of air leak points compared to conventional sealing test. It is especially suitable for VATS, as it provides an optimal surgical view with a collapsed lung state.

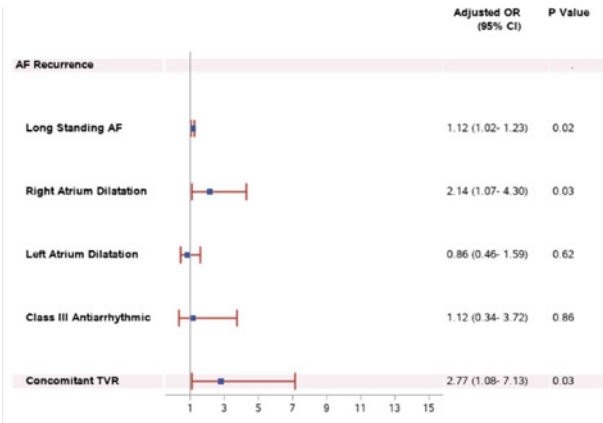
74. Predictors of Recurrent Atrial Fibrillation After Surgical Ablation

Charles F. Laurin¹, Emilia Bagiella², A. Marc Gillinov³, Samantha Raymond², Annetine C. Gelijns², Alan J. Moskowitz², Wendy Taddei-Peters⁴, Patrick T. O’Gara⁵, Eugene Blackstone³, Michael Argenziano⁶, Pierre Voisine¹
¹Institut Universitaire de Cardiologie et de Pneumologie de Québec (IUCPQ), Québec, QC, Canada; ²Icahn School of Medicine at Mount Sinai, New York, NY; ³Cleveland Clinic, Cleveland, OH; ⁴National Heart, Lung, and Blood Institute, Bethesda, MD; ⁵Brigham and Women’s Hospital, Boston, MA; ⁶Columbia University Medical Center, New York, NY

Invited Discussant: James Cox

Objectives: In an NIH-supported randomized trial of surgical ablation (n = 260) for persistent or longstanding persistent atrial fibrillation (AF) in patients undergoing mitral valve surgery the freedom from AF at one year was 63.2% in ablation patients compared to 29.4% in controls (p < 0.001). We analyzed preoperative factors associated with AF recurrence in surgical ablation patients.

Methods: AF recurrence was assessed using weekly transtelephonic monitoring (TTM) strips and 3-Day Holter monitoring at 6 and 12 months in patients undergoing either pulmonary-vein isolation or biatrial Maze (n = 133). Univariate analyses explored baseline factors and surgical approach, and multivariable logistic regression models were constructed. AF recurrence did not differ between lesion sets and, therefore, groups were combined.



Results: Mean age was 69.7 years, 42.9% were women, 5.3% had previous CABG, 15.0% previous PCI, and 10.5% used Class III antiarrhythmics. Figure 1 depicts the odds of AF recurrence, assessed by Holter or TTM (120/133). AF recurrence was associated with longer duration of preoperative AF (p = 0.02; 95% CI 1.02; 1.23), dilated right atrium (p = 0.03; 95% CI 1.07; 4.30) and tricuspid valve (TV) repair for moderate to severe tricuspid regurgitation (p = 0.03; 95% CI 1.08; 7.13). Left atrial size did not predict AF recurrence.

Conclusions: As in previous studies, longer AF duration was associated with AF recurrence after surgical ablation. AF recurrence was also higher among patients with a dilated right atrium or the need for TV repair, suggesting the importance of the right atrium in the pathogenesis of AF in mitral valve patients.

75. The Long-Term Impact of Postoperative Atrial Fibrillation After Cardiac Surgery

Valentino J. Bianco, Arman Kilic, Derek Serna-Gallegos, Edgar Aranda-Michel, Yisi Wang, Forozan Navid, Ibrahim Sultan
University of Pittsburgh Medical Center, Pittsburgh, PA

Invited Discussant: James R. Edgerton

Objective: Literature has reported worse in-hospital outcomes for patients with atrial fibrillation. The objective of the following study is to provide detailed results on the long-term impact of postoperative atrial fibrillation on morbidity and survival in cardiac surgery.

Methods: All patients undergoing open cardiac surgery were reviewed with the exclusion of preoperative atrial fibrillation or patients undergoing VAD, transplant, or Cox-Maze procedures. Propensity matching (1:1) was performed to ensure similar baseline characteristics. Multivariable Cox-regression analysis and competing risk regression identified associations with mortality and readmission, respectively.

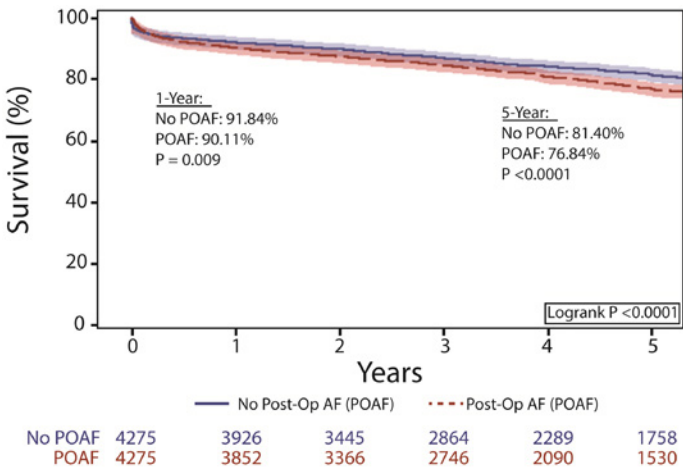


Figure: Survival is significantly improved for patients without POAF, at both 1-year (91.8% vs 90.1%; p = 0.009) and 5-years (81.4% vs 76.8%; p < 0.001).

Results: A total of 12,227 cardiac patients were divided into 7,927 (64.8%) patients without postoperative AF and 4,300 (35.2%) patients with new-onset postoperative AF (POAF). Propensity matching (1:1) yielded 4,275 risk-adjusted pairs. There was no difference between the POAF cohort and the cohort without POAF, regarding operative mortality [176 (4.12%) vs 197 (4.61%); p = 0.26] and stroke [118 (2.76%) vs 99 (2.32%); p = 0.191]. Patients with POAF had higher rates of reoperation [518 (12.12%) vs 292 (6.83%); p < 0.001], transfusion [1856 (43.42%) vs 1579 (36.94%); p < 0.001], sepsis [85 (1.99%) vs 34 (0.80%); p < 0.001], prolonged ventilation [679 (15.88%) vs 395 (9.24%); p < 0.001], pneumonia [282 (6.60%) vs 101 (2.36%); p < 0.001], renal failure [295 (6.90%) vs 144 (3.37%); p < 0.001], and new onset dialysis [211 (4.94%) vs 89 (2.08%); p < 0.001]. The POAF cohort had significantly higher incidence of AF on follow-up [502 (11.74%) vs 203 (4.75%); p <

0.001]. On Kaplan-Meier estimates, survival is significantly improved for patients without POAF, at both 1-year (91.8% vs 90.1%; $p = 0.009$) and 5-years (81.4% vs 76.8%; $p < 0.001$) (Figure). Postoperative atrial fibrillation was an independent predictor of mortality [HR 1.22 (1.12, 1.33); $p < 0.001$], all-cause readmissions [HR 1.07 (1.01, 1.14); $p = 0.016$] and heart failure-specific readmission [HR 1.14 (1.04, 0.01); $p = 0.007$].

Conclusions: Patients who developed POAF had worse perioperative morbidity, lower survival, and more readmissions for heart failure on long-term follow-up, compared to patients without AF.

76. To Bentall, or Not to Bentall, That Is the Question

Busra Cangu, Kevin L. Greason, Vishal Khullar, Arman Arghami, Gabor Bagameri, Prasad Krishnan, Phillip Rowse, Juan A. Crestanello, Richard C. Daly, Joseph A. Dearani, Alberto Pochettino, John M. Stulak, Hartzell V. Schaff
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Invited Discussant: Mohamed Ezani Md Taib

Objective: There is controversy on how to address mild aortic root dilation during concomitant aortic valve replacement (AVR): composite aortic valve conduit replacement (CAVC) versus separate aorta-aortic valve replacement (SAAV). We reviewed our experience to address the issue.

Methods: We retrospectively reviewed 778 adult patients with aortic root diameter 55 mm or less who received combined ascending aorta and AVR from January 1994 through June 2017. We excluded patients with endocarditis. Patients were divided into two groups based on type of aortic root intervention: CAVC was done in 406 patients (52%, CAVC group) and SAAV was done in 372 (48%, SAAV group). Multivariable analysis was used to assess for differences between the two groups in operative mortality, additional aorta/cardiac operation, and long-term mortality. The change in sinus of Valsalva (SoV) diameter was calculated based on the difference between the last pre- and postoperative echocardiograms in the SAAV group.

Results: Median patient age was 63 years (Interquartile range 53–70), valve was bicuspid in 489 patients (63%), and Sinus of Valsalva diameter was 43 mm (39–47). Concomitant cardiac operations were performed in 88 patients (24%) in the SAAV group and in 84 (21%) in the CAVC group ($P = 0.319$). Operative mortality occurred in 18 patients (2.3%), and in only 3 (1.4%) operated with isolated SAAV ($n = 208$). Median duration of follow-up was 7.0 years (3.8–11.5) during which 47 patients (6.2%) received an additional aorta/cardiac operation and 161 died (21%). Multivariable analysis demonstrated similar risk of operative mortality (SAAV group: OR 0.96; 95% CI 0.36–2.52; $P = 0.928$), additional aorta/cardiac operation (SAAV group: RR 1.11; 95% CI 0.56–2.24; $P = 0.757$), and long-term mortality (SAAV group: RR 1.09, 95% CI 0.75–1.59; $P = 0.646$). The change in SoV diameter measurement was minus 2 mm (minus 4–0) at a median follow-up of 3.1 years (0.9–6.5).

Conclusions: In patients with mild aortic root dilation, separate aorta-aortic valve replacement and composite aortic valve conduit replacement can be done with low operative mortality. Separate aorta-aortic valve replacement results in similar long-term risk of additional aorta/cardiac operation and mortality in comparison to composite aortic valve replacement. Separate aorta-aortic valve replacement is not associated with subsequent aortic root dilation on medium-term follow-up.

77. Open Proximal Aortic Aneurysm Repair in Contemporary Era

Tsuyoshi Yamabe¹, Yanling Zhao¹, Casidhe-Nicole R. Bethancourt², Christian A. Pearsall², Ilya Kim², Diane Hu², Joshua Bergsohn¹, Paul A. Kurlansky¹, Virendra Patel¹, Isaac George¹, Craig R. Smith¹, Hiroo Takayama¹

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Invited Discussant: Maral Ouzounian

Objective: As open repair of proximal aortic aneurysm is commonly performed with lower mortality rate, patients are increasingly interested in fast postoperative recovery, avoiding any complications. We investigated the likelihood of “uneventful recovery” after open proximal aortic aneurysm repair in the contemporary era. Influence of extent of aortic resection was also investigated.

Methods: This is a single-center retrospective study of 1132 patients with aortic aneurysm who underwent graft replacement of proximal aorta, defined as aortic segment from the aortic root to the aortic arch (Zone 0 to 4). Patients who had aortic dissection, infective endocarditis, needed urgent/emergent surgery or concomitant surgery other than aortic valve replacement (AVR) were excluded. The patients were divided into 4 groups based on the extent of the aortic replacement: isolated ascending aortic replacement (ASC, $n = 52$); ascending aortic replacement with distal extension either with hemiarch, partial arch or total arch replacement (DST, $n = 126$); ascending aortic replacement with proximal extension with AVR or root replacement (PRX, $n = 620$); ascending aortic replacement with distal and proximal extension (D+P, $n = 334$). Achieving “uneventful recovery” was used as the primary end point. Uneventful recovery is defined as avoidance of any of the following postoperative complications, including 30-day mortality, stroke, re-exploration for bleeding, respiratory failure, acute renal failure, deep sternal wound infection, post-cardiotomy shock and permanent pacemaker implantation. Our previous study in aortic root replacement showed that uneventful recovery was associated with better long-term outcomes. For comparison of the end point among the procedures, odds ratios for inability to achieve uneventful recovery in each procedure were calculated using ASC as a reference. Differences of patient characteristics were adjusted by entering variables with $p < 0.1$ in univariate analyses into the model.

Results: Overall in-hospital mortality and stroke were low with a total of 18 (1.6%) mortalities and 29 (2.6%) strokes among 1132 patients. Uneventful recovery was achieved in 80.2%. It occurred in 86.5% in ASC, 63.5% in DST, 83.4% in PRX, and 79.6% in D+P, respectively ($p < .001$). With ASC as the reference, the risk adjusted odds ratios for inability to achieve uneventful recovery were 7.9 [95% CI, 2.0–53.4] in DST, 2.3 [95% CI, 0.6–15.4] in PRX, and 2.7 [95% CI, 0.7–18.4] in D+P. A multivariable logistic regression revealed DST was an independent risk factor of inability to achieve uneventful recovery.

In-hospital outcomes and 30-day mortality	Overall (n=1132)	ASC (n=52)	DST (n=126)	PRX (n=620)	D + P (n=334)	P value
Uneventful recovery	902 (80.2)	45 (86.5)	80 (63.5)	517 (83.4)	266 (79.6)	<.001
In-hospital mortality	18 (1.6)	1 (1.9)	5 (4.0)	4 (0.6)	8 (2.4)	<.001
30-day mortality	19 (1.7)	1 (1.9)	5 (4.0)	5 (0.8)	8 (2.4)	.001
Stroke	29 (2.6)	1 (1.9)	12 (9.5)	7 (1.1)	9 (2.7)	<.001
Re-exploration for bleeding	48 (4.2)	2 (3.8)	3 (2.4)	19 (3.1)	24 (7.2)	.016
Respiratory failure	87 (7.7)	3 (5.8)	30 (23.8)	26 (4.2)	28 (8.4)	<.001
Acute renal failure	69 (6.1)	1 (1.9)	9 (7.1)	41 (6.6)	18 (5.4)	.493
Post-cardiotomy shock	13 (1.1)	1 (1.9)	2 (1.6)	6 (1.0)	4 (1.2)	.879
Deep sternal wound infection	12 (1.1)	0	2 (1.6)	5 (0.8)	5 (1.5)	.598
Permanent PM implantation	51 (4.5)	0	3 (2.4)	29 (4.7)	19 (5.7)	.179

Conclusions: This study confirms excellent outcomes of proximal aneurysm repair in the contemporary era. Distal extension of the repair was associated with less likelihood of uneventful recovery. Our data help preoperative surgical planning especially when the aortic arch is only modestly dilated.

78. Towards an Aortic Risk Calculator: Using Machine Learning to Predict Adverse Ascending Aortic Events

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Invited Discussant: Yuichi Ueda

Objective: Use machine learning models to predict adverse events for patients with dilated ascending aortas in order to improve upon diameter-based surgical intervention criteria.

Methods: Retrospective clinical, radiological, and long-term follow-up data was collected from 2485 patients at our institution with ascending aortic aneurysms. Missing data was imputed using multivariate imputation by chained equations (MICE). Six machine learning

classifiers were trained to predict three outcomes: type A dissection, an aortic specific composite endpoint of type A dissection, ascending rupture, and ascending-aortic related death, and an all-cause composite endpoint of type A dissection, ascending rupture, and all-cause mortality. The risk of each outcome within 1, 2, and 5 years was estimated, resulting in 9 predictions per classifier. In order to account for censoring due to loss to follow up or prophylactic ascending aortic repair, inverse probability of censoring weighting (IPCW) was used while training models. Classifier performance was assessed using Harrel's c-index.

Results: Machine learning classifier that used 29 clinical variables as inputs were trained using a 1988 patient training set and the outputted the probabilities of adverse event for a 497 patient test set. An elastic net model performed best across nearly all endpoints on the test set, achieving a c-index of 0.750–0.803 for type A dissections, 0.747–0.794 for aortic specific composite endpoints, and 0.719–0.775 for all-cause composite endpoints. These models outperformed ascending aortic diameter alone to prognosticate outcomes as well as two indexed diameter measures, aortic height index (diameter/height) and aortic size index (diameter/body surface area). Feature importance analysis revealed that while ascending aortic diameter remained the most important covariate when predicting outcomes, other variables such as hypertension, family history of aortic aneurysms, and diabetes mellitus also contributed to predicting adverse events.

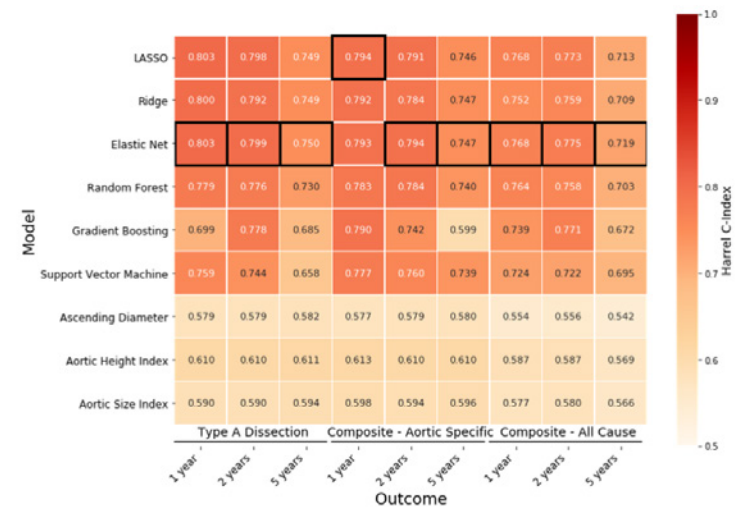


Figure 1. Machine learning model performance across the three outcomes specified as measured by Harrel's c-index. An elastic net model performed best across nearly all endpoints and outperformed sized-based prognostication metrics such as ascending diameter.

Conclusions: These machine learning models provide surgeons with a better tool to prognosticate high risk ascending aortic aneurysm patients across a variety of endpoints and outcomes, outperforming size based metrics.

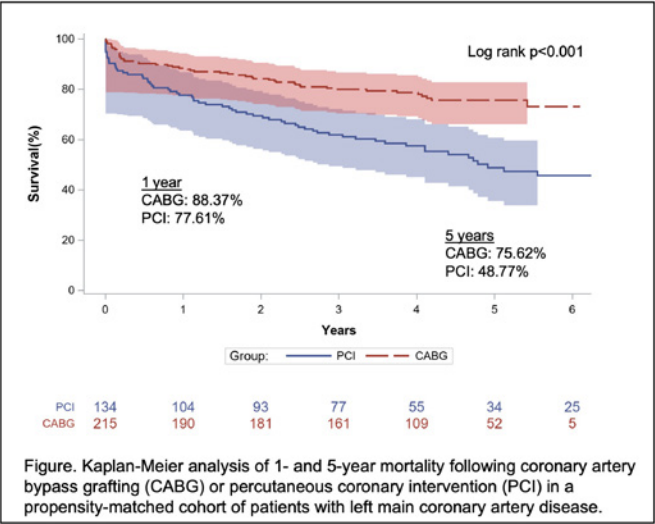
79. Real-World, Propensity-Matched Analysis of Surgical versus Percutaneous Revascularization for Left Main Coronary Disease

Lauren V. Huckaby, Ibrahim Sultan, Francis D. Ferdinand, Suresh Mulukutla, Saloni Kapoor, Floyd Thoma, Yisi Wang, Arman Kilic
University of Pittsburgh, Pittsburgh, PA

Invited Discussant: David Kandzari

Objective: Percutaneous coronary intervention (PCI) is being performed more frequently for left main coronary artery disease (LMCAD). This study evaluated a real-world propensity-matched analysis of surgical versus percutaneous revascularization for LMCAD.

Methods: Adults (≥18 years) at a single academic institution undergoing coronary artery bypass grafting (CABG) or PCI for left main stenosis ≥50% between 2010–2018 were examined. Baseline characteristics were explored. Greedy propensity-matching techniques were used to generate well-matched CABG and PCI patients in a 2:1 ratio, and Kaplan-Meier analysis was used to compare unadjusted survival between matched cohorts. Multivariable Cox proportional hazards models were created for 5-year mortality and major adverse cardiac and cerebrovascular events (MACCE), the latter representing a composite of mortality, stroke, myocardial infarction (MI), or repeat revascularization.



Results: 1091 with LMCAD were identified (898 CABG, 193 PCI). Patients undergoing PCI were significantly older (77 vs 68 years, $p < 0.001$), more likely to be female (36.79% vs 24.72%, $p = 0.001$), more likely to have heart failure (26.94% vs 13.14%, $p < 0.001$), and were less likely to have 3-vessel disease (42.49% vs 65.59%, $p < 0.001$). Propensity-matching yielded 215 CABG and 134 PCI well-matched patients. Society of Thoracic Surgeons predicted risk of mortality (CABG 2.2% vs PCI 2.9%; $p = 0.098$) and composite mortality/morbidity (CABG 18.1% vs PCI 16.5%; $p = 0.483$) were similar after matching. In the matched analysis, 1-year (77.61% vs 88.37%) and 5-year (48.77% vs 75.62%) survival were lower with PCI (Figure). Rates of MACCE at 5-years were also higher with PCI (64.93% vs 32.56%,

$p < 0.001$). Individual rates of both MI (19.40% vs 7.44%, $p = 0.001$) and repeat revascularization (26.12% vs 7.91%, $p < 0.001$) were higher with PCI, with similar rates of stroke (4.48% vs 2.79%, $p = 0.400$). Following risk adjustment, CABG remained associated with reduced risk of mortality (HR 0.40, 95% CI 0.29–0.54; $p < 0.001$) and MACCE (HR 0.37, 95% CI 0.28–0.48; $p < 0.001$) at 5 years. In adjusted competing risks analysis, CABG was also associated with lower rates of hospital readmission (HR 0.76, 95% CI 0.59–0.98; $p = 0.030$).

Conclusions: This real-world, propensity-matched analysis demonstrates substantial advantages in survival, MACCE, and readmission with CABG as compared to PCI for LMCAD, supporting surgical revascularization in this clinical setting in appropriate operative candidates.

80. A Novell Intra-Pericardial Pulsatile Device for Individualized, Biventricular Circulatory Support Without Direct Blood Contact—The Impact of Electro-Mechanical Synchronization

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Invited Discussant: David D. Yuh

Objective: There is an unmet clinical need for heart failure patients, with or without ventricular dyssynchrony, for a device which provides biventricular mechanical support without blood contact. Here we present *in vivo* pre-clinical functional data acquired from a novel MCS device which can be implanted rapidly and safely around the beating heart. The main features include rate-adaptive, biventricular support based on electro-mechanical synchronization in real-time using R and T-wave recognition.

Methods: The functional implant surrounding both ventricles consist of three inflatable cushions and six epicardial electrodes. A portable driver analyses the ECG signals in real-time and provides pneumatic power to the inflatable cushions on the epicardial surface. In seven pigs (weight range: 50–80 kg), ECG-signals were analysed acutely (under β -blockade, $n = 5$) and in 30-day survival model ($n = 2$). Intracardiac pressures, aortic and pulmonary blood flow recordings allowed determination of LV and RV stroke work (SW) and stroke volume (SV) at three levels of support. The presented haemodynamic improvements were achieved using pneumatic support pressures of up to 60 mmHg. Epicardial ECG-signals, acquired by the device, were continuously analysed thereby allowing real-time systolic and diastolic synchronization of mechanical support.

Results: Three levels of biventricular support resulted in progressive improvements in cardiac hemodynamics (Table). Comparing clinical annotations (reference) to automatic algorithm annotations within a predefined, tight and specific time-window, revealed a 100% R-wave and 99.58% T-wave recognition accuracy, respectively (Table). This resulted in precise mechanical synchronization of the device with each cardiac cycle in real-time. Long-term survival after implantation of the device over a 30-day period demonstrated safety and showed clear and stable ECG signal detection over time.

Support Level	HR	LV SW	RV SW	LV SV	RV SV	ECG recognition		
Baseline	76.8 ± 8.9 bpm	2681.7 ± 1033.5 mmHg.ml	1321.7 ± 697.5 mmHg.ml	36.8 ± 10.9 ml	43.3 ± 16.1 ml	n = 5576 heart cycles		
%: compared to baseline, in healthy animals *: p<.05, **: p<.01						Accuracy [clinical annotation vs.]	R-wave [±20 ms]	T-wave [-20/+80 ms]
1	75.4 ± 9.3 bpm	8.3 ± 6.6 % **	8.5 ± 5.8 % **	4.0 ± 2.9 % **	2.9 ± 2.9 % **	sensitivity	100.00 %	99.58 %
2	78.0 ± 8.0 bpm	17.2 ± 13.4 % **	13.6 ± 9.3 % **	8.0 ± 4.9 % **	5.6 ± 4.7 % **	positive predictive value	100.00 %	99.79 %
3	79.8 ± 9.0 bpm	25.2 ± 6.6 % **	15.4 ± 5.6 % *	12.4 ± 4.0 % **	6.2 ± 3.2 % **			

Conclusion: Precise synchronisation of the device and cardiac heart cycle using a novel real-time epicardial R and T-wave recognition method provides rate-adaptive improvement of biventricular cardiac hemodynamics without blood contact. This is a novel, less complex treatment strategy in heart failure patients.

81. Biomechanical Engineering Analysis of Standard Interrupted, Running, and Loop Neochord Mitral Valve Repair Techniques

Mateo Marin-Cuarteras^{1,2}, Annabel M. Imbrie-Moore^{1,3}, Yuanjia Zhu^{1,4}, Matthew H. Park^{1,3}, Robert Wilkerson¹, Michael A. Borger², Y. Joseph Woo^{1,4}

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Invited Discussant: Matthew A. Romano

Objective: Numerous neochord techniques for mitral valve (MV) repair have been described. However, no strong biomechanical data is available that supports the use of one technique over another. Superior biomechanical neochord performance translates into less long-term accumulated stress-related damage and greater MV repair durability. The aim of this study was to evaluate the tensile strength of the most common neochord techniques and sutures in order to identify the neochord technique biomechanically most resistant to rupture.

Methods: Several types of neochord techniques (i.e., standard interrupted neochords, continuous “running” neochords and “loop technique”), different number of neochords, and neochord suture sizes (i.e., polytetrafluoroethylene [PTFE] 3-0 to 6-0) were compared. Additionally, the leaflet attachment of the loop technique with either polypropylene (5-0) or PTFE (5-0) was also compared. To perform the tests, both ends of the neochords were attached to two 3D-printed fixtures, one representing the papillary muscle (PM) and the other one representing the MV leaflet. The fixtures were then loaded in a tensile force analysis machine (Instron 5848 Microtester, Norwood, MA). During the test,

the machine applied tension to both opposing fixtures (Figure 1A) until ultimate failure (i.e., rupture) of the neochord was achieved. A tensile force profile was obtained. The tests were performed 3 times for each type of neochord technique and averaged for statistical analysis. All neochords had a length of 16 mm. Comparison of the measured forces was performed by means of Student’s T-test and two-way ANOVA analyses.

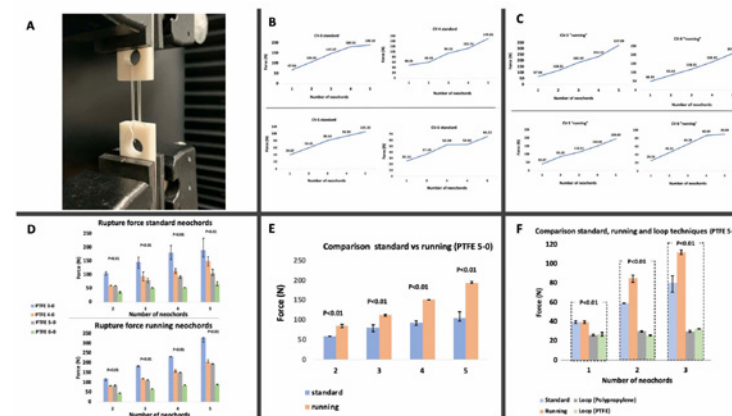


Figure 1 (A) Tensile test of the standard neochord technique (in this example: two standard interrupted sutures). (B – C) Progressive increase of the rupture force with greater numbers of neochords for PTFE 3-0 to 6-0 suture sizes (B: standard technique; C: running technique). (D) Progressive increase of the rupture force with thicker suture sizes for the standard and running neochords. (E) Comparison of standard vs running neochords (PTFE 5-0): Rupture forces were significantly higher for running than for standard neochords. This significant statistical difference was also observed in all other suture sizes (PTFE 3-0 to 6-0). (F) Comparison of standard, running and loop neochord techniques (PTFE 5-0): Rupture forces are significantly lower for the loop technique (independently of suture type for leaflet attachment, i.e. PTFE (5-0) or polypropylene (5-0)) compared to those of standard and running neochords. N: Newton; PTFE: Polytetrafluoroethylene.

Results: For both running and standard neochords, a greater number of neochords (Figure 1B-C) as well as a thicker suture size significantly increased the neochordal rupture force (Figure 1D). Rupture force was significantly higher for running neochords in comparison to standard neochords (Figure 1E). However, a single failure in the running technique resulted in failure of the complete neochord system, due to the lack of redundant independent neochords. The rupture point of the neochords for 100% of the specimens occurred immediately adjacent to the knot for both running and standard techniques. The loop technique ruptured at significantly lower forces compared to standard and running neochords (Figure 1F) due to failure of the leaflet attachment suture (33%) or suture rupture immediately adjacent to the knots on the bottom of the loop (66%). Increasing the number of loops (i.e., one, two or three loops) did not have significant influence on the rupture force.

Conclusions: The running neochord technique has the best biomechanical performance. More than one independent set of multiple running neochords (i.e., >2 independent sets of multiple running neochords in each set) have a higher resistance to rupture, which clinically translates into improved MV repair durability.

82. Tailored Strategy to Match Anatomy and Physiology with Intervention Can Improve Outcomes of Symptomatic Neonates with Ebstein Anomaly and Tricuspid Valve Dysplasia

Christian Pizarro, Majeed Bhat, Deborah Davis, Daniel Duncan, Glenn Pelletier, Claude Beaty, Paul Anisman, Gina Baffa
Alfred I duPont Hospital for Children, Wilmington, DE

Invited Discussant: Richard G. Ohye

Objective: Neonatal presentation of Ebstein anomaly (EA) and tricuspid valve dysplasia (TVD) represents the most severe clinical form of these conditions. Despite significant advances in surgical technique and perioperative care, operative mortality remains high and the decision between management options is difficult. We review our experience with a strategy aimed to match physiology with intervention in order to decrease operative mortality.

Methods: Review of all patients with fetal or neonatal diagnosis of EA and TVD referred to a single center between 2007 and 2020. Clinical data was collected prospectively and abstracted from the electronic medical record.

Results: Among 21 patients (17 EA & 3 TVD) 11 underwent surgical intervention in the newborn period. Most common form of presentation included cyanosis and heart failure 11/11, end organ dysfunction 8/11 and maldistribution of cardiac output in 7/11. Median age at surgery was 10 days (1–30) and median weight 2.7 Kgs (1.8–4.0). Only 2/11 had antegrade pulmonary blood flow and 3/11 had anatomic pulmonary atresia. 8/11 patients received PGE1. Associated conditions included significant pulmonary regurgitation in 7/11, atrial tachyarrhythmia in 4 and a VSD in 3. Chromosomal anomalies were present in 4 patients. All patients exhibited a cardiothoracic ratio greater than 0.8 and a GOS Score greater than 1.1. Six patients underwent initial stabilization with pulmonary valve occlusion with or without bilateral pulmonary artery banding, including one who received ECMO support preoperatively. Six patients underwent biventricular repair (Cone in 5) with conversion to RV exclusion in 2. Five other patients underwent Starnes procedure and a systemic to pulmonary artery shunt as originally intended. One patient received ECMO following acute decompensation secondary to cardiac arrhythmia. Median duration of mechanical ventilation and ICU stay were 9 days (5–37) and 30 days (11–100) respectively. Operative mortality was 1/11. At median follow up of 130 months (5–146), there is 1 non-cardiac late death and survivors remain in functional class I and free of valvular reintervention.

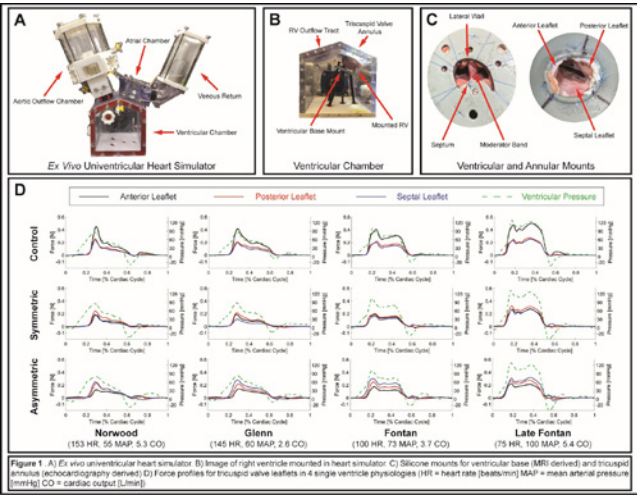
Conclusions: In the contemporary era symptomatic neonates with EA and TVD can be effectively managed with good outcomes. Preoperative stabilization and choice of management pathway based on anatomy and physiology can help reduce morbidity and mortality. New risk stratification predictors need to be developed.

83. Force Profiles of Single Ventricle Atrioventricular Leaflets in Response to Annular Dilation

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Invited Discussant: Tain-Yen Hsia

Purpose: Atrioventricular (AV) valve insufficiency in single ventricle physiology (SVP) is associated with increased risk of Fontan failure, morbidity, and mortality. Annular dilation causing functional regurgitation is a common finding in valves undergoing surgical repair. This dilation is often not symmetric, with the anterior and posterior leaflet dilating more than the septal. We sought to understand how the forces on the leaflets change in response to annular dilation.



Methods: Explanted fetal bovine tricuspid valves were sutured onto echo-derived custom annuli (Figure 1C). Control valves (CV) were secured to the appropriate size annulus whereas the experimental arms were upsized by an average of 11%. In the symmetric dilation (SD) model, the dilation was distributed equally across all three leaflets. In the asymmetric dilation (AD) model, the radial distance of the septal leaflet was preserved and the dilation was distributed proportionately between the anterior and posterior leaflets. The specimens were secured onto a custom MRI-derived ventricular mounts and placed in a previously validated univentricular heart simulator (Figure 1A-B). Leaflet forces were measured using optical strain sensors (fiber Bragg grating) sutured to each leaflet edge. The valve was then subjected to the typical systemic flows and pressures seen at Norwood, Glenn, early Fontan, and late Fontan stages. Statistical significance was determined using ANOVA and Tukey's HSD test.

Results: A total of 10 CV, 6 SD, and 7 AD specimens underwent testing. Amongst CV, the anterior leaflets had a significantly higher average force compared to the posterior (0.23 N vs 0.13 N, $p < 10^{-6}$) and septal leaflets (0.23 N vs 0.11 N, $p < 10^{-7}$). With dilation, average force in the anterior leaflet was significantly lower in both SD (0.11 N vs 0.23 N, $p < 10^{-6}$) and AD (0.09 N vs 0.23 N, $p < 10^{-7}$) relative to CV. Average force on the posterior leaflet remained constant in all models (CV: 0.13 N, SD: 0.13 N, AD: 0.13 N). Average forces in the septal leaflet were not significantly different in AD (0.16 N vs 0.10 N, $p = 0.23$) and SD (0.096 N vs 0.102 N, $p = 0.99$) relative to controls. However, the AD average force in the septal leaflet was significantly different compared to SD (0.16 N vs 0.096 N, $p = 0.03$). Force profiles at each physiology mirrored these aggregate findings (Figure 1D). Pressure and flow tracings demonstrated no significant regurgitation.

Conclusions: In a non-dilated annulus, the anterior leaflet experiences the largest force in all single ventricle physiologies. This difference is decreased in the setting of both symmetric and asymmetric annular dilation. The septal leaflet experienced a larger force in the AD model. These results suggest a redistribution of forces in the setting of dilation. Future studies mapping the force distribution and those modeling other AV pathologies can further our biomechanical understanding of SVP.

84. Prosthesis-Patient Mismatch Due to Somatic Growth After Mechanical Mitral Valve Replacement in Small Children: Predictor and Outcomes of Reoperation

Yuji Nakamura¹, Hoashi Takaya¹, Motoki Komori¹, Naoki Okuda¹, Kenta Imai¹, Kenichi Kurosaki², Isao Shiraishi², Hajime Ichikawa¹

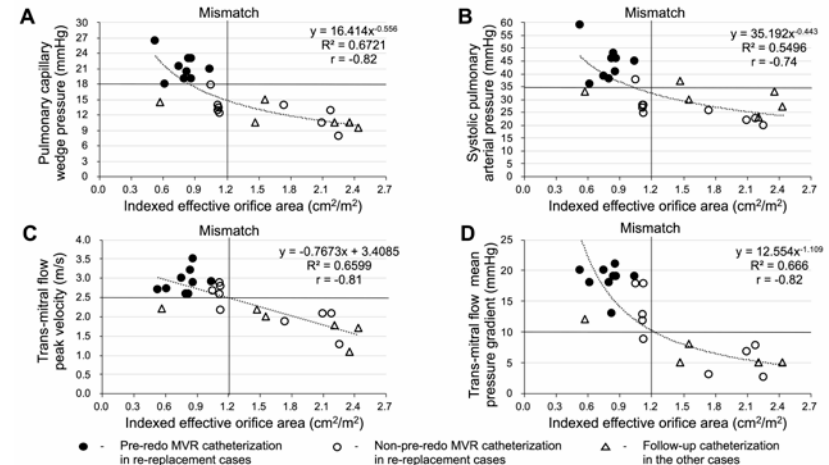
¹Department of Pediatric Cardiovascular Surgery, National Cerebral and Cardiovascular Center, Suita, Osaka, Japan; ²Department of Pediatric Cardiology, National Cerebral and Cardiovascular Center, Suita, Osaka, Japan

Invited Discussant: Christopher A. Caldarone

Objective: To establish the predictor of inevitable prosthesis-patient mismatch (PPM) as a result of somatic growth after mechanical mitral valve replacement (MVR) using small prostheses in early childhood and to evaluate the outcomes of redo MVR for PPM.

Methods: Of 27 patients undergoing initial MVR between 1999 and 2018 using the small-est commercially available mechanical prosthesis, the 16-mm ATS Advanced Performance valve, 15 patients without obstructive left heart lesions other than mitral valve, who received follow-up catheterization, were enrolled. The primary diagnoses were acute mitral regurgitation (MR) due to ruptured chorda tendineae in 10 patients, congenital MR concomitant with ventricular septal defect in 2, isolated congenital MR in 2 and post repair of complete atrioventricular septal defect in 1. The median age and body weight at initial MVR was 4.9 months (interquartile range [IQR]: 6.6, 3.6), and 5.9 kg (IQR: 7.3, 5.0). A total of 28 follow-up catheterizations were performed, as well as trans-thoracic echocardiogram. Nine patients underwent redo MVR for PPM at the median duration from initial MVR of 10.0 years (IQR: 11.9, 9.2). No patient developed excessive pannus formation except for one. Firstly, correlations between hemodynamic indices measured by catheterization or trans-thoracic echocardiogram and the indexed effective orifice area (iEOA) calculated with Gorlin formula in catheterization were assessed. Secondly, the outcomes of nine redo MVR patients were reviewed. Follow-up was completed in 90% of patients and mean follow-up period was 8.8 ± 4.4 years (max, 16.1 years).

Results: The iEOA was strongly correlated with pulmonary capillary wedge pressure ($r = -0.82$) and systolic pulmonary arterial pressure ($r = -0.74$) measured by catheterization, and also trans-mitral flow peak velocity ($r = -0.81$) and trans-mitral flow mean pressure gradient ($r = -0.82$) measured by trans-thoracic echocardiogram (Figure). Regarding pre-redo MVR catheterization, the iEOA was less than $1.2 \text{ cm}^2/\text{m}^2$, pulmonary capillary wedge pressure was over 18 mmHg, systolic pulmonary arterial pressure was over 35 mmHg, trans-mitral flow peak velocity was over 2.5 m/s, and trans-mitral flow mean pressure gradient was over 10 mmHg in all nine patients (Figure). All patients survived after redo MVR, and 20 or 21 mm of mechanical prosthesis could be implanted newly with mean valve size increase of 4.1 ± 0.3 mm. No patient required permanent pacemaker implantation newly. During the mean follow-up period from redo MVR of 1.6 years (max, 7.3 years), no patient underwent re-redo MVR.



Conclusion: The iEOA of small mechanical mitral prosthesis implanted during early childhood was well correlated with various hemodynamic indices, and PPM was encountered when iEOA decreased to $1.2 \text{ cm}^2/\text{m}^2$, as with adult patients. Late redo MVR for PPM could be performed safely with mean valve size increase of 4.1 ± 0.3 mm.

85. Contemporary Outcome After Pulmonary Artery Banding in Complete Atrioventricular Septal Defect: How the Band Tightness Affect the Outcome?

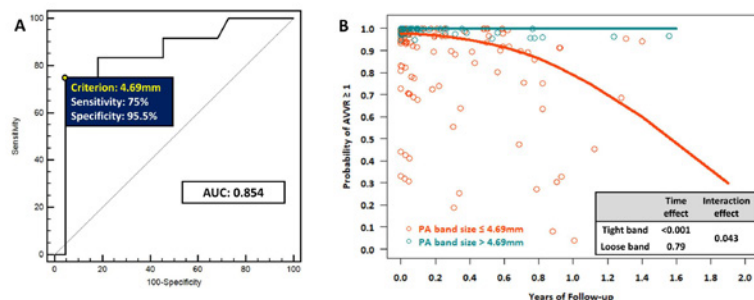
Mi Jin Kim, Seulgi Cha, Jae Suk Baek, Eun Seok Choi, Bo Sang Kwon, Tae-Jin Yun, Chun Soo Park

Asan Medical Center, Seoul, Republic of Korea

Invited Discussant: Paul J. Chai

Objective: Pulmonary artery banding remains a surgical option for patients with complete atrioventricular septal defect presenting earlier. This study investigated the outcomes after pulmonary artery banding in patients with complete atrioventricular septal defect.

Methods: From 2000 through 2019, a total of 34 infants who underwent pulmonary artery banding for early presenting complete atrioventricular septal defect were included in this study. Preoperative and operative characteristics were analyzed as independent variables for identifying factors associated with adverse outcome, which was defined as prolonged stay in the intensive care unit (>10 days) or in-hospital death, using multiple logistic regression model. Receiver operating characteristic analysis was performed to identify a threshold band tightness for adverse outcome. The change with time in the level of B-type natriuretic peptide was analyzed using linear mixed model, and the change with time in grade of atrioventricular valve regurgitation was analyzed using mixed-effects ordinal logistic regression.



Results: The median age and weight were 43 days (IQR, 22-64 days) and 3.6 kg (IQR, 2.7-4.1 kg), respectively. There were 4 early death including 3 in-hospital deaths. Median intensive care unit stay and hospital stay were 8 days (6-14 days), and 14 days (9-22 days), respectively. Twenty-six patients (26/30, 87%) underwent corrective surgery at a median of 337 days after pulmonary artery banding. In multivariable logistic regression analysis, pulmonary artery band size was identified as an independent factor associated with adverse outcome (OR 4.530, 95% CI 1.008-20.360; $p = 0.049$). Receiver operating characteristic analysis indicated 4.7 mm in diameter measured by echocardiography during immediate postoperative period as a threshold band tightness for adverse outcome (AUC 0.854, 95% CI 0.705-1.000, $p < 0.001$) (Figure 1A). The level of B-type natriuretic peptide similarly decreased after pulmonary artery banding regardless of band tightness, although the probability of worsening in atrioventricular valve regurgitation was decreased in patients with tighter band ($p = 0.043$) (Figure 1B).

Conclusions: Pulmonary artery banding is a viable option for patients with early presenting complete atrioventricular septal defect. Tighter band might be beneficial for early postoperative outcomes and preventing progression of atrioventricular valve regurgitation.

86. Peri-Operative Outcomes Following Esophagectomy Between Older and Younger Adults with Esophageal Cancer

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Invited Discussant: Joshua R. Sonett

Objective: Older patients fear esophagectomy produces permanent disability and nursing home placement. We investigated this hypothesis in a cohort of patients with esophageal cancer who underwent an esophagectomy.

Methods: Single institution retrospective analysis of all patients treated for esophageal cancer with esophagectomy from 2005-2020. Differences in outcomes were stratified according to 3 age groups: <70, 70-79, ≥80 years old.

Results: Of 1135 patients, 789 patients were <70 years (69.5%), 294 were 70-79 years (25.9%), and 52 were ≥80 years (4.6%). We define older adults as ≥70 years. Baseline characteristics were similar aside from CAD, HTN, smoking history, and higher albumin, lower ECOG scores and higher rates of neoadjuvant therapy (83.8% (663/789) vs 75.5% (225/294) vs 65.4% (34/52) respectively) which were more prevalent in the youngest age group (all $p < 0.05$).

There was no age association with tumor characteristics or operative techniques (all $p > 0.05$) except lower rates of positive longitudinal margins with younger age (0.51% (4/789) vs 2.7% (42/294) vs 1.9% (1/52) respectively; $p = 0.008$).

Table 1 shows older adults experienced an increased overall rate of complications (53.6% (423/789) vs 69.7% (205/294) vs 65.4% (34/52) respectively; $p < 0.001$), but this was due to increased grade II complications (41.2% (325/789) vs 60.9% (179/294) vs 63.5% (33/52) respectively; $p < 0.001$), but not grade III-V complications ($p > 0.05$).

Table 1: Overall and complications by grade for patients undergoing esophagectomy by age group

Variable	<70 years-old N=789	70-79 years-old N=294	≥80-years-old N=52	Overall N=1135	p-value
Overall Complications, n (%)	423 (53.6)	205 (69.7)	34 (65.4)	662 (58.3)	<0.001
Complications by Grade, n (%) *					
-Grade II	325 (41.2)	179 (60.9)	33 (63.5)	537 (47.3)	<0.001
-Grade III	218 (27.6)	95 (32.3)	16 (30.8)	329 (30.0)	0.306
-Grade IV	48 (6.1)	22 (7.5)	5 (9.6)	75 (6.6)	0.478
-Grade V	6 (0.76)	4 (1.4)	2 (3.9)	12 (1.1)	0.091

*Based on Clavien-Dindo Classification

Older adults had increased median length of stay (10 vs 11 vs 12 days respectively; $p = 0.003$) and were more likely to be discharged to inpatient rehabilitation (11.9% (93/784) vs 30.4% (89/293) vs 50% (26/52) respectively; $p < 0.001$). However, 89% (23/26) of those aged ≥ 80 years-old were eventually discharged home from inpatient rehabilitation, the majority within 90-days. 30-day hospital re-admission, re-operation, and mortality rates (all $< 2\%$) showed no age association (all $p > 0.05$).

Logistic regression identified increasing age as an independent risk factor for cardiovascular complication (OR 1.8 95% CI 1.33–2.49 for 70–79 and 2.8 95% CI 1.56–5.09 for 80+ years respectively; $p < 0.001$) which was most commonly atrial fibrillation (16.5% (130/789) vs 27.6% (81/294) vs 36.5% (19/52) respectively; $p < 0.001$). Age 70–79 years-old (ref < 70) was associated with increased odds of discharge to facility (OR 3.077 95% CI 2.12–4.74; $p < 0.001$). Age was not an independent risk factor for prolonged length of stay (both $p < 0.05$).

Conclusions: Older adults undergoing esophagectomy at a high-volume academic center had a $< 10\%$ risk of Grade IV events and a risk of death between 1.4% and 3.9%. If increased complications can be managed, then carefully selected older patients can achieve benefits of esophagectomy with similarly low re-admission and short-term mortality rates as younger patients. Although 50% of patients > 80 yrs went to rehab, 89% returned home.

87. The Impact of Weight Loss on the Regression of Barrett's Esophagus After Roux-en-Y Gastric Bypass As an Anti-Reflux Operation

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Invited Discussant: Moishe Liberman

Objective: Gastroesophageal reflux (GERD), obesity and Barrett's esophagus (BE) have been implicated in the dramatic rise in esophageal adenocarcinoma (EAC), particularly in western countries. Previous studies have shown that obesity correlates with GERD. Roux-en-Y gastric bypass (RNYGB) can address obesity and be effective as an anti-reflux procedure. We investigated our hypothesis that weight loss associated with RNYGB for GERD, may lead to regression of BE.

Methods: This was a retrospective analysis of patients who underwent RNYGB as anti-reflux procedure. Patients with BMI ≥ 25 kg/m² with biopsy-proven diagnosis of intestinal metaplasia (IM), confirmed endoscopic BE segment measurement, and post-operative surveillance endoscopy were included in the study. Pre-operative and post-operative weights at each follow-up endoscopic visit were recorded to calculate body-mass index (BMI); post RNYGB weight loss was quantified using percent excess body weight loss (% EBWL = $[\text{Initial Weight} - \text{Postop Weight}] / [\text{Initial Weight} - \text{Ideal Weight}] \times 100\%$), with $\geq 50\%$ EBWL at 1-year classified as successful weight loss. Events of BE regression were analyzed using survival analysis with interval censoring. Estimation of the BE regression events were obtained using non-parametric maximum likelihood estimate.

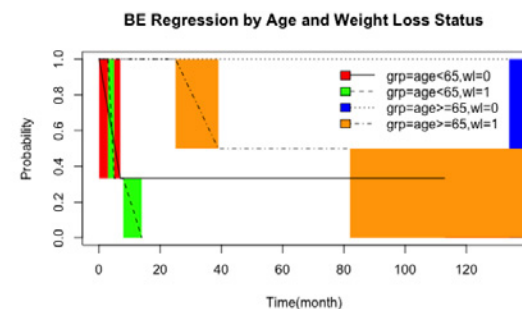


Figure: Non-parametric maximum likelihood estimation (NPMLE) of BE regression events stratified by age and weight loss status. wl=0 indicates unsuccessful weight loss. wl=1 indicates successful weight loss. Y-axis represents probability of persistent BE. Achieving probability of 0 marks the regression of BE. Colored regions are intervals where NPMLE is indeterminate. The changes of survival probability occur within the colored region. As seen in the Figure Patients ≤ 65 years with successful weight loss (denoted in green) showed a trend in achieving early BE regression.

Results: We identified 18 patients that met all inclusion criteria. During median follow-up of 22 months, after RNYGB, 50% (9/18) experienced regression (absence of BE on endoscopy, resolution of IM on pathology, or decreased BE length). Nine patients did not experience regression (BE segment length unchanged/increased, development of dysplasia on pathology, or could not be assessed due to ablation therapy). There was no significant difference in sex ($p = 1.00$), pre-operative BMI ($p = 0.757$), and BE segment length ($p = 0.206$) between the regression and no-regression groups. The no-regression group had a trend towards older age when compared to the regression group (median: 68 vs 54 years, $p = 0.077$). Patients in regression group had a trend of achieving higher %EBWL (99.6% vs 71.4%) but the difference was not significant ($p = 0.354$). Patients ≤ 65 years old had significant earlier achievement of BE regression compared to older patients (Exact log-rank test, $p = 0.030$). Combining age and weight loss, there was a strong trend towards early BE regression in young patients with successful weight loss (Figure, exact log-rank k-sample test, $p = 0.067$).

Conclusions: There was regression of BE in nearly 50% of patients who had undergone Roux-en-Y for GERD. Younger age and successful weight loss were associated with a trend in achieving early regression of BE. Future studies with a larger group of patients are necessary to further delineate the effects of RNYGB and weight loss on BE, and factors associated with regression of BE.

88. Patients with Diabetes Are Less Likely to Achieve Pathologic Complete Response Rate After Neoadjuvant Chemoradiation Therapy for Esophageal Cancer: A Multi-Institutional Analysis

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Invited Discussant: Shawn S. Groth

Objective: Diabetes is a common co-morbidity in the United States and is associated with adverse outcomes in a variety of disease processes. Other cancer types have shown decreased response to neoadjuvant treatment among diabetics. We hypothesized that diabetes would decrease pathologic complete response rate (pCR) in patients who received neoadjuvant chemoradiation therapy for resectable esophageal cancer.

Methods: Patients with esophageal or gastroesophageal junction cancer who received neoadjuvant chemoradiation (nCRT) followed by esophagectomy from 2010–2019 were retrospectively identified from two high-volume academic hospitals. Patients were excluded if they had histology other than squamous cell carcinoma or adenocarcinoma, did not receive multi-agent chemotherapy, or received a radiation dose <39.6 Gy. Patients were also excluded for unknown clinical variables including radiation dose, chemotherapy regimen, clinical stage, and pathologic stage. The primary outcome was pCR and secondary outcome was disease recurrence. Multivariate logistic regression was used to assess likelihood of pCR and recurrence.

Table 1: Multivariable logistic regression analysis of factors associated with pathologic complete response rate (pCR).

	OR	95% Confidence Interval	p value
Radiation Dose	1.12	0.993-1.267	0.063
Diabetes	0.30	0.109-0.852	0.024
Histology	0.58	0.223-1.500	0.259
Clinical T Stage			
T1	1		(ref)
T2	4.55	0.448-46.342	0.200
T3	1.85	0.204-16.734	0.584
Clinical N Stage > 0	1.93	0.789-4.726	0.15
Chemotherapy Regimen			
Carboplatin/Paclitaxel	1		(ref)
Cisplatin/5-FU	0.74	0.276-2.004	0.558
Other	1.55	0.502-4.799	0.445

Results: 244 patients met inclusion criteria. 204 (84%) were male and 40 (16%) were female with a median age of 64 (IQR 57.5–70). 54 (22.1%) patients had a diagnosis of diabetes. The median radiation dose was 50.4 Gy (IQR 45–50.4) and the most common chemotherapy regimen was Carboplatin/Paclitaxel (n = 181, 74.2%). pCR occurred in 46 patients (18.9%) and there was a trend towards reduced pCR among diabetics (6/56 (10.7%) vs 42/191 (22.0%), p = 0.61) in bivariate comparison. Multivariable logistic regression showed

that patients with diabetes were less likely to have pCR (AOR 0.30, p = 0.024, Table 1). In a secondary analysis of disease recurrence, patients with pCR (AOR 0.44, p = 0.023) were less likely to recur, but presence of diabetes (AOR 1.21, p = 0.578) had no significant impact.

Conclusions: This multi-institutional study suggests that diabetes adversely affects pCR in patients receiving neoadjuvant treatment for esophageal cancer. Despite lack of effect on disease recurrence, the decreased rate of pCR suggests existing neoadjuvant regimens may be inadequate for patients with diabetes. Future studies are required to determine the optimal neoadjuvant treatment strategy for esophageal cancer patients with diabetes.

89. Impact of COVID-19 on the Delivery of Care for Thoracic Surgery Patients

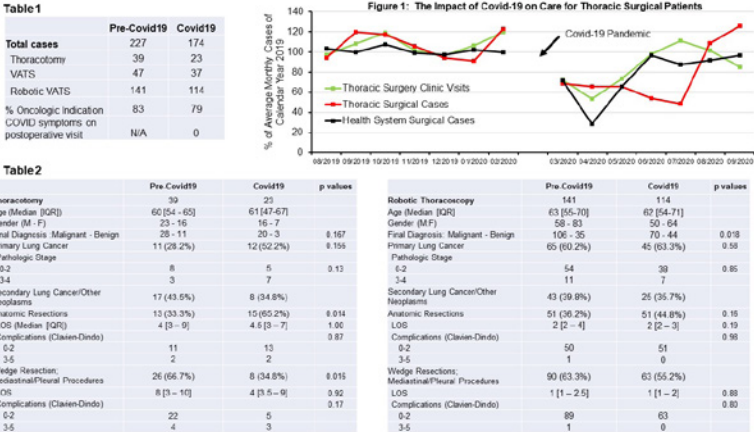
Joanne B. Szewczyk, Karishma Kodra, Joy Stephens-McDonnough, Nestor R. Villamizar, Dao M. Nguyen

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Invited Discussant: James M. Isbell

Objective: The emergence of SARS-CoV-2 at the beginning of 2020 has led to an unprecedented nationwide shift in the approach to patient care, including temporary closure of surgical services to allow for resource allocation to address the surge of critically ill COVID-19 patients. Non-emergent cases were postponed, with the focus on life-saving operations, especially those for neoplasms. Our institution experienced clinical services closure in early March 2020 in response to the SARS-CoV-2 pandemic, with phased re-opening starting several months later in June. This study aims to determine the impact of COVID-19 on the delivery of care for thoracic surgical patients at an urban medical center.

Methods: A retrospective analysis of a prospectively maintained database of all thoracic surgical cases from 8/1/2019 to 9/30/2020 was conducted. Demographics, pre-operative surgical indications, surgical procedures, final pathologic diagnosis and clinical outcomes were recorded for all patients. A census of all operative cases in our entire health system and outpatient thoracic clinics were obtained from our institutional database.



Results: A total of 401 patients were included in this study: 174 received surgical care during the COVID-19 period (3/1/2020 to 9/30/2020) while 227 patients had thoracic procedures in the preceding seven months (8/1/2019 to 2/28/2020), serving as historical controls. The two cohorts were very comparable. During the first five months of COVID-19, total thoracic operations were reduced before returning to pre-COVID values, lagging behind the re-opening of thoracic clinics and the health system operative services (Figure 1). There was an overall 23% reduction in total operative cases during the COVID-19 period with proportional reduction across surgical approaches (Table 1). There was no difference in final pathologic diagnosis, primary lung cancer stages, length of hospital stay, or post-operative complications between the two cohorts. However, during the COVID-19 period, there were more anatomic resections performed, either by thoracotomy (15/23–65.2% versus 13/39–33.3%, $p = 0.014$) or by combined approach (66/137–48.2% versus 64/180–35.5%, $p = 0.023$) (Table 2). More importantly, none of the 174 patients receiving in-hospital thoracic surgery care reported COVID-19 symptoms at their first postoperative clinic visits 10 to 14 days after discharge (Table 1).

Conclusions: During the initial surge of SARS-CoV2 with temporary closure of operative services, our institution was able to continue to provide safe care for thoracic surgery patients, especially those with thoracic neoplasms. Since reopening, we have experienced a higher volume in thoracic surgical cases, especially those with benign thoracic conditions, which may reflect a backlog of those patients whose operations deemed non-emergent and initially postponed, now presenting to the forefront.

90. Safety of Lung Cancer Surgery During COVID-19 in a Pandemic Epicenter

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Invited Discussant: Michael Zervos

Objective: The mortality of patients with COVID-19 infection who have lung cancer may be as high as 50%. There is little information on the perioperative outcomes of surgical resection for lung cancer during the SARS-CoV-2 pandemic. The objective of this study was to determine the morbidity and mortality of lung resection for cancer in a tertiary care hospital located in a pandemic epicenter.

Methods: We conducted a retrospective review of a prospectively maintained database to identify patients who had lung cancer resection before (1/1/20–3/10/20, Group 1) and during the COVID-19 pandemic lockdown period (3/11–6/10/20, Group 2) in a tertiary care hospital at a major metropolitan area. As of 4/2/20, all patients were screened by SARS-CoV-2 RT-PCR of nasopharyngeal swabs preoperatively. Patients with positive results were not offered surgery. Characteristics and outcomes were compared between groups, before, and after screening implementation.

Table 1. Demographic and clinical characteristics of lung cancer patients who underwent resection before (Group 1) and during (Group 2) the COVID-19 pandemic and COVID-19 related complications (* $p < 0.05$ indicating statistical significance).

Characteristic	Group 1 (1/1-3/10/20, n=57)	Group 2 (3/11-6/10/20, n=41)	p-value
Median age	70 (44-85)	72 (46-88)	$p=0.133$
Male	26 (46%)	19 (45%)	$p=0.843$
White	40 (71%)	28 (67%)	$p=0.202$
African American	7 (12%)	2 (5%)	
Asian	7 (12%)	11 (26%)	
Other/Unknown	3 (5%)	1 (2%)	
Smoker	47 (83%)	27 (66%)	$p=0.070$
Cerebrovascular disease	2 (3%)	3 (7%)	$p=0.648$
Chronic kidney disease	3 (5%)	4 (9%)	$p=0.453$
Chronic pulmonary disease	17 (30%)	9 (21%)	$p=0.348$
Congestive heart failure	0 (0%)	2 (5%)	$p=0.177$
Coronary artery disease	6 (10%)	10 (24%)	$p=0.076$
Diabetes	7 (12%)	10 (24%)	$p=0.133$
Hypercholesterolemia	23 (40%)	22 (52%)	$p=0.235$
Hypertension	25 (44%)	29 (69%)	$p=0.013^*$
Myocardial infarction	2 (3%)	1 (2%)	$p=0.999$
Peripheral vascular disease	4 (7%)	1 (2%)	$p=0.392$
Clinical Stage IA/IB	47 (83%)	30 (73%)	$p=0.444$
IIA/IIB	3 (5%)	4 (10%)	
IIIA/IIIB and IV	7 (12%)	7 (17%)	
Neoadjuvant treatment	8 (14%)	5 (12%)	$p=0.972$
VATS/Robotic	54 (95%)	39 (95%)	$p=0.999$
Thoracotomy	3 (5%)	2 (5%)	
Sublobar resection	24 (42%)	12 (32%)	$p=0.257$
Lobectomy	33 (58%)	26 (68%)	
COVID-19 infection	2 (3%)	3 (7%)	$p=0.398$
COVID-19 related death	0 (0%)	2 (5%)	$p=0.088$
All-cause mortality	0 (0%)	2 (5%)	$p=0.088$

Results: There were 57 patients in group 1 and 41 patients in group 2. Patient characteristics were not significantly different between the two groups except for hypertension (group 1: 44% [25/57], group 2: 69% [29/41], $p = 0.013$). Post-resection 90-day COVID-19 infection rates were similar between the two groups (3.5% [2/57] vs 7.3% [3/41], $p = 0.398$). Infections occurred in five patients after discharge from the surgical admission (10–62 days post-operatively). Four out of five patients were male, former smokers with hyperlipidemia. All five were symptomatic and two patients in group 2 required hospitalization and eventually died of their infection (mortality 2/5; 40%). Ninety-day mortality was 5% (2/41) for lung cancer surgery performed during the pandemic lockdown period, with all deaths due to COVID-19 infection, compared to 0% (0/57) mortality in the pre-pandemic period ($p = 0.088$, Table 1). COVID-19 related 90-day mortality prior to screening for SARS-CoV-2 was 2/73 patients (2.7%). After implementation of pre-operative screening (25 patients) there was only one confirmed COVID-19 infection and no mortality.

Conclusions: During the pandemic lockdown period, surgical resection for lung cancer patients was associated with a 2% COVID-related 90-day mortality. The mortality of COVID-19 infections in this cohort was 40%. Although preoperative screening of asymptomatic patients may reduce post-operative in-hospital COVID-19 infections, these patients remain at risk from community exposure after discharge and close follow-up may be necessary.

91. Association Between the Frailty and Outcomes Following Elective Lobectomy

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UMASS Medical School, Worcester, MA

Invited Discussant: John Howington

Objectives: Elective thoracic surgery is safe in well-selected elderly patients. In addition to comorbidities and pulmonary assessments, frailty is an important risk factor that can lead to poor perioperative outcomes. The association of frailty with postoperative morbidity in patients undergoing open and video-assisted thoracoscopic (VATS) lobectomies has not been studied in large databases. We sought to examine the value of frailty as an independent predictor of complications after accounting for other patient factors with use of the modified Frailty Index (mFI).

Methods: The National Surgical Quality Improvement Program (NSQIP) database was used to examine patients undergoing elective VATS or open lobectomies from 2010 to 2018. Beginning in 2013, the original mFI was modified from an 11-point to a 5-point score due to reduced NSQIP reporting requirements. We calculated the mFI-5 in both cohorts and the 11-point score in the earlier cohort (2010–2012) only. Patient frailty was defined as an mFI greater than or equal to three. Odds ratios (ORs) and multivariate logistic regression were used to characterize the risk of post-operative complications from patient characteristics including mFI-11 and mFI-5 along with c-statistics (AUROCs) to assess the predictive power of modified Frailty Index. Results: A total of 4,734 patients were included in the earlier (2010–2012) cohort, while 20,358 subjects were identified between 2013 and 2018. In both cohorts, 19% of patients developed complications and 7% had mFI-5 scores ≥ 3 . Open lobectomies were more common in the earlier cohort (54.0% vs 37.6%) and were strongly associated with post-operative complications (ORs > 1.5) in both cohorts. The mFI-11 identified substantially more frail patients than the mFI-5 (30.6% vs 6.5%) in the 2010–2012 group. However, “frailty score > 3 ” was an independent risk factor for complications (with OR-1.4) using either index or cohort. The mFI-11 led to a more powerful model than the mFI (c-statistic = 0.64 vs 0.60) in the earlier cohort where they could be compared.

Conclusion: Frailty is a significant predictor of any post-operative complications following elective open and VATS lobectomies. As a potentially modifiable risk factor, frailty should be considered in surgical decision-making and when counseling patients regarding post-operative risks.

Table: Patient Characteristics and Risk for Post-Operative Complications, 2010–2018

2010–12 (n = 4,734) Cohort; 19.3% Complications				Using the 11-Point Frailty Index		Using the 5-Point Frailty Index	
Variable	Prevalence	Odds Ratio	95% CI	P-Value	Odds Ratio	95% CI	P-Value
Gender, male	47.1%	0.99	0.85–1.15	0.875	1.00	0.87–1.16	0.976
Open lobectomy	54.0%	1.54	1.32–1.79	0.001	1.53	1.32–1.78	0.001
ASA ≥ 3	78.2%	1.34	1.09–1.64	0.005	1.41	1.15–1.72	0.001
Age ≥ 65 years	61.0%	1.27	1.09–1.49	0.003	1.32	1.13–1.55	0.001
Frailty index ≥ 3 (11pt/5pt)	30.8%/6.5%	1.40	1.19–1.64	0.001	1.42	1.09–1.86	0.01
Pre-operative dyspnea	23.1%	1.29	1.09–1.52	0.003	1.33	1.13–1.57	0.001
Pre-operative weight loss	3.0%	1.61	1.11–2.34	0.013	1.61	1.11–2.34	0.013
Area under the receiver operating curve (C-statistic)				0.6446			0.6034

2013–18 (n = 20,358) Cohort; 18.6% Complications				Using the 11-Point Frailty Index		Using the 5-Point Frailty Index	
Variable	Prevalence	11-Point Index Not Available	Odds Ratio	95% CI	P-Value		
Gender, male	44.6%		1.19	1.10–1.28	0.001		
Open lobectomy	37.6%		1.86	1.72–2.01	0.001		
ASA ≥ 3	80.3%		1.45	1.30–1.62	0.001		
Age ≥ 65 years	61.3%		1.22	1.13–1.32	0.001		
mFI ≥ 3 (5 pt index only)	7.0%		1.43	1.25–1.64	0.001		
Pre-operative Dyspnea	17.8%		1.35	1.23–1.48	0.001		
Pre-operative weight loss	1.9%		1.82	1.45–2.28	0.001		
Area under the receiver operating curve (C-statistic)					0.6224		

92. Long-Term Assessment of Efficacy with a Novel Thoracic Survivorship Program for Patients with Lung Cancer

Hari B. Keshava, Kay See Tan, Joseph Dycoco, James Huang, Prasad Adusumilli, Manjit Bains, Matthew Bott, Robert J. Downey, Danelia Molena, Bernard J. Park, Gaetano Rocco, Smita Sihag, David R. Jones, Valerie W. Rusch

Memorial Sloan Cancer Center, New York, NY

Invited Discussant: Paula A. Ugalde

Objective: The approach to long-term follow-up (f/u) after lung cancer (NSCLC) resection remains controversial and can consume significant physician resources. We previously developed a novel, highly structured, nurse practitioner (NP)-run Thoracic Survivorship Program (TSP) [Huang et al. *Ann Thorac Surg*. 2014; 98: 955–61.] NSCLC patients who were disease-free for at least 1-year post-resection could be referred into TSP by their surgeon. Here, we analyze the long-term outcomes of this program.

Methods: Patients who had Ro resection for stages I-IIIa NSCLC between 2006 to 2016 were reviewed. Patients were stratified by enrollment in the TSP versus f/u by their surgeon (non-TSP). To decrease bias, only data after the first TSP visit was included in the TSP cohort. F/u included every 6-month chest CT scans for 2 years then annually thereafter. Lack of f/u compliance was defined by 2 or more consecutive missed appointments/CT scans. The relationships between TSP enrollment and overall survival, disease-free survival, 2nd primary NSCLC, and new extra-thoracic cancers were quantified using an adjusted multivariate Cox proportional hazards regression with time-varying covariate reflecting the timing of patient's enrollment into the TSP.

Results: Of 3951 total patients, 1219/3951 (31%) were ultimately enrolled in TSP. Median (25th, 75th percentile) time to TSP enrollment was 2.4 (1.7, 13.1) years and median f/u for all patients was 6.4 years. 3020/3951 (76.4%) had complete follow-up and CT scan data. 329/3020 (10.9%) patients had 1 delayed visit, 60/3020 (2.0%) had 2 or more delayed visits. Of the total number of visits, 333/16876 (2%) of non-TSP visits and 132/5203 (2.5%) of TSP visits were deemed non-compliant. Of all TSP patients, 155/1219 (13%) developed a 2nd primary NSCLC (134 [86%] c stage I) and 109/1219 (9%) an extra-thoracic cancer, while 303/2732 (11%) of non-TSP patients developed a 2nd primary NSCLC (255 [84%] c stage I), and 186/2732 (7%) an extra-thoracic cancer. TSP status was associated with lower hazard of death (HR 0.37; 95% CI 0.32–0.43; p < 0.001) and lower hazard of progression or death (HR 0.48; 95% CI 0.42–0.56; p < 0.001).

Conclusions: Our novel, NP-run TSP is associated with high patient compliance, excellent outcomes and early detection of 2nd primary NSCLC, all comparable with physician-based f/u care. These results have important implications for health care resource allocation and costs.

93. The Ross Procedure—10-Year Experience in 472 Consecutive Patients Using Contemporary Techniques

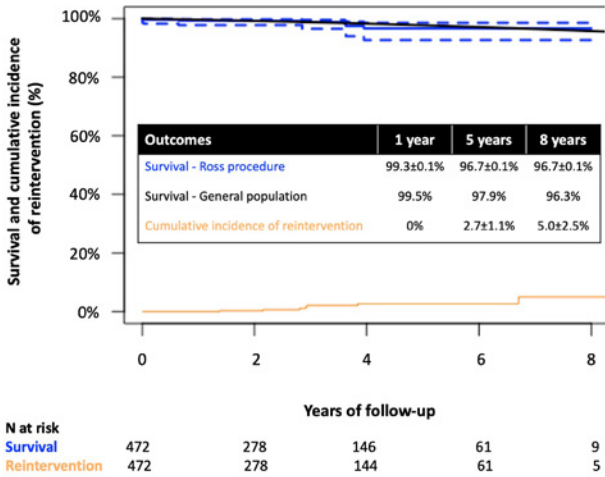
Ismail El-Hamamsy¹, Vincent Chauvette², Ismail Bouhout², Laurence Lefebvre², Raymond Cartier², Philippe Demers², Nancy Poirier²
¹Mount Sinai Hospital, New York, NY; ²Montreal Heart Institute, Montréal, QC, Canada

Invited Discussant: Emile A. Bacha

Objective: The Ross procedure presents many advantages for young adults. However, durability remains a concern. In recent years, factors associated with late failures have become clearer. As a result, we have adopted a tailored surgical approach aimed at ensuring long-term durability. The aim of this study is to report our mid-term clinical and echocardiographic outcomes of the Ross procedure performed using standardized, contemporary techniques.

Methods: From July 2010 to December 2019, 472 patients underwent a tailored Ross procedure at a single institution (mean age: 48 ± 12 [range 18–68 years], 73% male). The main indication for surgery was stenosis in 386 patients (82%) and isolated aortic

regurgitation in 86 patients (18%). Seventy-one patients (15%) had ≥1 previous cardiac surgery and 27 (6%) had active endocarditis. After surgery, patients were prospectively followed with yearly clinical and echocardiographic examinations (n = 1552 echocardiograms). The median follow-up is 3.3 years (range = 0.7–9.6) and 99% complete.



Results: There were 2 operative deaths (0.4%), both in the first 100 cases with no subsequent peri-operative mortality. The incidence of myocardial infarction, stroke and pacemaker implantation was <1%. No patient had moderate or severe patient-prosthesis mismatch at discharge. At 8 years, the mean aortic gradient was 4.1 ± 1.8 mmHg. Mean sinus of Valsalva diameter increased from 32 ± 4 mm postoperatively to 36 ± 8 mm at 8 years (≈ 0.5 mm/year). Six patients required reintervention: autograft valve replacement (n = 3), percutaneous homograft reintervention (n = 2) and abscess drainage (n = 1). At 8 years, the cumulative incidence of any reintervention was 5 ± 0.3% (Figure 1). Five patients had a valve-related complication: 2 patients developed a pulmonary homograft endocarditis and 3 patients suffered from a thromboembolic event (stroke n = 2, TIA n = 1). At 8 years, the cumulative incidence of any valve-related complication was 1.6 ± 0.1%. A total of 5 patients died during the study follow-up (4 from non-cardiac causes). At 8 years, survival was 96.7 ± 0.1%, similar to that of an age- and sex-matched general population (Figure 1).

Conclusions: Using a tailored approach and specific management strategies after the Ross procedure, this study demonstrates good structure and function of the pulmonary autograft in the first decade. These data, in an all-comer patient population, suggest efficacy of this patient-specific approach in improving durability after the Ross procedure. Continued follow-up is warranted to confirm our early observations.

94. The Contemporary Status of Socioeconomic Based Disparities in Cardiac Surgery: Are We Closing the Disparities Gap?

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¹Brigham and Women's Hospital, Boston, MA; ²Boston University School of Medicine, Boston, MA; ³Harvard Medical School, Boston, MA

Invited Discussant: Jennifer S. Lawton

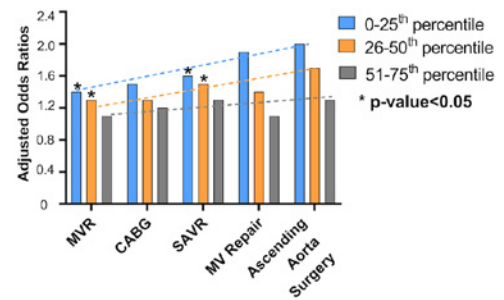
Objective: Female gender and lower household median income are established independent risk factors for increased mortality in the coronary revascularization literature and are beginning to emerge as risk factors in the valve disease literature. There have been efforts to close this disparity gap in the last decade, but the current state of these disparities is not known. This study will analyze the modern day impact of gender and median household income on cardiac surgery outcomes and if improvements in safety and accessibility in recent years has narrowed the disparities gap.

Methods: Patients older than 18 years within the National Readmissions Database (NRD) who have undergone a coronary artery bypass graft (CABG), surgical aortic valve replacement (SAVR), open mitral valve replacement (MVR), mitral valve repair (MV repair), or repair/replacement of the ascending thoracic aorta in 2016–2017 were included. Primary outcome was 30-day mortality. Multivariate analysis adjusting for patient comorbidities and hospital level factors was performed to compare outcomes across gender and socioeconomic status within each intervention group. Characteristics of hospitals that are providing care to historically underserved populations were also identified.

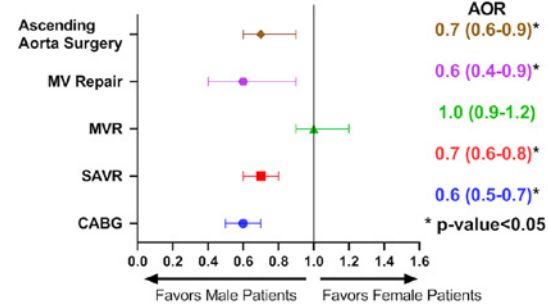
Results: A total of 243,121 patients were included. Demographic data was comparable across intervention groups in terms of age, median household income distribution, and Hospital Episode Statistics (HES) Frailty Risk Score. The majority of patients who underwent MVR were female (52.3%), but females were the minority for other procedures (22.8% for CABG, 32.4% for SAVR, 38.7% MV repair, and 30% for ascending aorta surgery). Adjusted 30-day mortality demonstrated that male patients had a significantly lower odds of dying compared to female patients for CABG (AOR 0.6, p-value < 0.001), SAVR (AOR 0.7, p-value < 0.001), MV repair (AOR 0.6, p-value = 0.009), and ascending aorta surgery (AOR 0.6, p-value < 0.001). Patients in the 0–25th percentile and 25th–50th percentile for household income had a significantly increased odds of mortality when undergoing SAVR (AOR 1.6 and 1.5 respectively, p-value < 0.03) or MVR (AOR 1.4 and 1.3 respectively, p-value < 0.03) compared to patients in the highest quartile. Furthermore, a lower percentage of female patients received care at urban and academic teaching hospitals than did male patients for CABG and SAVR. Patients in lower quartiles for household income received less of their care at such institutions for CABG, SAVR, MVR, MV repair, and ascending aorta surgery.

Conclusions: Despite advances in safety and accessibility, female and patients of lower socioeconomic status have worse outcomes after particular cardiac surgery. This study highlights the persistent disparities in cardiac surgery even in the contemporary era and the need for root cause analysis.

Adjusted 30-day Mortality by Median Household Income



Adjusted 30-day Mortality by Gender



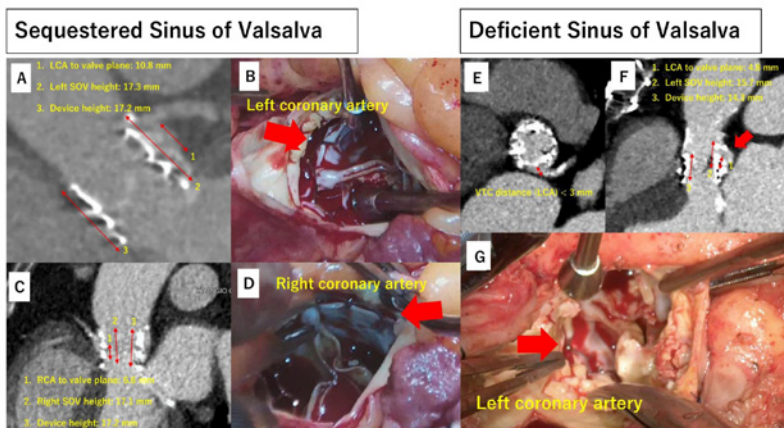
95. Aortic Valve Reintervention After Transcatheter Aortic Valve Replacement: Repeat Transcatheter Therapy Is Not Guaranteed

Shinichi Fukuhara, Chan Tran N. Nguyen, George Michael Deeb, Karen M. Kim, Bo Yang, Gorav Ailawadi, Himanshu J. Patel
University of Michigan, Ann Arbor, MI

Invited Discussant: Elaine E. Tseng

Objective: Despite the rapid adoption of transcatheter aortic valve replacement (TAVR), there are scant data regarding aortic valve reintervention. The purpose of this study is to review the outcomes in TAVR patients who required a valve reintervention.

Methods: Between 2011 and 2019, a total of 1,479 consecutive patients underwent a TAVR at our institution, including 161 (11%) valve-in-valve-TAVR within surgical valve (TAVR-in-SAVR). Among these, 24 (1.6%) patients required an aortic valve reintervention. Additionally, 4 TAVR recipients from another institution underwent a reintervention at our institution. We retrospectively reviewed the outcomes of these 28 patients.



Results: The median age was 72 and 10 (36%) were female including extreme- (11%), high- (50%), intermediate- (36%) and low-risk (4%) patients at index TAVR. Most (86%) were self-expandable device recipients and 10 (36%) were TAVR-in-SAVRs. The time from the TAVR to reintervention was 1.2 (interquartile range [IQR] 0.2–3.2) years. The most common indication for reintervention was structural valve degeneration (39%) followed by paravalvular leak (36%) and endocarditis (10%). The cumulative incidence of aortic valve reintervention was 4.6% at 8 years. Furthermore, TAVR-in-SAVRs demonstrated a higher reintervention rate (13.2% vs 3.8%, subdistribution hazard ratio 3.7, 95% confidence interval 1.6–8.8, $p = 0.003$). Twenty (out of 28; 71%) were deemed not suitable for redo TAVR procedure, most commonly due to the need for concurrent cardiac procedures (10/20; 50%) and/or unfavorable anatomy (9/20; 45%). As for unfavorable anatomy, the most common factor was associated with the risk of coronary obstruction (6/9; 67%) due to a sequestered (4/9; 44%) or deficient sinus of Valsalva (2/9; 22%) with insufficient valve-to-coronary distance (Figure). Concomitant procedures during surgical TAVR valve explant (TAVR-explant) including aortic repair (7/20; 35%), mitral repair/replacement (7/20; 35%), tricuspid repair (5/20; 25%), and coronary artery bypass grafting (4/20; 20%). Five (out of 7; 71%) underwent an unplanned aortic repair due to the TAVR-explant trauma. In contrast, redo TAVR ($n = 8$) was successful in all patients. However, 5 (63%) required post-deployment balloon valvuloplasty for paravalvular leak \geq mild. The mean transvalvular gradient was 4.4 mmHg (IQR 3.0–6.2). There were 3 (15%) in-hospital mortalities in the TAVR-explant group with no mortality in the redo TAVR group.

Conclusions: Repeat TAVR in failing previous TAVR is frequently not feasible due to unfavorable anatomy and/or the need for concurrent cardiac procedures with redo TAVR/TAVR-explant ratio of 0.4. With the increased number of complex TAVR-explant, careful assessment of TAVR procedure repeatability should be weighed at the initial TAVR work-up especially in younger patients who are expected to require a second aortic valve procedure.

96. Classic Surgical Risk Prediction Fails for Isolated Tricuspid Valve Surgery—What Is the Impact of Liver Dysfunction?

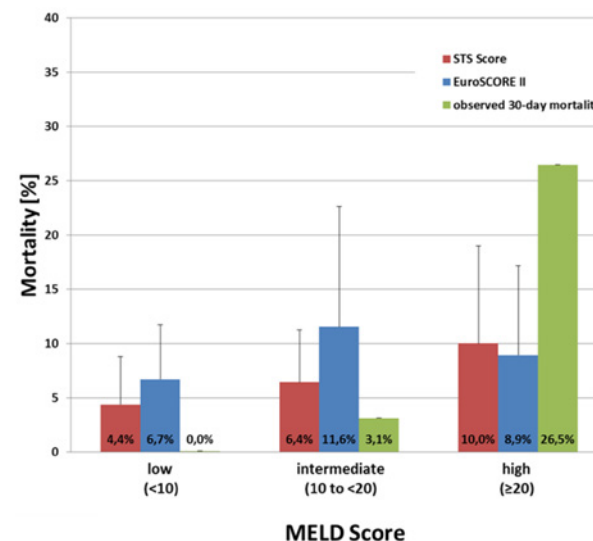
Gloria Faerber¹, Jonas Marx¹, Christoph Sponholz², Michael Bauer³, Sven Moebius-Winkler⁴, Torsten Doenst¹

¹Friedrich Schiller University Jena, University Hospital, Department of Cardiothoracic Surgery, Jena, Germany; ²Friedrich Schiller University Jena, University Hospital, Department of Anesthesiology and Critical Care Medicine, Jena, Germany; ³Friedrich-Schiller-University Jena, University Hospital, Department of Anesthesiology and Critical Care Medicine, Jena, Germany; ⁴Friedrich Schiller University Jena, University Hospital, Department of Internal Medicine I/Cardiology, Jena, Germany

Invited Discussant: David H. Adams

Objective: Isolated tricuspid valve (TV) surgery is perceived as a high-risk procedure. This perception is nurtured by the presentation of patients with often significant liver dysfunction, which may not be appropriately reflected in current surgical risk scores (e.g., STS or EuroSCORE II). We calculated these scores in a large single-center series of patients receiving isolated tricuspid valve surgery and also used the model for end-stage liver disease (MELD), which is usually applied to predict liver transplant mortality.

Methods: Between April 2011 and May 2019, 140 patients underwent isolated TV repair ($n = 98$, 70%) or replacement ($n = 42$, 30%) for TV regurgitation in our center. We retrospectively assessed preoperative risk (STS, EuroSCORE II and MELD) and correlated it with perioperative and mid-term outcome. Follow-up was 1 day to 8.4 years (mean 2.5 years) and was 95% complete. Patients were stratified into three groups: MELD <10 = low, 10 to <20 = intermediate, and ≥ 20 = high and comparisons to the other scores were made.



Results: Patients were 71 ± 11 years old, 42% male ($n = 59$), had a mean STS-Score of $6.7 \pm 6.3\%$ and EuroSCORE II of $9.4 \pm 9.1\%$. Total mortality at 30-days was 7.9% ($n = 11$) and 44% ($n = 62$) at latest follow-up. Patients who died had worse preoperative LVEF, more dialysis and cardiogenic shock. Unexpectedly, survival curves for patients below (0.5–6.5%) and above (6.5–62%) the median EuroSCORE II were identical, suggesting an inability of classic surgical risk assessment to predict mortality in these patients. The MELD score, however, was strongly associated with 30-day mortality (multivariate analysis: $p < 0.001$). The Figure shows that mortality was overestimated by STS score and EuroSCORE II at low and intermediate MELD scores (observed mortality 0 and 3.1%, respectively) and underestimated at high MELD scores (observed mortality 26.5%). High MELD scores were also associated with longer ICU stay ($p = 0.035$) and renal failure ($p < 0.001$) but not with bleeding and transfusion rates.

Conclusions: Classic surgical risk prediction with EuroSCORE II or STS score failed to adequately predict mortality in patients undergoing isolated tricuspid valve surgery. However, preoperatively assessed MELD score was a useful discriminator. Thus, high risk of isolated TV surgery appears to be more connected to liver-related comorbidities than to classic cardiac surgical risk factors or the procedure itself.

97. Long-Term Outcomes of Mitral and Concomitant Tricuspid Valve Repair for Degenerative Mitral Valve Prolapse

Percy Boateng, Shinobu Itagaki, Nana Toyoda, Ahmed E-Eshmawi, Anelechi Anyanwu, Hannah Adams, Jason Storch, Dimosthenis Pandis, David H. Adams
Icahn School of Medicine at Mount Sinai, New York, NY

Invited Discussant: Adanna Akujuo

Objective: Describe the long-term outcomes of mitral and concomitant tricuspid valve repair in patients presenting with degenerative mitral valve prolapse.

Methods: Of 646 consecutive patients who presented with degenerative mitral valve prolapse at our institution between 2003 and 2011, 645 patients (mean age 57 years) underwent successful mitral valve repair (repair rate 99.8%) for either Class I or Class II triggers according to contemporary ACC/AHA guidelines. Concomitant tricuspid repair was performed in 419 (65%) patients with moderate or greater TR and/or annular dilatation. Prospective follow up was performed to determine long-term outcomes in all patients. The primary endpoints were long-term survival, and recurrent moderate to severe or severe mitral valve regurgitation (MR) and/or recurrent tricuspid regurgitation (TR). Outcomes were analyzed with multivariable cox regression models adjusting for pre-operative class I and II ACC/AHA triggers (symptoms, LVEF less than 60%, LV end-systolic dimension [LVESD] more than 40 mm, pulmonary artery hypertension, the presence of atrial fibrillation). The mean follow-up time was 9.0 years.

Results: The survival at 10 years and 15 years were 92.0% (95% confidence interval [CI] 89.4–94.2%) and 81.7% (95% CI 74.9–87.0%). After adjusting for age and sex, the number of surgical triggers present at the operation was associated with increased mortality (adjusted hazard ratio [HR] 1.3, 95% CI 1.1–1.7, $P = 0.008$). The cumulative incidence of recurrent MR at 10 years and 15 years were 2.8% (95% CI 1.6–4.7%) and 7.4% (95% CI

2.0–17.5%) with preoperative LVESD more than 40 mm as a risk factor (HR 2.8, 95% CI 1.1–7.6, $P = 0.038$). The cumulative incidence of recurrent TR at 10 years and 15 years were 2.0% (95% CI 0.8–4.3%) and 5.0% (95% CI 1.1–13.5%). Concomitant tricuspid repair was highly protective against late recurrent TR (HR 0.11, 95% CI 0.02–0.56, $P = 0.008$).

Conclusions: An all-comers mitral valve repair strategy regardless of lesion complexity results in excellent long-term freedom from recurrent MR. Concomitant tricuspid valve repair for moderate TR or annular dilatation results in very low recurrent TR in the long-term. Long-term survival is negatively impacted by the presence of interventional triggers, reinforcing the current guideline recommendations for early valve repair in patients with degenerative mitral valve prolapse and severe mitral valve regurgitation.

98. Reoperations on the Ascending Aorta and Aortic Arch: A Retrospective Series of 479 Patients

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S. Orsola Hospital, Bologna, Italy

Invited Discussant: Ourania Preventza

Objective: Aortic redo surgery remains one of the hardest challenge also for high volume centers: tailored surgical planning and careful perioperative management are crucial for best results. Our overall experience in thoracic aorta redo surgery has been reviewed, reporting the outcomes of 453 patients.

Methods: From 1986 to 2019, were referred 479 patients who underwent aortic reoperations for degenerative aneurysm, acute and chronic/residual aortic dissection, pseudoaneurysm and endocarditis. Perioperative data have been collected retrospectively. Early mortality, morbidity and follow up survival are reported, comparing ascending aorta and arch surgery.

Results: Root replacement was performed in 38.4% of cases, arch in 30.5%, root and arch in 21.4%, ascending aorta in 9.7%. Thirty-days mortality rate was 7.5% (root/ascending 6.4% versus arch 8.5%; $p = 0.399$). Postoperative myocardial infarction/heart failure rate was 5.3%, stroke 3.3% and re-sternotomy 11.3%. Long term survival at 1 y, 5 y, 10 y was 91.2%, 79.4%, 66.3% for ascending aorta group, and 80.7%, 68.8%, 55.3% for arch group (log-rank = 0.038). Arch surgery had a higher rate of neurological complications, renal failure, respiratory failure ($p < 0.05$). Moreover, it resulted also a risk factor for follow up mortality (log-rank = 0.039; $p = 0.05$, HR = 1.55 [1.00–2.39]). Degenerative aneurysms, pseudoaneurysms, endocarditis, chronic and acute aortic dissection had different survival rate regardless proximal or distal aortic replacement (Log-rank < 0.001).

Conclusions: Aortic surgery in redo setting is a high risk surgery, regardless of anatomical extension of procedures: however, it may be performed with relatively low mortality rate. Arch surgery accounts for higher postoperative morbidity and long-term mortality.

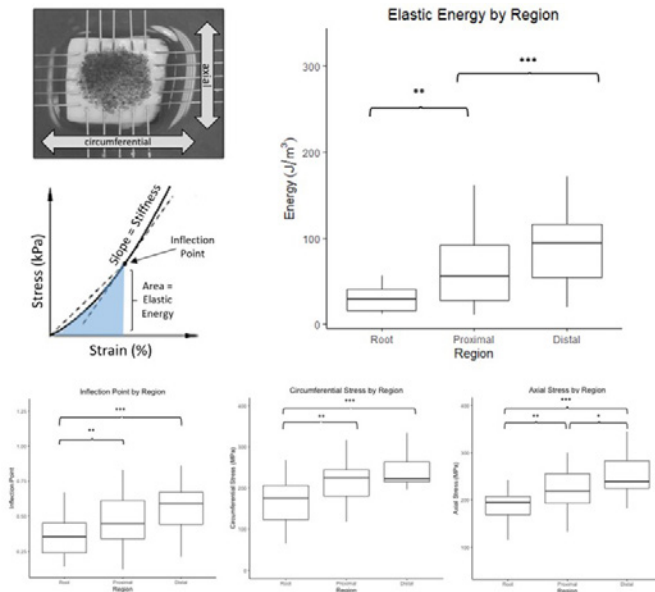
99. Ex-Vivo Biaxial Load Testing Analysis of Aortic Biomechanics Demonstrates Variation in Energy Distribution Across Aortic Zone Zero: Early Results from the Matadors Trial

Emily Durbak¹, Emidio Germano¹, Frank Cikach¹, Callan Gillespie¹, Robert Borden², Samar Tarraf³, Benjamin Kramer¹, Kelly Emerton⁴, Jennifer Hargrave¹, Robb Colbrunn¹, Chiara Bellini³, Eugene Blackstone¹, Eric Roselli¹

¹Cleveland Clinic, Cleveland, OH; ²Stanford University, Stanford, CA; ³Northeastern University, Boston, MA; ⁴CryoLife, Inc., Cleveland, OH

Invited Discussant: Scott A. LeMaire

Objective: To assess regional and directional variation in biomechanical metrics within Zone o of the aorta. The aorta is an elastic tissue, and the energy it produces in response to forces in both the circumferential and axial directions is crucial to its function. Biomechanical assessment of tissue stress and elastic energy may provide insight into aortic structural integrity beyond diameter. The MATADORS trial has previously reported on uniaxial testing to failure. Since the aorta experiences both circumferential and axial loads, biaxial testing best replicates physiological conditions. This report provides early insights into biaxial biomechanics from the MATADORS trial.



Methods: From 5/2018 to 6/2020 the MATADORS trial prospectively enrolled 203 patients undergoing ascending aortic replacement. Included are patients with aneurysm, acute aortic dissections, and patients without aortic disease undergoing cardiac transplant as controls. Preoperative aortic diameter was determined using computed tomography. Intraoperative transesophageal echocardiographic images were assessed using two-dimensional speckle tracking. Aortic specimens were excised from the noncoronary

sinus and root (Zone oA), proximal (Zone oB), and distal (Zone oC) ascending aortic segments. Specimens were subjected to uniaxial load testing to failure or biaxial testing to evaluate elastic energy and stress at inflection point. Groups were compared across Zone o regions.

Results: This cohort includes 54 patients with biaxial biomechanical testing, including 45 with aneurysms (n = 9 with connective tissue disorders, CTD) and 9 controls. Mean age is 54 ± 14 years and mean maximum aortic diameter is 5.1 cm (95% CI: 4.6–5.8 cm) in the aneurysm group, 4.4 cm (95% CI: 3.7–5.3 cm) in the CTD group, and 3.4 cm (95% CI: 3.1–3.6 cm) in the control group. Axial and circumferential stress values were observed to differ from each other in both uniaxial (p < .001) and biaxial (p = .02) testing. In biaxial testing, inflection point (p < .001), elastic energy (p < .001), and tissue stress in both the circumferential (p < .001) and axial (p < .001) directions increased from Zone oA to Zone oC, indicating stiffening at higher stresses.

Conclusion: Aortic stress at inflection point increases along Zone o of the Aorta. This indicates that tissues from the root (Zone oA) engage at lower strains compared to Zone oB and Zone oC segments, suggesting that the aortic root may be stiffer and less elastic than the proximal and distal segments. Furthermore, differences in circumferential and axial stress values were observed in uniaxial and biaxial test conditions. These observations provide evidence of regional differences in the biomechanics of the ascending aorta and emphasize the anisotropic nature of aortic mechanical behavior. Future work is warranted to further evaluate the biomechanical heterogeneity within Zone o.

100. Single-Cell Analysis Reveals Paradoxical TGF-Beta Signaling and Increased Expression of Elastin-Associated Genes in the Aortic Wall That Is Specific to Ascending Aortic Aneurysms in Patients with Marfan Syndrome

Ashley Dawson¹, Yanming Li¹, Chen Zhang¹, Hernan Vazquez¹, Pingping Ren¹, Waleed Ageedi¹, Alon Azares², Aladdein Mattar¹, Hong S. Lu³, Lisa A. Cassis³, Joseph S. Coselli^{1,2}, Alan Daugherty³, Ying H. Shen^{1,2}, Scott A. LeMaire^{1,2}

¹Baylor College of Medicine, Houston, TX; ²Texas Heart Institute, Houston, TX;

³University of Kentucky, Lexington, KY

Invited Discussant: Thomas G. Gleason

Objective: Marfan syndrome (MFS) is known to be caused by mutations in *FBN1*, however the processes leading to aneurysm formation remain poorly understood. We have previously observed downregulation of transforming growth factor (TGF)-β signaling despite upregulation of the ligand *TGFB1* in fibroblasts in MFS compared to non-aneurysmal controls. Additionally, despite downregulation of *FBN1*, several elastin-associated genes were upregulated in fibroblasts and smooth muscle cells (SMCs) in MFS. We aimed to determine if these changes were unique to MFS by comparing cell-specific gene expression in MFS and sporadic ascending thoracic aortic aneurysms (ATAAs).

Methods: We performed single-cell RNA sequencing of ATAA tissues from patients with MFS (n = 4) and sporadic disease (n = 6). Tissues were digested, single cells isolated and sequenced, and data from non-immune cells were extracted. In all, 9450 non-immune cells underwent unsupervised clustering using the Seurat package in R.

Results: We identified 15 clusters of non-immune cells, including contractile SMCs (n=3), modulated SMCs termed fibromyocytes (n = 1), immature SMCs (n = 3), fibroblasts (n = 1), and endothelial cells (ECs; n = 2). Cluster proportion was similar in both groups with the exception of an increased proportion of fibroblasts in sporadic tissues (23% [1153/4964] vs 9% [384/4486]). Elastin-associated genes *FBN1*, *ELN*, and *MFAP4* were most highly expressed in fibroblasts and SMCs. *FBN1* was downregulated in fibroblasts and fibromyocytes while *ELN* was upregulated in fibroblasts in MFS compared to sporadic ATAAs. Neither were differentially expressed in other SMCs. *MFAP4* was downregulated in fibroblasts but upregulated in SMCs in MFS.

Within TGF-β signaling, *TGFB1* was most highly expressed in fibroblasts and SMCs. *TGFB1* was upregulated in fibroblasts and downregulated in fibromyocytes and contractile SMCs in MFS compared to sporadic tissues. TGF-β receptor expression differed by cluster; *TGFB1* was most highly expressed in SMCs and fibroblasts while *TGFB2* and *TGFB3* expression was highest in ECs. TGF-β receptors and downstream SMAD genes were downregulated in MFS compared to sporadic ATAAs in these clusters.

As the median age of patients with MFS was younger than those with sporadic disease (39 vs 67 yrs, p = 0.04), we also evaluated the differential gene expression in non-aneurysmal tissues in younger (n = 4; 41 yrs, IQR 34–45) vs older (n = 3; 61 yrs, IQR 57–62) controls. We did not identify similar changes to those described above, suggesting that the changes reflect differences in pathology rather than in patient age.

Differential Gene Expression between MFS and Sporadic Ascending Thoracic Aortic Aneurysms				
Gene	Gene Name	log2FC	FDR	Cluster
<i>Elastin-associated genes</i>				
<i>FBN1</i>	fibrillin-1	-1.521	9.39E-40	Fibroblast
<i>FBN1</i>	fibrillin-1	-0.788	4.29E-10	Fibromyocyte
<i>ELN</i>	elastin	1.018	5.04E-23	Fibroblast
<i>MFAP4</i>	microfibril-associated protein-4	-0.648	2.02E-14	Fibroblast
<i>MFAP4</i>	microfibril-associated protein-4	0.323	2.81E-04	Fibromyocyte
<i>MFAP4</i>	microfibril-associated protein-4	0.515	4.89E-17	Contractile SMC
<i>MFAP4</i>	microfibril-associated protein-4	0.514	7.37E-03	Proliferative immature SMC
<i>Genes associated with TGF-β signaling</i>				
<i>TGFB1</i>	transforming growth factor beta-1	1.124	1.53E-19	Fibroblast
<i>TGFB1</i>	transforming growth factor beta-1	-0.555	6.03E-07	Contractile SMC
<i>TGFB1</i>	transforming growth factor beta-1	-0.461	1.98E-04	Fibromyocyte
<i>TGFB1</i>	transforming growth factor beta receptor-1	-0.927	1.01E-13	Fibroblast
<i>TGFB2</i>	transforming growth factor beta receptor-2	-1.031	9.45E-21	Fibromyocyte
<i>TGFB2</i>	transforming growth factor beta receptor-2	-0.753	4.09E-15	Normal EC
<i>TGFB3</i>	transforming growth factor beta receptor-3	-0.891	4.77E-12	Normal EC
<i>SMAD2</i>	SMAD-2	-0.508	2.67E-05	Fibroblast
<i>SMAD3</i>	SMAD-3	-0.693	9.15E-08	Fibroblast
<i>SMAD4</i>	SMAD-4	-0.701	4.99E-07	Fibroblast
<i>SMAD5</i>	SMAD-5	-1.016	8.49E-18	Fibroblast
<i>SMAD5</i>	SMAD-5	-0.596	5.94E-08	Contractile SMC
<i>SMAD9</i>	SMAD-9	-1.216	6.90E-21	Fibroblast
<i>Genes that are upregulated in MFS compared to sporadic aneurysms are shown with log2FC in bold.</i>				
<i>MFS, Marfan syndrome; SMC, smooth muscle cell; EC, endothelial cell.</i>				

Conclusions: Our results indicate that upregulation of *TGFB1* in fibroblasts without associated upregulation of downstream TGF-β signaling is specific to ATAA in MFS. The upregulation of elastin-associated genes may indicate a compensatory response to the *FBN1* mutation rather than a response to aortic wall stress.

101. Predictors of Long-Term Stenosis in Bicuspid Aortic Valve Repair
 Cristiano Spadaccio¹, Arnaud Henkens¹, Antonio Nenna², Stefano Mastrobuoni¹, Emiliano Navarra¹, Guillaume Lemaire¹, *Alain Poncelet¹, David Vancraenest¹, Parla Astarci¹, *Gebrine El Khoury¹, *Laurent De Kerchove¹
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Invited Discussant: Emmanuel Lansac

Objective: To identify predictors of long-term aortic stenosis (AS) and reoperation for stenosis after bicuspid aortic valve repair.

Methods: A prospectively collected database of aortic valve repair surgery from a single center was analyzed with focus on echocardiographic and clinical outcomes of patients with bicuspid aortic valve (BAV). Classification and regression tree (CART) and survival analysis were performed to identify predictors of moderate-to-severe AS, reoperation for stenosis at long-term follow-up and freedom from reoperation.

Results: A total of 246 patients with BAV underwent repair surgery (mean age 41.6 ± 11.9). Indications for surgery included aortic regurgitation (AR) (56.5%), AR and ascending aorta aneurysm (42.3%), AS in 2 patients and dissection in 1 patient. Mean ascending aorta diameter was 42.7 ± 7.4 mm. Type of surgery included isolated valve repair (30.1%), valve repair and ascending aorta replacement (8.1%), valve sparing root replacement (VSSR) with reimplantation technique (58.9%). Techniques to achieve valve repair included central plicating stitch (88.2%), cusp resection (67.5%), resuspension with Gore-tex running suture (31.7%) and patch reconstruction (16.7%). Annuloplasty with Cabrol stitches was performed in 30.9% and with external rings in 4.9% of the patients. Incidence of reoperation for stenosis was 10.1% at 20 years, with 23.1% of patients found with moderate to severe AS at similar follow-up echocardiogram. Among the preoperative variables, age >58, Valsalva sinuses <36 mm and sinotubular junction (STJ) >42 mm were independent predictors of reoperation for AS. The presence of any of these factors identified a subpopulation at risk of reoperation for stenosis (SHR 4.06 CI 2.02–10.3 P < 0.001). Among intraoperative variables, multivariate analysis identified the presence of cusp fenestration (HR 4.33 0.14–12.95 P: 0.009) and patch reconstruction (HR 2.60 1.13–5.97 P: 0.024) as predictors of reoperation. Significant predictors of long-term echocardiographic moderate to severe AS included the finding of cusp perforation (HR 8.59 2.82–26.1), leaflet decalcification (HR 4.93 2.19–11.09) and use of Gore-Tex running suture of leaflet free margin (HR 1.88 1.00–3.53).

Conclusions: Age >58 or Valsalva sinuses <36 mm or STJ >42 mm identify a subpopulation of patients with ascending phenotype aortopathy who are at risk for stenosis after BAV repair surgery. Presence of cusp perforation or fenestration, use of pericardial patch or Gore-Tex sutures of leaflet free margin and leaflet decalcification are intraoperative factors associated to risk of AS.

102. Saphenous Vein versus Right Internal Thoracic Artery As a Y-Composite Graft: Ten-Year Angiographic and Long-Term Clinical Results of the SAVE RITA Trial

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Invited Discussant: Xin Chen

Objectives: We retrospectively compared the 10-year graft occlusion rates and long-term clinical outcomes of saphenous vein (SV) composite grafts with those of right internal thoracic artery (RITA) composite grafts in patients who were enrolled in the **S**aphenous **V**ein versus **R**ight **I**nternal **T**horacic **A**rtery as a Y-Composite Graft (SAVE RITA) trial.

Methods: Of 224 eligible patients with multivessel coronary artery disease who were randomized to undergo off-pump revascularization using the saphenous vein (SV group, n = 112) or right internal thoracic artery (RITA group, n = 112) as Y-composite grafts based on the in situ left internal thoracic artery from September 2008 to October 2011, 219 patients (SA group, n = 109; RITA group, n = 110) entered the analysis. A third limb conduit to lengthen the graft limb for complete revascularization was used in 47 patients (SV group vs RITA group, 8 vs 39). Postoperative 10-year (116.2 ± 9.6 months) angiograms were performed in 141 patients (64.4%; SV group = 66; RITA group = 75). Follow-up was complete in 98.6% (216/219) of patients with a median follow-up of 122.7 months (111.1–133.6 months).

Results: There was 1 operative death in the RITA group. No statistically significant differences in postoperative morbidities, including atrial fibrillation and acute renal failure, were observed between the groups. The number of distal anastomoses using the side-arm Y-composite graft (SV vs RITA) were 2.3 ± 0.8 and 1.9 ± 0.7 in the SV and RITA groups, respectively (*P* < .001). A third conduit was used in 44 patients (SV vs RITA groups, 4/109 vs 40/110; *P* < .001) to extend the side-arm Y-composite graft for complete revascularization. The overall graft occlusion rate was 4.2% (21/498) at 10 years (3.8% [9/234] in the SV group vs 4.5% [12/264] in the RITA group, *P* = .641). The 10-year occlusion rate of the second limb conduits in the SV group was 4.7% (7/149) and was non-inferior to that of the RITA group (3.5% [5/141]) within the 95% 2-sided confidence interval of –5.7% to 3.4% (*P* = .003 for non-inferiority). No statistically significant differences were found in the overall survival (*P* = .400) and the freedom from major adverse cardiac and cerebrovascular event rates (*P* = .800) between the 2 groups.

Conclusions: The saphenous vein composite grafts were noninferior to the right internal thoracic artery composite grafts in terms of 10-year graft occlusion rates and long-term clinical outcomes.

103. Secondary Prevention Medication with Statins and Major Adverse Events After Coronary Artery Bypass Grafting—A Population-Based Study from the Swedeheart Registry

Emily Pan¹, Susanne J. Nielsen^{2,3}, Ari Mennander⁴, Erik Björklund⁵, Andreas Martinsson⁶, Martin Lindgren⁶, Emma C. Hansson⁶, Aldina Pivodic^{3,7}, Anders Jeppsson⁶
¹Central Finland Central Hospital, Jyväskylä, Finland; ²Göteborg University, Gothenburg, Sweden; ³Sahlgrenska Academy, Gothenburg, Sweden; ⁴Tampere University Hospital, Tampere, Finland; ⁵South Alvsborg Hospital, Borås, Sweden; ⁶Sahlgrenska University Hospital, Gothenburg, Sweden; ⁷Statistiska Konsultgrupp, Gothenburg, Sweden

Invited Discussant: Paul Kurlansky

Objective: To evaluate the association between statin use after coronary artery bypass grafting (CABG) surgery and long-term major adverse events in a large population-based, nationwide cohort.

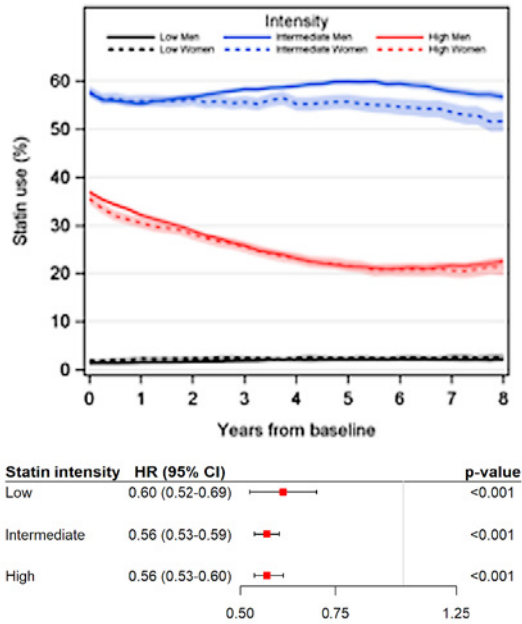


Figure 1: The curves present percentage of patients with time-updated dispensed statin prescriptions in men and women, stratified by intensity of statin dose. The forest plots compare association between on and off statin treatment in different intensity groups and major adverse cardiovascular events. Shaded area represents 95% confidence interval for proportions.

Methods: All 35,193 patients that underwent first time isolated CABG in Sweden from 2006 to 2017 and survived six months after discharge were included. Individual patient data from SWEDEHEART and four other nationwide registries were merged. Multivariable Cox regression models adjusted for age, sex, socioeconomic factors, comorbidities and time-updated treatment with other secondary preventive medications (beta-blockers, RAAS-inhibitors and platelet inhibitors), were used to evaluate the association between time-updated statin treatment and outcomes. Treatment with statins was studied overall and separately for low, intermediate and high dosages. Primary endpoint was major adverse cardiovascular events (MACE) including all-cause mortality, myocardial infarction and stroke. The follow-up started six months after discharge (baseline), and median time was 5.8 years (interquartile range 2.9–8.6).

Results: Statins were dispensed to 95.7% of the patients at baseline and to 78.9% after ten years. At baseline, 1.4% of the patients was dispensed low dose, 57.6% intermediate and 36.7% high dose statins. Ongoing statin treatment was associated with a significantly reduced risk for MACE (adjusted hazard ratio [aHR] 0.56 [95% confidence interval 0.53–0.59]), cardiovascular mortality (aHR, 0.54 [0.50–0.59]), stroke (aHR 0.66 [0.59–0.73]) and myocardial infarction (aHR 0.61 [0.55–0.69]), irrespective of the intensity of the statin dose (all $p < 0.001$).

Conclusions: Ongoing use of statins was in this large real-life study associated with a markedly reduced incidence of cardiovascular events and mortality after CABG. Initiating and maintaining statin medication is essential in CABG patients.

104. Utilization of Extracorporeal Life Support Therapies at Urban Teaching Hospitals: Trend Analysis Using ICD 9 and ICD 10 Data

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Invited Discussant: Tomasz A. Timek

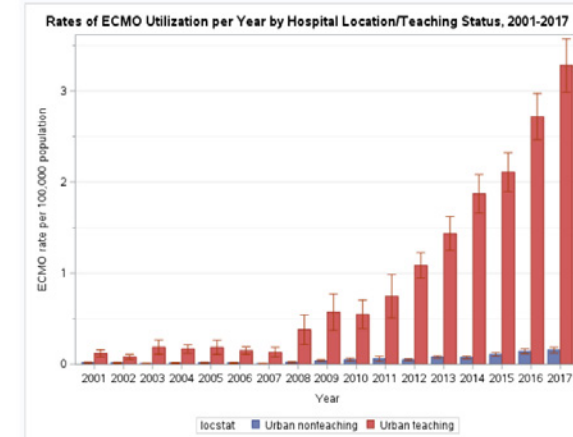
Objectives: The use of extra corporeal life support (ECLS) therapies, extracorporeal membrane oxygenation (ECMO) and PVAD (Percutaneous VAD) has witnessed exponential growth. We sought to identify trends of utilization of ECLS associated with the expansion of indications. Prior studies limit analysis to International Classification of Diseases, 9th edition (ICD-9) codes. We examined ECMO and PVAD growth from 2001 to 2017 using ICD-9 and 10 codes.

Methods: We used the National Inpatient Sample (NIS) to identify adult patients supported on ECMO and PVAD between 2001 and 2017. We compared trends in utilization depending on the expansion of indications for ECLS, and determined whether increased utilization occurred in rural versus urban teaching and non-teaching hospitals. Analyses were performed in SAS and incorporated trend weights to calculate national estimates of utilization and survey methods taking into account the complex design of the NIS. The yearly US census estimates (age 18 and older) were used to calculate utilization/100,000 persons.

Results: From 2001–17, a total of 104,086 hospitalizations in the U.S. coded for ECLS were identified, of which 40,463 involved ECMO and 63,623 were coded for PVAD. From 2008

to 2017 ECMO utilization increased 759%, from 0.4 to 3.4/100,000 population. Similarly, PVAD utilization increased 2118%, from 0.3 to 7.0/100,000 population. The mean age of the ECMO and PVAD cohorts was 50.8 and 62.3 years, respectively in 2008 vs 53.2 and 65.8 years in 2017. Most patients were white and male (Table). Teaching hospitals were the most common site of performance for both ECMO (95% both years) and PVAD (80.2% in 2008 and 82.4% in 2017). Survival in the ECLS hospitalization improved significantly for the ECMO cohort from 30.6% in 2008 vs 49.8% in 2017 ($p < .001$), but changed only slightly in the PVAD cohort from 72.2% in 2008 to 73.5% in 2017 ($p = .466$). Respiratory failure as an indication for ECLS increased dramatically from 2008 to 2017 for both ECMO (41.7% to 80.5%, respectively, $p < .001$) and PVAD (27.8% to 46.0%, $p < .001$).

Characteristic	ECMO		PVAD	
	2008	2017	2008	2017
Age, mean (SD)	50.8	53.2	62.3	65.8
Male	59.7%	65.5%	69.0%	71.9%
White race	60.4%	58.7%	59.4%	66.8%
Discharged alive	30.6%	49.8%	72.2%	73.5%
ECLS in Teaching Hospital	94.6%	95.2%	80.2%	82.4%
Indications				
Respiratory Failure	41.7%	80.5%	27.8%	46.0%
Cardiogenic Shock	37.7%	47.2%	35.4%	51.6%



Conclusion: This is the first study to evaluate utilization of ECLS using both ICD-9 and ICD 10 data. Massive growth in ECLS therapies has been noticed over last decade with improvement in survival.

105. Cerebral and Vascular Access Site Complications of Postcardiotomy Extracorporeal Life Support: Focus on Peripheral Cannulation Strategies

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Invited Discussant: Christian Andres Bermudez

Objective: To assess the impact of the primary arterial access (axillary vs femoral artery) on outcome of patients receiving postcardiotomy extracorporeal life support (PC-ECLS).

Methods: A retrospective analysis of 483 patients requiring PC-ECLS between 2000–2019 at a single center was performed. Patients were divided into groups according to primary arterial cannulation site (axillary artery [ax] or femoral artery [fem]). Patients with central cannulation (n = 43) were excluded. The rate of access-site related complications and fatal/disabling stroke was compared between both groups.

Results: Of 440 patients with peripheral ECLS cannulation, the axillary artery was cannulated in 250 patients (56.8%) while the femoral artery was used as primary access site in 190 patients (43.2%). There were no relevant differences in baseline parameters apart from duration of ECLS which was significantly longer in the axillary group (4.64 days [2.91–7.1 d] vs 4 d [2.45–6.2 d], p = 0.042). 30-day and 1-year survival were not significantly different with 62% and 42.5% in the axillary group vs 64.7% and 44.8% in the femoral group respectively. Incidence of CCT-confirmed stroke with a modified ranking scale (MRS) ≥4 was significantly higher in the axillary group (ax: n = 28, 11.2% vs fem: n = 4, 2.1%; p = 0.0002). Of 28 cases of stroke with MRS ≥4 in the axillary group, localization was right hemispheric in the majority of cases (right hemispheric n = 18 [64%]; bilateral n = 4 [14.3%], left hemispheric n = 4 [14.3%], infratentorial n = 2 [7.1%]). There was no significant difference in major cannulation site bleeding requiring surgical revision, however, change of cannulation site for bleeding was significantly more frequent in the ax group (ax: n = 13; 5.2% vs fem: n = 2; 1.1%; p = 0.0175). Clinically apparent limb ischemia (ax: n = 12, 4.8%; fem: n = 33, 17.4%; p < 0.0001) was significantly more frequent in the femoral group. Moreover, wound healing disorders requiring surgical intervention were significantly more frequent in the femoral group, (Table 1).

Table 1: Access Site Related Complications and Stroke Grouped by Primary Arterial Cannulation Site

	All Patients (n = 440)	Axillary Artery (n = 250)	Femoral Artery (n = 190)	P
Fatal/disabling stroke (≥MRS 4) n, %	32 (7.3)	28 (11.2)	4 (2.1)	0.0002
Thereof ischemic stroke n, %	23 (5.2)	19 (7.6)	4 (2.1)	0.0097
Major cannulation site bleeding n, %	60 (13.6)	34 (13.6)	26 (13.7)	0.99
Limb ischemia n, %	45 (10.2)	12 (4.8)	33 (17.4)	<0.0001
Fasciotomy n, %	22 (5)	8 (3.2)	14 (7.4)	0.075
Limb amputation n, %	5 (1.1)	2 (0.8)	3 (1.6)	0.656
Wound healing disorder/lymphocele n, %	44 (10)	10 (4.0)	34 (17.9)	<0.0001
Change of cannulation site for bleeding n, %	15 (3.4)	13 (5.22)	2 (1.1)	0.0175
Change of cannulation site for limb ischemia n, %	11 (2.5)	3 (1.2)	8 (4.2)	0.0628

Conclusions: Although survival did not differ between axillary and femoral artery cannulation, surgeons should be aware of the different complication profiles in the choice of peripheral access site for PC-ECLS. While lower rates of limb ischemia and the advantage of antegrade flow seem beneficial for axillary cannulation, the higher stroke rate, especially the high incidence of right hemispheric stroke in axillary artery cannulation is considerable.

106. Racial Disparities in Mitral Valve Surgery: A Statewide Analysis

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Invited Discussant: Dawn Hui

Objective: Racial disparities in access to medical and surgical care for cardiovascular conditions are well-established. The purpose of this study was to examine differences in preoperative characteristics, procedure selection, and short-term outcomes among races in patients undergoing mitral valve repair or replacement.

Methods: All patients who underwent isolated mitral valve repair or replacement with or without coronary artery bypass grafting from July 2011 to June 2020 in a statewide collaborative database were stratified into three racial groups, White, African-American, and ‘Other’. Preoperative characteristics, procedural performance, and outcomes were evaluated.

Results: A total of 9,074 mitral valve operations were performed at 33 centers with 11.11% (n = 1,009) of procedures occurring in African-American patients. The overall rate of mitral valve repair was 64.4%. White patients were significantly more likely to undergo repair compared to the African-American or ‘Other’ groups (66.01% White, 53.32% African-American, 57% Other [p < 0.0001]). African-American patients were significantly younger at the time of intervention (57.3 ± 12.2 years) compared to the White (65.4 ± 12.1 years) or ‘Other’ (61.9 ± 14.5) race groups (p < 0.0001). Preoperative combined STS morbidity and mortality was significantly higher for African-American patients compared to White or ‘Other’ races (32% African-American, 22% White, 23% ‘Other’ [p < 0.0001]) due to higher rates of diabetes, hypertension, chronic lung disease. Operative mortality was similar across racial groups (White 3.7%, African American 4.6%, ‘Other’ 4.5% [p = 0.356]). However, African-American patients were significantly more likely to have a length of stay greater than 14 days (19.6%) compared to White (10.4%) or ‘Other’ (14%) race groups. African-Americans were also discharged to extended care facilities at higher rates (30.8%) relative to White patients (21.69%) with higher rates of readmission (23.4% African-American, 14.5% White [p < 0.0001]).

Conclusions: Compared to Whites, African Americans underwent mitral valve surgery at a significantly younger age with higher rates of comorbid conditions. Importantly, African-American patients were less likely to undergo mitral valve repair, had longer lengths of stay, and were more likely to require readmission. These findings support a focused emphasis on recognition, understanding, and reducing disparities in mitral valve surgery.

107. Survival After Mitral Valve Repair, Replacement, or Clip in Octogenarians with Non-Ischemic Mitral Regurgitation

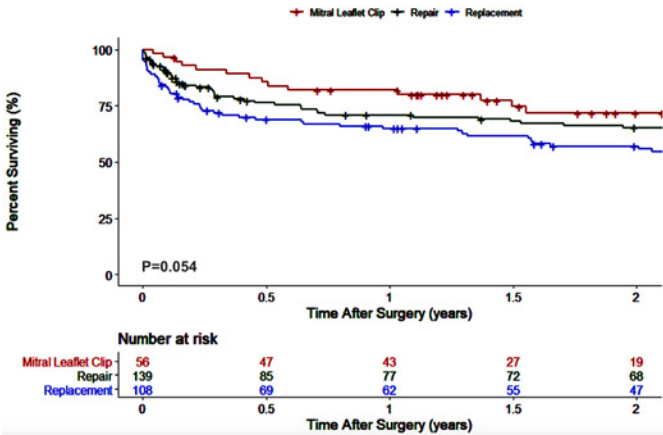
Meghan O. Kelly, Samuel Perez, Nadia H. Bakir, Martha M.O. McGilvray, Christian Zemlin, Marc R. Moon, Ralph J. Damiano, Spencer J. Melby
Barnes Hospital, Saint Louis, MO

Invited Discussant: Matthew A. Romano

Objective: The number of patients aged ≥80 years old who need mitral valve intervention is increasing. New technology such as the MitraClip and advances in surgical and perioperative care make it important to understand outcomes in this group of patients. Our goal was to assess differences in outcomes in patients ≥80 years old who underwent mitral valve intervention for nonischemic pathology.

Methods: All patients >80 who underwent mitral valve surgery or clip for nonischemic pathology at our institution between January 2000 and December 2019 were retrospectively reviewed. Type of surgery or clip placement was determined by clinical factors, although surgical repair was favored. Mortality outcomes were evaluated by valve/leaflet pathology and procedure type. Thirty preoperative and perioperative covariates were evaluated as risk factors for late mortality. EuroSCORE II values were analyzed by ANOVA and Tukey Pairwise-comparison was done to compare groups. Univariable and multivariable risk factors for late mortality were evaluated by Cox proportional hazards regression. Discharge to home versus facility as a surrogate for functional status was assessed.

Results: Operative mortality was 11.5% (n = 16/139), 18.5% (n = 20/108), and 0% (n = 0/56) in the repair, replacement, and clip groups. When evaluated by EuroSCORE II, baseline characteristics were similar for the repair (8.6% ± 7.7%) and clip (7.6% ± 7.2%) groups (P = 0.75) but were significantly worse in the replacement group (13.3% ± 10.6%) vs the repair and clip groups (P < 0.001 for both). On multivariable analysis, predictors of late mortality included renal failure [2.9 (1.66–5.09), P < 0.001], NYHA III/IV [1.72 (1.11–2.67), P = 0.02], and calcific disease [1.88 (1.12–3.16), P = 0.03]. The number of patients discharged to home was 45% (n = 63/139), 34% (n = 37/108) and 80% (n = 45/56) in the repair, replacement, and clip groups (P < 0.0001). Longitudinal survival was not significantly different amongst all three groups (Figure).



Conclusions: Long-term survival was similar following mitral valve repair, clip, or replacement in octogenarians. Renal failure, worse NYHA class, and calcific mitral disease portended worse outcomes. Although fewer patients had the less invasive clip procedure, it demonstrated promising results with low operative mortality, high rate of discharge to home, and excellent survival. Larger studies to examine the mitral clip procedure compared to open surgical intervention in this elderly population are needed.

108. The Ross/Konno Procedure in Infancy Is a Safe and Durable Solution for Aortic Stenosis

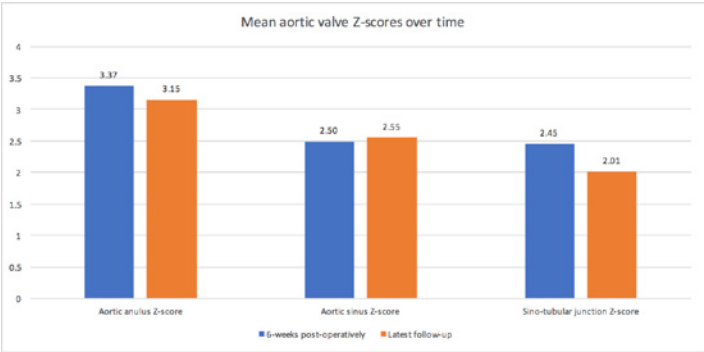
Jack Luxford^{1,2}, Julian Ayer^{1,2}, Yishay Orr¹, Gananjay Salve¹, Gary Sholler^{1,2}, Philip Roberts¹, David Winlaw^{1,2}

¹The Children’s Hospital at Westmead, Sydney, Australia; ²The University of Sydney, Sydney, Australia

Invited Discussant: Victor T. Tsang

Objective: The role of the Ross/Konno procedure in early infancy remains contentious. We aimed to characterize early and mid-term outcomes following Ross/Konno procedure performed in infancy for severe aortic valve disease. Our institution has a preference for balloon dilatation as the initial intervention for aortic stenosis.

Methods: Between January 1995 and December 2018, 35 infants under one year (including 13 neonates) underwent a Ross/Konno procedure. Patients were followed up to a median of 4.1 years (range 0.4–21.0). Primary outcome measures were survival, early morbidity, freedom from re-intervention and long-term functional and echocardiographic status.



Results: Median age at operation was 49 days (range 4–265) and weight was 4 kg (2.4–7.1). Thirty-one (89%) had undergone a prior procedure, including balloon valvuloplasty in 26 (74%). The haemodynamic indication for operation was stenosis in 26 (74%), mixed stenosis/regurgitation in 3 (9%), and isolated regurgitation in 6 (17%, in 4, this was secondary to balloon valvuloplasty). Five patients underwent a Ross procedure, 30 required annular enlargement (Konno incision). Five required concomitant aortic arch surgery (2 neonates, 3 infants). Post-operatively 6 patients (17%) required temporary ECMO support. Median length of intubation post-operatively was 7 days (range 2–34), intensive care unit stay was 17 days (3–161), and time to hospital discharge was 30 days (8–235). There were no early deaths, and one late death at 18 months. The Kaplan Meier survival estimate was 100% at

1-year (32 at risk) and 97% (SE = 3.2) at 5-years (16 at risk) and 10-years (7 at risk). Freedom from re-operation was 85% (SE = 6.2) at 1 year, 76% (SE = 8.5) at 5 years, and 62% (SE = 11.2) at 10 years. One modified Konno was performed at 5 years. Eight surgical RV-PA conduit replacements have been required and two percutaneous pulmonary valve implantations. Three have required mitral valve operation—two repairs, and one replacement. One child required a permanent pace-maker for complete heart block. At latest follow-up, 32 (94%) of 34 survivors were asymptomatic. Twenty-five (74%) had none or only trivial neo-aortic regurgitation, and nine (26%) had mild neo-aortic regurgitation. Mean neo-aortic annulus, sinus, and sino-tubular junction diameter Z-scores were 3.2 (SD = 1.2), 2.6 (SD = 1.1), and 2.1 (SD = 1.1), respectively. There was no statistically significant change in Z-scores over time from 6-week post-operatively to latest follow-up. Seven (20.6%) had moderate or severe RVOT obstruction. Sixteen (47%) had moderate or severe RV-PA conduit regurgitation.

Conclusions: The neonatal and infant Ross/Konno procedure can be performed with low risk of mortality and achieves a stable, high quality left ventricular outflow tract. There remains significant early morbidity and an inevitable need for re-intervention to address RV-PA conduit dysfunction.

109. Valve-Sparing Root Replacement After the Ross Procedure

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University of Michigan, Ann Arbor, MI

Invited Discussant: Jennifer S. Nelson

Objectives: The Ross procedure is a preferred treatment for infants and children with aortic valve disease. Progressive aortic root dilation and aortic insufficiency (AI) are late complications of the Ross procedure. Due to the frequent young age in this population, valve sparing aortic root procedures are appealing for the treatment of these late complications. The aim of this study is to better understand this unique cohort of patients and the impact of different aortic valve sparing techniques on outcome.

Methods: A retrospective chart review of all patients treated with valve sparing aortic root replacement after a prior Ross procedure at single center from 4/2008 to 9/2020 was performed. Clinical characteristics of this cohort were analyzed. The study was approved by the Institutional Review Board.

Results: Twenty-one patients with aortic root and valve pathology who had previously undergone a Ross procedure in childhood were identified. Patients were treated with the David V procedure (15), a traditional Yacoub procedure (1), or a modified Yacoub procedure that utilizes an annuloplasty ring (5). The modified Yacoub procedure has been adopted in our institution over the past two years and obviates the need for deep root dissection as well as remodels and stabilizes the annulus based on existing leaflet sizes. Patient demographics and comorbidities were similar between groups. Mean follow-up for these three cohorts were 7.9 years, 10.8 years, and 0.2 years respectively. Overall survival was good, with one early death due to hemorrhage in the David V group and

one death due to malignancy in the Yacoub group. Three patients (2 David V; 1 Yacoub) required subsequent aortic valve replacements within three years due to AI while none in the modified Yacoub group have required any reintervention and continue to have minimal to no AI. Overall, patients requiring valve replacement had lower grades of pre-operative AI and higher grades of postoperative AI. Greater than mild postoperative AI predicted the need for subsequent aortic valve reinterventions.

Conclusions: Valve sparing aortic root replacement is a safe procedure in patients with a history of a prior Ross procedure. Greater than mild AI on post-operative echocardiogram should prompt additional attempts at valve repair or replacement prior to leaving the operating room. A modified Yacoub aortic root replacement with annuloplasty that is personalized to the patient's individual anatomy is safe with good short-term results.

110. Valve-Sparing Aortic Root Reconstruction in Children and Adults: A Dual-Center Experience

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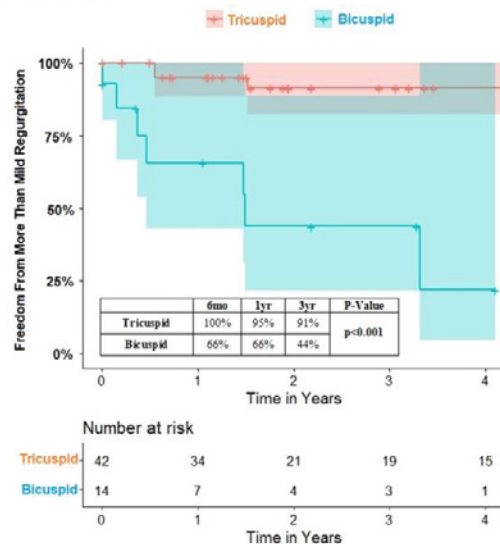
Invited Discussant: Edward Hickey

Objective: The purpose of this study is to review a dual-institution experience with valve-sparing aortic root reconstruction (VSARR) in children, teenagers, and adults.

Methods: Patients who underwent VSARR from 2003 to 2019 at two institutions with congenital cardiac surgery programs were included in the current study. Results of this dual-institution experience with VSARR in children, teenagers, and adults were retrospectively analyzed.

Results: Between 2003 and 2019, 70 patients underwent VSARR at our two institutions. Median age at surgery was 21 years (range = 7–59 years). Indications for VSARR included aortic root dilation (n = 68) and aortic dissection (n = 2). Loeys-Dietz syndrome was prevalent in 12 (17%), Marfan Syndrome in 27 (39%), and bicuspid aortic valve in 18 (26%). Concomitant procedures included replacement of ascending aorta (n = 6) and replacement of aortic arch (n = 2). Median length of stay was 5 days (interquartile range [IQR] = 4–7 days). Cardiac complications requiring reoperation occurred in 10 patients, with the most common complications being aortic aneurysm/dissection (n = 3) and coronary button aneurysm/stenosis (n = 2). No patients required aortic valve replacement after VSARR. There were no in-hospital deaths post-operatively. At a median follow up of 3.2 years (IQR = 1.6–7.6 years), 69 of 70 (99%) patients remained alive. Bicuspid aortic valves (BAV) were associated with development of significant aortic regurgitation (>mild) post-operatively, with >90% of tricuspid aortic valves remaining free of significant aortic regurgitation at 4 years (Figure).

Figure: Kaplan-Meier curves comparing freedom from more than mild regurgitation between tricuspid and bicuspid patients after VSARR surgery.



Conclusions: VSARR is a reliable and reproducible technique that achieves acceptable short and long-term outcomes. No patients experienced in-hospital mortality and 99% remain alive at a median of 3 years. The majority of patients (>85%) in our series never experienced more than mild regurgitation post-operatively but the presence of BAV was associated with increased likelihood of significant aortic regurgitation.

111. Long-Term Outcomes of Aortic Valve Repair for Isolated Congenital Aortic Stenosis in Children

Fraser R.O. Wallace, Edward Buratto, Michael Zhu, Tyson A. Fricke, Christian P. Brizard, Igor E. Konstantinov

Royal Children's Hospital, Melbourne, Parkville, Australia

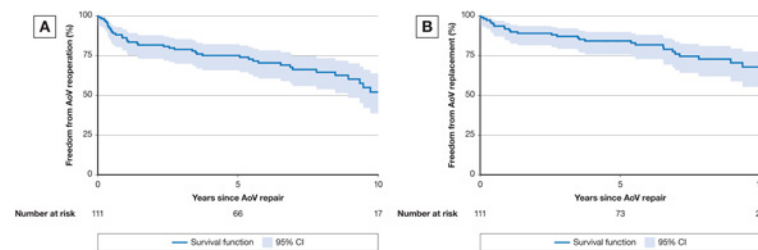
Invited Discussant: Ming Si

Objective: Congenital aortic stenosis may be treated with either surgical valve repair or balloon valvuloplasty, and there is ongoing controversy regarding the optimal strategy. In our institution the preferred initial approach is surgical aortic valve repair, with the aim of preserving the native valve, and delaying the Ross procedure as long as possible. We aimed to assess the long-term outcomes of children with isolated congenital aortic stenosis who underwent aortic valve repair.

Methods: All children (n = 111) with isolated congenital aortic stenosis who underwent aortic valve repair between 1980 and 2016 were reviewed.

Results: Median age at surgery was 0.5 years (IQR: 1 month–9.1 years) and median weight at surgery was 7.0 kg (IQR: 3.9–29.6 kg). Fifty-two patients (46.8%, 52/111) underwent AoV repair with the use of patches. Neonates comprised 26.1% (31/111) of the cohort. Operative mortality was 0.9% (1/111). Overall survival was 99.1% ± 0.01 (95% CI: 93.8–99.9) at 10 years.

Overall freedom from AoV reoperation was 75.1% ± 0.1 (95% CI: 65.8–82.2) at 5 years and 52.1% ± 0.1 (95% CI: 38.7–63.8%) at 10 years (Figure 1A). Specifically in neonates, freedom from AoV reoperation at 5 years was 61.3% ± 0.1 (95% CI: 42.0–75.9) at 5 years, 31.8% ± 0.1 (95% CI: 14.6–50.6) at 10 years. Risk factors for AoV reoperation on multivariate analysis were neonatal age at operation (p = 0.02, HR 1.9, 95% CI: 1.1–3.4) and concomitant mitral regurgitation (p = 0.01, HR 2.2, 95% CI: 1.2–4.1). The use of pericardial patches was not a risk factor for AoV reoperation. Freedom from AoV replacement was 83.5% ± 0.03 (95% CI: 75.4–89.2) at 5-years and 65.6% ± 0.06 (95% CI: 53.5–75.22) at 10-years (Figure 1B).



Conclusions: Aortic valve repair achieves relief of congenital aortic stenosis with very low early mortality and excellent long-term survival, even in neonates. However, nearly half of all patients required aortic valve reoperation by 10 years. The use of patch reconstruction was not associated with worse freedom from reoperation. Surgical aortic valve repair allows eventual replacement to be delayed until later childhood or adulthood.

112. Long-Term Surgical Outcomes of Primary Supravalvar Aortic Stenosis Repair with Modified Simple Sliding Aortoplasty

Eun Seok Choi, Chun Soo Park, Bo Sang Kwon, Tae-Jin Yun

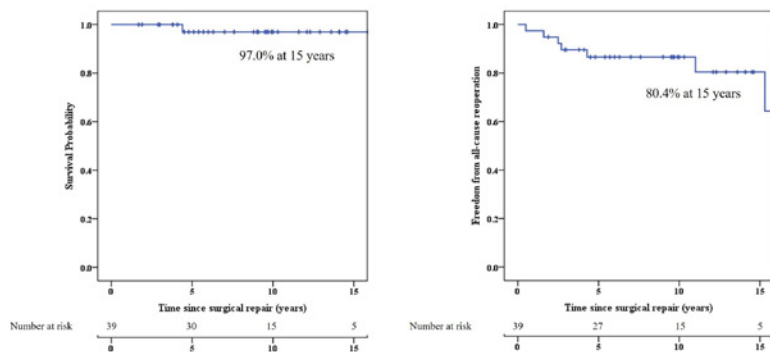
Asan Medical Center, Seoul, Republic of Korea

Invited Discussant: Dilip Nath

Objective: Supravalvar aortic stenosis (SVAS) is a rare congenital anomaly. The aim of the study was to evaluate long-term prognosis of patients who underwent primary SVAS repair.

Methods: Between 1999 and 2018, 39 patients underwent surgical repair of primary SVAS. A total of 25 (64.1%) patients had Williams syndrome. Bicuspid aortic valve was found in 5 (12.8%) patients. Four (10.3%) patients had diffuse type SVAS. Median age and body weight at operation was 4.3 years (interquartile range [IQR], 1.1–8.2) and 16.9 kg (IQR, 9.8–31.5) respectively. The surgical technique of modified simple sliding aortoplasty was applied in 35 (89.7%) patients. Pulmonary artery stenosis was repaired concomitantly in 14 (35.9%) patients. Median follow-up duration was 9.5 years (IQR, 5.1–13.6). Medical records were reviewed and analyzed retrospectively.

Results: There was no early death but one late death. Overall survival rates was 97.0% at 15 years. There were 7 reoperations during follow-up. Freedom from left ventricular outflow tract reoperation were 91.9% at 15 years. Freedom from all-cause reoperation was 80.4% at 15 years. Age younger than 2 years and preoperative mild or greater mitral regurgitation were associated with all-cause reoperation in the univariable analysis.



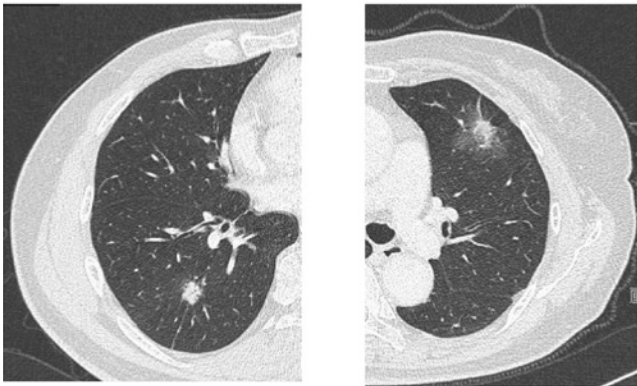
Conclusions: Long-term survival is excellent in patients who underwent surgical repair of SVAS with modified simple sliding aortoplasty. Regular medical follow-up is mandatory because all-cause reoperation rate is significant.

113. Subsolid Lesions Exceeding 3 cm: Do the Ground-Glass Opacity Components Still Matter?

Fanfan Fan
Shanghai Cancer Center, Shanghai, China
Invited Discussant: Robert E. Merritt

Objective: Recent studies on the favorable prognosis of ground-glass opacities (GGO) featured lung adenocarcinoma compared with solid nodules were limited to small tumors measuring ≤ 3.0 cm. This study aimed to investigate whether GGO component could predict better prognosis in patients with large subsolid lesions exceeding 3 cm compared with small solid nodules within the same clinical T category.

Similar solid part size, whose prognosis is better?



Solid nodule 1.5cm

Subsolid lesion 4.5cm
Solid part size 1.5cm

Methods: From 2010 to 2015, a total of 1010 patients with completely resected clinical No lung adenocarcinoma were enrolled, including 860 solid lesions and 150 subsolid lesions exceeding 3 cm. To analyze the prognostic significance of GGO component, propensity score matching (PSM) adjusting solid component size was performed.

Results: After PSM, 144 pairs of patients were finally analyzed. The mean size of the solid component was 23.7 mm in the GGO group and 24.4 mm in the solid group ($p = 0.450$). The GGO group had significantly better overall survival and recurrence-free survival ($p = 0.011$ and $p = 0.003$, respectively), which were also validated in patients with solid-predominant lesions. Subgroup analysis showed the GGO group was associated with better prognosis in each clinical T category.

Conclusions: The prognosis of patients with GGO lesions exceeding 3 cm was better than that of patients with small solid lesions even within the same clinical T category. Clinical T classification incorporating GGO component may provide better prognostic prediction for patients with lung cancer exceeding 3 cm.

114. Complete Lymphadenectomy for Clinical Stage I Lepidic Adenocarcinoma of the Lung: Is It Justified?

Giulio Maurizi, Antonio D'Andrilli, Anna Maria Ciccone, Mohsen Ibrahim, Claudio Andreotti, Camilla Vanni, Simone Maria Tierno, Federico Venuta, Erino Angelo Rendina
Sapienza University of Rome, Rome, Italy
Invited Discussant: Allison J. McLarty

Objective: The role of a systematic lymphadenectomy in patients undergoing surgery for clinical stage I lung lepidic adenocarcinoma is still unclear. In last years, some authors have advocated the possibility to avoid a complete lymph-node dissection in this setting. Results of patients who received systematic hilar-mediastinal nodal dissection for this oncologic condition are here reported.

Methods: Between 2012 and March 2019, 135 consecutive patients underwent lung resection for clinical stage T1/T2No lepidic adenocarcinoma, at our institution. Only patients ($n = 98$) undergoing lobectomy or sublobar resection associated with systematic hilar-mediastinal nodal dissection were retrospectively enrolled in the study.

Results: Patients' mean age was 67.8 ± 8.7 years (range 37–84). Three were 52 females and 46 males. Resection was lobectomy in 77.6% ($n = 76$) and sublobar in 22.4% ($n = 22$). All the resections were complete (Ro). Histology was lepidic predominant adenocarcinoma in 85 cases and minimally invasive adenocarcinoma in 13 cases. At pathologic examination, No was confirmed in 78 patients (79.6%), while N+ was found in 20 cases (20.4%), (N1 in 12, 12.2% and N2 in 8, 8.2%). No mortality occurred. Complication rate was 8.2%. At a median follow-up of 45.5 months, recurrence rate was 26.5%. Disease-free 5-year survival was 98.6% for stage I, 75% for stage II and 45% for stage III, $p < 0.001$.

Conclusions: A complete nodal dissection can reveal occult nodal metastases in lepidic adenocarcinoma patients and can increase the accuracy of pathologic staging. N1/N2 disease is a negative prognostic factor for this histology. A systematic lymph-node dissection should be considered even in this setting.

115. Pattern and Impact of Nodal Metastases After Neoadjuvant and Surgical Treatment in Esophageal Adenocarcinoma

Caitlin A. Harrington, Rebecca Carr, Smita Sihag, Prasad Adusumilli, Manjit Bains, Matthew Bott, James Isbell, Bernard Park, Gaetano Rocco, Valerie Rusch, David Jones, Daniela Molena

Memorial Sloan Kettering Cancer Center, New York, NY

Invited Discussant: Harmik J. Soukiasian

Objective: Although the pattern of nodal metastasis and the prognosis of number and location of positive nodes have been well described with esophageal cancer undergoing upfront surgery, little is known about nodal metastasis after neoadjuvant treatment. The aim of this study is to assess the pattern of nodal metastases in esophageal adenocarcinoma treated with neoadjuvant chemoradiation and surgery and evaluate its effect on prognosis.

Methods: All patients with esophageal adenocarcinoma who had undergone neoadjuvant chemoradiation and an Ro esophagectomy between 2010 and 2018 at our institution were included (n = 577). Pathology reports were reviewed for sites of lymph node metastases. Patients were excluded if nodal stations were not listed separately (n = 40). Age, sex, race, tumor location, histologic grade, pT stage, number of positive lymph nodes, number of positive nodal stations, and specific nodal stations were analyzed for risk of recurrence using univariate Cox regression, and significant covariates were included in a multivariate Cox regression model.

Results: Of 537 patients, 193 (40%) had pathologic nodal metastases (mets) at time of surgery. 153 patients (32%) had single station disease: 135 (88%) at the paraesophageal station, 16 (10%) at the left gastric, 1 at the subcarinal and 1 at the paratracheal station (0.65% each). 32 patients (6.0%) had two-station and 8 (1.5%) had three-station disease. The majority of patients with multiple positive nodal stations had positive nodes in the paraesophageal (90%) and/or left gastric artery stations (60%), whereas subcarinal, celiac, paratracheal and inferior pulmonary ligament nodes were positive in 33%, 15%, 7.5% and 2.5% of cases respectively. On univariate analysis, both number of positive lymph nodes and positive nodal stations were significantly associated with increased risk of recurrence. On multivariate analysis, age, race, pT, and pathologic grade were combined with number of positive stations, and significant individual stations (subcarinal, paraesophageal and left gastric). Number of positive nodal stations (1 station: HR 1.74, CI 1.33–2.27; 2 stations: HR 3.06, CI 1.98–4.70; p < 0.001), subcarinal (HR 2.30, CI 1.23–4.28, p = 0.009) and paraesophageal stations (HR 1.697, CI 1.322–2.178, p < 0.001) were associated with increased risk of recurrence.

Conclusions: Patients who have undergone neoadjuvant and Ro esophagectomy for adenocarcinoma often have lymph node metastases at time of surgery, most commonly at the paraesophageal station. The number of nodal stations, subcarinal and paraesophageal metastases were associated with increased risk of recurrence, with multi-station metastases carrying an especially high risk.

116. The Optimal Extent of Lymphadenectomy for Patients with Esophageal Squamous Cell Carcinoma: Results from Two Randomized Clinical Trials

Bin Li

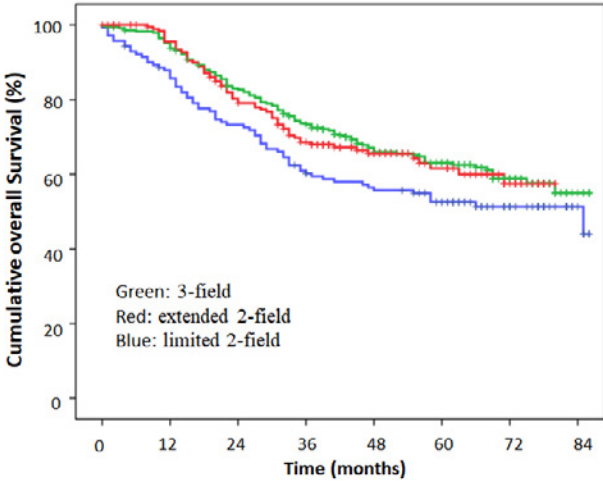
Fudan University Shanghai Cancer Center, Shanghai, China

Invited Discussant: Cherie P. Erkmén

Objective: To determine the optimal extent of lymph nodes dissection for patients with resectable esophageal squamous cell carcinoma (ESCC).

Methods: Patients with ESCC, from 2 randomized clinical trials, were divided into 3 groups based the extent of lymphadenectomy, limited 2-field lymphadenectomy (middle and lower mediastinum and upper abdomen), extended 2-field lymphadenectomy (total mediastinum and upper abdomen), and 3-field (neck, chest and abdomen) lymphadenectomy. Disease-free survival (DFS) and overall survival (OS) were compared among the 3 groups.

Results: A total of 665 patients were included, with 140 patients (21.1%) in limited 2-field group, 228 (50.8%) in the extended 2-field group, and 187 (28.1%) in the 3-field group. Of the 665 patients, there were 538 male patients, the median age were 61 years, 436 patients (65.6%) had the tumor located in the middle esophagus, and 229 (34.4%) in the lower esophagus. Based on postoperative examination, there were 322 T1/2 tumors (48.4%) and 343 T3/4 tumors (51.6%), and 313 patients (47.1%) had lymph node metastasis. For patients in the limited 2-field group, extended 2-field group, and 3-field group, 5-year DFS were 45%, 54%, and 57%, respectively, and 5-year OS were 53%, 63%, and 61%, respectively.



Conclusions: For patients with middle and lower esophagus, extended 2-field with lymph nodes dissection in the upper mediastinum is the necessary during esophagectomy.

117. Comparative Effectiveness of Primary Radiation Therapy versus Surgery for Stage I Lung Cancer in Otherwise Healthy Patients: An Instrumental Variable Analysis

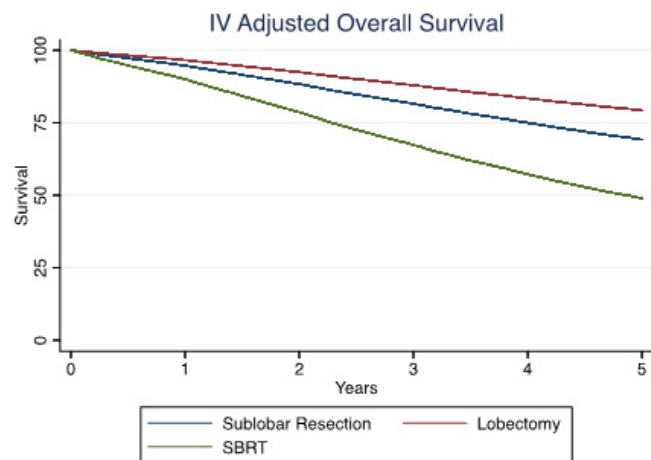
Michael J. Littau, Jr.¹, Richard Freeman², Wickii Vigneswaran², James Lubawski², Fred A. Luchette^{2,3}, Marshall S. Baker^{2,3}, Wissam Raad², Tyler Grenda⁴, Zaid M. Abdelsattar^{1,2}, Maria Lucia L. Madariaga⁵

¹Stritch School of Medicine – Loyola University Chicago, Maywood, IL; ²Loyola University Medical Center, Maywood, IL; ³Edward Hines Jr. VA Hospital, Hines, IL; ⁴Thomas Jefferson University Hospital, Philadelphia, PA; ⁵University of Chicago Medical Center, Chicago, IL

Invited Discussant: Harvey I. Pass

Objective: Radiation therapy is an established primary treatment modality in lung cancer patients with multiple comorbidities and/or advanced stage disease. However, its role in otherwise healthy patients with stage I lung cancer is unclear. In this context, we compare the effect of primary radiation therapy versus surgery on overall survival using a national database.

Methods: We identified all patients with clinical stage I (cT1No) non-small cell lung cancer from the National Cancer Database (NCDB) between 2004 to 2016. We excluded patients with a Charlson Deyo comorbidity index of 1 or greater and those who had a contraindication to surgery. We included only patients who had no comorbid disease and either received surgery or were offered surgery but opted for primary radiation therapy instead. We first used propensity score matching and Cox proportional hazard models to identify factors associated with overall survival (OS). To further account for unmeasured confounding, we then fit 2-stage residual inclusion models using an Instrumental Variable (IV) approach and used these to compare the effect of radiation therapy to that of surgery on OS.



Results: 26,080 patients met all inclusion/exclusion criteria. 5,465 (21%) were treated with primary radiation therapy. In the surgery group, 15,822 (76.6%) underwent lobectomy, 4,676 (22.7%) underwent a sub-lobar resection, and 117 (0.6%) underwent a pneumonectomy. On unadjusted analysis, patients receiving radiation therapy were older

(74.9 ± 9.1 vs 66.8 ± 10.2; $p < 0.001$), more likely to have squamous histology (30.9% vs 18.3%; $p < 0.001$) and less likely to have private insurance (13.2% vs 34.3%; $p < 0.001$) than those undergoing surgical resection. On Cox modeling, advanced age (HR 2.32), squamous histology (HR 1.12), cT1c stage (HR 1.28), and radiation therapy (HR 2.87) were associated with increased risk of death (all $p < 0.03$). In the IV adjusted model, radiation therapy remained associated with increased risk of death (HR 2.64, $p < 0.001$). Lastly, both lobectomy (HR 0.17) and sub-lobar resection (HR 0.28) were associated with improved overall survival compared to primary radiation therapy (Figure; all $p < 0.001$).

Conclusions: In otherwise healthy patients with stage I NSCLC, surgical resection is associated with a survival benefit compared to primary radiation therapy. This is true for both lobar and sub-lobar resections. These findings are important for optimal shared decision-making when considering treatment options.

118. Endobronchial Ultrasound-Guided Bipolar Radiofrequency Ablation for Lung Cancer: A First-in-Human Clinical Trial

Tsukasa Ishiwata¹, Hideki Ujiie¹, Terunaga Inage¹, Yamato Motooka¹, Kosuke Fujino¹, Masato Aragaki¹, Zhenchian Chen¹, Tomonari Kinoshita¹, Alexander Gregor¹, Andrew Effat¹, Nicholas Bernards¹, Laura Donahoe¹, Jonathan Yeung¹, Marcelo Cypel¹, Marc De Perrot¹, Andrew Pierre¹, Gail Darling¹, Thomas Waddell¹, Shaf Keshavjee¹, Prodipto Pal², Kazuhiro Yasufuku¹

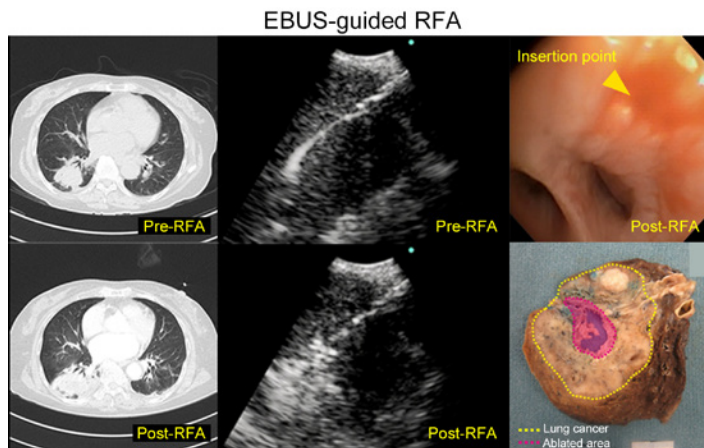
¹Division of Thoracic Surgery, Toronto General Hospital, University Health Network, Toronto, ON, Canada; ²Department of Laboratory Medicine and Pathobiology, University Health Network, Toronto, ON, Canada

Invited Discussant: Thomas Gildea

Objective: Radiofrequency ablation (RFA) is a therapeutic option for treatment of lung tumors. Currently, percutaneous access is the standard for monopolar RFA but has constraints such as predominantly done by interventional radiology, limited access to central lung regions and potential complications (e.g., pneumothorax, hemothorax). To overcome these limitations, a needle-type bipolar RFA device compatible with an endobronchial ultrasound (EBUS) bronchoscope enabling real-time ultrasound guidance has been developed. The aim of this study was to evaluate the safety and to characterize the ablation zone created by EBUS-guided RFA within a lung tumor.

Methods: This was a single-center, prospective observational study including patients who were scheduled for surgical resection for clinical stage I or II lung cancer with 1 cm or larger tumor that was accessible via an EBUS bronchoscope. The procedure was performed in the guided therapeutic operating room (GTx OR) equipped with computed tomography (CT) scanner and a cone-beam CT. Excluded patients were those with prior treatment with radiation and/or chemotherapy, or with any electronic implantable device. Under general anesthetic, the RFA electrodes were placed within the lung nodule under EBUS guidance followed by ablation with the total delivered energy ranging from 4 to 8 kJ. Cone-beam CT was used for real-time monitoring of RFA ablation. After EBUS-guided RFA, bronchoscopy and radiological assessment by CT was conducted to evaluate the safety and effect. Subsequently, the patient underwent surgical resection in the same setting. The resected lung underwent pathological assessment to measure and characterize the ablation zone.

Results: A total of five primary lung cancers (4 adenocarcinomas and one squamous cell carcinoma) were ablated in five separate patients. For a total energy of 4 kJ (n = 3), 6 kJ (n = 1), and 8 kJ (n = 1) delivered, the mean ablation time was 13.8 min (range: 10.3–16.0 min), 8.4 min, and 15.6 min, and the average of maximum ablation diameter according to pathological assessment was 1.8 cm (range: 1.3–2.1 cm), 2.7 cm, and 2.6 cm, respectively. All ablations were located within the tumor boundaries, as intended. No adverse events related to RFA procedures were observed.



Conclusions: This first-in-human trial demonstrated that EBUS-guided bipolar RFA can access and safely ablate lung tumors under real-time ultrasound guidance. EBUS-guided bipolar RFA may become a minimally invasive therapeutic option for patients with lung cancer.

119. The Feasibility Study of a Novel Localization Technique Using Radiofrequency Identification Marker for Deeply Located Small Lung Lesions

Yojiro Yutaka¹, Toshihiko Sato², Satona Tanaka¹, Soh Miyahara², Akinori Iwasaki², Hiroshi Date¹

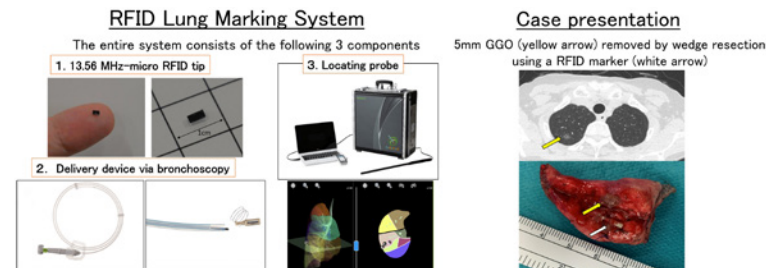
¹Kyoto University Hospital, Kyoto, Japan; ²Fukuoka University Hospital, Fukuoka, Japan

Invited Discussant: Anthony W. Kim

Objective: We introduced a novel localization technique for deeply located small lung lesions using wireless communication using radiofrequency identification (RFID) technology. Micro-RFID tips with nickel titanium coil anchoring were designed to be fixed in an airway via bronchoscopy. The objective was to evaluate the safety and efficacy of this novel RFID marking technique in two Japanese centers.

Methods: Under general anesthesia, cone-beam computed tomography (CT)-guided bronchoscopy was conducted to place a RFID marker as close as possible to the tumor, or on a planned resection line. The marker was localized by scanning with a detection probe under minimally invasive thoracoscopic surgery. Operators located the marker by following tone changes in accordance with the marker-probe distance, without palpating the lung. The tumor was then resected with the marker. The safety of RFID marking was

evaluated based on CT findings immediately after RFID marker placement, and on the presence of intraoperative dislodgement of the RFID marker. The efficacy of RFID marking was evaluated by functional marker placement (bronchoscopy procedure time and marker position [distance to the lesion and depth from the pleura]) and tumor localization (tumor recovery rate, margin status, and marker localization time).



Results: A total of 21 RFID markers were placed for 19 lesions (mean size: 8.4 mm, C/T ratio: 47.7) located at a mean depth from the pleura of 14.3 mm (range 0–27.9 mm). The preoperative marking procedure took 22.5 min (range 9–50 min). Post-procedural CT revealed no apparent adverse effects, including intrapulmonary hemorrhage. The operations comprised 10 wedge resections, six sub-segmentectomies, two segmentectomies, and one lobectomy. Intraoperative pathological findings revealed that one lesion removed by wedge resection was a 10-mm invasive adenocarcinoma with a solid component, so lobectomy was performed. Although two cases had severe intrapleural adhesion, all bronchoscopically delivered markers retained their positions despite intraoperative manipulation. For the 10 lesions removed by wedge resection, markers were placed at a mean distance of 5.4 mm (range 0–12.0 mm) from the lesion, and 12.9 mm (range 3.0–42.0 mm) from the pleura. The markers were accurately localized using a detection probe in 4.3 sec (range 2–8 sec). All tumors were recovered with the markers, and the surgical margins were negative. The mean depth of the surgical margin was 10.0 mm (range 3.0–14.0 mm).

Conclusions: Bronchoscopically delivered RFID markers were successfully fixed in the airway by nickel titanium coil anchoring. RFID markers provided the precise location of small lung lesions with appropriate deep margins. This novel marking technique enabled precise sublobar resection of deeply located small lung lesions.

120. Clinical Validation of the Canada Lymph Node Score for Endobronchial Ultrasound

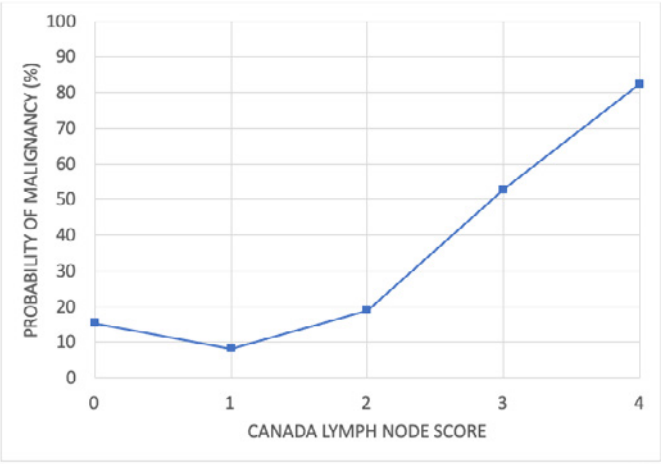
Richard He¹, Danielle A. Hylton², Eric L.R. Bédard¹, Scott Johnson¹, Bryce Laing¹, Azim Valji¹, Wael C. Hanna², Simon R. Turner¹

¹University of Alberta, Edmonton, AB, Canada; ²McMaster University, Hamilton, ON, Canada

Invited Discussant: Joseph B. Shrager

Objective: The Canada Lymph Node Score (CLNS) uses four sonographic criteria to predict the risk of malignancy in lymph nodes during endobronchial ultrasound (EBUS), and may play a role in identifying targets for biopsy or re-biopsy during invasive mediastinal staging for lung cancer. However, the CLNS has not yet been prospectively validated in routine clinical practice.

Methods: The CLNS scores for each lymph node biopsied during EBUS were prospectively captured for one year (2019) in a single general thoracic surgery practice. The CLNS and the presence of malignancy in each lymph node were compared. The sensitivity, specificity, odds ratios (OR), negative and positive likelihood ratios (LR), negative predictive values (NPV), and positive predictive values (PPV) were calculated. Univariate binary logistic regression was completed for each ultrasonographic feature, as well as a multivariate logistic regression model and receiver operator characteristic.



Results: CLNS score and diagnostic pathology results were available for 367 lymph nodes. The diagnostic rate was 87.0%. Incidence of malignancy increased with increasing CLNS score (Figure 1). The indication for EBUS was suspected lung malignancy in 355 (91.7%). Scores ≥ 3 were significantly associated with malignancy ($p < 0.001$, specificity 84.4%, positive likelihood ratio 4.0). All of the individual aspects of the CLNS were significantly associated with risk of malignancy on multivariate modelling, with the exception of the border characteristic. Receiver operating characteristic area under the curve was 0.76, indicating a good ability of the model to predict presence or absence of malignancy. Nodes scoring < 2 that were also negative on CT and PET were malignant in 10.1% (specificity 75.2%, negative predictive value 91.3%).

Conclusion: This study provides real world validation data for the Canada Lymph Node Score, employed in routine clinical practice by a group of general thoracic surgeons in 189 unselected, consecutive patients. The CLNS correlates well with the presence or absence of malignancy in thoracic lymph nodes, and could serve as an important adjunct to currently available methods of invasive and non-invasive mediastinal staging. The CLNS may be most helpful to select which non-diagnostic nodes require re-biopsy. Using a combination of low CLNS score and negative conventional radiology may obviate the need for any initial biopsy, but this approach remains to be studied in prospective trials.

121. Bilateral Ultrasound-Guided Erector Spinae Plane Block for Postoperative Pain Management After Surgical Repair of Pectus Excavatum: A Retrospective Study

Silvia Fiorelli, Cecilia Menna, Claudio Andreotti, Valentina Peritore, Domenico Massullo, Monica Rocco, Erino Angelo Rendina, Mohsen Ibrahim
Sant'Andrea Hospital, Rome, Italy

Invited Discussant: Linda Martin

Objective: Pectus Excavatum (PE) repair is burdened by severe postoperative pain caused by dissection of pectoralis major and rectus abdominis muscles, resection of deformed cartilages, and transverse wedge sternal osteotomy during Ravitch technique. Dislocation of costovertebral joints following the forceful repositioning of the sternum through bar placement during minimally invasive approach (Nuss procedure) can also lead to intense postoperative pain. Adequate pain management is paramount in order to facilitate deep breathing and encourage early mobilization. Although thoracic epidural has been considered for years the gold standard, less invasive regional techniques can be successfully employed. This retrospective study aimed to determine whether the analgesic effect of preoperative ultrasound-guided erector spinae plane block (ESPB) plus standard intravenous analgesia might be superior to standard intravenous analgesia alone in pain control after PE surgical repair via Ravitch or Nuss technique.

Methods: From January 2017 to December 2019 patients underwent surgical repair of PE were retrospectively investigated. All patients were divided into two groups: patients received ESPB and standard intravenous analgesia (ESPB group), and patients received standard intravenous analgesia alone (SIV group). All patients of both groups received as standard postoperative analgesia a 24-h continuous infusion of tramadol 0.1 mg/kg/h and ketorolac 90 mg with an elastomeric pump (2 mL/h), and morphine 2 mg IV as rescue drug. Patients in the ESPB group also received before surgery a bilateral ultrasound-guided erector spinae plane block. Levels of pain, reported using a numerical rating scale (NRS) at 1, 12, 24, and 48 hours after surgery, the number of required rescue doses, and the incidence of postoperative nausea and vomiting (PONV) were analyzed.

Results: A total of 105 patients were enrolled in this monocentric retrospective study, divided into an ESPB group ($n = 28$ patients) and a SIV group ($n = 77$ patients). Levels of pain at 1, 12, and 24 hours after surgery, number of rescue doses, and the incidence of PONV were lower in the ESPB group ($p < 0.005$) (see Table 1).

Table: NRS Values, Number of Required Rescue Drug, and PONV Episodes for ESPB Group and the SIV Group

Parameter	ESPB Group (n = 28)	SIV Group (n = 77)	P-Value
NRS 1 H	0.71 ± 1.26	4.19 ± 2.75	0.001
NRS 12 H	0.93 ± 1.20	3.21 ± 2.22	0.001
NRS 24 H	1.07 ± 1.20	3.69 ± 2.27	0.001
NRS 48 H	2.00 ± 1.88	2.43 ± 2.28	0.375
Rescue drug, n°	0.93 ± 0.85	1.70 ± 1.19	0.002
PONV, n°	0.04 ± 0.42	0.21 ± 0.41	0.004

Conclusions: ESPB can be an effective option for pain management after surgical repair of PE as part of a multimodal approach, providing adequate perioperative analgesia and helping to reduce postoperative opioids requirement and opioid-related adverse effects.

122. The Ross Procedure Provides Superior Outcomes in Young Adults: A Statewide Propensity-Matched Analysis

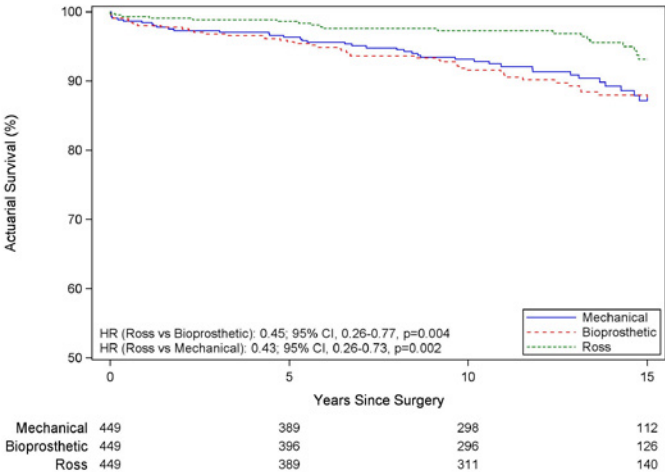
Ismail El-Hamamsy, Nana Toyoda, Shinobu Itagaki, Natalia Egorova, Robin Varghese, Elbert E. Williams, Paul Stelzer, David H. Adams

Icahn School of Medicine at Mount Sinai, New York, NY

Invited Discussant: Peter D. Skillington

Objective: Biological and mechanical prostheses remain the most commonly used substitutes in young adults requiring aortic valve replacement (AVR). Nevertheless, there have been encouraging data in the last decade about late outcomes after the Ross procedure from single center series. The aim of this study was to compare the long-term outcomes of the Ross procedure versus biological or mechanical AVR in young adults using a propensity-matched analysis of prospective statewide data.

Methods: Mandatory California and New York databases were queried between January 1, 1997 and December 31, 2014 to identify 449 consecutive young adults (range 18 to 50 years—median 37 years [28–43 years]) who underwent a Ross procedure during the study period. Using propensity scoring, they were matched to 2 cohorts of patients undergoing biological or mechanical AVR, respectively. Patients with dialysis, acute endocarditis, IV drug use, concomitant procedures, reinterventions and acute dissections were excluded. The primary endpoints were long-term survival, stroke, major bleeding, reoperation, and endocarditis, and were analyzed with adjustment of baseline demographics and surgeon/institutional surgical experience. Mean follow-up was 11.1 ± 4.2 years.



Results: In matched patients, the long-term survival was significantly higher after the Ross procedure versus biological AVR (hazard ratio [HR] 0.45, 95% CI 0.26–0.77, $p = 0.004$) and mechanical AVR (HR 0.43, 95% CI 0.26–0.73, $p = 0.002$) with 15-year survival of 93.1% (95% CI 89.1–95.7%), 87.2% (95% CI 82.4–90.7%), and 88.0% (95% CI 84.0–91.0), respectively (see Figure). Compared to biological AVR, the Ross procedure was associated with a lower cumulative risk of reintervention at 15 years (18.3% [95% CI 14.2–22.8%] versus 28.3% [23.2–33.5%], $p < 0.001$) and endocarditis (2.4% [1.2–4.4%] versus 6.7% [4.3–9.9%], $p = 0.01$). Compared to mechanical AVR, the Ross procedure was associated with a higher cumulative incidence of reoperation at 15 years (18.3% [14.2–22.8%] versus 9.2% [6.4–12.6%], $p < 0.001$), but significantly lower risks of major bleeding (1.6% [0.60–3.6%] versus 7.2% [4.6–10.6%], $p = 0.001$), and stroke (1.8% [0.73–3.8%] versus 7.3% [4.9–10.4%], $p < 0.001$).

Conclusions: In young adults requiring isolated elective AVR, the Ross procedure is associated with significantly better long-term survival than biological or mechanical AVR. Furthermore, at 15 years, Ross patients had a lower risk of re-intervention and endocarditis compared to patients receiving a biological AVR, and a lower risk of major bleeding and stroke compared to patients receiving a mechanical AVR. These statewide data support the expansion of the Ross procedure as a preferred approach in the management of young adults with aortic valve disease.

123. Ex Vivo Biomechanical Analysis of the Ross Procedure Using the Modified Inclusion Technique in a 3D-Printed Left Heart Simulator

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Invited Discussant: Pedro J. del Nido

Objective: The Ross procedure allows the replacement of a diseased aortic valve with an autologous living substitute. The inclusion technique was developed to reinforce the autograft to prevent late dilation. Additionally, anti-commissural plication has been described to reduce graft size and create neosinuses that are geometrically similar to native aortic roots. The objective was to evaluate pulmonary valve (PV) biomechanics using the inclusion technique with and without anti-commissural plication.

Methods: To test pulmonary autografts in a 3D-printed ex vivo heart simulator (Figure A), porcine ($n = 5$) and human ($n = 5$) pulmonary autografts were harvested from hearts obtained from a meat abattoir and from heart transplant recipients and donors, respectively. PV were sized, and Dacron grafts 3–4 mm larger in diameter were used. After completing the proximal suture line, the three commissures were fixed onto the Dacron graft (Figure B). Anti-commissural plications were performed at the level of the commissures (Figure C). Next, the middle suture line was performed (Figure D). Hemodynamic data, echocardiography, and high-speed videography were collected using the left heart simulator. The anti-commissural plication sutures were removed, and the middle suture line was performed again, followed by data collection.

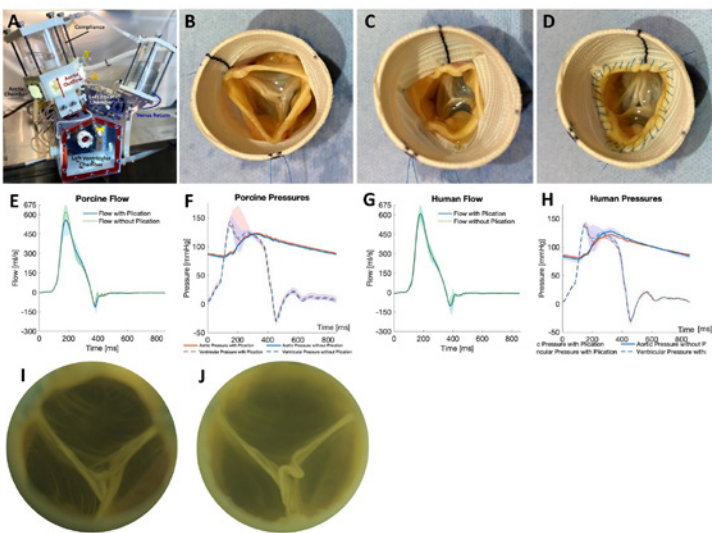


Figure: (A) Diagram of the ex vivo left heart simulator. (B) Human pulmonary autograft positioned in a Dacron prosthetic graft with three commissures attached. (C) Anti-commissural plications at the level of the commissures effectively reduced the diameter of the Dacron graft. (D) The middle suture line completed the pulmonary autograft preparation for the Ross procedure. (E) Aortic flow measurements of porcine pulmonary autografts with and without anti-commissural plications. (F) Pressure measurements of porcine pulmonary autografts with and without anti-commissural plications. (G) Aortic flow measurements of human pulmonary autografts with and without anti-commissural plications. (H) Pressure measurements of human pulmonary autografts with and without anti-commissural plications. (I) Human pulmonary autograft with anti-commissural plications captured by high-speed videography during diastole. (J) The same human pulmonary autograft without anti-commissural plications captured by high-speed videography during diastole. Shaded regions represent standard deviation.

Results: The aortic regurgitation fractions using porcine pulmonary autografts with and without anti-commissural plications were $8.5 \pm 1.8\%$ and $6.3 \pm 2.3\%$ ($p = .10$, Figure E, F) and using human pulmonary autografts were $9.0 \pm 2.5\%$ and $10.7 \pm 5.3\%$ ($p = .58$, Figure G, H), respectively. No significant aortic stenosis was observed as evidenced by 2D echocardiography with a mean gradient of 18.0 ± 8.8 mmHg and 12.6 ± 3.9 mmHg ($p = .27$) for porcine vs 12.8 ± 5.1 mmHg and 13.8 ± 5.2 mmHg ($p = .49$) for human pulmonary autografts with and without anti-commissural plications, respectively. Leaflet motion tracking analysis of high-speed videometric data (Figure I, J) demonstrated that anti-commissural plication vs. without anti-commissural plication in both porcine and human pulmonary autografts was associated with lower leaflet opening velocity (3.0 ± 2.2 cm/s vs 5.2 ± 2.2 cm/s, $p = .03$; 3.5 ± 0.9 cm/s vs 4.4 ± 1.0 cm/s, $p = .01$), leaflet closing velocity (1.0 ± 0.4 cm/s vs 2.0 ± 0.8 cm/s, $p = .05$; 1.8 ± 0.7 cm/s vs 2.2 ± 0.3 cm/s, $p = .13$), relative leaflet opening force (4.3 ± 3.7 vs 7.9 ± 6.2 , $p = .06$; 3.0 ± 0.6 vs 4.0 ± 2.1 , $p = .30$), and relative leaflet closing force (2.4 ± 4.2 vs 3.8 ± 2.7 , $p = .61$; 1.4 ± 1.3 vs 2.3 ± 0.6 , $p = .25$).

Conclusions: The Ross procedure using the inclusion technique demonstrated excellent hemodynamic results. The anti-commissural plication technique was associated with more favorable leaflet biomechanics, potentially affecting the long-term durability of the pulmonary autografts. In vivo validation should be performed to allow direct translation to clinical practice.

124. Efficacy of Del Nido Cardioplegia in Adult Cardiac Procedures with Prolonged Aortic Cross Clamp Time

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Invited Discussant: David A. Bull

Purpose: Del Nido cardioplegia (DC) offers equivalent myocardial protection and clinical outcomes to blood cardioplegia (BC) in adult isolated CABG and valve patients, but the safety and efficacy of DC in cardiac procedures with prolonged aortic cross-clamp (AXC) times is still unknown.

Methods: From 5/2014 to 9/2019, 2,819 adult patients at our center underwent cardiac surgery requiring prolonged aortic cross clamp time defined as 90 minutes or longer. Myocardial protection was achieved with BC in 2268 patients and DC in 551 patients. Emergency and re-operative cases were included. Two surgeons used DC exclusively and six used BC exclusively over the study period. Propensity matching of pre-operative characteristics including primary cardiac pathology yielded 527 well matched pairs. Troponin T levels were drawn at 12 hours post-op in all patients. Clinical data were extracted from our local STS database.

	AXC 90-120 min		AXC 121-150 min		AXC 151-180 min		AXC >180 min	
	BC (n=147)	DN (n=302)	BC (n=119)	DN (n=110)	BC (n=103)	DN (n=64)	BC (n=158)	DN (n=51)
AXC time (min)	107 [97, 114]	102 [95, 110]	138 [130, 145]	135 [127, 142]	163 [157, 172]	161 [156, 166]	223 [201, 268]	206 [191, 248]
Mortality	1 (0.7)	6 (2.0)	1 (0.8)	6 (5.4)	3 (2.9)	2 (3.1)	7 (4.4)	4 (7.8)
Stroke	3 (2.0)	5 (1.7)	1 (0.8)	5 (4.6)	4 (3.9)	3 (4.7)	5 (3.2)	4 (7.8)
Renal failure	3 (2.0)	12 (4.0)	2 (1.7)	6 (5.4)	3 (2.9)	8 (12.5)*	12 (7.6)	8 (15.7)
Atrial fibrillation	27 (18.4)	90 (29.8)*	36 (30.2)	40 (36.4)	36 (35.0)	29 (45.3)	74 (46.8)	29 (56.9)
IABP	4 (2.7)	17 (5.6)	6 (5.0)	5 (4.6)	4 (3.9)	2 (3.1)	4 (2.5)	4 (7.8)
ECMO	0 (0.0)	5 (1.7)	2 (1.7)	3 (2.7)	3 (2.9)	2 (3.1)	8 (5.1)	6 (11.8)
Troponin T (ng/ml)	0.38 [0.24, 0.55]	0.42 [0.25, 0.71]	0.60 [0.37, 0.95]	0.60 [0.35, 1.13]	0.57 [0.39, 1.02]	0.82 [0.45, 1.45]*	0.88 [0.55, 1.46]	1.19 [0.66, 2.32]*

Not normally distributed numeric variables are reported as median [25th, 75th percentile] and categorical variables as frequency (percent). AXC= aortic cross clamp. IABP= intra-aortic balloon pump. ECMO= extracorporeal membrane oxygenation. *p<0.05

Results: With propensity matching, age (63 ± 12 yrs vs 63 ± 13 yrs), male gender (73.6% vs 71.5%), and left ventricular ejection fraction (56.0 ± 11.6 vs $55.8 \pm 11.5\%$) were similar in BC and DC as were twenty other pre-operative clinical variables. Primary indication for surgery was isolated CABG (16.5% vs 16.7%), valve (31.3% vs 30.6%), CABG+valve (28.3% vs 27.7%), or aorta (23.9% vs 25%) and was similar for BC and DC. Emergent operations (6.4% vs 6.3%) and re-operations (17.1% vs 18.0%) were equally distributed between BC and DC. The median AXC was significantly longer in BC (150 [117,193] min vs 114 [100,145] min, $p < 0.0001$) while intra-operative peak glucose ($196 [169,224]$ g/dl vs $173 [147,200]$ g/dl, $p < 0.001$) and nadir hematocrit ($26.9 \pm 5.3\%$ vs $26.2 \pm 5.1\%$, $p = 0.03$) were higher in BC. For the entire propensity matched cohort, peri-operative mortality (2.3% vs 3.4%), stroke

(2.5% vs 3.2%), renal failure (3.8% vs 6.4%), atrial fibrillation (32.8% vs 34.0%), IABP use (3.4% vs 5.3%), or ECMO use (2.5% vs 3.0%) did not differ between BC and DC. Post-op Troponin T levels were 0.56 [0.35,1.02] ng/ml and 0.53 [0.30,0.96] ng/ml for BC and DC, respectively (p = 0.07). Subgroup analysis of propensity matched patients separated by AXC time increments of 30 minutes is summarized in the Table. One-, three-, and five-year survival rates were 95.8%, 90.9%, and 83.7% for BC and 93.3%, 88.4%, and 81.4% for DC, respectively, and did not differ significantly (p = 0.326).

Conclusions: In adult cardiac surgical procedures requiring aortic cross clamping of more than 90 minutes, del Nido cardioplegia was associated with shorter operative time and comparable myocardial protection, peri-operative mortality and morbidity, and distant survival to blood cardioplegia. With AXC exceeding 150 minutes, troponin release and renal failure were higher in DC, but this was not associated with increased mortality.

125. Hybrid Frozen Elephant Trunk Device for Transverse Aortic Arch Replacement: One-Year Results from a US IDE Trial

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Invited Discussant: Axel Haverich

Objective: This prospective US IDE study aims to assess the safety and 1-year clinical outcomes of a hybrid device for the frozen elephant trunk technique.

Methods: The trial, which involves 12 US sites, recruited 65 patients into the primary study group and 9 patients into the rupture group. The primary endpoint was freedom from composite major adverse events (MAE), defined as permanent stroke, permanent paraplegia/paraparesis, unanticipated aortic-related reoperation (excluding reoperation for bleeding), or all-cause mortality.

Table: MAE Outcomes at One Year

	Primary Group (n = 64*)	Rupture Group (n = 9)
At least one event	10 (16%)	2 (22%)
Permanent stroke	1 (2%)	1 (11%)
Permanent paraplegia/paraparesis	3 (5%)	0
Unanticipated aortic-related reoperation	2 (3%)	0
All-cause mortality	7 (11%)	2 (22%)

*One patient was lost to follow-up

Results: In the primary study group, 1 patient was lost to follow-up. Freedom from MAE at 1 year was 84% (54/64; see Table). Seven patients died (11%), including 4 within 30 days or before discharge. Eight patients (13%) developed renal failure. Twenty-five patients (39%) underwent extension procedures. In the aortic rupture group, freedom from MAE at 1 year was 78% (7/9). Two patients had a stroke and died (22%). One patient (11%) developed renal failure. No extension procedures were performed in the rupture group.

Conclusions: One-year results with this hybrid device are promising. Long-term data will be necessary to assess the durability of these repairs.

126. Nitric Oxide Administered Through the Oxygenator During Selective Cerebral Perfusion Improve Neuroprotection in an Experimental Model of Hypothermic Circulatory Arrest

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Invited Discussant: T. Brett Reece

Objective: Hypothermic circulatory arrest in aortic arch surgery has a significant risk of neurological injury despite the introduction of selective cerebral perfusion and other newest protective techniques and strategies. Nitric oxide (NO) is involved in many different cellular pathways and could exert a protective role in ischemia-reperfusion damage and could reduce infarct area and increase cerebral perfusion. The present study aims to investigate the possible neuroprotective effects of NO gas administered in the oxygenator during selective cerebral perfusion during hypothermic circulatory arrest.

Methods: Thirty male SD adult rats (450–550 g) underwent CPB assisted cooling to 22°C body core temperature followed by Hypothermic Circulatory Arrest for 30 min. At the beginning of circulatory arrest, rats were randomized to receive simple selective cerebral perfusion (SCP), selective cerebral perfusion and NO (20 ppm) administered by the oxygenator (SCP-NO), or no treatment other than hypothermia (HCA). All animals underwent CPB assisted rewarming to a target temperature of 35°C in 60 minutes. At the end of the experiment, rats were sacrificed, and brain collected. Immunohistochemistry analysis was performed in blind conditions with dedicated software.

Results: Inflammatory pattern was assessed by microglial activation. Ionized calcium-binding adaptor molecule 1 (Iba1) is a microglia/macrophage-specific calcium-binding protein, and it indicates the inflammatory activation of these cells. Iba1 expression was significantly decreased in SCP-NO compared to SCP and HCA (4.13% ± 0.8 vs 6.02% ± 0.27 (p < 0.015); vs 6.28% ± 0.26 (p < 0.027)) (Figure 1). Caspases 3 is expressed during the apoptotic process, and it was reduced in SCP-NO group but not in SCP compared to HCA. Thiol formation, a marker of oxidative stress, was significantly reduced in SCP-NO compared with the other two groups.

Conclusions: NO administration in the oxygenator during selective cerebral perfusion and hypothermic circulatory arrest improves neuroprotection, decreasing inflammation, apoptosis, and oxidative stress.

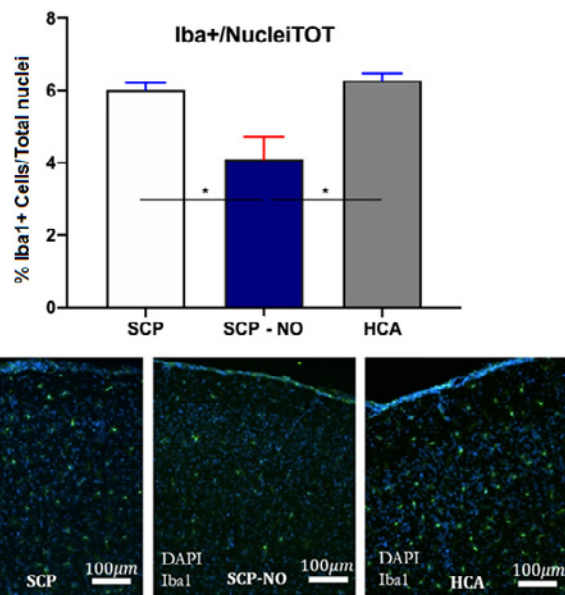


Figure 1: Graphic representation and sections of the cortex in brains of the three groups of rats: selective cerebral perfusion (SCP), selective cerebral perfusion with nitric oxide 20 ppm (SCP-NO) and hypothermic circulatory arrest (HCA). Iba1: ionized calcium-binding adapter molecule 1, marker of microglia activation; DAPI: 4',6-diamidino-2-phenylindole, marker for DNA.

127. Early Results of Geometric Ring Annuloplasty for Bicuspid Aortic Valve Repair During Aortic Aneurysm Surgery: A Multi-Institutional Analysis

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¹Franciscan St. Francis Heart Center, Indianapolis, IN; ²University of Colorado, Aurora, CO; ³Washington University Medical Center, St. Louis, MO; ⁴University of Michigan, Muskegon, MI; ⁵West Virginia University, Morgantown, WV; ⁶Ohio Health Riverside Methodist Hospital, Columbus, OH; ⁷Maine Medical Center, Portland, ME; ⁸Missouri Baptist Hospital, St. Louis, MO; ⁹Cedars Sinai Medical Center, Los Angeles, CA; ¹⁰Columbia Presbyterian Medical Center, New York, NY; ¹¹Billings Clinic, Billings, MT; ¹²Northeast Georgia Medical Center, Gainesville, GA; ¹³University of Michigan, Ann Arbor, MI; ¹⁴Pennsylvania State University, Hershey, PA; ¹⁵Duke University Medical Center, Durham, NC

Invited Discussant: Hans-Joachim Schäfers

Objectives: Geometric ring annuloplasty (GRA) has shown promise for annular reconstruction during bicuspid aortic valve (BAV) repair for aortic insufficiency (AI). This study examined initial outcomes of GRA for BAV repair associated with replacement of proximal aortic aneurysms in the United States.

Methods: From September 2017 to October, 2020, 70 patients underwent BAV repair supported by internal GRA with concomitant ascending aortic and/or root aneurysm reconstruction. Patient age was 49.7 ± 14.3 years (mean \pm SD), 77% were male, NYHA Class was 1.8 ± 0.8 , and preoperative AI grade was 2.4 ± 1.5 . Ascending aortic diameter was 49.8 ± 6.8 mm, and all patients had graft replacement of the ascending aorta. Twenty-one patients had sinus diameters >45 mm prompting additional remodeling root procedures. Sixty-four patients had Sievers Type 1 valves, three had Type 0, and three had Type 2 defects. Sixty-five had primarily right/left fusion, four had right/non fusion, and one left/non fusion. The rings were machined from Titanium blocks with circular base geometry incorporating two 180° sub-commissural posts and covered with a thin layer of Dacron. Ring size was determined as non-fused leaflet free-edge length/1.5, and rings were sutured sub-annularly with 7-10 trans-annular horizontal mattress sutures. Ultrasonic leaflet decalcification was employed in 18 patients. Leaflet reconstruction usually utilized Schäfers' methods of central leaflet plication and cleft closure.

Results: All BAV repairs were successful, with the most common ring size being 21 mm (21.6 ± 2.2 mm). Thirteen of the twenty-one root procedures were selective non-fused sinus replacements. Aortic clamp time was 145 ± 31 minutes, and bypass time 182 ± 44 minutes. Intraoperative post-repair AI grade was 0.2 ± 0.8 , and mean valve gradient was 12.3 ± 5.8 mmHg. No 30-day operative mortalities occurred. Two patients required reoperation for bleeding, and three needed pacemakers. At a mean follow up of 11.7 ± 9.2 months (maximum 34 months), sixty-six patients were in NYHA I, three were NYHA Class II, and one patient required aortic valve replacement for commissural leaflet rupture. Follow up AI grade was 0.2 ± 0.6 , and mean valve gradient was 11.7 ± 7.3 mmHg. No late deaths or valve-related complications have occurred.

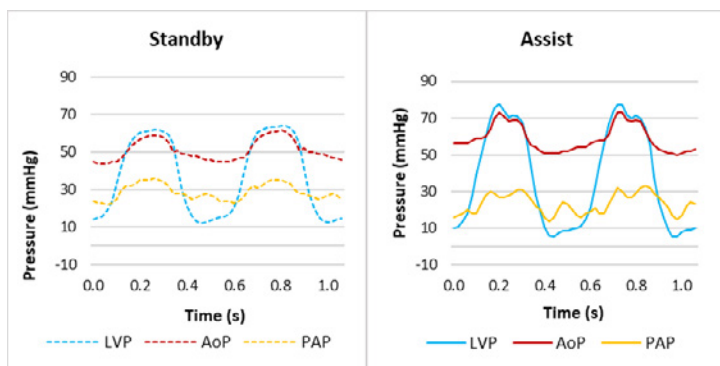
Conclusions: Geometric ring annuloplasty for BAV repair with proximal aortic aneurysm reconstruction is safe and associated with good one-year outcomes. Further experience and follow up will help inform long-term durability.

128. Mechanical Cardiac Support Using a New Implantable Cardiac Compression Device

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Invited Discussant: Michael E. Jessen

Objective: We examined the hemodynamic effects of a new, implantable cardiac assist system in an ovine heart failure model. It encompasses and encircles both left and right ventricles. The device is inserted via the apex of the pericardium. It self-expands to encompass the heart without suturing; it is held in place by the pericardium. There are 2 concentric chambers. An internal chamber is saline-filled and conforms to the heart. An external chamber is air-filled and provides external compression followed by negative pressure to aid with relaxation. (See Figure). Device compression and relaxation is EKG-triggered.



Methods: The device was implanted in 7 sheep with heart failure induced by microsphere embolization. Cardiac performance was assessed for 6–8 hours. Invasive monitoring with a Swan-Ganz catheter, LV catheter, and flow probes provided data on cardiac function.

Results: Initiation of cardiac assist resulted in increased cardiac output of up to 0.7 L/min (21% increase). Systolic BP increased by 15 mmHg (22% increase). Mean pulmonary artery pressure decreased by 3 mmHg (10% decrease). Filling pressures declined indicating ventricular and pulmonary artery unloading. Diastolic pulmonary pressure declined by 7 mmHg on average (from 23 mmHg to 16 mmHg; ~30%). LVEDP declined from 17 mmHg to 13 mmHg. The figure shows representative tracings with the device activated and in standby mode.

Conclusions: Systolic and diastolic cardiac assistance can be achieved with a new implantable device that encompasses the heart compressing and relaxing sequentially in an ovine heart failure model.

129. Primary Cardiac Sarcomas: Treatment Strategies from an Institutional Experience of 121 Resections

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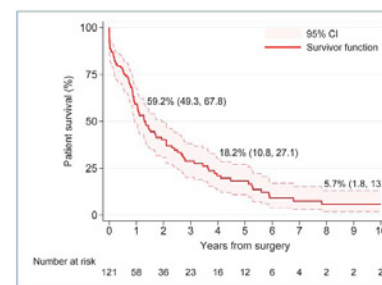
³Hadassah Medical Center, Jerusalem, Israel

Invited Discussant: Leora B. Balsam

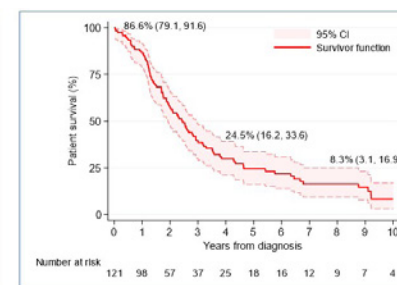
Objective: Primary cardiac sarcoma is an exceedingly rare disease with a dismal prognosis. The rarity of this condition allows few surgeons or institutions to acquire significant experience to allow for the development of treatment strategies. Our multidisciplinary cardiac tumor team now has an experience of operating on 121 cases of cardiac sarcoma. The purpose of this study is to present our short- and long-term outcomes for cardiac sarcoma.

Methods: We performed a retrospective review of an IRB-approved cardiac tumor database for cardiac sarcoma. Patient characteristics, surgical factors and patient outcomes were analyzed. Perioperative data were collected from all available medical records. The primary endpoint was all-cause mortality at 1, 5, and 10 years from the time of our surgery. Secondary endpoints include survival from initial diagnosis and disease-free survival.

Results: From October 1998 to October 2020 we operated on 121 patients with a primary cardiac sarcoma. Median age of the patients was 45.1 years old. Tumors were most frequently found in the left atrium (47, 38.8%) and right atrium (38, 31.4%). The most common type of tumor histologically was an angiosarcoma (48, 39.7%), followed by spindle cell sarcoma (19, 15.7%). Survival at 1, 5, and 10 years from surgery was 59.2%, 18.2%, and 5.7%, respectively. Survival at 1, 5, and 10 years from diagnosis was 86.6%, 24.5%, and 8.3%, respectively. When comparing outcomes from different time periods, we found no significant difference in survival between the previous era (1998–2011) and the current era (2011–2020). Complete follow up was available in 116/121 (96%) patients.



Patient survival from surgery



Patient survival from diagnosis

Conclusions: Survival in cardiac sarcoma patients is extremely limited without surgical excision. Patients are often referred for management and resection after initial attempts at surgery prove unsuccessful. Management of these complex patients can show reasonable outcomes in centers with a multidisciplinary cardiac tumor team.

130. Multi-Spectrum Robotic Cardiac Surgery: Early Outcomes in 1000 Cases from a Single Institution

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Objective: The robotic cardiac surgery program at our current institution began in 2013. All cases were performed by an experienced surgeon and team. The aim of this study is to review early outcomes in the first 1000 patients.

Methods: We retrospectively reviewed our patient database for all robotic-assisted cardiac surgical procedures performed at a single institution by an experienced surgeon and team between July 2013 and September 2020. Our robotic approach is totally endoscopic for all cases: off-pump for coronary and other epicardial procedures, and on-pump with the Endoballoon for mitral valve (MV) and other intracardiac procedures. The primary outcomes were mortality and perioperative morbidity.

Table: 1018 Robotic Cardiac Surgery Cases

Case Numbers	All Patients (n = 1018)
TECAB (off-pump), n (%)	545 (54)
Intracardiac, n (%)	368 (36)
Mitral valve, n (%)	292 (29)
Atrial septal defect repair, n (%)	21 (2.1)
Cryomaze, n (%)	21 (2.1)
Benign cardiac tumor, n (%)	21 (2.1)
Other, n (%)	13 (1.3)
EP-related procedures (Epicardial), n (%)	69 (7)
AF ablation/LAA ligation, n (%)	36 (3.5)
Lead placement, n (%)	19 (1.9)
VT ablation, n (%)	14 (1.4)
Other epicardial procedures, n (%)	36 (3)
Pericardiectomy, n (%)	14 (1.4)
Myocardial bridge, n (%)	12 (1.2)
Other, n (%)	10 (1.0)

TECAB: Totally Endoscopic Coronary Artery Bypass; EP: Electrophysiology;
AF: Atrial Fibrillation; LAA: Left Atrial Appendage; VT: Ventricular Tachycardia

Results: There were a total of 1018 robotic-assisted cardiac surgeries over 7-years. 545 (54%) were off-pump totally endoscopic coronary artery bypass (TECAB), 368 (36%) intracardiac cases (including isolated and concomitant MV procedures, isolated tricuspid valve repair, Cryomaze, atrial or ventricular septal defect repair, benign cardiac tumor, septal myomectomy, dual-chamber right ventricle, partial anomalous pulmonary venous drainage, and aortic valve replacement); 69 (7%) epicardial electrophysiology-related procedures (epicardial atrial fibrillation ablation, left atrial appendage ligation, lead placement, and ventricular tachycardia ablation); and 36 (3%) other epicardial procedures (pericardiectomy, unroofing myocardial bridge). Mortality was 1.2% in the whole cohort (observed/expected (O/E) ratio 0.7). In the TECAB and intra-cardiac groups mortality was 0.9% (O/E 0.6), and 1.6% (O/E 0.98) respectively. Overall, there were 7 conversions to

sternotomy (0.7%) and 23 (2.3%) take-back for bleeding. 79% of patients were extubated in under 6-hours, and intra-op blood transfusion rate was 13%. Mean hospital and ICU length of stay were 2.99 ± 1.69 days and 1.50 ± 1.23 days, respectively.

Conclusion: This experience demonstrates that a robotic endoscopic approach can safely and effectively be used in a multitude of cardiac surgical procedures both on and off-pump with excellent early outcomes. An experienced surgeon and team are necessary. Longer term follow up is warranted.

131. Peripheral ECMO Support Expands the Application of Robotic-Assisted Coronary Artery Bypass

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Invited Discussant: Paul W.M. Fedak

Objective: Robotic assisted coronary artery bypass (RCAB) using left internal mammary (LIMA) has demonstrated a lower stroke rate, less bleeding and quicker recovery while maintaining a similar LIMA graft patency rate when compared to conventional CAB. However, the application of RCAB has been hindered in patients who have poor pulmonary reserve, decreased cardiac function, prior cardiac surgery, challenging chest wall anatomy and critical coronary artery disease/anatomy. In this study, we report our experience with the use of intraoperative peripheral ECMO during RCAB as partial cardiopulmonary support for patients who were considered high risk candidates for conventional CAB and at the same time not suitable for RCAB without cardiopulmonary support.

Table: Perioperative Data After Robotic-Assisted CAB with ECMO

Mortality	0.0%
CVA	0.0%
Graft failure/MI	0.0%
Conversion to open sternotomy	4.5% (n = 1)
Failure to wean intraop ECMO support	4.5% (n = 1)
Access vessel complication	0.0%
Blood transfusion	45.5% (n = 10)
Extubated within 6 hours	72.7% (n = 16)
Extubated after 6 hours	27.3% (n = 6)
Transient renal insufficiency	9.1% (n = 2)
Pneumonia	4.5% (n = 1)
Average LOS	7.5 days
Discharge to home	81.8% (n = 18)
Discharge to facility	18.2% (n = 4)

Methods: Seventy patients underwent RCAB at our institution in the past 20 months. The indications for ECMO support in RCAB were: 1) inability to tolerate single lung ventilation, 2) low EF < 35%, 3) difficult exposure of IMA, 4) critical coronary disease/anatomy and 5) hemodynamic instability or arrhythmias. Twenty-two (31%) of them required intraoperative ECMO support. The patients with ECMO support had a mean age of 67 ± 10 years

(77% male), mean STS score of $7.3\% \pm 8.4\%$, and a mean preoperative LVEF of $41\% \pm 12\%$. Six (27%) of 22 patients underwent bilateral IMA harvesting while the remaining ($n = 16$, 73%) had only LIMA harvesting. The ECMO flow was maintained between 3–5 L/min. The ACT was kept between 180 and 300 seconds. All patients had beating heart MIDCAB through a two-inch left anterior mini-thoracotomy. A hybrid approach with PCI was planned for eight (36%) patients.

Results: Twenty-two RCAB patients had ECMO support for the following indications: inability to tolerate single lung ventilation ($n = 11$, 50%), low LVEF $< 35\%$ ($n = 9$, 41%), difficult exposure of IMA ($n = 8$, 36%), critical coronary disease/anatomy ($n = 3$, 14%), or hemodynamic instability or arrhythmia ($n = 3$, 14%). Most patients had more than one indication for ECMO support. At the conclusion of the procedure, 21 (95%) patients had ECMO removed while one (5%) had ECMO support for 24 hours. There were no operative deaths (0%), strokes (0%), IMA graft failures or MI (0%), or access vessel complications (0%). One redo CAB (4.5%) patient was converted to open sternotomy to locate the target vessel. One patient returned to OR for bleeding from the chest wall (4.5%). Sixteen (73%) patients were extubated within 6 hours after surgery while six (27%) were extubated after 6 hours.

Conclusions: Peripheral ECMO during RCAB is a new approach that allows safe IMA harvesting and beating heart IMA to target coronary anastomoses. Our results demonstrated the safety and feasibility of using this technique in this group of very high-risk patients who otherwise had limited options. The use of peripheral ECMO in RCAB can potentially expand the surgical treatment options in high-risk CAD patients.

133. Outcomes of Patients with Inverted Coronary Anatomy After the Arterial Switch Operation

Kaushik Thungathurthi, Tyson Alexander Fricke, Edward Buratto, Christian Brizard, Igor Konstantinov

Royal Children's Hospital, Melbourne, Australia

Invited Discussant: Glen Scott Van Arsdell

Objective: Patients undergoing the arterial switch operation (ASO) with inverted coronary anatomy represent a technical challenge. We sought to determine the long-term outcomes of 44 patients with inverted coronary anatomy who underwent the ASO.

Methods: A retrospective analysis of all patients who underwent an ASO with inverted coronary anatomy at a single institution was performed. Operative reports were used to identify patients with inverted coronary anatomy using the Leiden classification. Inverted coronary anatomy was defined as the right coronary artery (RCA) arising from sinus 1 with the left anterior descending (LAD) and circumflex (LCx) arteries arising from sinus 2 (1RCA;2LAD,LCx) or the RCA and LAD arising from sinus 1 with the LCx from sinus 2 (1RCA,LAD;2LCx).

Results: There were 44 (5.2%, 44/844) patients with inverted coronary anatomy. Twenty patients (45%, 20/44) with 1RCA;2LAD,LCx anatomy and 24 (55%, 24/44) patients with 1RCA,LAD;2LCx. Sixteen patients (36%, 16/44) had Transposition of the Great Arteries with an intact ventricular septum, 17 patients (39%, 17/44) had Transposition of the Great Arteries with a ventricular septal defect (VSD) and 11 patients (25%, 11/44) had Taussig-Bing Anomaly.

Median follow-up was 17 years (interquartile range 12–21 years). Overall early mortality was 6.8% (3/44) compared to 3.1% (17/556) in patients with normal coronary anatomy operated over the same time period ($p = 0.17$). There were 2 (10%, 2/20) early deaths in the 1RCA,LAD;2LCx group and 1 (4.2%, 1/24) early death in the 1RCA;2LAD,LCx group. There were 2 late deaths occurring at 1 and 3 months after arterial switch. Four (9.1%, 4/44) patients required postoperative mechanical circulatory support.

Nine (20%, 9/44) patients had 15 reinterventions occurring at median 3.6 years (interquartile range 1.1–8.2 years) after surgery. Seven (35%, 7/20) patients with 1RCA;2LAD,LCx required reintervention compared to 2 (8.3%, 2/24) patients in the 1RCA,LAD;2LCx group. The most common cause of reintervention was main or branch pulmonary artery stenosis (14%, 6/44). Two (4.5%, 2/44) patients required reoperation on the neo-aortic valve. Freedom from reintervention was 78% (95% confidence interval 68–93%) and 75% (95% confidence interval 56–86%) at 10 and 20 years respectively. One (2.3%, 1/44) patient required 2 reoperations for coronary obstruction. At last follow-up, all surviving local patients except 1 was in New York Association Class I.

Conclusions: Patients with inverted coronary anatomy who underwent the arterial switch operation had a high overall mortality. However, coronary reintervention was uncommon.

134. A Simplified Approach to Predicting Reintervention in the Arterial Switch Operation

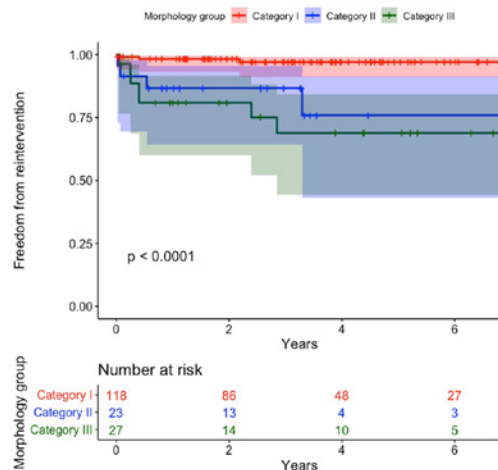
Gananjay G. Salve¹, Kim Betts², Julian G. Ayer^{1,3}, Richard B. Chard^{1,3}, Ian A. Nicholson^{1,3}, Yishay Orr^{1,3}, David S. Winlaw^{1,3}

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Invited Discussant: Yasuhiro Kotani

Objective: Conventional criteria for classifying d-transposition of the great arteries (d-TGA) is more related to surgical complexity and mortality than risk of reintervention. It does not consider the overlap of multiple risk factors and groups d-TGA intact septum with d-TGA and ventricular septal defect (VSD). The purpose of this study was to evaluate a simplified approach to categorize patients undergoing arterial switch operation (ASO) to estimate their risk of reintervention.

Methods: A retrospective review was performed. 180 consecutive patients underwent ASO from 2009 to 2018. Patients were classified as Category I ($n = 122$) d-TGA + intact ventricular septum (IVS), Category II ($n = 28$) d-TGA + VSD and Category III ($n = 30$) d-TGA + aortic arch obstruction (AAO) \pm VSD or Taussig-Bing Anomaly (TBA) \pm AAO. Palliative ASO in the context of functional single ventricles and operations for d-TGA with left ventricular outflow tract obstruction including Nikaidoh procedures were excluded. Outcomes included reintervention-free survival (using Kaplan-Meier estimates with Log-Rank test) and predictors of reintervention (Cox regression analysis).



Results: Median follow up was 3.3 (interquartile range 1.7–5.8) years with no difference between categories ($p = 0.082$). There were 3 mortalities in 179 patients (mortality rate 1.7%)—two early (one each in Category I and II) and one late (in Category I). Reintervention-free survival for the whole group at 1, 5, and 8 years was 94%, 90%, and 86% respectively. There were 3 reinterventions in Category I, 5 in Category II, and 7 in Category III. In all three categories, right sided reinterventions ($n = 12$) were more common than left sided reinterventions ($n = 3$).

Conventional criteria predicting reintervention included the presence of TBA ($p = 0.0054$) and AAO ($p = 0.027$). Low birth weight did not predict reintervention ($p = 0.073$) and there was a single reintervention related to abnormal coronary anatomy. The Kaplan-Meier analysis by category (Figure) indicated a significantly higher rate of reintervention in Category II and Category III as compared to Category I ($p = <0.0001$). Multivariable analysis showed that patients in Category III carried a high risk of reintervention [Hazard risk (HR) = 12.30, 95% confidence interval (CI) = (3.17, 47.72), $p < 0.001$], as did those in Category II [HR = 9.77, 95% CI = (2.33, 40.94), $p = 0.002$] compared to Category I.

Conclusions: Conventional risk factors for technical difficulty may not be the best predictors of reintervention. A simplified categorization of d-TGA patients undergoing ASO, relating to presence of a VSD and great vessel anatomy provides an estimation of reintervention risk that is easily translated into everyday clinical practice and counselling for parents. Reintervention rates are high for particular anatomic subtypes, including those with d-TGA + VSD, a previously under-recognized risk.

135. Branch Pulmonary Artery Stenosis After Arterial Switch Operation: The Impact of Preoperative Anatomic Factors on Reoperation

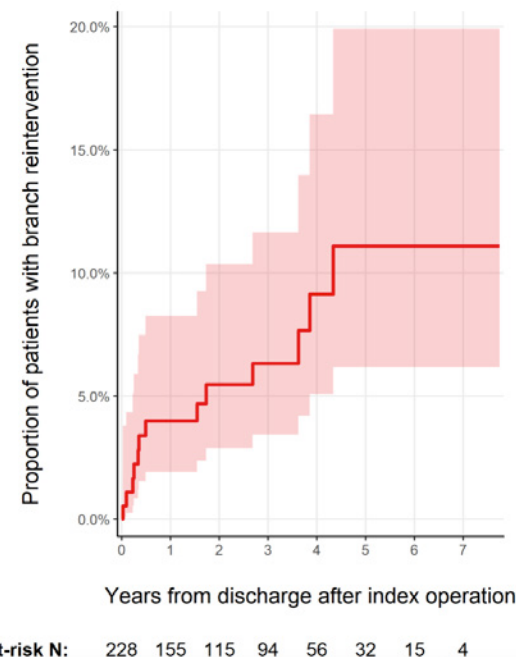
Shuhua Luo¹, Martui Haranal², Mimi xiaoming Deng², Jaymie Varenbut², Kyle Runeckles², Steve Chun-po Fan², Osami Honjo²

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Invited Discussant: Robert D.B. Jaquiss

Objectives: We hypothesized that preoperative patient's characteristics and branch pulmonary artery (PA) size may influence the rate of postoperative re-intervention to the branch PA in patients with transposition of the great arteries (TGA) undergoing arterial switch operation (ASO) with or without ventricular septum defect repair.

Methods: The retrospective single-center study includes 264 consecutive (2008–2017) newborns who underwent ASO. Demographics, echocardiography, and clinical outcomes were reviewed. Branch PA reintervention was defined as any reoperation or catheterization-based reintervention on the left or right PA. Competing risk analysis modelled incidence of branch PA reintervention and cause-specific hazard regression for predictors analyses.



Results: Median age and weight were 7 (5–11) days and 3.4 (3.1–3.8) kg. The majority of patients ($n = 200$, 75.8%) were diagnosed with TGA/IVS. Thirty-six (13.6%) patients had BPA intervention during the same hospitalization as ASO, 11 (4.2%) having concomitant branch PA plasty and 26 (9.8%) requiring branch PA reintervention before discharge (1 patient required both). These patients had significantly prolonged ventilation ($p = <0.001$), and

ICU duration was 9 (3–12) days compared to 2 (1–5) days in patients without same hospitalization PA reintervention. The left (pairwise difference = -0.13 , $p = <0.001$) and right PA diameters (pairwise difference = -0.08 , $p = <0.001$) were significantly smaller at pre-discharge echocardiography than at baseline. Left PA reintervention was most common ($n = 31$, 86.1%), followed by both PA ($n = 3$, 8.3%) and right PA ($n = 2$, 5.5%) reintervention. After the median 20.8 (0.9–44.7) months follow-up, 14 patients required branch PA reintervention. The cumulative proportion of patients requiring branch PA reintervention was 4.0% at 1 year, 6.5% at 3 years, and 11.1% at 5 years. Lower weight (HR = 1.19 [95% CI: 1.07–1.34] per 100 g decrease, $p = 0.002$), smaller left PA (per 1 mm decrease, HR = 1.11 [1.04–1.19], $p = 0.002$) and smaller right PA (HR = 1.14 [1.07–1.21], $p < 0.001$) were associated with higher risk of branch PA reintervention during the follow-up by univariable cause-specific hazard regression. Ascending aortic size, and the presence of ventricular septal defect or arterial duct were not associated with the rate of branch PA intervention.

Conclusion: The left and right PA diameter became significantly smaller after ASO due to the stretching effect. Smaller body weight and smaller preoperative left or right PA were associated with an increased risk of PA re-intervention, indicating less margin of geometrical tolerance to the stretching.

136. Outcomes of the Arterial Switch Operation in Patients with Taussig-Bing Anomaly and Aortic Arch Obstruction

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Invited Discussant: Jeffrey S. Heinle

Objective: Arterial switch operation (ASO) in children with Taussig-Bing anomaly (TBA) and associated aortic arch obstruction (AAO) is technically demanding. This study sought to determine outcomes of patients with TBA and AAO who underwent ASO at a single institution.

Methods: From 1983 to 2015, 844 patients underwent an ASO for biventricular repair. Twenty-eight patients (3.3%, 28/844) patients had TBA and AAO.

Results: Twenty-one (75%, 21/28) patients underwent ASO and AAO repair as a single stage procedure and 7 (25%, 7/28) patients had arch repair prior to ASO. There were no early or late mortalities. Follow-up after hospital discharge was available for all patients. Median follow-up was 17.5 years (interquartile range 9.2 to 22.3 years, range 4.0 to 31.5 years). All patients were in NYHA Class I at last follow-up. Freedom from reintervention was 61% (95% CI 40–76%) and 56% (95% CI 36–73%) at 5 and 15 years after ASO. The most common cause for reintervention was repair of recurrent AAO. Four (14%, 4/28) patients required 5 reinterventions (3 reoperations and 2 catheter reintervention) for recurrent AAO at a median 2.2 years after ASO (interquartile range 2.1–2.3 years).

Conclusions: Patients with TBA and AAO can undergo the ASO with excellent survival. Reintervention is common with an initial early risk of reintervention for recurrent AAO.

137. Comparison of On- versus Off-Pump Revascularization for Left Main Disease: Insights from the Excel Trial

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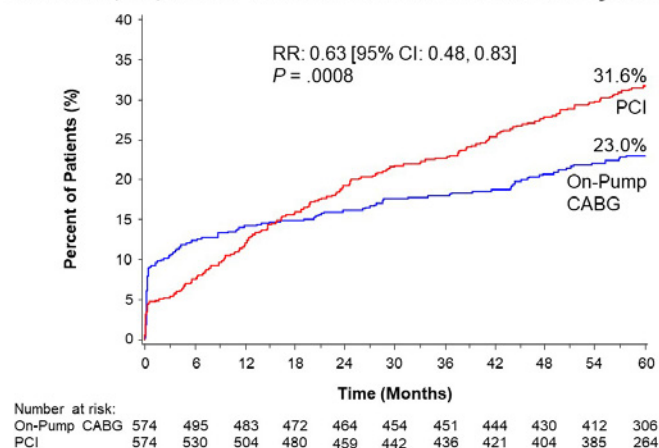
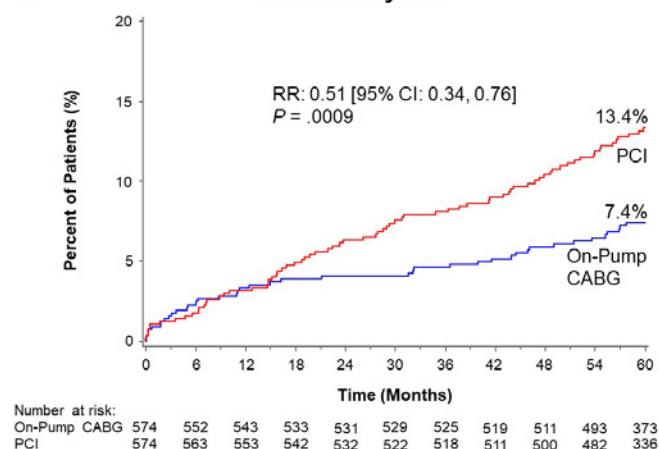
¹University Hospitals Cleveland Medical Center, Cleveland, OH; ²Cardiovascular Research Foundation, New York, NY; ³Erasmus Medical Center, Rotterdam, Netherlands; ⁴Imperial College of Science, Technology and Medicine, London, United Kingdom; ⁵National University of Ireland, Galway, Ireland; ⁶Icahn School of Medicine at Mount Sinai, New York, NY

Invited Discussant: Rosemary F. Kelly

Objective: There are concerns off-pump CABG may result in higher rates of revascularization and decreased survival compared with on-pump CABG. We performed a post hoc analysis of the Evaluation of XIENCE Versus Coronary Artery Bypass Surgery for Effectiveness of Left Main Revascularization (EXCEL) trial to determine the effect an on-versus off-pump strategy had on outcomes when compared with PCI.

Methods: EXCEL was a large-scale, international, multicenter, randomized, controlled, clinical trial comparing PCI and CABG for left main coronary artery disease of low or intermediate anatomical complexity. CABG was performed with or without cardiopulmonary bypass (on-pump vs off-pump) at the discretion of the operator. Outcomes between off-pump vs. PCI and on-pump vs. PCI were compared on an intent-to-treat basis using propensity score matching. The primary endpoints for the present analysis were the composite of death from any cause, stroke, or myocardial infarction (MI) at 5 years, the primary composite endpoint or ischemia-driven revascularization at 5 years, and rate of death from any cause at 5 years. Secondary endpoints included ischemia-driven revascularization, stent thrombosis or graft stenosis or occlusion, and in-hospital complications. Event rates were based on Kaplan-Meier estimates in time-to-first-event analyses.

Results: Of 1905 eligible patients, 948 patients were randomized to PCI and 957 patients were randomized to CABG. Of the 957 patients assigned to CABG, 940 patients underwent revascularization, with CABG as the first procedure in 923 patients—271 (29.4%) off-pump and 652 (70.6%) on-pump. Propensity matching resulted in groups of 476 patients (238 each) for off-pump CABG vs PCI and 1148 patients (574 each) for on-pump CABG vs PCI. In off-pump CABG vs PCI matched groups, the primary composite endpoint (19.3% vs 18.0%, $P = .68$), primary composite endpoint or ischemia-driven revascularization (25.7% vs 30.8%, $P = .26$), and death rate (12.4% vs 10.0%, $P = .38$) were similar at 5 years. In on-pump CABG vs PCI matched groups, the primary composite endpoint (17.7% vs 23.7%, $P = .01$), primary composite endpoint or ischemia-driven revascularization (23.0% vs 31.6%, $P = .0008$), and death rate (7.4% vs 13.4%, $P = .0009$) were lower in the on-pump CABG group at 5 years.

A Death, MI, Stroke or Ischemia Driven Revasc at 5 years**B Death at 5 years**

Conclusions: Among patients with left main disease in the EXCEL trial, on-pump CABG was associated with a decreased rate of the composite end point (death, stroke, or MI), a decreased rate of the composite end point or ischemia-driven revascularization, and a decreased risk of 5-year all-cause death when compared with PCI, whereas outcomes of off-pump CABG were similar to PCI. On-pump CABG should be considered the “gold standard” for surgical revascularization of left main disease, and future comparison studies should take this into account.

138. Improved Stroke-Free Survival with Routine Left Atrial Appendage Closure During Mitral Repair

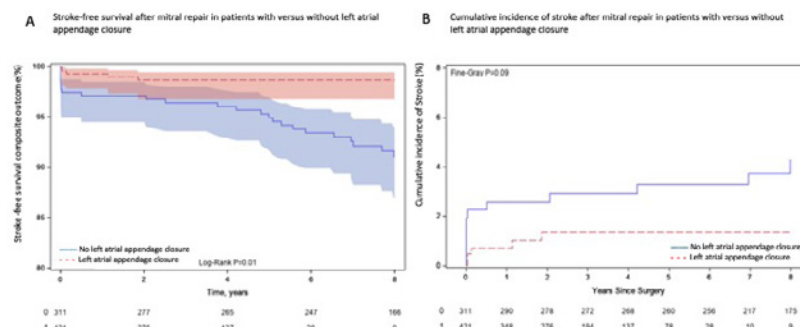
Joanna Chikwe¹, Amy Roach¹, Dominic Emerson¹, Achille Peiris¹, Georgina Rowe¹, George Gill¹, Asma Hussaini¹, Danny Ramzy¹, Wen Cheng¹, Natalia Egorova², Alfredo Trento¹

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Invited Discussant: Ralph J. Damiano, Jr.

Objectives: Stroke rates after mitral repair are reported to be 1–2% per year in cohorts that include patients without documented atrial fibrillation (AF). The role of routine atrial appendage closure is undefined in patients without AF: this study was therefore designed to compare long-term stroke-free survival after mitral repair in patients without recent AF, according to whether the left atrial appendage was closed.

Methods: An institutional registry with prospective clinical follow-up was linked to state-wide all-hospital admissions and vital statistics databases to identify 1016 consecutive patients undergoing isolated robotic mitral repair between 2005–2020. Patients with recent AF (n = 247, 23.8%) defined as AF <30 days before surgery, transcatheter left atrial appendage device (n = 3, 0.3%), prior stroke (n = 31, 3%), or active endocarditis (34, 3.3%) were excluded, leaving 732 patients (70.7%). Left atrial appendage closure was performed via the left atriotomy, following leaflet repair and prior to annuloplasty using a double layer continuous suture technique in 5.2% (14/267) patients prior to 2014, vs 87.5% (407/465) after 2014, reflecting a step change in practice. Stroke was defined as a permanent neurological event as the primary diagnosis for any state-wide hospital admission. Long-term stroke-free survival was compared according to whether patients underwent left atrial appendage closure, using Cox regression and propensity analysis to adjust for differences in patient characteristics. Median follow-up was 4.6 (range 0–15) and censored at 8 years.



Results: Patients receiving left atrial appendage closure were older (63 vs 57 years, $p < 0.001$), with higher prevalence of remote AF requiring cryomaze (9%, $n = 38$ vs 1%, $n = 3$, $p < 0.001$): there were no other significant differences in clinical baseline characteristics. Median clamp time decreased significantly over the study and was lower in patients who underwent left atrial appendage closure (71 mins) vs those who did not (87 mins) ($p < 0.0001$). After left atrial appendage closure there were significantly fewer reoperations for bleeding (0.5% [$n = 2$] vs 2.6% [$n = 8$] $p = 0.02$), and significantly higher incidence of AF (31.4% [$n = 132$] vs 24.4% [$n = 76$] $p = 0.04$). At five years freedom from $>2+$ mitral regurgitation was 97%. Five strokes were identified in patients with left atrial closure compared to 10 in those without ($p = 0.046$), with a significant difference in stroke-free survival maintained at 8 years (Figure). The number of patients needed to treat with atrial appendage closure to prevent one stroke in 8 years was 28.

Conclusions: Routine suture closure of the left atrial appendage during mitral repair in patients without recent AF appears safe, and associated with a long-term significant stroke-free survival benefit. This data may support routine suture closure of the left atrial appendage during mitral repair in most patients.

139. Surgical Ablation for Atrial Fibrillation Is Efficacious in Patients with Large Left Atria

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Washington University School of Medicine, St. Louis, MO

Invited Discussant: Marc Gillinov

Objective: Surgical ablation of atrial fibrillation (AF) is indicated both in patients with AF undergoing concomitant cardiac surgery and as a stand-alone procedure in patients with AF not well-controlled by medical therapy or catheter ablation. Left atrial (LA) size is a documented risk factor for both development of de novo AF and AF treatment failure. This has biased some clinicians against surgical management of patients with large left atria (LLA); however, no recent subgroup analysis has been published to evaluate the merit of this concern. This study examined late outcomes after the Cox-Maze IV procedure (CMP-IV) in patients with LLA as defined by LA diameter >6.5 cm.

Methods: Between April 2004 and March 2020, 66 patients with LLA underwent elective biatrial CMP-IV for refractory AF. Freedom from atrial tachyarrhythmias (ATAs) was assessed by electrocardiography, Holter, and/or pacemaker interrogation with mean follow-up of 4.6 ± 4.2 years. Recurrence was defined as any documented ATA lasting ≥ 30 seconds. Perioperative characteristics and outcomes were compared in multiple subgroups. Predictors of recurrence were determined by analyzing 15 covariates with univariable and, if significant, multivariable Fine-Gray regression with death as a competing risk.

Results: Mean age at surgery was 62.2 ± 11.6 years and mean LA diameter was 7.3 ± 0.8 cm. The majority of patients (52/66, 79%) had non-paroxysmal AF, and 21% (14/66) had failed at least one catheter ablation. Median preoperative AF duration was 5 years (IQR [1,9]). Seventy-three percent of patients (48/66) had a concomitant mitral valve procedure and 18% (12/66) had stand-alone ablation. Nine patients (14%) required postoperative pacemaker placement. There was no documented 30-day mortality. Freedom from ATAs on or off antiarrhythmic drugs was 91% (43/47) and 83% (39/47) at 1 year, respectively; 82% (18/22) and 64% (14/22) at 5 years; and 72% (13/18) and 61% (11/18) at 7 years. These rates were comparable to those for patients with LA ≤ 6.5 cm over the same period (total $N = 674$): 93% (468/505) and 85% (431/505) at 1 year, 84% (218/260) and 70% (181/260) at 5 years, 82% (132/161) and 65% (104/161) at 7 years (Figure 1). On multivariable Fine-Gray regression, increased preoperative time in AF (SHR 1.09 [1.03–1.16], $P = 0.004$), rhythm status at discharge (SHR 2.99 [1.17–7.66], $P = 0.022$), and increased LA diameter (1.59 [1.04–2.43], $P = 0.034$) were identified as predictors of ATA recurrence.

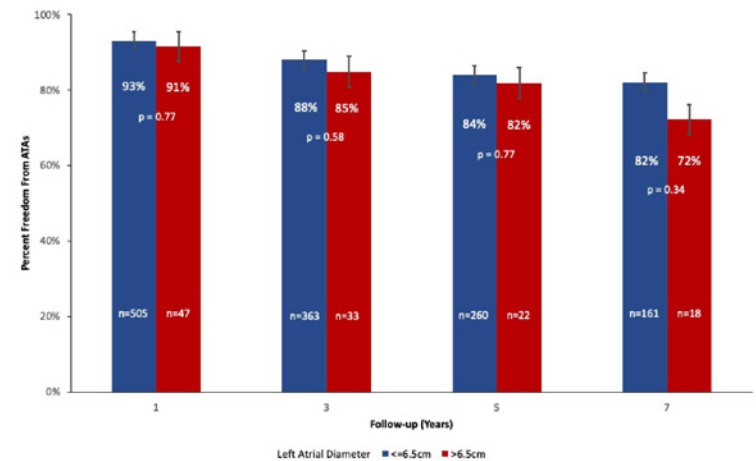


Figure 1: Freedom from atrial tachyarrhythmias (ATAs) after Cox-Maze IV by years of follow-up is similar between patients with pre-operative left atrial diameter ≤ 6.5 cm versus > 6.5 cm (proportions shown with standard error, Fisher's exact two-sided p values listed for each pair by year(s) of follow up).

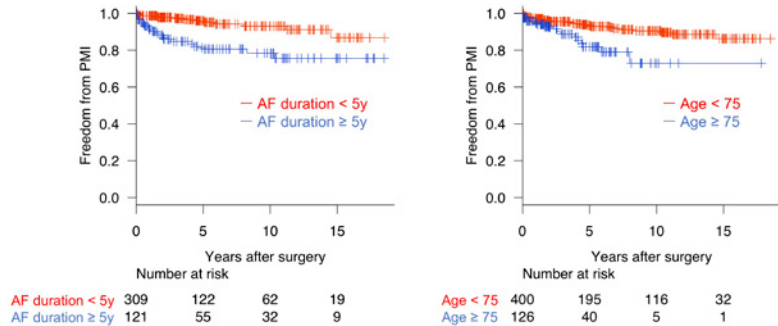
Conclusions: The CMP-IV had very good efficacy and durability in patients with LLA, despite the risk of recurrence with increased LA size. CMP-IV was particularly successful in LLA patients with shorter durations of preoperative AF. Postoperative pacemaker rates in this cohort were not higher than our previously reported institutional rates after CMP-IV for any atrial size. A biatrial CMP-IV should be considered in patients with LLA and AF.

140. Impact of Atrial Fibrillation Duration on Pacemaker Implantation After Cryomaze Procedure for Persistent Atrial Fibrillation

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Invited Discussant: Hersh Maniar

Objective: Maze procedure is a well-established treatment by Cox and recognized as an exceptional option for treatment of atrial fibrillation (AF). However, recurrence of AF or maze procedure induced-bradycardia sometimes complicate the outcomes. The purpose of this study was to review the rate of early- and late-onset pacemaker implantation (PMI) after Maze procedure and to explore the risk factors for it.

Methods: This study enrolled a consecutive series of 528 patients who underwent Maze procedure using Cryo-ablation system for non-paroxysmal AF in our institute between 2001 and 2020. The demographics of cohort showed age of 67 ± 10-year-old, male sex of 277 (52.5%), left atrial diameter of 54 ± 8 mm, AF duration of 3.5 ± 4.1 years and concomitant with aortic valve replacement of 144 (27.2%). The median follow up of entire cohort was 6.1 ± 5.0 years. Multivariable logistic regression was used to determine risk factors for in-hospital PMI and Cox proportional hazards model was used for late-onset PMI.



Results: Nine patients (1.7%) had in-hospital PMI and 37 patients (7.0%) had late-onset PMI after CryoMaze procedure. Most common primary indication for PMI was sick sinus syndrome (40 patients [7.6%]), followed by complete atrio-ventricular block (6 patients [1.1%]). Freedom rate from PMI was 96.6% at 1 year, 91.0% at 5 years, 87.4% at 10 years, and 83.4% at 15 years, respectively. The only risk factor for in-hospital PMI was preoperative AF duration (OR: 1.74, 95% CI: 1.08–2.81, p = 0.024), whereas the risk factors for late-onset PMI were preoperative AF duration (HR: 1.61, 95% CI: 1.25–2.08, p < 0.001] and age (HR: 2.21, 95% CI: 1.23–3.93, p = 0.007). Survival rate, freedom rate from cerebrovascular accidents and rate of AF recurrence were similar for patients with or without PMI.

Conclusions: The preoperative AF duration was a great risk factor for early- and late-onset PMI after CryoMaze procedure. However, the incidence of PMI was not associated with increased morbidity or AF recurrence.

141. Single-Center 25-Years Experience with Valve-Sparing Aortic Root Replacement Using a Straight Tube Graft (David I Procedure)

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Invited Discussant: Tirone E. David

Objective: Aortic valve saving David Procedure has evolved into an accepted technique to replace the dilated aortic root. However, few results with large patient cohort and long follow-up have been published. We present our single-center experience.

Methods: Between 1993 and 2019, 677 patients underwent David I procedure with a straight tube graft at our center. The mean age was 52.9 ± 15.4 and 480 (70.9%) were male. Marfan syndrome was present in 112 (16.5%) and bicuspid aortic valve in 71 (10.5%) patients, respectively. 135 (19.9%) were emergent and 542 (80.1%) elective respectively. The indication for surgery was aortic root aneurysm in 489 (84.0%) patients and acute aortic dissection in 136 (20.1%) patients. This case series was performed by more than 25 surgeons over almost 3 decades.

Results: Mini-sternotomy access was used in 57 (8.4%) patients. Additional Cusp plasty was performed in 84 (12.4%) patients. Concomitant procedures were; CABG in 122 (18.0%), proximal aortic arch replacement in 149 (22.0%) and total arch replacement in 102 (15.1%) patients, respectively. Overall in-hospital mortality was 27 (4.0%) and peri-operative stroke was 26 (3.8%). Postoperative echocardiography was available for 631 patients and showed aortic insufficiency ≤ I° in 601 (88.8%) patients. The 1-, 5-, 10-, 15-, and 20-year survival rates were: 93%, 88%, 80%, 65%, and 47%, respectively. The rates for freedom from valve-related re-operation at 1, 5, 10, 15, and 20 years were: 97%, 92%, 87%, 84%, and 79%, respectively.

Conclusions: This study represents one of the largest single-center cohort of patients who underwent David I Procedure with a straight tube graft with a long follow up times. Regardless of the underlying pathology, valve-sparing David I procedure can be performed with low peri-operative morbidity and mortality. Both the short- and long-term results are excellent. The straight Dacron graft does not seem to lead to increased Leaflet degeneration. Our experience shows that this procedure is reproducible by multiple surgeons.

142. Long-Term Outcomes Following Valve Sparing Root Replacement with Concomitant Mitral Valve Repair

Maral Ouzounian¹, Myriam Lafreniere-Roula², Carolyn David¹, Jennifer C.Y. Chung¹, Tirone E. David¹

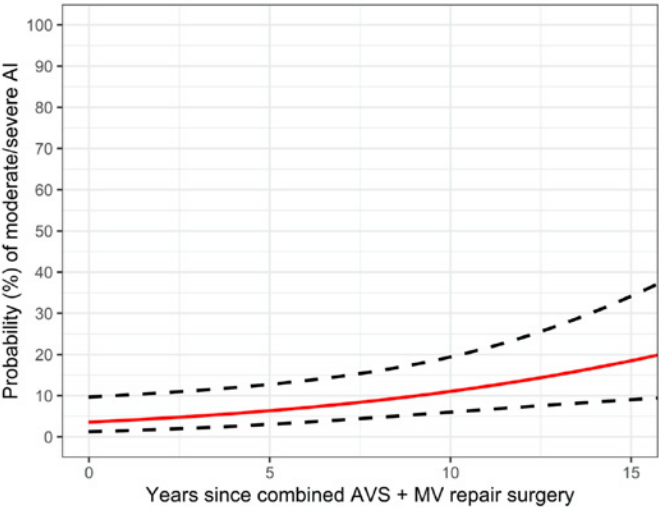
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Invited Discussant: Laurent De Kerchove

Objectives: To examine the late outcomes of valve-sparing root replacement and concomitant mitral valve repair in patients who have been followed prospectively for more than two decades.

Methods: From 1992 to 2020, 54 consecutive patients (mean age 47 ± 16 years; 80% male; 57% Marfan syndrome) underwent valve-sparing root replacement (46 reimplantation; 8 remodeling) with concomitant repair of the mitral valve. At baseline, 53% and 95% of the cohort had greater than mild aortic and mitral insufficiency, respectively. Patients were followed prospectively for a median (IQR) of 9 (3–14) years. 13 patients were at risk at 15 years.

Results: No patient suffered a perioperative death or stroke. There were 3 late deaths and the 15-year overall survival (95% CI) was 96.0% (74.8%, 99.4%), similar to the age- and sex-matched population. Over the follow-up period, 6 patients had reoperation of the aortic valve and 4 on the mitral valve. Of those, 2 had reoperation on both aortic and mitral valves for a total of 8 reoperations in this cohort (14.8%). The cumulative proportion (95% CI) of reoperation at 10 years of either or both valves were as follows: aortic valve 11.4% (3.9%, 33.3%); mitral valve 6.1% (1.4%, 26.1%); both valves 13.5% (5.2%, 34.9%). There were no late events of endocarditis or myocardial infarction, and the cumulative proportion of thromboembolism at 15 years was 2.8% (0.4%, 19.2%). The estimated probability of developing moderate/severe aortic insufficiency at 15 years was 18.5 (9.0%–34.3%) (Figure). On last echocardiographic follow-up, none of the patients had developed moderate/severe mitral regurgitation.



Conclusion: In the largest reported series to date, concomitant valve-sparing root replacement and mitral valve repair provides excellent late clinical outcomes with a low risk of death or valve-related complications. Continued surveillance of late valve function is necessary.

143. Surgical Management and Outcomes in Patients with Acute Type A Aortic Dissection and Cerebral Malperfusion—Insights from a Multicenter Study

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Invited Discussant: Mohamad Bashir

Objectives: To evaluate the results of surgical management of patients presenting with acute type A aortic dissection (A-AAD) and cerebral malperfusion (CM) based on the degree of preoperative brain injury.

Methods: Out of 1034 consecutive patients with A-AAD, from 2000 to 2019, 195 (19%) with signs of CM were stratified into 3 Groups according to the severity of brain injury at time of presentation: 31 (16%) with syncope (Group 1), 137 (70%) with persistent loss of focal neurological function (Group 2) and 27 (14%) with coma (Group 3). Syncope was defined as loss of consciousness and postural tone with spontaneous recovery and no permanent deficits and coma as any non-medically induced complete mental unresponsiveness to external stimulation. Results were evaluated by uni- and multivariable analysis by comparing the 3 groups.

Results: There were no significant differences in baseline characteristics except for incidence of cardiac tamponade or shock at presentation which was higher in Group 3 (77%) vs Group 1 (39%) and Group 2 (17%) patients (p < 0.001) and smoking habit (47% in Group 1 vs 26% in Group 2 and 17% in Group 3, p 0.047). Median age was 68, 65, and 68 years for Group 1, 2, and 3 (p = 0.82); male was the prevalent sex in all the Groups, 58%, 59%, and 65% in Group 1, 2, and 3, respectively (p = 0.82). A femoral artery was the most common cannulation site while the axillary artery was used in 23% of Group 1, 31% of Group 2, and 27% of Group 3 patients (p = 0.65); antegrade cerebral perfusion was performed in 78% of Group 1, 77% of Group 2, and 88% of Group 3 patients (p = 0.45) and retrograde cerebral perfusion in 19% of Group 1, 25% of Group 2, and 8% of Group 3 patients (p = 0.17). Ascending aorta replacement was more frequent in Group 2 (77%) vs 55% of Group 1 and 18% of Group 3 (p = 0.03) while arch surgery was performed more frequently in Group 1 (45%) p = 0.04. Cardiopulmonary bypass, myocardial ischemia and circulatory arrest times were similar. In-hospital mortality was 13% in Group 1, 29% in Group 2, and 50% in Group 3 (p = 0.01); Group 3 patients had a higher incidence of permanent neurological deficits; 1- and 5-year survival was 72 ± 8% and 47 ± 11% in Group 1, 67 ± 4% and 54 ± 5% in Group 2, and 50 ± 10% and 44 ± 10% in Group 3 patients (log-rank p test = 0.135). At multivariable analysis cardiogenic shock (HR 2.3, p = 0.004), Group 3 (HR 4.81, p = 0.003), and previous cardiac surgery (HR 8.75, p = 0.001) were independent risk factors for mortality, while axillary cannulation was a brain protective factor (HR 0.38, p = 0.03).

Table 1: Univariable and Multivariable Analysis for In-Hospital Death

Univariable Analysis		
	OR (95% CI)	P
Age	1.03 (1.00–1.06)	0.024
Male sex	0.39 (0.72–2.33)	0.396
Group		
Syncope vs Neurological deficit	0.59 (0.27–1.33)	0.205
Coma vs Neurological deficit	3.48 (1.59–7.63)	0.002
Cardiac tamponade/shock	2.46 (1.37–4.44)	0.003
Chest pain	0.70 (0.39–1.24)	0.221
Organ malperfusion	1.61 (0.74–3.50)	0.232
Aortic insufficiency ≥moderate	1.00 (0.49–2.05)	0.994
Systemic hypertension	0.78 (0.42–1.45)	0.430
Smoking habitus	0.73 (0.38–1.38)	0.329
Dyslipidemia	0.74 (0.30–1.85)	0.35
Diabets mellitus	1.61 (0.37–6.94)	0.523
Chronic kidney disease	1.81 (0.62–5.32)	0.99
Acute kidney disease	2.83 (1.01–7.92)	0.048
Chronic atrial fibrillation	1.98 (0.75–5.25)	0.168
Chronic oral anticoagulation	3.90 (1.28–11.91)	0.017
History of stroke	3.36 (0.99–11.46)	0.052
Coronary artery disease	2.69 (0.93–8.68)	0.098
Previous cardiac surgery	3.14 (0.93–10.67)	0.067
Bicuspid aortic valve	1.26 (0.23–7.07)	0.791
Axillary vs Femoral artery cannulation	0.48 (0.24–0.98)	0.045
Central vs Femoral artery cannulation	0.95 (0.67–2.49)	0.921
Ascending aorta + arch replacement vs ascending aorta + hemiarch replacement	0.56 (0.29–1.07)	0.08
Retrograde cerebral perfusion	1.40 (0.68–2.88)	0.357
Antegrade cerebral perfusion	0.85 (0.40–1.80)	0.667
No cerebral perfusion	1.30 (0.70–2.43)	0.830
CPB time	1.01 (1.00–1.01)	0.036
Clamp time	1.00 (1.00–1.01)	0.548
Arrest time	1.00 (1.00–1.01)	0.533
Temperature	0.90 (0.82–1.00)	0.045
Nadir HCT	0.95 (0.85–1.06)	0.322
VAM≥96 h	2.48 (1.27–4.84)	0.008
UTI stay	1.01 (0.99–1.03)	0.268
Surgical re-exploration	3.06 (1.48–6.36)	0.003
Postoperative neurological deficit	3.31 (1.64–6.67)	0.001
Paraplegia	1.71 (0.81–3.64)	0.161
Coma	37.46 (13.21–106.18)	0.000
Acute miocardial infarction	6.89 (1.22–38.81)	0.029
Atrial fibrillation	0.57 (0.29–1.14)	0.113
Acute kidney injury	2.30 (1.23–4.31)	<0.001
CVVH/Dialysis	2.73 (1.33–5.62)	0.006
Multivariable Analysis		
	OR (95% CI)	p
Axillary artery cannulation vs Femoral	0.12 (0.03–0.54)	0.006
Postoperative coma	45.10 (11.48–177.19)	<0.001
Group coma vs neurological deficit	3.95 (1.15–13.50)	0.029
Chest re-exploration	3.46 (1.18–10.16)	0.024
History of stroke	6.73 (1.22–37.12)	0.029

Conclusions: Patients with A-AAD and CM without preoperative coma showed acceptable mortality, while those presenting with coma had a high in-hospital mortality regardless of the surgical strategy for brain protection. Early and medium-term results were influenced by the severity of neurologic injury at presentation. The use of the axillary artery for arterial cannulation appeared to be a protective factor during repair of A-AAD with CM.

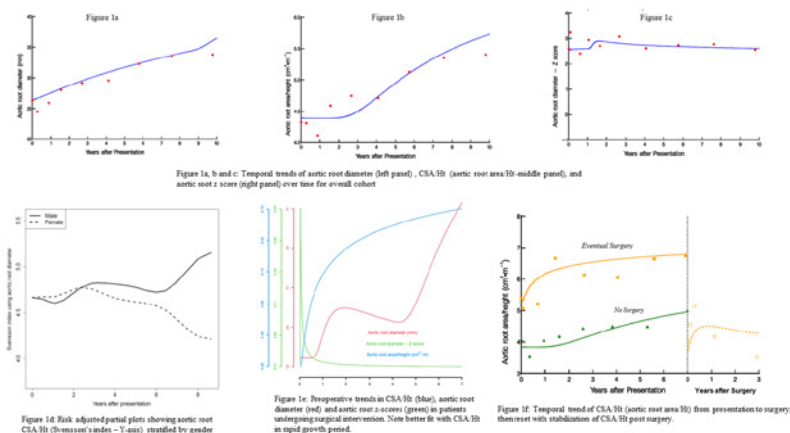
144. Optimizing Evaluation and Predictive Utility in Pediatric Marfan Syndrome: Novel Longitudinal Metrics to Track Growth of Aortic Structures
Salima Bhimani, Abdelrahman Rahmy, Justin Jin, Rukmini Komarlu, Kenneth Zahka, Suzie Kim, Vidyasagar Kalahasti, Lars G. Svensson, Milind Desai, Eric Roselli, Hani K. Najm, Gosta Pettersson, Jeevanatham Rajeswaran, Amol Pande, [Tara B. Karamlou](#)
Cleveland Clinic, Cleveland, OH

Invited Discussant: Luca A. Vricella

Objective: Cardiovascular surveillance metrics in pediatric Marfan Syndrome (pMFS) are Z-score based and extrapolated from adult MFS guidelines. We evaluated the utility of aortic root cross sectional area/height index (CSA/Ht) among a large cohort of pMFS, as a potential novel risk-stratification and surgical triage metric.

Methods: Pediatric patients presenting with genotypic or phenotypic MFS ≤age 26 years treated at our center from 2001–2020 were identified. Serial echocardiographic images (N = 801) were reviewed with off-line measurements of specific structures. Time-related transition to surgery was modeled using parametric methods. Predictive utility of CSA/Ht compared to aortic root diameter (ARd) and root Z-score (ARz) were modeled using nonlinear multivariable longitudinal regression analyses with surgery as a time-varying covariate.

Results: 81 patients (44% female) were identified with median age 6.4 years (15/85%: 0.76–17.3 y) and median follow-up 4.4 years (range 0–18.5 y). Family history of MFS was present in 49 (63%) and 91% (N = 51) were positive for fibrillin-1 gene mutation. Baseline echocardiographic data were: CSA/Ht 3.97 ± 1.49, ARd 24.1 ± 8.99 (mm), and ARz 2.49 ± 1.64. CSA/Ht tracked ARd better than ARz (Figure 1a-c). Risk-adjusted plots showed females had early increases in CSA/Ht while males had later, accelerated rise (Figure 1d). N = 19 (23%) patients underwent surgery, 2 of whom were neonates. Echo data at surgery were: CSA/Ht 7.25 ± 2.24, ARd 40.5 ± 8.19 (mm), and ARz 3.9 ± 2.16. One death occurred in a neonate with massive aortic dilation and acute mitral valve (MV) chordal rupture. Surgical procedures included at least two components in 17 (aortic, mitral, tricuspid, or pulmonary valve, aortic root, and arch procedures) and isolated MV procedures in 2 patients. Time-related transition to surgery showed a prominent early phase (to 1 year post- presentation), followed by a slowly rising late phase. Increasing CSA/Ht had a more linear correlation vs. ARd or ARz during periods of rapid somatic growth in surgical patients, and also tracked postoperative root stabilization (Figure 1e-f). Surgical repair occurred at CSA/Ht values between 5–7 cm²/m.



Conclusions: Surgery for pMFS occurs early after presentation at referral centers and includes multiple component operations for the majority. CSA/Ht tracks ARd well over time in pMFS, with prominent gender differences. CSA/Ht between 5–7 cm²/m has promise as an accurate surgical triage in pMFS. Importantly, CSA/Ht surgical threshold values in pMFS occurred at lower than current accepted ‘surgical’ threshold ARd values and CSA/Ht adult MFS threshold values.

145. Predictors of Left Ventricular Outflow Tract Obstruction Following Neonatal Arch Repair: Role of Computed Tomography

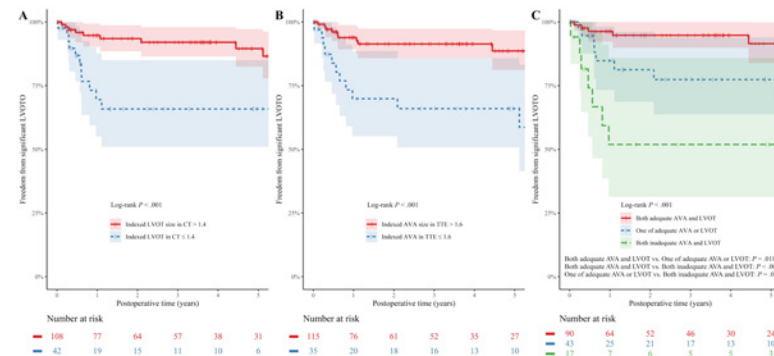
Dong-Hee Kim¹, Eun Seok Choi¹, Bo Sang Kwon¹, Tae-Jin Yun¹, Dong Hyun Yang², Chun Soo Park¹

¹Division of Pediatric Cardiac Surgery, Department of Thoracic and Cardiovascular Surgery, University of Ulsan College of Medicine, Asan Medical Center, Seoul, Republic of Korea; ²Department of Radiology, University of Ulsan College of Medicine, Asan Medical Center, Seoul, Republic of Korea

Invited Discussant: Ronald K. Woods

Objective: Despite the improved surgical outcome of neonatal arch repair, later development of left ventricular outflow tract obstruction (LVOTO) is still a concern. This study investigated the validity of computed tomography (CT) scan in predicting future LVOTO following neonatal arch repair.

Methods: From 2008 through 2019, among 340 patients who underwent neonatal arch repair, 150 patients who underwent one-stage repair without left ventricular outflow tract (LVOT) intervention were retrospectively analyzed. Patients who were associated with complex cardiac anomalies (n = 106), repaired through thoracotomy (n = 27), or lack of preoperative images (n = 23) were excluded. The diameters at the level of aortic valve annulus (AVA) and LVOT were measured with transthoracic echocardiography (TTE) and CT scan. Outcomes of interest were the development of significant LVOTO (peak flow velocity > 3 m/s on TTE) and reintervention or reoperation for LVOTO.



Results: Median follow-up duration was 3.6 years. Overall survival, freedom from reintervention for LVOTO, and freedom from significant LVOTO at 5 years were 93.7%, 88.2%, and 83.4%, respectively. In univariable Cox regression analysis, indexed AVA and LVOT diameters were identified as predictors for the development of significant LVOTO regardless of diagnostic tool. Indexed LVOT diameter (LVOT diameter [mm] – body weight [kg], concordance index [C-index] = 0.729, P = .002) among CT measures, and indexed AVA diameter (AVA diameter [mm] – body weight [kg]; C-index = 0.723, P < .001) among TTE measures achieved the highest accuracy in predicting the development of LVOTO. The maximal chi-square test identified cutoff values for the development of LVOTO; 1.4 for indexed LVOT diameter in CT and 1.6 for indexed AVA diameter in TTE. Freedom from the development of LVOTO was higher in patients with a greater than 1.4 of indexed LVOT diameter (adequate LVOT) in CT scan (89.5% vs 65.9% at 5-year, Log-rank P < .001 [Figure 1A]), and in patients with a greater than 1.6 of indexed AVA diameter (adequate AVA) in TTE (88.6% vs 66.0% at 5-year, Log-rank P < .001 [Figure 1B]). When both indexed diameters were combined, the difference in the development of LVOTO became more prominent (5-year freedom from the development of LVOTO, 91.5% in both adequate AVA and LVOT vs 77.4% in one of adequate AVA or LVOT vs 51.9% in both inadequate AVA and LVOT; Log-rank P < .001 [Figure 1C]).

Conclusions: The indexed LVOT dimension in CT scan could provide additional information regarding the future development of LVOTO and could also independently predict future development of LVOTO following neonatal arch repair.

146. One Year Results of a Novel PTFE-Based Pulmonary Valved Conduit in a Pediatric Patient Population

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Invited Discussant: James A. Quintessenza

Objective: To present 12 month outcome data of a prospective, multicenter, single-arm, early feasibility study to evaluate the safety and performance of a novel ePTFE-based biosynthetic valved conduit for replacement of the pulmonary valve and reconstruction of the Right Ventricular Outflow Tract.

Methods: The investigational device is a 20 mm valved conduit comprised of ePTFE with stretch technology and a flexible tri-leaflet polymeric valve made of an advanced proprietary composite material. The conduit can be tailored to length requirements of the anatomy. The subject population included symptomatic or asymptomatic patients requiring surgical replacement of the native pulmonary valve and right ventricular outflow tract or of a previously implanted right ventricle to pulmonary artery conduit. All enrolled patients met study inclusion/exclusion criteria and had a signed informed consent form. All patients had pre- and postoperative evaluation via transthoracic echocardiography (TTE) with follow up physical exams, assessment of adverse events, and review of anti-platelet/anticoagulant medications. Aspirin was administered for a minimum of three months post procedure and, per institutional protocols, four patients were on temporary Coumadin (warfarin).

Results: Of the 17 patients enrolled from three sites, 52.9% were male. Ages ranged from 6 to 17 years (mean 11.5 ± 3.7). BSA ranged from 0.82 to 1.57 m². Twelve-month follow up data was available in fourteen patients. No patient exhibited post-implant valvular stenosis (RVOT gradient > 20 mmHg). Favorable changes vs. baseline in echocardiographic parameters of RV function were demonstrated throughout follow-up. There was only one observation of pulmonary regurgitation above baseline (\leq mild) through 12 month follow up. There were no reinterventions, and the only serious adverse event reported through 12 months was a procedural pneumothorax. Throughout postoperative serial TTE evaluation at discharge, 1, 3, 6, and 12 months, no evidence of worsening valvular insufficiency was observed. No patient developed endocarditis and TTE detected no clinically significant thrombus or calcification formation of the leaflets or conduit by TTE.

Conclusions: Early experience in a small cohort of patients has shown the novel polymeric pulmonary valved-conduit, to be a safe option for patients needing reconstruction or replacement of the RVOT. Demonstration of early resistance to thrombosis, infection, and structural valve deterioration with improvements in RV function is encouraging. Further follow up and additional study in a larger cohort of patients is needed to determine whether the initial benefits persist over clinically relevant timeframes needed to significantly delay the need for operation due to valve or conduit failure.

147. Risk Factors of Early Adverse Outcomes After Right Ventricular Outflow Tract Reconstruction with Bovine Jugular Vein Conduit

Dong-Hee Kim, Young Kern Kwon, Eun Seok Choi, Bo Sang Kwon, Chun Soo Park, Tae-Jin Yun

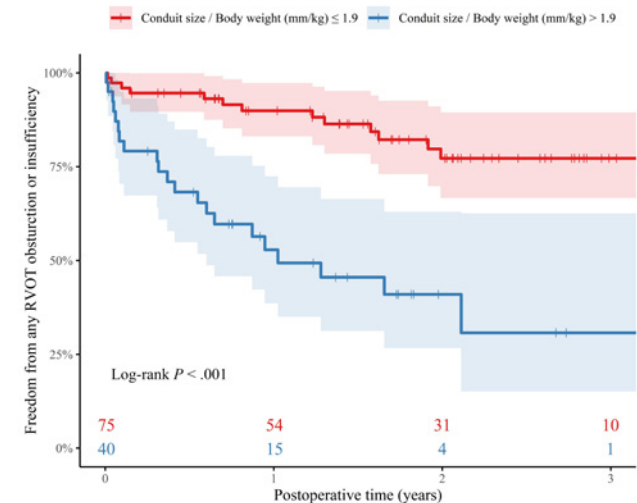
Division of Pediatric Cardiac Surgery, Department of Thoracic and Cardiovascular Surgery, University of Ulsan College of Medicine, Asan Medical Center, Seoul, Republic of Korea

Invited Discussant: Max B. Mitchell

Objective: The bovine jugular vein conduit (Contegra, Medtronic Inc., Minneapolis, MN, USA) has been widely used for right ventricle outflow tract (RVOT) reconstruction in patients with various types of congenital heart disease. We sought to evaluate the clinical outcomes after Contegra implantation and risk factors for early adverse events.

Methods: A single-center retrospective review was done for 115 consecutive patients (54 males [54/115, 47%]) who underwent RVOT reconstruction using Contegra from 2016 to 2019. Outcomes of interest were overall survival, conduit explantation, significant lesions in each level of reconstructed RVOT, and dysfunction of the conduit per se. Significant lesions were defined as Contegra valve insufficiency (\geq moderate) or stenosis at any level of RVOT (flow velocity ≥ 3.5 m/s).

Results: Median age, body weight, Contegra diameter, and Contegra diameter over body weight ratio were 10.3 months (Interquartile range [IQR], 5.7–26.9), 7.8 kg (IQR, 6.3–12.4), 14 mm (IQR, 12–16), and 1.7 (IQR, 1.3–2.1), respectively. Most common diagnosis was tetralogy of Fallot or its variant (95 patients [95/115, 83%]). During the 25 months of median follow-up duration, 7 patients died (1 early death, 6 late deaths). There were 15 patients with conduit explantation, including three cases of infective endocarditis. Overall survival and freedom from conduit explantation at 3 years were 95% and 82%, respectively. There were 34 patients (34/115, 30%) with significant RVOT lesions, including 8 patients (8/155, 7%) with valve regurgitation, 22 patients (22/115, 19%) with stenosis, and 4 patients (4/115, 3.5%) with combined lesions. Among the 26 patients (26/115, 23%) with stenosis, the level of stenosis was conduit per se in 8 patients (8/26, 31%) and at distal anastomoses between Contegra and the pulmonary arteries in 18 patients (18/26, 69%), while no patient had stenosis at proximal anastomotic site. Overall freedom from RVOT lesions and freedom from the dysfunction of conduit per se at 3-years were 63% and 75%, respectively. The ratio of conduit size over body weight (mm/kg; HR 2.76, $P < .001$) was identified as a risk factor for developing significant RVOT lesions on multivariable Cox analysis. Time-related receiver operating characteristics curve analysis ascertained optimal cut-off value of 1.90 mm/kg (sensitivity, 0.77; specificity, 0.76; area under curve, 0.82) at postoperative one year. Patients with conduit size/weight ratio over 1.90 had significantly poor outcome in terms of RVOT lesions (30.7% vs 77.2% at 3-year, Log-rank $P < .001$; Figure).



Conclusions: Clinical outcomes after Contegra implantation for RVOT reconstruction are promising; however, oversized conduit should be used with caution to reduce the risk of significant RVOT stenosis or Contegra valve insufficiency.

148. Handmade Tri-leaflet ePTFE Conduits versus Homograft for RVOT Reconstruction: An Institutional Experience

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Invited Discussant: Christoph Haller

Objective: To investigate the performance of handmade tri-leaflet ePTFE conduits when there was no suitable homograft.

Methods: Patients who underwent RVOT reconstruction with tri-leaflet ePTFE conduits or homograft were included from December 2016 to August 2020. Patients who used bovine jugular vein grafts or other materials were excluded. The end points were composite of more than moderate conduit stenosis (≥ 36 mmHg) and more than moderate insufficiency.

Table 1: Patients Characteristics

Variables	ePTFE (n = 102)	Homograft (n = 52)	P-Value
Male gender, n (%)	61 (59.8%)	30 (57.7%)	0.801
Weight (IQR), median (Kg)	13.5 (10.0–19.0)	17.8 (13.6–25.8)	0.003
Age (IQR), median(months)	34.5 (20.8–62.8)	60.0 (39.3–81.0)	0.001
Reoperation for previous conduit failure, n (%)	33 (32.4%)	17 (32.7%)	0.966
Prior palliative surgery	36 (35.3%)	11 (21.2%)	0.096
Primary diagnosis			0.000
PAA/VSD	56 (54.9%)	21 (40.4%)	0.088
Complex DORV	16 (15.7%)	3 (5.8%)	0.077
TGA/VSD/PS	9 (8.8%)	3 (5.8%)	0.752
Truncus arteriosus	3 (2.9%)	7 (13.5%)	0.032
CCTGA/PS	9 (8.8%)	0	0.029
Complex TOF	5 (4.9%)	3 (5.8%)	1.000
DOLV	1 (1.0%)	0	1.000
ROSS/ROSS II procedure	3 (2.9%)	15 (28.8%)	0.000
AS/AR	3 (2.9%)	14 (26.9%)	0.000
MS	0	1 (1.9%)	0.338
Conduit characteristic			
Conduit size (mm)	17.9 ± 2.2	20.5 ± 3.0	0.000
Conduit Z score	1.48 ± 1.04	1.83 ± 1.05	0.048
12 mm	1 (1.0%)	0	1.000
14 mm	8 (7.8%)	0	0.052
16 mm	23 (22.5%)	6 (11.5%)	0.098
18 mm	42 (41.2%)	12 (23.1%)	0.026
20 mm	17 (16.7%)	13 (25.0%)	0.217
22 mm	11 (10.8%)	10 (19.2%)	0.149
24 mm	0	6 (11.5%)	0.001
26 mm	0	5 (9.6%)	0.004

Table 2: Postoperative and Follow-Up Results

Variables	ePTFE (n = 102)	Homograft (n = 52)	P-Value
Postoperative results			
Delayed sternal closure, n (%)	2 (2.0%)	1 (1.0%)	1.000
ECMO support, n (%)	2 (2.0%)	1 (1.0%)	1.000
Peritoneal dialysis, n (%)	7 (6.9%)	3 (5.8%)	1.000
Diaphragmatic paralysis, n (%)	3 (2.9%)	2 (3.8%)	1.000
Mechanical ventilation time, hours	27.5 (19.0–94.5)	24.5 (15.3–97.3)	0.586
Third degree A-V block, n (%)	1 (1.0%)	1 (1.9%)	0.329
Respiratory tract infection, n (%)	23 (22.5%)	11 (21.2%)	1.000
ICU stays, days	4.0 (2.0–8.0)	4.5 (2.3–8.0)	0.797
Early deaths, n (%)	1 (1.0%)	1 (1.0%)	1.000
Peak gradient of conduit (mm Hg)	11.6 ± 7.0	6.9 ± 6.3	0.000
Follow-Up Results			
Follow-up time (months)	18.4 ± 10.6	15.2 ± 10.0	0.079
Late deaths, n (%)	1 (1.0%)	0	1
Conduit dysfunction rate, n (%)	15 (14.7%)	9 (17.3%)	0.674
More than moderate PS	12 (11.9%)	4 (7.7%)	0.580
More than moderate PR	3 (2.9%)	6 (11.5%)	0.062
*Moderate to severe PS/PR	0	1 (1.9%)	0.338
Conduit failure rate, n (%)	2 (2.0%)	0	0.550
Severe PS	1 (1.0%)	0	1.000
Severe PR	1 (1.0%)	0	1.000
Peak pressure gradient (mm Hg)	19.2 ± 13.2	13.2 ± 10.8	0.005

Results: A total of 102 patients in ePTFE group and 52 patients in homograft group (5 aortic homograft and 47 pulmonary homograft). The median age was younger and the median weight was lower in ePTFE group, 34.5 (interquartile range: 20.8–62.8) months versus 60.0 (39.3–81.0) months, $P = 0.001$; 13.5 (10.0–19.0) kilograms versus 17.8 (13.6–25.8) kilograms, $P = 0.003$. There were also significant differences in the distribution of primary diagnosis mainly affected by the available conduit size, $P < 0.001$. The conduit size and conduit z score was smaller in ePTFE group, 17.9 ± 2.2 mm versus 20.5 ± 3.0 mm, $P < 0.001$; 1.48 ± 1.04 versus 1.83 ± 1.05, $P = 0.048$. One patient occurred early death in each group. At the latest follow up (18.4 ± 10.6 months versus 15.2 ± 10.0 months), one patient occurred late death in ePTFE group but no patient in homograft group. There was no significant difference occurred in the composite endpoint, 14.7% versus 17.3%, $P = 0.079$.

Conclusions: Handmade tri-leaflet ePTFE conduits showed acceptable early and mid-term outcomes when there was no suitable homograft, but longer follow up was needed.

149. Intraoperative Opioid Exposure Is Associated with Survival Differences Relative to the Tumor Genomic Profile in Early-Stage Lung Adenocarcinoma Patients: An Exploratory Analysis

James G. Connolly, Kay See Tan, Brooke Mastrogiacomio, Joseph Dycoco, Patrick J. McCormick, Francisco Sanchez-Vega, Prasad S. Adusumilli, Gaetano Rocco, James M. Isbell, Daniela Molena, Matthew J. Bott, Gregory W. Fischer, David R. Jones, Joshua S. Mincer

Memorial Sloan Kettering Cancer Center, New York, NY

Invited Discussant: Mark Onaitis

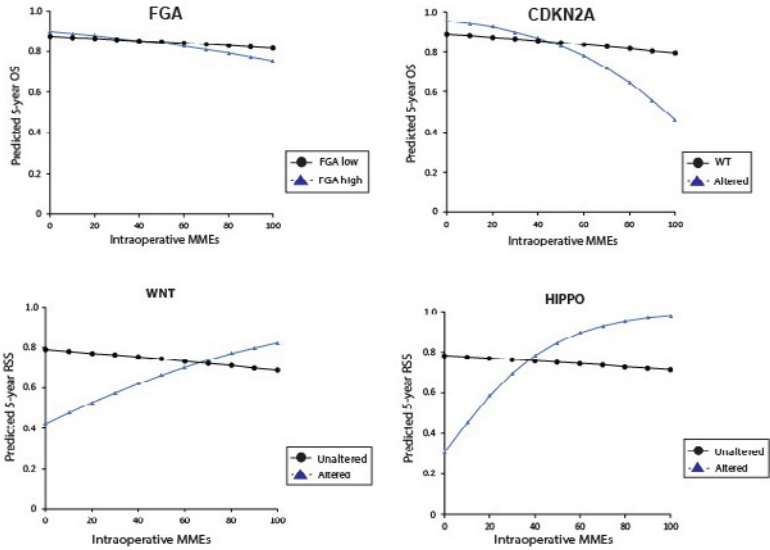
Objective: Opioids have been linked to worse oncological outcomes in cancer patients. While preliminary studies in breast cancer have identified associations with intratumoral opioid receptor gene alterations and survival, no study has determined whether a tumor genomic profile-opioid exposure relationship exists and its impact on survival. To address this knowledge gap, we hypothesized that higher intraoperative opioid exposure was associated with worse recurrence-specific survival (RSS) and overall survival (OS) in early-stage lung adenocarcinoma (LUAD) patients. We also examined if the opioid-sparing analgesic adjuncts, ketamine and dexmedetomidine, may improve survival and if selected tumor genomics are associated with this opioid exposure-survival relationship.

Methods: We reviewed 740 patients with pathological stage I-III LUAD and next generation sequencing data who underwent a complete (R0) resection from 2010 to 2019. OS and RSS were estimated using the Kaplan-Meier approach and stratified by 1) intraoperative opioid dose (expressed as morphine milligram equivalents [MMEs]) and 2) adjunct administration of ketamine and dexmedetomidine. Comparisons were made using log-rank tests. A multivariable Cox regression model for OS and RSS was generated with genes altered at $\geq 5\%$ frequency, canonical oncogenic pathways (N = 10), fraction genome altered (FGA), and tumor mutational burden individually added to the Cox model to test for interaction with opioid dose.

Results: The majority of patients were female (N = 489, 66%) with a median age of 68 years (interquartile range [IQR], 61–73 years), and were pathologic stage I (N = 456, 62%). Five-year RSS was 62% (95% CI, 54.7%–69.7%) and OS was 74% (95% CI, 68.6%–80.6%). On multivariable analysis, ketamine administration was protective for RSS (HR 0.44, 95% CI 0.24–0.80; $p = 0.007$) compared to no adjunct. Higher intraoperative MMEs were significantly associated with worse OS (HR 1.09 per 10 MME, 95% CI 1.02–1.17; $p = 0.010$). There were no associations with dexmedetomidine. Exploratory analysis of tumor genomics found that higher FGA and CDKN2A alteration interacted significantly with MMEs to predict worse OS ($p = 0.04$ and 0.05 , respectively). In contrast, alterations in the Wnt ($p = 0.03$) and Hippo oncogenic pathways ($p = 0.04$) were associated with improved RSS at higher MMEs compared to unaltered pathways (Figure 1).

Conclusions: This is the first study in LUAD patients to observe associations between tumor-specific genomics and intraoperative opioid administration and their impact on survival. We found intraoperative opioid exposure is associated with worse OS, while ketamine exposure is associated with improved RSS in early-stage LUAD. These associations are hypothesis-generating and, if proven correct on future studies, may ultimately guide intraoperative analgesic choices in lung cancer patients.

Figure 1



150. The Role of Surgery versus Immunotherapy in Stage IIIA/N2 Non-Small Cell Lung Cancer Following Chemoradiation

Susan Ansley Smith, Jaimin R. Trivedi, Matthew C. Black, Victor H. van Berkel, Matthew P. Fox

University of Louisville, Louisville, KY

Invited Discussant: Linda W. Martin

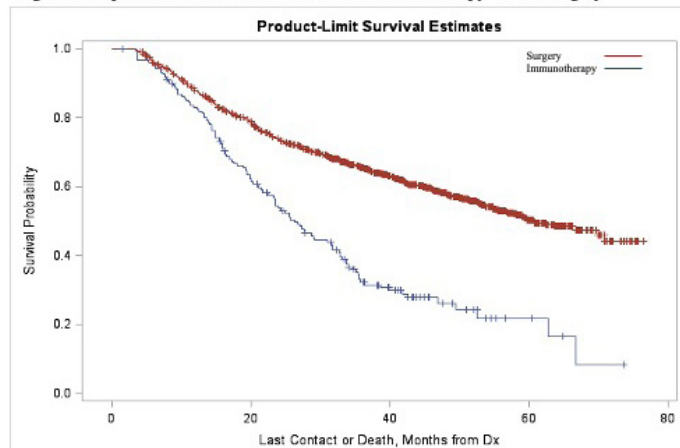
Objective: Recent clinical trials involving chemoradiation and immunotherapy have once again called into question the role of surgery in patients with Stage IIIA non-small cell cancer (NSCLC). We sought to determine survival differences among these patients who undergo surgical resection versus immunotherapy following chemoradiation.

Methods: The National Cancer Database (NCDB) was used to identify all clinical stage IIIA/N2 NSCLC from 2004–2016 according to the 7th edition of TNM staging. Patients were categorized based on treatment modality following initial systemic therapy. Survival among the surgery and immunotherapy cohorts was evaluated using Kaplan-Meier estimates. Cox Proportional Hazards Regression Analysis was performed, adjusting for several preoperative factors, to determine if surgery or immunotherapy provides a survival advantage for patients with N2 disease (Reported in Hazard Ratios [HR]).

Results: Of the 1,602 patients with stage IIIA/N2 NSCLC identified, 1,440 patients underwent surgical resection and 162 underwent immunotherapy after neoadjuvant systemic therapy. The median age of both cohorts was similar. Of the patients who received immunotherapy, 61% (99) were adenocarcinoma and 24% (39) were squamous cell carcinoma. Histologic origin for the surgery cohort was adenocarcinoma in 55% (799) and squamous cell carcinoma in 30% (427). Mean tumor size was 40 millimeters (interquartile range

25–60) for patients who underwent immunotherapy and 39 millimeters (range 25–55) for patients undergoing surgery ($p = 0.24$). Thirty-six percent (59) of patients who underwent immunotherapy were treated at an academic center and had private insurance, whereas 58% (838) of the surgery cohort were treated in an academic center and 47% (680) had private insurance. Cox hazard regression analysis showed that male patients are at a higher risk of mortality (HR 1.269, $p = 0.0019$) whereas patients undergoing surgical resection are at a lower mortality risk (HR 0.456, $p < 0.0001$). Kaplan-Meier survival estimates showed improved survival with surgical resection ($p < 0.01$; Figure 1).

Figure 1. Kaplan-Meier Survival Estimates of Immunotherapy versus Surgery



Conclusions: Although immunotherapy has recently shown an increased progression-free and overall survival versus placebo in patients with Stage III NSCLC, this retrospective review showed that surgical resection is associated with a survival advantage over immunotherapy in the Stage IIIA cohort.

151. Establishment and Validation of Primary Non-Small Cell Lung Cancer Organoids As In Vitro Lung Cancer Models

Raphael S. Werner¹, Sylvia Hoeller², Michaela B. Kirschner¹, Isabelle Opitz¹

¹University Hospital Zurich, Department of Thoracic Surgery, Zurich, Switzerland;

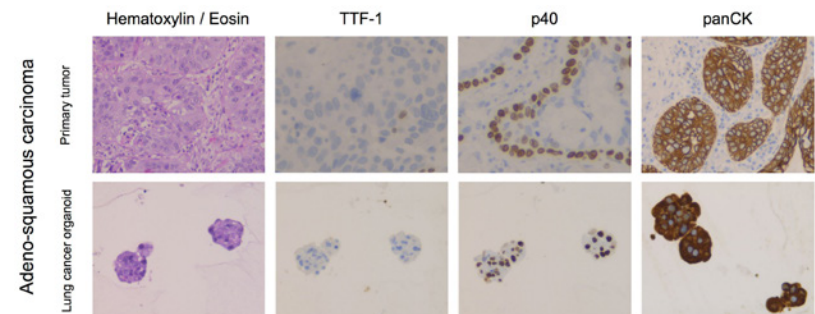
²University Hospital Zurich, Department of Pathology, Zurich, Switzerland

Invited Discussant: Christopher W. Seder

Objective: For both the identification of non-small cell lung cancer (NSCLC)—specific biomarkers, as well as for the development and early assessment of personalized candidate cancer treatments, representative *in vitro* systems that reflect tumor heterogeneity are needed. However, since commercially available cancer cell lines do not generally maintain their original heterogeneity and three-dimensional structure, they are fundamentally limited in representing the complexity of NSCLC. While organoid models have already been shown to prospectively predict chemotherapy response in other types of cancer, no such translational applications are available for NSCLC. We therefore aim to create new model systems that may operate as patient avatars for precision medicine and offer a reliable platform for further investigations.

Methods: Small pieces from surgically resected NSCLC tissue were collected between January and October 2020. Tissue pieces were mechanically processed and passed through 70 μ m cell strainers. The cell suspension was then mixed with a gelatinous extracellular matrix for three-dimensional cell culture. Organoid growth medium was adapted from existing protocols based on DMEM-F12 and was complemented with additional growth factors. The organoids were cultured at 37°C and passaged after 5–20 days. For histological validation, the growing NSCLC organoids were transferred into plasma-thrombin cell blocks, formalin-fixed and paraffin embedded.

Results: From 35 resected NSCLC samples, 10 organoid cultures were successfully established and expanded during early passages *in vitro*. The growing organoids were histologically and immunohistochemically validated (Hematoxylin-Eosin and Elastica van Gieson staining, immunohistochemistry of Thyroid Transcription Factor-1, p40 and Pan-Cytokeratin) and showed identical characteristics when compared to the resected primary tumor. Validated histological subtypes included adenocarcinoma, squamous-cell carcinoma, adeno-squamous/mucoepidermoid carcinoma and lung carcinoid.



Conclusions: The establishment of primary NSCLC organoids from surgically resected tissue is feasible. The expanded organoids maintain the histological and immunohistochemical characteristics of its parental tumor. However, low establishment rates and slow organoid growth currently still restrict the application of NSCLC organoids in the clinical context.

152. Perioperative Outcomes of Video-Assisted Thoracoscopic Surgery After Neoadjuvant Pembrolizumab and Chemotherapy in Patients with Resectable Non-Small Cell Lung Cancer

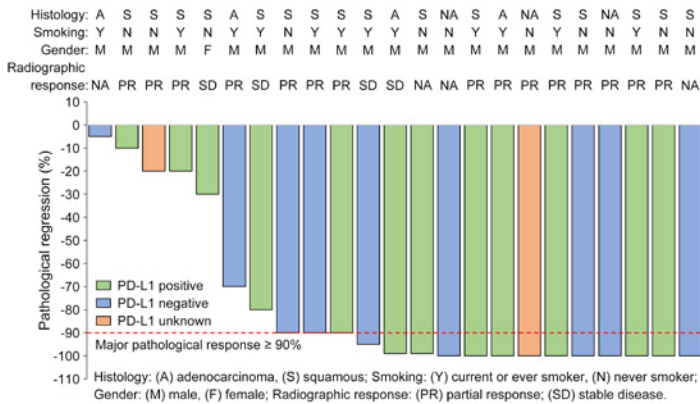
Deping Zhao, Long Xu, Junqi Wu, Dong Xie, Yuming Zhu, Gening Jiang, Chang Chen
Tongji University Affiliated Shanghai Pulmonary Hospital, Shanghai, China

Invited Discussant: Ke-Neng Chen

Objective: Immune checkpoint inhibition immunotherapy has revolutionized the treatment of non-small cell lung cancer (NSCLC). In this study, we analyzed perioperative outcomes of pulmonary resection via video-assisted thoracoscopic surgery (VATS) after neoadjuvant pembrolizumab and chemotherapy to assess the safety of this strategy in patients with resectable NSCLC.

Methods: Patients with untreated and surgically resectable stage IB-IIIB NSCLC evaluated by a multidisciplinary treatment, received 2 to 4 cycles of pembrolizumab (200 mg) plus platinum-based doublet chemotherapy every 3 weeks. Primary endpoints were safety and feasibility of neoadjuvant pembrolizumab and chemotherapy followed by VATS pulmonary resection. Data on additional surgical details were collected through chart review.

Results: A total 23 patients underwent pulmonary resection via uniportal VATS approach from December 2018 to September 2020 were enrolled. Major pathological response was identified in 16 of 23 patients (69.6%). The median time from last treatment to surgery was 34 (range, 24–61) days. There were 13 lobectomies, 8 sleeve lobectomies, 1 bilobectomy, and 1 pneumonectomy. Median operative time was 141 (range, 73–244) minutes; median estimated blood loss was 100 (range, 50–200) mL; median length of hospital stay was 4 (range, 2–11) days, and median length of drainage was 4 (range, 2–10) days. There was no operative mortality. Four patients required postoperative transfusion (4 of 23, 17.4%). The most common postoperative complication was nausea (3 of 23, 13.0%), followed by pneumonia (2 of 23, 8.7%).



Conclusions: Neoadjuvant pembrolizumab and platinum-based chemotherapy could be a potential treatment strategy for resectable NSCLC and was not associated with unexpected perioperative morbidity or mortality after pulmonary resection via VATS approach.

153. Intersectional Discrimination in Lung Cancer Screening

Michael R. Poulson, Alaina Geary, Virginia Litle, Kei Suzuki
 Boston Medical Center, Boston, MA

Invited Discussant: Bryan M. Burt

Objective: There are well documented disparities in lung cancer screening between black and white patients. The purpose of our study was to understand the impact of historic redlining and structural racism on disparities in screening between black and white patients at our tertiary care center.

Methods: Lung cancer screening data for all black and white patients at our institution between January 2015 and January 2017 were used. Addresses were geocoded and

overlaid with redlining vector files from the *Mapping Inequality* project. Each patient was assigned a redlining designation and further linked to U.S. census data at the block level. Multivariate logistic regression was performed stratified by redlining designation and gender, controlling for age and insurance status.

Results: 1063 patients were analyzed, half of which were white and the other half black. Black patients had significantly decreased odds of screening when compared to white (OR 0.66, 95% CI 0.52, 0.85). Stratified by gender, there were no significant differences in screening between black and white males (OR 0.79, 95% CI 0.57, 1.09), but black women were significant less likely to undergo screening than white women (OR 0.52, 95% CI 0.35, 0.76). Stratified by redlining designation, there were no significant racial disparities in screening in non-redlined areas (OR 0.68, 95% CI 0.44, 1.04). However, in redlined areas black patients had significantly lower odds of screening when compared to white (OR 0.52, 95% CI 0.37, 0.75). Among men in non-redlined areas, there were no significant racial differences in screening (OR 0.83, 95% CI 0.47, 1.47). However, among men in redlined areas, black men had lower odds of screening compared to white men (OR 0.59, 95% CI 0.37, 0.93). Black women in both non-redlined (OR 0.51, 95% CI 0.27, 0.98) and redlined (OR 0.59, 95% CI 0.37, 0.93) areas had significantly lower odds of screening compared to white women.

Conclusion: Our analyses highlight the impact of structural racism and intersectional discrimination on lung cancer screening. Redlining particularly affects screening among men, while black women consistently exhibit lower odds of screening compared to white women. Critical race theory posits that discrimination through racism and sexism can become intersectional to create unique disparities particularly among women of color. We find that this intersectional discrimination affects access to lung cancer screening among patients in Boston.

154. Objective Performance Indicators Are Associated with Bleeding Events During Robotic-Assisted Lobectomy by Cardiothoracic Surgery Residents

John F. Lazar¹, Ariana Metchick¹, Kristen Brown², Sadia Yousaf³, Anthony Jarc², Jonathon Nesbitt⁴, Desmond D'Souza⁵, Manu Sancheti⁶, Jules Lin⁷, Richard Feins⁸, Stephen Yang⁹, Daniel Oh¹⁰

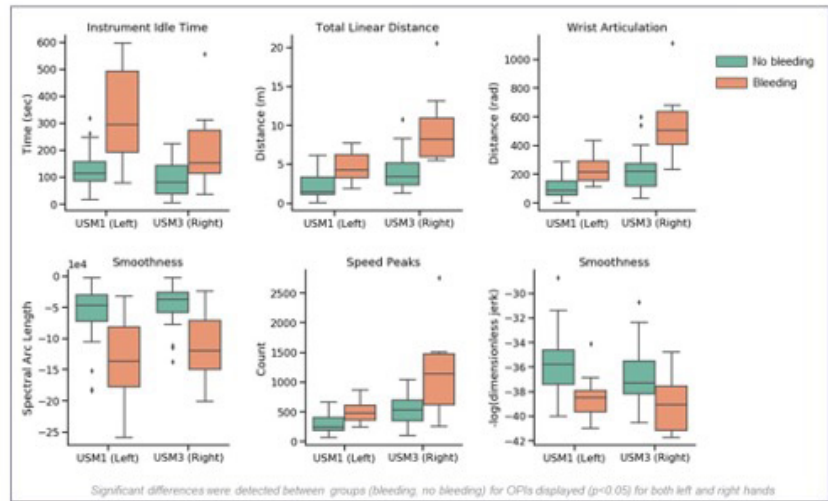
¹MedStar Georgetown University Hospital, Washington, DC; ²Intuitive Surgical, Sunnyvale, CA; ³Intuitive Surgical, Washington, CA; ⁴Vanderbilt, Nashville, TN; ⁵The Ohio State University, Columbus, OH; ⁶Emory University, Atlanta, GA; ⁷University of Michigan, Ann Arbor, MI; ⁸University of North Carolina, Chapel Hill, NC; ⁹Johns Hopkins Medical Institutions, Baltimore, MD; ¹⁰University of Southern California, Los Angeles, CA

Invited Discussant: Bernard J. Park

Objective: An attending can watch a trainee operate and try to sense subjectively whether or not the requisite skills are present to complete a safe operation. However, the difficulty of objectively assessing technical performance without inherent bias complicates this process. A novel data recorder for the surgical robot can capture synchronized kinematic and video data during an operation and enables the calculation of quantitative, objective performance indicators (OPIs). We hypothesized that certain OPIs could be identified at the beginning of a robotic-assisted lobectomy (RL) performed by a resident that could be associated with an adverse event during the task.

Methods: Cardiothoracic residents at the 2019 Thoracic Surgery Directors Association Resident Boot Camp were enrolled. Residents completed video review on the anatomy and choreography of RL on a standardized ex-vivo perfused porcine left upper lobe model with vascular pulsatility. Virtual reality simulation was completed for technical familiarity on the robot prior to starting. All participants performed RL while continuous video and kinematic data was recorded. Faculty provided coaching but did not operate. The case video was segmented into tasks, and OPIs were calculated for the initial major task of the case, reflecting bimanual dexterity, energy use, events, instrument movement, smoothness, time, and wrist articulation. Every video was reviewed for a major bleeding event at any time during the task. The OPIs of the residents who had bleeding and those who did not were compared using Mann-Whitney or Welch's t-test.

Results: A total of 46 residents participated in the porcine RL and 42 had data for analysis. The exposure of the superior pulmonary vein was the first task [for most residents (40/42) and there were 10 cases with major bleeding (25%) during the task. After assessing 20 OPIs for both the right and left hands during the initial task, there were several statistically significant OPIs that differed between residents who had bleeding and those who did not (Figure). Of these OPIs, 3 were related to instrument usage: idle time, total linear distance, and wrist articulation. The other 3 OPIs were related to smoothness of motion. These differences in OPIs were significant for both hands. Additionally, residents who had bleeding events had asymmetric OPIs for their left and right hands, indicating lower bimanual proficiency.



Conclusions: There are OPIs associated with instrument usage and smoothness at the beginning of porcine lobectomy which are correlated with a subsequent bleeding event. Development of exercises and simulation focused on these objectively identified domains could help improve overall performance while reducing major complications during their learning curve. To our knowledge, this is the first study to demonstrate a link between objective performance metrics and an adverse event in thoracic surgery.

155. CABG Public Star Ratings and Program Performance: The Intersection Between Statistics, Perceptions, and Reality

Hiba Ghandour¹, Ozgun Erten¹, Mario Gaudino², Edward Soltesz¹, Tara Karamlou¹, Aaron Weiss¹, Eric Roselli¹, A. Marc Gillinov¹, John Puskas³, Todd Rosengart⁴, Danny Chu⁵, Husam Balkhy⁶, John Stulak⁷, Deepak Bhatt⁸, Bradley Taylor⁹, Anthony Warmuth¹, Marco Zenati¹⁰, Eugene Blackstone¹, Lars Svensson¹, Faisal Bakaeen¹

¹Cleveland Clinic, Cleveland, OH; ²Weill Cornell, NewYork-Presbyterian Hospital, New York, NY; ³Icahn School of Medicine at Mount Sinai, New York, NY; ⁴Baylor College of Medicine, Houston, TX; ⁵University Of Pittsburgh, Pittsburgh, PA; ⁶University of Chicago, Chicago, IL; ⁷Mayo Clinic, Rochester, MN; ⁸Brigham and Women's Hospital and Harvard Medical School, Boston, MA; ⁹University of Maryland, Baltimore, MD; ¹⁰VABHCS and Brigham and Women's Hospital, Harvard Medical School, Boston, MA

Invited Discussant: Anelechi C. Anyanwu

Objective: There is controversy relating to rating and ranking algorithms for reporting hospital performance in cardiovascular care. These algorithms may lead to risk aversion/diversion and may not accurately capture case complexity or reflect the quality of clinical practice particularly at academic medical centers generally known to treat high risk referrals. We sought to examine the correlation between widely used CABG ratings, center characteristics, and reputation for cardiovascular care.

Methods: Star ratings from the Society of Thoracic Surgeons (STS) public reporting database for isolated CABG were extracted for 2018/2019. Three additional data sources were utilized: 1) U.S. News and World report (USNWR) best hospitals for heart care, 2) Centers for Medicare & Medicaid Services (CMS) Hospital Compare; and 3) Accreditation Council for Graduate Medical Education (ACGME). Pearson correlation coefficients determined the relationship between the STS rating, CABG volume, raw operative mortality, and USNWR reputation score.

	STS Star Rating	CMS CABG Volume	CMS CABG Mortality	USNWR Reputation Score
STS Star Rating	1	0.37	-0.26	0.14
CMS CABG Volume	0.37	1	-0.27	0.39
CMS CABG Mortality	-0.26	-0.27	1	-0.28
USNWR Reputation Score	0.14	0.39	-0.28	1

Prism correlation matrix displaying all the pairwise correlations for the listed variables.

- The green boxes represent variables that have a negative trending relationship.
- The pink boxes represent variables that have a positive trending relationship.
- The darker the box, the closer the correlation is to negative or positive 1, and therefore, the stronger the correlation.

Results: Of the 675 hospitals that publicly report STS ratings, the majority had a 2-star rating (1 star: n = 15, 2 star: n = 593, and 3 star: n = 67). Of the 3 star-hospitals, 7.5% (5/67) were ranked in the top 50 hospitals for heart care by USNWR, 47 (70.1%) were eligible for ranking, but did not make the top 50 rank list, and 15 (22.4%) did not meet the minimum

volume cut-off/eligibility criteria needed for ranking. Only one of the top twenty USNWR-ranked hospitals was 3-star-rated and the remaining 19 were 2-star. Both the STS star-rating and USNWR reputation score ($r = 0.15$) were positively correlated with CMS CABG volume ($r = 0.37$), but weakly (Figure). Operative mortality and star rating were also weakly correlated in a negative direction ($r = -0.26$). Of the 77 academic centers with cardiac surgery training programs, 16 (21%) were not STS public reporting participants and, only 7 (11%) of reporting programs were 3-star.

Conclusions: Correlation between STS CABG star-rating and center reputation for excellence, academic status, or CABG volume is weak. Further work should refine and standardize CABG performance metrics to accurately capture scope and complexity of contemporary surgical practice and provide more accurate perspectives for patients.

156. Impact of Aortic Valve Effective Height Following Valve-Sparing Root Replacement on Postoperative Insufficiency and Reoperation

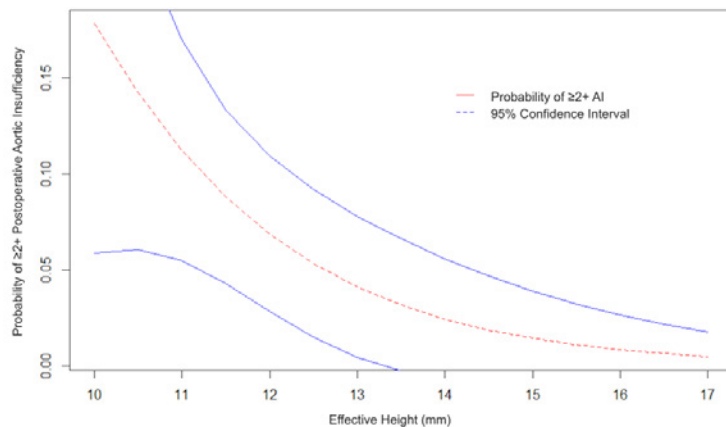
Puja Kachroo, Meghan O. Kelly, Nadia H. Bakir, Catherine Cooper, Nicholas T. Kouchoukos, Marc R. Moon

Barnes Hospital, Saint Louis, MO

Invited Discussant: Tirone E. David

Objective: To evaluate the impact of anatomical aortic valve and root parameters during valve-sparing root replacement (VSRR) on the probability of postoperative aortic insufficiency (AI) and freedom from aortic valve reoperation.

Methods: From 1995 to 2020, 177 patients underwent VSRR (163 reimplantations, 14 remodeling). Pre and postoperative echocardiograms were analyzed to measure annulus and sinus diameters, effective height of leaflet coaptation, and degree of AI. Logistic regression was used to evaluate predictors of $\geq 2+$ postoperative AI. Fine-Gray multivariable regression determined independent predictors for aortic valve reintervention.



Results: The study population included 122 (69%) males and 55 (31%) females with a mean age of 43.4 ± 14.5 years. 119 (67%) patients had an identified connective tissue disorder (Marfan, $n = 84$; Loeys Dietz, $n = 22$; other mutations, $n = 13$). The cumulative incidence of aortic valve reoperation was estimated to be 7% at 5 years and 12% at 10 years. The probability of $\geq 2+$ postoperative AI was inversely related to effective height during VSRR ($P = 0.02$) (Figure). As postoperative effective height fell below 11 mm, the probability of $\geq 2+$ AI exceeded 10%. On multivariable logistic regression, effective height (odds ratio: 0.53 (0.33, 0.86), $P = 0.010$), preoperative annulus diameter (1.44 (1.13, 1.82) $P = 0.003$), and degree of preoperative AI (2.57 (1.46, 4.52) $P = 0.001$) were associated with increased incidence of $\geq 2+$ postoperative AI. On multivariable Fine-Gray regression, independent risk factors for aortic valve reintervention included preoperative annulus diameter (sub-distribution hazard ratio: 1.28 (1.03, 1.59), $P = 0.027$), history of $\geq 3+$ AI (4.28 (1.60, 11.44), $P = 0.004$), and $\geq 2+$ postoperative AI (5.22 (2.29, 11.90), $P < 0.001$).

Conclusions: Measures to increase effective height during VSRR may decrease the risk of postoperative AI and the need for aortic valve reoperation. Strategies to stabilize a larger aortic annulus may also improve late outcomes.

157. Delineating the Optimal Circulatory Arrest Temperature for Aortic Hemiarch Replacement with Antegrade Cerebral Perfusion Strategy: An Analysis of the Society of Thoracic Surgeons National Database

Laura Seese¹, Edward Chen², Vinay Badhwar³, Jeffrey Jacobs⁴, Vinod Thourani⁵, Faisal Bakaeen⁶, Dylan Thibault⁷, Sean O'Brien⁷, Oliver Jawitz⁷, Brittany Zwischenberger⁸, Thomas Gleason⁹, Ibrahim Sultan¹, Arman Kilic¹, Joseph Coselli¹⁰, Lars Svensson⁶, Robert Habib¹¹, Joanna Chikwe¹², Danny Chu¹

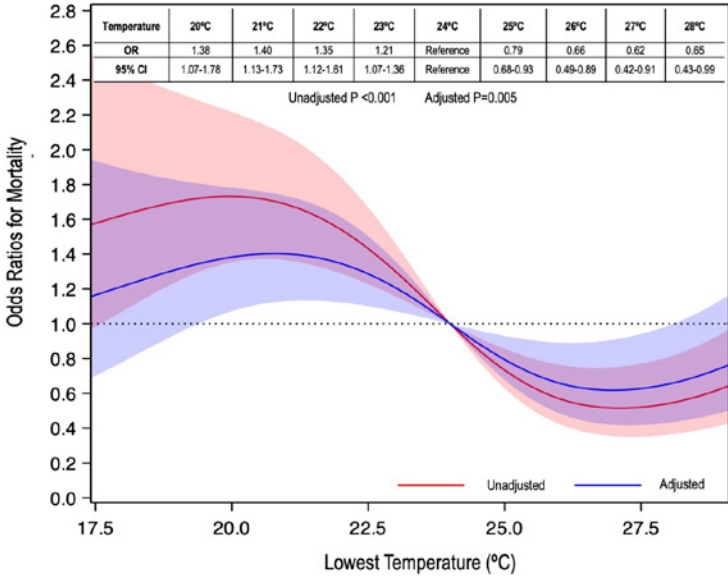
¹University of Pittsburgh School of Medicine, Pittsburgh, PA; ²Emory University, Atlanta, GA; ³West Virginia University, Morgantown, WV; ⁴University of Florida, Gainesville, FL; ⁵Piedmont Heart Institute, Atlanta, GA; ⁶Cleveland Clinic Foundation, Cleveland, OH; ⁷Duke Clinical Research Institute, Durham, NC; ⁸Duke University, Durham, NC; ⁹Brigham and Women's Hospital/Harvard Medical School, Boston, MA; ¹⁰Baylor College of Medicine, Houston, TX; ¹¹Society of Thoracic Surgeons, Chicago, IL; ¹²Cedars-Sinai Medical Center Smidt Heart Institute, Los Angeles, CA

Invited Discussant: Joseph E. Bavaria

Objective: The aim of this study was to identify the optimal temperature of hypothermic circulatory arrest for patients undergoing elective aortic hemiarch replacement with the adjunctive use of antegrade cerebral perfusion (ACP).

Methods: The Society of Thoracic Surgeons (STS) National Database was queried for adults undergoing elective hemiarch replacement using ACP for aneurysmal disease between July 2014 and June 2019. The primary outcome was a composite of new onset renal failure, gastrointestinal complications, neurological dysfunction, and 30-day mortality. Secondary outcomes included the rates and risk-adjusted odds of 30-day mortality, composite of all postoperative morbidities including neurological dysfunction. Generalized estimating equations and restricted cubic splines were utilized to determine the risk-adjusted relationships between temperature as a continuous parameter and outcomes. Covariates used for risk-adjustment included patient co-morbidities as well as intraoperative parameters including circulatory arrest times.

Results: Elective hemiaortic replacement with ACP was performed in 3,898 patients at 374 centers with a median nadir bladder temperature of 24.9°C (interquartile range [IQR] = 22.0°C–27.5°C) and median circulatory arrest time of 19 minutes (IQR = 14.0 minutes–27.0 minutes). In reference to 24°C, the composite outcome was similar regardless of the nadir hypothermic circulatory arrest temperature (all $p > 0.05$). After adjustment for comorbidities, circulatory arrest time, and individual surgeon, patients cooled between 25 and 28°C had a significant survival advantage over those cooled between 20 and 23°C (Figure). Specifically, a nadir temperature of 27°C was associated with the lowest risk-adjusted mortality at 30-days (OR 0.62; 95% CI 0.42–0.91). A nadir temperature of 21°C had the highest risk-adjusted mortality at 30 days (OR 1.4; 95% CI 1.13–1.73). Similarly, the occurrence of any major postoperative morbidity was the highest in patients cooled to 21°C (OR 1.12; 95% CI 1.01–1.24). Furthermore, cooling to nadir temperatures of 20.0°C compared to patients cooled between 25 and 27.5°C was associated with longer intensive care unit stays [median = 66.5 hours (IQR = 41.00–115.70) vs median = 48.00 hours (IQR = 25.78–88.51), $p < 0.001$], higher rates of prolonged ventilation (18.28% vs 10.77%, $p < 0.001$), and increased stroke rates (5.29% vs 3.27%, $p = 0.04$).

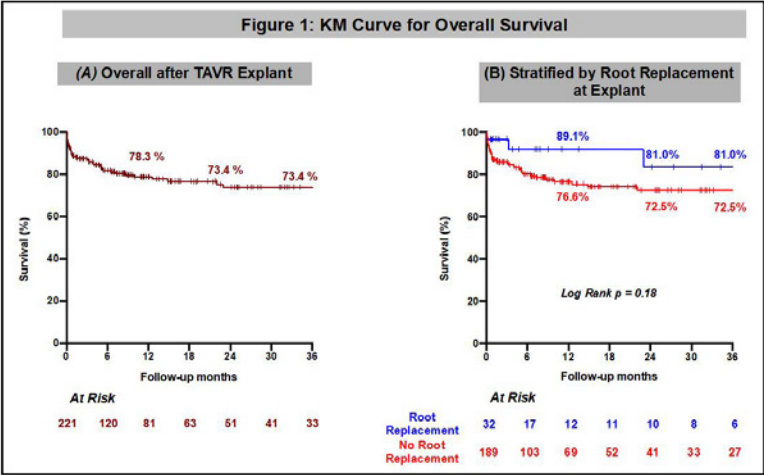


Conclusions: For patients with aneurysmal disease undergoing elective hemiaortic replacement and adjunctive ACP, a nadir temperature between 25°C to 28°C conferred early survival benefits compared to those cooled to 24°C, with the greatest reduction in risk-adjusted mortality observed at 27°C.

158. Surgical Explantation After Transcatheter Aortic Valve Replacement (TAVR) Failure: Midterm Outcomes from the Explant-TAVR International Registry
 Vinayak N. Bapat¹, Syed Zaid², Shekhar Saha³, Christian Hagl³, Keti Vitanova⁴, Michael Mack⁵, Paolo Denti⁶, Thomas Modine⁷, Tsuyoshi Kaneko⁸, Gilbert Tang⁹
¹Minneapolis Heart Institute, Minneapolis, MN; ²Westchester Medical Center, Valhalla, NY; ³LMU Klinikum, Munich, Germany; ⁴Germany Heart Center, Munich, Germany; ⁵Baylor Scott & White Health, Plano, TX; ⁶San Raffaele Hospital, Milan, Italy; ⁷CHU Bordeaux, Bordeaux, France; ⁸Brigham and Women's Hospital, Boston, MA; ⁹Mount Sinai Hospital, New York, NY

Invited Discussant: Vinod H. Thourani
Objective: Surgical explantation following transcatheter aortic valve replacement (TAVR) is often necessary in patients requiring valve reintervention. We sought to determine outcomes of aortic root versus valve surgery after TAVR explantation, as they are largely unknown.

Methods: Data from the multicenter, international EXPLANT-TAVR registry of patients who underwent TAVR explantation were retrospectively reviewed, divided by need for aortic root replacement at explant. Explants performed during the same admission as the initial TAVR procedure were excluded. 30-day and 1-year Valve Academic Research Consortium-2 outcomes were reported.



Results: From 11/2009 to 9/2020, 228 patients across 39 centers with mean age 72 ± 10 years underwent TAVR explantation. Mean STS risk at initial TAVR was $4.7 \pm 4.7\%$ (0.50–29.3%) and 27.4% were deemed low surgical risk. The median time to surgical explant was

12.8 months (IQR: 4.9–35.2 months). 18.8% of patients had unfavorable anatomy for redo-TAVR. Balloon-expandable (BE) and self-/mechanically expandable (SME) valves accounted for 53.5% and 46.5% respectively. Indications for explant included endocarditis (41.3%), structural valve degeneration (23.3%), paravalvular leak (16.1%), prosthesis-patient mismatch (7.6%) and valve migration (3.1%). 47.8% of cases were urgent/emergent. 14.0% of patients needed aortic root replacement and 32.9% had concomitant cardiac procedures. Patients requiring root replacement had more SME valves explanted (62.5% vs 43.8%, $p = 0.049$) with longer cardiopulmonary bypass (202 + 84 vs 146 + 68 minutes, $p < 0.001$) and aortic cross-clamp times (149 + 58 vs 107 + 55 minutes, $p < 0.001$), longer ICU length of stay (221 + 284 vs 111 + 131 hours, $p < 0.001$) and higher incidence of in-hospital life threatening bleed (12.5% vs 2.6%, $p = 0.025$). Other in-hospital complications included atrial fibrillation (10.3%), new pacemaker (14.0%), and acute renal failure (8.4%). Follow-up was 97% complete and averaged 36.2 ± 25.7 months after initial TAVR and 16.0 ± 22.4 months after TAVR explant. Overall survival at follow-up was 78.0%, and there were no differences in survival between root replacement groups (Figure). In-hospital, 30-day, and 1-year mortality rates were 10.5%, 11.9%, and 28.7%, respectively, and stroke rates were 5.3%, 5.7% and 9.8%, respectively.

Conclusion: Our findings from the EXPLANT-TAVR global registry provide opportunities for further in-depth studies of this patient population. Root replacement did not increase mortality or morbidities after TAVR explantation.

159. Staged Ventricular Recruitment and Biventricular Conversion Following Single-Ventricle Palliation in Unbalanced Atrioventricular Canal Defects

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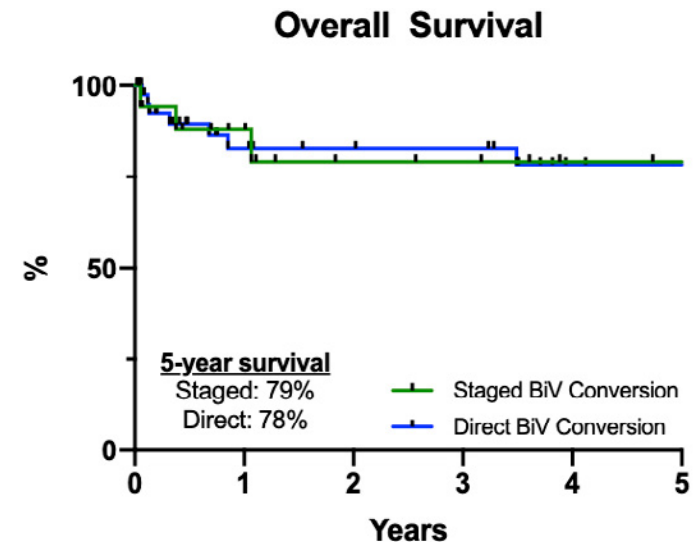
³Hospital for Sick Children, Toronto, ON, Canada

Invited Discussant: David M. Overman

Objective: Current management of unbalanced atrioventricular canal defects (uAVCD) includes single-ventricle palliation (SVP) which may lead to long-term complications associated with single-ventricle physiology. Restoration of biventricular circulation is an alternative management option, especially in patients with risk factors for SVP failure. In severe cases where the ventricular volume is inadequate for biventricular circulation, recruitment procedures may accommodate its growth. In this study, we review our uAVCD experience with biventricular conversion after prior SVP, and hypothesize that recruitment can lead to ventricular growth and successful biventricular repair.

Methods: This is a single institution, retrospective cohort study of uAVCD patients who underwent biventricular conversion after SVP, either with staged recruitment over several procedures (staged) or primary biventricular conversion (direct) between 2003 to 2018. Mortality, unplanned reintervention rates, imaging and catheterization data were analyzed.

Results: From 2003 to 2018, 65 patients underwent biventricular conversion from SVP (17 Stage 1, 42 bidirectional Glenn, 6 Fontan). Decision for conversion was made based on poor SVP candidacy or failing Fontan ($N = 37$) or two adequately sized ventricles ($N = 23$). Of the 65 patients, 20 patients underwent recruitment procedures prior to conversion, consisting of fenestrated closure of atrial septal defect ($N = 16$), AV canal septation ($N = 13$), or aorto-pulmonary shunts ($N = 8$). End-diastolic volumes (EDV) z-scores were significantly lower in the staged conversion group compared to the direct conversion group (-3.99 – staged vs, -2.6 – direct, $p < 0.01$). After recruitment maneuvers, EDV z-scores improved in the staged group from $(-3.99$ to -1.78 , $p < 0.01$). Median follow-up time was 1.0 year. Survival and post-operative catheter interventions were similar between staged and direct biventricular conversion (HR: 0.9, 95% CI: 0.2–3.7; $p = 0.953$, HR: 1.9, 95% CI: 0.9–4.1, $P = 0.09$), but more reoperations occurred with staged approach (HR: 3.1, 95% CI: 1.3–7.1; $P = 0.008$). Recruitment significantly increased indexed ventricular volume (pre-recruitment = 43.88 to post-recruitment = 61.90 mL/m², $p < 0.05$). ROC curves suggest that biventricular conversion can be successfully achieved through recruitment when pre-operative indexed ventricular EDVs are less than 20.15 mL/m².



Conclusions: Biventricular conversion from SVP is an alternative strategy to manage uAVCD, particularly in patients with risk factors for failure with SVP physiology. Ventricular recruitment allows for adequate growth of hypoplastic ventricles. Severe forms of uAVCDs can eventually be converted with recruitment from SVP physiology to biventricular circulation with acceptable mortality, albeit increased reinterventions, when direct biventricular conversion is not possible.

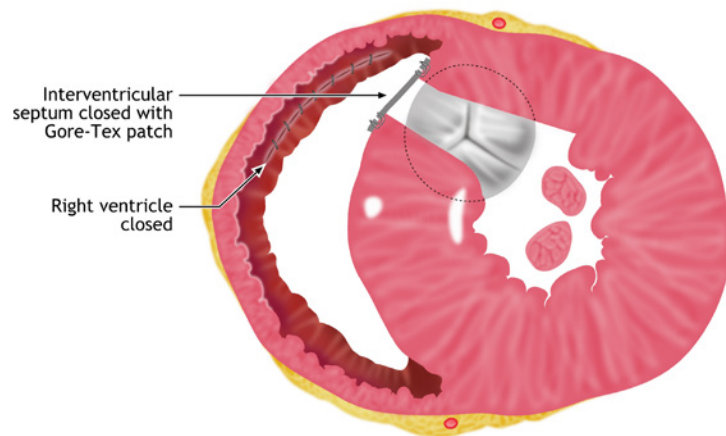
160. Ventriculo-Septoplasty for Hypertrophic Obstructive Cardiomyopathy in Children

Edward Buratto, Igor E. Konstantinov, Christian P. Brizard
Royal Children's Hospital, Melbourne, Parkville, Australia

Invited Discussant: Joseph A. Dearani

Objective: Hypertrophic obstructive cardiomyopathy (HOCM) is commonly treated via trans-aortic septal myectomy. However, in children with small aortic annulus and difficult surgical access or those with biventricular hypertrophy, it may provide less optimal results and generate iatrogenic damage to the aortic valve. We report our experience of the modified Konno procedure or ventriculo-septoplasty from a right ventricular approach for the treatment of HOCM in children.

Methods: All children who underwent with ventriculo-septoplasty procedure at the study institution between 2001 and 2020 were included. In all cases full thickness septal resection was achieved via a biventricular approach, with subsequent closure of the septum using a Gore-Tex (W.L. Gore and Associates Inc, Newark, DE, USA) patch (Figure 1). Follow-up was obtained from review of hospital records and correspondence with cardiologists.



Results: A total of 18 patients underwent ventriculo-septoplasty procedure at a median age of 7.3 years. There was no operative mortality. Mean gradient across the left ventricular outflow tract (LVOT) decreased significantly after surgery (9.8 ± 7.4 mmHg vs 63.3 ± 30.5 mmHg, $p < 0.001$). The mean grade of mitral regurgitation also significantly decreased after ventriculo-septoplasty (0.6 ± 0.13 vs 1.4 ± 0.2 , $p < 0.001$) without any specific mitral valve surgery. Permanent pacemaker for complete heart block was required in 11.1% (2/18). Reoperation for residual LVOT obstruction was required for one patient in the early post-operative period, with a 10-year freedom from LVOT reoperation of 94.4% (95% CI: 66.6–99.2%). At a mean follow-up of 7.1 ± 5.1 years, LVOT gradient remained stable (mean 4.4 ± 3.0 mmHg). Survival at 5 and 10 year was 91.7 (95% CI: 53.9–98.8). There was a single late death due to a motor vehicle accident.

Conclusions: Ventriculo-septoplasty can be performed in children with HOCM without operative mortality and provides complete and permanent elimination of the gradient with no recurrence of the left ventricular outflow tract obstruction. In patients with small aortic annuli and those with biventricular obstruction, the ventriculo-septoplasty procedure represents an excellent alternative to trans-aortic septal myectomy.

161. Atrial Fenestration During Atrioventricular Septal Defect Repair Is Associated with Increased Mortality

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Invited Discussant: Jennifer C. Romano

Objective: During repair of atrioventricular septal defect (AVSD), surgeons may leave an atrial level shunt when they have concerns about postoperative pulmonary hypertension, a hypoplastic right ventricle (RV), hypoplastic left ventricle (LV), or as part of their routine practice. However, the association of fenestration with outcomes is unclear. We sought to determine factors associated with mortality after biventricular repair of AVSD.

Methods: We included 581 patients enrolled from 31 institutions from Jan. 1, 2012–June 1, 2020 in the Congenital Heart Surgeons' Society AVSD cohort. We previously defined balanced AVSD as atrioventricular valve index (AVVI) of 0.4–0.6, right dominant unbalanced as AVVI < 0.4, and left dominant unbalanced as AVVI > 0.6. Parametric multiphase hazard analysis was used to identify factors associated with mortality. We adjusted for procedures after AVSD repair as time varying covariates. A random effect model was used to account for possible inter-institutional variability in mortality.

Results: An atrial fenestration was placed during biventricular repair in 133/581 (23%) patients. Overall, 5-year survival after repair was 91%. The atrial fenestration group had an 83% 5-year survival compared to 93% in the non-fenestrated group ($p < 0.001$). When examined by AVVI categories, the fenestrated groups in both left and right dominant unbalanced patients had the lowest 5-year survival compared to their non-fenestrated counterparts (Figure). Variables associated with mortality by multivariable hazard analysis included institutional diagnosis of unbalance (HR = 2.5, $p < 0.001$), prior coarctation of the aorta repair without pulmonary artery band (HR = 4.6, $p < 0.001$), preoperative mechanical ventilation (HR = 4.8, $p < 0.001$), preoperative > moderate left atrioventricular valve regurgitation

(HR = 1.7, $p = 0.002$), atrial fenestration (HR = 2.9, $p < 0.001$), and reoperation for residual VSD (HR = 3.7, $p < 0.001$). Fenestrated patients had lower RV/LV inflow angle (84 vs 90, $p = 0.002$) than non-fenestrated on baseline echocardiogram, but did not differ in AVVI, or measures of RV and LV size when compared between fenestrated and non-fenestrated for all patients and when examined within AVVI categories. No significant inter-institution variability in mortality was observed based on the random effect model ($p = 0.7$).

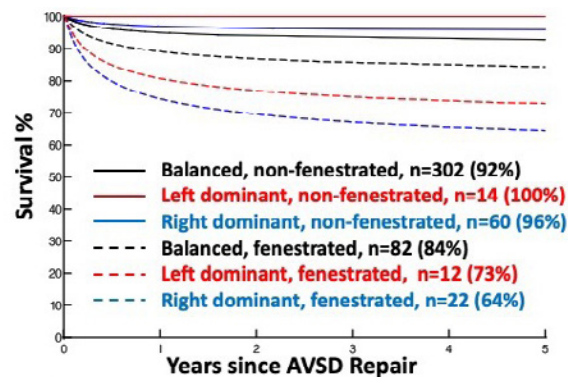


Figure. Parametric survival after biventricular AVSD repair, stratified by degree of balance, and atrial fenestration where AVVI measurements were available. Solid lines indicate no atrial fenestration, while dashed lines indicate fenestrated patients. Black represents balanced patients, red represents left dominant (AVVI > 0.6) patients, and blue represents right dominant (AVVI < 0.4) patients. In all categories, fenestrated patients had worse survival at five years. Five-year survival rate is in parentheses.

Conclusions: Leaving an atrial communication at biventricular repair of unbalanced AVSD is associated with significantly reduced long-term survival after adjusting for other known risk factors. It is unknown whether this association is causal or related to unmeasured factors, or a combination of both. The impact of fenestration can optimally be derived from a randomized clinical trial. In particular, these findings may impact programs where fenestration is part of routine practice.

162. Delayed Strategy of Total Anomalous Pulmonary Venous Connection Repair Improves Survival to Achieve Fontan Completion in Right Atrial Isomerism

Eiri Kisamori, Yasuhiro Kotani, Yosuke Kuroko, Takuya Kawabata, Shingo Kasahara
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Invited Discussant: Rachel D. Vanderlaan

Objective: Repair of total anomalous pulmonary venous connection (TAPVC) in neonates with right atrial isomerism and functional single ventricle is challenging. In our novel strategy, primary draining vein stenting (DVS) was applied to patients with preoperative pulmonary vein obstruction (PVO) to delay TAPVC repair. This study investigated our initial experience of delayed strategy of TAPVC repair, incorporating DVS.

Methods: Twenty-nine patients with right atrial isomerism and functional single ventricle who had severe obstruction in the course of draining veins, requiring surgical or catheter intervention in their neonatal periods were retrospectively reviewed (primary DVS: $n = 11$, primary TAPVC repair: $n = 18$).

Results: The baseline characteristics were comparable. Kaplan-Meier analysis showed that primary DVS repair was significantly associated with improved survival compared with primary TAPVC repair (survival rates at 90 days, 1 year, 3 years and 5 years: primary DVS: 100%, 80%, 68.6%, and 54.9%; primary TAPVC repair: 55.6%, 38.9%, 38.9%, and 38.9% [$P = 0.045$]). Post-procedural PVO was noted in 5 patients in the primary DVS group (45.5%) and 6 patients in the primary TAPVC group (46.5%) ($P = 0.93$). Of 4 patients who underwent stenting of the ductus venosus, 3 patients had an elevated aspartate transaminase and alanine transaminase due to the steal of blood flow to the liver through the portal vein, which markedly improved after embolization of the stent.

Conclusions: For neonates with obstructive TAPVC and functional single ventricle, our delayed strategy for TAPVC repair using primary DVS resulted in the improvement of survival compared to the conventional strategy. When TAPVC repair is performed after ductus venosus stenting, we should be aware of the potential liver damage and consider an early catheter intervention.

163. Randomized Trial of Segmentectomy Compared to Lobectomy in Small-Sized Peripheral Non-Small Cell Lung Cancer

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Invited Discussant: Nasser K. Altorki

Objective: Lobectomy is standard mode of surgery for even small-sized (≤ 2 cm) peripheral non-small cell lung cancer (NSCLC). The survival and clinical efficacy have not been investigated between lobectomy and segmentectomy in a randomized trial setting. We conducted a phase 3 trial to confirm the non-inferiority of segmentectomy to lobectomy for survival and the superiority of segmentectomy for postoperative respiratory function.

Methods: Patients with invasive peripheral NSCLC (maximum tumor diameter ≤ 2 cm; consolidation/tumor ratio [CTR] > 0.5) were randomly assigned to undergo either lobectomy or segmentectomy. The primary endpoint was overall survival (OS). Secondary endpoints included postoperative respiratory function (six months, one year), relapse-free survival (RFS), and frequency of local recurrence. We assumed that the 5-year OS was 90% and the non-inferiority margin of the hazard ratio (HR) to lobectomy was 1.54 (corresponding to 5-year OS of 85% in segmentectomy). The planned sample size was 1100 to confirm non-inferiority with a power of 80%, a one-sided type I error of 0.05, an accrual period of 3 years and a follow-up period of 5 years.

Results: In total, 1106 patients (lobectomy arm, n = 554; segmentectomy arm, n = 552) were enrolled between August 2009 and October 2014. Of these, 583 (53%) were male, 422 (38%) were ≥70 years old, 968 (88%) had adenocarcinoma, and 923 (83%) had pathological stage IA disease (7th TNM classification). The median whole tumor diameter was 1.6 cm (range: 0.6–2.0) and 553 (50%) showed CTR = 1.0. Patients' baseline clinicopathological factors were well-balanced. At median follow-up of 7.3 years, 5-year OS were 94.3% for segmentectomy and 91.1% for lobectomy. Superiority as well as non-inferiority in OS were confirmed by a stratified Cox regression model (HR, 0.663; 95% CI, 0.474–0.927; one-sided $p < 0.0001$ for non-inferiority, $p = 0.0082$ for superiority). The 5-year RFS were 88.0% for segmentectomy and 87.9% for lobectomy (HR, 0.998; 95% CI, 0.753–1.323). Postoperative respiratory function analysis revealed that the proportions of decrease of median FEV1.0 ml (six months and one year) were 10.4% and 8.5% for segmentectomy, which were significantly better than the values for lobectomy (13.1% and 12.0%, $p < 0.0001$ and $p < 0.0001$, respectively). The local recurrence proportion was 10.5% in the segmentectomy arm versus 5.4% in the lobectomy arm ($p = 0.0018$). Fifty-two (63%) of 83 patients in the lobectomy arm died of other diseases compared to 27 (47%) of 58 patients in the segmentectomy arm.

Conclusions: JCOGo802/WJOG4607L is the first phase 3 trial to demonstrate the benefit of segmentectomy with significant differences in OS and respiratory function. These results indicate that segmentectomy should be the standard surgical procedure instead of lobectomy for patients with small-sized (≤ 2 cm, CTR > 0.5) peripheral NSCLC.

164. Outcome After Pulmonary Endarterectomy for Segmental Chronic Thromboembolic Pulmonary Hypertension: A Canadian National Cohort Study

Marc de Perrot¹, Laura Donahoe¹, Karen McRae¹, John Thenganatt¹, Jakov Moric¹, Jason Weatherald², Naushad Hirani³, Mitesh Thakrar², Doug Helmersen², John Swiston³, Nathan Brunner³, Robert Levy³, Sanjay Mehta⁴, Ali Kapasi⁵, Dale Lien⁵, Evangelos Michelakis⁵, Paul Hernandez⁶, Kristina Kemp⁷, Andrew Hirsch⁸, David Langleben⁸, Nathan Hambly⁹, Punginathn Dorasamy¹⁰, Christine D'Arigny¹¹, George Chandy¹², David Christiansen¹³, George Fox¹⁴, Karen Laframboise¹⁵, Steeve Provencher¹⁶, John Granton¹

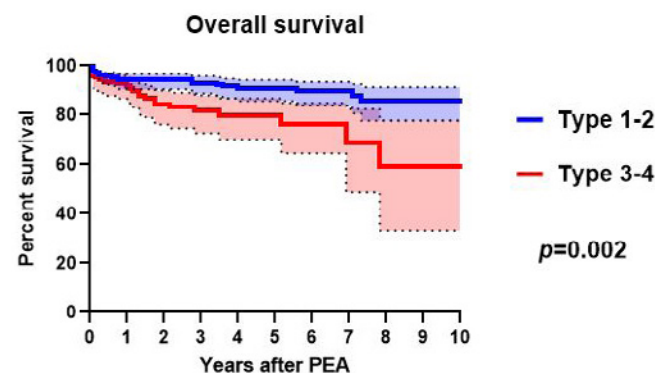
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Invited Discussant: Cameron D. Wright

Objective: Long-term outcome after pulmonary endarterectomy (PEA) for chronic thromboembolic pulmonary hypertension (CTEPH) with disease located in the segmental pulmonary artery and more distally is not well documented.

Methods: We performed a comprehensive analysis of all CTEPH patients undergoing PEA in our institution between 01/2005 and 03/2020. Follow-up was completed for all patients referred to our program from across the country. Disease located at the segmental level and more distally was defined as Jamieson type 3 and 4 (Type 3-4) and compared to more proximal disease defined as Jamieson type 1 and 2 (Type 1-2).

Results: 401 consecutive patients underwent PEA, 35% (n = 142) presented with Type 3-4. The proportion of patients with Type 3-4 increased from 13% (n = 6) in 2005–2010, to 33% (n = 49) in 2011–2015, and 42% (n = 87) in 2016–2020. Compared with Type 1-2, patients with Type 3-4 were predominantly women (70% vs 40%, $p < 0.0001$), more frequently on direct oral anticoagulation (40% vs 30%, $p = 0.03$) and on targeted PH therapy (29% vs 20%, $p = 0.04$). At baseline, age, NYHA functional class (FC), 6-minute walk distance (6 MWD), right ventricular systolic pressure (RVSP) and pulmonary vascular resistance (PVR) were not significantly different between Type 3-4 and Type 1-2. Total circulatory arrest time was longer in Type 3-4 (44 ± 15 min vs 40 ± 13 min in Type 1-2, $p = 0.006$). Total PVR decreased from 921 ± 528 Dynes.s.cm⁻⁵ pre-PEA to 420 ± 180 Dynes.s.cm⁻⁵ after PEA in Type 3-4 ($p < 0.0001$) but remained higher than in Type 1-2 after PEA (420 ± 180 Dynes.s.cm⁻⁵ in Type 3-4 vs 372 ± 172 Dynes.s.cm⁻⁵ in Type 1-2, $p = 0.001$). The mortality at 30-day and at 1-year were similar between Type 3-4 and Type 1-2 (2.8% vs 2.3% at 30-day, $p = 0.8$ and 7.7% vs 5.5% at 1-year, $p = 0.4$). At 1-year post-PEA, the 6 MWD (427 ± 124 m vs 367 ± 139 m pre-PEA, $p = 0.003$), RVSP (48 ± 24 mmHg vs 68 ± 25 mmHg pre-PEA, $p < 0.0001$) and percentage of patients in FC I-II (78% vs 25% pre-PEA, $p < 0.0001$) improved in Type 3-4, but improvement remained inferior to Type 1-2 (at 1-year, 6 MWD 427 ± 124 m in Type 3-4 vs 490 ± 129 m in Type 1-2, $p = 0.0001$; RVSP 48 ± 24 mmHg in Type 3-4 vs 40 ± 17 mmHg in Type 1-2, $p = 0.008$; FC I-II 78% in Type 3-4 vs 95% in Type 1-2, $p < 0.0001$). The 5-year survival reached 80% in Type 3-4 and 91% in Type 1-2 (Figure). After a median follow-up of 3 (range 0–14) years, 74 patients were started on targeted PH therapy after PEA (31% in Type 3-4 vs 12% in Type 1-2, $p < 0.0001$), and 14 patients underwent balloon pulmonary angioplasty (BPA) after PEA (6% in Type 3-4 vs 2% in Type 1-2, $p = 0.004$).



Shaded area: 95% confidence interval.

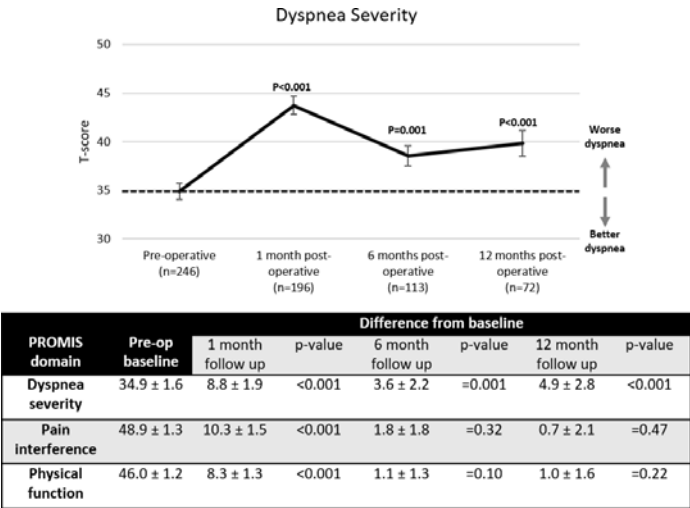
Conclusions: The proportion of patients undergoing PEA with disease located in the segmental artery and more distally increased over time. PEA achieves excellent early and long-term results in these patients, albeit not to the same degree as in patients with Jamieson type 1 and 2. Continuous monitoring after PEA is important to determine the need for targeted PH therapy and evaluate the possibility of BPA.

165. Long-Term Patient-Reported Outcomes Following Non-Small Cell Lung Cancer Resection

Brendan T. Heiden, Melanie P. Subramanian, Jingxia Liu, Angela Keith, Bryan F. Meyers, Varun Puri, Benjamin D. Kozower
Washington University School of Medicine, St. Louis, MO
Invited Discussant: Ara A. Vaporciyan

Objective: Patient-reported outcomes (PROs) are critical tools for evaluating patients before and after lung cancer resection. Despite this, the routine use of PROs in thoracic surgery remains rare. In this study, we examined PROs following lung cancer resection to assess patient-reported pain, dyspnea, and functional status up to 1 year post-operatively.

Methods: This study included patients undergoing resection for non-small cell lung cancer at a single institution from May 2017 until March 2020. The National Institutes of Health (NIH)-developed Patient Reported Outcome Measurement Information System (PROMIS) was employed for PROs collection in three domains: dyspnea severity, physical function, and pain interference. PROs data were prospectively collected as part of standard care in our clinic and merged with our institutional Society of Thoracic Surgery (STS) database. Using a multivariable mixed model, PROMIS scores were assessed and compared between pre-operative and several post-operative visits.



Results: A total of 334 patients were included in the study. Surgical patients had lower baseline dyspnea and physical function scores but equivalent pain scores compared to the United States reference population (dyspnea severity 34.9 ± 1.6; pain interference 48.9 ± 1.3; physical function 46.0 ± 1.2; reference population mean 50 with standard deviation 10 for all assessments). Using a mixed multivariable model, pain, physical function, and dyspnea severity scores changed significantly across the visits (p < 0.001) and were consistently worse at the 1-month post-operative visit (Figure 1). While pain and physical function scores returned to baseline by 6-months, dyspnea severity persisted out to 1-year post-operatively (1-month difference 8.8 ± 1.9; 6-month difference 3.6 ± 2.2; 1-year difference 4.9 ± 2.8, p < 0.001, Figure 1). The impact of surgical approach (minimally invasive versus thoracotomy) on PROMIS outcomes was also evaluated. Patients undergoing thoracotomy initially reported a higher difference in pain interference (2.9 ± 2.2, p = 0.01) and lower physical function (3.6 ± 1.7, p < 0.001) at 1-month; however, scores were not different between the groups at both the 6-month and 1-year follow up. There were no differences in dyspnea scores between minimally invasive and thoracotomy approaches at any time point (p = 0.38).

Conclusions: PROs are important metrics for gauging recovery after lung cancer resection. Our prospectively collected data suggest that patients report persistent dyspnea for at least 1 year after resection. Additionally, while patients undergoing thoracotomy initially report more pain and lower physical function, these impairments seem to be transient and improve by 6-months.

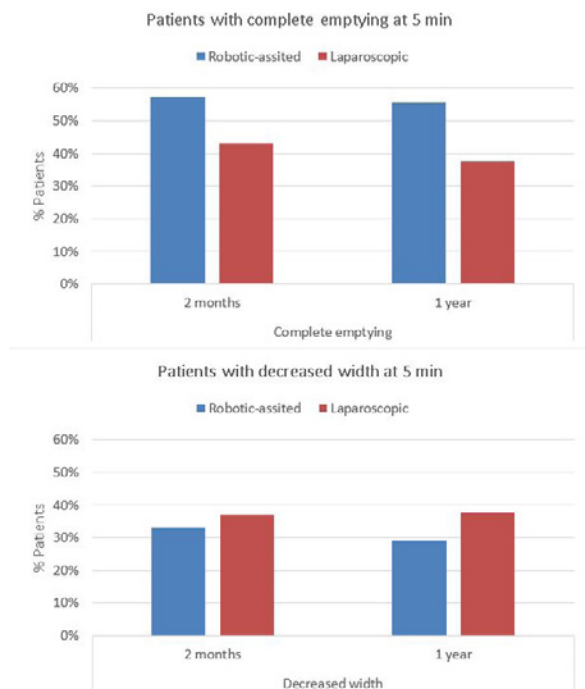
PROs are important surgical outcomes that should be widely collected in order to guide operative candidacy and to assess quality of care.

166. A Comparison of Robotic versus Laparoscopic Heller Myotomy: Are We Ready to Switch?

Saurav Adhikari, Sudish Murthy, Prashanti Thota, Scott Gabbard, Mark Baker, Jesse Rappaport, Usman Ahmad, Eugene H. Blackstone, Siva Raja
Cleveland Clinic Foundation, Cleveland Ohio, OH
Invited Discussant: Steven R. DeMeester

Objective: Laparoscopic Heller myotomy (LHM) for achalasia is now frequently performed with robotic assistance (RAHM). While RAHM has been demonstrated to be safe, it unclear if it adds value to justify the increased cost of the platform. We aim to compare the two approaches.

Methods: From 1/2010–1/2020, 451 patients underwent primary Heller myotomy with anterior fundoplication, 280 LHM and 171 RAHM, in a quaternary care setting. Endpoints included operative time, mucosal perforation, change from preoperative to postoperative esophageal emptying by timed barium esophagogram (TBE), symptom relief by Eckardt score, and post-procedural pH studies. The groups were stratified by esophageal morphology as those with vs. without end-stage esophagus. End-stage esophagus was defined by significant angulation of the distal esophagus or width >5 cm. Comparisons were made using the Wilcoxon rank-sum test.



Results: Median operative time was shorter in the RAHM group than LHM group (121 min [Q1-Q3, 107–138] vs 142 min [Q1-Q3, 126–164], $P < .001$). 5 patients (1.8%) in the LHM group had an intraoperative mucosal perforation and none (0%) in the RAHM group. In patients without end-stage esophagus, there was a greater frequency of complete emptying at 5 minutes on TBE in RAHM compared to LHM [57% (59/103) vs 43% (78/181), respectively] at 2 months as well as at 1 year post-operatively [56% (25/45) vs 38% (46/122)]. A comparable frequency of patients had decreased esophageal width after surgery in RAHM and LHM groups [33% (34/103) vs 37% (67/181) at 2 months and 29% (13/45) vs 38% (46/122) at 1 year]. This pattern was also seen in those with end-stage esophagus. A small number of patients showed worsening at 2 months [1% (1/103) after RAHM vs 2% (4/181) after LHM] and 1 year [4% (2/45) after RAHM and 7% (8/122) after LHM]. Both groups had excellent palliation (Eckardt score ≤ 3) at 2 months [99% (106/107) after RAHM and 98% (60/61) after LHM] and 1 year [92% (43/47) after RAHM and 92% (42/46) after LHM], regardless of esophageal morphology. Abnormal post-operative pH study was similar in both RAHM and LHM patients [17% (15/89) vs 16% (24/152), respectively].

Conclusions: Intermediate-term symptom relief in patients undergoing Heller myotomy is excellent regardless of approach. However, objective assessment by TBE suggests a greater frequency of complete emptying in patients undergoing RAHM compared to LHM, with shorter operative time and less mucosal perforations. Interestingly, patients with end-stage esophagus also appear to have excellent palliation and increased frequency of complete emptying by both approaches. Long term follow-up is needed to see if these objective findings translate into clinically relevant benefit and, therefore, added value.

167. Mitral Valve Endocarditis: Observing the Impact of Patient Factors, Echocardiographic Parameters and Operative Findings on Surgical Outcomes

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Invited Discussant: James E. Davies, Jr.

Objective: For isolated mitral valve infective endocarditis (IE), identify patient characteristics, echocardiographic features, and valve pathology associated with hospital outcomes and time-related reinfection, mortality, and reoperation among repair patients.

Methods: From 1/2002–1/2020, 450 patients underwent surgery for isolated mitral valve infective endocarditis (133 valve repairs and 317 valve replacements). Patients undergoing replacement were older (52 ± 14 vs 57 ± 14 , $P = .004$), had more comorbid diseases and worse baseline cardiac function than those undergoing valve repair and valve replacement was more frequently used for invasive IE (97 [31%] vs 15 [11%], $P < 0.001$). Therefore, for comparison of hospital outcomes and time-related risk of first reinfection and survival, weighted propensity matching was used, which yielded 91 patient pairs. Multivariable analysis of time-related reinfection and mortality for the entire study group utilized random survival forests machine learning.

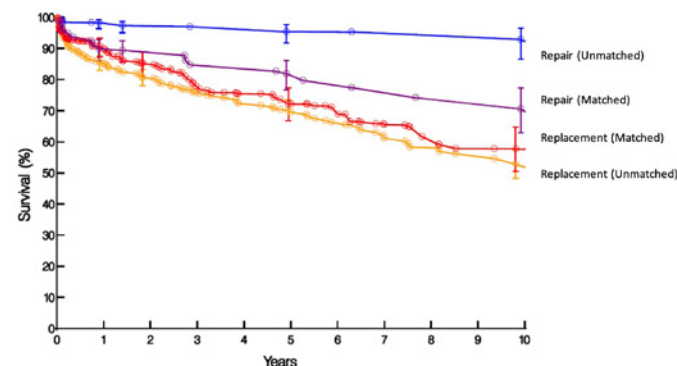


Figure: Survival after mitral valve repair or replacement for infective endocarditis in propensity matched patients and those that were unmatched. This illustrates superior survival of patients with non-invasive endocarditis undergoing repair rather than replacement.

Results: There were 34 first reinfections, 6 after valve repair and 28 after valve replacement. Risk factors for reinfection among valve replacement patients included later date of surgery, history of smoking, and preoperative bilirubin level. After valve repair, freedom from reoperation at 1, 5, and 8 years was 95%, 89%, and 86%, respectively. 17 hospital deaths occurred, 3 after repair (2.3%) and 14 after replacement (4.4%); strongly associated with dialysis. Among propensity-weighted patients, hospital mortality was 2.2% vs 2.5%, $P = .09$. Unadjusted survival at 1, 5, and 10 years was 92%, 84%, and 74% after repair and 86%, 68%, and 51% after replacement, respectively. Propensity weighted survival was similar ($P = 0.4$); 90% vs 91% at 1 year, 82% vs 72% at 5 years and 71% vs 58% at 10 years (Figure). However, matched valve repair patients were less representative of those typically undergoing valve repair. Risk factors for time-related mortality included older age and renal failure.

Conclusions: Mitral valve repair is preferred for treatment of isolated mitral valve endocarditis whenever technically feasible owing to excellent survival and repair durability in patients with non-invasive pathology. The need for valve replacement in this setting represents the presence of advanced disease where replacement does not negatively impact survival in those for whom valve repair is not possible.

168. Impact of UNOS Listing Policy Changes on Utilization and Outcomes of Patients Bridged to Heart Transplant with Intra-Aortic Balloon Pump

Gillian O'Connell, Andrew Melehy, Paul Kurlansky, Yuming Ning, Veli Topkara, Farhana Latif, Maryjane A. Farr, Gabriel Sayer, Nir Uriel, Yoshifumi Naka, Koji Takeda
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Invited Discussant: Robert S. Higgins

Objective: Intra-aortic balloon pump (IABP) support may improve the hemodynamic profile of patients in cardiogenic shock and successfully bridge patients to heart transplant. In 2018, the United Network for Organ Sharing (UNOS) introduced new heart allocation criteria that increased the waitlist status of patients with IABP to Status 2, thus increasing their opportunity for transplant. This study sought to assess the impact of this change on IABP use and patient outcomes.

Methods: We queried the UNOS database for first adult heart transplant recipients listed or transplanted with IABPs in the year prior to or after UNOS policy changes (October 18, 2017–October 17, 2018 or October 18, 2018–October 18, 2019). We compared post-transplant survival and waitlist outcomes between these two groups using Kaplan Meier and Fine-Gray analyses.

Results: 1,000 patients met inclusion criteria for the post-transplant analysis; 1,291 met inclusion criteria for the waitlist analysis. In the year after the policy change, the patients bridged to transplant with IABPs increased by 236%. Pre- and post-transplant survival was comparable before and after policy change ($p = 0.21$, $p = 0.69$). Patients with IABPs listed after the policy change were more likely to receive transplant and were transplanted more quickly, with an 80% probability of receiving transplant by 30 days opposed to 60% in the pre-policy change era (Figure 1a, $p < 0.001$). Patients that did not receive transplant were more likely to be delisted in the post-policy change era (Figure 1b, $p = 0.03$).

Conclusions: The UNOS allocation criteria abruptly changed the landscape of bridge to transplant with IABP. The majority of patients bridged with IABP have benefitted from this change, as indicated by a higher transplant rate and shorter time to transplant post-policy change. Increased delisting in the post-policy change era may indicate increased IABP utilization in higher-risk patients.

169. Left Ventricular Oversizing > +50% Is Associated with Poorer Outcomes After Heart Transplantation

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Invited Discussant: Shu S. Lin

Objective: Recent literature in donor-recipient matching has explored ventricular mass matching over prior methodologies involving weight, BMI, or gender. Here we aim to explore the impact of LVM oversizing on heart transplant outcomes.

Methods: We performed a UNOS Database retrospective analysis of adult primary heart transplants from 1997 to 2017. Using previously validated equations we calculated estimated left ventricular mass for donors and recipients. Recipients of undersized LVMS (< -20%) were excluded from our study. Multivariable Cox Proportional Hazards analysis was used to identify independent predictors of mortality; model was adjusted for recipient age, ECMO, Ventilator, IABP, inhaled nitric oxide, inotropes, diabetes, AICD, transpulmonary gradient, cigarette use, prior cardiac surgery, creatinine, pre-transplant LVAD and RVAD, and ischemic time. Analysis of variance (ANOVA), t-test, and chi-square test were used for comparing postoperative outcomes when appropriate.

Results: A total of 34,455 patients were included in our study. Average recipient LVM was 154.5 ± 30.1 g; average donor LVM was 157.7 ± 28.3 g. Fractional polynomial regression demonstrated increased risk of 1-year mortality with higher LVM mismatch. Patients were subdivided into 3 groups; LVM -20% to +30% (31,575 patients), +30% to +50% (2,186 patients), and > +50% (694 patients). LVM oversize > +50% had poorer 1-year survival (Figure 1). Multivariable Cox Proportional Hazards analysis demonstrated LVM oversize > +50% to be an independent predictor of mortality (HR 1.63, $P < 0.001$). LVM oversize > +50% was also associated with a higher rate of postoperative stroke (2.5% and 2.9% vs 4.5%, $P < 0.001$) and longer length of stay (20.2 and 21.1 vs 22.6 days, $P < 0.001$). LVM oversizing from +30% to +50% was not associated with poorer survival ($P = 0.23$), longer LOS ($P = 0.16$), or rate of postoperative stroke ($P = 0.31$) or dialysis ($P = 0.23$).

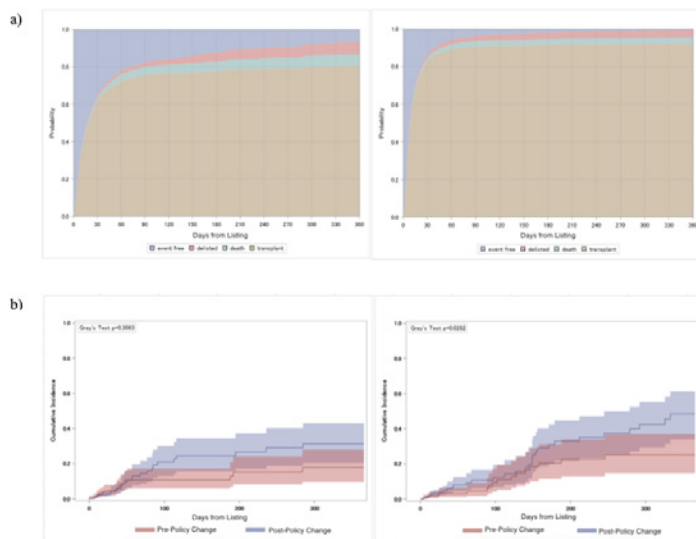
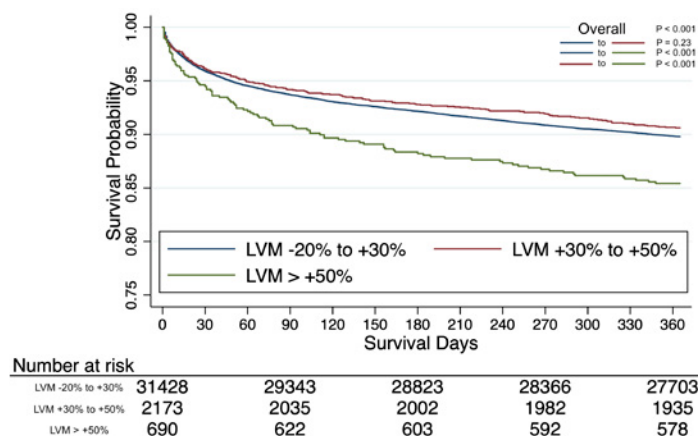


Figure 1: (a) Stacked CIF curves of delisting, death and transplant before (left) and after (right) UNOS policy change and (b) Fine-Gray curves of mortality with delisted as competing risk (left) and delisted with mortality as competing risk (right) before and after UNOS policy change. UNOS, United Network for Organ Sharing.



Conclusions: LVM oversizing up to +50% is not associated with poorer outcomes. However, oversizing > +50%, although comprising a small portion of transplants, is associated with lower 1-year survival and higher rate of postoperative strokes. As donor-recipient matching begins shifting to ventricular mass-based assessments, degree of LVM oversize should be limited to +50%.

171. Should Hearts from Hepatitis C NAT+ Donors Continue to Be Transplanted? A UNOS Registry Analysis

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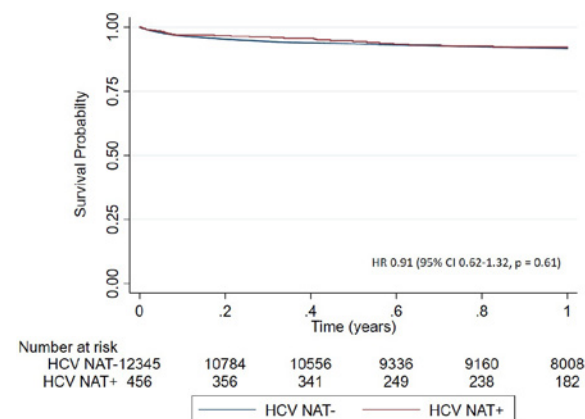
Invited Discussant: Ashish Shah

Objective: With the advent of a cure for HCV, HCV NAT+ donor hearts are being increasingly utilized for transplantation, but their outcomes are understudied. Our goal was to examine one-year survival of heart transplant recipients from HCV NAT+ donors.

Methods: We conducted retrospective review of all primary adult heart transplant recipients in the UNOS registry between January 1, 2015 and June 12, 2020. Donors were identified as being HCV NAT+ or HCV NAT-. One-year survival was examined with the Kaplan Meier method and a multivariable Cox-proportional hazards model.

Results: Of 12,913 heart transplants performed during the study period, 464 came from HCV NAT+ donors (3.6%). HCV NAT+ donors tended to be older (34 ± 8 vs 32 ± 11 yrs, $p < 0.01$) and were more likely to be white (83% vs 64%, $p < 0.01$), blood group O (61% vs 50%, $p < 0.01$), CDC high risk (87% vs 30%, $p < 0.01$), have clinical infection (83% vs 79%, $p = 0.02$), and have drug intoxication as cause of death (59% vs 17%, $p < 0.01$). Recipients of HCV NAT+ donors tended to be older (56 ± 12 vs 54 ± 13 years, $p < 0.01$). They were more likely to be blood group O (48 vs 39%, $p < 0.01$), HCV seropositive (5% vs 2%, $p < 0.01$), be supported with IABP at time of transplant (18% vs 14%, $p = 0.01$), and less likely to have had prior cardiac surgery (44% vs 51%, $p = 0.01$). One-year survival was not significantly

different among recipients of HCV NAT+ and NAT- donor hearts on univariate (HR 0.91, 95% CI 0.62–1.32, $p = 0.61$) or multivariate analysis (adjusted HR 0.80, 95% CI 0.51–1.25, $p = 0.33$). Incidence of treatment for rejection at one year was also not significantly different (12% vs 14%, $p = 0.27$).



Conclusions: Despite coming from high-risk donors, HCV NAT+ hearts have similar one-year survival and acute rejection as those coming from HCV NAT- donors. While longer-term studies are necessary, this report supports the use of NAT+ donor hearts among heart transplant candidates.

172. Cardiac Xenotransplantation from Genetically Modified Swine with Growth Hormone Knockout and Multiple Human Transgenes Prevents Accelerated Diastolic Graft Failure

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¹University of Maryland School of Medicine, Baltimore, MD; ²Johns Hopkins School of Medicine, Baltimore, MD; ³Revivicor, Blacksburg, VA

Invited Discussant: Ravi K. Ghanta

Objective: Genetically modified swine are thought to be a potential organ source for patients in end-stage organ failure unable to receive a timely allograft. However, cardiac xenografts ultimately succumb to early hypertrophic cardiomyopathy and diastolic heart failure in less than one month. Life-supporting function in these xenografts has been demonstrated for up to 6 months, but only after administration of temsirolimus and afterload reducing agents. Here we investigate the use of growth hormone receptor (GHR) knockout xenografts to prevent cardiac hypertrophy from intrinsic graft growth to improve graft survival, without the use of other adjuncts.

Methods: Genetically engineered swine hearts were transplanted orthotopically into weight-matched baboons between 15–30 kg, utilizing continuous perfusion preservation prior to implantation (n = 4). Genetic constructs included knock-outs of dominant carbohydrate antigens and knock-ins of human transgenes for thromboregulation, complement regulation and inflammation reduction (non-GHRKO, n = 2). Two grafts additionally contained knock-out of GHR (GHRKO, n = 2). TTEs were obtained twice monthly. Temsirolimus and afterload reducing agents were not administered postoperatively in either cohort. An anti-CD40-based immunosuppression regimen was used as previously described.

Results: All recipients were extubated within 24 hours of transplantation and rapidly weaned from inotropic support, if needed. Recipient survival is ongoing for up to 134 days (4.5 months) at the submission of this abstract without evidence of hypertrophy by TTE in GHRKO grafts. All recipients of either non-GHRKO or GHRKO grafts demonstrate satisfactory biventricular function and end-organ perfusion with creatinine and LFTs within normal limits. Serum troponin levels remain low or undetectable in all recipients. There is no difference in intrinsic growth as measured by septal and posterior wall thickness on TTE out to one month in either GHRKO or non-GHRKO grafts (Figure 1). However, hypertrophy as measured by septal wall thickness is markedly elevated at 54 days in one of the non-GHRKO grafts (the other has yet to reach this timepoint). There appears to be minimal hypertrophy out to 4.5 months in both GHRKO grafts, far exceeding prior cardiac xenografts.

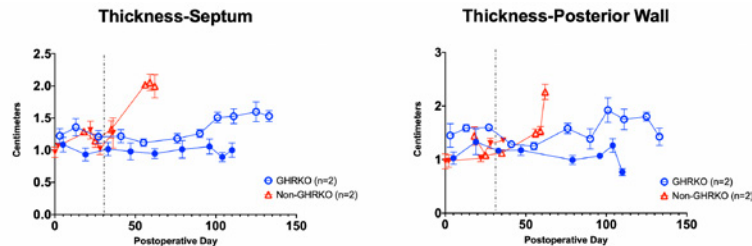


Figure 1-Septal and Posterior Wall Thickness as measured by TTE. Dotted line indicates 28 days postoperatively, corresponding with average prior xenotransplantation graft failure from hypertrophy in prior studies. Each data point corresponds to the average of three measurements of either the septum or posterior wall. Bars indicate \pm standard deviation.

Conclusions: We demonstrate that multi-gene xenografts from genetically engineered swine containing GHRKO prevent hypertrophy, with survival ongoing at the submission of this abstract. Non-GHRKO containing multi-gene xenografts exhibit delayed hypertrophy. All GHRKO grafts exhibit excellent graft function without cardiomyopathy or end-organ dysfunction up to 4.5 months post-transplantation, without the need for afterload reduction or temsirolimus. Non-GHRKO grafts have surpassed 1 month without evidence of intrinsic growth, but by 54 days exhibit a marked increase in septal wall thickening.

174. Factors Determining Perfect Vein Graft Patency at 2 Years After Coronary Artery Bypass Grafting

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¹Medical University of Vienna, Vienna, Austria; ²Krankenhaus der Barmherzigen Brüder Trier, Trier, Germany; ³University Hospital Bristol, Bristol, United Kingdom; ⁴Blackpool Victoria Hospital, Blackpool, United Kingdom; ⁵Immanuel Klinikum Bernau Herzzentrum Brandenburg, Bernau, Germany; ⁶Papworth Hospital, Cambridge, United Kingdom; ⁷Medical University of Innsbruck, Innsbruck, Austria; ⁸Rambam Medical Center, Rambam, Israel; ⁹German Heart Center Berlin, Berlin, Germany; ¹⁰University Hospital Essen, Essen, Germany; ¹¹Kerckhoff Heart Center, Bad Nauheim, Germany; ¹²University Hospital Southampton, Southampton, United Kingdom; ¹³University of Oxford, John Radcliffe Hospital, Oxford, United Kingdom

Invited Discussant: Thomas A. Burdon

Objective: The VEST III trial (NCT02511834) was a prospective within-patient randomized controlled multi-center trial investigating the performance of a venous external support (VEST) stent at 2 years after coronary artery bypass grafting. However, early vein graft failure due to technical failure may mask the effect of the external stent on mitigating late vein graft failure caused by intimal hyperplasia.

Methods: In this post hoc analysis participating sites (n = 14; 183 patients) were stratified by early vein graft patency as assessed by computed tomography angiography at 6 months into superior early patency (SEP) sites (200/213 vein grafts, 93.9%) and inferior early patency (IEP) sites (94/118 vein grafts, 79.7%). Overall early patency was 88.8% (294/331 vein grafts) and the cut-off for stratification was therefore set at 88%. Fitzgibbon I patency and intimal hyperplasia thickness were assessed by coronary angiography and intravascular ultrasound at 2 years.

Results: IEP sites (n = 65 patients) compared with SEP sites (n = 118 patients) had higher use of endoscopic vein harvesting (EVH) (n = 40, 61.5% vs n = 17, 14.4%; $P < 0.001$), above-knee origin vein grafts (n = 31, 47.7% vs n = 5, 4.2%; $P < 0.001$), and greater diameter external stent (n = 14, 21.5% vs n = 8, 6.8%; $P = 0.003$). SEP sites compared with IEP sites had higher early patency rates in stented vein grafts (99/106, 93.4% vs 44/59, 74.6%; $P = 0.002$) and control vein grafts (101/107, 94.4% vs 50/59, 84.7%; $P = 0.04$), and higher 2-year patency rates in stented vein grafts (77/83, 92.8% vs 31/46, 67.4%; $P < 0.001$) and control vein grafts (74/82, 90.2% vs 36/46, 78.3%; $P = 0.07$). Correspondingly, in SEP sites, stented vein grafts vs control vein grafts at 2 years demonstrated higher Fitzgibbon I patency (56/77, 72.7% vs 41/75, 54.7%; $P = 0.004$), and lower intimal hyperplasia thickness (0.23 ± 0.01 vs 0.32 ± 0.02 , $P < 0.001$) while in IEP sites, stented vein grafts vs. control vein grafts demonstrated similar Fitzgibbon I patency (16/31, 51.6% vs 20/36, 55.6%; $P = 0.58$) and intimal hyperplasia thickness (0.32 ± 0.03 vs 0.37 ± 0.03 , $P = 0.11$).

Conclusions: In the VEST III trial there were clear differences in early and 2-year vein graft patency in different centers and according to method of harvest, site of vein graft origin and diameter of external stents. In sites with lower early vein graft failure, external stents produced superior perfect patency accompanied by significantly reduced intimal hyperplasia at 2 years.

175. Surgical Strategy and Outcomes for Atrial FMR: All FMR Is Not the Same!

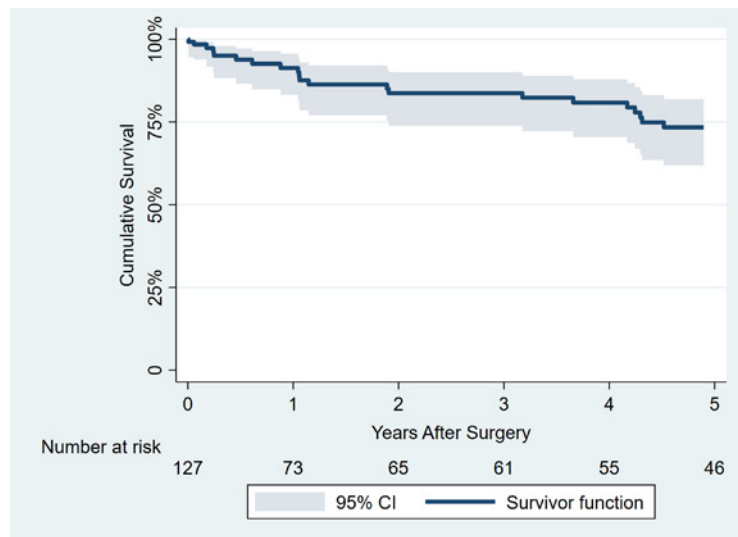
Catherine M. Wagner, Alexander A. Brescia, Tessa M.F. Watt, Liza M. Rosenbloom, Nicolas N. Ceniza, Grace E. Markey, Gorav Ailawadi, Matthew A. Romano, Steven F. Bolling

University of Michigan, Ann Arbor, MI

Invited Discussant: Song Wan

Objective: Mechanisms of mitral regurgitation (MR) have been divided between degenerative mitral regurgitation (DMR, valvular) and functional mitral regurgitation (FMR, non-valvular). Patients, therapies and outcomes are different between DMR and FMR. Mitral valve repair (MVR) is the therapy of choice for DMR and results in excellent outcomes. However, the optimal strategy for FMR remains unclear, and FMR outcomes may be poor. A recently described sub-population of atrial FMR (AFMR) includes those with atrial dilation leading to mitral annular dilation. The purpose of this study was to evaluate the short- and long-term outcomes in patients with AFMR.

Methods: Patients undergoing surgery for MR at a single quaternary care institution from 1/1/00–6/30/20 were reviewed. Patients with degenerative/myxomatous disease, rheumatic disease, endocarditis, atrial tumors, congenital anomalies, and the following concomitant procedures: CABG, AVR, aortic procedures, septal myectomy, were excluded. VFMR patients with ejection fraction (EF) <50% were excluded, to create a “pure” population of AFMR patients. Using STS database and chart review, descriptive characteristics, complications, and outcomes data were collected and analyzed.



Results: AFMR patients (127) were identified, with 56% (71/127) female, having a mean age of 62.3 ± 15.3 years. Mean preop left atrial dimensions were enlarged to 4.9 ± 0.9 cm, while mean preop left ventricular diastolic dimensions remained near normal at 5.0 ± 0.8 cm. Preop atrial fibrillation (AF) was noted in 61% (77/127). All patients successfully underwent MVR (mean postop MR 0.3 ± 0.3). MVR involved ring annuloplasty \pm cleft closure only.

MAZE and left atrial appendage ligation were performed in all patients in AF and 77% (98/127) of patients were in sinus rhythm at late follow up (975 days, 21–7187). In addition, 49% (63/127) had tricuspid valve repair. TTE was performed in 60% (76/127) of patients at a median of 568 (2–5315) days after surgery. Of those, 75% (57/76) had trivial or no MR, 19% (15/76) had mild and only 5% (4/76) had moderate or worse MR. Only 1.6% (2/127) required redo mitral valve intervention. The estimated 5-year survival by Kaplan Meier was 74% (Figure 1).

Conclusions: Patients with atrial FMR are unique from ventricular FMR, and benefit substantially from mitral valve repair, with excellent 5-year survival, long term repair outcomes, and rare need for valve reintervention. They should be excluded from consideration for mitral valve replacement. AFMR and VFMR are different pathophysiologies and therefore strategies and expected outcomes should be developed separately for each.

176. Mitral Valve Repair with Bilateral Papillary Muscle Relocation in the Direction of the Anterior Mitral Annulus Improves the Long-Term Outcomes for Functional Mitral Regurgitation

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Invited Discussant: Song Wan

Objective: To treat functional mitral regurgitation (FMR), we have actively intervened in the mitral subvalvular apparatus. This study investigated our long-term results.

Methods: 88 patients who underwent mitral valve repair for FMR were included in the study. The mean age was 68 years, 69 men (78%), mean LVDd 66 mm, LVDs 53 mm, LVEF 36%. Regarding the subvalvular intervention, bilateral papillary muscle relocation (PMR) was performed in patients with decreased valve leaflet mobility due to tethering with left ventricular enlargement. Tethering of the secondary chordae was cut. PMR was initially conducted toward the posterior leaflet annulus (PMR-P) and later changed the relocation toward the anterior leaflet annulus (PMR-A). PMR-P was performed in 11 cases (13%), PMR-A in 24 cases (27%), secondary chordal cutting was performed in 36 cases (41%), and only the annuloplasty was performed in 29 cases (33%). Postoperative 5-year survival, the survival by PMR, and reverse remodeling were investigated.

Results: 1) 5-year survival: The 5-year survival for all 88 patients was 67.9%. Preoperative risk factors for 5-year mortality were analyzed, and LVEF [hazard ratio (HR) 0.943, $P = 0.024$], Age [HR 1.096, $P = 0.011$], and preoperative BNP value (log conversion) [HR 3.074, $P = 0.036$] were identified as the independent risk factors. The 5-year survival for patients with preoperative BNP value at 900 pg/ml or higher (24 cases) was 38.5%. However, the patients' survival with BNP less than 900 pg/ml (62 cases) was good as 79.9% [$P = 0.001$]. 2) Survival by PMR: The 5-year survival of patients with the BNP <900 pg/ml by PMR-A, PMR-P, and without PMR was 90.0%, 57.1%, and 79.8%, respectively. A significant difference was observed between the PMR-A group and the PMR-P group ($P = 0.031$). 3) Reverse remodeling: Echocardiography of the patients with the BNP <900 pg/ml was followed for three years after surgery to observe the changes in LVDd, LVDs, and LVEF. The mean LVDd of PMR-A cases decreased to 65–54–51–49 in the order of preoperatively-1 year-2 years-3

years [$P < 0.001$]. The mean LVDs also reduced to 54–39–35–34 [$P < 0.001$], and the mean LVEF increased to 33–54–58–60 [$P = 0.001$]. A reverse remodeling continued for three years in PMR-A cases. The changes were not significant in PMR-P cases as mean LVDd: 67–64–64–65, mean LVDs: 52–49–49–50, mean LVEF: 35–42–44–45. And in patients with-out PMR, mean LVDd decreased to 64–57–59–58 [$P = 0.001$], mean LVDs also decreased to 51–47–48–48 [$P = 0.029$], but no increase in mean LVEF was observed as 44–40–42–41 [$P = 0.325$].

Conclusions: The long-term survival after valve repair for FMR was excellent in patients undergoing PMR-A but poor in significantly high BNP patients and patients undergoing PMR-P. In FMR cases with left ventricular enlargement and decreased valve leaflet mobility, PMR-A induced reverse remodeling of the left ventricle, suggesting that long-term outcomes can be improved.

177. Comparative Effects of Papillary Muscle Apical-Basal Hoisting and Papillary Muscle Lateral Approximation on Mitral Valve Hemodynamics and Kinematics in Functional Mitral Regurgitation

Elorm J. Agra, Kirthana Suresh, Qi He, Daisuke Onohara, Muralidhar Padala

Emory University, Atlanta, GA

Invited Discussant: Spencer J. Melby

Objective: Functional mitral regurgitation (FMR) is a consequence of tethering of the mitral valve leaflets by the dyskinetic and dilated left ventricle in heart failure. Though the annulus is dilated, it is often not the primary cause of regurgitation. Current surgical strategies fail to achieve a durable correction of FMR, as undersizing mitral annuloplasty (UMA), addresses the annular component without relieving the tethering forces on the valve. The need for sub-annular approaches is well recognized, but the mechanistic basis or their impact on the mitral valve is not established. In this study, we use a novel *ex vivo* heart simulator that mimics a dilated left ventricle and tethered mitral valve geometry with FMR, to investigate the effects of papillary muscle apical-basal hoisting (PMBH) and papillary muscle approximation (PMA), when used concomitantly with UMA of different sizes, on mitral valve hemodynamics and kinematics.

Methods: A dilated ventricle and tethered mitral valve phenotype was mimicked in pig hearts by thinning their ventricular walls to 65% of their original thickness and pressurizing them in a pulse duplicator. The pump was programmed to generate a peak LV pressure of 120 mmHg, and a cardiac output of 5 LPM. Mitral valve hemodynamics were measured in the diseased and subsequent repair states with electromagnetic flow probes, and systolic mitral valve geometry measured with echocardiography (Figure 1A-C). Mitral valve tethering forces were measured by instrumenting 8 chordae tendineae with miniature force transducers (Figure 1D).

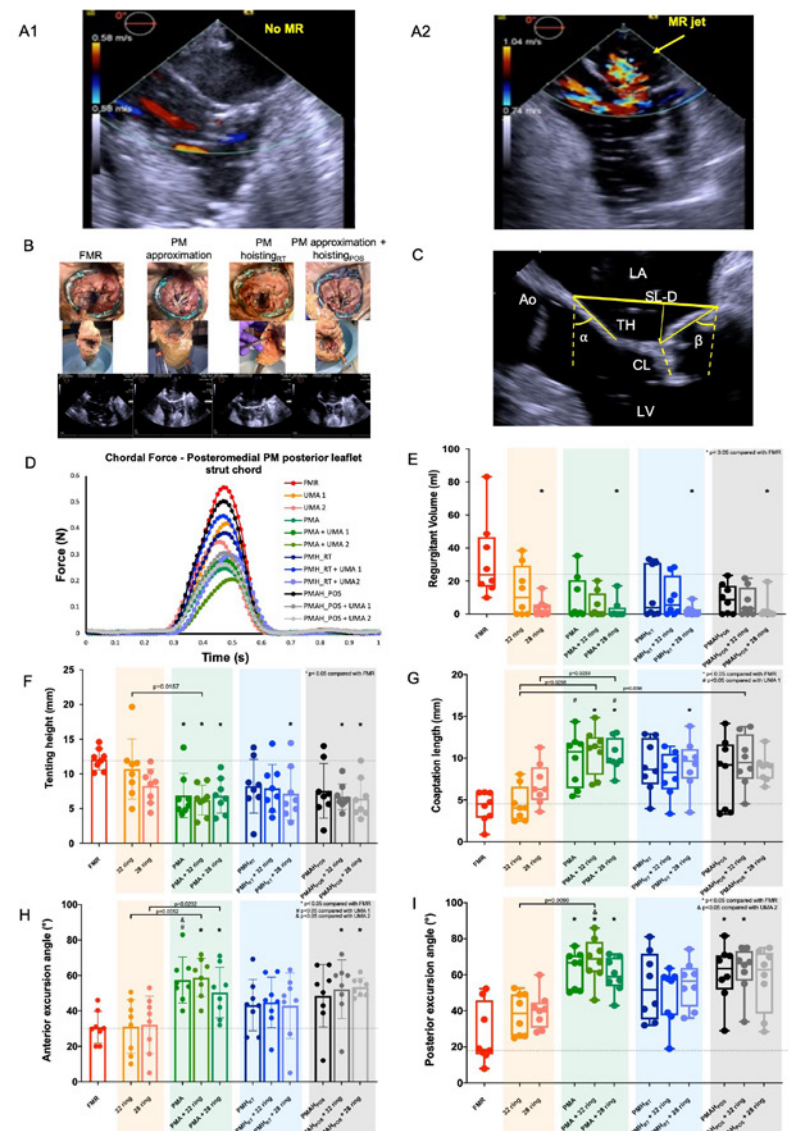


Figure 1: (A1) Representative color doppler image showing no mitral regurgitation in systole before LV resection and (A2) severe mitral regurgitation after LV resection; (B) Representative images of PM approximation, PM hoisting to the right trigone (PMBH_{RT}) and PM approximation and hoisting to the posterior annulus (PMAH_{POS}); (C) Representative images showing 2D echocardiography measurements; (D) Chordal force measurements showing decreased posterior leaflet strut chordal force from the postero medial papillary muscle (PM) with PMA, PMBH_{RT} and PMAH_{POS}; (E) Regurgitant volumes showing regurgitation in FMR and correction with 28 ring, PMA, PMBH_{RT}, and PMAH_{POS} in combination with a 28 ring; (F) Coaptation lengths showing improvement in coaptation with PMA at true-size, 32 and 28 ring, and PMAH_{POS} with a 32 and 28 ring; (G) Tenting height showing reduction in tenting with PMA at true-size, 32 and 28 ring, PMBH_{RT} with 32 and 28 ring, PMBH_{RT} when combined with a 28 ring; (H) Anterior leaflet excursion angles showing improvement with PMA at true-size, 32 and 28 ring and PMAH_{POS} with 32 and 28 ring; (I) Posterior leaflet excursion angles showing improvement with PMA at true-size, 32 and 28 ring and PMAH_{POS} with true-size and 32 ring.

Results: At the baseline/disease condition, the FMR regurgitant volume was 33.0 ± 24.1 ml, the coaptation length (CL) was 4.2 ± 1.8 mm, tenting height (TH) was 12.1 ± 1.6 mm, anterior excursion angle (ALEA) was 30.7 ± 9.0 , and posterior excursion angle (PLEA) was 26.8 ± 16.7 . These factors are significantly worse than a non-diseased heart and are similar to values in humans reported in literature. When UMA of the smallest size (28 mm) was used, CL increased to 6.9 ± 2.5 mm, TH decreased to 8.2 ± 2.4 mm, ALEA increased to 32.2 ± 16.2 and PLEA 40.1 ± 10.1 . When PMA was performed with the 28 mm ring, CL increased to 10.3 ± 1.9 mm ($p = 0.007$), TH decreased to 6.9 ± 2.5 mm ($p = 0.027$), ALEA increased to 50.4 ± 14.3 ($p = 0.023$) and PLEA 59.9 ± 9.7 ($p = 0.040$); When PMBH was performed with a 28 mm ring, CL increased to 9.2 ± 3.0 mm ($p = 0.006$), TH decreased to 7.1 ± 3.8 mm ($p = 0.027$), ALEA increased to 42.9 ± 18.6 and PLEA 55.0 ± 12.8 . Other combinations were also tested by performing the sub-annular repairs with a larger, true sized UMA as well, and the results are summarized in Figure 1E-I.

Conclusions: Both PMA and PMBH were effective in reducing regurgitation and restoring valve kinematics, however, the best effect was with PMA. PMA achieved better leaflet kinematics, with minimal annular downsizing.

178. Mitral Valve Replacement in Patients 50–70 Years of Age—A Propensity Matched Cohort

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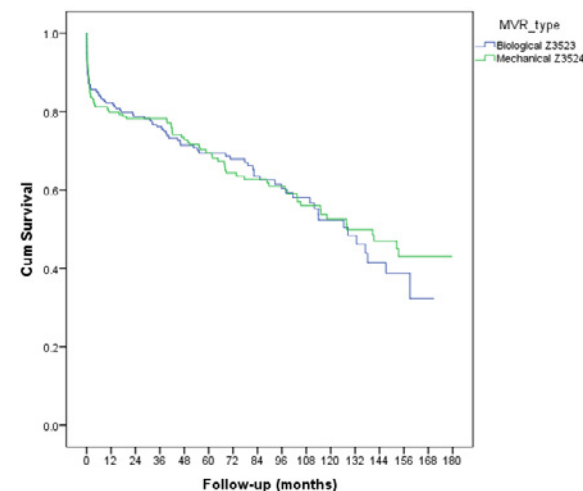
Invited Discussant: Joanna Chikwe

Objective: Adoption rates of bioprosthetic valves (BV) in the mitral position has been increasing in all age groups. The choice between a mechanical and bioprosthetic valve is of particular importance in middle aged patients. Long term outcomes including mortality and major valve related morbidity is still a matter of debate. We sought to explore these outcomes in patients aged 50–70.

Methods: We conducted a retrospective analysis of a comprehensive clinical cohort of a large health maintenance organization. All patients aged 50–70 years undergoing first time mitral valve replacement (MVR) between January 2005 and December 2019 were included in the primary analysis. Patients were included if they underwent isolated MVR surgeries or those performed with concomitant CABG, tricuspid valve repair or replacement and with left atrial appendage closure. Propensity score matching (PSM, 1:1) was used to identify patients with comparable baseline features ($n = 208$ in each group). Outcomes were all-cause mortality, mitral valve reoperation, major bleeding, and cerebrovascular accident (CVA). Median follow-up was 5.7 years.

Results: During the study period, 1729 MVR procedures were performed. Of them, 1066 (61.7%) used mechanical valves (MV) and 663 (38.3%) BV. Patients undergoing BV replacement tended to be older, with higher rates of comorbidities including hypertension and diabetes. From the total cohort 796 patients (46%) of patients were aged 50–70 (539 MV and 257 BV). From this population 208 pairs of patients were analyzed using PSM. Long term all-cause mortality was 40.3% ($n = 84$) in the MV and 39.9% ($n = 83$) in the MV with no significant difference between groups (Hazard ratio, [HR] 1.1; confidence interval [CI] 0.83–1.46; $P = 0.498$). There were 13 (6.25%) major bleeding events in the MV group and

11 (5.3%) events in the BV group (HR, 0.96; CI 0.45–2.05; $P = 0.924$). CVA occurred in 19 (9.1%) patients in the MV group and 15 (7.2%) in the BV group (HR, 0.84; CI 0.45–1.6; $P = 0.601$). Surprisingly, there were also a similar number of mitral valve reoperations in both groups with 4 (1.9%) reoperations in the MV group and 9 (4.3%) in the BV group (HR, 2.2; CI 0.91–5.5; $P = 0.081$).



Conclusions: In this PSM cohort of MVR patients aged 50–70 years there was no significant difference in any of the outcomes between MV and BV. These results support the ongoing trend of more liberal use of bioprosthesis for MVR in this age group.

179. The Role of False Lumen Area Ratio on Late Aortic Events After Open Repair of Non-Syndromic Acute Type I Aortic Dissection

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Invited Discussant: R. Scott Mitchell

Objective: The aim of this study was to determine whether distal aortic maximum false lumen area (MFLA) ratio predicts the late aortic dilatation and reintervention after open repair of acute type I aortic dissection.

Methods: We analyzed 309 non-syndromic acute type I aortic dissection patients, who were treated with a repair to the proximal aorta between 1994 and 2017. From 230 patients who did not show completely thrombosed false lumen on post-operative computed tomography (CT), MFLA ratio (MFLA/aortic area) on descending thoracic or abdominal aorta was measured with post-operative CT. The patients were divided into 3 groups according to the quartile range of MFLA ratio: low (<0.62 , $n = 57$), intermedium (0.62 – 0.81 , $n = 116$), and high (≥ 0.82 , $n = 57$) MFLA group.

Results: The 10-year freedom from aortic reintervention rate was significantly lower in high MFLA group ($37.4 \pm 7.6\%$) compared with low ($97.9 \pm 2.1\%$, $p < 0.01$) and intermedius ($91.0 \pm 3.4\%$, $p < 0.01$) MFLA group. The aortic expansion rate was significantly higher in high MFLA group (11.5 ± 21.2 mm/year) compared with low (1.1 ± 7.6 mm/year, $p < 0.01$) and intermedius (3.6 ± 7.6 mm/year, $p = 0.02$) MFLA group. The 10-year freedom from significant aortic expansion rate was significantly lower in high MFLA group ($33.5 \pm 7.9\%$) compared with low ($97.6 \pm 2.4\%$, $p < 0.01$) and intermedius ($73.9 \pm 6.6\%$, $p < 0.01$) MFLA group. The multivariate analysis showed that a high MFLA was an independent risk factor for aorta reintervention (HR = 5.84, 95% CI = 2.35–14.50, $p < 0.01$) and significant aortic expansion (HR = 2.22, 95% CI = 1.15–4.30, $p = 0.02$).

Conclusions: A high MFLA ratio on descending thoracic or abdominal aorta after acute type I aortic dissection repair was associated with increased the risk of late aortic reintervention and distal aortic dilatation.

180. Long-Term Outcomes of Tetralogy of Fallot Repair: Impact of Right Ventriculotomy in Pulmonary Valve Sparing Procedures

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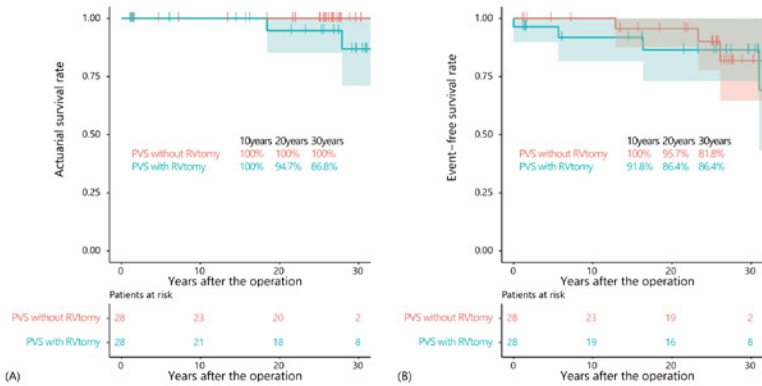
Invited Discussant: Joseph B. Clark

Objective: Pulmonary valve sparing (PVS) procedure is believed to be the key to long-term success after tetralogy of Fallot (TOF) repair, and reasonable long-term results have been reported. However, disadvantage of making an incision on the right ventricular free wall is controversial. Herein we reviewed the long-term results of patients who underwent tetralogy of Fallot repair with different procedures, to evaluate the advantages of PVS procedures and effects of right ventriculotomy (RVtomy) in PVS procedures.

Methods: Between 1978 and 2003, 440 consecutive patients aged younger than 10 years underwent TOF repair. Of those, 242 patients (55.0%) underwent transannular patch repair, 106 patients (24.1%) underwent PVS repair without RVtomy, and 92 patients (20.9%) underwent PVS repair with RVtomy. Endpoints were set as mortality or adverse events, which include all-cause mortality, reoperation, catheter intervention, and arrhythmias that required intervention or hospitalization. Firstly, risk factors for adverse events were evaluated using Cox proportional-hazards model in all cohorts. Then, 28 patients from PVS with or without RVtomy group were matched for comparison using propensity score matching, and survival rates and event-free survival rates were compared.

Results: The median follow-up period [IQR] was 20.3 years [10.7–27.6]. The follow-up rates at 10, 20, and 30 years were 80.0% (352 patients), 53.4% (235 patients), and 20.5% (90 patients), respectively. In all cohorts, PVS procedure was the independent factor that reduced the events after TOF repair (Hazard ratio: 0.469, 95% confidence interval: 0.254–0.867, $p = 0.0157$). After propensity score matching in the PVS group, patients' backgrounds were similar in PVS with or without RVtomy. Actuarial survival rates at 10, 20, and 30 years after the operation were 100%, 100%, and 100% in PVS without RVtomy group, and 100%, 94.7%, and 86.8% in PVS with RVtomy group ($p = 0.249$, Figure A). Event-free survival rates at 10, 20, and 30 years after the operation were 100%, 95.7%, and

81.8% in PVS without RVtomy group, and 91.8, 86.4, and 86.4% in PVS with RVtomy group ($p = 0.805$, Figure B). At the latest echocardiography, 15 patients (57.7%) in PVS without RVtomy group and 14 patients (58.7%) in PVS with RVtomy group had moderate or severe pulmonary regurgitation. ($p = 1.00$).



Conclusions: PVS procedure was proved to be effective in reducing the long-term events after TOF repair. Disadvantages of RVtomy in PVS procedures were not identified. Further studies are needed to evaluate the effects of RVtomy on the hemodynamic status and cardiac function in PVS procedures.

181. Late Outcomes of Surgical Reconstruction of Peripheral Pulmonary Arteries: More Than a Decade Experience

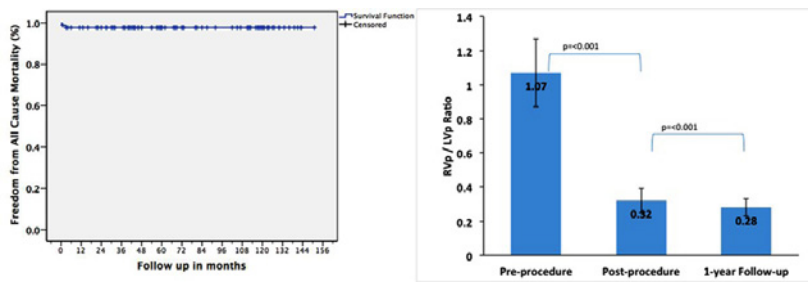
Abdulaziz Al-Khaldi¹, Ahmad D. Abuzaid¹, Omar Tamimi², Atif Alsahari¹, Abdulmajeed Alotay¹, Tarek Momenah¹, Juan J. Alfonso¹

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Invited Discussant: Elisabeth Martin

Objective: The ideal management of peripheral pulmonary artery stenosis (PPAS) is still controversial. We adopted a primary surgical approach to this complex lesion with excellent early outcomes. In this study, we analyzed our late outcomes.

Methods: We conducted a retrospective review of biventricular patients who underwent peripheral pulmonary artery (PA) reconstruction from March 2008 to July 2020. A total of 91 patients were identified. The mean pre-operative right ventricular/left ventricular pressure (RVp/LVp) ratio was 1.07 ± 0.20 (range, 0.59 to 1.6). Our surgical approach included either a single stage complete repair through median sternotomy or a two-stage repair through sternotomy/left thoracotomy, depending on the degree of distal involvement in the left pulmonary artery branches. Concomitant procedures were performed in 30 (32.9%) patients.



Results: Median age was 26 months (range, 2 to 252). Syndromic etiology was established in 54 patients (59.3%) vs non-syndromic etiology in 37 patients (40.7%). The types of PPAS were type 3 (lobar) in 21 patients (23%) vs type 4 (lobar and segmental) in 70 patients (77%). Single stage repair in 68 patients (74.7%), while 23 patients (25.3%) required two-stage repair. There were 2 (2.1%) early mortalities at 78 and 11 days. Seven patients (7.6%) required Extra-Corporeal Membrane Oxygenation for pulmonary reperfusion injury. The mean RVp/LVp ratio decreased to 0.32 ± 0.07 early post-operatively ($P < 0.001$), representing a 70.1% reduction compared with the pre-operative values. In late post-operative catheterization (about one year after surgery), the mean RVp/LVp ratio was 0.28 ± 0.05 ($P < 0.001$ compared to early post-operative value). Follow-up for patients who survived to hospital discharge was complete (100%), with median follow-up 68 months (range, 3 to 153). There was no late mortality after discharge. All patients were active and asymptomatic on most recent follow-up. There was no early or late re-intervention on pulmonary arteries.

Conclusions: Late outcomes of surgical reconstruction for PPAS are excellent and durable in various pathologies (syndromic and non-syndromic) with significant reduction in RVp/LVp ratio, low mortality and no re-intervention.

182. The Impact of Pulmonary Artery Coarctation on Pulmonary Artery Growth in Patients Undergoing Modified Blalock-Taussig Shunt

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Invited Discussant: James M. Hammel

Objective: Proportionate pulmonary artery (PA) growth is a key to achieve adequate physiology at definitive repair or Fontan operation. Presence of PA coarctation (PACoA) may pose a risk for pulmonary stenosis and subsequent failure in achievement of the definitive repair. We sought to assess the impact of PACoA on PA growth.

Methods: Retrospective chart review was performed in 130 patients, including 37 single ventricle who had a Modified Blalock-Taussig Shunt (MBTS) as a first palliation. PACoA was defined as a discrete stenosis of pulmonary artery with a diameter of less than 3 mm where the ductus arteriosus drains into. Preoperative echocardiography showed PACoA in 29 (22%) patients. The laterality of MBTS was right PA in 89 patients, left PA in 37 patients, and main PA in 4 patients. Concomitant PA plasty (MBTS directly anastomosed

to the site of PACoA in 8 patients, Goretex patch in 5 patient, autologous pericardial patch in 4 patients, a ductal tissue resection and end to end anastomosis of PA in 2 patients) was performed in 14 patients who had PACoA with a diameter less than 2 mm.

Results: There were 8 early and 4 late deaths (all patients had single ventricle physiology). Proportionate PA growth was observed in both right and left PA after MBTS (right PA z-score: -1.5 (IQR: $-2.6, -0.4$) to -0.28 ($-2.6, 0.7$), $p = 0.017$; left PA z-score: -2.4 ($-3.9, -1.1$) to 0.45 ($-2.7, 4.0$), $p < 0.001$). Pre-BTS left PA z-score was smaller in patients with PACoA compared to the ones without PACoA (-4.8 ($-6.3, -3.3$) vs -1.9 ($-2.8, -0.9$), $p < 0.001$), and this remained the same even after MBTS (-3.0 ($-6.4, -1.2$) vs 1.0 ($-1.0, 4.8$), $p = 0.004$). Concomitant PA plasty did not result in catch-up growth of the left PA (post-BTS left PA z-score in patients with PA plasty: -3.5 ($-7.7, -2.3$) vs those without PA plasty: -3.0 ($-6.8, -1.3$), $p = 0.231$). The definitive repair/Fontan completion was achieved in 111 (85%) patients and this was not affected by the presence of PACoA.

Conclusions: PACoA affected the disproportionate PA growth throughout the staged repair but did not resulted in the failure of the definitive repair/Fontan completion. PA plasty for PACoA at neonatal period did not contribute to catch-up growth of LPA, hence the surgical indication should be carefully considered.

183. Pulmonary Artery Growth Patterns Following Neonatal Intervention for Variants of Tetralogy of Fallot

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Royal Brompton Hospital, London, United Kingdom

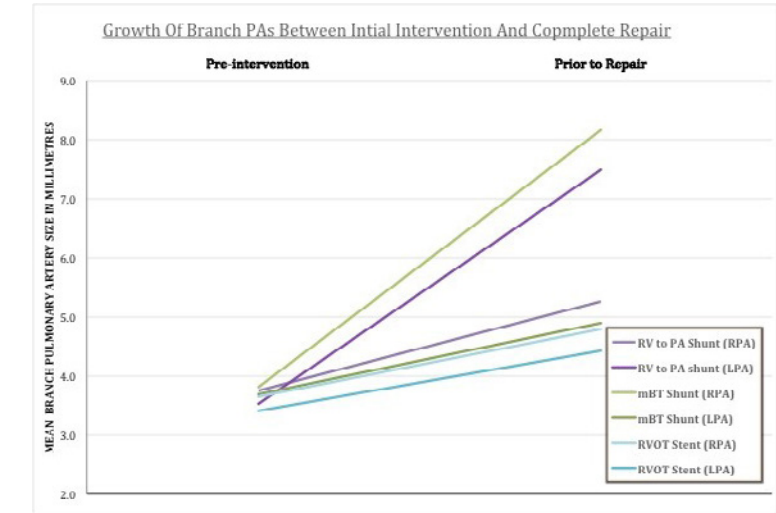
Invited Discussant: S. Adil Husain

Objective: To compare the pulmonary artery growth patterns and clinical course of neonates with variants of Tetralogy of Fallot (TOF) and pulmonary atresia or severe pulmonary stenosis who required early intervention, prior to repair, to improve pulmonary blood flow.

Methods: Between 2014 and 2020, 39 patients unsuitable for repair had intervention to augment pulmonary blood flow. The eight patients who had Right Ventricular Outflow Tract Stent (RVOTS) and the eight patients who had Right Ventricular to Pulmonary Artery Shunt (RVPAS) were compared with a propensity-matched group who had modified Blalock-Taussig Shunt (BTS). In the surgical patients five had catheter intervention prior to shunting (2 BTS, 3 RVPAS). Pulmonary arteries were interrogated by CT angiography, diagnostic angiography or echocardiography at initial definitive intervention and then prior to repair. Results: The groups were well matched in terms of demographics, weight and co-morbidities but with a higher prevalence of pulmonary stenosis rather than atresia in patients having trans-catheter intervention ($p < 0.05$). Early mortality after an initial intervention was 4.1% (1/24) with one late death after repair for an overall survival of 91.8% at a median follow-up of 29.6 months (Range 6–43).

There was no significant difference in in-hospital mortality, mechanical ventilation time, intensive care unit stay and hospital stay between groups. There we no stent or shunt thrombosis or anastomotic aneurysms seen in the cohort. Four RVOTS patients needed trans-catheter re-intervention and one RVPAS had balloon angioplasty of the proximal anastomosis, prior to complete repair. Mean right pulmonary artery (RPA) and left

pulmonary artery (LPA) at initial procedure were 3.7 mm (range, 2.8–5.5) and 3.5 mm (range, 2.0–5.0), respectively. Repair was performed at a median age of 8 months (IQR 4–31), with a median Nakata index of 221 mm²/m² (IQR 171–481). Weight gain prior to repair and timing of repair were similar in the three groups. Surgical patients had higher Nakata indices prior to repair (P < .05). Stenting was associated symmetrical pulmonary growth while RVPAS were associated with preferential LPA growth and BTS were associated with preferential pulmonary artery growth on the side of the shunt.



	RV to PA Shunt (RVPAS) (n = 8)	mBT Shunt (mBTS) (n = 8)	RVOT Stent (RVOTS) (n=8)	Entire Cohort (n=24)
Median age in days at initial intervention (IQR)	15.3 (11.0-19.0)	23.1 (16.2-30.0)	14.6 (10.1-19.1)	18.3 (13.1-22.5)
Mean weight in kg at initial intervention (SD)	3.03 (±0.91)	3.20 (±0.78)	2.75 (±0.62)	2.9 (±0.62)
Trans-catheter intervention prior to definitive initial intervention	4/8 (50%)	1/8 (12.5%)	2/7 (28.6%)	8/24 (25.0%)
Mean RPA diameter in mm at initial repair (SD)	3.75 (±0.52)	3.81 (±0.67)	3.64 (±0.66)	3.71 (±0.51)
Mean LPA diameter in mm at initial repair (SD)	3.53 (±0.81)	3.68 (±0.88)	3.41 (±0.72)	3.56 (±0.69)
Death after initial intervention	0/8 (0%)	0/8 (0%)	1/8 (12.5%)	1/24 (3.1%)
Trans-catheter re-intervention prior to complete repair	1/8 (12.5%)	0/8 (0%)	2/7 (28.6%)	3/23 (13.0%)
Surgical invention prior to complete repair	0/8 (0%)	0/8 (0%)	0/7 (0%)	0/23 (0%)
Death prior to Repair	1/8 (12.5%)	0/8 (0%)	0/7 (0%)	1/23 (4.3%)
Median interval to repair in days (IQR)	210 (152-268)	220 (137-303)	192 (111-273)	204 (130-278)
Mean weight in kg at repair (SD)	7.0 (±0.91)	8.0 (±1.03)	6.0 (±0.89)	7.0 (±0.76)
Mean RPA diameter in mm at repair or last FU (SD)	5.26 (±0.96)	8.15 (±1.17)**	4.80 (±1.19)	6.12 (±0.88)
Mean LPA diameter in mm at repair or last FU (SD)	7.49 (±1.18)**	4.89 (±1.10)	4.43 (±1.01)	5.67 (±0.97)
Death after repair	0/6 (0%)	0/7 (0%)	0/6 (0%)	0/18 (0%)
Overall survival at median FU of 23.5 months	7/8 (87.5%)	8/8 (100%)	7/8 (87.5%)	22/24 (91.6%)

Normally distributed continuous variables are expressed as mean ± standard deviation (SD). Skewed continuous variables are expressed as median with inter-quartile range (IQR). Categorical variables are expressed as frequency count with percentage of total. Parameters reaching significance are written with asterisk**.

Conclusions: Early trans-catheter or surgical intervention for inadequate pulmonary blood flow in variants of TOF leads to acceptable pulmonary artery growth. Though surgical intervention results in superior pulmonary artery development at the time of repair, growth was more symmetrical with transcatheter rather than surgical treatment. Early and late, morbidity and mortality in this complex patient group is low.

184. Waiting List Death and ECMO Bridge to Lung Transplant—A National Registry Analysis

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Invited Discussant: Stephanie Chang

Objective: The use of extracorporeal membrane oxygenation (ECMO) as a bridge to lung transplant has increased >250% in the last decade. Several authors have reported good outcomes for this population. However, little is known about patients placed on ECMO that die while on the waiting list. Using a national lung transplant dataset, we investigated patient variables associated with waitlist mortality and compared to those who were successfully bridged to transplant.

Table 1 – Univariate Comparisons

Variable	Lived to Tx N (%)	Died on WL N (%)	p
Blood Type			0.003
A	172 (75.1)	57 (24.9)	0.007
AB	11 (44.0)	14 (56.0)	0.007
B	38 (59.4)	26 (40.6)	0.11
O	219 (67.2)	107 (32.8)	0.55
Number of Previous Transplants			0.12
0	374 (69.5)	164 (30.5)	
1	63 (61.2)	40 (38.8)	
2	3 (100.0)	0 (0.0)	
Diagnosis Group			0.001
Obstructive	12 (75.0)	4 (25.0)	0.55
Pulmonary Vascular	19 (50.0)	19 (50.0)	0.012
Infectious	83 (82.2)	18 (17.8)	< 0.001
Restrictive	326 (68.3)	163 (31.7)	0.11
Sex			0.051
Female	165 (64.0)	93 (36.0)	
Male	275 (71.2)	111 (28.8)	
Prostacyclin Infusion	8 (53.3)	7 (46.7)	0.21
Prostacyclin Inhalation	16 (69.6)	7 (30.4)	0.9
Inhaled NO	32 (60.4)	21 (39.6)	0.19
Previous Malignancy	28 (66.7)	14 (33.3)	0.6
Pan-Resistant Bacterial Lung Infection	28 (77.8)	8 (22.2)	0.27
Inotropes/Vasodilators	32 (53.3)	28 (46.7)	0.007
History of Cigarette Use	166 (66.4)	84 (33.6)	0.4
Prior Cardiac Surgery	18 (58.1)	13 (41.9)	0.2
Diabetes	157 (68.6)	72 (31.4)	0.95
Ethnicity			0.4
White	327 (69.6)	143 (30.4)	
Black	47 (61.8)	29 (38.2)	
Other	66 (67.3)	32 (32.7)	
Center Volume			<0.001
Lowest Quartile	119 (60.4)	78 (39.6)	0.0037
2 nd Quartile	84 (60.9)	54 (39.1)	0.028
3 rd Quartile	116 (72.5)	44 (27.5)	0.19
Highest Quartile	119 (82.1)	26 (17.9)	<0.0001
Weight (kg)	7.57 (27.4)	75.6 (27.2)	0.87
Height (cm)	170.20 (15.2)	169.25 (17.8)	0.06
Cardiac Output (L/min)	5.57 (2.2)	5.2 (2.2)	0.014
O2 Requirement	20.0 (16.0)	20.0 (13.5)	0.66
Serum Creatinine	0.7 (0.48)	0.73 (0.57)	0.28
Lung Allocation Score at Listing	88.19 (13.2)	86.96 (20.4)	0.028
Days on Waitlist	7.0 (10)	11.0 (18)	< 0.001
BMI (mg/kg ²)	26.46 (7.7)	26.46 (8.26)	0.058

Methods: We used the UNOS STAR file to identify patients who were on ECMO at the time of listing. Patients outcomes were determined by waitlist removal code (i.e., died, became too sick to transplant or removed due to transplant). Patients who improved and did not require transplant or underwent multi organ transplants were excluded. Analyses were performed using Mann-Whitney U test and chi-square. Multivariable analysis was performed using logistic regression. Analyzed variables were selected based on clinical significance and availability within the dataset.

Results: From May 2005 to March 2020, 644 patients met inclusion criteria. 440 (68.3%) were successfully bridged to transplant, and 204 (31.7%) died on the waitlist. Univariate analysis found associations between death on the waitlist and several variables: blood group, diagnosis category, sex, use of inotropes/vasopressors, cardiac output, lung allocation score, and days on ECMO (Table 1). Significant variables were entered into a single-step logistic regression with waitlist death as the outcome. Limitations within the dataset did not allowed us to differentiate between patient's mode of support and mortality. However, the multivariable analysis revealed that, use of inotropes/vasopressors (O.R. 2.04, $p = 0.025$) and number of days on ECMO (O.R. 1.01, $p = 0.01$) were associated with increased risk of death on the waitlist. Patient's height or BMI were not associated with mortality on the waiting list. However, we observed an association trend for females (O.R. 1.59, $p = 0.051$) and blood type B (O.R. 2.46, $p = 0.059$) as having increased risk of death on the waiting list. We also observed that center transplant volume had a protective effect (O.R. 0.71, $p = 0.001$) for each increase in volume quartile. Highest volume centers (4th quartile) only had 17% patients dying on ECMO while for low volume centers the waitlist mortality on ECMO was as high as 40%.

Conclusions: The analysis of this large national dataset revealed that 30% of patients who were placed on ECMO as a bridge to lung transplant died waiting for an organ. Our analysis revealed that the number of days on ECMO and vasopressor support were associated with higher mortality on the waiting list. In addition, higher lung transplant center volume was associated with a greater percentage of patients successfully bridged on ECMO to lung transplant.

185. Long-Term Outcome of Living-Donor Lobar Lung Transplantation Performed More Than 16 Years Ago

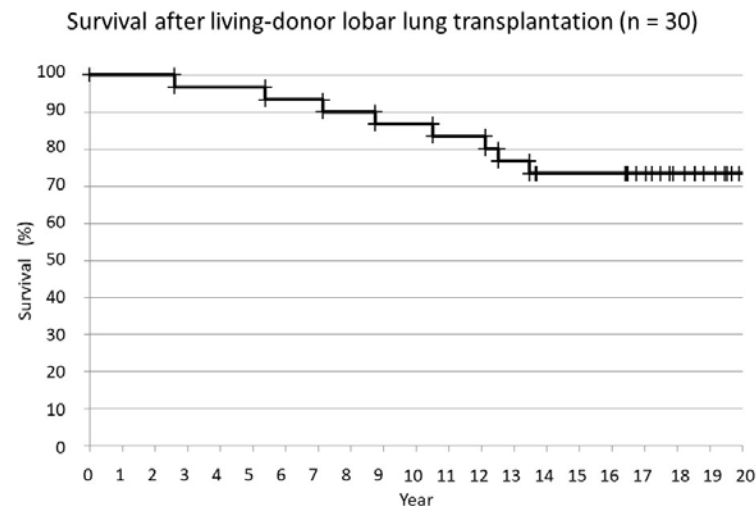
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¹Kyoto University, Kyoto, Japan; ²Okayama University, Okayama, Japan

Invited Discussant: Walter Klepetko

Objective: In 2004, at the 84th AATS meeting, we reported intermediate (mean follow-up, 22.2 months) outcome of the first 30 consecutive patients receiving living-donor lobar lung transplantation (LDLLT). All patients were alive and 4 patients (13%) had developed unilateral chronic allograft dysfunction (CLAD). The purpose of this study was to summarize long-term outcome of these 30 patients who received LDLLT more than 16 years ago.

Methods: Between October 1998 and April 2004, we performed LDLLT in 30 critically ill patients including 5 (17%) patients on a ventilator. All but one patient received bilateral LDLLT and one young boy received single LDLLT from immediate family members. There were 25 female and 5 male patients, with ages ranging from 8 to 55 years (average, 30.4 years). Six of the patients were children, and 24 were adults. The diagnoses included pulmonary hypertension ($n = 11$), pulmonary fibrosis ($n = 7$), bronchiolitis obliterans ($n = 5$) and others ($n = 7$). Routine full postoperative assessment was performed annually until death. All data were collected prospectively and were analyzed retrospectively as of August 2020.



Results: None of the patients were lost to follow-up and mean follow-up was 189.7 months. At the time of final analysis, 22 patients (73%) were alive and 8 (27%) were dead. Causes of death were infection ($n = 3$), malignancy ($n = 2$), acute rejection ($n = 2$), and CLAD ($n = 1$). Unilateral CLAD occurred in 16 patients (53%) and only one developed bilateral CLAD subsequently. Two patients received bilateral cadaveric lung re-transplantation due to unilateral CLAD at 13 and 14 years after initial LDLLTs, respectively, and they were alive at 4 and 5 years after re-transplantation. Five patients (17%) developed chronic renal failure requiring hemodialysis and two of them received a living-related renal transplantation. Postoperative malignancy developed in 7 patients (23%) and two of them died of malignancy. The 5, 10, and 15-year overall survival for the 30 recipients was 96.7%, 86.7%, and 73.3%, respectively (Figure).

Conclusions: Although only two lobes are implanted, LDLLT provides encouraging long-term outcome. Unilateral CLAD with functioning contralateral graft appears to be an important contributing factor for the favorable long-term outcome. Renal dysfunction, malignancy, and infection are to be paid enough attention in the long-term management.

186. Clinical Features and Outcomes of Unplanned Single Lung Transplants

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Washington University in St. Louis, Saint Louis, MO

Invited Discussant: Victor H. van Berkel

Objective: Single lung transplants (SLT) constitute nearly 31% of all lung transplants performed worldwide. SLT is usually offered to patients with chronic obstructive pulmonary disease (COPD) or idiopathic pulmonary fibrosis (IPF) who are over 65 years old. Typically, the decision to perform SLT or double lung transplants (DLT) is made prior to the operation. We have previously reported that a proportion of SLT are performed in the setting of an aborted DLT, and that these patients may be at a higher risk of worse short-term outcomes. However, long-term outcomes in this unique group of patients remain unknown.

Methods: We analyzed a prospectively maintained single-center database of lung transplant patients and compared recipients undergoing planned SLT to those undergoing unplanned SLT in the setting of aborted DLT. We performed root cause analyses to understand reasons for conversion to SLT and compared long-term outcomes.

Results: Between January 2000 and June 2020, 1,326 patients underwent lung transplants, of which 1266 (95%) were DLT and 60 (5%) were SLT. Twenty-two of 60 (37%) SLT were planned, while 38 (63%) were unplanned SLT in the setting of aborted DLT. There was no significant difference in the recipient age, gender, BMI, smoking history, CMV mismatch and lung function between the planned and unplanned SLT groups. Underlying indications for transplant were significantly different; all planned SLT were performed for COPD (55%) or IPF (45%), while nearly 40% of unplanned SLT were performed for bronchiolitis obliterans syndrome and other indications including sarcoidosis ($p = 0.01$). The primary reasons for unplanned SLT were unexpected donor lung pathology 8/38 (21%), difficult pneumonectomy 14/38 (37%), prolongation of bypass time 6/38 (16%), hemodynamic instability 5/38 (13%), coagulopathy 2/38 (5%), and others 3/38 (8%). Patients undergoing unplanned SLT were more likely to have secondary pulmonary hypertension (28/38, 74% vs 10/22, 45%, $P = 0.045$), to require cardiopulmonary bypass during the operation (19/38, 50% vs 4/22, 18% $p = 0.02$), and had shorter ischemic times (220 ± 49 min vs 251 ± 58 min, $p < 0.001$). The incidence of primary graft dysfunction grade 3 (planned 2/22, 9% vs. unplanned 9/38, 24%, $p = 0.3$) and acute cellular rejection \geq grade 2 (planned 7/22, 32% vs unplanned 13/38, 34%, $p = 0.51$) was similar between the two groups. The one-year chronic lung allograft dysfunction-free survival rate was 100% in the planned and 93% in the unplanned group ($p = 0.52$). The five-year overall survival rates were 53% in the planned and 59% in the unplanned group ($p = 0.27$).

Conclusions: Unplanned SLT in the setting of aborted DLT is associated with acceptable long-term outcomes. This strategy should be strongly considered when unexpected donor or recipient factors increase the risk of perioperative morbidity and mortality when proceeding with the second lung during a planned DLT.

187. Effect of Mode of Support on Primary Graft Dysfunction (PGD): Analysis of an International Multicenter Registry on Extracorporeal Life Support (ECLS) in Lung Transplantation

Gabriel Loo¹, Stephen Huddleston², Matthew Hartwig³, Brandi Bottiger³, Daoud Daoud¹, Qi Wei¹, Fabio Ius⁴, Gregor Warnecke⁵, Mauricio Villavicencio⁶, Briana Tirabassi⁶, Tiago Machuca⁷, Dirk Van Raemdonck⁸, Anna Elizabeth Frick⁸, Arne Neyrinck⁸, Yoshiya Toyoda⁹, Mohammed A. Kashem⁹, Michelle Landeweer², Satish Chandrashekar¹⁰
¹Baylor College of Medicine, Houston, TX; ²University of Minnesota Medical School, Minneapolis, MN; ³Duke University Health System, Durham, NC; ⁴Hannover Medical School, Hannover, Germany; ⁵Heidelberg University Hospital, Heidelberg, Germany; ⁶Massachusetts General Hospital, Boston, MA; ⁷University of Florida, Gainesville, FL; ⁸University Hospitals Leuven, Leuven, Belgium; ⁹Temple University School of Medicine, Philadelphia, PA

Invited Discussant: Stephanie Chang

Objective: There is uncertainty amongst the transplant community regarding the association between use of extracorporeal life support (ECLS) during lung transplantation (LTx) and the development of PGD, largely because of variability in reported outcomes and differences in ECLS choices. To clarify the relationship between use of ECLS during LTx and PGD we developed and analyzed a novel multicenter international registry.

Methods: The ECLS in LTx registry was established to identify intraoperative factors associated with patient outcomes. The registry includes double lung transplants performed at high volume centers including 6 centers in the United States and 2 in Europe. Multiorgan transplants were excluded. PGD was graded according to the 2016 International Society for Heart and Lung Transplantation guidelines. We defined PGD as PGD₃ at time 48 or 72 hours post-reperfusion. Modes of support included off-pump, extracorporeal membrane oxygenation (ECMO) and cardiopulmonary bypass (CPB). Univariate analysis was used for comparisons of demographics and outcomes. For assessing the effect of mode of support on PGD we used multiple regression adjusted for demographic and intraoperative factors. A step-wise selection method starting with known risk factors was used to get the final module, which has 10 covariates.

Results: 852 transplants performed between January 2016 and March 2020 were analyzed including 422 (50%) off-pump, 273 (32%) ECMO and 157 (18%) CPB cases. 235 (86.71%) of the ECMO cases used either veno-arterial or veno-venous-arterial cannulation. Table 1 shows characteristics of patients supported by either mode. The rates of PGD were 12.09% (51/422) for off-pump, 28.94% (79/273) for ECMO, and 42.68% (67/157) for CPB. The adjusted model resulted in the following risk profile for development of PGD: CPB vs ECMO, odds ratio (OR) 1.89 (95% CI 1.05–3.41, $P = 0.033$), CPB vs off-pump OR 4.24 (95% CI 2.24–8.04, $P < 0.001$), and ECMO vs off-pump OR 2.24 (95% CI 1.38–3.65, $P = 0.001$). 90-day unadjusted mortality was 8.5% (13/153), 8.95% (23/257) and 3.98% (16/402) and 1-year mortality was 16.41% (21/128), 15.73% (28/178) and 9.03% (26/288) for CPB, ECMO and off-pump groups, respectively.

Table 1 – Recipient, Donor and Operative Characteristics

Variable	CPB, n=157	ECMO, n=273	Off-Pump, n=422	P Value
Recipient Characteristics				
Primary diagnosis, n=852				<0.001
Obstructive lung disease	32 (20.38)	58 (21.25)	201 (47.63)	
Cystic fibrosis	25 (15.92)	48 (17.58)	69 (16.35)	
Restrictive or vascular lung disease	100 (63.69)	167 (61.17)	152 (36.02)	
Age (year), n=852	53.85 ± 14.75	53.58 ± 14.51	54.88 ± 13.42	0.449
BMI (kg/m2), n=851	25.29 ± 5.35	25.06 ± 4.59	23.67 ± 4.16	<0.001
Condition at transplant, Hospitalized, n=851	30 (19.11)	78 (28.57)	37 (8.79)	<0.001
Pulmonary hypertension, n=850	130 (82.80)	196 (72.06)	267 (63.42)	<0.001
Mean PAP, n=759	31.79 ± 13.28	30.88 ± 15.28	24.89 ± 8.29	<0.001
Lung allocation score, n=852	47.84 ± 15.74	50.15 ± 18.56	39.39 ± 11.38	<0.001
Life support prior to transplant, n=851	15 (9.55)	44 (16.12)	35 (8.31)	0.005
Pre-op ECMO	7 (4.46)	32 (11.72)	0 (0.00)	<0.001
Prior lung surgery (non-transplant), n=794	21 (14.48)	40 (15.04)	68 (17.75)	0.533
Pervious lung transplant, n=851	5 (3.18)	7 (2.56)	9 (2.14)	0.765
Donor characteristics				
Donor age, n=852	35.52 ± 13.07	38.48 ± 14.89	41.74 ± 15.59	<0.001
Extended criteria donor, n=807	90 (60.81)	166 (62.17)	233 (59.44)	0.779
Donor ever smoked, n=774	71 (50.00)	114 (43.85)	147 (39.52)	0.093
Donor type (DBD/DCD), n=852				0.818
DBD	143 (91.08)	246 (90.11)	377 (89.34)	
DCD	14 (8.92)	27 (9.89)	45 (10.66)	
Last PF ratio, n=764	449.98 ± 85.16	423.84 ± 93.35	410.74 ± 94.69	<0.001
Ex vivo lung perfusion, n=852	7 (4.46)	30 (10.99)	24 (5.69)	0.010
Operative characteristics				
Total ischemic time, n=849	358.83 ± 126.06	450.17 ± 137.38	439.76 ± 117.77	<0.001

Conclusions: A review of the ECLS in lung transplantation registry suggests that VA ECMO is being increasingly used to support transplant recipients during bilateral lung transplantation. This practice was associated with a higher risk of PGD than off-pump but lower risk than CPB. When ECLS is required during LTx, ECMO may be the preferred approach when feasible.

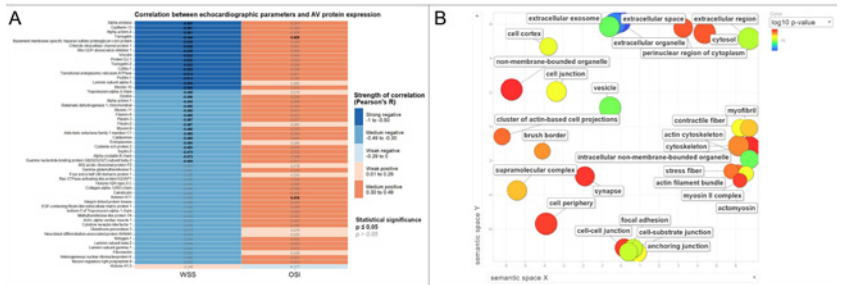
L1. Correlation Between Aortic Valve Protein Expression and Vector Flow Mapping of Wall Shear Stress and Oscillatory Shear Index in Patients Supported with Continuous-Flow Left Ventricular Assist Devices

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Invited Discussant: Gabriel Loor

Objective: Continuous-flow left ventricular assist devices (LVADs) commonly lead to aortic insufficiency (AI), which results in decreased pump efficiency and worsening heart failure. We have previously demonstrated that the ventricularis layer (VL) of the aortic valve (AV) in these patients is exposed to significantly different hemodynamic forces than in controls without LVADs. We hypothesized that non-physiological wall shear stress (WSS) and oscillatory shear index (OSI) acting on the VL alter the expression of structural proteins in AVs of LVAD patients and, in turn, lead to increased risk of AV leaflet degeneration and development of AI.

Methods: AV and root color Doppler images of patients undergoing heart transplants were obtained using intraoperative epiaortic echocardiograms. Ten patients had been supported with LVADs, whereas eight were not. AVs were collected from explanted hearts and processed to extract and digest proteins from the leaflet tissue. Protein expression was analyzed using mass spectrometry and data processed using a software system for protein expression analysis. Echocardiographic images were analyzed and WSS and OSI calculated using specialized software on the VL of the AV. Statistical analysis of the relationship between normalized expression levels of individual proteins and WSS/OSI was conducted by calculating the Pearson correlation coefficients. Gene ontologic analysis was conducted using PANTHER Overrepresentation Testing with the Fisher exact test and Bonferroni correction for multiple comparisons.



Results: Of the 54 proteins of interest, there was a strong negative correlation between levels of expression of 15 proteins and the WSS ($R < -0.5$, $p \leq 0.05$), and a medium negative correlation between 38 proteins and WSS, of which 16 were statistically significant ($R -0.49$ to -0.30 , $p \leq 0.05$). No protein was highly correlated with OSI. Only two proteins had a medium positive correlation with OSI ($R 0.30$ to -0.49 , $p \leq 0.05$) (Figure 1A). Gene ontology analysis of the 31 proteins with a statistically significant negative correlation between levels of expression and WSS using the PANTHER Overrepresentation Test demonstrated clusters of proteins involved in cellular structure. Proteins negatively correlated with WSS included those with cytoskeletal, actin/myosin, cell-cell junction and extracellular functions (Figure 1B).

Conclusions: In aortic valve tissues, we have identified 15 proteins with a strong negative, and 16 proteins with a medium negative correlation between levels of expression and the WSS. Gene ontology analysis demonstrated these proteins are largely involved in cellular structure and extracellular junctions. These findings suggest a direct relationship between the forces acting on the AV and leaflet protein expression, and may form a mechanical basis for the increased risk of leaflet degeneration and development of AI in LVAD patients.

L2. Toll-Like Receptor 4 Mediates Reflux-Induced Inflammatory Responses in a Murine Reflux Model

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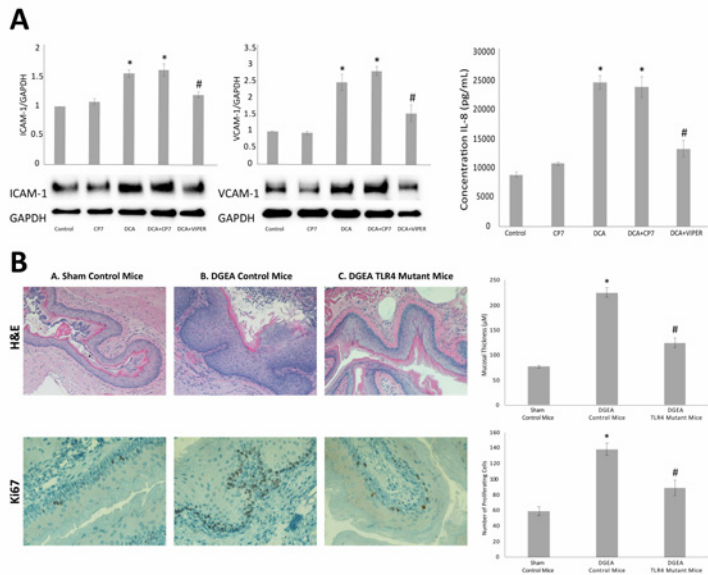
Invited Discussant: David T. Cooke

Objective: To evaluate the role of toll-like receptor 4 (TLR4) signaling in the development of gastroesophageal reflux-mediated inflammation and mucosal changes of the distal esophagus.

Methods: Verified human esophageal Barrett’s cells with high grade dysplasia (CPB) were treated with deoxycholic acid (DCA) for 24 hours. Cells were pretreated with a TLR4-specific inhibitor peptide (VIPER) or an inert control peptide (CP7) 2 hours prior to DCA treatment. Inflammatory markers were evaluated using immunoblotting and enzyme-linked immunosorbent assay. A surgical reflux mouse model was generated by performing a side-to-side anastomosis between the gastroesophageal junction and the first portion of the duodenum (duodeno-gastroesophageal anastomosis, DGEA). Control animals underwent laparotomy with incision and closure of the esophagus superior to the gastroesophageal junction (sham procedure). Procedures were performed in C3H/HeNcrI mice, which served as the non-mutated control, and C3H/HeJ mice, which exhibit a spontaneous mutation in the TLR4 gene resulting in reduced TLR4 signaling ($n = 8$ per group). Tissue was harvested 6 weeks following surgery. Esophageal sections were evaluated using hematoxylin and eosin staining and immunohistochemistry for ki67, a marker of cell proliferation.

Results: DCA treatment increased expression of inflammatory markers including intercellular adhesion molecule-1 (ICAM-1), vascular cell adhesion molecule-1 (VCAM-1), and interleukin 8 (IL-8; $p < 0.05$). Exposure to DCA also significantly upregulated TLR4 expression ($p < 0.05$). Pretreatment with a TLR4 inhibitor significantly decreased DCA-induced

ICAM-1, VCAM-1, and IL-8 expression ($p < 0.05$; Figure 1A). C3H/HeNcrI mice demonstrated a significant increase in mucosal hyperplasia and proliferation following DGEA compared to sham procedure ($p < 0.0001$). TLR4 mutant mice (C3H/HeJ) undergoing DGEA demonstrated an attenuated response in regard to mucosal thickness and cell proliferation compared to C3H/HeNcrI mice ($p < 0.0001$; Figure 1B).



Conclusions: TLR4 plays a key role in the development of inflammation and histologic changes resulting from exposure of the distal esophagus to gastroduodenal contents. Both *in vitro* and *in vivo* models demonstrate that inhibition of TLR4 signaling attenuates reflux-induced inflammatory responses. These findings identify TLR4 inhibition as a potential therapeutic target to halt the development of esophageal adenocarcinoma in the setting of chronic gastroesophageal reflux disease.

L3. Association of BAP1 Expression with Immune Microenvironment in Malignant Pleural Mesothelioma

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¹Brigham and Women’s Hospital, Boston, MA; ²Massachusetts General Hospital, Boston, MA

Invited Discussant: Bryan M. Burt

Objective: BRCA1- associated protein-1 (BAP1) is tumor suppressor gene frequently lost in malignant pleural mesothelioma (MPM). Recently, a role for BAP1 in immunotherapy resistance has been suggested. Our group previously identified molecular and clinical features that correlate with different BAP1 immunohistochemical (IHC) staining patterns in MPM. The objective of this study was to evaluate whether these patterns are associated with alterations in the MPM immune microenvironment.

Methods: Formalin-fixed paraffin-embedded (FFPE) tumor specimens from patients with MPM underwent IHC staining for BAP1. Staining was classified as nuclear (wild-type), cytoplasmic, or absent. Tumors exhibiting multiple staining patterns were excluded from analysis. Immune-specific gene expression was quantified using the HTG EdgeSeq immuno-oncology assay. Differential gene expression (DGE) analysis, transcriptomic quantification of the immune infiltrate, and pathway analysis were performed. A genewise negative binomial generalized linear model was constructed to control for the effect of sex and histologic subtype in DGE analysis. To prioritize sensitivity, a false discovery rate (FDR) of 10% and log₂ fold change (logFC) >1 were set for significance.

Results: A total of 215 tumor samples displaying single-pattern staining were included: 90 (41.9%) nuclear, 86 (40.0%) cytoplasmic, and 39 (18.1%) absent. Only 4/549 tested immune-related genes reached statistical significance for differential expression among the different groups (Table). Transcriptomic quantification of the immune infiltrate revealed significantly higher proportions of B-lineage cells (p = 0.017), natural killer cells (p = 0.008), myeloid dendritic cells (p = 0.014), and neutrophils (p = 0.017) in tumors showing cytoplasmic BAP1 compared with tumors showing nuclear BAP1 staining. Hallmark pathway analysis comparing these two groups identified differences in 4/50 tested gene sets including the IFN and IFN α responses (Table).

Table: Summary of DGE and Pathway Analysis Result

Differential Gene Expression			
Gene (by Group)		logFC	FDR
Nuclear vs. Others	IL4	1.258	0.005
	MMP9	1.004	0.031
Nuclear vs. Cytoplasmic	IBSP	1.12	0.002
	IL4	1.5	0.009
Cytoplasmic vs. Others	IL4	-1.218	0.024
Absent vs. Others	IL20RB	1.128	<0.001
Pathway Analysis			
Pathway	Enrichment Score*	P-Value*	
IFN Response	1.918	0.006	
Unfolded Protein Response		1.723	0.012
Epithelial-mesenchymal Transition	-1.773	0.034	
IFN α Response	1.834	0.034	

*Adjusted for multiple comparisons. Score represents cytoplasmic relative to nuclear BAP1 staining.

Conclusions: While BAP1 staining pattern was associated with few differences in individual immune-related gene expression in MPM, there were significant differences in immune cell infiltration and inflammatory response pathways. These immunomodulatory factors may play a role in response to checkpoint inhibition. Further work is ongoing to determine the mechanisms underlying these observations.

L4. Cardioprotective Effects of Glucagon-Like Peptide-1 Analogue Exenatide on the Donation After Circulatory Death Heart Model in Juvenile Pigs

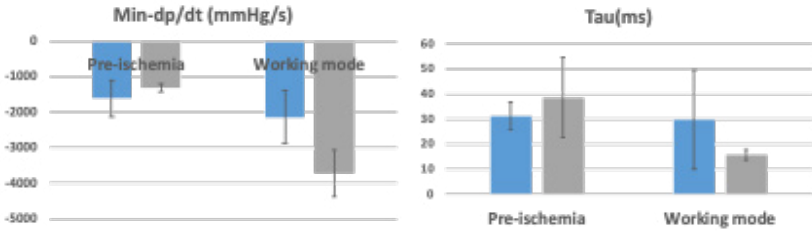
Sachiko Kadowaki¹, Ahsan Siraj², Weidan Chen¹, Jian Wang¹, Kyle Runeckles³, Steve Fan³, Christoph Haller¹, Mansoor Husain², Osami Honjo¹

¹The Hospital for Sick Children, Toronto, ON, Canada; ²Toronto General Hospital, Toronto, ON, Canada; ³University of Toronto, Toronto, ON, Canada

Invited Discussant: Ashish Shah

Objective: Glucagon-like peptide-1 analogue exenatide exerts myocardial protective effects via modulation of myocyte metabolism. We hypothesized that exenatide attenuates ischemia-reperfusion injury and preserves the donation after circulatory death (CDC) donor cardiac function in the juvenile pig model.

Methods: 13 juvenile pigs weighing at 10–12 kg were randomized into the exenatide group (n = 6) and the control group (n = 7). After a sternotomy and baseline functional measurement, cardiac arrest was induced by clamping the endotracheal tube followed by 15 min of global warm ischemia. Cardioplegia solutions were administered, and the heart was harvested. The heart was then perfused in the pediatric-specific ex-vivo heart perfusion (EVHP) device with the arterial perfusion cannula inserted into the right brachiocephalic artery. The heart was resuscitated and maintained in the EVHP system for 2 hours followed by cardiac functional measurement in the working mode where the left ventricle is loaded via the left atrium. The left atrium pressure was maintained under 10 mmHg, and preload gradually increased up to 120% of cardiac output. Exenatide was added into the venous reservoir 20 min before reperfusion. Echocardiogram and pressure-volume catheter analysis were done at baseline and working mode. The blood gas analysis was performed every 30 min after reperfusion. Variables between the groups were compared by Wilcoxon rank sum test.



Results: Median oxygen consumption at 90 and 120 minutes after reperfusion in the exenatide group was double compared to that of the control group (90 min: 6.6 mL O₂/min/100 grams (5.6–7.0) vs 3.2 (2.1–4.5), p = 0.007 and 120 min: 5.2 mL O₂/min/100grams (5.2–6.2) vs 2.8 (2.0–4.1), p = 0.02). During the working mode, lateral-e' and septal-e' were almost double in the exenatide group compared to the control (Lateral-e': 10.3 cm/s (9.9–12.5) vs 5.5 (4.8–10.7), p = 0.03 and septal-e': 9.4 cm/s (9.3–11.0) vs 4.7 (4.6–7.5), p = 0.02). The exenatide group had significantly lower minimum first derivative of left ventricular pressure (Min-dP/dt) and Tau (Min-dP/dt: -3870 mm Hg/s (-4175– -3273) vs -2195

(-2531- -1956), $p = 0.004$ and Tau: 14.9 ms (14.4-16.1) vs 23.3 (18.2-28.7), $p = 0.02$), and significantly higher for ejection fraction (39% (38-47) vs 32 (20-37), $p = 0.05$). The change in Min-dP/dt and Tau between pre- and post-ischemia values also showed more significant changes in the exenatide group than in the control group (Min-dP/dt: -2633 mm Hg/s (-3023- -1835) vs -679 (-1297- -249), $p = 0.004$ and Tau: -20.0 ms (-21.5- -14.25) vs -7.0 (-9.7- -0.1), $p = 0.02$). There was no difference in maximum +dP/dt between the groups.

Conclusion: Exenatide significant improved diastolic cardiac performance and myocardial metabolism in the DCD juvenile pig model. Further molecular study to delineate the mechanism of myocardial protection by exenatide is warranted.

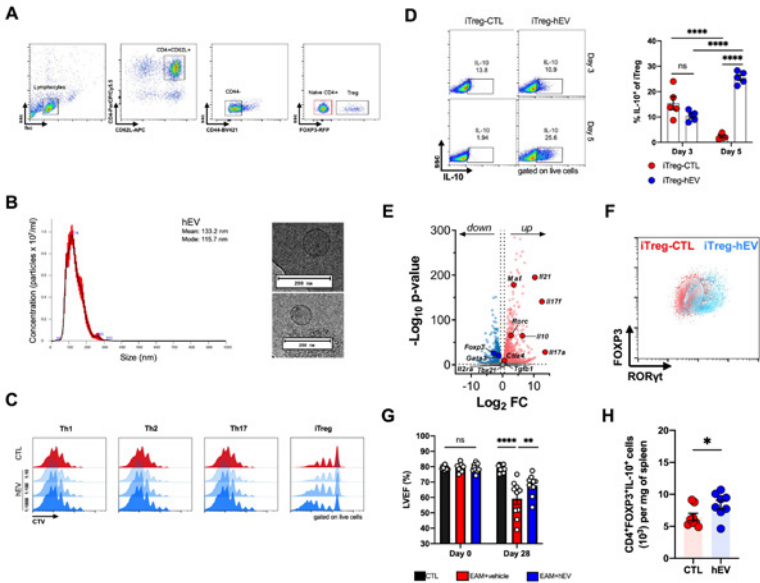
L5. Heart-Derived Extracellular Vesicles Activate Regulatory T Cells and Attenuate Experimental Autoimmune Myocarditis

Akbarshakh Akhmerov, Geoffrey de Couto, Jackelyn Valle, Liang Li, Russell Rogers, Ahmed Ibrahim, Lizbeth Sanchez, Rui Zhang, Yen-Nien Lin, Weixin Liu, Eduardo Marbán Cedars-Sinai Medical Center, Los Angeles, CA

Invited Discussant: Ram Kumar Subramanyan

Objective: Extracellular vesicles (hEV) from heart-derived stromal cells modulate innate immunity, with salutary effects in a variety of cardiac disease models. Little is known, however, about the effects of hEV on adaptive immunity. If they modulate T cells, hEV may be useful in treating myocarditis and other inflammatory disorders.

Methods: Ex vivo polarization of naïve CD4⁺ T cells (Figure A) was conducted to assess the effect of hEV (Figure B) on cytokine production and proliferation of T cells. These effects were further tested *in vivo* using the experimental autoimmune myocarditis (EAM) model.



Results: Using ex vivo differentiated CD4⁺ T cells, we show that hEV (Figure B) selectively influence the phenotype, activity, and proliferation of regulatory T (Treg) cells. Exposure of Treg cells to hEV results in faster proliferation (Figure C), augmented production of IL-10 (Figure D), and polarization toward an intermediate FOXP3⁺RORγt⁺ phenotype (Figure E, F). In experimental autoimmune myocarditis, hEV attenuate cardiac inflammation and functional decline (Figure G), in association with increased numbers of splenic IL10⁺ Treg cells (Figure H).

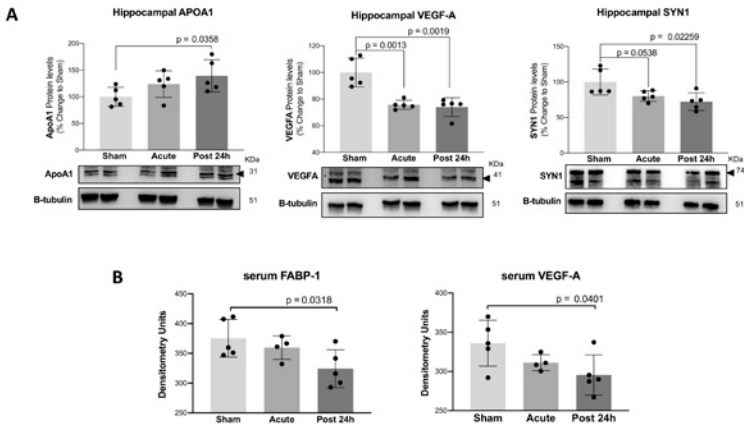
Conclusions: T cell modulation by hEV represents a novel therapeutic approach to inflammation, harnessing endogenous immunosuppressive mechanisms.

L6. Rodent Survival Model of Cardiopulmonary Bypass Demonstrates Systemic and Organ-Specific Inflammation

Aimee Y. Zhang, Nathan S. Haywood, Dustin T. Money, Matthew R. Byler, Hari P. Osuru, William Z. Chancellor, Jared P. Beller, Victor E. Laubach, J. Hunter Mehafeff, Mark E. Roeser, Jennifer R. Charlton, Nadia Lunardi, Irving L. Kron, Nicholas R. Teman University of Virginia Medical Center, Charlottesville, VA

Invited Discussant: Ravi K. Ghanta

Objective: Cardiopulmonary bypass (CPB) can impose significant physiologic derangements and complications such as post-operative delirium and acute kidney injury (AKI). Data suggests that persistent cognitive dysfunction following CPB is attributable to a sustained neuroinflammatory response. We hypothesized that a rodent model of CPB elicits a reproducible systemic inflammatory response with associated neurologic and renal inflammatory changes contributing to post-CPB organ dysfunction.



Methods: Adult Sprague-Dawley rats were randomized to three groups (n = 5/group), sham surgical cannulation, CPB followed by acute phase harvest, or CPB followed by 24-hour survival. An innovative venous cannula was placed into the right internal jugular vein and an arterial cannula was placed in the tail artery for CPB. The circuit consisted of a venous reservoir connected in series with an external oxygenator and in-line flow probe, driven by a peristaltic roller-pump and primed with whole blood phlebotomized

from donor rats. CPB with goal flow of 150 mL/kg/min was carried out for 60 minutes before decannulation and weaning from mechanical ventilation. Clinical, histologic, and biochemical endpoints were compared between groups. Gene expression analysis of hippocampal tissue was performed using quantitative RT-PCR panels and protein expression levels were confirmed with Western blot.

Results: Sixteen animals underwent cannulation and were successfully decannulated without further transfusion requirement or inotrope use with one procedure-related mortality. Serum acute phase pro-inflammatory chemokines CINC-1, CINC-3, fractalkine, and LIX as well as IL-10 were increased 1 hour following CPB compared to sham ($p < 0.05$). Significant changes in hippocampal expression of neuroinflammatory markers APOA1, VEGF-A, and SYN1 were demonstrated following CPB (Figure 1A). AKI developed within 24 hours after CPB with histologic changes observed including the loss of normal brush border and increased tubular dilation. Serum biomarkers of AKI and cognitive dysfunction FABP-1 and VEGF-A and were decreased at 24 hours (Figure 1B).

Conclusions: In this reproducible small-animal survival model, CPB induced an organ-specific and systemic inflammatory response as well as evidence of brain and kidney injury. These results identify differentially expressed proteins that may serve as prognostic biomarkers, and suggest that modulation of the CPB-associated inflammatory response may be a promising therapeutic strategy to attenuate post-CPB cognitive dysfunction and kidney injury. Additionally, the validation of a survival rat model of CPB with low surgical attrition will allow for more comprehensive evaluations of the short- and long-term effects of CPB with the ability to use genetic manipulation techniques and avoid the logistical limitations presented by large animal models.

L7. Recellularization of Xenograft Heart Valves Reduces the Xenoreactive Immune Response in an In-Vivo Rat Model

Sabin J. Bozso, Ryaan EL-Andari, Lin Fu Zhu, Benjamin Adam, Michael C. Moon, Darren H. Freed, Jayan Nagendran, Jeevan Nagendran
University of Alberta, Edmonton, AB, Canada

Invited Discussant: Sunjay Kashual

Objective: Current xenograft valve constructs provoke an intense immune response that may lead to valve dysfunction. Our aim was to address the role of autologous mesenchymal stem cell (MSC) recellularization of xenogenic valves on the activation of the xenoreactive immune response in an *in-vivo* rat model.

Methods: Explanted aortic valve constructs from female Hartley guinea pigs were procured and decellularized, followed by recellularization with syngeneic Sprague-Dawley rat MSCs. The recellularized aortic valve xenografts were then implanted into the infrarenal aorta of recipient female Sprague-Dawley rats. Grafts were implanted as either syngeneic grafts, non-decellularized (fresh), decellularized and recellularized xenografts. Rats were euthanized after 7-days, exsanguinated and the grafts explanted. Total serum immunoglobulin was quantified and histological analysis performed to analyze the immune response.

Results: Overall survival to endpoint was significantly lower in the decellularized xenograft group (67%; 4/6), compared to fresh (100%; 6/6) and recellularized grafts (100%; 6/6). Similarly grafts in the decellularized group were more likely to have completely thrombosed (50%; 2/4), compared to fresh (33%; 2/6) and recellularized grafts (0%; 0/6). Decellularized guinea pig xenografts, when implanted into rats *in-vivo*, result in significantly reduced total serum immunoglobulin production and significantly reduced graft cellular infiltrate when compared to fresh xenografts. Moreover, when decellularized guinea pig xenografts were recellularized with syngeneic rat MSCs there was an additional decrease in total serum immunoglobulin production and graft cellular infiltrate when compared to both fresh and decellularized xenografts. Importantly, recellularized guinea pig xenografts had an equivalent total immunoglobulin production and graft cellular infiltrate when compared to syngeneic rat aortic valve controls.

Conclusions: Autologous MSC recellularization of xenogenic valves reduces the xenoreactive immune response in an *in-vivo* rat model and may be an effective approach to decrease the progression of xenograft valve dysfunction.

CV1. Thymectomy with Angioplasty Through Subxiphoid Approach with Double Elevation of the Sternum in Masaoka III Stage Thymoma

Xing Wang, Tongkai Xu, Jiang Fan

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Invited Discussant: Kenneth A. Kesler

Objective(s): Subxiphoid approach with double elevation of sternum is a novel minimally invasive method which might provide good surgical view and space for operating. In this study we reported the management by this approach for a Masaoka III stage thymoma with invasion to the edge of innominate vein, which proved the safety and feasibility of this approach.

Case Video Summary: The case was a 66-year-old female patient with an anterior mediastinal mass with a diameter of 5 cm, incidentally detected during physical examination and was diagnosed with thymoma. The subxiphoid thymectomy with double elevation of the sternum was performed as Zieliński et al described. The patient was placed in a supine position. A 4-cm vertical incision was made approximately 1-cm caudal to the xiphoid process and an additional 2-cm skin incision was made between the 4th and 5th intercostal anterior axillary line on the right side. A 1-cm incision was generated at the level of the jugular process to place hooks. In this way, the sternum could be elevated and the space of anterior mediastinum was enlarged. The surgeon opened the right mediastinum pleura, dissect the connective tissue around the subxiphoid process, and continue to open the right mediastinal pleura upward. Then the surgeon detached the thymus and proceeded along the innominate vein by closing the thymic veins with vascular clips until the left internal thoracic vein was visualized. The superficial adipose tissues were gradually detached from the area to expose the distal side of the left brachiocephalic vein safely. The superior pole of the thymus and the cervical adipose tissues were dissected from the right brachiocephalic vein on the right side. The fat and thymus tissue on the inside of bilateral phrenic nerve were removed completely, as well as the invaded pericardial tissue, to guarantee the negative margins, in agreement with the International Thymic Malignancy Interest Group (ITMIG) criteria. During surgery we found that the tumor invaded the edge of the innominate vein, but not surround. Then we tried to block and control the right and left innominate vein before the invaded part was excised. After the en-bloc resection for thymectomy, the specimen bag was used to take out the resected tissue. Heparin solution was used to flush the inner wall of innominate vein before we made the continuous suture. Then the blocker was removed. The surgery lasted for 108 minutes and the patients recovered well, discharging on 3rd day after surgery.

Conclusions: This case indicated that thymectomy by subxiphoid approach with double elevation of the sternum might have more advantages in Masaoka III stage thymomas, and we recommend this approach for the initial attempt for potential Masaoka III stage thymoma. However, immediate conversion to open surgery should be performed for incomplete resection or intraoperative accidents, and more evidence should be accumulated.

CV2. Intraoperative Conduction Mapping in Complex Congenital Heart Surgery

Eric N. Feins, Edward O'Leary, David Hoganson, Noah Schulz, Emily Eickhoff,

John K. Friedman, Pedro J. del Nido, Elizabeth DeWitt, Sitaram Emani

Boston Children's Hospital, Boston, MA

Invited Discussant: Carl L. Backer

Objective(s): Postoperative heart block remains a challenging problem in congenital heart surgery despite many advances in the field. While the incidence of heart block requiring permanent pacemaker approximates 1% across all of congenital heart surgery, subsets of patients with more complex heart disease, requiring more complicated cardiac repairs, are at significantly higher risk of iatrogenic heart block. Postoperative heart block requiring pacemaker is associated with increased mortality and significant morbidity. While techniques to intraoperatively map the conduction system were developed decades ago, mapping is not currently routinely performed in congenital heart surgery. Our group has found that intraoperative conduction mapping with high-density electrodes enables the identification of conduction tissue, in order to minimize the risk of injury and to optimize the hemodynamic result of complex biventricular repairs.

Case Video Summary: A 14-year-old boy with heterotaxy/polysplenia, {S,D,D}, right-dominant complete atrioventricular canal defect (CAVC), and D-looped transposition of the great arteries with pulmonary atresia had previously been palliated to a Fontan. He underwent biventricular repair, consisting of Fontan takedown, CAVC repair with baffling of the left ventricle (LV) to aorta (Ao), and right ventricle to pulmonary artery (RVPA) conduit placement. Intraoperative mapping was performed using a high-density multielectrode grid catheter to collect real-time, intracardiac electrograms on the empty/beating heart. Mapping confirmed the inferiorly-located conduction tissue and enabled muscle division/resection superiorly to open up the LV-Ao pathway. A three-year-old boy with heterotaxy/asplenia, {A,L,L}, dextrocardia, CAVC, double outlet right ventricle with pulmonary atresia had previously undergone single-ventricle palliation. Biventricular repair involved bilateral bidirectional Glenn takedown, atrial switch procedure, CAVC repair with LV-Ao baffle, and RVPA conduit. Intraoperative mapping identified an inferiorly-located His bundle despite L-looped ventricles. Mapping enabled muscle bar division/resection superiorly to open up the LV-Ao pathway. Both children had preserved conduction function and unobstructed baffle pathways postoperatively.

Conclusions: Conduction system mapping with a high-density multielectrode grid catheter successfully locates conduction tissue during surgery and enables the surgeon to avoid its injury. This can lower the risk of heart block requiring pacemaker in children undergoing complex biventricular repair. Confirming where conduction tissue is absent also enables a more thorough muscle bundle division/resection and/or VSD enlargement to optimize the LV-Ao pathway and improve the hemodynamic result of the biventricular repair.

CV3. Infected TAVR with Severe Invasion, Atrial Fistula, Mitral Extension, and Embolization Treated with Modified Hemi-Commando Homograft

Eric E. Roselli, Gosta Pettersson
Cleveland Clinic, Cleveland, OH

Objective(s): To demonstrate a complex repair in a patient with invasive transcatheter aortic valve endocarditis with root abscess, extension to the mitral valve, and right atrium fistula complicated by cerebral embolism.

Case Video Summary: The video describes the patient presentation and demonstrates the wide debridement and reconstruction of all involved structures using a homograft and mitral ring in a hemi-commando fashion plus coronary bypass grafting and placement of epicardial pacemaker leads.

Conclusions: As TAVR has become commonplace we expect to see more cases such as the one demonstrated here requiring a complex operation.

CV4. En-Bloc Double Root Translocation in Transposition of the Great Arteries with Pulmonary Valve Stenosis

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Invited Discussant: Victor Morell

Objective: The purpose of this case video is to illustrate the operative techniques of en-bloc double root translocation in a patient with transposition of the great arteries (TGA) and pulmonary valve (PV) stenosis.

Case Video Summary: Our patient is a 6-month old boy with a history of TGA, ventricular septal defect (VSD), dysplastic PV, left ventricular outflow tract (LVOT) obstruction, and PV stenosis. Patient underwent atrial septostomy as a neonate. He then developed worsening cyanosis and underwent pulmonary balloon valvuloplasty at 2 months of age. He then presented to our institution. Echocardiogram (Echo) demonstrated D-TGA with large conoventricular VSD, severe stenosis of his bicuspid PV, moderate posterior-deviated conal septum LVOT obstruction, and normal ventricular function. Patient was taken to the operating room for surgical correction. The ascending aorta and main pulmonary artery were transected. The PV was hypoplastic and thickened. We proceeded with en-bloc double root translocation. The coronary buttons were excised, followed by en bloc excision of the combined aortic and pulmonary roots. The en-bloc root was rotated 180-degrees and re-implanted. The VSD was closed with a bovine pericardial patch. Right ventricular outflow tract (RVOT) reconstruction required a transannular patch. The coronary buttons were re-implanted into the aortic root. A LeCompte maneuver was performed and the ascending aorta was re-anastomosed to the aortic root. The distal main pulmonary artery was then anastomosed to the pulmonary root. Finally, the ASD was closed primarily. The patient was weaned from cardiopulmonary bypass without difficulty. Transesophageal echo showed good biventricular function, no LVOT obstruction, no residual VSD, but significant residual RVOT obstruction. The transannular patch was revised. Final transesophageal echo showed no RVOT obstruction. Patient recovered well after surgery and was discharged home on postoperative day 7 in stable condition.

Conclusions: En-bloc double root translocation is a reliable and reproducible technique to manage TGA patients with VSD and PV stenosis. By incorporating the pulmonary root, the en bloc double root translocation results in a more conventional RVOT with better filling of the RVOT ventriculotomy. Our patient tolerated the procedure well and was discharged home one week after the operation.

CV5. Right Transthoracic Approach for the Robotic Left Main Stem Bronchus Sleeve Resection

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Fox Chase Cancer Center, Philadelphia, PA

Invited Discussant: Harmik J. Soukiasian

Objective(s): Approaching the proximal left main stem bronchus (LMSB) for lung-sparing resection is challenging due to the difficulty of exposure from the left side and single lung ventilation from the right side. There are conflicting descriptions in the literature including open left thoracotomy or extracorporeal membrane oxygenation (ECMO). We present a case of lung-sparing robotic thoracoscopic proximal LMSB sleeve resection via the right chest with intraoperative ventilation of the left lung.

Case Video Summary: 43-year-old female had a proximal LMSB lesion identified 2 years previously on a chest computed tomography during a workup for severe asthma. The lesion debrided via rigid bronchoscopy by a pulmonologist prior to referral to surgery. During the staging workup a gallium dotatate scan revealed uptake in a subcarinal LN with SUV 13.8. Endobronchial ultrasound guided biopsy confirmed isolated subcarinal LN involvement with well differentiated neuroendocrine tumor. The base of the tumor was then tattooed to facilitate identification during surgery. Surgical plan included robotic assisted thoracoscopy via the right chest approach. Intraoperative ventilation to the left lung was accomplished with 6 mm single lumen armored tube. Patient was placed in the left lateral decubitus position. Four 8 mm intercostal robotic ports were placed. A 15 mm assistant port was placed in the subcostal position at the mid-axillary line. Robotic instruments included bipolar Maryland (right arm), bipolar grasper (left arm) and tip up grasper (retracting arm) for the dissection. Bronchus was divided with robotic scissors and robotic needle driver was used for the anastomosis. Surgical field was controlled with remotely operated surgical irrigator system (ROSI). A capnothorax of 10 mm Hg with CO₂ insufflation was achieved. After division of the mediastinal pleural reflection along the posterior hilum, the esophagus was mobilized posteriorly, exposing the distal trachea and mainstem bronchi. Subcarinal lymph node package was completely resected. Proximal LMSB was circumferentially dissected only along the proximal 2.5 cm of its length and resected. Primary bronchial carinal anastomosis was performed with 2 running absorbable barbed sutures. Suture line was reinforced with pedicled pericardial thymic flap. Final pathology revealed 6 mm well-differentiated neuroendocrine tumor with negative resection margins. Patient was discharged after 2 days.

Conclusions: Minimally invasive lung-sparing proximal LMSB sleeve resection is feasible via right robotic thoracoscopy. This approach allows excellent carinal exposure enabling left bronchial resection and reconstruction. Distal left bronchial ventilation enabled us to achieve right lung isolation while avoiding the side effects of ECMO and the morbidity of open thoracotomy.

CV6. Robotic Repair of Redundant Conduit and Para-Conduit Hernias Following Esophagectomy

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Invited Discussant: Robert E. Merritt

Objective: Para-conduit herniation and redundant conduit formation following esophagectomy are two rare and challenging complications following esophagectomy. These two distinct entities are often noted incidentally on postoperative imaging but can also present with severe symptoms such as obstruction, strangulation and conduit necrosis. Surgical repair is recommended, ideally in an elective setting, to prevent morbidity and mortality. Here we describe technical aspects of robot-assisted repair of these post-esophagectomy complications.

Case Video Summary: Two patients underwent Ivor-Lewis minimally invasive esophagectomy (MIE) via the robotic approach for locally advanced esophageal cancer and benign peptic stricture, respectively. The first patient presented with dysphagia two years following MIE and was found to have a redundant conduit. The second patient presented with recurrent pneumonia and reflux secondary to a para-conduit hernia. Both patients underwent trans-abdominal robotic repair. Tenets for this approach are safe re-entry into the abdomen, circumferential dissection of the hiatus, protection of the gastroepiploic artery, reduction of all intra-abdominal contents, tension free repair, conduit pexy and consideration for a pylorus drainage procedure. Both patients had an uneventful recovery and remain free from recurrence four- and one-year following repair.

Conclusions: Redundant conduits and para-conduit hernias are rare but important causes of dysphagia and delayed conduit emptying following esophagectomy, particularly MIE. Symptomatic hernias should be repaired and may be effectively treated with a robotic trans-abdominal approach.

CV7. A “Y” Incision and Rectangular Patch to Enlarge the Aortic Annulus by Two—Three Valve Sizes

Bo Yang
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Objective: To develop a surgical technique to enlarge the aortic annulus by 2–3 valve sizes without violating the adjacent structure around the aortic root.

Case Video Summary: First case was a 63-year-old 300 lb male with body surface area (BSA) of 2.55 m², severe aortic stenosis and CAD. His aortic annulus was 24–25 mm. After root enlargement, we placed a 29 mm stented bioprosthesis with mean gradient of 5 mmHg. Second case was a 37-year-old female with BSA of 2.05 m², who had had five previous operations, including resection of subaortic membrane, myectomy + PFO closure, aortic valve repair, aortic valve replacement with a 23 mm stented bioprosthesis, and valve-in-valve TAVR, presenting with severe aortic stenosis and insufficiency. Her annulus was 21 mm. After root enlargement, we placed a 27 mm mechanical valve with mean gradient of 7 mmHg.

Operative Technique: A partial transverse aortotomy was made 1.5 cm above the sinotubular junction. The stenotic aortic valve was excised and the annulus was debrided. The left-non commissure was incised from the aortotomy into the aorto-mitral curtain close to the left atrial dome. The incision was extended in a “Y” fashion undermining the left and non-coronary annulus to their respective nadir. A rectangular shaped Dacron patch was trimmed in width slightly greater than the distance between the two cusp nadirs. This patch was sewn to the mitral annulus from left to right fibrous trigone with running 4-0 Prolene suture. The suture line was transitioned to the undermined aortic annulus at the nadir of both left and non-coronary sinuses, sutured along the longitudinal length of the patch up to the level of the transverse aortotomy incision and secured. The upsized valve sizer was placed in the enlarged root touching three nadirs of aortic annulus and the position of the sizer on the patch was marked to guide the placement of valve sutures. The 2-0 Ethibond sutures were placed along the native aortic annulus and from outside in on the patch. The bioprosthesis was placed with one strut (mechanical valve with one pivot guard) facing the left-right commissural post, one strut close to right-non commissural post, and one facing the patch. The sutures at nadirs of non-coronary and left coronary sinuses, which were the lowest point of aortic annulus, were tied first to seat the valve well and prevent paravalvular leak. A portion of the patch lay beneath the prosthetic valve thereby enlarging the root and left ventricular outflow tract. The aortotomy was then closed from the left to the right incorporating the patch. We have performed this novel root enlargement for four patients, increasing the annulus size from 19 to 23 mm, and 21 to 25 mm in the other two patients with no mortality and 3/4 patients with no blood transfusion (Table).

Table: The Operative Outcomes of Aortic Root Enlargement with “Y” Incision and Rectangular patch (n = 4)	
Age	63 (50, 69)
Sex, female	3 (75%)
BSA (m ²)	1.9 (1.7, 2.3)
Annular size before enlargement (mm)	21 (20, 23)
Valve size after enlargement (mm)	26 (24, 28)
Mean gradient of prosthesis (mmHg)	7.0 (6.0, 8.0)
New onset renal failure	0 (0%)
Stroke	0 (0%)
Complete heart block	0 (0%)
Operative mortality	0 (0%)

Conclusions: Our enlargement technique was simple and effective for avoiding patient prosthesis mismatch and preparing patients for future valve-in-valve TAVR.

CV8. Remodeling Valve-Sparing Aortic Root Replacement with Bicuspid Valve Repair Using Rigid Internal Geometric Ring Annuloplasty, Repair of Aorto-Atrial Fistula, and VSD Closure in a 16-Year-Old with Marfan Syndrome

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Objective(s): Rigid internal geometric ring annuloplasty has been developed to simplify and standardize repair of the bicuspid aortic valve (BAV). We present a unique case involving remodeling valve-sparing aortic root replacement (VSRR) with concomitant BAV repair and repair of associated membranous ventricular septal defect (VSD) and aorta-atrial fistula in a pediatric patient.

Case Video Summary: A 16-year-old male with the Marfan syndrome, a family history of aortic dissection, Sievers type 0 congenital BAV with 1+ eccentric aortic insufficiency (AI), and an enlarging 4.3 cm aortic root aneurysm is presented. In addition, he had multiple small aorto-right atrial fistulae secondary to anterior sinus of Valsalva aneurysm rupture, as well as an 8 mm membranous VSD. Recently, Wolsky has reported the first description of BAV repair with rigid internal geometric ring annuloplasty in the pediatric population with excellent results. In this patient, we chose to repair the BAV with a similar technique, while replacing the coronary sinuses, repairing the aorto-right atrial fistulae, and closing the VSD. The video demonstrates the surgical repair. After opening the aorta, the sinuses of Valsalva (SOV) are resected and coronary buttons fashioned. The aorto-right atrial fistulae and the VSD are closed primarily. The aortic valve annulus is dilated and measures 25 mm. The commissure-to-commissure free edge lengths of the BAV leaflets correspond to a 21 mm annuloplasty ring. The ring is secured under the annulus with 8 symmetric mattress sutures tied over Dacron pledgets using the “lateral suture fixation” technique, which positions the knot towers laterally away from the valve cusps. Following ring implantation, the aortic valve leaflets are assessed using Schäfers’ calipers. The anterior leaflet is prolapsed with an effective height <8 mm. As such, the anterior cusp is plicated with two 7-0 polypropylene sutures bringing the effective height to 8 mm and correcting the cusp prolapse. A 26 mm Valsalva graft is fashioned to replace both SOV by creating two 180-degree sinuses (remodeling VSRR). This is anastomosed to the sinus remnants with running 4-0 polypropylene sutures. The coronary buttons are reimplanted. Aortic valve competency is assessed by transesophageal echocardiography during a period of antegrade cold blood delivery with no residual AI. The distal aortic anastomosis is completed. Post-bypass, the leaflets move freely with zero AI and a mean gradient of 6 mmHg. Cardiac MRI performed 10 months post-operatively revealed no AI and a mean gradient of 9 mmHg.

Conclusions: Remodeling valve-sparing aortic root replacement may be combined with bicuspid valve repair using rigid internal geometric ring annuloplasty. This technique recapitulates aortic valve geometry, provides durable annular downsizing, promotes cusp coaptation, and standardizes aortic valve repair.

CV9. Tricuspidization of a Regurgitant Quadricuspid Truncal Valve: A Versatile Adaptation for Aortic Valve Repair

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Invited Discussant: Igor E. Konstantinov

Objective: Limited options exist for durable correction of truncal valve regurgitation. Standardization of leaflet replacement with the Ozaki technique has enabled novel operations to address unique valve pathology. We demonstrate a case of tricuspidization of a regurgitant quadricuspid truncal valve, using an Ozaki template to replace two abnormal, small cusps with a single autologous pericardial leaflet.

Case Video Summary: A nine-month 6.5 kilogram female with truncus arteriosus underwent surgical repair as a neonate. At initial repair, she was found to have an abnormal quadricuspid truncal valve with moderately severe regurgitation. The valve consisted of two small posterior leaflets with a shared commissure below the left main coronary artery as well as two anterior leaflets of adequate size. Valve repair was performed by shaving the thickened tissue on the leaflets to improve mobility followed by joining the two posterior leaflets side-to-side to reduce the central orifice. Postoperative echocardiogram showed trivial truncal valve regurgitation.

Serial echocardiographic exams demonstrated worsening truncal valve regurgitation with left ventricular dilation. In addition, she was found to have moderate stenosis and regurgitation of the previously placed right ventricular to pulmonary artery conduit. Both were the basis for reoperation.

Following redo sternotomy, initiation of cardiopulmonary bypass and cardiac arrest with antegrade cardioplegia, the aorta was opened and the valve inspected. The anterior two large leaflets were thinned by resecting extra fibrous tissue. The two posterior leaflets were small and failed to coapt with the remaining leaflets. We decided to replace the two posterior leaflets with a single leaflet constructed from glutaraldehyde-treated autologous pericardium. An Ozaki sizer and template (Japanese Organization for Medical Device Development, Inc., Tokyo, Japan) was used to size and create the leaflet, which was then sutured to the aortic root. The newly created commissures were suspended at the same height of the native leaflets to achieve coaptation. Figure-of-eight commissuroplasty was performed to ensure commissural competency.

Following replacement of the right ventricular to pulmonary artery conduit with a valved conduit, the patient was easily weaned from cardiopulmonary bypass. Transesophageal echocardiography showed a large area of leaflet coaptation and trivial truncal valve regurgitation. The patient recovered well and was discharged within six days.

Conclusions: Techniques for truncal or aortic valve repair and reconstruction in infants are limited. Preservation of the aortic root is important for future surgeries. In appropriately selected patients, one or two leaflet replacement is possible with autologous pericardium to improve central coaptation and long-term valve performance.

CV10. Da Silva Cone Repair in Double Orifice Ebstein’s Malformation Tricuspid Valve

Luciana Da Fonseca da Silva, Jose Pedro da Silva, Melita Viegas, Mario Castro-Medina
UPMC Children’s Hospital of Pittsburgh, Pittsburgh, PA

Invited Discussant: Christopher J. Knott-Craig

Objective(s): Ebstein’s malformation presents a great variability of anatomical presentations. This video aims to educate surgeons about surgical maneuvers that can be applied in this special variation of double orifice tricuspid valve in Ebstein’s malformation.

Case Video Summary: Presentation of the Cone Tricuspid valve repair in a 6 yo girl with a double orifice tricuspid valve in Ebstein’s malformation. This operation’s surgical concepts are to undo most of the tricuspid valve attachments and create a cone-like structure from all available leaflet tissue. This video presents the surgical maneuvers that we applied to obtain the best functional result for the tricuspid valve in this severe anatomical variation. The mobilization of the TV by complete section of tissue between tricuspid leaflets and the ventricular wall (tethering), leaving the leaflet tissues attached to the ventricle at its distal margin only. The aggressive detachment of the leaflet down to its distal point is a critical part of the procedure because it allows an adequate amount of tissue to construct the cone and gives sufficient mobility to the body of the leaflet. The cone is constructed using all the available tissue, performing vertical suturing of leaflet tissue, posterior to septal, and septal to anterior. Close any holes/fenestrations in the proximal 2/3 of the cone membranous tissues to have similar depth circumferentially and prevent regurgitation leak. Also, fenestrations, natural or surgically made, should be present at the distal 1/3 of the cone to allow unrestricted forward blood flow in diastole. In this double orifice Ebstein’s variation, special evaluation is needed to decide how to construct the cone and which orifice should be closed to achieve TV competency Plication of the right ventricle and the true tricuspid annulus is done. Extra sutures are applied in the muscles of the RV anterior free wall to create trabeculations of RV, preventing the ballooning of the RV and reducing the risk of RV failure in the postoperative period. The cone is attached proximally to the true annulus. The proximal cone circumference is correct for the true annular dimension. Special care is used in the area medial to the coronary sinus, due to the risk of heart block. In this area, we reimplant the valve above the true annulus in Todaro’s tendon and the coronary sinus border. The competency of the valve is tested with saline solution. The ASD is closed in a valved fashion. Sinus rhythm is observed at the end.

Conclusions: The cone procedure for reconstructing the TV in Ebstein’s malformation can be challenging in patients with a double orifice tricuspid valve, but it is feasible. This repair results in full coaptation of the leaflets, providing efficacious Tricuspid Valve function.

CV11. Customized Aortic Valve Reconstruction in Children

Ignacio G. Berra¹, Pablo A. Takeuchi², Alfredo Irusta², Pablo García Delucis¹, Adalberto Yamil Guglielmone¹, Javier Cornelis¹, Laura Zenobi¹, María Sol De Los Santos¹, Ramiro Goldman¹, Carin Vandoorn³, Sebastián Berra⁴

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Invited Discussant: Christopher W. Baird

Objective(s): In children, our research efforts at improving the reproducibility of the aortic valve reconstruction techniques have included the 3D reconstruction of the aortic root of each patient and we then develop the best shape and size of each leaflet using a computer program and 3D printing.

Case Video Summary: We design the 3D aortic root reconstruction and the creation of the best shape and size of each cusp. The 3D heart model is imported into mesh mixer software and the leaflet insertion lines are selected and exported in an STL format obtaining a 3D model with the leaflet insertion lines. This allows us to analyze the measurements of each sinus of Valsalva and each leaflet. In the 3D model, we measure the diameter of the aortic annulus, the height of the aortic root, and the diameter of the sinotubular junction. Then we calculate the size of each leaflet obtaining the perimeter of the aortic root, we divide the result by three and then we add 1 cm in height and 1 cm in width. The aortic root is imported into Solid Works and is interpolated with a 3D leaflets sketch using a plane in 3D space. At the top of the leaflet insertion lines, a plane containing the 3 edges is defined and 3 lines crossing this point are drawn. Also, a plane tangent to the bottom of the insertion is defined. Each new insertion leaflet line is extruded as a surface following a smooth curve towards the lines drawn on the plane of the leaflet. A resin impression of the patient’s aortic root is performed. Each porcine pericardium leaflet is attached within the printed aortic root in 3D, the coronary ostium is identified, and the shape that the depressurized leaflets acquire is observed. The height of the leaflets is recorded compared to the height of the aortic root. In our design, the three cusps are the same size and are distributed equidistantly within the circumference of the aortic root.

Conclusions: Customizing the neocuspidization in this surgical technique allows the adaptation of the anatomy of each patient to the best possible design. It is a reproducible, simple, and safe technique. We performed 7 patients with endocarditis by calculating an oversizing of each neocuspid, it is possible to achieve a valve competence that accompanies the growth of the aortic root structure and the development of the child. We still do not have a similar material to replace the biological tissue of each original leaflet. Being able to perform the same oversizing with respect to the size of each neocuspid in the reconstruction of the valve favors the surgical technique because it simplifies the surgery. We know that when the human pericardium is used as a material there is a retraction of the material throughout the time in which each child develops and grows. Therefore, to increase the durability of the valve repair, this oversizing is necessary. This technique is only a mathematical calculation adapted to the geometry of the anatomy of the aortic root of each patient.

CV12. Bicuspid Neoaortic Insufficiency Following Single Ventricle Palliation: Repair with a Rigid Annuloplasty Ring

Kellianne C. Kleeman, Aishwarya Ramaswami, Richard G. Ohye, Ming-Sing Si
University of Michigan, Ann Arbor, MI

Invited Discussant: Joseph W. Turek

Objective: This video demonstrates the novel use of a rigid annuloplasty ring to treat bicuspid neoaortic insufficiency in a patient with HLHS following staged palliation.

Case Video Summary: Following staged repair of HLHS, nearly all patients experience progressive neoaortic root dilation. Over time, the Z-scores of the neo-aortic valve annulus, root, and sinotubular junction increase out of proportion to normal growth. This increase in size may promote the development of neoaortic insufficiency. Furthermore, intrinsic neoaortic valve abnormalities, such as a bicuspid morphology, can also predispose to later insufficiency. Hitherto, options for repair of the neoaortic valve and root complex have been limited, and valve replacement is often required. However, neo-aortic valve replacement in patients with single ventricle physiology is associated with poor outcomes and valve repair is strongly preferred. Recently, we have developed experience with trileaflet, bicuspid, and unicuspid aortic valve repair using an FDA-approved rigid annuloplasty ring to downsize and remodel the annulus combined with leaflet reconstruction. In this video, we present the case of a 13-year-old boy with hypoplastic left heart syndrome who underwent staged surgical palliation early in childhood and presented with progressive bicuspid neoaortic insufficiency, neoaortic root dilation, and right ventricular dilation and dysfunction. We demonstrate the technique of repair of the bicuspid neoaortic valve with implantation of a rigid annuloplasty ring and leaflet reconstruction. The demonstration includes preoperative imaging, annulus sizing, ring implantation, leaflet reconstruction, and postoperative imaging.

Conclusions: The options for surgical treatment of neoaortic insufficiency caused by root and annular dilation include repair or replacement. However, repair options are limited, and most require aortic valve replacement despite poor outcomes following replacement in single ventricle patients. We believe that the use of a rigid annuloplasty ring for neoaortic valve repair is highly reproducible and widely applicable. The technique is particularly impactful for use in the growing population of congenital heart patients with neoaortic insufficiency.

CV13. 3D Visualization of Cardiac Fibromas for Prospective Planning and Intraoperative Guidance

Emily Eickhoff, Noah Schulz, Rebecca Beroukhim, Tal Geva, Peter Hammer, David Hoganson, Pedro del Nido

Boston Children's Hospital, Boston, MA

Invited Discussant: Jennifer C. Romano

Objective: Cardiac fibromas are tumors composed of fibroblasts that present within cardiac muscle. Although most are benign, they can disrupt normal cardiac function and are often removed to restore optimal functioning of the heart. Fibromas are very rare, affect mostly children, and often require surgical excision. Complicating factors include the tumor location, size, and impact on surrounding cardiac components such as coronaries and valvular apparatus.

Case Video Summary: A 3D digital model was reconstructed from axial imaging for four patients who presented for cardiac fibroma resection. In each case, the fibroma was shown in relation to the cardiac components (ventricles and atria) as well as the coronary anatomy where possible. Reconstructed digital models offer the advantage of resolved 3D relationships between the cardiac anatomy and tumor; there is a limitless number of objects and views which may be included in the model. Distortion of intracardiac components and compression of extracardiac structures were clearly elucidated by the models. Individual components of the anatomy and blood pool were represented by different colors and adjustable opacities to enhance visualization during intraoperative guidance. The digital 3D models also offered the capability to apply arbitrary rotations and cut planes, offering enhanced visualization over traditional 2D axial imaging. In all four patients, the models were used preoperatively to strategize on the surgical approach. In several cases there was coronary involvement to be considered, and the models were used to prospectively map out coronaries which may run around and through the fibroma. These patient-specific 3D models contributed to the goal of the surgeon performing a fibroma excision: to extract as much of the tumor as possible while leaving as much viable cardiac muscle and vasculature intact as possible.

Conclusions: A digital 3D model illustrating the complex three-dimensional spatial relationships between a cardiac fibroma and the rest of the cardiac anatomy can inform the debulking strategy employed by the surgeon. As part of the surgical planning workflow, the enhanced visualization possible with a patient-specific 3D model may lead to smoother resections, fewer intraoperative surprises, and ultimately improved patient outcomes.

CV14. Norwood Modification for Hypoplastic Left Heart with Right Aortic Arch

Ralph Mosca, David Williams, Joshua Scheinerman, Sunil Saharan, Michelle Ramirez, Michael Argilla, T.K. Susheel Kumar

New York University Langone Health, New York, NY

Invited Discussant: Ram Kumar Subramanyan

Objective: Right aortic arch in hypoplastic left heart variant is extremely uncommon and poses challenges to aortic reconstruction during Norwood Stage 1 operation with only two successful cases described in the literature. We present a case report with an instructional video on the modification of the Norwood procedure for hypoplastic left heart with a right aortic arch and right descending aorta.

Case Video Summary: A full term one-week old infant weighing 4 kg was referred to our institution with a complex diagnosis of unbalanced complete atrioventricular canal defect, hypoplastic left ventricle, right aortic arch which descended down on the right side of the spine, right sided ductus arteriosus, and aortic coarctation. A decision was made to perform a Norwood stage 1 operation with right ventricle to pulmonary artery conduit on day 11 of life. The patient was placed on cardiopulmonary bypass via arterial cannulation of the distal main pulmonary artery and venous cannulation of the right atrium. Both branch pulmonary arteries were snared soon after commencement of cardiopulmonary bypass to prevent pulmonary runoff. Systemic cooling to deep hypothermia was initiated. The arterial cannula was advanced and snared within the ductus arteriosus. The main pulmonary artery was transected just below its bifurcation and the distal end was closed with a fenestrated pulmonary homograft patch. A 5 mm ringed PTFE graft was anastomosed to the right ventricle using our periscopic technique. The ascending aorta was clamped just proximal to the origin of the left common carotid artery and antegrade cardioplegia was administered for myocardial arrest. The ascending aorta was divided at the same level as the division of the main pulmonary artery. The aorta and main pulmonary artery were sewn together for approximately one-third of the circumference of the aorta (DKS anastomosis). The ascending aorta was then transposed to the distal portion of the left lateral aspect of the divided main pulmonary artery such that arch reconstruction could be performed on the right lateral aspect of the neo-aorta to maintain the normal curvature of the aorta. The ductus arteriosus was then divided under circulatory arrest. The transverse arch incision was continued down the descending aorta past the ductus arteriosus. The right lateral aspect of the arch was then patched with pulmonary allograft using continuous 7-0 Prolene. The remaining circumference of the proximal aorta and pulmonary artery were encompassed in the patch. On distension with saline, the neo-aorta demonstrated a nice lie. The distal anastomosis of the Sano conduit was performed and the patient was gradually weaned off cardiopulmonary bypass with good hemodynamics. The chest was closed. He was discharged home on postoperative day 17.

Conclusions: Hypoplastic left heart with right aortic arch can be successfully treated with a modified Norwood procedure.

CV15. Bicuspid Aortic Valve Repair with Valve-Sparing Root Replacement

John J. Kelly¹, Christopher Mehta², Brittany J. Cannon¹, Nimesh Dilip Desai¹, Joseph E. Bavaria¹

¹University of Pennsylvania, Philadelphia, PA; ²Northwestern University, Chicago, IL

Objective(s): To demonstrate our step-by-step process in performing a bicuspid aortic valve repair with valve-sparing root replacement.

Case Video Summary: A 26-year-old male with a known congenital bicuspid aortic valve developed an aortic root aneurysm with severe aortic insufficiency. A valve-sparing root replacement using the reimplantation technique with bicuspid valve leaflet repair was performed. Filmed from an overhead perspective, this video captures each step of the procedure. This includes the careful dissection of the aortic root, the creation of the coronary buttons, the analysis of the bicuspid valve, bicuspid leaflet repair with plication of the conjoined cusp and figure-of-eight stitch at the left-non commissure, the placement of the sub-annular primary suture line, the sizing and implantation of the root graft, the reimplantation of the bicuspid valve commissures in a 180–180 arrangement, the secondary suture line securing the valve complex to the root graft, the reimplantation of the coronary buttons, and the final valve analysis. Intra-operative post-procedure transesophageal echocardiogram showed a well-functioning aortic valve without insufficiency or stenosis. The patient had an uneventful post-operative hospital course and was discharged home.

Conclusions: This video demonstrates our step-by-step technique in performing a bicuspid aortic valve repair with valve-sparing root replacement.

CV16. Fenestrated Frozen Elephant Trunk Repair of Type A Aortic Dissection

Yuting Chiang, Isaac George, Hiroo Takayama

Columbia University Irving Medical Center, New York, NY

Objective(s): To present a case video illustrating the fenestrated frozen elephant trunk technique.

Case Video Summary: A 53-year-old male presented with a Type A aortic dissection with an intimal tear on the lesser curvature of the distal aortic arch resulting in a dissection extending from the left subclavian artery to the sinotubular junction. The ascending aorta and aortic arch were repaired using the fenestrated frozen elephant trunk technique, as described by Roselli et al.¹ The proximal landing zone of the aortic stent graft was in zone 2, with a branch stent graft deployed into the left subclavian artery through a fenestration created within the aortic stent graft at the site of the left subclavian artery takeoff.

Conclusions: The use of a fenestrated frozen elephant trunk technique is a relatively simple and effective method for ascending aortic and aortic arch repair in the setting of Type A aortic dissection.

¹Roselli E, Idrees J, Bakaeen F, et al: Evolution of simplified frozen elephant trunk repair for acute DeBakey type I dissection: midterm outcomes. *Ann Thorac Surg.* 2018; 105(3): 749–755.

CV17. The Operative Management of an Acquired Gerbode Ventricular Septal Defect Due to Infective Endocarditis

David Williams, Jonathan Hyde, Eddie Louie, Stanley Schrem, Deane Smith, Aubrey Galloway
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Objective: Acquired left ventricle to right atrium shunts, or acquired Gerbode ventricular septal defects, are a rare complication of infective endocarditis. Because of their rarity, the diagnosis and surgical management of Gerbode defects is challenging. We present a case report with instructional video demonstrating the repair of an acquired type II Gerbode ventricular septal defect.

Case Video Summary: A 72-year-old male with a history of patent foramen ovale and benign prostatic hyperplasia requiring self catheterization was referred for management of methicillin-sensitive Staph aureus endocarditis with a type II Gerbode ventricular septal defect. Given a left to right shunt fraction of 1.5:1 and persistent leukocytosis, the decision was made to proceed with operative repair. The patient was placed on cardiopulmonary bypass via aortobicaval cannulation and systemically cooled. The ascending aorta was clamped and antegrade cardioplegia was administered for myocardial arrest. An aortotomy was made revealing a partially healed aneurysmal abscess cavity on the anterior leaflet of the mitral valve. The ventricular side of the Gerbode ventricular septal defect was visualized beneath the right coronary/non coronary cusp commissure of the aortic valve. The orifice was approximately 0.5 cm in diameter with shaggy necrotic material on its edges which was debrided. A right atriotomy was then performed. The right atrial side of the Gerbode ventricular septal defect was just above the membranous septum and extended to the upper portion of the septal leaflet of the tricuspid valve. In this region, a bulky vegetation prevented the occurrence of a much larger shunt to the right atrium. Necrotic tissue was debrided leaving a ventricular septal defect approximately 2 cm in its widest dimension which was closed with a bovine pericardial patch. The remaining portion of the septal leaflet of the tricuspid valve was detached from its annulus and transposed to its junction with the anterior leaflet. The commissure between the anterior and septal tricuspid valve leaflets was reconstructed with interrupted sutures reinforced with autologous pericardial pledgets. The patent foramen ovale was closed primarily. The aortotomy and right atriotomy were closed, the patient weaned from cardiopulmonary bypass, and the chest was closed. The patient required placement of a permanent pacemaker for complete heart block and was discharged home on postoperative day nine. He remains well at last follow up.

Conclusions: Acquired type II Gerbode ventricular septal defects due to infective endocarditis can be diagnosed with careful interpretation of preoperative imaging and successfully treated with aggressive debridement of necrotic debris, patch closure, and repair of the tricuspid valve.

CV18. Tricuspid Valve Repair with Pericardial Leaflet Reconstruction for Infective Endocarditis

Timothy S. Lancaster, Rachel Lee, Puja Kachroo, Marc R. Moon
Washington University, Saint Louis, MO

Objective: The prevalence of tricuspid valve infective endocarditis has increased in association with the opioid epidemic, and disproportionately affects young adults. Currently available tricuspid valve prostheses have significant drawbacks, including high reinfection risk as well as limited durability of bioprosthetic valves and high anticoagulation requirements for mechanical valves. Advanced tricuspid valve repair techniques utilizing native tissue and valve reconstruction can help to mitigate these negatives by avoiding prosthetic valve placement.

Case Video Summary: We present the case of a 32-year old woman with history of intravenous drug use presenting with MSSA bacteremia and tricuspid valve endocarditis. Preoperative echocardiography demonstrated a large tricuspid valve vegetation on the anterior leaflet and severe tricuspid regurgitation. She had extensive septic pulmonary emboli and symptoms of heart failure with volume overload, and, after initial treatment with antibiotics and diuresis, decision was made to proceed with tricuspid valve repair. After median sternotomy, autologous pericardium is harvested and fixed with glutaraldehyde. Bicaval cannulation is completed and the heart is arrested with cardioplegia. The valve is examined through a right atriotomy. The 3 cm vegetation is debrided from the anterior leaflet, which is reconstructed by augmentation with a patch of autologous pericardium. Several neochords are placed to the newly reconstructed anterior leaflet. Finally, a ring annuloplasty is performed. Postoperative echocardiography demonstrated excellent leaflet coaptation and no residual tricuspid regurgitation, and the patient recovered from surgery uneventfully.

Conclusions: The wider application of native-tissue tricuspid valve repair techniques may improve outcomes in this population by reducing reinfection risk and increasing valve durability without the need for anticoagulation.

CV19. Stentectomy/Endarterectomy for Left Anterior Descending Coronary Artery “Full Metal Jacket” with In-Stent Restenosis

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Objective: Our indications for stentectomy/endarterectomy and onlay patch reconstruction with skeletonized left internal mammary artery (LIMA) for severe in-stent restenosis (ISR) of left anterior descending (LAD) full metal jacket (FMJ: ≥ 60 mm overlapping stents) are:

- Severe ISR of a long segment of the LAD (FMJ), with total or sub-total occlusion;
- Poor or no bypassable LAD target beyond the FMJ;
- Percutaneous techniques exhausted or felt not to be beneficial;

- Septal perforator or diagonal branch(es) that could be revascularized through a stentectomy/endarterectomy;
- Significant viable myocardium in anterior wall and septum;
- Symptoms (typically angina) not controlled by optimal medical therapy and limiting quality of life;
- Otherwise low-to-moderate surgical risk due to associated comorbidities.

Case Video Summary: We demonstrate our technique for the surgical revascularization of symptomatic severe ISR of a FMJ of the LAD coronary artery: on-pump cardioplegic-arrest, stent removal (stentectomy) with 10 cm endarterectomy and skeletonized LIMA onlay patch reconstruction. Early post-operative antiplatelet/anticoagulation regimen includes aspirin 162 mg, clopidogrel 150 mg and heparin 5000 U SQ TID given 2–4 hours after arrival in ICU. Aspirin 81 mg/day, clopidogrel 75 mg/day and apixaban 2.5 mg BID are continued from postoperative day #1 through the first 6 postoperative months. A repeat catheterization is performed after six postoperative months; if it shows wide patency of the LIMA to LAD graft and endarterectomized segment, apixaban is discontinued. Clopidogrel is discontinued at 1 year post-operatively, while aspirin is continued lifelong.

Conclusion: With proper patient selection, multidisciplinary collaboration and surgical expertise, this advanced coronary procedure may offer significant survival and quality-of-life benefits to a growing population of patients otherwise deemed untreatable.

CV20. Massive Left Main Coronary Artery Aneurysm Treated with In-Situ Reconstruction + Mitral Repair

Eric E. Roselli, Gosta Pettersson
Cleveland Clinic, Cleveland, OH

Objective(s): To demonstrate a particularly complex presentation of giant coronary artery aneurysm of the left main coronary artery with associated mitral regurgitation.

Case Video Summary: The patient presented with chronic progressive dyspnea on exertion and was found to have severe mitral regurgitation. Further workup revealed massive left main coronary artery aneurysm measuring greater than 9 cm. The video demonstrates the pathology and a primary repair of the aneurysm through a hemi-autotransplant approach with in-situ reconstruction of the native coronary arteries as well as mitral valve repair.

Conclusions: As routing cross section imaging becomes more prevalent, we are likely to see more patients with unusual findings such as coronary aneurysm. This operation demonstrates a useful strategy for exposure of pathology at the base of the heart and a novel technique for coronary reconstruction.

CV21. Valve-Sparing Root Replacement with Zone 2 Arch for Type A Dissection

Nimesh D. Desai, John J. Kelly, Christopher K. Mehta, Brittany Cannon, Joseph E. Bavaria
University of Pennsylvania, Philadelphia, PA

Objective(s): To demonstrate our step-by-step process in performing a valve-sparing aortic root replacement and Zone 2 aortic arch replacement and in a patient with a Type A aortic dissection.

Case Video Summary: A 49-year-old male presented with chest pain and was found to have a DeBakey Type 1 aortic dissection without malperfusion. We performed a Zone 2 aortic arch replacement with valve-sparing aortic root replacement. The ascending aorta was cannulated via modified Seldinger technique. The aortic root was dissected and the primary suture line of the valve-sparing aortic root replacement performed. The distal aortic and left common carotid anastomoses were performed under deep hypothermic circulatory arrest with retrograde cerebral perfusion using a specialized branch graft. After resumption of cardiopulmonary bypass, the innominate artery anastomosis, the secondary suture line of the valve-sparing aortic root replacement, coronary buttons, and graft-to-graft anastomosis were completed. Intraoperative post-procedure transesophageal echocardiogram showed a well-functioning aortic valve without insufficiency or stenosis. The patient had an uneventful post-operative hospital course and was discharged home. Transthoracic echocardiogram at 30 days revealed only trace AI. At six-month follow-up, the patient continued to do well without readmissions. He is currently undergoing evaluation for thoracic endovascular aortic repair for his residual Type B aortic dissection.

Conclusions: This video demonstrates our step-by-step technique in performing a Zone 2 aortic arch replacement and valve-sparing aortic root replacement in a patient with a Type A aortic dissection.



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