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THE RECONSTRUCTION OF THE MITRAL VALVE WITH STABILIZED BIOLOGIC TISSUE IN 33 CLINICAL CASES

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The complex structure of the mitral valve and its interrelated function with other components of the mitral apparatus and left ventricle make difficult the duplication with an artificial substitue. The clinical application of heart valve replacement and the search for an ideal valvular substitute entered the 3rd decade. In the absence of an ideal valvular substitute the conservative surgery of the mitral valve still has indications in cases with anatomical and functional correctable lesions. Although the literature contains many data about mitral valve reconstruction procedures for mitral incompetence (7—14), there are few reports on the conservative surgery with leaflet advancement for mitral stenosis. We are not aware of the utilization of a stabilized biologic tissue for mitral valve reconstruction in cases with isolated of predominant mitral stenosis. The dissatisfaction with available valvular substitutes renewed the interest in the reconstruction of the mitral valve.

Previous works of *Sauvage* et al. (1), *Selmonosky* et al. (3), *Bailey* et al. (12), *Marion* et al. (4), *Frater* et al. (19), have shown the possibility to reconstruct the mitral valve by leaflet advancement using autologous biologic tissue (pericaridium, fascia lata). There are data indicating that *autologous fresh* pericardium and fascia lata shrink in valvular area. The availability of a stabilized biologic tissue of human or animal origin with known qualities prompted us to evaluate its use for leaflet advancement in combination with procedure of complete valvotomy for mitral valve reconstruction in cases with predominant stenotic lesions.

Materials and metods

Between February 1980 and July 1982, 33 patients with predominant mitral stenosis of rheumatic origin were operated upon. In this group 29 were females (87%) and 4 males (12,2%). The mean age was 33 (age range 22—56 years).

Table I. Type of valvular lesions

Mitral stenoses — isolated	18 cases
Mitral stenosis + Mitral incompetence	6 cases
Mitral stenosis + Associated valvular lesions. . .	9 cases

Twenty-two patients were in sinus rhythm and 12 in atrial fibrilation. At time of operation 2 patients were in New York Heart Association Functional Class II, 29 in Class III and 2 in Class IV. Two patients had previous closed mitral valvotomy. Left atrial thrombus was found intraoparatively in 5 patients and 2 patients had previous cerebral embolisms. Only 8 patients, essentially those with associated anomalies, had hemodynamic studies performed before the operation. Complete mitral valvotomy combined with mitral valvuloplasty by patch advancement of the mural leaflet were performed in 27 cases of mitral stenosis as an insolated lesion or associated with minor to moderate mitral incompetence. In 6 cases associated procedures were performed.

Operative technique

The patients were operated upon through median sternotomy under cardio-pulmonary by-pass with moderate body hypothermia (25—30 °C) combined with cardioplegic arrest and local cooling for myocardial protection. Left ventricular (LV) vent was introduced via LV apex. Wide exposure of the mitral valve was often obtained through an incision in the left atrium (LA), posterior to the interatrial groove and facilitated by a relaxed state of the heart under cardioplegic conditions. The mitral orifice was estimated by the operating surgeon as being between 1—1,5sq. cm in 18 cases and below 1 sq. cm in 9 cases. Twenty four cases had also changes at the cordae level as thickening, fusion and shortening. In all 33 cases the mural leafet was thikened and shortened. Both commissures were fused and fibrotic. Due to a variety of intraoperative reporting a computerized operative protocol has been designed. Complete mitral valvotomy was performed by bilateral commissurotomy, splitting of the papillary muscles and mobilization of the leaflets and subvalvular structures when required. The shortend mural leaflet was incised at its insertion for the most of the circumference up to 5—10 mm to the commissural area (fig. 1, 2). Few 3rd degree chordae were sectioned. Through this incision the subvalvular structures were examined from the ventricular site and further mobilization of the chordae, papillary muscles and leaflets performed. Commissurotomy is carried further under this "biplane" control.

Stenosed mitral valve (A) and Reconstructed posterior leaflet with biologic patch (B)

Fig. 1

Posterior leaflet advancement technique with biologic patch

Fig. 2

The decision to reconstruct or to replace the valve is taken only after the examinations of the mitral apparatus from above and below through the described incision. After the complete valvotomy which produced an adequate mitral orifice, a stabilized biologic tissue patch was inserted in the incision at the base of the mural leaflet by a continuous single 3/0 Ethibond suture. The stabilized biologic tissue patch was tailored according to the size of the orifice in the mural leaflet and to the desired shape of the leaflet itself related to the necessity to coapt efficiently with the anterior leaflet. In 29 cases the biologic tissue patch used was human dura mater stabilized with Glutharaldehyde and in 4 cases the patch was heterologous pericardium. The competence of the mitral valve was assessed intraoperatively by known procedures. The cardio-pulmonary by-pass time varied from 65 to 116 minutes with a mean of 81 minutes for isolated procedure and from 105 to 173 minutes (mean 134 minutes) in the group with associated procedures. Two cases were operated upon on beating heart with a mean perfusion time of 100 minutes. Thirty-one cases were operated under cardioplegia with a mean aortic cross-clamping time of 47 minutes for isolated procedures and 68 minutes for the group with associated procedures. The first 2 patients were anticoagulated with Prothrombin depressant for 6 weeks. Three patients are on continuous anticoagulation treatment, 2 for aortic valve replacement with Björk-Shiley valves and 1 for left atrial thrombus removed at the operation (patient in atrial fibrillation). Mitral valve incompetence at the commissural area was corrected by sutures with teflon pledgets. In other 2 cases it was left uncorrected.

Results

There was no operative or hospital death in the present series. Thirty-three patients left the hospital and 32 (97%) were followed up between 4 and 32 months after the operation (mean 13.8 months). All the patiens examined recently have improved after operation except two of them. Twenty-two patients are now in NYHA Class I, 8 in Class II, 1 in Class III and 1 in Class IV.

At chinical examination 3 patiens have systolic murmur grade 3/VI in the mitral area (one with mitral incompetence before the operation). Six patiens have 1—2/VI systolic murmur at the apex (3 had mitral incompetence before the operation). Twenty-three patiens have competent mitral valves. Eight patients with previous mitral incompetence have no systolic murmur in the mitral area (Table II).

Table II. Systolic murmurs in the mitral area.

No systolic murmur	23 cases
Systolic murmur 1—2/VI	6 cases
Systolic murmur 3/VI	3 cases

The cardio-thoracic ratio could be calculated in 30 patients: in 4 cases did not change in comparison with that before the operation, in 19 cases decreased and in 7 cases increased (5 with systolic murmurs). The LA size measured in 26 cases decreased in 16, did not change in 5 and increased in 5 cases.

Three patients have diastolic rumble at 6, 6 and 7 months after the operation. In other 8 patiens at 10 to 32 months after the operation a

short diastolic rumble could be detected after exercise. Eleven patients have normal heart sounds.

No TE complications were noted in this series of operated patients.

Discussion

In the surgical treatment of the predominant stenotic lesions of the mitral valve we have favored the open-heart approach since 1975. The safety of the open valvotomy and the better control of operative technique, were proved in our first series of 100 cases without operative or hospital death. Inspite of adequate valvotomy, some of the competent mitral valve tested on the operative table showed systolic murmur due to residual mitral incompetence shortly after the operation. It was evident from our intraoperative findings that the residual mitral incompetence due to the impaired coaptation of the mitral leaflets after open valvotomy in up to 20% of the cases was related to the thickened and shortened mural leaflet, among other factors. Correction of the mitral incompetence at the commissural area could be performed by annuloplastic sutures at the price of rendering the mitral orifice less than optimal. Evidence from the literature indicates the involvement of the mural leaflet in physiologic and pathologic mitral valve closure. The ratio of rough zone to clear zone in the middle scallop of the posterior leaflet is 1.4 while in the anterior leaflet it is 0.6. This implies that a greater portion of the posterior leaflet comes into contact with the anterior leaflet during valve closure (18). The mobility of the posterior leaflets was restricted by diseases more frecvently than the anterior leaflet (7). A good hinge movement is required for leaflet and the subvalvular apparatus must be explored and freed if indicated (12). In other cases the posterior leaflet is tethered down and has no full excursion to meet the anterior leaflet (12). *Carpentier* (9) has shown that this frequent finding is due to the reatraction of secondary chordae at that point and therefore must be sectioned selectively (12). In cases with advanced lesions of the subvalvular structure and of the anterior leaflet or calcification of the valve we indicated and performed mitral valve replacement. However, in other group of patients we found lesions with marginal indications for valve replacement, cases in whom the valve could be salvaged by a reconstructive procedure. Some of the explored mitral valves had components too good to be replaced inspite of lesions at different levels of subvalvular apparatus. The refined reconstructive techniques developed by *Carpentier* (8—11) and *Duran* (12, 13) have opened the era of modern conservative surgery of the mitral valve. Previous works of *Lillehei, Merendino, Kay, Reed. Wooler, McGoon, Gerbode* and many others described various techniques to correct mitral incompetence (14). Inspired by well-known techniques 1—4, 19), we have performed since February 1980, 33 mitral valve reconstructions with complete valvotomy and patch extension of the mural leaflet with stabilized biologic tissue. In an effort to ensure an adequate mitral orifice and a competent valve, the insertion of the pliable tissue patch offered to the mural leaflet a larger area for coaptation with the anterior leaflet and a mobile hinge for the movement of the thickened mural leaflet. The autologous tissue (pericardium, fascia lata) used in the technique described by *Sauvage* (1), *Bailey* (2), *Marion*

(4), *Selmonosky* (3), *Frater* (19) has the disadvantage of fibrotic thickening in valvular area.

The ideal tissue for leaflet extension in mitral valve reconstruction would be one readily available, sterile, less antigenic and durable without calcification. Human dura mater stabilized with Glutharaldehyde was chosen an an appropriate tissue for leaflet advancement seeing its qualities and the similarity with aortic leaflet structure — bundle of collagen crossing each other in opposite directions as a network-like structure. Experimental studies in dogs up to 14 months after the insertion as a conduit with valve between the right ventricle and pulmonary artery showed good preservation of dura mater structure and good thromboresistance. This tissue has also been used in 15 clinical cases for closure of atrial septal defects and for right ventricular outflow tract reconstruction in Fallot tetralogy since 1976 with no evidence of shrinking, calcification or aneurysmal dilatation. As an allograft it is possible to be less antigenic than a xenograft. The pericardial xenograft tissue preserved with Glutharaldehyde has been used in 4 cases for leaflet extension as described, based on large experience of many centers with pericardial xenograft valve, including ours (5,20). The indications for mitral valve reconstruction with stabilized biologic tissue were: adult patients with predominantly mitral stenotic lesions of rheumatic origin with short and thickend mural leaflet; absence of significant pathology of the anterior leaflet; mitral valve free of calcifications; small LV inadequate for a large biologic prosthetic valve to match the surface area of a given patient; less than severe pathology of subvalvular structures. As a policy, the operative procedure to be performed for a stenotic lesion of the mitral valve is decided only intraoperatively after careful assessment of every component of the mitral apparatus. Every effort was made to attempt the reconstruction before taking the decision to replace the valve. In cases with unsatisfactory reconstructive procedure valve replacement is indicated. The advantages of the procedure are the preservation of the patient's own valve, the absence of thrombo-embolic complications, and freedom of anticoagulant treatment. The reconstructive procedure could be done with low or no mortality. The small number of patients in this group and the very short follow-up does not allow yet valid conclusions. The procedure is still a palliative operation. The more severe the deformity of the leaflets and subvalvular apparatus at the time of the operation, the greater the likelihood that the patient would require valve replacement in the future (6,16). As a more aggresive approach, it seems possible to resect and replace larger parts of the leaflets with stabilized biologic tissue if the free margin of the original leaflet and its cordal attachment could be preserved and sutured to it. The long term behaviour of the stabilized biologic tissue in the functioning leaflet of the mitral valve could be important for the future of biological valves. The reconstructive procedure as described offers the possibility to explore and correct subvalvular lesions not obvious through the mitral orifice and from the atrium. The procedure could be combined with other reconstructive procedures of the mitral valve. Less turbulent flow through the reconstructed valve may protect the structures from further deterioration. In this era of although not yet ideal, but better valvular substi-

tutes, we need new comparison between improved procedures of valvular reconstructions and valve replacement.

Conclusions

1. Mitral valve reconstruction with stabilized biologic tissue could be carried out successfully.

2. Satisfactory results have been obtained in 33 patients (low mortality and morbidity, avoidance or delayed valve replacement).

3. In cases with short posterior leaflet the decision for replacement or reconstruction is facilitated by an incision at its base, which allows exploration of mitral apparatus.

4. Complete mitral valvotomy combined with extension of posterior leaflet produced an adequate mitral orifice and a competent valve in cases with correctable lesions.

5. Satisfactory function of the mitral valve could be obtained with this technique up to 2½ years the operation.

References

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