

1969 ANNUAL MEETING PROGRAM



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MONDAY MORNING, MARCH 31, 1969

8:30 A.M. Business Session (Limited to Members) Grand Ballroom

8:45 A.M. Scientific Session: REGULAR PROGRAM Grand Ballroom

1. Human Cardiac Transplantation: Clinical Experience

M. E. DEBAKEY, E. B. DIETRICH,* G. P. NOON,* W. BUTLER,*
S. A. KINARD,* J. M. LEWIS,* J. E. LIDDCOAT,* and D. K. BROOKS,*
Houston, Texas

Cardiac transplantation as a form of treatment for end-stage heart disease has met with a degree of early success and certainly warrants further investigation. This report deals with our accumulative experience including a discussion of operative technique and donor-recipient selection with specific emphasis on the role of tissue typing and immunosuppressive therapy in these cases. The postoperative course will be reviewed with reference to clinical and laboratory signs and symptoms of rejection and the treatment used for its prevention and control. Special studies regarding the effectiveness of antilymphocytic globulin and suggested dosages and route of administration will be discussed. Results obtained in these cases with postoperative hemodynamic and angiographic studies will be included.

2. Function of the Transplanted Human Heart

GRADY L. HAZLMAN, LOUIS L. LEATHERMAN,* ROBERT D. LEACHMAN,*
DONALD G. ROCHELLE,* DONALD L. BRICKER,* ROBERT D. BLOODWELL,*
and DENTON A. COOLEY, Houston, Texas

The transplanted heart is a denervated organ. Experience with cardiac transplantation in 12 patients has permitted us to make physiologic observations of the human heart under these conditions. All transplanted hearts resumed activity soon after removal of vascular clamps, some in sinus rhythm, some in ventricular fibrillation. Fibrillation was easily converted with direct current countershock. Both recipient and donor sinus nodes remained intact and produced P waves in the electrocardiogram, but only the impulse from the donor node was associated with ventricular contraction. Cardiac output was measured in 6 patients before, during, and after exercise at intervals following operation. Resting outputs were normal and increased with exercise in a variable fashion utilizing both intrinsic and humoral mechanisms. Heart rate and systemic arterial pressure were observed during the Valsalva maneuver. The usual change in heart rate did not occur because of denervation, but response of the systemic arterial pressure was normal. Reflex control of the recipient's own SA node remained intact as illustrated by slowing of the respective P wave in the electrocardiogram. This presentation will summarize the function of the transplanted heart at rest and its response to exercise, Valsalva maneuver, cold, pain, and various drugs.

3. Cardiac Transplantation in Man. II: Immunosuppressive Therapy

EDWARD B. STINSON,* EUGENE DONG, JR.,* and NORMAN E. SHUMWAY,
Palo Alto, Calif.

The Stanford program of immunosuppressive management for cardiac transplantation was developed from clinical experience in renal and hepatic transplantation, from our past experience with canine cardiac transplantation, and from the progress of our first seven clinical cases. *Protocol:* Patients accepted for transplantation are given azathioprine 1 mg per kilogram per day until the day of surgery. Immediately preoperatively the patients are given a loading dose of azathioprine 4 mg/kg orally and the first dose of antilymphocyte globulin administered intramuscularly. During surgery, methylprednisolone is infused intravenously for a total dose of 5 mg/kg. On the first postoperative day maintenance immunosuppressive therapy is begun consisting of azathioprine 2-3 mg/kg per day, prednisone 2-3 mg/kg per day, and daily antilymphocyte globulin. Prednisone and anti-lymphocyte globulin are tapered gradually after the first two postoperative weeks. Of the seven patients, rejection was not identified in four. In the three remaining patients, four episodes of rejection were well documented by electrocardiographic, hemodynamic, enzymatic, and general systemic indicators. Three rejection crises were reversed successfully by combined therapy consisting of massive intravenous infusions of methylprednisolone given rapidly and actinomycin D as well as systemic heparinization. One patient died six weeks postoperatively of inadequate treatment. None of the four surviving patients has evidence of residual cardiac impairment.

4. Dissecting Aneurysms of the Aorta: Treatment and Results in 54 Patients

M. W. WHEAT, JR., Gainesville, Fla, P. D. HARRIS,* J. R. MALM,
G. KAISER,* F. O. BOWMAN, JR.,* New York, N.Y., and
R. F. PALMER,* Gainesville, Fla.

During the past 4 ½ years, 54 patients with acute dissecting aneurysms of the aorta have been treated on two separate thoracic surgical services, one in New York City and the other in Gainesville, Florida. Twelve of these underwent surgical correction with a mortality rate of 25 per cent. Forty-two patients were treated with drugs during the acute phase with a mortality rate of 10 per cent. In the group of 42 patients treated with drugs, 48 per cent were seen within 24 hours, 90 per cent within one week and all within two weeks of the onset of symptoms. Forty-eight per cent originated in the descending aorta and 52 per cent involved either ascending aorta, arch of the aorta, or both. The diagnosis was confirmed by aortography in 51, autopsy in one, and clinical impression in two cases. The indications for surgical approach to the aneurysm itself have been significant aortic valve insufficiency, poor response to drugs, or progression of the dissection. Contrary to recently published "Reservations," absence of hypertension, ischemic limbs, and paraplegia are not contraindications to successful drug therapy. This study validates further the concept of the use of drug therapy in most patients with acute dissecting aneurysms of the aorta.

5. Complications of Prophylactic Digitalization in Thoracic Surgical Patients

EDWARD A. STEMMER, Long Beach, Calif., GEORGE L. JULER,*
and JOHN E. CONNOLLY, Irvine, Calif.

Because of the increased incidence of cardiac arrhythmias in thoracic surgical patients, many surgeons employ prophylactic preoperative digitalization. Our experience with 564 patients undergoing thoracotomy for non-cardiac lesions does not support this policy. Prophylactic digitalization was not employed from 1954 to 1959. The incidence of postoperative arrhythmias in 295 patients was 6.5%. Thirteen of these patients, or 4.4% of the entire group, died as a result of arrhythmia. After 1960, prophylactic digitalization was employed in 169 unselected patients and omitted in an additional 100 patients. Thirty-eight (23%) of the 169 digitalized patients developed cardiac arrhythmias postoperatively. Eleven of these patients, or 7.0% of the 169, died as a result of the arrhythmia. The incidence of arrhythmias in the 100 patients without prophylactic digitalization was 8.0% with a 4.0% postoperative mortality due to the arrhythmia. It was apparent that a patient's chance of surviving a post-thoracotomy arrhythmia was better (70% vs 55%) if he had been prophylactically digitalized. However, the greatly increased incidence of arrhythmias in digitalized patients resulted in a post-thoracotomy mortality of almost twice that of patients who had not been prophylactically digitalized. The advantages of prophylactic digitalization of noncardiac surgical patients are more apparent than real.

6. Heart Block in Children: Treatment with a Radiofrequency Pacemaker

WILLIAM W. L. GLENN, NATALIE DELEUCHTENBERG,*
DANIEL W. VAN HEECKEREN,* GENICHI SATO,* and WADE G. HOLCOMB,*
New Haven, Conn.

A transthoracic radio-frequency (R-F) pacemaker has been implanted in 9 children at Yale since 1961. In three, aged ½, 1 and 4 years, heart block was congenital. In six, aged 6-10, block followed repair of a ventricular septal defect. One patient died 2 months after implantation, and one reverted to normal sinus rhythm enabling discontinuation of pacing. In the remaining 7 patients the average duration of pacemaker function is 2¼ years (29 months), ranging from 16 to 37 months. In four patients a dysfunctioning of implanted radio-receiver required replacement, twice in one case. The same defect, found in all receivers, has been corrected. To allow for growth of the child, a loop of the myocardial electrode (cathode) is coiled in a teflon bag and placed in the subcutaneous tissue of the chest wall. Experiments with young pigs have shown that the wire will uncoil as the subject grows. Observations on cardiac output at various heart rates, in two patients aged 2 and 6 years demonstrate a parallel increase in output with rates up to 120 per minute. Advantages of the R-F pacemaker for children with heart block are small size, externally controlled rate and power source and the infrequent (if ever) need for reoperation.

7. Hemodynamic Consequences of Respiratory Insufficiency Following Trauma

DONALD B. DOTY,* ROGER V. MOSELEY,* and BASIL A. PRUITT,*
Washington, D.C.

Sponsored by JUDSON G. RANDOLPH

Ability to maintain an increased cardiac output to supply increased tissue oxygen demand following tissue trauma may be the determining factor in the recovery or death of the injured patient. Concomitant respiratory insufficiency with incomplete ability to oxygenate the blood may place further work requirements on the heart sufficient to exceed its reserve pumping capability and result in high cardiac output failure. A uniform group of previously healthy soldiers were studied following battle injury in Vietnam to determine the hemodynamic consequences of trauma with associated respiratory insufficiency. There were 27 patients who had arterial hypoxemia ($pO_2 < 80$ mm Hg) in whom serial hemodynamic studies were performed. The mean cardiac index was 4.1 L/min.M² with 75% of the values above accepted resting normal of 3.0 L/min.M². Highest cardiac output values were associated with marked physiologic intra-pulmonary shunting of blood (venous admixture). Such high levels of cardiac output were usually well tolerated by these young patients. Five patients were observed to have increasing cardiac output until death occurred presumably as a result of increasing hypoxemia. Clinical course of these patients will be detailed. A low cardiac output was found only with concomitant severe hypovolemia documented by blood volume studies.

8. Diagnosis and Management of Mediastinal Masses in Children

J. ALEX HALLER, JR., DAVID MAZUR,* and WILLIAM W. MORGAN, JR.,*
Baltimore, Md.

Mediastinal masses in children represent a wide variety of conditions which present numerous problems in management. To give factual, clinical perspective to therapy we have reviewed records of eighty children treated for mediastinal masses in The Johns Hopkins Hospital between 1933 and 1968. Arbitrary division of the mediastinum into anterior, middle and posterior compartments was most useful for diagnosis and management. Thymic hyperplasia and teratomas were the commonest masses of the anterior mediastinum, lymph node neoplasms and infection were predominant lesions of the middle mediastinum and neurogenic tumors and duplication cysts formed the overwhelming majority of posterior masses. Forty per cent of all mediastinal masses were malignant with a 65% mortality. Except in infants with hyperplasia of the thymus in whom steroids were both therapeutic and diagnostic, operative intervention was necessary to establish the diagnosis and in most cases to excise the mass. Combined Cobalt-60 irradiation and drug therapy were used for primary lymph node tumors and undifferentiated stem cell tumors. X-ray features of different masses will be discussed as well as the drug regimens for malignant lesions. Technical features of several unusual congenital anomalies of the mediastinum will be stressed.

9. The Effects of Pneumonectomy in Children

QUENTIN R. STILES,* BERT W. MEYER, GEORGE G. LINDESMITH,
and JOHN C. JONES, Los Angeles, Calif.

During the past 25 years, 22 total pneumonectomies have been done at the Childrens Hospital of Los Angeles. The reason for most of these was a destroyed lung from chronic suppuration, but 6 were done for neoplasm. The age ranges were from one month to seventeen years. Followup on most of these has been for many years and has included a period of life when the post-pneumectomy patient still has a considerable period of expected body growth. A pneumectomy is well tolerated by the child in the immediate postoperative period. There was one death during this time in this group. The long term followup shows that these children continue to grow and develop normally. An attempt is made to evaluate objectively the effects of pneumectomy upon future growth and development and upon the prognosis for a normal life expectancy in children who must have an entire lung removed.

10. Superior Mediastinotomy: An Improved Modification of Previous Approaches to the Diagnosis and Evaluation of Chest Disease Without Palpable Nodes

JOHN ARTHUR JACOBNEY,* Denver, Colo.

Sponsored by WILLIAM B. CONDON

Utilizing a horizontal incision above the suprasternal notch with gentle retraction, this technique affords exposure of both right and left paratracheal and carinal nodes using surgical dissecting technique without the restriction of working through an endoscope. This represents a logical progression from the approaches of Daniels, Harken, Radner and Carlens. It has the advantages of maximum exposure of the suspect nodes using the most efficient and safe methods of dissection in an area where complications can be life threatening. In a series of 1,285 undiagnosed chest lesions without palpable nodes, superior mediastinal exploration produced a tissue diagnosis in 53%. This compares favorably with 32% using cervicomediastinal exploration and 25% using scalene fat pad biopsy. In evaluating operability of patients with bronchogenic carcinoma, of 1,577 cases, 770 or 49% were considered operable. Of more importance is that at operation 607 or 79% of the 770 patients were considered resectable for cure. In the author's series there have been no complications. Two and seven tenths per cent of mediastinoscopies have had complications, notably pneumothorax, transient recurrent nerve palsy and hemorrhage. A film of this procedure will be presented as a demonstration of an approach that allows proper surgical dissecting technique instead of endoscopic biting or tearing procedures for the biopsy of nodes within the mediastinum.

*By Invitation

MONDAY AFTERNOON, MARCH 31, 1969

2:00 P.M. Scientific Session: REGULAR PROGRAM Grand Ballroom

11. Aortic Valve Replacement: Long Term Results

ROBERT D. BLOODWELL,* J. EDWARD OKIES,* GRADY L. HALLMAN, JR.,
and DENTON A. COOLEY, Houston, Texas

Total excision and prosthetic replacement has become the most satisfactory method of treatment of advanced acquired aortic valvular disease. Overall hospital mortality among 799 patients undergoing aortic valve replacement during the past six years was 12 per cent. Current mortality's eight per cent despite denying no patient because of severity of cardiac disability. Late deaths have brought the cumulative mortality to 29 per cent. Despite reduced risk of valve replacement, late complications have not been eliminated. Late thromboembolic complications have occurred in patients who had remained clinically improved for long periods after operation providing an overall incidence of 12.2 per cent. Half of the emboli occurred over one year after operation. While ball variance occurred in early ball and seat valves, none has occurred in modified ball valves used during the past three years. Ninety percent follow-up is available for patients operated upon over one year ago. Clinical trial of various types of prostheses used permits comparison of mechanical complications, thromboembolism, and late mortality. Low hospital mortality, salvage of many extremely ill patients, functional and clinical improvement in most patients, and a low incidence of late complications and valve malfunction provide a basis for continued use of prosthetic aortic valve replacement.

12. Biological Factors Affecting Long-term Results of Valvular Heterografts

ALAIN CARPENTIER,* and CHARLES DUBOST,* Paris, France

Sponsored by FRANK GERBOPE

The use of valvular heterografts raises two sorts of problems: technical and biological. Having been subjected to a great deal of work, the technical problems seem to be solved, whereas the biological problems still remain relatively unknown, although they play a great part in the long term results of this kind of graft. Since September 1965, date of the first successful valvular heterograft in human, we have used this method in aortic, mitral or tricuspid position sixty-one times, using different methods of preservation of the graft (freeze drying, chemical sterilization, formaldehyde, neta-periodate, ethylenglycol and glutaraldehyde). Analysis of these results shows that the method of preservation used is the essential factor in the long-term durability of the grafts. In the light of this clinical experience and biochemical studies the criteria of efficiency of a method of preservation have been defined as follows: 1. Guaranteed sterilization. 2. Elimination of the antigenic components previously defined in laboratory, i.e. soluble proteins, glycoproteins, mucopolysaccharides, cells.

3. Prevention of the collagen and elastin denaturation. 4. Protection against the cellular ingrowth. When the method used respects all these criteria the long term fate of the grafted valves becomes excellent.

13. Tricuspid Insufficiency in Patients Undergoing Mitral Valve Replacement: Conservative Management, Annuloplasty, or Replacement?

JAMES R. PLUTH,* ROBERT L. FRYE,* and F. HENRY ELLIS, JR.,
Rochester, Minn.

Severe mitral valve disease may be accompanied by tricuspid insufficiency of variable magnitude. Opinions vary as to whether or not the insufficiency should be surgically corrected at the time of mitral valve replacement and, if so, by what means. This review concerns 148 mitral valve replacement procedures carried out between January, 1963, and January, 1968, on patients with associated tricuspid insufficiency. Twenty-two had intrinsic disease of the tricuspid valve with combined stenosis and insufficiency. Pure tricuspid insufficiency was present in the rest. The overall hospital mortality was 18 per cent. In 89 patients no procedure was performed on the tricuspid valve; tricuspid annuloplasty was done in 34 and tricuspid valve replacement in 25. Follow-up study, including cardiac catheterization, in some instances suggests that pure tricuspid insufficiency secondary to mitral valve disease and right heart failure does not always regress after mitral valve replacement, nor is tricuspid annuloplasty always effective. Tricuspid valve replacement is usually required in the presence of combined mitral and tricuspid valve disease, and when pure tricuspid insufficiency of severe degree is present.

14. Aortic Arch Atresia and Aortic Arch Interruption: Operative Experience with 11 Children

R. L. TAWES, JR.,* P. PANAOPOULOS,* E. ABERDEEN,* D. J. WATSON,*
and R. E. BONHAM-CARTER,* London, England

Sponsored by H. BRODIE STEPHENS

Aortic arch atresia and interruption are rare anomalies which are usually fatal in early infancy. Only 18 of the 111 reported cases were living children and only 12 underwent operation. Our 11 cases were preoperatively diagnosed by angiocardiography and cardiac catheterization in five, and by thoracotomy in six. Nine had aortic arch atresia, two had interruption. Operation corrects or palliates the triad of cardiac defects that usually exist with this anomaly: atresia or interruption, patent ductus arteriosus, and ventricular septal defect. The patent ductus was ligated, the atresia resected, and the aorta anastomosed end to end in three cases. In five others with atresia a hypoplastic arch precluded this anastomosis, therefore the left subclavian artery was anastomosed to the descending aorta in four, and to the aortic arch in one. One infant died before any definitive operative procedure. The pulmonary artery was banded in two of these infants. In the two infants with aortic arch interruption, only pulmonary artery constriction was attempted. Four of the nine children with aortic arch atresia survived operation and left the hospital. The five deaths were in infants less than six months of age. The two neonates with aortic arch interruption died at operation.

15. Neurologic Abnormalities Following Open Heart Surgery

HUSHANG JAVID, HENRY M. TUFO,* HASSAN NAJAFI, WILLIAM S. DYE,*
JAMES A. HUNTER, and ORMAND C. JULIAN, Chicago, Ill.

While numerous reports of central nervous system disturbances following open heart surgery have appeared in the literature, the precise incidence, natural course and causes of these disturbances remain unknown. The following longitudinal study of 100 consecutive patients undergoing open heart surgery was developed to answer the following questions: (1) What is the incidence, magnitude and reversibility of central nervous system dysfunction following open heart surgery? (2) What factors are related to the occurrence of these disorders? Preoperative studies consisted of tape recorded interviews designed to elicit medical and psychological information in addition to complete neurological examination, standardized mental status evaluation and five psychometric tests. The following results were observed. Half of the sample had one or more neurological signs present at the time of the first postoperative examination. Fourteen of 15 operative deaths had evidence of focal or diffuse cerebral damage. Neurological abnormalities remained at the time of discharge in 12 patients. Of the survivors, one-third exhibited one or more of the following: disorientation, memory disturbance, bizarre motor restlessness, visual hallucinations and depressed intellectual function. Several factors appeared to be important in the genesis of these changes: severe preoperative depression, advanced age, and a prolonged period of persistent low mean arterial pressure during bypass.

16. Pericardial Tamponade Following Open Heart Surgery

RUSSELL M. NELSON, CONRAD B. JENSON,* and
WENDELL M. SMOOT III,* Salt Lake City, Utah

The occurrence of pericardial tamponade in the postoperative period can produce severe hemodynamic alterations. The differential diagnosis from low cardiac output syndrome due to other causes becomes important considering the necessity for reoperation for the relief of significant tamponade. Therefore, a retrospective study has been done to analyze the records of 422 patients subjected to open heart surgery in a ten year period from 1959 to July of 1968. Significant pericardial tamponade was diagnosed in sixteen of these patients, and confirmed in 14. Two patients had myocardial insufficiency found at the time of re-exploration. The incidence was greatest among patients having open operations on the aortic and mitral valves, and least among the congenital abnormalities. Low arterial pressure, high venous pressure and a paradoxical pulse occurred most commonly as expected. Abnormal chest X-rays, electrocardiograms, or muffled heart tones were present in less than half of the cases. The average amount of thoracostomy drainage was 1200 ml. in the tamponade group, similar to the amount drained from the control group of patients subjected to open heart surgery without pericardial tamponade. Seventy-five per cent of the patients with pericardial tamponade developed this problem within the first two days following surgery. At reoperation, a specific site of bleeding was not found in 50% of the patients. Patients with primary

myocardial insufficiency exhibited the same hemodynamic abnormalities, but their thoracostomy drainage was significantly less. Differential diagnosis and proper treatment programs for postoperative pericardial tamponade will be presented.

17. Pericardectomy in Non-Tuberculous Pericarditis

DONALD G. MULLEN,* MARCUS L. DILLON, W. GLENN YOUNG, JR.,
and WILL G. SEALY, Durham, N.C.

During the last fifteen years we have performed pericardectomies on twenty-four patients who had non-tuberculous pericarditis. This review is concerned with the indications for surgical therapy, the course following the operation, and the long-term follow-up of these patients. Particular emphasis will be placed on those patients who had recurrent episodes of pain, and those in whom the pericardectomy was done for prevention of constriction. The cause of the pericarditis was trauma in two patients, rheumatoid disease, one patient; unsuspected tumor, four patients; and, presumably a virus in 17. The indications for operation included diagnosis, constriction, prevention of recurrent episodes of pain or tamponade, and recurrent fluid accumulation. It is concluded from this study that an aggressive approach is indicated in patients with non-tuberculous pericarditis who demonstrate persistence or recurrence of symptoms, and in whom there is evidence from the character of the fluid that constriction will likely occur. Early removal of the anterior pericardium will prevent some of the more serious complications of this disorder.

18. Partial Cardiopulmonary Bypass, Hypothermia, and Total Circulatory Arrest: A Life Saving Technique in Certain Complicated Situations

G. WALTON LILLEHEI, and ROBERT J. ELLIS,* New York, N.Y.

Six years ago we were presented with a patient bleeding from a hole in the ascending aorta exposed in the depths of an infected sternotomy who had had two open heart procedures and at this time had a staphylococcus septicemia. With manual aorta compression, operation was instituted by peripheral cannulation, partial bypass, and total body hypothermia. At 21°C the pump oxygenator was shut off and the blood drained into the oxy-generator. During circulatory arrest of 21 minutes the hole was closed and an uneventful early and late recovery followed. Since then, we have used this method as an emergency (occasionally electively) in 30 patients with a variety of complicated situations many of which would have been impossible by any other approach. These included most frequently infected sternotomy wounds with massive hemorrhage. Other occasional indications were adult tetralogies with massive bronchial flow, aortic-innominate vein arteriovenous fistulas, ruptured acute myocardial infarctions, unusual tears in inferior cava or arch of the aorta, large coronary arteriovenous fistula into the posterior right ventricle. Twenty-three (75%) have been successful. Conversations with others indicate that the value and simplicity of this technique, which will be presented in detail, is not generally recognized.

19. A New Operation for Correction of Transposition of the Great Arteries, Ventricular Septal Defect, and Pulmonary Stenosis

G. G. RASTELLI,* ROBERT B. WALLACE, and DWIGHT C. MCGOON,
Rochester, Minn.

Hospital mortality rate for complete correction of transposition associated with ventricular septal defect (VSD) and subvalvular pulmonary stenosis (SPS) by creating transposition of venous return has been 61% (8 of 13 patients) at the Mayo Clinic. The location and variable nature of the SPS prevent adequate surgical relief, and this is probably responsible for high surgical mortality. A new "anatomic" correction for this type of transposition was devised in which SPS was relieved without a direct approach to it. This repair consists of (1) division of the main pulmonary artery, the cardiac end of which is oversewn, (2) construction of an intracardiac tunnel between the VSD and the aorta, and (3) construction of a new right ventricular outflow by anastomosing a homograft of ascending aorta, including the aortic valve, between the distal end of the pulmonary artery and the right ventricle. This repair may achieve better correction than would transposition of venous return, because the left ventricle is made to eject into the aorta and the right ventricle to eject into the pulmonary artery. Two patients 14 and 15 years were successfully operated on with this technique. Cardiac catheterization and angiocardiographic findings before and after operation will be presented.

20. Ebstein's Anomaly: Further Experience with Definitive Repair

KENNETH L. HARDY,* and BENSON B. ROE, San Francisco, Calif.

A functional concept of the altered cardiodynamics in Ebstein's anomaly and a reconstructive operation to correct them was described before this Association by one of us (KLH) in 1964. The patient reported at that time, now five years postoperative, remains clinically well and active, in a functional Class I status. While the relative rarity of this lesion does not provide an opportunity for extensive experience, we have now treated a total of six patients by the operation originally described with satisfactory functional correction in every case. There has been one death, not related to the method of repair. This experience supports the original belief that the procedure is effective and provides a more desirable alternative to the presence of a mechanical device in the low pressure side of the heart with its commitment to lifelong anticoagulation and the threat of repeated pulmonary emboli. In this consecutive series, it was feasible to correct the dysfunction without having to consider the need for a prosthetic valve or foreign tissue. Further observations about the anatomical constants and variables in the Ebstein heart will be demonstrated to facilitate operative evaluation and repair of the abnormality. Minor technical refinements of the basic technique have evolved from this experience and will be described.

*By Invitation

TUESDAY MORNING, APRIL 1, 1969

8:30 A.M. Scientific Session: THORACIC SURGERY FORUM Grand Ballroom

21. Myocardial Viability and Hypothermia

WILLIAM W. ANGELL,* LAYTON RIKKERS,* EUGENE DONG,*
and NORMAN E. SHUMWAY, Palo Alto, Calif.

Myocardial hypothermia has been used for anoxic preservation in cardiac transplantation and in several hundred other open heart procedures at the Stanford Medical Center. It permits 2 hours of total anoxia without myocardial damage. A quantitative relationship (related to organ viability) was defined between temperature and the interval of anoxia. The interval of anoxia compatible with viability (defined as survival of the transplanted heart without infarction) was determined in 40 canine hearts at 37, 30, 22, and 15°C. Function was studied by left ventricular pressure curves, heart rate, contractility, oxygen consumption, CO₂ production, enzyme liberation, edema formation, and light and electron microscopic morphology. The allowable interval of anoxia proved to be a linear function of the log of

temperature. This is also permitted a prediction of viability in any given heart undergoing anoxia at variable temperatures. (Viability was accurately predicted in 10

human and 10 canine hearts from the

formula:

Proven preoperative donor heart viability is essential to successful heart transplantation. Any heart can be definitively evaluated as a donor organ if the temperature and anoxic interval are known.

22. The Microcirculation of Transplanted Hearts

WILLIAM E. NEVILLE, ROQUE PIFARRE,* JOHN W. BALIS,* WILLIAM COX,*
FRANCIS DWAN,* and EDWARD S. RAPPAPORT,* Hines, Ill.

The gross, histologic and ultrastructural changes of hearts, orthotopically transplanted from goat-to-dog, dog-to-dog and dog-to-goat were studied. The coronary blood flow, heart contractility, color and ultrastructure appeared normal in dog hearts transplanted to either dogs or goats. On the other hand, the goat hearts transplanted to dogs failed to contract properly, and rapidly developed bluish red discoloration with sharp diminution of coronary blood flow within one hour after transplantation. Histologic and ultrastructural studies in these hearts showed- 1) Obstruction of capillaries by agglutinated erythrocytes, and marked endothelial damage without platelet aggregates and fibrin deposits 2) Interstitial edema and extravasated erythrocytes, 3) Typical changes of acute ischemic damage of the myocardium, namely, mitochondrial swelling, loss of glycogen, clumping and margination of nuclear chromatin. Since dog erythrocytes are appreciably larger than goat erythrocytes, it is suggested that differences in size and other properties as well accounts, in part, for the rapid agglutination of these cells in the microcirculation following heterologous heart transplantation. The possibility exists that similar events in the capillary circulation may be responsible for the "acute immunologic rejection" of transplanted organs in man.

23. The Immediate Prophylactic Role of Myocardial Revascularization Following Internal Mammary Artery Implantation into Normal Myocardium

SUSUMU TANAKA,* WILLIAM R. RASSMAN,* RICHARD FLEMING,*
ROBERT J. ELLIS,* and G. WALTON LILLEHEI, New York, N. Y.

The functional effects of internal mammary artery implantation (I.M.A.) into normal myocardium and ischemic myocardium of dogs was compared. Implantation performed in normals demonstrated 90% patency at 6 months and there was *no difference* in patency rate into ischemic muscle. However, I.M.A. implants into ischemic myocardium showed angiographically much more widespread connections at 3 months. However, a striking finding of these studies was demonstration that I.M.A. implants into healthy myocardium did after 6 months show, following creation of acute ischemia, an immediate (within 60 sec.) widespread opening of collateral vessels equal in size and number to those visible in animals with chronic ischemia. The following measurements were also taken: ventricular size (utilizing epicardial strain gauges), ventricular and systemic pressures, coronary artery flow and implanted I.M.A. flow. Acute ischemia was then created by coronary artery ligations. Contribution of blood from internal mammary implants significantly offset immediate effects of acute ischemia confirming the angiographic observations. Conclusion: I.M.A. implantations are capable of establishing widespread latent arterial communications without need of myocardial ischemia. The number, size and area of distribution of these communications become immediately functional in the presence of acute ischemia.

24. Experimental Evaluation of Myocardial Tunnelization as a Method of Myocardial Revascularization

ISAM N. ANABTAWI,* HUBERT F. RIEGLER,* and ROBERT G. ELLISON,

Augusta, Ga.

The protective effect of surgically created myocardial tunnels between the left ventricular chamber and the myocardium was studied in dogs whose myocardium was rendered ischemic by ameroid constriction of left coronary artery. Four of five control dogs whose myocardium was made ischemic without benefit of tunnels died within two months of operation from extensive myocardial infarction whereas ten of 13 animals protected with tunnels were alive and well five months after operation. Tunnel communication with the left ventricular chamber could be demonstrated in the early postoperative period whereas at autopsy five months later no communications were present indicating healing closure of

the endocardial entry site. The tunnels, however, remained patent as large myocardial blood channels which freely communicated with both right and left coronary artery branches. Endothelial cells could be seen lining some channels. The results indicate the feasibility of vascularizing multiple areas in the myocardium by creation of channels which promote intercoronary passage of blood between branches of both coronary arteries. This seems preferable to the limitation of two artificially implanted internal mammary arteries with their inherent risk of thrombosis.

25. The Hemodynamics and Coronary Arteriographic Patterns During Acute Myocardial Infarction

F. R. BEGO,* M. A. KOOROS,* G. J. MAGOVERN, E. M. KENT,
L. B. BRENT,* and W. B. GUSHING,* Pittsburgh, Pa.

The effects of coronary occlusion on left ventricular function have been studied extensively in the experimental laboratory but the left ventricular response during acute coronary occlusion has not been studied in man. This paper presents our findings in 51 patients who have been studied 10 hours to 4 weeks following the onset of myocardial infarction and describes 1) the coronary angiographic pattern in acute myocardial infarction and 2) the intra-ventricular pressures and angiographic assessment of left ventricular function. Five patients were studied within twenty-four hours of the onset of their myocardial damage with right and left heart catheterization, selective angiocoronary arteriography and left ventriculography. There were no complications. The remaining forty-six patients had selective coronary arteriography and left ventriculography to study the arteriographic pattern in evolving myocardial infarction. The results demonstrate that retrograde left heart catheterization with selective coronary arteriography can be successfully applied to any phase of coronary arterial disease and points put by illustrating the arteriographic pattern in all phases of myocardial infarction the potential surgical implications of acquiring this physiological and angiographic data within hours of the onset of an occlusion of the coronary artery.

26. The Effect of Excessively High Perfusion Pressures on the Histology, Histochemistry, Birefringence and Function of the Myocardium

A. HEDLEY BROWN,* MARK V. BRAIMBRTDOE,* NELSON R. NILES,*
FRANK GERBODE, and MARY S. AGUILAR,* San Francisco, Calif.

During operations on the aortic valve, the coronary arteries may be perfused at higher pressures than normal. The purpose of this investigation is to demonstrate that high perfusion pressure does in fact damage the heart. The model was an isolated heart preparation. One group of hearts was perfused at normal aortic pressures, and another at elevated aortic pressures. Myocardial damage was assessed by the following methods: (a) Histochemistry (Succinic dehydrogenase, free phospholipids) (b) Birefringence of myocardial fibers (c) Hematoxylin and Eosin stain (d) Ventricular wall tension (e) Velocity of contraction (f) Ventricular compliance (g) Ventricular wall thickness. Perfusion was carried out for three hours. There were significant changes in both ventricular wall tension and velocity of contraction in both groups. Hearts perfused at high pressures had a significant marked loss of ventricular compliance and increase in ventricular wall thickness. Histochemistry and birefringence were not significantly altered in either group. Microscopic examination demonstrated marked difference in the two groups. Hearts perfused at normal pressure were normal. Those perfused at high pressure were congested, edematous and exhibited red cell infiltration between myocardial fibers. These results indicate that high coronary artery perfusion pressure is detrimental to the myocardium and should be accurately controlled during aortic valve surgery.

27. Postoperative Isoproterenol Ventricular Arrhythmias: Conversion with Insulin

S. A. HOFFMAN,* H. W. WALLACE,* H. ZINSSER,* Philadelphia, Pa.,
A. E. BAUE, St. Louis, Mo, and W. S. BLAKEMORE, Philadelphia, Pa.

Postoperative open heart patients who have previously received digitalis and diuretics frequently develop ventricular arrhythmias when isoproterenol is administered. To study this, hypokalemia was produced in dogs. Isoproterenol did not induce ventricular arrhythmias in nondigitalized hypokalemic dogs, while in digitalized hypokalemic dogs, the administration of isoproterenol caused ventricular arrhythmias. The administration of KGL was found to abolish these arrhythmias. When a combination of slow and rapid acting digitalis was used, the administration of KCL resulted in heart block. Isoproterenol, 2 ug./min., produced serious ventricular arrhythmias in six hyperkalemic patients in acute renal failure on long term digitalis and diuretics. The addition of regular insulin (0.05 units/ug. of isoproterenol) effectively converted the ventricular arrhythmias to a normal rhythm. This insulin supplement in addition reduced the myocardial requirements for isoproterenol by 90 per cent of its dose to 0.2 ug./min. Beta adrenergic reception stimulation by isoproterenol probably affected the relationship of cardiac glycosides and myocardial potassium. Insulin presumably altered the intracellular-extracellular potassium balance.

28. An Operative Technique for the Prevention of Reflux Following Oesophagostomy

F. G. PEARSON, and R. M. PARRISH,* Toronto, Ontario

Oesophago-gastrostomy is the simplest method of reconstruction following oesophagectomy for carcinoma of the intrathoracic oesophagus, but results in frequent and significant disability due to gastro-oesophageal reflux. Ottosen of Denmark (1959) described a modified oesophagogastric anastomosis in which a long segment of intrathoracic oesophagus is inyaginated into the gastric fundus, permitting normal swallowing but preventing significant reflux. This modified anastomosis was used in 12 consecutive patients at the Toronto General Hospital with carcinoma of the middle or lower third of the oesophagus managed by resection and oesophagostomy in one stage. Follow-up varies from 9 months to 3 years after operation. Nine patients are still living and 3 have died of recurrent carcinoma. The effectiveness of the modified anastomosis in preventing reflux has been evaluated by clinical assessment, detailed cine-radiographic follow-up, and oesophagoscopy. There were no operative deaths and no anastomotic leaks. None of 12 patient has developed symptomatic reflux, none have shown evidence of aspiration, and none have developed oesophagitis or stricture proximal

to the anastomosis. Although the number of patients reported is small, and the follow-up period relatively short, current observations merit an optimistic preliminary report.

29. Autonomic Innervation in Achalasia of the Esophagus

D. M. JACOBOWITZ,* P. BERG,* S. A. STEINBERG,* and P. NEMIR, JR.,
Philadelphia, Pa.

Studies were carried out on the autonomic innervation at various levels of the esophagus in the normal dog and in a group with severe naturally occurring achalasia. The parasympathetic innervation has been studied by the histochemical method for acetylcholinesterase and, for the first time, sympathetic innervation by a histofluorometric method for the localization of catecholamines. The adrenergic innervation is seen primarily in the Auerbach's plexus and about blood vessels and not innervating the smooth muscle as classically believed. No change in the innervation of the adrenergic and cholinergic fibers was observed in the body of the normal and dilated esophagus. In animals with achalasia the sympathetic fibers in anatomical proximity to Auerbach's plexus are either absent or markedly reduced in the lower esophagus as compared to the normal. These findings indicate that the primary derangement in achalasia is a spasm on the basis of parasympathetic predominance rather than a failure of relaxation. Moreover, studies indicate that the effectiveness of esophagomyotomy is through restoration of autonomic balance. Since the influence of catecholamines on the esophagus may be either stimulatory or inhibitory, we are presently testing certain alpha and beta stimulator and blocking agents using cine-roentgenographic, manometric and electromyographic techniques.

30. The Experimental Treatment of Esophageal Strictures by Intralesional Steroid Injections

KEITH W. ASHCRAFT,* and THOMAS M. HOLDER, Kansas City, Kan.

The treatment of short esophageal strictures by dilatations has often been frustrating and unsuccessful. The demonstration that keloids, hypertrophic scars, and burn contractures resolved after intralesional injection of triamcinolone diacetate suggested a new method of management of esophageal stricture. This drug enhances the solubility of saline extractable collagen and depresses mucopolysaccharide formation in the synthesis of collagen. Short esophageal strictures were created in 15 dogs by sodium hydroxide burns. These strictures were documented by endoscopy and by cine radiography. Nine animals received intralesional injections of triamcinolone endoscopically. Six animals served as controls - three receiving no treatment and three receiving saline injections. None of the 15 strictures were dilated and all animals were maintained on a liquid diet. Repeat cine-esophagrams and esophagoscopy were performed prior to sacrifice. Of the treated animals seven demonstrated at least a four-fold increase in cross sectional area at the stricture. Two were unchanged. None of the controls improved. Four patients with short esophageal strictures were treated by this method. Three of these had undergone multiple dilatations prior to the addition of the steroid injections. All showed marked and lasting relief of the stricture functionally and radiographically.

31. Oxygen Consumption During Cardiopulmonary Bypass Circulation: Effect of Pulsatile Flow

RICHARD B. SHEPARD,* and JOHN W. KIRKLIN, Birmingham, Ala.

Portions of the microcirculation may not be perfused during shock and during some types of cardiopulmonary bypass. While tolerable for short periods, this is disadvantageous over long periods. To test the hypothesis that perfusion of the microcirculation is more complete with pulsatile than with non-pulsatile flow, 23 calves were subjected to 4 hour periods of complete cardiopulmonary bypass circulation (2.1 L/min/M²; 36.5-37°C) using a disc oxygenator. A roller pump was used for non-pulsatile perfusion (NPP) (13 animals). A modified roller pump was run at pulse rates of 60-70 for pulsatile perfusion (PP) (10 animals). Phasic flow and pressure were measured in the animals. Oxygen consumption during NPP was 126 ± 25 cc/min/M²; during PP it was 159 ± 16 (p < .001). During PP, the pulsatile component of hemodynamic energy was not significantly different from that existing before and after bypass (.7 < p < .8). It was higher by 8500 ergs/cm³ blood during PP compared to NPP (.001 < p < .005). Bronchial artery flow was 128 ± 56 cc/min/M² during PP and 36 ± 11 during NPP (p < .001). The data suggest that in these calves perfusion of the microcirculation was more complete when flow was pulsatile than when it was non-pulsatile.

32. Improved Organ Function During Cardiac Bypass With a Roller Pump Modified to Deliver Pulsatile Flow

LLOYD A. JACOBS,* EDWARD H. KLOPP,* WOODROW SEAMONE,*
STEPHEN R. TOPAZ,* and VINCENT L. GOTT, Baltimore, Md.

The importance of pulsatile flow during cardiac bypass has not been completely established. Evidence is accumulating, however, suggesting that steady flow perfusion causes greater disturbance of physiologic function than pulsatile perfusion. To further evaluate this hypothesis, a roller pump has been modified to achieve pulsatile flow by the addition of a torque motor powered by a triangular waveform. Rate and stroke volume are adjustable and pulsatile or steady flow may be selected. The femoral artery pressure waveform produced in the dog is nearly indistinguishable from that seen in the intact animal. Total left heart bypass has been performed in twenty dogs, five with steady flow and fifteen with pulsatile flow. Dogs perfused with steady flow showed immediate, large decreases (85-100%) in urine output and creatinine clearance; those perfused with pulsatile flow showed only small (10-15%) decreases in urine output and creatinine clearance during four-hour perfusions. Furthermore, those perfused with pulsatile flow showed smaller changes in peripheral resistance, less edema and somewhat lower serum lactate levels. It was possible to demonstrate unimpaired renal function, reflexes and responsiveness after twelve hours of pulsatile perfusion.

33. A Central-Flow, Low-Profile, Leaflet-Deforming Mitral Valve Prosthesis Free of Prolonged Anticoagulation Requirements

K. W. EDMARK,* W. J. HILL,* G. I. THOMAS, and T. W. JONES,
Seattle, Wash.

Described is a new concept in artificial heart valve prosthesis which is a central-flow, leaflet-deforming valve giving normal heart sounds, free of murmurs or clicks. The advantages of this valve are its laminar central-flow characteristics with low profile and its non-thrombogenic surface coating of tetrafluoropropylene, which does not require long-term anticoagulant therapy. The anti-thrombogenic properties of this valve have been developed after four years of animal implant experimentation, with dog survival beyond two years. It has also been fatigue-tested beyond 405 million cycles, with a closing pressure of 250 mm. Hg, giving a fatigue life beyond 40 years, with a flex life beyond ten years. The presentation will include laboratory data and the clinical experience in the initial ten patient implants, beginning February, 1968, and continuing.

*By Invitation

TUESDAY AFTERNOON, APRIL 1, 1969

2:00 P.M. Executive Session (Limited to Active and Senior Members)
Grand Ballroom

3:00 P.M. Scientific Session: REGULAR PROGRAM
Grand Ballroom

Address by the President

Edward M. Kent, Pittsburgh, Pennsylvania

Address by Honored Guest

E. J. Zerbin, M.D.

University of Sao Paulo Medical School

Sao Paulo, Brazil "The Surgical Treatment of Tetralogy of Fallot"

34. Surgical Considerations in "Atypical" Mycobacterial Pulmonary Disease

R. T. Fox, K. V. VEERRAJU,* WILLIAM M. LEES, and T. W. SHIELDS,

Chicago, Ill.

The medical management of pulmonary disease caused by Mycobacteria other than M. Tuberculosis is fairly well accepted, with use of varying combinations of "first-line" and "second-line" drugs. Despite the rather poor success rate of this management the role of surgery has been controversial. As in any other type of surgery, the fate of the non-operated patient must be weighed against the mortality, morbidity, and ultimate favorable results in the surgically treated patient. In order to document the excellent results and minimal adverse effects of surgery we have analyzed our series of patients with "Atypical" Mycobacterial disease. From 1951 through 1967, 163 patients with such disease have had definitive surgery. There have been 153 resections (12 bilateral) and 27 plombage thoracoplasties (5 bilateral). Major complications consisted of seven instances (4.5%) of broncho-pleural fistula, two with post-operative bleeding necessitating re-operation, and two of lobar atelectases. Twenty four patients (15.6%) had minor space problems. There was no surgical mortality in the entire group. Five of the resected patients ultimately needed further surgery to achieve control of the disease. Two of the plombage patients needed additional surgery. The final success rate has been approximately 96%.

35. Pulmonary Complications in Burn Patients: A Comparative Study of 700 Patients

ROBERT J. FLEMMING,* FRANK C. DIVINCENTI,* BASIL A. PRUITT, JR.,* and
FRANKLIN D. FOLEY,* Fort Sam Houston, Texas
Sponsored by W. GLENN YOUNG, JR.

Comparison of 311 burn patients in 1962-1963 with 389 in 1967 reveals that with the advent of topical chemotherapy, pulmonary complications are now the leading cause of death in burn patients. Pneumonia is foremost, occurring in 17% of all burn patients and in 50% of mortalities in 1967. Complications of tracheostomy, including pneumothorax, are the second leading complication. Pulmonary edema, suppurative thromboembolism, pulmonary melioidosis, and empyema as a result of pneumothorax treatment are less common but difficult in management because of the burn. Bronchiectasis as a late sequela to smoke inhalation is rare but of unusual interest. Greater use of respirators in 1967 led to an increased recognition of "oxygen toxicity," although identical histologic findings have been noted in patients who did not require respiratory support. The pneumonias currently seen are considered to be airborne in contrast to hematogenous pneumonia which was common in 1962-1963. Increased use of respirators and unnecessary tracheostomy are considered important in this relative increase in airborne pneumonia. Prolonged hypoxemia and alkalosis occur in most burn patients, suggesting ventilation-perfusion abnormalities. The application of the basic principles of thoracic surgery as modified in the treatment of the burn patient and as related to these complications is emphasized and discussed in detail.

36. Respiratory Failure in Infants Following Cardiovascular Surgery

J. J. DOWNES,* H. NICODEMUS,* and J. A. WALDHAUSEN,
Philadelphia, Pa.

Acute respiratory failure commonly follows operations for congenital heart disease in infants because of the associated abnormal pulmonary circulation. Our criteria for respiratory failure include: abnormal arterial carbon dioxide tension (PaCO_2), physiologic dead space-tidal volume ratio greater than 0.50, increased respiratory frequency, and excessive work of breathing. Of 99 infants operated in a 2 year period, 41 met these criteria and received mechanical ventilation. Despite severe, complex lesions, 17 (42%) survived after mechanical ventilation of 24 hours to 3 months duration. Of the 58 infants without respiratory failure, all but one survived. Pulmonary sequelae of high alveolar oxygen tensions contributed to the deaths of 3 infants early in the series. Subsequently, the inspired oxygen concentrations were maintained at the minimum level consistent with an arterial oxygen tension (PaO_2) above 35 mmHg (cyanotic lesions) or 70 mmHg (acyanotic lesions). Controlled constant volume ventilation aided by morphine and chest physiotherapy provided optimal distribution of gas and minimal alveolar-arterial oxygen tension gradients. An indwelling systemic arterial catheter permitted frequent determination of pH, PaCO_2 , and PaO_2 , and continuous pressure monitoring. We conclude that respiratory failure following cardiovascular surgery in infants can be successfully treated with mechanical ventilation.

*By Invitation

TUESDAY EVENING, APRIL 1, 1969

7:00 P.M. Reception

Pavilion Room

8:00 P.M. Dinner and Dancing

Terrace Room

Attendance limited to Members of the Association and their ladies, Invited Speakers and their ladies, Invited Guests and their ladies.

Dinner dress preferred

WEDNESDAY MORNING, APRIL 2, 1969

8:30 A.M. Scientific Session: THORACIC SURGERY FORUM

Grand Ballroom

37. A Permanent Transvenous Atrial Electrode Catheter

NICHOLAUS P. D. SMYTH, LASZLO VASARHELYI,* and
WILLIAM MCNAMARA,* Washington, D.C.

Synchronous pacing in patients with complete heart block offers several advantages over asynchronous (fixed rate) and demand pacing. These include: response to increased physiological demand by an increase in rate as well as stroke volume, and preservation of the hemodynamic advantage of the "atrial kick." The lack of a suitable transvenous electrode for permanent "P" wave pick-up has restricted the application of synchronous pacing, since thoracotomy is still required for reliable detection of the "P" wave. Patients with symptomatic bradycardia without heart block are currently treated by demand ventricular pacing. A more logical treatment for many of these patients would be demand or fixed rate, atrial pacing. The lack of a suitable transvenous electrode for permanent atrial pacing has slowed the development of this approach. We have developed a unipolar catheter electrode which can be inserted transvenously and securely positioned in the right atrium. Studies in the dog show stable location of the catheter, with satisfactory "P" wave pick-up and atrial capture on stimulation for up to 30 days. Atrial stimulating thresholds are consistently higher than ventricular thresholds measured in the same animal at the same time. A modification of the catheter suitable for use in patients has been developed and clinical trial is in progress. Satisfactory short-term results have been obtained in two patients.

38. Long-Term Follow-Up of a New Method of Pacer Lead Implantation

JAMES R. JUDE, KAZI MOBIN-UDDIN,* CARLOS R. LOMBARDO,* and
GEORGE M. CALLARD,* Miami, Fla.

Cardiac pacemaker leads were implanted under local anesthesia on the out-flow tract of the right ventricle in 25 patients over a period of three years. The parasternal approach used did not enter the pleural space. It retained the simplicity of the transvenous method with the reliability of the epicardial suture technique. The pacer power pack was placed in the epigastrium or sub-pectoral area. Both fixed rate and demand pacemakers were employed. In three patients the incision was extended to the left and the electrodes placed on the left ventricle due to the absence of a bare area on the right ventricle. One patient died post-operatively of renal failure. There have been no late deaths. The battery pack has been replaced in six patients giving an opportunity to study the threshold for stimulation of the electrodes on the right ventricle. The thresholds varied from 1.5 to 4.0 milliamperes with the longest measured at 24 months of 2.5 milliamperes. No lead difficulties have been seen with follow-up up to 36 months, in view of changing opinions, an employment of a transvenous electrode with

problems of repositioning or perforation, this method provides an alternative simple method of placement without general anesthesia.

39. Water and Solute Excretion Following Cardio-Pulmonary Bypass with Hemodilution: The Effects of the Osmolarity of the Perfusion-Prime

J. B. DAS,* A. J. ERAKLIS,* and J. E. JONES,* Boston, Mass.

Sponsored by ROBERT E. GROSS

Renal water and solute excretion was studied following open-heart surgery with hemodiluted primes of varying osmolarity (290 mOsm/L-377 mOsm/L). The water and electrolyte content of skeletal muscle and red cells before and following bypass was also measured. With hyperosmolar primes, a hypertonicity of the plasma and a sharp osmotic diuresis was noted within the first six hours after cardio-pulmonary bypass. In the next 18 hours the urinary output for the hyperosmolar groups dropped well below (22.5 ml/hour/1.73m²) that for the iso-osmolar group (37.3 ml/hour/ 1.73m²). However, the total solute excretion in the hyperosmolar group was only slightly higher (729 mOsm/day/1.73m²) than the solute excretion in the iso-osmojar group (672 mOsm/day/1 73m²). The obligatory water loss is greater in the hyperosmolar groups leading to a relative dehydration, persistent hyperosmolarity of the serum, hypernatremia and high BUN levels. The water and solute excretion was correlated with changes in water and electrolyte content of red cells and skeletal muscle. An increase in sodium and water content of the cells accompanied by a potassium washout was noted during cardio-pulmonary bypass at lie highest prime-osmolarities studied. The data collected suggests that monitoring the osmolarity of the prime prior to cardio-pulmonary bypass and the patient's serum post-operatively will offer a guide to fluid therapy and avoid sudden shifts of water and electrolytes between fluid compartments.

40. Development of a Membrane Oxygenator: Overcoming Blood Diffusion Limitation

ROBERT H. BARTLETT,* DIANE KITTREDGE,* BERTRAM S. NOYES, JR ,*
RALPH WILLARD,* and PHILIP A. DRINKER,* Boston, Mass.

Sponsored by DWIGHT E. HARKEN

Current membrane oxygenators are limited by diffusion of oxygen through the laminar blood film at the membrane surface, achieving only 10-30% of the gas transfer capacity of the membrane. We have previously described the convective mixing produced in a fluid flowing through a torsionally oscillating helix. This principle, applied to membrane oxygenator design, has been shown to eliminate the blood film limitation. A helix of 5-mil silicone rubber membrane was made by wrapping 10 feet of .25 in. diameter tubing around a 12 inch cylinder. Oxygen transfer to blood *in vitro* increased from 45 cc/m²/min. to 203 cc/m²/min. as the frequency of oscillation was increased Maximum possible oxygen transfer through 5-mil silicone rubber tubing is 205 cc/m²/min.(670 mmHg gradient). These observations were repeated in veno-venous and arterio-venous bypass in dogs. The oxygenator has performed at maximum transfer rates *in vivo* periods up to 7 hours. In this system there is no blood-gas interface, hemolysis is negligible, and bubbling cannot occur. Rapid flow through the oscillating large-bore tubing prevents stagnation and decreases the tendency to thrombosis. Studies are underway to evaluate prolonged extracorporeal oxygenation in the dog.

41. An Appraisal of Blood Trauma and the Blood-Material Interface Following Prolonged Assisted Circulation

W. F. BERNHARD, L. BUTTON,* T. ROBINSON,* S. KITRILAKIS,* and
C. G. LAFARGE, Boston, Mass.

Assisted circulation (flows of 1500-3000 ml/minute) was carried out (continuously) in 30 calves (7-120 days), employing a totally implantable, Left Ventricular-Aortic assist pump. The pneumatically actuated, double-valved device was completely lined with flocked Dacron fibrils to encourage deposition of a smooth, cellular interface. In some experiments, the pump matrix was seeded with bovine fetal fibroblasts to accelerate pseudoendothelial development. These primitive cells, maintained in tissue culture (37°C), were obtained from fetuses (two to five months gestation) by trypsinization of muscle and connective tissue. In 20 animals, sacrificed after 30 days of bypass, histologic study of the lining revealed masses of viable fibroblasts and collagen attached to the Dacron matrix. Identification of fetal cells was accomplished with liquid scintillation using C¹⁴.Thymidine Blood trauma was minimal and consisted of: a 15 percent hematocrit reduction; temporary (14 day) increase in incubated osmotic fragility; and a 24 hour increase in mechanical fragility. Erythrocyte survival (D.F.P.³²) was reduced approximately ten percent (24 day half-life). Red cell mass (Cr⁵¹) was also less, with a reciprocal rise in plasma volume. Plasma hemoglobin, haptoglobins, reticulocyte count, platelets, and intracellular cations were unchanged.

42. Closed Chest Left Heart Bypass Without Anticoagulation

AKIO WAKABAYASHI,* WILLIAM DIBTRICK,* and JOHN E. CONNOLLY,
Irvine, Calif.

Need for heparinization has been a major handicap preventing prolonged assisted circulation. Experiments were undertaken to devise a non-thrombogenic transeptal left heart bypass unit. A Dennis transeptal cannula, an arterial cannula, and polyvinyl tubings were coated with Graphite-Poly-urethane-Polyvinyl. The pump consisted of a silicone rubber bag with Dacron velour linings energized with compressed oxygen via an adjustable automatic switch and solenoid valve. Two homograft aortic valves were used as inlet and outlet valves of the pump. The following circuit was established in six dogs and tested for 10 to 30 hours without anticoagulation The circuit consisted of a Dennis transeptal cannula placed through the right jugular vein into the left atrium. The blood was then pumped from die left atrium back to a carotid artery. Blood pressure and primary output were maintained within normal range throughout all bypasses. No transfusions were required. All dogs survived and none showed blood diarrhea which is common when an extracorporeal circulation with heparinization

is used for a prolonged period. No clotting was found in the pump unit and no animal showed neurologic damage at later sacrifice. This is the first successful use of left heart bypass for a prolonged period without thoracotomy and heparinization.

43. On-Line Digital Analysis of Respiratory Mechanics and the Automation of Respirator Control

MARK HILBERMAN,* JOHN SCHILL,* and RICHARD M. PETERS,
Chapel Hill, N.C.

The construction of an automatic system of respirator control depends on detailed studies of respiratory mechanics in the postoperative period. At first a digital control system will be essential. We have used a medium-sized digital computer to perform breath-by-breath analysis of pressure and flow, measurements which are then used to calculate compliance, resistance, total work, resistive work, tidal volume, and rate. A 40% reduction in compliance and a 40% increase in resistance is quite usual on the first day after cardiac surgery, however in individual cases large changes predict deterioration of function and may be used for alarm purposes. Previous work has demonstrated the deterioration of respirator efficiency following such pulmonary changes and detection of these acute changes form essential input for a respirator control system. We have a number of measurements which show that the pressure the respirator "sees" is not necessarily the same one "seen" by the lungs (because of nasotracheal tubes, etc.). This discrepancy must be taken into account if a successful system is to be developed which will warn the physician and control a respirator. Both the needed information and the possible network will be demonstrated.

44. Protracted Survival After Homotransplantation of the Lung and Simultaneous Contralateral Pulmonary Artery Ligation

FRANK J. VEITH,* KENNETH RICHARDS,* and PARVEZ LALEZARI,*
New York, N.Y.

Sponsored by ALLAN E. BLOOMBERG

Previous attempts to demonstrate the absolute functional adequacy of homografted lungs by ablation of contralateral pulmonary function have failed. Twenty dogs underwent left lung homotransplantation. When the pulmonary artery anastomosis was made distensible by spatulation of host and donor artery or by insertion of a vein patch, the vascular resistance of the transplant decreased 14-52% following ligation of the right pulmonary artery which was performed immediately after completion of the transplant. Recipients were treated with low dose azathioprine and rabbit anti-dog lymphocyte serum. All dogs lived at least 5 days after operation showing that transplanted lungs with a distensible arterial anastomosis can provide total pulmonary function and can vasodilate to accept the entire cardiac output without damage to the pulmonary microvasculature. Eleven dogs survived 4-20 weeks without pulmonary hypertension or decreased exercise tolerance. Eight still live. Thus, with distensible arterial anastomoses and heterologous anti-lymphocyte serum, lung homotransplantation can dependably produce recipient survival even when the transplant is responsible for total respiratory and pulmonary vascular function. These observations indicate the absolute functional adequacy of lung homografts and provide an experimental basis for lung homotransplantation in patients with pulmonary hypertension.

45. Intermittent Inflatable Endotracheal Cuffs

JAMES F. ARENS,* and JOHN L. OCHSNER, New Orleans, La.

Long-term controlled and assisted ventilation has resulted in complication secondary to the cuffs on either endotracheal or tracheostomy tubes. Constant cuff pressure causes ischemia of the tracheal wall with subsequent stenosis. A cuff that inflates only during the inspiratory phase of the respirator and deflates during the expiratory phase will allow better blood flow to the trachea. A device has been designed to produce a constant volume of air delivered only during inspiration to the cuffs when either a pressure cycle or volume cycle respirator is employed. Series of anesthetized dogs which were ventilated mechanically for 72 hours have been compared. Ten dogs had constantly inflated cuffs and another 10 had cuffs intermittently inflated by the designed device. At completion of the experiment the animals were sacrificed. In a similar series, the animals were allowed to recover and were sacrificed two weeks later. In each series the tracheae were compared grossly and microscopically. Results of this study revealed a marked difference. The advantages of the intermittently inflated cuff will be reviewed and the mechanical device used to inflate and deflate the cuff will be demonstrated. Use of this device should prevent tracheal ischemia associated with long-term ventilation.

46. Oxygen Consumption After Oxygen Therapy for Hypoxemia

A. G. GROVES,* J. H. DUFF,* A. P. H. MCLEAN,* R. LAPOINTE,*

and L. D. MACLEAN, Montreal, Quebec

Although increased oxygen concentration of inspired air will often correct hypoxemia, it has not been shown that oxygen therapy improves oxygen consumption (VO_2). This study attempts to determine the relationship between arterial pO_2 and VO_2 after administration of 50% O_2 to hypoxemic patients in septic shock, hypoxemic post-operative patients with atelectasis, and the dog with atelectasis produced by balloon occlusion of the right mainstem bronchus. In 5 hypoxemic patients with septic shock, average pO_2 while breathing 20% O_2 was 47 mmHg and average VO_2 was 272 ml/min. Administration of 50% O_2 increased average pO_2 to 87 mmHg but average VO_2 was unchanged (265 ml/min). Two of these patients had hyperlactacidemia (98 mg%, 74 mg%). Similarly, in 5 patients with atelectasis, 50% O_2 raised the pO_2 but VO_2 did not increase.

	CONTROL		ATELECTASIS	
	20% O_2	50% O_2	20% O_2	50% O_2
pO_2 mmHg	98.7	236.5	51.7	74.5
VO_2 ml/min	147.8	147.4	170.	167.
M.V. l/min	5.84	4.82	9.65	6.29

TEMP. 100.5° 100.13° | 102.2° 101.97°

The table summarizes data obtained from 10 dogs before and after bronchial occlusion. Although 50% O₂ increased average pO₂ in dogs with atelectasis, VO₂ was not increased pO₂ does not reflect VO₂. In ranges of pO₂ seen clinically, administration of 50% O₂ increased arterial pO₂ but failed to improve VO₂.

47. Mitral and Aortic Valve Replacement with Autogenous Fascia Lata on a Stent

W. STERLING EDWARDS, ROBERT B. KARP,* and DAVID ROBILLARD,*
Birmingham, Ala.

Autogenous tissue has not received extensive clinical trial in cardiac valve replacement because of difficulty in constructing functioning valves at the operating table. Senning reports occasional incompetence from tailoring errors in constructing aortic valves of fascia lata, but in those with competent valves, he reports a five year follow-up without degeneration or calcification of the fascia, which is quite impressive. A technique has been developed to construct tricuspid semilunar valves of autogenous fascia lata. Fascia is cut to a pattern, folded over a mold designed from the sinuses of valsalva and sutured to a rigid metal stent. The stent is not cloth covered, but is completely covered by fascia so that no foreign material is exposed to blood and so that autogenous tissue is sutured directly to the valve ring for secure healing. The valve is constructed and tested for competence with water pressure while the chest incision is made and cannulations performed. Human aortic and mitral valves have been successfully replaced using this technique. Valves of this design can be inserted as quickly as a prosthesis. They can be made any size; procurement, sterilization and storage are not a problem, and there should be no rejection.

48. A New Technique for Replacement of the Mitral Valve by a Homograft Semilunar Valve

MAGDI H. YACOUB,* and C. FREDERICK KITTLE, Chicago, Ill.

In 13 patients the mitral valve was replaced with either an aortic or pulmonary homograft; in 7 of these the aortic valve was also replaced with a homograft. A new technique of implanting the aortic valve in the mitral position has been devised to maintain function of the aortic sinuses, to allow mobility of the mitral orifice, and to avoid any protrusion into the left ventricular cavity. These have been mentioned as criticisms of previous techniques. The aortic valve and its adjacent aorta are sutured at both ends to a Dacron tube slightly longer than the sinuses are deep. A collar of pericardial-covered Dacron is attached to the atrial side of the graft. The ventricular side of this prosthesis is sutured first to the mitral annulus; on the atrial side the collar is sutured to the atrium constituting a new atrial floor. Of 13 patients (34 to 68 years old) 10 are living and well; 5 are double and 5 single valve replacements. Valves were generally prepared by radiation and freezing. Postoperative results from 2-12 months indicate a very good correction of the hemodynamic lesion. In no instance has anticoagulant therapy been used or thrombo-embolic phenomena observed.

49. Hemodynamic State Following Open Mitral Valve Replacement and Reconstruction

CLAUDE A. ROULEAU,* ROBERT L. FRYE,* and F. HENRY ELLIS, JR.,

Rochester, Minn.

Hemodynamic studies were carried out preoperatively, at operation, for 3 days after operation, and prior to dismissal in 36 patients undergoing open operations on the mitral valve. In 27 patients the valve was resected and replaced, a Kay-Shiley disc valve being used in 9, a Smeloff-Cutter full orifice ball valve in 9, and a Starr-Edwards valve in 9. Nine patients had mitral valve reconstruction. The cardiac index was lowest on the afternoon of operation, (1.9 (L/min/M²) after prosthetic replacement and 1.5 (L/min/M²) after valve reconstruction) but increased from a preoperative mean of 2.1 to 3.1 at dismissal after valve replacement and from 2.2 to 2.9 after reconstruction. LA and PA pressures decreased immediately after operation. Pulmonary arteriolar resistance showed an early increase but was below preoperative values at dismissal. Left ventricular enddiastolic pressure was above normal in the immediate postoperative period. There was no statistically significant difference in hemodynamics between the four operative procedures. It is concluded that the low cardiac output seen after open operations on the mitral valve is not related to the presence of a prosthesis within the heart, to valve design or to the disruption of normal chordal papillary attachments.

*By Invitation

WEDNESDAY AFTERNOON, APRIL 2, 1969

2:00 P.M. Scientific Session: REGULAR PROGRAM Grand Ballroom

50. Bronchoplastic Procedures for Bronchogenic Carcinoma

DONALD L. PAULSON, HAROLD G. URSCHEL, JR., J. JUDSON MCNAMARA,*
and ROBERT R. SHAW, Dallas, Texas

Bronchoplastic procedures in combination with radical lobectomy have been used for bronchogenic carcinoma in 52 patients since 1952, 6 per cent of all resections. The procedure is feasible and applicable for the localized hilar carcinoma, preferably without nodal involvement, but it may be used also as a compromise with pneumonectomy for the more extensive lesion. Preoperative irradiation has been used for 20 patients to attain better localization. The site of greatest usefulness for this procedure is the localized epidermoid carcinoma involving the right upper lobe bronchial orifice (35 patients). Wide sleeve resection of the right main bronchus combined with right upper lobectomy, thorough mediastinal nodal dissection,

and anastomosis of the intermediate bronchus to the stump of the main bronchus accomplishes the same ends as a pneumonectomy, with the advantage of preservation of the middle and lower lobes. The results to date, calculated by the life table method, indicate a 40 per cent overall 5-year survival rate, 50 per cent in the group of patients in whom the procedure was done deliberately as an adequate operation for the particular carcinoma concerned and 20 per cent for those in whom it was done as a compromise with pneumonectomy.

51. Preoperative X-ray Therapy as an Adjuvant in the Treatment of Bronchogenic Carcinoma

T. W. SHIELDS, Chicago, Ill., G. A. HIGGINS, JR.,* R. L. LAWTON,*
A. HEIBRUM,* and R. J. KEEHN,* Washington, D.C.

A randomized study of preoperative X-ray therapy in patients with bronchogenic carcinoma was carried out by VA Surgical Adjuvant Cancer Chemotherapy Study group. One hundred sixty-seven patients were randomized for preoperative X-ray therapy and 165 as controls. An X-ray dose of 4,000 r to 5,000 r was given in 4 to 6 weeks followed by operation within 4 to 6 weeks. The control patients were operated upon shortly after randomization. Eighty-six of the treated patients and 90 of the control patients were resected. Twenty X-ray patients and 63 controls underwent thoracotomy only. No operative procedure was performed in the remaining patients. The 30-day mortality and morbidity were essentially the same in both groups. The last patient was accepted for study 10 months ago and the last operation was performed 7 months ago. A marked difference in survival, six months following clinically curative surgery was seen: 44.6% for preoperative X-ray patients and 81.7% for controls, $P < 0.01$. The reasons for the poor survival in patients treated with X-ray therapy are obscure, but does not appear to be related to delay in performing surgery. Routine preoperative X-ray therapy in patients with bronchogenic cancer appears of little benefit and actually may exert a harmful effect resulting in a substantially reduced survival following curative resection.

52. Abdominal Exploration in the Evaluation of Patients with Carcinoma of the Thoracic Esophagus

JAMES M. GUERNSEY,* and D. FREDERICK KNUDSEN,* Stanford, Calif.
Sponsored by JAMES B. D. MARK

Five year survival is uncommon for patients with carcinoma of the thoracic esophagus. In an attempt to select patients who would benefit from preoperative x-ray therapy, forty patients with carcinoma of the thoracic esophagus in whom no metastatic carcinoma could be found by conventional means, were subjected to exploratory laparotomy prior to embarking on this treatment plan. At abdominal exploration, sixteen of the forty patients had metastatic squamous cell carcinoma from the esophagus in the celiac lymph nodes. No patient had tumor outside of these lymph nodes. All patients were then subjected to 6,600 rads of 6 MeV radiation to the primary lesion and to the celiac lymph nodes if they were involved with tumor. Four weeks later, total esophagectomy with simultaneous reconstruction was carried out when possible. All sixteen patients with metastatic carcinoma of the celiac lymph nodes are dead of their disease within eleven months of the beginning of treatment. Of the twenty-four patients with negative celiac lymph node biopsies, only ten have died of their disease. Our experience demonstrates that patients with metastatic esophageal carcinoma in the celiac lymph nodes are not candidates for radical radiation therapy or surgery.

53. Spontaneous Rupture of the Esophagus: A Review of a Large Series and Comments on a New Method of Treatment

OSLER A. ABBOTT, WILLIAM D. LOGAN, JR., CHARLES R. HATCHER,
and PANAGIOTIS N. SYMBAS,* Atlanta, Ga.

A study of 41 cases of spontaneous rupture of the esophagus is presented. These have resulted from the usual causes; i.e. posterior fossa brain surgery, alcoholism, pre-existing lower esophageal disease, and some idiopathic cases. Comparison of the result of 22 cases treated without open thoracotomy versus a more aggressive approach is made, especially those in which a positive diagnosis was made within 48 hours of onset. Special emphasis is placed on nine (9) patients diagnosed after 24 hours who are treated by a special "T-tube" method. Survival in this group was remarkably high, especially when compared to a similar group of equally late diagnoses in whom direct surgical repair was performed. Certain errors in application of the "T-tube" method were noted in all such cases which did not survive or had major complications. In those patients wherein this type of treatment was applied correctly, we experienced no deaths, major complications or strictures. Certain diagnostic points are emphasized which should lead to earlier recognition of this disease.

54. Clinical and Hemodynamic Assessments of Fabric-Covered Starr-Edwards Prosthetic Valves

ROBERT L. REIS,* D. LUKE CLANCY,* KEVIN O'BRIEN,*
STEPHEN E. EPSTEIN,* and ANDREW G. MORROW, BETHESDA, MD.

Fabric-covered Starr-Edwards prostheses (Model 2300 aortic, models 6300 and 6300c mitral) were utilized in 96 patients. None of 13 early deaths was related to valve function. No late deaths occurred in 33 patients surviving isolated aortic replacement; 3 have had cerebral emboli, and 2 have severe hemolytic anemia. Thirty-five patients survived isolated mitral replacement; 4 have had systemic emboli, 2 of which were fatal. Three of 15 patients living after multiple replacements have died late (valve unrelated), and 2 others have had emboli. In 22 patients with aortic prostheses resting peak systolic gradients, measured 6 months post-operatively, averaged 43 mm. Hg (12-75); aortic areas averaged $0.60 \text{ cm}^2/\text{M}^2$ (0.35-1.07). In 28 patients with mitral prostheses, mean left atrial pressure averaged 16 mm. Hg (6-28) at rest, and 28 mm. Hg (20-40) during exercise; orifice areas averaged $1.03 \text{ cm}^2/\text{M}^2$ (0.67-1.43) for 2M, and $1.18 \text{ cm}^2/\text{M}^2$ (0.82-1.69) for 3M valves. Nine of the 77 surviving patients remain severely symptomatic (class III or IV), all have poor hemodynamic results, and one mitral prosthesis has been replaced. Serial hemodynamic assessments, now in progress, will indicate

whether the valves are stenotic at insertion or become so from tissue ingrowth. Valves of these designs are no longer employed in this clinic.

55. Early Clinical Results with Cloth-Covered Prosthetic Cardiac Valves

F. C. SPENCER, R. H. CLAUSS, G. E. REED, and D. A. TICE,
New York, N.Y.

Cloth-covered, steel-ball prosthetic valves were recently developed to decrease thromboembolism and ball variance. In the 12 month period ending September, 1968, 119 such prostheses were inserted as single or double valvular replacements, with 16 deaths within one month after operation. Anticoagulant therapy was begun 4 to 7 days after operation and continued indefinitely. Only one embolus has occurred (incidence approximately 1 per cent), a massive fatal one 15 days after operation. In an earlier reported series of 66 mitral replacements, the frequency of thromboembolism was 12 per cent. Prosthetic valve function has been excellent to date, with no recognized occurrence of late stenosis of the cloth-covered prostheses. A detailed clinical comparison of the new prostheses with over 430 previous ones (Starr-Edwards, disc, Magovern) will be presented.

56. The Experimental and Clinical Results of a Modified Cage Disc Mitral Prosthesis

G. J. MAGOVERN, F. R. BEGG,* E. M. KENT, W. B. GUSHING,*
M. L. GERBER,* and D. L. FISHER,* Pittsburgh, Pa.

The process of tissue encapsulation of heart valve prostheses has been effective in reducing thromboembolic complications but has introduced additional functional problems. This paper describes our experimental results following several modifications of a cage disc mitral prosthesis designed to prevent the complications specific to cloth covering a valvular prosthesis, and describes the clinical results in thirty patients in whom the most favorable design was ultimately employed. There were four hospital deaths and one late death, and the remaining twenty-five patients are well. Anticagulation was maintained for three to six months and then discontinued and there have been no early or late thromboembolic complications, one month to twelve months following insertion. We feel this prosthesis has several advantages: 1. Total Dacron cloth covering to permit encapsulation. 2. A vertical cuff sewing ring to facilitate placement and prevent inflow orifice tissue impingement. 3. A hypobaric metallic disc which as yet has not caused cloth distinction. Follow-up results and postoperative catheterization data will be presented on all survivors. The results show that the design of the fixation ring, the method of covering the cage, the type of material employed, the design of the disc and the fixation position, all have a bearing on the ultimate result.

57. Internal Thoracic (Mammary) Arteriography: A Questionable Index of Myocardial "Revascularization"

Y. KATO,* C. H. DART, JR.,* R. G. FISH,* W. M. NELSON,*
S. M. SCOTT, and T. TAKARO, Oteen, N. G.

Internal thoracic (mammary) arteriograms performed on 139 patients one to five years after implant operations showed that 31% of implants could opacify coronary arteries well, 55% poorly or not at all, and in 7% implants were occluded. Nevertheless, late mortality, incidence of infarction, and relief of symptoms were similar in all three groups. There was striking variation in coronary opacification, depending on position of catheter tip. The significance of this variation was studied in 140 implant arterio-grams in nine previously operated animals. Arteriography itself almost always caused temporary elevation of implant flow. If the volume of contrast medium was kept constant, the number of opacified vessels and the intensity of opacification varied directly with injection pressure and measured flow in the implant induced during arteriography. In some patients, and in all animals in which arteriography produced increase in implant flow, the contrast medium instead of progressing distally in the usual manner, appeared to move back and forth in the opacified proximally occluded coronary, suggesting movement against intercoronary collateral flow. Since internal thoracic arteriography itself alters implant flow, this procedure cannot be used as a quantitative evaluation of myocardial revascularization. These observations help to explain the inconsistencies in the clinical results following internal thoracic artery implantation.

58. The Aggressive Surgical Approach to Coronary Disease

W. DUDLEY JOHNSON,* HAROLD HARDING,* and DERWARD LEPLEY, JR.,
Milwaukee, Wis.

The published criteria of acceptable risks for coronary artery surgery have often denied help to the patients most in need. For 20 months we have extended our criteria so that 192 of 197 patients presented have been accepted for surgery (advanced age, 3-vessel disease and elevated end-diastolic pressure notwithstanding). Impressive results have been achieved using combinations of the following three basic procedures: (1) All ventricular aneurysms are excised (21 patients), (2) All avascular areas of the left ventricle are attacked using 4 to 9 separate arterial implants from a single internal mammary artery pedicle, and (3) Immediate improvement in coronary flow using vein grafts from the ascending aorta to any available coronary vessel (28 patients). Fifteen of the 28 vein grafts were placed to branches of the main coronary arteries. All those restudied to date show patent veins and improved coronary flow. The mortality has been 11% and is lower in the group with vein grafts. One hundred per cent clinical follow-up has been accomplished and only five of 192 patients are unimproved at two months or longer after surgery. A description of operative techniques and representative postoperative angiograms will be presented.

59. Left Ventricular Resection for the Poorly Functioning Heart with Coronary Artery Disease

JEROME HAROLD KAY, EDWARD F. DUNNE,* BERNARD G. KROHN,*
HAROLD K. TSUJI,* JOHN V. REDINGTON,* ADOLFO MENDEZ,*
and OSCAR MAGIDSON,* Los Angeles, Calif.

Large portions of the left ventricle distal to the papillary muscles have been removed from thirteen patients with pronounced coronary artery disease, revealed by selective coronary arteriography. Portions of the ventricular septum have been removed also. In four more patients, the non-functioning posterior portion of the left ventricle has been plicated. In fourteen patients, revascularization was also performed. Preoperatively, a forward left ventriculogram in all patients revealed a noncontractile distal % to % of the left ventricle or nonfunctioning posterior portion of the left ventricle. Before surgery, the left ventricle in these patients ejected only 20 to 53% of the end-diastolic volume (normal 70%). After surgery, ventriculographic studies in ten patients revealed the ejection fractions to be normal or significantly improved. Removing the noncontractile distal % to % of the left ventricle or plication of the posterior portion of the left ventricle significantly improved the cardiac function. These areas are not aneurysms and differ in that the involved areas have muscle with fibrous involvement.

*By Invitation

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