Mitral valve gradient after valve repair of degenerative regurgitation with restrictive annuloplasty

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ABSTRACT

Backgrounds: Outcomes of mitral valve repair have been well described for patients with degenerative regurgitation. The hemodynamic effects of repair have not been as well studied, however. We report hemodynamic outcomes in these patients.

Methods: We reviewed 1147 patients who underwent isolated mitral valve repair for degenerative mitral valve regurgitation between January 2004 and December 2013. Baseline characteristics included mean age 58.6 ± 13.4 years, male sex in 792 patients (69.1%), mean ejection fraction of 0.64 ± 0.07 , and New York Heart Association class III/IV dyspnea in 215 patients (18.8%).

Results: Mitral valve repair involved the posterior leaflet in 764 patients (66.6%), anterior leaflet in 57 patients (5.0%), both leaflets in 260 patients (22.7%), and annuloplasty alone in 66 patients (5.8%). Among the patients who underwent posterior leaflet repair, 713 (93.3%) were treated with our standard technique of triangular leaflet resection/plication and repair with partial posterior band annuloplasty using an unmeasured 63-mm flexible band. Follow-up echocardiography data were obtained in 1138 survivors (99.4%) at 600 ± 880 days. Mild or less valve regurgitation was present at last follow-up in 1030 patients (90.5%). The mean mitral valve gradient was 3.1 ± 1.4 mm Hg in the operating room and 3.5 ± 1.6 mm Hg at the last follow-up ($P < .001$). The mean mitral valve gradient decreased from the first to the second median time periods (124.5 days) of follow-up (3.7 ± 1.6 mm Hg to 3.3 ± 1.8 mm Hg; $P < .001$).

Conclusions: Mitral valve repair for degenerative regurgitation results in a small mitral valve gradient that appears to decrease with time after discharge. (J Thorac Cardiovasc Surg 2016;151:106-9)

The changes of mitral valve gradient after valve repair of degenerative regurgitation.

Central Message

Mitral valve repair for degenerative disease results in a low mitral valve gradient that decreases with time after discharge.

Perspective

The mitral valve gradient after mitral valve repair has not been well studied. We retrospectively reviewed 1147 patients over a 10-year period. Our standard technique includes leaflet resection and annuloplasty with a standard-sized flexible band. We found that our repair technique results in a good long-term durability, as well as a small mitral valve gradient that decreases with time after discharge.

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Mitral valve repair is preferred over replacement in the setting of degenerative mitral valve disease.¹ In this condition, most mitral valve repair techniques involve leaflet resection, suture repair, and restrictive band or ring

annuloplasty.² It is intuitive that some narrowing of the valve orifice will occur after the use of these techniques, and indeed the literature supports such a concept.³ The effects of such repair have not been well studied, however, and only a few reports have been published to date.^{4,5} We studied our experience in this setting to better understand the effect of mitral valve repair as it relates to long-term valve gradient.

METHODS

The Mayo Clinic's Institutional Review Board approved the collection and analysis of the data for this study. We reviewed the records of 1255 patients who underwent isolated mitral valve repair for degenerative valve regurgitation between January 2004 and December 2013. We excluded 108 patients (8.6%) who had undergone previous valve surgery or had a

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history of active endocarditis or mitral valve stenosis. A total of 1147 patients (91.4%) were enrolled in this study.

Baseline patient characteristics, operative data, surgical techniques, and echocardiography data were abstracted from the Division of Cardiovascular Surgery's database and individual patient medical records. Data were collected in keeping with definitions outlined in the Society of Thoracic Surgeons' Adult Cardiac Surgery Database.

Mitral valve repair techniques are defined based on the leaflets involved in the repair as posterior, anterior, bi-leaflet, or ring annuloplasty alone. Commissuroplasty is classified as a bi-leaflet repair. In general, our institutional strategy for posterior leaflet repair includes posterior leaflet triangular resection/plication, cleft closure, and repair with an unmeasured 63-mm flexible band (Medtronic, Minneapolis, Minn) annuloplasty (Figure 1). This is a "one size fits all" strategy that involves no modification of the band. Follow-up echocardiography was done at Mayo Clinic and interpreted by cardiologists.

Descriptive statistics for categorical variables are reported as count (percentage), and those for continuous variables are reported as mean $\pm$ standard deviation or median (interquartile range) as appropriate. Statistical analyses were performed using the χ^2 or Fisher exact test for categorical variables and the nonparametric rank-sum test for continuous variables. Freedom from recurrent mitral valve regurgitation was calculated using Kaplan-Meier estimates.

RESULTS

The 1147 patients included 792 males (69.0%). The mean age at surgery was 58.6 ± 13.4 years, and the mean preoperative left ventricular ejection fraction was 0.64 ± 0.07 . The preoperative New York Heart Association functional class was I in 335 (29.2%), II in 595 (51.9%), III in 180 (15.7%), IV in 35 (3.1%), and missing in 2 patients. Atrial fibrillation was present in 91 patients (7.9%).

The mitral valve surgical technique was median or partial sternotomy in 784 patients (68.3%) and right thoracotomy with or without robot assistance in 363 patients (31.6%). The mean duration of cardiopulmonary bypass was

57.1 ± 27.8 minutes. The aortic cross-clamp time was 41.0 ± 19.7 minutes. Operative mortality occurred in 2 patients (0.2%).

Valve repair included operation on the posterior leaflet in 764 (66.6%), anterior leaflet in 57 (5.0%), both leaflets in 260 (22.7%), and ring annuloplasty alone in 66 patients (5.8%). Among the patients that underwent operation on the posterior leaflet alone, 713 (93.3%) received our standard repair technique of triangular leaflet resection/plication and partial posterior band annuloplasty with an unmeasured 63 mm flexible band.

Adjunctive mitral valve repair techniques were done in 434 (37.8%) patients. Such techniques included one or more of the following: artificial chordae in 206 (18.0%), commissuroplasty in 182 (15.9%), posterior leaflet quadrangular resection in 41 (3.6%), or an Alfieri (ie, edge-to-edge) repair in 27 patients (2.4%).

Intraoperative transesophageal echocardiography data about valve regurgitation were available in 1146 (99.9%) patients, while follow-up transthoracic echocardiography data were available in 1138 survivors (99.4%) survivors at 600 ± 880 days (median 124.5, interquartile range, 4–884.3). Mild or less grade mitral valve regurgitation was present in the operating room in 1136 patients (99.1%) and at last follow-up in 1031 patients (90.6%). Freedom from moderate or greater mitral valve regurgitation at 5 years was $77.0\% \pm 2.6\%$.

Mitral valve gradient data were reported intraoperatively in 920 patients (80.3%) and at last follow-up in 1136 survivors (99.2%) (Table 1). A mitral valve gradient was present in 917 patients (99.7%) intraoperatively and in 1136 (100%) at last follow-up. The mean gradient was 3.1 ± 1.4 mm Hg in the operating room and 3.5 ± 1.6 mm Hg at last follow-up.

FIGURE 1. Illustration of our standard mitral valve repair technique including triangular leaflet resection/plication and partial posterior band annuloplasty with an unmeasured 63-mm flexible band.

TABLE 1. Mitral valve gradient, stratified by type of repair

Variable	Intraoperative transesophageal echocardiography		Follow-up transthoracic echocardiography	
	No. with data/no. at risk (%)	Mitral valve gradient, mm Hg	No. with data/no. at risk (%)	Mitral valve gradient, mm Hg
All patients	920/1147 (80.2)	3.1 ± 1.4	1136/1145 (99.2)	3.5 ± 1.6
Type of leaflet repair				
Posterior leaflet	618/764 (80.9)	3.1 ± 1.3	756/764 (99.0)	3.4 ± 1.5
Anterior leaflet	41/57 (71.9)	3.0 ± 1.4	57/57 (100)	3.7 ± 1.8
Bi-leaflet	214/260 (82.3)	3.4 ± 1.6	257/258 (99.6)	4.0 ± 1.9
Ring annuloplasty only	47/66 (71.2)	2.7 ± 1.1	66/66 (100)	3.5 ± 1.6
<i>P</i> value		.004		<.001
Posterior leaflet repair				
Our standard repair technique	573/713 (80.4)	3.1 ± 1.3	707/713 (99.2)	3.4 ± 1.5
Other repair	45/51 (88.2)	2.9 ± 1.2	49/51 (96.1)	3.3 ± 1.3
<i>P</i> value		.405		.689
Artificial chordae				
Yes	169/206 (82.0)	3.1 ± 1.5	203/205 (99.0)	3.6 ± 1.8
No	751/941 (79.8)	3.1 ± 1.4	933/940 (99.3)	3.5 ± 1.6
<i>P</i> value		.758		.641
Commissural repair				
Yes	156/182 (85.7)	3.5 ± 1.6	179/180 (99.4)	4.1 ± 1.9
None	764/965 (79.2)	3.0 ± 1.4	957/965 (99.2)	3.4 ± 1.6
<i>P</i> value		<.001		<.001
Alfieri repair				
Yes	25/27 (92.6)	3.8 ± 1.6	27/27 (100)	4.3 ± 1.7
No	895/1120 (79.9)	3.1 ± 1.4	1109/1118 (99.2)	3.5 ± 1.6
<i>P</i> value		.036		.006

Paired data were available in 910 survivors (79.5%), and the difference between the 2 groups was statistically significant ($P < .001$).

Mitral valve gradient data stratified by type of repair are summarized in Table 1. At last follow-up, posterior leaflet repair was associated with a lower mean gradient (3.4 ± 1.5 mm Hg) than anterior leaflet repair (3.7 ± 1.8 mm Hg), bi-leaflet repair (4.0 ± 1.9 mm Hg), or ring annuloplasty alone (3.5 ± 1.6 mm Hg; $P < .001$). In cases of posterior leaflet repair, our standard unmeasured band annuloplasty technique resulted in a similar gradient as achieved with other techniques (3.4 ± 1.5 mm Hg vs 3.3 ± 1.3 mm Hg; $P = .689$).

The follow-up mitral valve gradient of operative survivors was also analyzed in the first and second median (124.5 days) and mean (600 days) follow-up periods. The mean valve gradient was 3.7 ± 1.6 mm Hg ($n = 567$) in the first median follow-up period and 3.3 ± 1.8 mm Hg ($n = 569$) in the second median follow-up period ($P < .001$). The mean valve gradient was 3.6 ± 1.7 mm Hg ($n = 776$) in the first mean follow-up period and 3.3 ± 1.6 mm Hg ($n = 360$) in the second mean follow-up period ($P < .001$).

A total of 35 (3.1%) early or late reoperations were performed, for mitral valve regurgitation in 32 patients (91.4%), mitral valve stenosis in 2 patients (5.7%), and endocarditis in 1 patient (2.9%). For recurrent mitral valve regurgitation, the operation included re-repair in 12 patients

and replacement in 20 patients. The remaining patients underwent valve replacement. In the 2 cases of mitral valve stenosis, vegetation on the annuloplasty ring with extension onto the leaflets was noted.

DISCUSSION

This study reports the outcomes of mitral valve repair with respect to postoperative valve regurgitation and gradient in 1147 patients. In this series of patients, valve repair appeared to be effective and durable, with a $77.0\% \pm 2.6\%$ rate of freedom from moderate or worse grade mitral valve regurgitation at 5 years. Repair resulted in a small hemodynamic effect on the function of the valve, however, with a mean gradient of 3.1 ± 1.4 mm Hg noted in the operating room compared with 3.5 ± 1.6 mm Hg at last follow-up. The good news is the gradient appeared to decrease with time after discharge; furthermore, only 2 patients (0.2%) underwent mitral valve replacement for subsequent mitral valve stenosis.

Techniques for mitral valve repair have been well described for patients with degenerative regurgitation, and this remains the preferred method of valve operation whenever possible.^{1,2,6} For the most part, valve repair results in effective and durable correction of valve regurgitation.^{7,8} The hemodynamic effects of repair have not been as well studied, however. Mesana and colleagues reported that compared with a partial ring, a complete ring may be

associated with a higher mitral valve gradient at rest and at exercise⁵; however, a focused analysis of mitral valve gradients after valve repair has not yet been reported.

The present study supports the concept that restrictive annuloplasty results in a small valve gradient. The temporal nature of the gradient is regression during mid-term follow-up (600 ± 880 days in this study). The gradient decreased during the first and second mean and median follow-up periods. This is an important finding, because progressive leaflet sclerosis/scarring (ie, gradient increase) was not seen. In our experience, only 2 of 1145 patients (0.2%) who survived mitral valve repair underwent subsequent valve replacement for mitral valve stenosis, which is similar to the proportion of 0.4% reported by Ibrahim and colleagues.⁴

Our group advocates mitral valve repair with posterior leaflet triangular resection and an unmeasured 63-mm posterior band annuloplasty.^{7,8} This technique is applicable to most patients. In our experience, 713 of 764 patients (93.3%) who underwent isolated posterior leaflet surgery received our standard repair. The hemodynamic effect of the “one size fits all” unmeasured posterior band annuloplasty is without apparent detriment, that is, the technique resulted in no significant difference in mitral valve gradient noted on intraoperative or last follow-up echocardiography compared with other types of repair. Whether such a concept would apply to a complete ring could not be addressed in the present study.

Whether leaflets should be resected or preserved is controversial. Perier and colleagues introduced the “respect rather than resect” approach for degenerative mitral regurgitation.⁶ They used artificial chordae for posterior leaflet prolapse, aiming to preserve the leaflets. It is intuitive that a leaflet-preserving technique should result in less mitral valve gradient than the resecting technique; however, this has not been well documented. Our data demonstrate no difference in mitral valve gradients at last follow-up between patients who received artificial chordae and those who did not; however, our data do verify that commissural or Alfieri plication results in higher mitral valve gradients at all follow-up time points.

This study has the usual limitations of a retrospective analysis, including selection and reporting biases with respect to the classification scheme for type of leaflet repair, reported by means of as-treated groups. An additional

limitation is that some patients underwent follow-up echocardiography in the early follow-up period (ie, first median follow-up period), and in those patients valve gradients might have been artificially elevated owing to increased stroke volume related to the operative procedure (eg, anemia, elevated heart rate). Finally, we had paired follow-up data on only 910 survivors (79.5%); however, the effect of this limitation may be minimized by our follow-up gradient data on more than 99% of survivors.

CONCLUSIONS

Mitral valve repair for degenerative disease results in long-term freedom from recurrent severe valve regurgitation. All methods of restrictive annuloplasty result in some element of a postoperative mitral valve gradient, none of which appears to be clinically significant requiring additional operation.

Conflict of Interest Statement

Authors have nothing to disclose with regard to commercial support.

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