Advances in valve repair for rheumatic mitral stenosis

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Central Picture
Peeling is one of the major advances and becomes an integral part of current rheumatic valve repair.

Central message:
Rheumatic mitral stenosis is challenging in valve surgery. Recent innovative approach has shown its efficacy in repairing the valve dysfunction. This paper reviews current strategy and techniques.
Introduction:

Rheumatic mitral valve disease is still a major challenge worldwide. Although mitral valve repair has been proven to be a preferred treatment over valve replacement especially for degenerative valve disease (1,2,3,4). However, for rheumatic valve disease, the overview outlook seems to be less favorable compare to degenerative valve entity. Even though good long term mitral valve repair results for rheumatic mitral regurgitation have been demonstrated by Carpentier et al and others (5,6,7), for rheumatic mitral stenosis, it is still a dilemma and pessimistic. Nevertheless, it is this particular group of patients that demands most for mitral valve repair. A lot of them are young, child bearing age, poor medication compliance and live in suboptimal health care environment. To put in mechanical valve, the risks of life threatening complications are real and dreadful. The challenging questions are how to improve the results of valve repair for rheumatic mitral stenosis and make it another gold standard. This paper summarizes current advances of valve repair for rheumatic mitral stenosis which is based on better understanding of mitral complex and mitral dynamics. The pathophysiology triad described by Carpentier (8) is of paramount and paves the way to correctly impose effective strategy, approach and surgical techniques as will be elaborated in this review.

Carpentier’s Pathophysiology Triad

Carpentier’s functional classification(1) explained functional disturbance of mitral valve. It generalizes this important issue for surgeons to capture the malfunction of the valve. Carpentier’s pathophysiology triad pushes forward for deeper perception of how each etiology can affect mitral valve and causing pathologic lesion that results in dysfunction at the end. With this guidance, surgical strategy and effective techniques can be implemented to improve surgical results. For rheumatic mitral stenosis, the mitral lesions are the consequence of wide spread rheumatic inflammatory response that affects several organs including the heart. The major mitral valvular lesions are commissural fusion, leaflet thickening, retraction and deformation of the valve leaflets. Subvalvular apparatus is often fused with shortened and thickened chords. Annular involvement on the other hand is often underestimated. It is often fibroed, rigid and deformed. These lesions significantly interfere with annular dynamic and its geometry. Calcification once it is seen signified a long standing rheumatic disease of the valve. It imposed significant burden for valve repair and drastically reduces the chance of success. With attempt and refinement of surgical techniques, this end stage valve lesion become amenable for repair with gratifying results (9). All of these above mitral valve lesions seriously affect not only valve opening but also closing of the valve. In essence, the dysfunction of rheumatic mitral stenosis includes both diastolic and systolic function by the damage caused by rheumatic disease process to mitral complex. This understanding dictates effective surgical strategy and integrated techniques to achieve better and successful results in this complex clinical setting.

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Strategy
1. Holistic repair: Repair for all parts of mitral valve
2. Correct both diastole and systole
3. Full and physiologic commissurotomy
4. Abolish problematic restrictive and obstructive chords
5. Achieve functional mobility type I for all valve segments
6. Restore pliability of leaflet and subvalvular apparatus
7. Assure adequate quantity and geometry of leaflets
8. Achieve good coaptation
9. Effective type and size of annuloplasty ring

Surgical techniques:
The paramount strategy for rheumatic valve repair for mitral stenosis must be a holistic repair for all mitral complex. Rheumatic disease affects every segments of mitral valve and creates primary lesion which results in primary dysfunction. This primary consequences will be followed by secondary lesions and dysfunction from continuous damage. The goals of this holistic repair are restoration as much as possible of normal diastolic and systolic function. With the better understanding of relationship between mitral anatomy and dynamics, surgical techniques gradually emerged to accomplish these goals.

**Diastolic function**

For normal diastole, mitral valve must be maximally open. This depends on several parameters.

1. The ability of leaflets to open the orifice along its full length of commissure.
2. The movement of the leaflets must not be hindered by any obstruction from subvalvular structure beneath.
3. The diastolic inflow from left atrium to left ventricle must comprise of both central orifice and collaterals through numerous fenestrated channels. This architecture of flow passage will facilitate and assure normal diastolic flow through the valve.
4. Pliability of leaflets and subvalvular structures are all crucial for normal diastolic dynamics of the valve. Technique of leaflet peeling and fenestration are useful and become integral techniques in repairing rheumatic mitral stenotic valve. Details of these techniques will be elaborated.
5. Annular dynamics is vital for normal diastole. Although significant of patients have severe damage of annular function, surgeons must thoroughly assess and identify the condition of the structure and its dynamics. This will pave the way to the appropriate choice of valve ring for good outcomes both immediate and long term.

**Techniques:**

1. Commissurotomy is the first step. The line of commissure usually can be identified by pulling of anterior leaflet downward to show both trigone areas. A few millimeters below are the origin of commissures. Commissure will run from central orifice and stop a few millimeters before the annulus.
2. Fan-shaped chordal insertion should be restored and maintained. This special anatomical character is unique with important functional implication. It allows commissural leaflet to move perpendicular to anterior and posterior leaflets. Mitral valve opening will be maximal and least stressful in this manner.
3. In many situations, when the commissure is badly damaged, the magic stitch, advocated by Carpentier, provides a reliable remedy to achieve commissural competency.
4. Once commissurotomy is done, the next step is to mobilize leaflets. Usually, due to severe subvalvular involvement, most of them are in type III. Mobilization involves resection of obstructive chords which can be primary, secondary or tertiary chords. Resection should be done first to posterior leaflet as it is close to surgeon and problematic chords can be identified easily. Mobilization of anterior leaflet can subsequently be done with the same approach.
5. Fenestration, advocated by Carpentier (1) has now become an integral part of repair technique to restore good diastolic function. It provides important collateral channels for diastolic flow in addition to the main mitral orifice. The technique in combination with papillotomy creates fenestrated spaces for diastolic flow in addition to central mitral orifice. Obviously, this improves diastolic function significantly.
6. Most of mobility dysfunction of mitral stenosis is Carpentier’s functional type III A. The subvalvular chords is usually thickened, fused and shortened from rheumatic disease. These chords cause both obstruction during diastole and restriction in systole. Precise resection of all of these problematic chords is essential and will gradually correct leaflet mobility back to normal type I. Appropriates chordal repair technique may be needed in the end of extensive resection to the unsupported valve area.
7. Peelingplasty, introduced for rheumatic mitral valve repair by Kumar (10) to restore
pliability of leaflet, has become an integral part of advanced rheumatic mitral valve repair. The technique usually starts at the hinge part of posterior leaflet with blunt dissection by two forceps. Once the plane of thick layer of rheumatic membrane is identified, peeling can usually moves toward the rough zone of leaflet. At rough zone, no further dissection can be continued as there is no tissue plane. The same procedure is carried out at the anterior leaflet by the same manner as previously described. Sharp cut to the membrane is done to accomplish the peeling technique (11). Peeling is not feasible if fibrosis and calcification involve full thickness of leaflet. In that situation, resection and tissue repair with pericardium is needed. Leaflet injury may occur during peeling but it usually can be solved by simple suture.

Systolic Function

Techniques:

8. Once mitral valve repair aimed for diastolic function is done, the focus is now shifted to systolic function. The prerequisites for optimal systole are the mobility functional class I of mitral leaflets, pliable leaflet with adequate tissue and good geometry, favorable annular dynamics, adequate coaptation with good left ventricular function and geometry.

9. To achieve functional class I mobility, the length of primary, secondary and tertiary chord are crucial and must be optimal. Those chords that are shortened will be restrictive during systole and need to be resected. This step requires precision to tackle the culprit chords without compromise. Chordal repair with appropriate technique may be used to unsupported valve area in cases with extensive chordal resection (12,13).

10. Adequate quantity of leaflet with good geometry and pliability are crucial for mitral valve competency and optimal coaptation. In rheumatic mitral stenosis, leaflets often retracted, thickened, deformed or calcified. Leaflet repair will be required if tissue is inadequate, severely deformed or full thickness calcified. Tissue repair with autologous or bovine pericardium is usually satisfactory with acceptable results.

11. Tissue repair to mitral leaflets can be done to either anterior or posterior leaflet or both if necessary (14,15). However, because the anterior leaflet play major role in mitral function, repair of anterior leaflet alone is usually adequate for satisfactory valve function. Tissue repair to the anterior leaflet starts by incise the leaflet at the middle part about 2 millimeter from the leaflet and annulus junction. The incision is extended to both sides toward commissure. It is advisable to extend the incision across the commissural line to about half of the leaflet. In this way, the tissue repair will include both commissures which are commonly affected as well. An ellipsoidal pericardial patch treated with 0.65% gluteraldehyde solution for 5 minutes is sutured with 5-0 prolene suture to repair the leaflet. The goals are to repair both the quantity of leaflet tissue as well as leaflet geometry. The same procedures are used for posterior leaflet if it is needed.

12. Last step is mitral annuloplasty and must be emphasized. It strengthens valve repair procedures, prevents further annular dilatation, remodels annular frame for optimal mitral valve function and ensures long term durability.

13. Choice of valve ring is often a debatable issue in mitral annuloplasty. Although there is still no perfect valve ring compare to natural mitral annulus, to make the best choice, surgeon have to pay attention to certain important points, i.e., proper ring sizing, annular suturing technique and selection of type of valve ring. Major considerations are optimal mitral orifice opening, adequate coaptation surface, remodeling of annular deformity. Surgeon’s experience and preference plays important role in choosing type of valve ring to ensure good long term results (16,17,20).

14. Transesophageal echocardiography is used for assessment of mitral valve and repair results the same way as in other type of mitral valve. Both diastolic and systolic parameters as well as coaptation depth are measured for acceptability, prediction of success and durability of the repair.

15. Although the feasibility and results of valve repair for rheumatic mitral stenosis have improved recently (9,18,19), however, certain limitations exist. In patients with severe valve pathology and calcification, elderly patients with comorbidity,
mitral valve replacement is still a viable choice.

16. Future challenges are improvement of the repair techniques and tissue substitute. These will facilitate valve repair for complex cases. Advances in prosthetic and transcatheter valve technologies are hopeful areas for future treatment.

Conclusion: With current knowledge of mitral valve anatomy and dynamics plus the state of the art of valve repair techniques, repairing of rheumatic mitral stenosis is becoming more feasible and promising. The innovative approaches have been introduced with encouraging results. Follow up of valve repair with this approach is mandatory.
References:


4. MA Gardner, KF Hossack, IR Smith: Long-Term Results Following Repair for Degenerative Mitral Regurgitation - Analysis of Factors Influencing Durability, Heart Lung and Circulation (2019) 28, 1852-1865


