PRESIDENTIAL ADDRESS
CHANGING CONCEPTS IN THORACIC VASCULAR SURGERY

Michael E. De Bakey, M.D., Houston, Texas

MY FIRST thought at this time is to express my sincere and grateful appreciation for the signal honor which you have accorded me as President of this Association. After observing the list of distinguished men who have preceded me on these occasions, my pleasure in receiving this honor is exceeded only by my sense of humility. My next thought is to express my deep gratitude to the other officers of the Association, particularly our Secretary, Dr. Langston, and our executive assistant, Miss Hanvey, who have performed their duties with such diligence and efficiency that mine required little more than occasional concurrence and courteous attention.

In the selection of an appropriate topic for this occasion it seemed to me that, first, it should be sufficiently challenging to merit your attention and, second, it should be related to an area of work in which I have had intensive interest. During the past decade my associates and I have devoted our main efforts and attention to surgical approaches to certain cardiovascular problems. Among these, I have been especially concerned with diseases of the aorta and major arteries, and particularly aneurysmal and occlusive lesions. Accordingly, I should like to discuss some of the more significant observations derived from our experience during this period as they pertain particularly to conceptual and technical developments as well as to factors having an important bearing upon successful application of the operative procedure.

In general, the primary objectives of therapy have been removal of the lesion and restoration of vascular continuity. With increasing experience, however, certain modifications in this concept of surgical treatment have evolved, depending largely upon the nature of the disease. In aneurysms, for example, extirpation of the lesion or its complete obliteration is essential. In some instances this may be accomplished by complete excision of the diseased segment, whereas in other instances this purpose may be achieved with greater technical facility by partial excision and endoaneurysmorrhaphy. In occlusive diseases, on the other hand, removal of the lesion is not always essential and indeed in some instances is even undesirable. Under these circumstances the major problem is concerned with the hemodynamic disturbances produced by

From the Cora and Webb Mading Department of Surgery, Baylor University College of Medicine, Houston, Texas.

Presented at the Thirty-ninth Annual Meeting of The American Association for Thoracic Surgery at Los Angeles, Calif., April 21-23, 1959.

the occlusive process, whether it is of congenital origin, such as in coarctation, or of acquired origin, as in atherosclerosis. Accordingly, the primary objective of therapy in these conditions is correction of the hemodynamic disturbances and restoration of normal circulation. This may be readily achieved by means of the bypass graft without removal of the occlusive lesion, thus

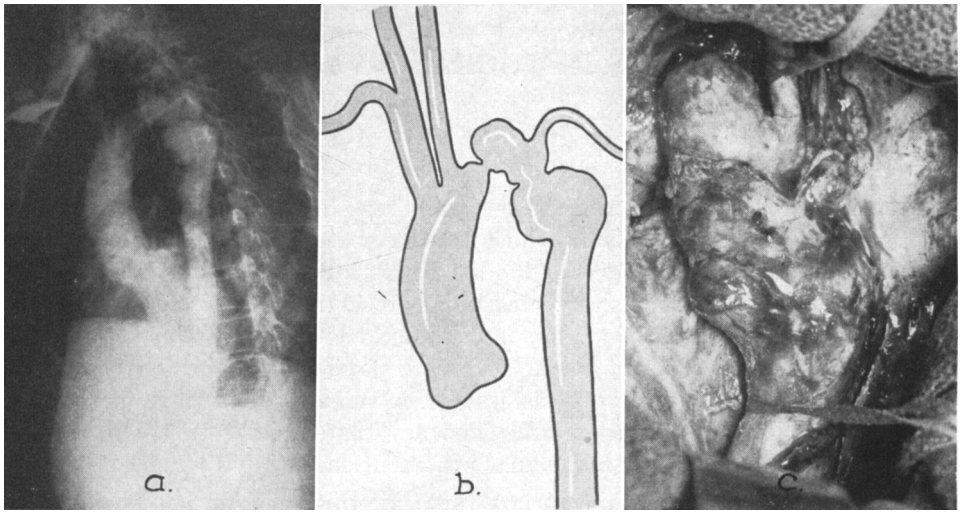

Fig. 1.—*a*, Preoperative angiocardiogram of patient with coarctation of aorta associated with aneurysmal formation, as depicted in *b* drawing. *c*, Photograph made at operation following exposure and immediately before resection of lesion.

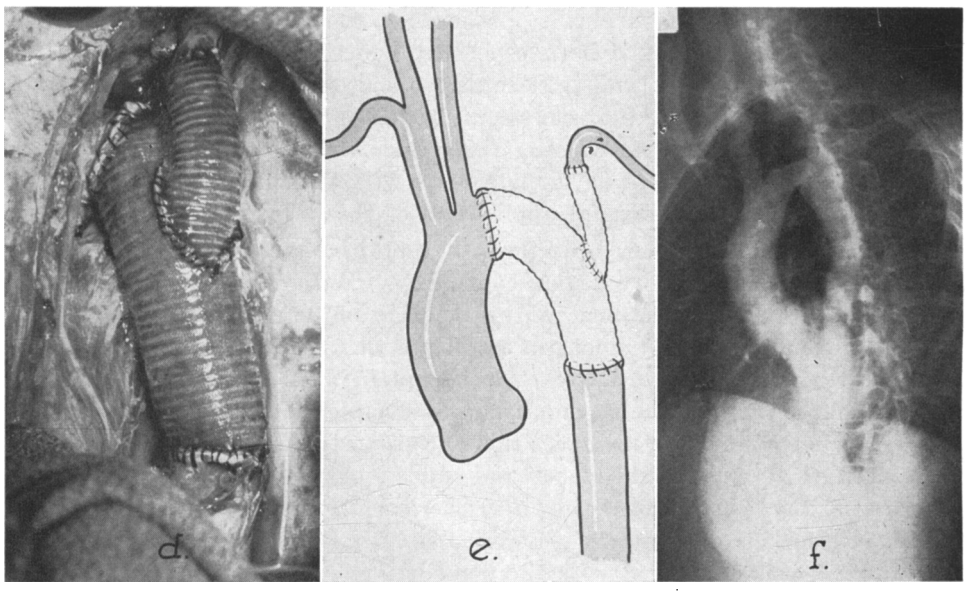

Fig. 1.—Cont'd. *d*, Photograph made at operation showing completed replacement of resected segment of coarctation and aneurysm of aorta with knitted crimped Dacron "graft," as depicted in *e* drawing. *f*, Angiocardiogram in same patient made about 2 months after operation showing normal restoration of vascular continuity and function.

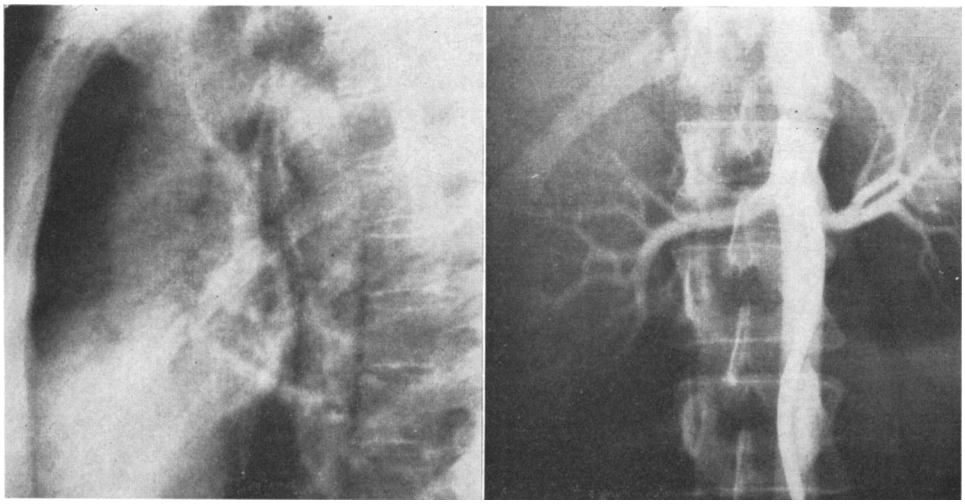

Fig. 2*A*.—Preoperative angiocardiogram and retrograde aortogram in patient with coarctation involving lower descending thoracic and upper abdominal aorta with marked calcification of latter segment.

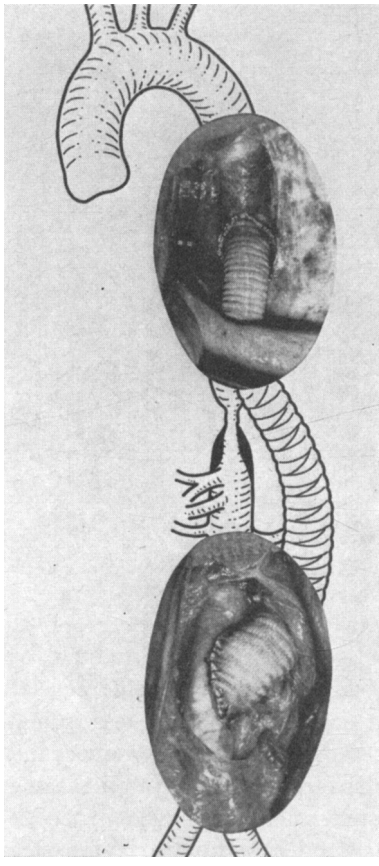

Fig. 2*B*.—Photographs made at operation with drawings in same patient illustrating application of bypass principle in patient with coarctation of aorta involving lower descending and upper abdominal aorta. The knitted crimped Dacron graft has been attached by end-to-side anastomosis to descending thoracic aorta above coarctation and similarly to abdominal aorta below coarctation.

avoiding some of the difficulties and hazards associated with excision and graft replacement. To be sure, extirpation of the coarcted segment with end-to-end anastomosis or with graft replacement is preferable in most of the usual forms of coarctation and should always be done in those associated with aneurysmal formation (Fig. 1). But in some of the more unusual types, particularly those associated with relatively long coarcted segments extending in some instances into the abdominal aorta, the use of the bypass graft principle has proved to be an entirely effective and much simpler technical procedure (Fig. 2). Similarly, in occlusive lesions involving the major

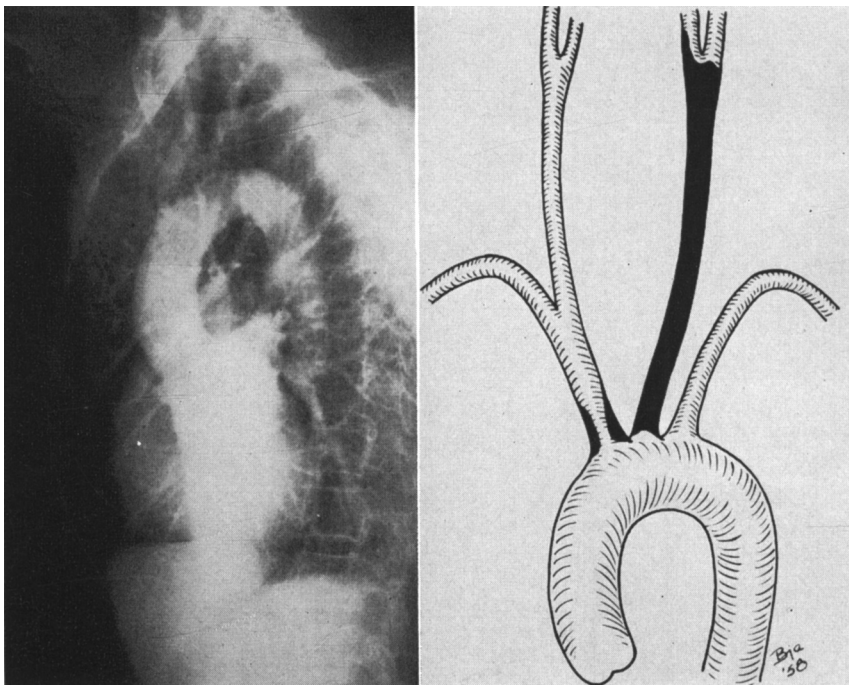

Fig. 3A.—Angiocardiogram in patient with atherosclerotic occlusive disease of major branches of aortic arch showing incomplete occlusion of innominate artery and complete occlusion of left common carotid artery, as depicted in drawing at right.

branches of the aortic arch, most of which are of atherosclerotic origin, the bypass graft principle has proved to be the most satisfactory procedure in most cases (Fig. 3). In a small proportion of these cases, in which the occlusive process is well localized and involves only one of these vessels, thromboendarterectomy may be the preferable procedure.

The most important consideration in the application of excisional therapy for aneurysms of the thoracic aorta is concerned with the necessity for temporary arrest of aortic circulation through the segment to be resected. The potentially hazardous consequences of this procedure are increased vascular resistance upon the heart with left ventricular strain and ischemic damage to the tissues distal to the occlusion, most important of which are the central nervous system and the kidneys. In general, this problem assumes increasing

significance as the level of occlusion becomes closer to the heart. Control of these factors, therefore, is of vital importance. Several methods may be used for this purpose depending upon the nature, extent, and location of the aneurysm. Among these, hypothermia was first used but, because of certain disadvantages associated with its application, it has been replaced by other methods which have been found superior. For most aortic aneurysms in which the proximal occluding clamp may be applied distal to the left common carotid artery, the most satisfactory method in our experience consists in the

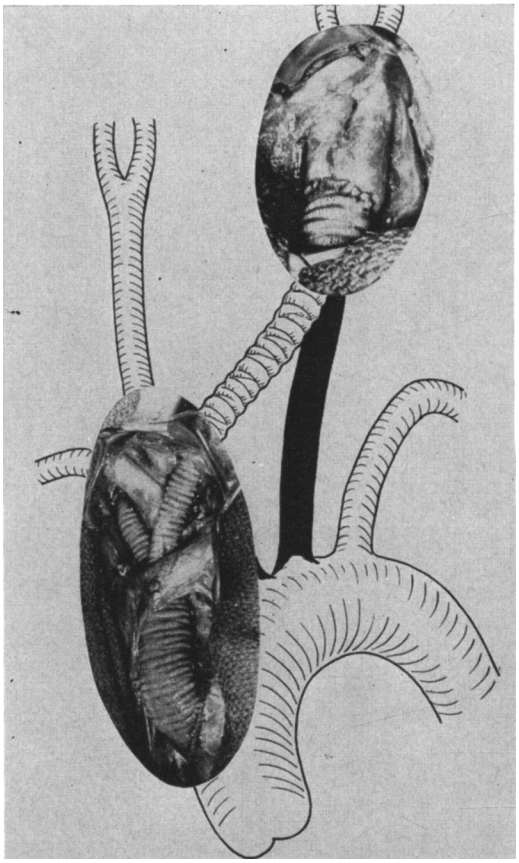

Fig. 3*B*.—Photograph in same patient made at operation with drawing illustrating application of bypass principle. The bifurcation Dacron "graft" has been attached by end-to-side anastomosis to ascending aorta, and in a similar manner the right limb of the graft has been attached to the right subclavian artery while the left limb of the graft has been anastomosed end-to-end to the endarterectomized distal opening of the left common carotid artery just below the bifurcation.

use of a pump bypass in which oxygenated blood is removed from the left auricle and pumped into the aorta distal to the occluding clamps through a plastic cannula inserted upward into the left femoral artery (Fig. 4). The major advantages of this method lie in the fact that it provides adequate circulation distal to the level of aortic occlusion to permit viability and even function, as reflected by renal function studies during this period, and to

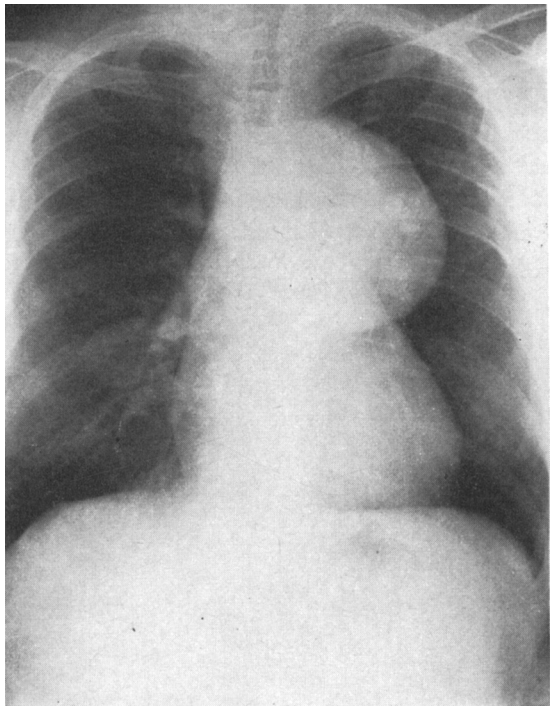

Fig. 4*A*.—Preoperative roentgenogram of chest in patient with large fusiform aneurysm of descending thoracic aorta.

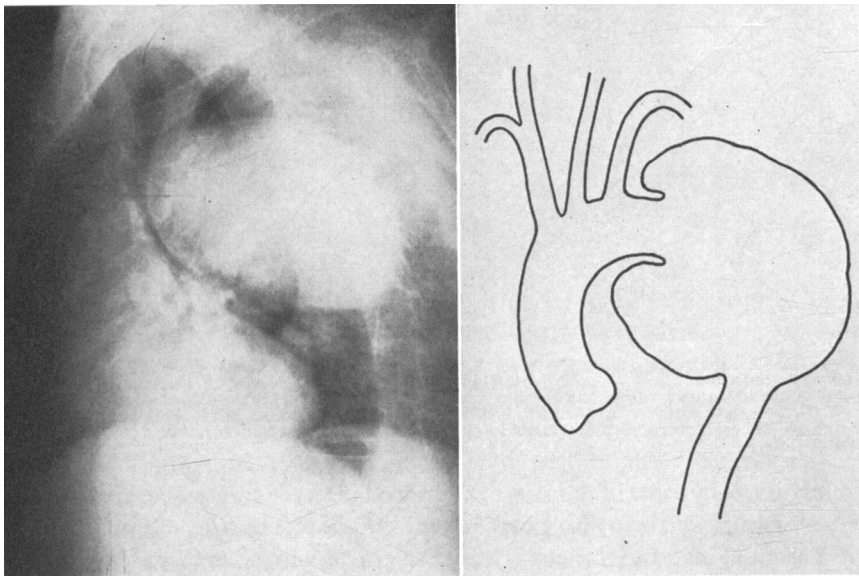

Fig. 4*B*.—Angiocardiogram in same patient showing location and extent of lesion, as depicted in drawing at right.

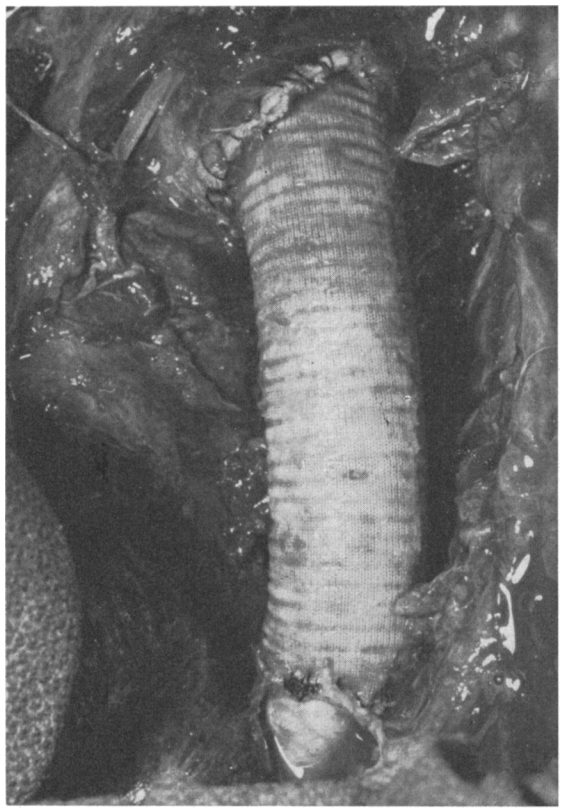

Fig. 4C.—Photograph made at operation showing completed replacement of excised segment of aorta and aneurysm with knitted crimped Dacron "graft."

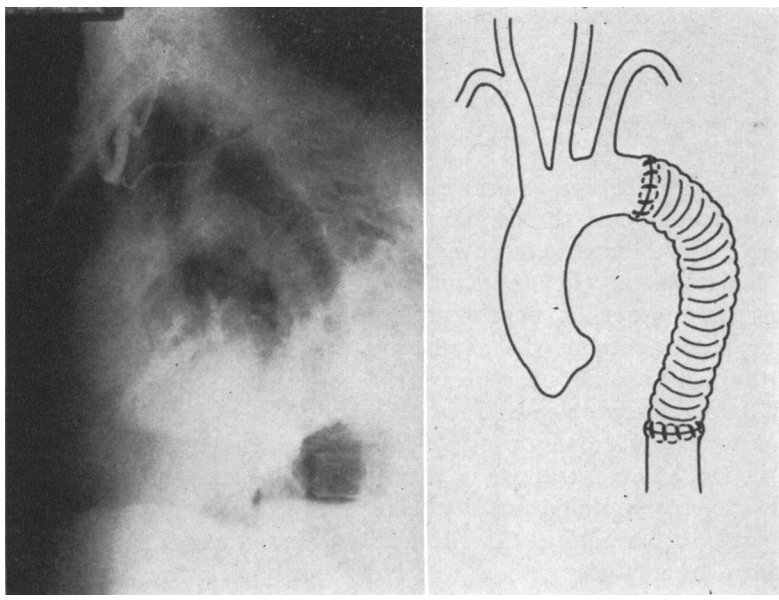

Fig. 4D.—Angiocardiogram in same patient made after operation showing relatively normal vascular continuity and function as depicted in drawing at right.

prevent serious left ventricular strain by maintenance of blood pressure at near normal levels. Although this method has been found to be the most satisfactory for aneurysms located in this region, it is not completely effective in preventing spinal cord damage, since among our 55 patients in whom this method was used, some manifestations of this complication occurred in 2. In this connection, it should be noted that in our earlier experience with hypothermia a somewhat similar incidence of the occurrence of this complication was encountered. This remains a rather baffling problem, as it has not been possible to correlate the occurrence of the complication with any significant

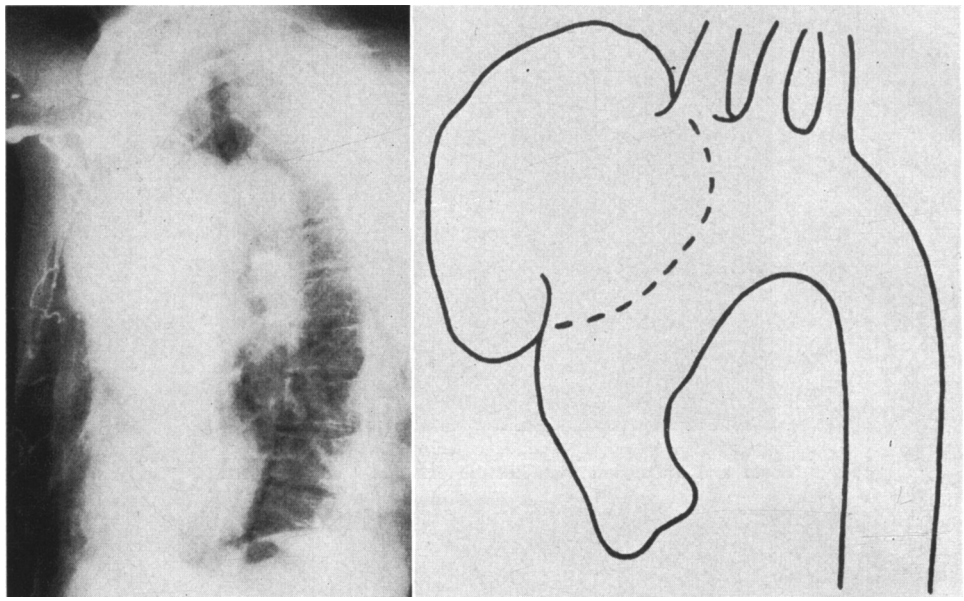

Fig. 5A —Angioaortogram of patient with large sacciform aneurysm involving ascending aorta as depicted in drawing at right.

factors, such as duration of occlusion, extent of resected segment, or pump bypass flow rates. For these reasons, along with other observations, we are inclined to believe that the more significant factors pertaining to this problem include variations in the anatomic pattern and segmental distribution of spinal arteries and development of collateral circulation.

Aneurysms involving the aortic arch that are located proximal to the level of the left common carotid artery are associated with much more difficult and hazardous problems, since arrest of aortic circulation at this level, even for a few minutes, may produce fatal heart failure or ischemic damage to the brain. Only in a few cases of sacciform aneurysms with a relatively narrow neck are these problems avoided, since they may be treated by tangential excision and aortorrhaphy. In all fusiform aneurysms, however, and even in sacciform aneurysms with a relatively wide neck that encroaches upon more than half the aortic circumference, measures must be taken to overcome the serious consequences of temporary arrest of aortic circulation at this level. Our experience with several methods which have been used for this purpose

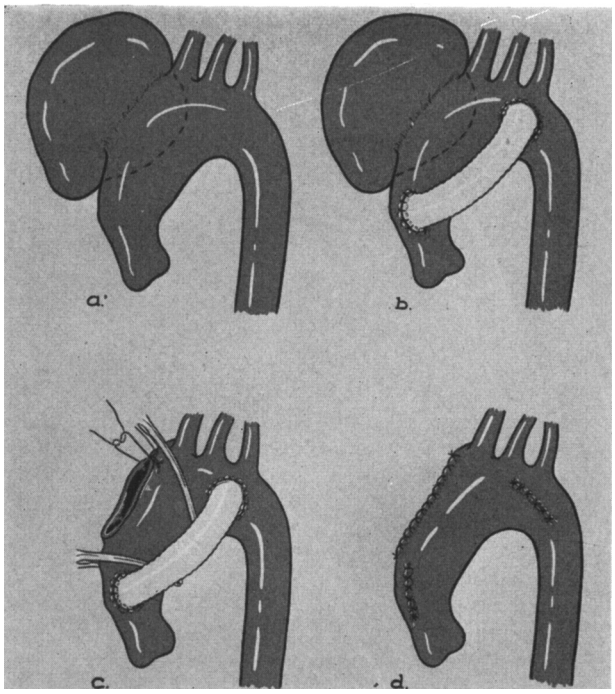

Fig. 5*B*.—Drawings illustrating surgical method of treatment employed in this patient utilizing temporary bypass graft to maintain aortic circulation during resection of aneurysm and repair by aortorrhaphy.

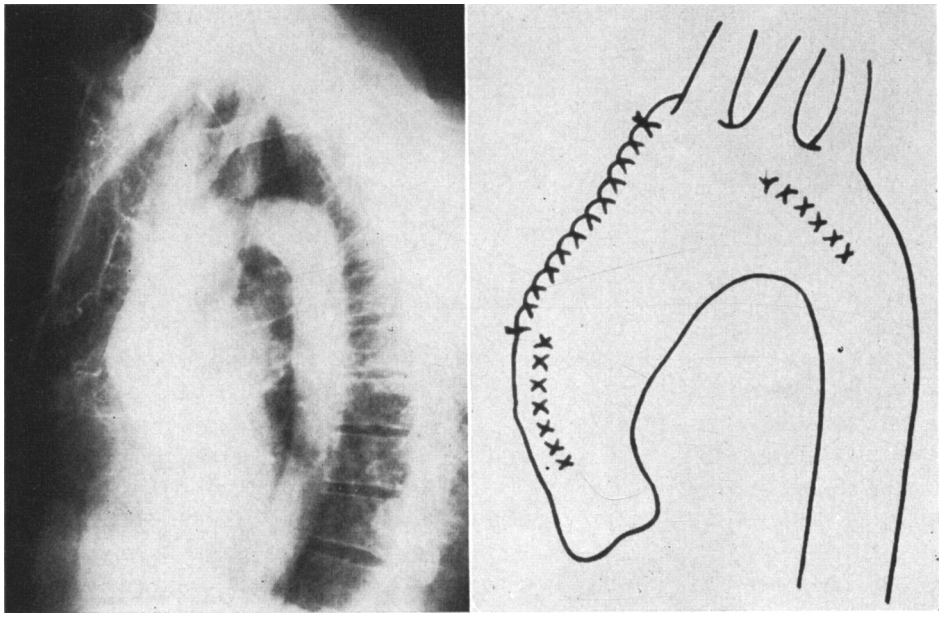

Fig. 5*C*.—Postoperative angiocardiogram in same patient showing relatively normal aortic continuity and function as depicted in drawing at right.

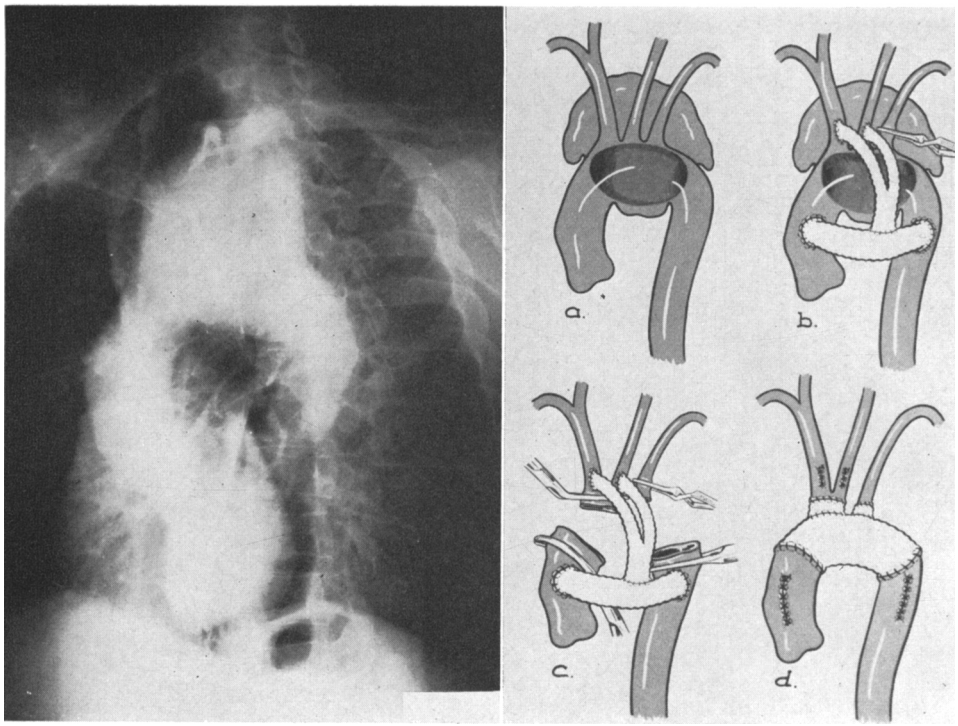

Fig. 6*A*.

Fig. 6*B*.

Figs. 6*A* and 6*B*.—*For legends see opposite page.*

would suggest that the critical determining factor in their application is the proximal extent of the aneurysm. Accordingly, the major factor in determining the method to be employed is dependent upon whether or not the aneurysm involves the proximal 3 or 4 cm. of the ascending aorta. Thus, in patients without involvement of this segment of the ascending aorta, the temporary bypass principle is employed. By this means and with the use of partial

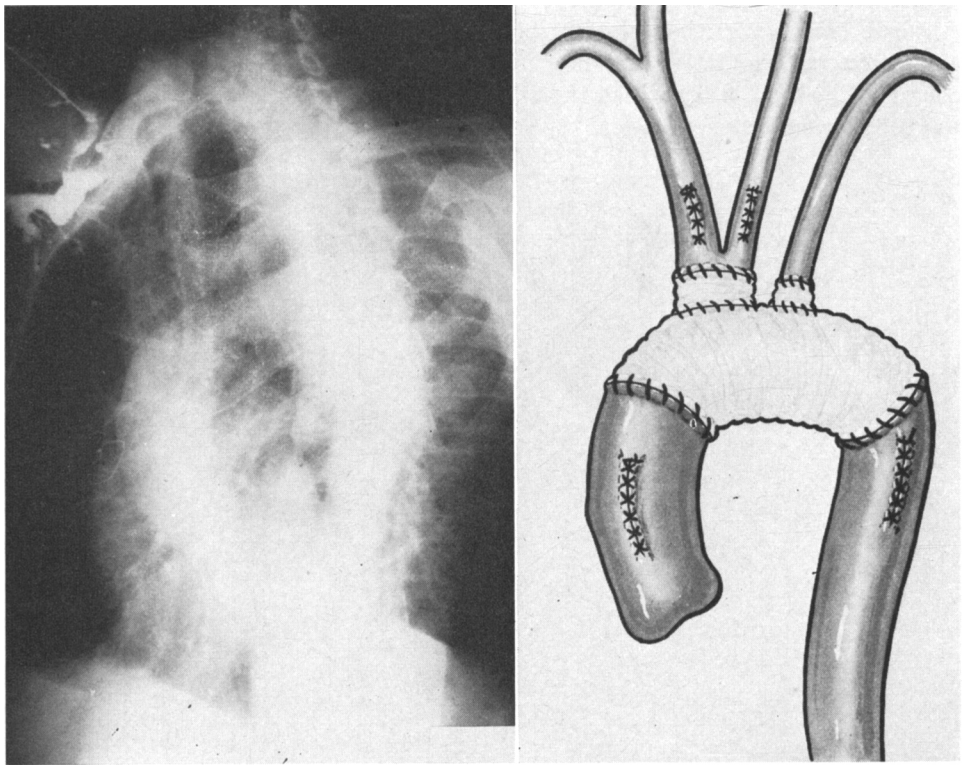

Fig. 6*C*.—Postoperative angiocardiogram in same patient showing relatively normal aortic vascular continuity and function in replaced segment of aortic arch as depicted in drawing at right.

occlusion clamps and end-to-side anastomosis, the bypass graft may be readily applied proximal and distal to the aneurysm after which the aortic segment to be removed may be isolated from the circulation with maintenance of relatively normal aortic circulation during the entire procedure (Fig. 5). In patients in whom the innominate and left common carotid arteries are also involved, appropriate branches from the bypass graft are extended to these vessels to provide cerebral circulation (Fig. 6). In this connection two technical principles have been evolved which have enhanced the simplicity and

Fig. 6*A*.—Preoperative angioaortogram showing large fusiform aneurysm involving aortic arch as depicted in drawing (*a*) at right. Drawings (*b*, *c*, and *d*) show method of surgical treatment employed in this patient utilizing temporary bypass Dacron graft to maintain aortic and carotid circulation during resection of aneurysm.

Fig. 6*B*.—Photograph made at operation showing completed replacement of excised segment of aortic arch and aneurysm with Dacron graft including anastomoses to innominate, left common carotid, and left subclavian arteries.

facility of the operative procedure. The first is concerned with the application of the bypass graft to the carotid arteries. In some cases, performance of end-to-side anastomosis on these vessels by use of a partial occluding clamp is technically difficult or may be associated with sufficient narrowing of the lumen to interfere significantly with cerebral circulation. These difficulties may be readily overcome with the use of the temporary internal shunt principle (Fig. 7). This can be easily done by use of a No. 14 soft polyethylene tube, approximately 10 cm. in length, which can be inserted through an opening in the artery in the same manner as a T-tube is inserted into the common bile duct, after which the artery is circumferentially tightened against the tube by means of umbilical tapes which had previously been looped around

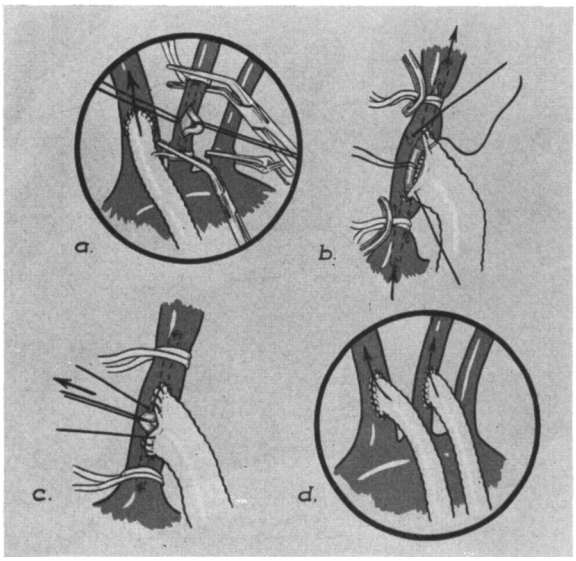

Fig. 7.—Drawings illustrating use of internal shunt principle to maintain circulation in carotid artery during end-to-side anastomosis of graft.

the vessels. While circulation is maintained through this polyethylene tube, the end-to-side anastomosis of the graft to the linear incision in the artery is performed and, just before the last few anastomotic sutures are tightened, the tube is quickly removed and the anastomotic sutures are tightened and tied. By this means cerebral circulation is interrupted for only a matter of seconds.

The second principle is concerned with conversion of the temporary bypass graft into the permanent graft. This has become possible with the development of the Dacron tube as a vascular replacement, which may be used as a temporary bypass graft as well as a graft replacement for the excised aortic segment. Although it is not always necessary or desirable to convert the temporary shunt into the permanent graft, under some circumstances it may have a distinct advantage in reducing the extent of the operation, particularly in cases in which the major branches of the aortic arch are involved in the procedure. Its further advantages will be discussed later in consideration of more extensive aneurysms involving both the thoracic and abdominal aorta.

Aneurysms that involve the proximal segment of the ascending aorta constitute by far the most serious and challenging problems in this field of surgery. Under these circumstances it becomes necessary to employ the cardiopulmonary bypass method with use of the artificial heart-lung apparatus. Application of this method imposes certain additional problems some of which have yet to be satisfactorily solved. For one thing, many of these patients are in the sixth to eighth decades of life and are likely to have varying degrees of associated heart disease. Temporary interruption or even decrease in coronary circulation in such patients is poorly tolerated and fatal heart failure may ensue. Second, owing to the necessity for heparinization in application of this method, control of hemorrhage in the grafted segment after completion of the procedure may be extremely difficult, despite the use of measures to counteract heparinization. To be sure, some success has been

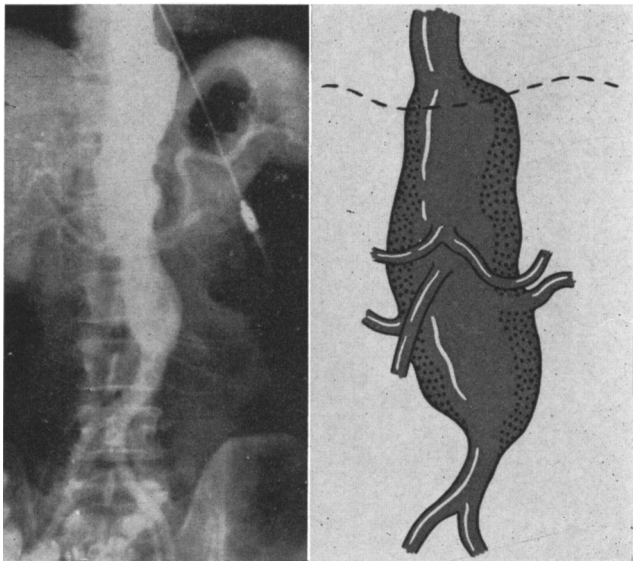

Fig. 8A.—Preoperative aortogram in patient with large fusiform aneurysm involving lower descending thoracic and upper abdominal aorta including major abdominal visceral branches of aorta as depicted in drawing at right.

achieved in application of this method, but an almost equal number of failures has occurred, resulting mainly from the aforementioned problems. It is thus apparent that this represents an area in which there is need for more clinical and experimental investigations, particularly in regard to improved methods of maintaining coronary artery perfusion.

Increasing experience in the surgical management of aortic aneurysms and in these various technical procedures has gradually permitted assumption of a more aggressive role in the application of excisional therapy for the more extensive lesions which were formerly considered inoperable. The limitations of this method of therapy have thus been steadily extended. Indeed, so far as the lesion itself is concerned, there are now few contraindications to resection. This is well exemplified by the successful application of this method

of treatment in patients having aneurysms involving the entire descending thoracic and upper segment of the abdominal aorta or the lower descending and entire abdominal aorta (Fig. 8). Similarly, patients with separate fusiform aneurysms of the thoracic and abdominal aorta have been successfully treated by this means (Fig. 9). In patients with such extensive aneurysms and particularly those involving the lower descending thoracic and upper segment of the abdominal aorta from which the vital branches of the abdominal viscera arise, the principle of subsequent conversion of the temporary bypass graft into the permanent graft has proved of inestimable value in the successful application of this method of therapy. The extent to which this

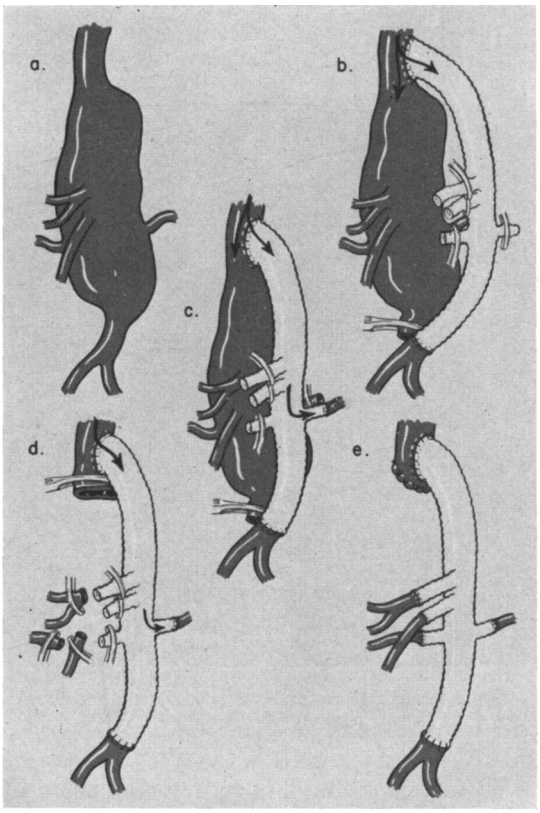

Fig. 8*B*.—Drawings illustrating method of resection and graft replacement in this patient utilizing principle of conversion of temporary shunt into permanent graft. An important advantage of this method lies in the fact that it minimizes the period of renal ischemia, which is the most critical factor in the operative procedure.

may be done is illustrated by a case of a huge dissecting aneurysm involving the descending thoracic and upper abdominal aorta which occupied virtually the entire left thoracic cavity (Fig. 10). The knitted Dacron bypass graft was attached by an end-to-side anastomosis to the aorta just distal to the left subclavian artery and then brought down through an opening in the diaphragm and retroperitoneally to be similarly attached to the abdominal aorta just below the renal arteries. With the graft serving as a temporary shunt, occluding clamps were applied to the aorta immediately above and below the aneurysm,

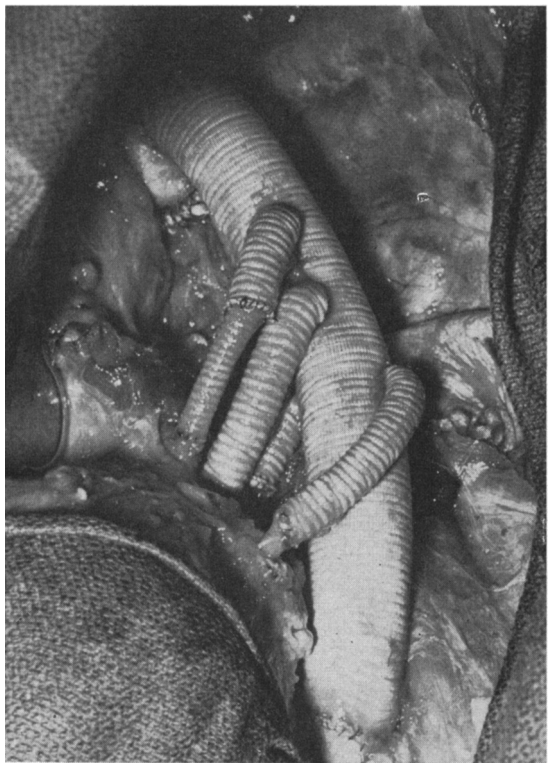

Fig. 8*C*.—Photograph made at operation in this patient showing completed replacement of resected segment of aorta with Dacron "graft" including branches to celiac, superior mesenteric, and renal arteries.

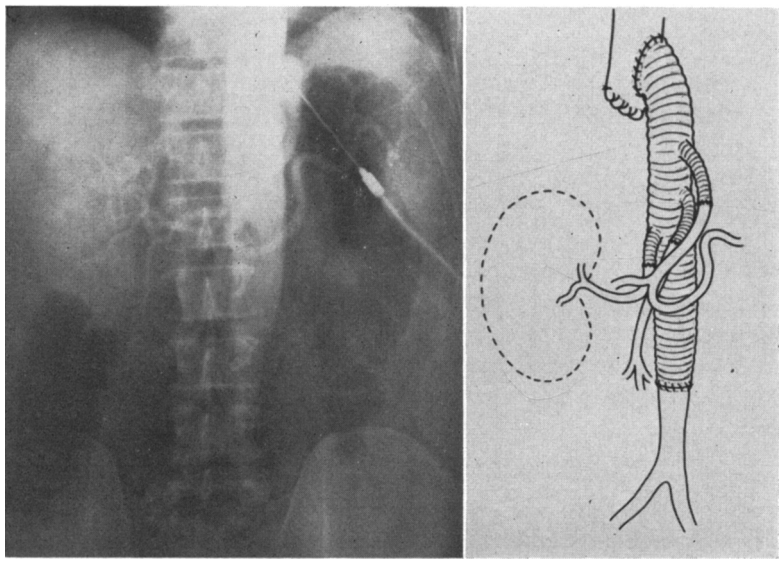

Fig. 8*D*.—Postoperative aortogram in same patient showing restoration of vascular continuity and function through Dacron graft as depicted in drawing at right.

thus isolating it from the circulation and permitting its excision. After completion of this procedure, the openings in the aorta adjacent to the occluding clamps were closed by suture and the occluding clamps were removed. The temporary bypass graft then remained to serve as the permanent graft. Since, during this entire procedure, there was no interference with aortic circulation, no hemodynamic disturbances occurred. Moreover, the extent of operative trauma, duration of anesthesia, and amount of blood lost were greatly minimized. These are factors which, from our experience, have assumed increasing importance in determining the patient's tolerance of the surgical procedure.

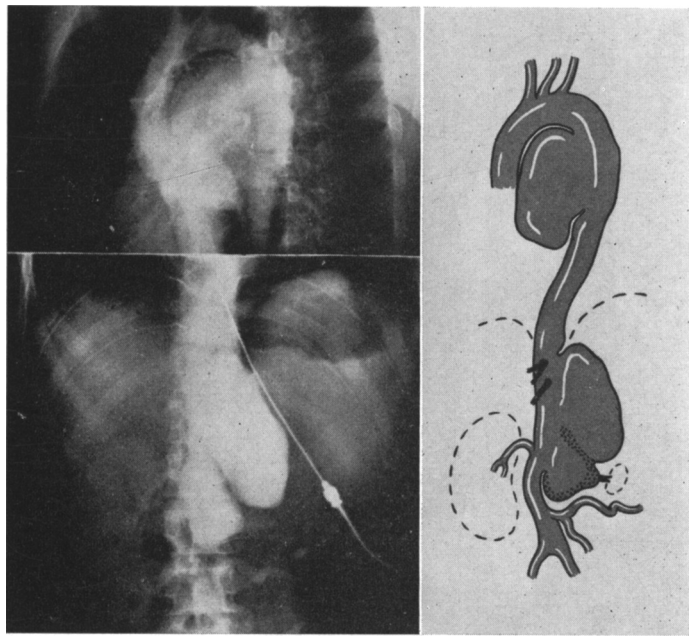

Fig. 9*A*.—Preoperative angiocardiogram and aortogram in patient with large fusiform aneurysm of upper descending thoracic aorta and another even larger fusiform aneurysm involving upper segment of abdominal aorta as depicted in drawing at right. Note that celiac, superior mesenteric, and left renal arteries are completely obliterated with compensatory collateral circulation being provided through enlarged inferior mesenteric artery.

There are, of course, a number of other factors, both systemic and local, which have an important bearing upon the risk of operation. Among the most important of these are advancing age, hypertension, and associated heart disease. The significance of age is well exemplified by the fact that the operative fatality rate for fusiform aneurysms of the descending thoracic

Fig. 9*B*.—Drawings illustrating methods of aneurysmal resection and graft replacement in this patient. The abdominal aneurysm was resected first, as illustrated by the upper three drawings, utilizing the principle of conversion of the temporary shunt into the permanent Dacron graft. On the fourth day following this operation the thoracic aneurysm ruptured necessitating emergency operation consisting of resection and Dacron graft replacement of the involved segment of descending thoracic aorta by the method shown in the lower left-hand drawing with pump bypass from left auricle to left femoral artery.

Fig. 9*C*.—Angioaortogram made approximately 1 month after operation showing restoration of aortic continuity and function through Dacron grafts in thoracic and abdominal aorta as depicted in drawing at right.

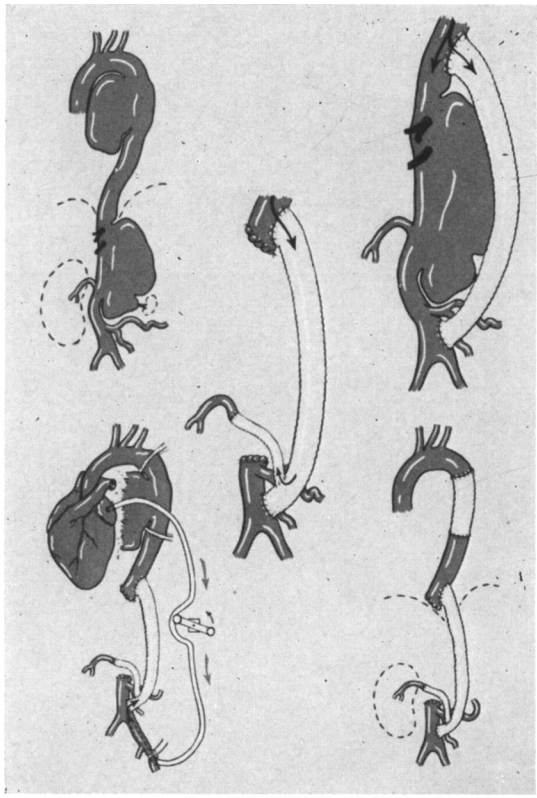

Fig. 9*B*

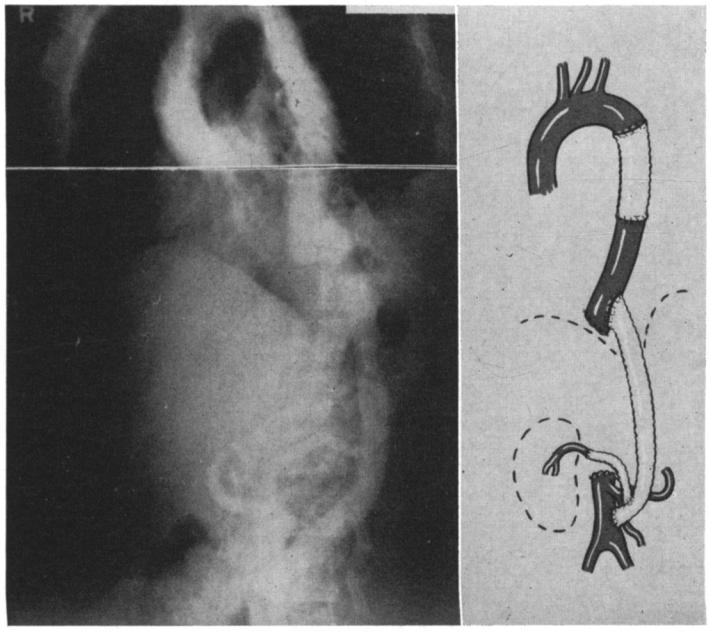

Fig. 9*C*.

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aorta was threefold greater in patients in the seventh and eighth decades of life than in those younger than this, the respective figures being 36 and 12 per cent. The importance of hypertension is demonstrated by the fact that the risk in this group of patients was almost three times greater than that in normotensive patients. Probably the most important factor in this regard is the presence of associated heart disease, particularly coronary artery disease, since in our experience the operative mortality in this group of patients was almost five times greater than that in patients without heart disease. There

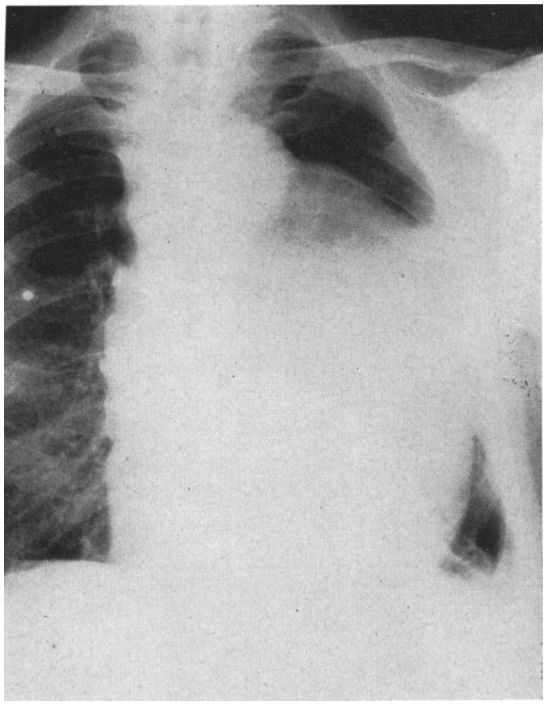

Fig. 10*A*.—Anteroposterior roentgenogram of patient showing large dissecting aneurysm of descending thoracic aorta occupying most of left pleural cavity.

is reason to believe, however, that despite these factors continued improvements in the surgical management of these patients should permit further reduction in the operative risk. This is indicated by the fact that in our most recent series of 62 cases of aneurysms of the descending thoracic aorta in which some of the technical developments just described were employed, the operative mortality was only 15 per cent which is exactly one half of that in our earlier series of 33 cases.

In addition to these tangible factors, which are concerned with the nature of the lesion and with associated local and systemic diseases, there are certain

Fig. 10*B*.—Aortogram of same patient showing extent of involvement of dissecting aneurysm arising just distal to left subclavian artery as depicted in drawing at right.

Fig. 10*C*.—Drawings illustrating method of surgical treatment employed in this patient utilizing the principle of conversion of temporary shunt into permanent graft as described in text.

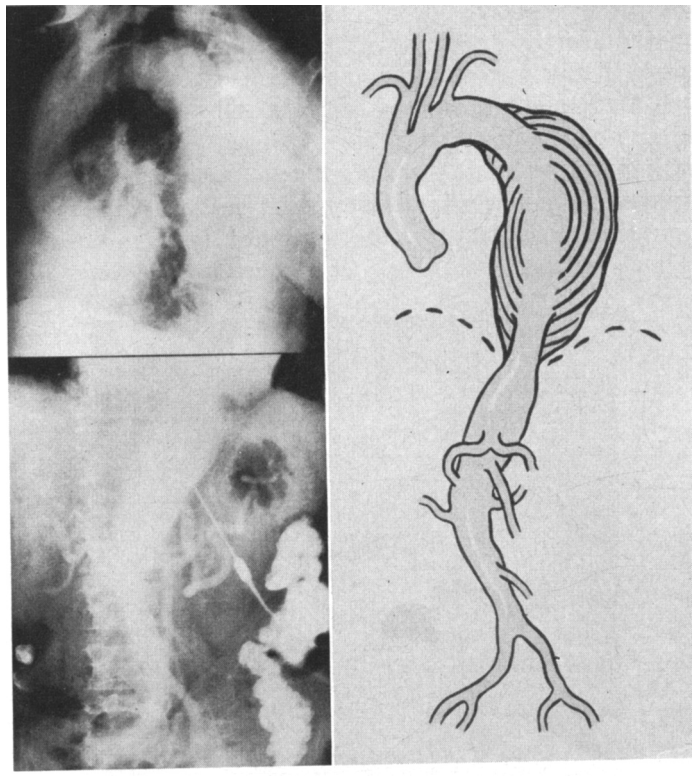

Fig. 10*B*.

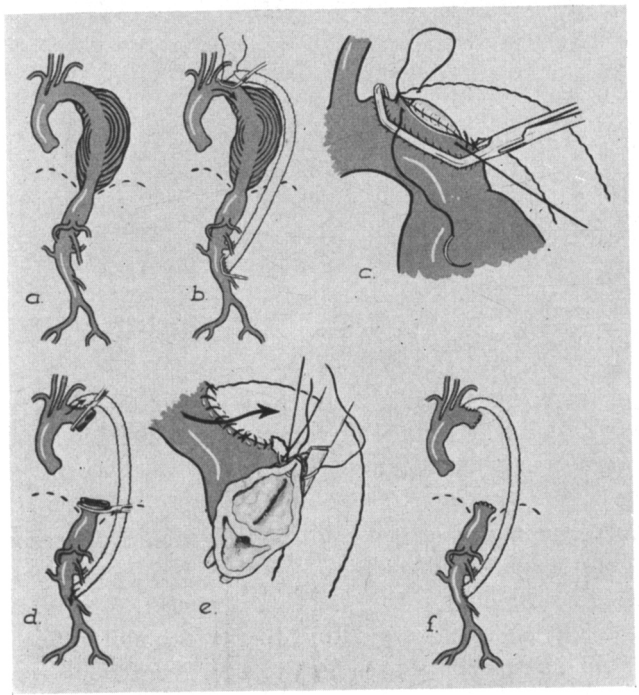

Fig. 10*C*.

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other considerations, less tangible in character, that also have an important bearing upon the success or failure of these methods of surgical treatment. They pertain particularly to surgical capability, extent of clinical experience, close attention to details, preciseness and dexterity in technical performance, and perhaps the attitude and temperament of the surgeon. To be sure, these are factors of importance in all types of surgery, but there is no field of surgery in which they assume as much significance as in cardiovascular surgery. This is due in large measure to the fact that the margin of safety in this field of surgery is often extremely small. Preciseness in dissection of tissues, in application

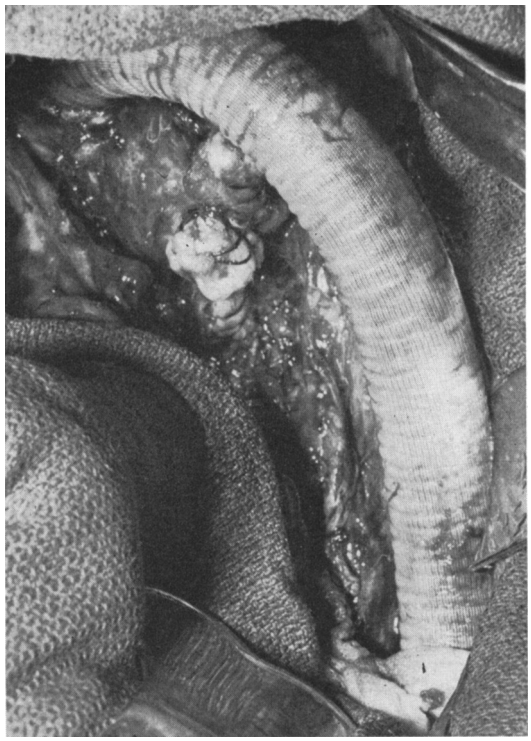

Fig. 10*D*.—Photograph made at operation following completion of procedure showing functioning thoracic portion of Dacron "graft" with end-to-side anastomosis of graft to descending limb of aortic arch just visible in upper right-hand corner of photograph. Most of abdominal portion of Dacron "graft" lies retroperitoneal.

of a suture, or even in tying a knot may make the difference between life and death. Technical errors which in some other fields of surgery would be considered minor can and do assume vital significance in cardiovascular surgery.

The relative importance of these intangible factors increases as a result of experience, and cognizance of these matters is of extreme value in the preparation of the surgeon for this field of surgery. The surgeon must be willing to put forth the necessary effort to perfect and refine his technical precision and skill in carrying out difficult procedures if he wishes to attain

the highest possible degree of success. Only by arduous attention to these details can he satisfactorily meet the difficult and challenging aspects of these problems. Still another factor, along these same lines that deserves emphasis, lies in the fact that cardiovascular surgery exemplifies so well the importance of fundamental training in general surgery. While one may consider this a highly specialized field of surgery, the need for thorough familiarity with the general field of surgery has been well illustrated by some of the cases to which reference has been made, in which the operative procedure was necessarily extended well beyond the thoracic cavity. Blood vessels have an inherent characteristic of reaching to all parts of the body and do not respect some of the artificial barriers which have been established by specialization. No less important are the various systemic problems of a physiologic or biochemical nature that are often associated with these vascular disturbances. Increasing experience in this field of surgery has led me, like others, to the firm conviction that successful surgical management, as well as progressive developments both conceptually and technically, is best expressed through a broad background in general surgery.

In conclusion, let me say that while the observations which I have presented here have been derived largely from our own experience, I am deeply appreciative of the pioneering efforts and the numerous contributions which have been made by a host of investigators throughout the world. Since many of them are present in the audience, it gives me much pleasure to express these sentiments of high tribute. The truly impressive progress that has taken place in the field of cardiovascular surgery during the past decade provides a brilliant reflection of these efforts. Among the most striking features of these advancements, and undoubtedly important factors underlying their attainment, have been the increasing intensity of research endeavors and the bold ingenuity and aggressive approach characterizing the surgical attack on these grave diseases. As a consequence, many conditions which only a few years ago were considered hopeless are now amenable to effective therapy. No less important has been the fact that these surgical investigations have contributed significantly to greater knowledge and better understanding of the underlying fundamental factors involved in the pathologic, physiologic, and biochemical disturbances of cardiovascular problems. With the continuing vigor and intense activity characterizing the current status of cardiovascular surgery, only the limits of imagination should restrict its progress.