

# Surgical Treatment of Annuloaortic Ectasia with Composite Grafts Including Homologous Dura Mater Valves

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**ABSTRACT** We describe 3 patients in whom a composite dura mater valve–Dacron tube graft was used for replacement of the entire ascending aorta and aortic valve. Two patients had Marfan's syndrome and 1, a chronic aortic dissection, type II. All had severe aortic regurgitation. There were no early or late deaths in a follow-up period of 2, 7, and 12 months, respectively. All 3 patients were asymptomatic when last seen. Two underwent postoperative aortography that disclosed well-functioning valves and good filling of the coronary arteries.

It is concluded that annuloaortic ectasia is best treated by the technique of total replacement of the ascending aorta and aortic valve by a composite valve–tube graft, and that the homologous dura mater valve, for its characteristics of central flow, lack of need for anticoagulants, and durability, represents a reasonable alternative for use in this situation.

Replacement of the ascending aorta and aortic valve was reported by Wheat in 1964 [16]. It has received wide acceptance since Bentall and DeBono [2] described their technique in 1968. Earlier papers reported the use of a Starr-Edwards aortic valve within the graft. More recently, it has been suggested that a "central-flow" tilting-disc prosthesis would be more suitable since the ball-valve prosthesis might not allow adequate flow around the ball at the distal end of the cage [4]. This is especially true when a large prosthesis is needed, a common situation in patients with annuloaortic ectasia. For whatever reason, the Björk-Shiley tilting-disc aortic prosthesis has become the prosthesis of choice of some surgeons [4, 9, 10].

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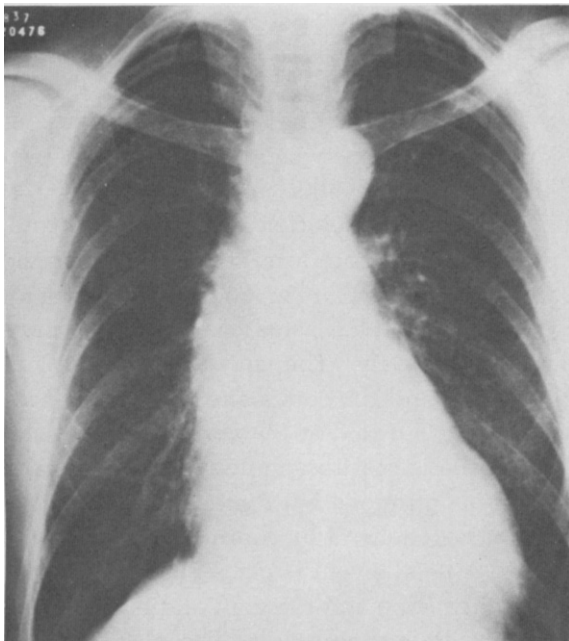
The homologous dura mater cardiac valve has been in clinical use since 1971 [12], with good results to date. It is now the first choice in a valve replacement procedure in many centers. We have replaced the ascending aorta and aortic valve with a composite valve–prosthetic tube graft in 3 patients with annuloaortic ectasia. We used an homologous dura mater valve.

## Material and Methods

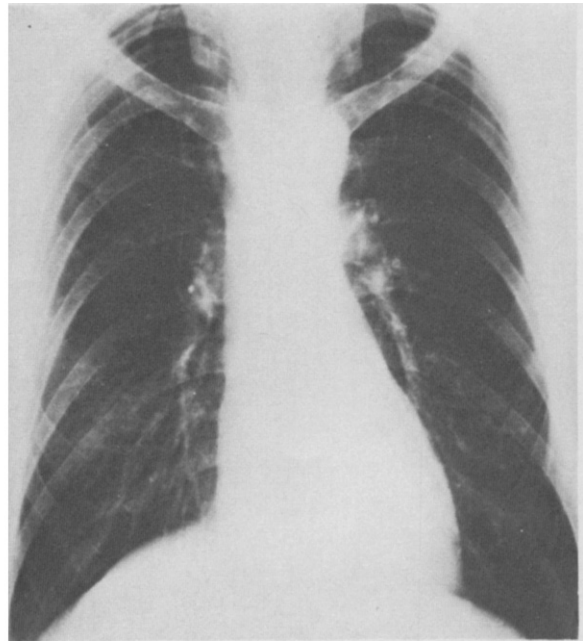
From April, 1976, to May, 1977, 3 patients were operated on for total replacement of the aortic valve and ascending aorta, with end-to-side implantation of the coronary ostia on the graft. Two had Marfan's syndrome and the other, a chronic aortic dissection of DeBakey type II [5] with severe aortic regurgitation. The operative technique was that described by Bentall and DeBono [2] with a few modifications.

### Patient 1

A 44-year-old man was admitted in April, 1976, with the complaint of dyspnea on exertion. He had the classic stigmata of Marfan's syndrome. The clinical diagnosis was severe aortic regurgitation, aneurysm of the ascending aorta, and left ventricular hypertrophy. The chest roentgenogram is shown in Figure 1A. He was classified in New York Heart Association (NYHA) Functional Class III. At operation a large aneurysm was found, limited to the proximal portion of the ascending aorta up to 2 cm below the brachiocephalic trunk. The coronary ostia were displaced, and the aortic valve was severely incompetent due to annulus dilatation with near normal cusps. The aneurysm wall was thin and attenuated, but without dissection. Histological examination revealed the characteristic findings of cystic medial necrosis. The operation was performed as described later in this report. The postoperative period was



A



B

Fig 1. (A) Preoperative chest roentgenogram of Patient 1. (B) Chest roentgenogram made 6 months after operation.

complicated by hemorrhage that led to reoperation, several episodes of ventricular tachycardia, cerebral edema, and coma. The patient eventually recovered with mild sequelae related to the left arm. He was discharged on the thirty-eighth postoperative day and was reviewed clinically after 6 months (Fig 1B). One year later an aortogram revealed a normally functioning aortic prosthesis and good filling of both coronary arteries. He was taking digitalis but had no symptoms related to the cardiovascular system.

#### Patient 2

A 36-year-old man, the brother of Patient 1, was admitted in December, 1976. He complained of progressing dyspnea and episodes of paroxysmal nocturnal dyspnea. He also had the characteristic stigmata of Marfan's syndrome. Clinical diagnosis was severe aortic regurgitation and ascending aortic aneurysm. Left ventricular hypertrophy and hypocontractility, left atrial enlargement, and roentgenographic signs of congestive heart failure were evident. The mitral valve was competent. Operative findings

were very similar to those described for Patient 1, and the operation was performed in the same manner. Histological examination of the aneurysm wall revealed cystic medial necrosis. The postoperative period was uneventful except for some electrical instability with two episodes of ventricular tachycardia, which were adequately treated and reverted. The patient was discharged on the fourteenth postoperative day on a regimen of digitalis and diuretics. Seven months later, he was asymptomatic and living a normal life.

#### Patient 3

A 46-year-old man was admitted in May, 1977, with a short-term history of precordial pain, palpitations, and progressing dyspnea. He was in NYHA Functional Class III. The diagnosis was severe aortic insufficiency and ascending aortic aneurysm, with left atrial enlargement, left ventricular hypertrophy, left anterior hemiblock on the vectorcardiogram, and upper lobe blood diversion on roentgenogram. The mitral valve was normal. At operation, performed as in Patient 1, a chronic dissecting aneurysm of DeBakey type II was found. The aortic valve was grossly incompetent due to a dilated annulus, but had otherwise normal cusps. The coronary ostia were neither displaced nor



Fig 2. (Patient 3.) Postoperative aortogram. The tube graft is in the ascending aorta, both coronary arteries are well seen, and the aortic valve prosthesis is competent.

dissected. Macroscopically, several points of intimal tear were evident, as were fibrosis and endothelialization of the ruptured areas. Elastic degeneration and dissection of the media were noted at histological examination. The patient had an uneventful postoperative course and was discharged on the eighth postoperative day. An aortogram taken 1 month later (Fig 2) demonstrated a well-functioning aortic prosthesis and normal filling of both coronary arteries. Two months after the operation, the patient was asymptomatic and taking digitalis, and had returned to work.

#### *Operative Technique*

While the thoracotomy is being made, a homologous dura mater cardiac valve of 22 mm (frame diameter) is sutured at the end of a 30 mm woven Dacron tube (Fig 3). The valve has been preserved in glycerin and sterilized with antibiotic solution. The heart is exposed and the venae cavae are cannulated for cardiopulmonary bypass. Arterial cannulation is performed through the right femoral artery. Cardiopulmonary bypass is established using a Temptral

Model Q200A bubble oxygenator with mild hypothermia (28°C). The aorta is cross-clamped, and a sump is inserted into the left ventricle through an opening adjacent to the interatrial septum, between the upper and lower right pulmonary veins. A continuous drip of 4°C normal saline solution is started [3, 15] and, throughout the procedure, several endocavitary baths of cold saline are given. Cardiac arrest for Patients 1, 2, and 3 lasted 86, 89, and 92 minutes, respectively. The aorta is opened longitudinally and the composite Dacron graft inserted. It is sutured at the aortic annulus with 2-0 Mersilene mattress suture, at the coronary ostia by continuous 5-0 Prolene suture, and at the graft's distal end by continuous 4-0 Prolene suture. A needle vent is placed in the aorta between the clamp and the graft and is connected to a cardiotomy reservoir. The aorta is then slowly unclamped, and gross leaks through the suture lines are sought and corrected. The left ventricular vent is removed and the air evacuated from the cardiac chambers. Heart beats are recovered by electrical defibrillation, and the aortotomy is closed over the graft with continuous suture of 4-0 Prolene. The aortic suture over the graft was anchored with strips of Teflon felt only in Patient 3. The patient is rewarmed and cardiopulmonary bypass discontinued. After hemostasis has been achieved, the chest wall is closed and a mediastinal drain is connected to continuous suction. The duration of cardiopulmonary bypass in Patients 1, 2, and 3 was 116, 120, and 135 minutes, respectively.

#### **Comment**

Annuloaortic ectasia has been a challenge for the cardiac surgeon. Previously used surgical techniques [7, 8] have led to major long-term complications. These include late failure of the aortic valvuloplasty with subsequent development of aortic regurgitation [11], perivalvular leaks when a prosthetic valve has been sutured directly to the aortic annulus, and further dilatation of the aneurysm in areas in which a major portion of aortic wall remains, with the risk of aortic rupture and even acute cardiac tamponade [4]. Fortunately, complications occur in only a small percentage of patients; but

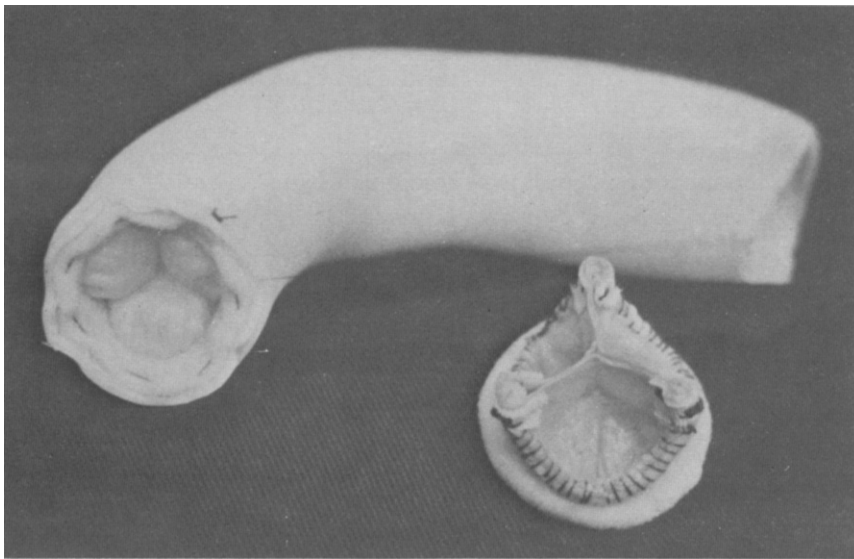


Fig 3. The composite dura mater valve-Dacron tube graft as prepared for insertion. At the end of the tube, the valve is seen from its ventricular side. An isolated valve is shown for purposes of illustration.

when they do, the surgical risk at reoperation is higher.

A method of total replacement of the affected area was described by Wheat in 1964 [16]. It consisted of resection of the aneurysm so as to leave a portion of aorta around the coronary ostia, which were sutured in a scalloped way to the proximal margin of the tube graft. In 1970, Edwards and Kerr [6] reported utilization of and clinical experience with a technique that was essentially the same as the one described in 1968 by Bentall and DeBono [2]. It consisted of total replacement of the aortic valve and ascending aorta by a composite prosthetic valve-Dacron tube graft with the coronary arteries anastomosed to the side of the prosthesis. Since then, several others have employed the procedure, sometimes with modifications [4, 9, 10]. The results have been excellent to date. The advantages are well recognized. (1) The procedure excludes the entire proximal aorta down to the aortic annulus, thus correcting both the aneurysm and the aortic regurgitation and leaving no room for new wall changes of the aneurysm. (2) The problem of periprosthetic leakage is eliminated; the aorta, tailored and sutured over the tube graft, provides considerable help in

achieving hemostasis and greatly reduces post-operative hemorrhage. (3) The operative time is shortened as are the perfusion and aortic cross-clamping times. (4) Saphenous vein grafts to the coronary arteries could be utilized if necessary and are especially useful when dissection is present and when undue tension on the suture line may lead to bleeding problems [17].

Methods of myocardial protection during the procedure vary according to the surgeon's personal preference. Bentall and DeBono [2] reported using brief periods of anoxic arrest and utilizing coronary perfusion for much of the time. We have used local hypothermia with cold saline in much the same way as others have described [3, 15]. This method provides a quiet, dry operative field and excellent surgical exposure while effectively protecting the myocardium for a sufficient period to perform the operation.

The ball-valve prosthesis may have some disadvantages in this situation [4]. It could prevent free flow of blood when a large prosthetic valve is needed, and it fits snugly inside the largest available tube graft. For this reason and perhaps because of personal preference, the Björk-Shiley tilting-disc prosthesis has been the valve of choice when a composite graft is to be used. Even this valve, however, does not eliminate the problems related to prosthetic valve replacement and requires adequate anticoagulation. It seems that the ideal correction has not

yet been devised, and continued research is justified in order to obtain more definitive surgical results.

The homologous dura mater cardiac valve was introduced for clinical use in 1971 [12]. It has the advantages of both a prosthetic and a biological valve. It is available in various sizes, can be stored for long periods at room temperature, has proved to be durable when implanted for at least 4 to 6 years [15], is as easy to insert as the mechanical valves, can be easily retrieved from patients who have died, is absolutely silent while functioning, and is nonthrombogenic. In addition, small or no gradients have been detected through the prosthesis, at least with the larger sizes [14], and the clinical results have been very good to date. For all these reasons, the homologous dura mater valve has become the first choice for valve replacement in many centers, including our own. For the composite graft, a dura mater valve (like other biological valves) seems to have the added advantage of being a "central-flow valve" that can be inserted into the prosthetic tube without compromising its function.

It could be argued that a biological valve should not be used for the procedure described because degenerative changes might compromise its competence and reoperation would pose a formidable surgical problem. Homologous dura mater valves, however, as just stated, have proved their durability. Puig and associates [13] followed a series of patients for from 4 to 6 years and found a late mortality of 7.82%. In 41 patients with the dura mater valve in the aortic position, early malfunction was detected in 2 and late malfunction in 4 patients. Abdulmassih and co-workers [1], studying 25 reoperations in 23 patients from a large series who needed re-replacement of a dura mater valve, encountered nine infections, eight leaflet ruptures, seven periprosthetic leaks, and 1 calcification. The mortality for reoperation was 24% and was higher in patients who had infection. If the risk of infection and of periprosthetic leaks is accepted as a problem of both biological and mechanical valves, we find that degenerative changes (including leaflet rupture) occur in a very small number of patients and

that the dura mater valves show late results that compare favorably with any available cardiac valve substitute. In our experience, 83 patients with a dura mater valve in the aortic position have been followed for a period of from 6 to 42 months. Four valves (4.8%) failed within this period, all due to bacterial endocarditis, leading to 3 late deaths (3.6%) and 1 successful reoperation. It should be noted that methods of sterilization have been improved in recent years and the incidence of valve infection is decreasing. Probably some of the valve failures in our experience and that of others were due to problems of preparation, preservation, and sterilization, which now should be avoidable. Based on these data, we believe we are justified to utilize a homologous dura mater valve in the composite graft. Furthermore, the need for anticoagulants is avoided with this valve; this consideration is particularly important when we operate on patients of low socioeconomic condition or patients who live in distant or remote areas, in whom proper control of anticoagulation would be difficult.

We believe that annuloaortic ectasia is best treated surgically by the technique of total replacement of the aortic valve and ascending aorta with a composite valve-Dacron tube graft. We think the homologous dura mater cardiac valve represents a reasonable alternative for use in this situation because it has central flow, obviates the need for anticoagulants, and compares favorably with other cardiac valves in terms of durability.

#### **Addendum**

After this paper was prepared, 3 additional patients were operated on by the technique described. The summarized case reports follow.

#### *Patient 4*

A 56-year-old white man was admitted in September, 1977. His chief complaint was angina pectoris. The clinical diagnosis was severe aortic regurgitation of luetic etiology. Angiography demonstrated that it corresponded to an aortic aneurysm that extended beyond the emergence of the brachiocephalic trunk, where it diminished in size. The patient was in NYHA Functional Class II. At operation a great ascending aortic aneurysm was found. The aortic wall was thin, with yellowish and

friable plaques internally. The aortic valve was severely incompetent due to a dilated annulus, and the leaflets were mildly fibrosed. Histological examination confirmed luetic aortitis. The surgical procedure was performed as already described. On the third postoperative day the patient suffered an episode of ventricular fibrillation that reverted promptly. However, cerebral edema and superficial coma were present for forty-eight hours. These eventually regressed, and the patient was discharged on the twelfth postoperative day. Two months later an aortogram revealed normal prosthesis function and good filling of both coronary arteries, although some residual aneurysm persisted distal to the brachiocephalic trunk. On the fourth postoperative month the patient was asymptomatic.

#### Patient 5

A 43-year-old white man was admitted in September, 1977, with a clinical history of progressive dyspnea, palpitation, and angina on exertion (NYHA Functional Class II). The clinical and angiographic diagnoses were severe aortic regurgitation, ascending aortic aneurysm, and left ventricular hypertrophy. At operation a well-delineated ascending aortic aneurysm with displacement of the coronary ostia and aortic regurgitation was approached as described in the text. Cystic medial necrosis was demonstrated at histological examination. The patient had excessive bleeding and was reoperated on in the fifth postoperative hour. He had no other complications and was discharged on the eighth postoperative day. An aortogram was taken 35 days later and demonstrated good surgical correction. Four months after the operation he was asymptomatic (NYHA Functional Class I).

#### Patient 6

A 63-year-old white man was admitted in October, 1977, with the complaint of progressive dyspnea and one episode of acute pulmonary edema. The diagnosis was severe aortic insufficiency and ascending aortic aneurysm with marked displacement of the coronary ostia. The operation was performed by the technique described in this paper, and histological examination revealed cystic medial necrosis of the aorta. On the fifth postoperative day atrial fibrillation developed and was treated by electric cardioversion. On the twelfth postoperative day he was discharged. Two months after the procedure, he was in NYHA Functional Class I and the aortogram showed a good surgical correction.

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**Editor's Note**

It must be recognized that the follow-up is short and the long-term durability of dura mater valves is not yet known.

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**Notice from the American Board of Thoracic Surgery**

The 1979 annual certifying examination of the American Board of Thoracic Surgery (written and oral) will be held Mar 22-24, 1979, in Chicago, IL. Final date for filing application is Aug 1, 1978.

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