

Cusp degeneration in frame-supported autologous fascia lata mitral valves

Clinical results in 67 patients

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Sixty-seven metal-frame-supported autologous fascia lata mitral valves were placed in 67 patients. There was an operative mortality of 25% and an overall mortality of 40% within 20 months. Most of the late deaths were due to valve malfunction which occurred in 50% of survivors. Female patients demonstrated a much higher rate of valve dysfunction than did men. This malfunction of the fascial valves in the mitral position, which has not been observed in the aortic position, may be due to inappropriate design for the mitral position. The fascia is not exposed to the continued and reproducible mechanical stimulation in the atrioventricular position that it has when used as an aortic valve substitute. The mechanical properties of fascia may make it suitable for human valve substitutes but it is clear that an inverted three-cusped semilunar fascial valve will not be adequate for mitral or tricuspid valve replacements because of the haemodynamic characteristics of the atrioventricular position.

Following Senning's (1967) report of long-term successful results using fascia lata to construct human aortic valves, this autologous tissue has been used in the fabrication of metal-frame-mounted, three-cusped valve replacements since May 1969 (Ionescu and Ross, 1969). This type of fascial graft affords the cardiac surgeon a valve having a central-flow orifice, with low pressure gradient, which is made of autologous living tissue and does not require long-term anticoagulation of the recipient. These characteristics are important among those which have been sought by surgeons using biological valves in order to avoid the complications of mechanical valve prostheses. We have reviewed the experience with this type of valve used in mitral replacement at Guy's Hospital and have found that a prohibitively high percentage of graft failure makes its use in the atrioventricular position unacceptable.

CLINICAL MATERIAL

Adequate pre and postoperative information was available on 67 patients who had frame-supported autologous fascia lata mitral valve replacement in single and double valve operations. There were 39

females and 28 males in this series and their ages ranged from 9 to 65 years. Rheumatic mitral disease was the predominant aetiology for the valvular dysfunction, and mitral regurgitation was the most common valvular lesion (Table I). The majority of the patients were in New York Heart Association functional class III or IV (58/67); nine were in class II. Twenty-seven of these patients had had previous mitral valve surgery and 30 of them had a second valve replaced at the time of mitral replacement (Table II).

TECHNIQUE

Autologous fascia lata, obtained immediately after the induction of anaesthesia, is attached, as described by Ionescu and Ross (1969), to a Dacron-velour-covered titanium frame¹ measuring 24 or 26 mm inside diameter (Figs 1 and 2) while normothermic bypass is instituted through a median sternotomy using aortic perfusion and vena caval cannulae. The mitral valve is exposed through a Dubost incision or an incision behind the interatrial groove. The fascial valve is inserted, using a continuous suture of 2-0 mersilene. Care is taken to ensure that the valve is orientated so that there is a metal prong on either side of the aortic valve, thereby avoiding any solid structure in the left ventricular outflow tract (Angell, Iben, Gianelly, and Shumway, 1969).

¹Hypodermic Services, 1 Headlands Road, Liversedge, Yorkshire

TABLE I
MITRAL VALVE LESION IN 67 PATIENTS

Mitral stenosis	6
Mitral stenosis after valvotomy	6
Mitral regurgitation	27
Mitral regurgitation after valvotomy/valvuloplasty	10
Mixed mitral stenosis/regurgitation after valvotomy/valvuloplasty	7
Mixed mitral stenosis/regurgitation	8
Malfunctioning inverted aortic homograft	2
Paravalvular leak (Starr-Edwards)	1
Total	67

TABLE II
OPERATIONS PERFORMED

Mitral valve replacement only	37
Mitral valve replacement plus aortic valve replacement	23
Aortic Starr	4
Aortic fascial valve	16
Aortic homograft	3
Mitral valve replacement plus tricuspid valve replacement	7
Inverted aortic homograft	3
Tricuspid fascial valve	2
Tricuspid Beall	2
Total	67

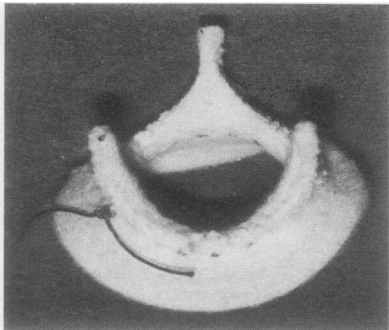


FIG. 1. Dacron-velour-covered titanium frame used to construct three-cusped fascia lata mitral valves.

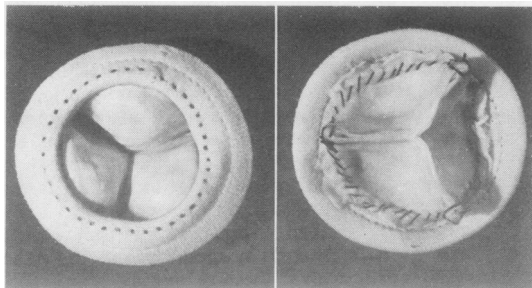


FIG. 2. Atrial (left) and ventricular (right) views of a fascia lata mitral valve ready for insertion.

Anoxic arrest, obtained by cross-clamping the aorta, is used during the accurate placement of the sutures. All fascial valves are tested for competence immediately after construction, using a hand-held tester, and *in situ* leaflet competence is guaranteed by filling the left ventricle with blood under pressure, through the apical vent, before the atrium is closed. Antibiotic treatment with cloxacillin and either streptomycin or gentomycin has been instituted for five days in most patients. Anticoagulation is started on the third postoperative day and continued for three months only.

RESULTS

Fifty of the 67 patients survived operation and left hospital. Eight of those who died underwent mitral valve replacement only, while the other nine had two valves replaced. The operative mortality is thus 25% with no statistical difference between the two groups (Table III). Only two operative deaths were associated with valve dysfunction. One patient had a left atrial thrombus occluding the valve, and the second patient's valve demonstrated a paravalvular leak at the time of a second operation for tricuspid valve replacement. The other 15 deaths were secondary to mechanical and physiological defects and verify the risk associated with mitral valve replacement in patients with stigmata of chronic mitral valve disease, as pointed out by Litwak *et al.* (1969).

TABLE III
OPERATIVE DEATHS

Single valve replacement (8)	
Intraoperative death—bleeding	1
Clotted aorta	1
Aortic rupture—1st postoperative day	1
Mediastinitis from tracheo-oesophageal fistula complicating tracheostomy	1
Renal failure	2
Respiratory failure (tracheal stenosis 1)	2
Multiple valve replacement (9)	
Intraoperative death (bleeding 2)	3
SBE (aortic fascial valve 1, tricuspid valve 1)	2
Low cardiac output syndrome	1
CNS lesions	3

There were 10 late deaths, giving a composite mortality of 40% during the period of this study. All of the late deaths were due to complications of the fascia lata mitral valve (Table IV). Two patients died within two months of valve replacement, one of cerebral haemorrhage while on anticoagulants, the other of candida endocarditis involving the valve replacement (H.C. and W.L., Table IV). The remaining eight patients succumbed following progressive biventricular decompensation secondary to regurgitation through the fascia lata mitral valve.

TABLE IV

LATE DEATHS

Name	Age	Sex	Other Procedures	Valve Failure	Time of Failure	Re-operation Performed	Appearance of Valve	Survival after	
								First Operation	Valve Failure
H.C.	65	F	—	No	—	None	Normal	2 mth	—
W.L.	48	M	—	Yes	2 mth	None	Candida	2 mth	2 wk
A.K.	60	F	—	(endocarditis) Yes	6 mth	Mitral Starr	2 contracted cusps	8 mth	2 mth
M.R.	57	F	—	Yes	3 wk	Mitral Starr Tricuspid Starr	1 contracted cusp	7 mth	6 mth
B.W.	47	F	A.V.R. (fascia)	Yes	3 mth	Mitral Björk	2 contracted cusps	6 mth	3 mth
M.P.	49	F	T.V.R. (fascia)	Yes	1 mth	Mitral Starr Tricuspid Starr	1 contracted cusp	5 mth	4 mth
M.S.	48	F	—	Yes	5 mth	Mitral Starr	1 contracted cusp	7 mth	2 mth
M.C.	56	F	T.V.R. (Beall)	Yes	2 mth	Mitral Starr	2 contracted cusps	6 mth	4 mth
K.M.	54	F	—	Yes	2 mth	Mitral Starr	1 contracted cusp + vegetations	6 mth	4 mth
O.C.	63	F	—	Yes	2 wk	Mitral Starr	2 contracted cusps	3 mth	3 mth

A.V.R.=aortic valve replacement; T.V.R.=tricuspid valve replacement.

The 50 survivors have been followed for from four to 20 months after valve replacement. Twenty-four valves were regurgitant, one was stenotic. Nine of the 24 patients with regurgitant valves have become severely incapacitated and have required removal of the fascial valve and replacement with a prosthesis. Eight of these patients have not recovered from this subsequent mitral valve surgery and compose the greater part of the 'late deaths' group. All nine of these patients were women.

The regurgitation in eight of these nine patients was central. In the ninth patient it was secondary to rupture of a valve leaflet along the sewing ring. The central regurgitation was uniformly a result of severe contraction and fibrosis of one or two of the three valve leaflets. The leaflet most frequently involved was the posterolateral cusp. The leaflet most perfectly preserved was the anterior 'aortic' leaflet. In three of the valves removed, it had a near normal appearance, cusp-shaped with minimal thickening, while the other two cusps were severely contracted and thickened (Fig. 3).

The mitral regurgitation in patients with frame-supported fascia lata mitral valves has been detected as early as within the first month and as late as seven months after insertion. Seventeen of the 24 patients had obvious valvar regurgitation within three months (Fig. 4).

Twenty of the 25 failed valves are in women; of the 39 females in this series, 31 have either

died or are surviving with a dysfunctioning fascial mitral valve. Seventeen of the 28 males in the

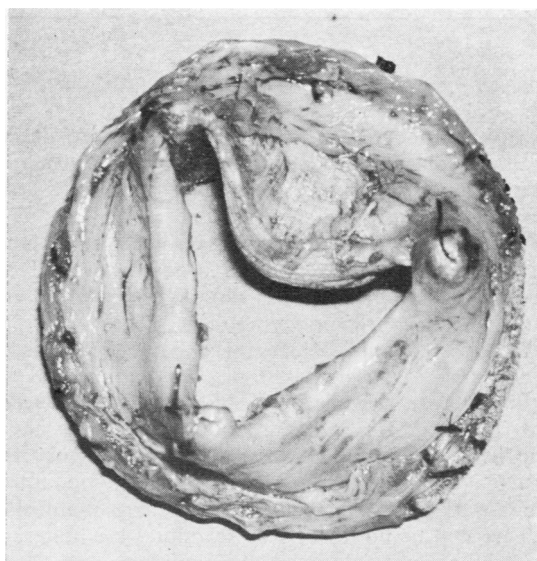


FIG. 3. The ventricular aspect of a freely regurgitant fascia lata mitral valve removed five months after insertion. This valve was noted to be regurgitant one month after insertion. The cusp at the top end of the picture is the 'aortic' or anterior leaflet. Notice the preservation of its gross architectural integrity compared to the thickened, rolled, contracted appearance of the two posterior leaflets, although it, too, is thickened with fibrin vegetations.

group, on the other hand, are surviving with competent valves and are greatly improved from the operation. There have been 22 other complications in these 50 survivors, and these are outlined in Table V.

TABLE V
COMPLICATIONS OF AUTOLOGOUS SUPPORTED FASCIA LATA MITRAL VALVE REPLACEMENT

Valve failure	25
Regurgitation	24
Removed	9
Contracted cusp	8
Detached cusp	1
Stenosis	1
Thromboembolism	3
Cerebral	1
Renal	1
Femoral	1
Haemorrhage	6
Aortic bleeding	1
Tamponade	2
Thigh wound haematoma	3
Post-pericardiotomy syndrome	2
Sepsis—S.B.E.	1
Myocardial infarction	1
Renal failure	3
Sacral pressure skin necrosis	1
Arrhythmia	1
Haemolysis	2
Hepatitis	1
Regurgitation through aortic fascial valve	1
Total	47

DISCUSSION

The complications associated with prosthetic valve replacement are well known: thromboembolism, haemolysis, high valve gradients, and infection are among the most frequent. Although these occur in a small percentage of patients, their existence justifies the use of non-obstructive valves made of biological tissues not requiring prophylaxis against thromboembolism (Ross, 1970). Homografts and heterografts have been used with marked success in replacing human valves, but the late degeneration and calcification seen in these grafts indicate that they, too, have undesirable complications (Missen and Roberts, 1970). The advantages of using a living autologous tissue to construct a valve are manifold. There will be no host tissue reaction; the material will be self-servicing and regenerative; and there will be no problems in acquiring the tissue. Ross's experience with autologous pulmonary valve grafts as aortic valve replacement bears out the benefits of autologous tissue replacements (Gonzalez-Lavin, Geens, and Ross, 1970).

Senning's use of fascia lata in the construction of aortic valves indicated that this tissue may fulfil the general needs of valve replacement. It

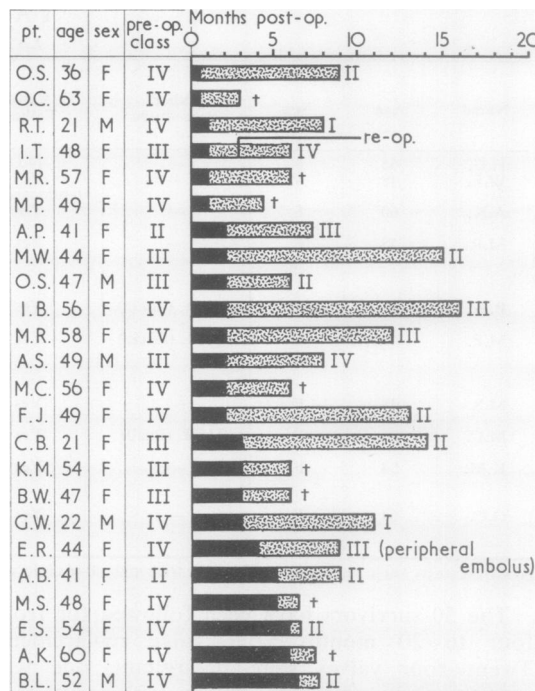


FIG. 4. Graphic representation of the time course of the 24 patients with regurgitant fascia lata mitral valves, arranged in order of increasing normal function of the valves. The Roman numeral at the end of each bar indicates the present N.Y.H.A. functional classification of each survivor. †Indicates late death. The dark area of each bar is the length of time the valve functioned normally. The stippled area represents the length of time the patient has been followed with a regurgitant valve. All deaths have followed operation to replace regurgitant valves.

was felt that his reported rate of diastolic murmurs may be avoidable by using a pre-constructed easily inserted fascial valve. The use of such a valve in the aortic position has proved beneficial (McEnany, Ross, and Yates, 1971). However, the disastrous results of mitral valve replacement, as shown here, make its further use in that position unacceptable in our view.

The anatomical failure of the fascia in these mitral valve replacements is, we think, a function of the haemodynamics of flow through the atrio-ventricular orifice (Reid, 1969). The normal, bicuspid, mitral valve is orientated in such a way that the physiological turbulence created by diastolic flow through the valvar orifice partially closes the mitral valve in diastole, so that the normal systolic excursion of the valve leaflet is short (Wharton and Lopez Bescos, 1970). The

fascia lata mitral valve is orientated so that one of the cusps mimics the position of the normal anterior, or aortic, leaflet of the mitral valve. This fascial cusp would be expected to enjoy the same benefits of diastolic valve closure as the normal valve cusp does. The two posterior-lateral cusps, however, because of their orientation at an angle to the posterior wall of the left ventricle, will be less disposed to normal closure in diastole. The sudden increase in ventricular systolic pressure will then be required to move these two posterior leaflets to the closed, central position. This high pressure gradient, quickly rising, will probably cause some irregular rolling of these two cusps with resultant thickening and shortening. The anterior leaflet is spared because, by the onset of systole, it will have regained its sinus-like shape and will require only a very short excursion to reach the fully closed position. Thus, the anterior cusp is more likely presented with a recurrent, steady, mechanical stimulus, of the type which is necessary for maintenance of anatomical integrity of fascial grafts anywhere (Ionescu *et al.*, 1970). The posterior leaflets, because of the irregularity of this stimulus, will most likely tend to shrink more than is expected, and this tissue loss leads to permanent loss of coaptability of the three leaflets.

This type of valve placed in the aortic position performs adequately, for, because of the matching of the cusps to the sinuses of Valsalva, the fascial leaflets probably attain the normal equilibrium position during systolic ejection, and then begin to close at the end of systole, requiring minimal retrograde aortic flow to close them (Bellhouse, Bellhouse, and Reid, 1968; Reid, 1970). The symmetry of reproducibility of this systolic closure can account for their continued good service.

The fact that all the fascial mitral valves have not become regurgitant may disclaim this hypothesis. However, individual variation in fascia is probable (for example, the vast majority of the

regurgitant valves are in females). Small differences in orientation of the valve or in left ventricular performance may result in stimuli of varying intensity being presented to fascial leaflets of quite different durability. Our fear, however, is that in time all the metal-frame-supported, three-cusped mitral valve replacements will demonstrate regurgitation.

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