Research Article

Non Resectional Methods of Mitral Valve Repair: The New Dynamic Indian Correction

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Abstract

Drawbacks persist relating to the irreversibility of leaflet resection, time-consuming leaflet reconstruction with sliding annuloplasty, monoleaflet function, and systolic anterior motion (SAM) risk. Neochord construction mitigates many of these but has the challenge of precise sizing and the possibility of leaving excessive tissue, risking SAM. When this reconstruction is based on stress analysis and shear analysis methods the outcome gives the best results. Short term evaluation has been done with good outcomes.

Key words

SAM- Subaortic Obstruction, IVT- Inter Ventricular Triangle, MR- Mitral Regurgitation.

Introduction

The evolution of repair techniques of the mitral valve has taken a concurrent route along with that of cardiac surgery itself. The concept of replacement to repair and now from respect rather than resect approach to the current non-resectional method has been due to a better understanding of the dynamic nature of the valve. Stress pattern studies that have currently received a boost with technological advancements **(**1**)**. While "resection" techniques are associated with good results, reparability rates stood at around 60-70% for the last decade. We are presenting a new technique based on the latest stress and dynamic updates on the valve, which would facilitate near to 100% reparability rates in the future. All current studies support our view of adopting a completely non-resectional method in mitral valve repair – or the dynamic Indian Correction as we call it.

Methods

Mitral valve repair done via non-resectional methods from January 2017 to November 2017 is included. The preoperative analysis included cardiac MRI and 3 D echocardiography. 25 patients who underwent non-resectional methods during this period and techniques are discussed. Patients who underwent leaflet resection, LVEF less than 45%, reoperative mitral valve repairs, beating heart repairs, or who underwent minimally invasive procedures during this period were excluded from the study. Intraop TEE was used in all cases. The approach to the mitral valve was through the superior septal approach with the initial assessment done on beating heart. The repair was fashioned on the arrested heart. After analysis of the valve artificial chordae were created with CV5 and CV6 e PTFE sutures (Gore-Tex R, WL Gore and associates Flagstaff AZ). Graded reconstruction with suture thickness simulating natural chordal stress patterns was used. The suture was first placed in the fibrous part of the papillary muscle. Pledgets and suture tie was avoided in the papillary muscle to minimize chances of ischemia, by taking a simple U stitch. The apposition points are marked on the anterior or posterior leaflets so that 1/3rd of the anterior leaflet enters the coapting zone. (**Figure**-1).

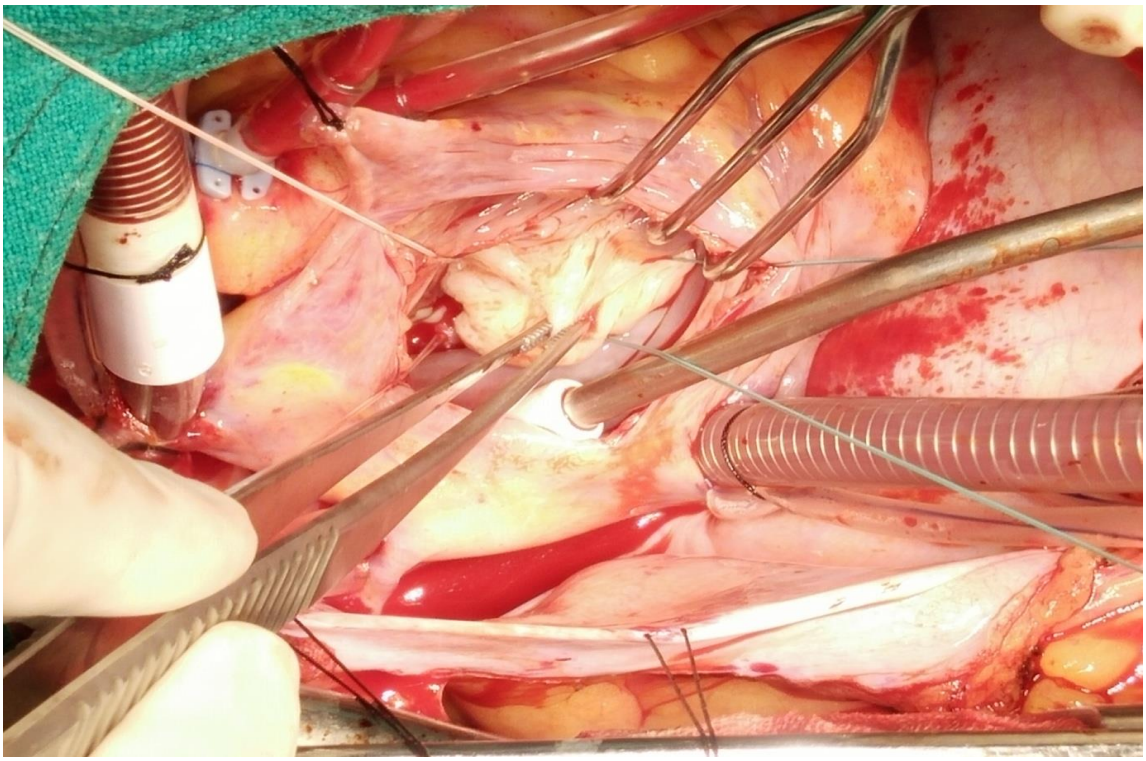

Figure-1 Mitral Valve Non Resectional Graded Chordal Neoconstruction Method

Slight billowing of the anterior leaflet should be permitted as it reduces the stress. The initial position of neochordae can be fixed with a clip placed lightly 1.5mm below the annular plane. The suture goes back through the leaflet edge from the atrial to the ventricular side placing knots on the ventricular side. The leaflet was drawn down into the ventricle so that the prolapse was eliminated and the area of the good zone of coaptation is ensured- usually 1/3rd. The peak height of the coaptation point should be only up to the plane of annulus. Use the annular plane as a guide for fixing the neo chordal length. As many neochordae as deemed necessary are created following the natural line of attachment to the papillary muscle. Avoid crossing the midline. Strut chordae are never excised. Repair methods are individualized as deemed necessary to shorten the leaflet height of the anterior leaflet or straightening of the posterior leaflet margin. Plication of the annulus at P2 and P3 needs to be done in ischemic lesions involving the posterior wall. Pulling together of papillary muscles with Gore-Tex sutures are done if more than 2cm apart.

Chordal shortening is avoided. In such cases, leaflet folding by transferring tissue from atrial to coaptation zone is done.

The Coaptation zone along neochordae creation allows maximum coaptation at the center and less towards commissures as in the normal valve. Excess leaflet tissue may require plication. Sub commissural fusion has to be released. Chordal splitting is done in an individual fashion depending on the pathology. Leaflet thinning and open commissurotomy may be required in rheumatic lesions. Reduction annuloplasty ring is fashioned making allowance for a push up of the ring at the interventricular triangle region of the anterior leaflet to allow for the posterosuperior movement of the annulus. Keep the posterior leaflet height less than 2cm. Diastolic and systolic assessment of repair is then done. Post bypass intraop TEE is done to confirm the results. A repair can be assessed in systole in beating heart before atrial septal closure or by simultaneous saline filling of the aortic root and left ventricle. No residual mitral regurgitation is accepted. The repair success rate was 100%. No patients underwent mitral valve replacement. All repairs were successful on the first attempt.

Statistics

The data was analyzed using SPSS version 13.0 for Windows XP. Descriptive statistics for continuous variables are expressed as median or mean as needed while qualitative variables are expressed as a percentage and $P < 0.05$ being considered significant.

Results

Demographic and clinical data were obtained from the hospital records. The mean age was 63+/-7.7, 15 were male. All patients were in NYHA class III. 2 patients required tricuspid valve repair and 4 patients needed coronary bypass surgery. Interpapillary distance in patients with inferior wall involvement was 31+/- 3 mm. One patient required LA myxoma removal. Median surgical risk based on Logistic Euroscore was 3.95% (2.38%). Median Total cross-clamp time was 74+/-7 min. Total extracorporeal time being a median of 120 (80 to 146) minutes.4 neochordae were created in 10, 6 in 12, 2 in 3 patients. 28 sized annuloplasty ring was used in one patient, 30 in 12 patients, 32 in 11 patients and 34 in 1patient. The Mean coaptation height achieved was 8+/-3mm. 25 patients had zero MR on post bypass TEE. No patients had SAM.

The preoperative annular area was 19.2 +/- 4 cm2 and post-op being 7.7 +/-2 cm2 by 3D methods showing a reduction efficiency of 60%. The median ICU stay was 2 days (1-10) days and the median total hospital stay was 7 days (5-17) days. One patient had atrial fibrillation which reverted with pharmacological therapy, 1 case of acute renal failure in a patient with chronic renal failure and types 1 neurological dysfunction in one patient. Preop ROA was median 9.10 (6.1-26.4) to post-op of 1.10 (0.3-2.1) cm2 P=0.001. At follow up of 90 days the median ROA was – 0.50 (0.9cm2) P=0.001.LVEF was the median of 63% (30-77) before surgery to 68% (55-80) post-op P=0.14. Clinical follow-up was 100%. 25 patients are alive, and all were free of MR signs and symptoms. No patient required reoperation for recurrent MR.

Echocardiographic follow-up has been obtained at the discretion of the referring cardiologists. Echocardiograms have been obtained on all patients with a mean follow-up of 1 year. All-cause mortality at 30 days, 60 days, 90 days; 1 year after surgery has been zero. No reoperations were needed due to recurrent mitral regurgitation, no new-onset atrial fibrillation or embolism or endocarditis were noted. No death, reoperations, heart failure, endocarditis, thromboembolism or pacemaker implantations were needed in any of these patients on follow up until Dec 25th, 2017 (median of 9 months). Follow-up was performed till Dec 25 2017 was 100% complete for survival. All patients are currently in NYHA class 1.

Discussion

The Mitral valve has stood the evolution test and the extremely dynamic nature brings forth a great concept of engineering skills to repair and hold on to this precious tissue. Resection creates extreme stress and should be avoided at all costs. To replace when a repair is feasible is a sin with our current understanding and technological evolution. Long term durability and SAM were intriguing concepts that made surgeons adopt technological modifications, but reparability rates remained constant in the last decade in most advanced cardiac centers around the world. The understanding of the intervalvular triangle as an important part of the anterior leaflet and the concept of avoiding placing a horizontal stiff ring across it was emphasized by the American correction version of mitral repairs. Mitral valve stress analysis shows at the beginning of systole the marginal chordae carries the maximum stress.

Stress increases now on the strut chordae in mid systole with more of leaflet coaptation with entire stress transfer to annulus during late systole with good leaflet coaptation. With annular dilatation, stress is evenly distributed to all valvular structures and that is the reason why mitral regurgitation tends to be a progressive disease.

Normal valve dynamics ensure optimal diastolic locking, a proper zone of coaptation with excellent left ventricular outflow dynamics and smooth leaflet and chordal stress distribution. Of the various geometric, kinetic and structural factors that can lead to SAM, impaired aorto mitral coupling dynamics are the most significant. It is important to avoid rigid and undersized rings which not only alter coupling dynamics but reduce the aorto mitral angle **(**4**)** also that leads to both LV inflow and outflow obstructions. Failures to recognize the interventricular component of the anterior leaflet and aortomitral coupling dynamics are important reasons for the failure of repair of this segment.

Avoid resection and true sized annuloplasty rings that take the interventricular triangle are keys to success. Ischemic mitral regurgitation often with sagging P2 P3 areas require annuloplasty to correct this portion and then bringing the papillary muscles to within 2cm of each other before placing the ring – for which a true sized ring would be most effective. The goals of the Indian method of correction would be explained as follows:

1. Eliminate mitral regurgitation.

2. Ensure normal leaflet coaptation.

3. Restore normal annular dynamics.

4. Maintain normal left ventricular outflow dynamics.

5. Restore stress ratios to normal thereby enhancing the durability of repair.

6. Graded Neochordal reconstruction of the valve chordae for natural stress redistribution

It is an excellent reproducible and safe procedure with 0.2 % mortality **(**2**)**. Failure with repair techniques due to leaving behind areas of stress which has to be meticulously avoided by proper assessment and optimal repair **(**3**)**.

Conclusion

The Indian Dynamic Correction of the mitral valve differs from the French correction that there is no resection of the valve and from American correction, in that a complete physio ring is used to preserve the aorto mitral dynamics with graded Neochordal reconstruction which would simulate the natural stress redistribution dynamics. This would in the future ensure 100% reparability and would increase the percentage of valve repairs in all centers. Stress dynamics enforce the need for proper surgical correction and the fallibility of the developing percutaneous concept in ignoring the aorto mitral dynamics.There is growing evidence showing that the "non-resection" technique has some potential advantages including:

(I)preserved leaflet mobility;

(II) larger surface of coaptation;

(III) no changes in annular geometry; and

(IV) implantation of a larger prosthetic annuloplasty ring.

The leaflet is the most precious part of the valve so preserve it. Mitraclips placed severely damage the valve and place it has the only option of replacing the valve if it fails. Current percutaneous methods fail to relieve the stress ratios and would certainly fail in the long run and surgery would remain the gold standard in the future.

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