Feasibility and Efficacy of Mitral Valve Repair for Degenerative Mitral Regurgitation in the Elderly

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Purpose: The number of elderly patients who require surgical treatment for mitral regurgitation (MR) is increasing. However, the feasibility and efficacy of mitral valve repair in elderly patients are unclear.

Methods: We retrospectively reviewed 55 patients, aged ≥75 years, who underwent mitral valve repair for degenerative MR between 1991 and 2011. All patients were followed up for 4.7 ± 3.4 years.

Results: The patients aged ≥75 years were more symptomatic and had a higher incidence of persistent atrial fibrillation and pulmonary hypertension than those aged <75 years. Thirty-day and in-hospital mortality was 1.8% and 7.3%, respectively, and the 5-year survival rate was 81.6% ± 5.8%. The leading cause of late death was stroke, which primarily occurred in patients with postoperative atrial fibrillation. Except for a single failure of repair due to technical reasons, there was no recurrence of severe MR or reoperation on the mitral valve. In the late follow-up period, the mean left ventricular diastolic diameter significantly decreased and the mean left ventricular ejection fraction was approximately 60%. Most patients had mild symptoms at follow-up.

Conclusion: Mitral valve repair can provide satisfactory early as well as long-term outcomes and can preserve left ventricular function even in the elderly.

Keywords: mitral valve repair, degenerative mitral regurgitation, elderly

Introduction

Aging of the population in Japan has led to a marked increase in its elderly segment. Epidemiological data show that the prevalence of mitral regurgitation (MR) increases with age. As a consequence, the number of elderly patients who require surgical treatment for MR is increasing.

In elderly patients, mitral valve surgery is considered to be associated with high early mortality. Severe preoperative characteristics, such as advanced symptoms of heart failure, higher frequency of coronary artery disease, and associated comorbidities, may contribute to poor surgical outcomes. Previous reports also demonstrated high operative mortality and morbidity after mitral valve surgery in the elderly.1-6

Mitral valve repair is the treatment of choice for severe MR in the general population because it provides a significant survival advantage over both medical treatment7,8 and mitral valve replacement.9 However, its feasibility and efficacy in elderly patients are unclear. Mitral valve
repair can be more technically demanding and time-consuming than mitral valve replacement. In addition, there is a fear of failure of repair both in the early period and in long term. Several new-generation bioprosthetic valves, which diminish residual gradients and improve late durability, are now available. This has led to a higher rate of replacement in the elderly than in the younger population. 10,11)

In our institution, we attempted aggressive mitral valve repair in treating MR. Since 1991, our repair rate for degenerative MR has been 100% and we apply this strategy even in the elderly. In this study, we retrospectively reviewed surgical outcomes after mitral valve repair in the elderly and examined the feasibility and efficacy of the procedure.

Materials and Methods

Data analysis for this retrospective study was approved by the Institutional Review Board of Kobe City Medical Center General Hospital. The need for patient consent was waived.

Patient population

A total of 1041 mitral valve repairs were carried out at Kobe City Medical Center General Hospital between January 1991 and December 2011. Among the patients who underwent mitral valve repair, 282 (27.1%) with type I or III MR were excluded. Patients with congenital MR and those who underwent concomitant aortic valve procedures were also excluded from this study. With respect to type II degenerative MR, our repair rate has been 100% since 1991. A total of 661 patients with type II degenerative MR were therefore retrospectively analyzed. Among them, 55 patients were ≥75 years of age at the time of surgery.

Definitions

Preoperative systolic pulmonary artery pressure was measured with Doppler echocardiography [modified Bernoulli equation: 4 × (tricuspid regurgitation jet velocity)² + right atrial pressure (10 mmHg)].

Clinical follow-up and examinations

Patients were followed up at the outpatient clinic or by telephone survey. For patients receiving warfarin therapy, our target prothrombin time/international normalized ratio was 1.5–2.0. All patients were followed up for 4.7 ± 3.4 (mean ± standard deviation, SD) years. Postoperative transthoracic echocardiography was performed at the outpatient clinic in 40 of 51 patients (78.4%) who survived the surgery. Postoperative echocardiographic follow-up was generally performed before discharge and at the outpatient clinic at 1, 3, 5, and 10 years post-operation. The mean duration of echocardiographic follow-up was 2.6 ± 3.0 years. Follow-up echocardiographic data were obtained for 29 patients at 1 year, 16 patients at 3 years, 11 patients at 5 years, and 4 patients at 10 years after surgery.

Statistical analysis

Continuous data are expressed as mean ± SD and range. Categorical variables were compared with the χ² or Fisher’s exact tests, and continuous variables were compared with unpaired t or Wilcoxon tests. Survival and freedom from events were calculated using the Kaplan–Meier method. Statistical analyses were performed using StatView (SAS Institute, Cary, North Carolina, USA).

Results

Preoperative characteristics

Patient characteristics and preoperative echocardiographic data are shown in Table 1. Variables were compared between patients who were aged ≥75 years and those who were aged <75 years at the time of surgery. Compared with the younger patients, patients aged ≥75 years had a higher proportion of women, higher rate of New York Heart Association (NYHA) functional class ≥III, and higher incidence of persistent atrial fibrillation. Echocardiography showed that the patients aged ≥75 years had a smaller left ventricular diastolic and systolic diameter, higher systolic pulmonary artery pressure, and higher rate of moderate and severe tricuspid regurgitation. The left ventricular ejection fraction and left atrial diameter were not different between the two groups.

Surgical techniques

Regarding the region of prolapse, 3 patients (5.5%) had anterior leaflet prolapse, 34 (62%) had posterior leaflet prolapse, and 18 (33%) had bileaflet prolapse. We used a median sternotomy approach and standard cardiopulmonary bypass techniques including bicaval cannulation, in all patients. The techniques of mitral valve repair have been previously described by Carpentier12) and David, et al.13) Posterior leaflet prolapse was usually corrected by resection and suture of mitral leaflets, anterior leaflet prolapse by chordal replacement with polytetrafluoroethylene sutures (Gore-Tex; W.L. Gore and Associates Inc., Flagstaff, Arizona, USA), and bileaflet prolapse by a combination of these procedures. During the
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surgery, we routinely performed transesophageal echocardiography. The necessity of a second pump run and intraoperative re-repair was determined according to the transesophageal echocardiography findings.

Concomitant procedures included tricuspid annuloplasty in 28 patients (51%), maze procedure in 16 (29%), and coronary artery bypass grafting in 8 (15%); these procedures were more frequently performed in the patients aged ≥75 years old than in the patients aged <75 years.

Details of the surgical procedures are shown in Table 2.

Early outcomes

Of 55 patients aged ≥75 years, 30-day mortality occurred in 1 (1.8%), which was due to intraoperative stroke. Of 606 patients aged <75 years, 30-day mortality occurred in 6 (1.0%). Although in-hospital mortality occurred in another 3 in patients aged ≥75 years (total in-hospital mortality was 7.3%) due to stroke, arrhythmia, and pneumonia, respectively, no other in-hospital mortality occurred in those aged <75 years. There was no statistical difference in 30-day mortality (p = 0.909) between the two groups of patients, although there was a statistically significant difference in in-hospital mortality (p = 0.002).

In terms of operative morbidity, in the patients aged ≥75 years, 3 patients had strokes (5.5%), 2 patients had respiratory failure requiring tracheostomy (3.6%), and 3 patients required re-explorations for bleeding occurred. No patient required postoperative circulatory support. Among the 3 cases of strokes, two were of intraoperative and one occurred during admission. In the patients aged <75 years, perioperative stroke occurred in 5 of 606 patients (0.8%). One patient required tracheostomy for respiratory failure (0.17%) and 10 patients underwent re-exploration for bleeding (1.7%). The incidence of perioperative stroke and respiratory failure requiring tracheostomy was higher in the patients aged ≥75 years (p = 0.018 and 0.009, respectively).

One patient experienced recurrence of severe MR due to leaflet suture dehiscence. While this patient was waiting

<table>
<thead>
<tr>
<th>Variable</th>
<th>Age ≥75 (n = 55)</th>
<th>Age &lt;75 (n = 606)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y)</td>
<td>77.6 ± 2.5</td>
<td>54.7 ± 14.0</td>
<td>&lt;0.001</td>
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<td>Female sex (n, %)</td>
<td>33 (60%)</td>
<td>241 (40%)</td>
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<td>NYHA functional class ≥III</td>
<td>21 (38%)</td>
<td>150 (25%)</td>
<td>0.032</td>
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<tr>
<td>Persistent atrial fibrillation (n, %)</td>
<td>20 (36%)</td>
<td>139 (23%)</td>
<td>0.026</td>
</tr>
<tr>
<td>LV diastolic diameter (mm)</td>
<td>52.6 ± 5.8</td>
<td>55.6 ± 6.9</td>
<td>0.004</td>
</tr>
<tr>
<td>LV systolic diameter (mm)</td>
<td>31.1 ± 7.0</td>
<td>34.2 ± 6.6</td>
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<tr>
<td>LV ejection fraction (%)</td>
<td>67.0 ± 9.1</td>
<td>66.5 ± 7.8</td>
<td>0.661</td>
</tr>
<tr>
<td>Left atrial diameter (mm)</td>
<td>48.6 ± 11.7</td>
<td>46.4 ± 9.1</td>
<td>0.125</td>
</tr>
<tr>
<td>Systolic PA pressure (mmHg)</td>
<td>49.7 ± 14.3</td>
<td>43.0 ± 15.5</td>
<td>0.006</td>
</tr>
<tr>
<td>≥ moderate TR</td>
<td>27 (49%)</td>
<td>151 (25%)</td>
<td>&lt;0.001</td>
</tr>
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</table>

NYHA: New York Heart Association; LV: left ventricle; PA: pulmonary artery; TR: tricuspid regurgitation

<table>
<thead>
<tr>
<th>Variables</th>
<th>Age ≥75 (n = 55)</th>
<th>Age &lt;75 (n = 606)</th>
<th>p value</th>
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</thead>
<tbody>
<tr>
<td>Procedures for mitral valve</td>
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<td></td>
<td></td>
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<td>leaflet resection and suture, n (%)</td>
<td>49 (89%)</td>
<td>505 (83%)</td>
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<td>artificial chordal reconstruction, n (%)</td>
<td>24 (44%)</td>
<td>275 (45%)</td>
<td>0.804</td>
</tr>
<tr>
<td>ring annuloplasty, n (%)</td>
<td>48 (87%)</td>
<td>537 (89%)</td>
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<td>Concomitant other procedures</td>
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<tr>
<td>tricuspid annuloplasty, n (%)</td>
<td>28 (51%)</td>
<td>139 (23%)</td>
<td>&lt;0.001</td>
</tr>
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<td>maze procedure, n (%)</td>
<td>16 (29%)</td>
<td>73 (12%)</td>
<td>&lt;0.001</td>
</tr>
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<td>coronary artery bypass grafting, n (%)</td>
<td>8 (15%)</td>
<td>27 (4.5%)</td>
<td>0.004</td>
</tr>
<tr>
<td>Second pump-run, n (%)</td>
<td>4 (7.3%)</td>
<td>43 (7.1%)</td>
<td>0.822</td>
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<tr>
<td>Cardiopulmonary bypass time (min)</td>
<td>168 ± 68</td>
<td>145 ± 46</td>
<td>&lt;0.001</td>
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<tr>
<td>Aortic cross-clamp time (min)</td>
<td>118 ± 44</td>
<td>103 ± 35</td>
<td>0.019</td>
</tr>
</tbody>
</table>

Table 1 Patient characteristics and preoperative echocardiographic data

Table 2 Details of surgical procedure
for reoperation, lethal ventricular arrhythmia occurred, resulting in in-hospital mortality.

Excluding 7 patients who had postoperative severe complication, 48 of 55 patients (87%) were discharged without severely compromised activity. In patients aged ≥75 years, the percentage of patients discharged without severe complications (87%, 48/55) was significantly lower than that in the patients aged <75 years (99%, 599/606; p <0.001).

Echocardiography at discharge showed that the MR grade was mild or less in all patients who survived the operation.

Survival

The overall survival curve is shown in Fig. 1. The 5-year survival rate was 81.6% ± 5.8% and eight late deaths occurred during follow-up. Three late deaths occurred due to stroke at 41 days, 5 months, and 1 year, respectively, after the surgery, three due to pneumonia at 1 year, 10 years, and 11 years, respectively, after the surgery, and two due to malignancy at 5 years and 7 years, respectively, after the surgery.

Stroke

Nine patients aged ≥75 years had stroke. The incident timing of stroke was intraoperative in two, during admission in one, and six in the late period. The six late strokes occurred at 41 days, 4 months, 9 months, 2 years, 3 years, and 9 years, respectively, after the surgery. The rate of freedom from stroke is shown in Fig. 2. This rate was higher in the patients aged <75 years than in those aged ≥75 years (5-year rate of freedom from stroke was 94.9% ± 1.0% in the patients aged <75 years and 82.7% ± 5.9% in those aged ≥75 years; Log-rank, p <0.001). In the patients aged ≥75 years, 6 of 9 patients who suffered from stroke had subsequent early or late death (mortality, 67%). Four of 6 late strokes occurred in patients who had postoperative atrial fibrillation, even though they were receiving warfarin therapy.

Late cardiac function

The chronological changes in left ventricular diastolic diameter and left ventricular ejection fraction after the surgery are shown in Fig. 3. In the late period, the mean left ventricular diastolic diameter significantly decreased from the preoperative value and this level was maintained over time. The mean left ventricular ejection fraction also decreased postoperatively, but remained at the same level of approximately 60%. Except for the single case of early recurrence of MR, no patient had late recurrence of severe MR during follow-up or underwent reoperation on the mitral valve.

During follow-up, 4 patients required readmission for congestive heart failure. The causes of heart failure were pneumonia-associated pulmonary congestion in 3 patients and symptomatic bradycardia in 1 patient. The rate of 5-year freedom from readmission for congestive heart failure was 90.9% ± 5.3%.

The late NYHA functional classes of 51 patients were as follows: 27 (53%) were class I, 23 (45%) were class II, and 1 (2.0%) was class III. Postoperative cardiac rhythm was sinus rhythm in 40 (78%), atrial fibrillation in 9 (18%), and permanent pacemaker rhythm in 2 (3.9%).

Discussion

With the aging of the population, the number of elderly patients referred for surgery due to mitral valve disease
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Mitral Valve Repair in the Elderly is increasing. However, mitral valve surgery in the elderly is associated with poor outcomes. Previous studies reported that operative mortality was between 10% and 20%. The poor surgical outcome may be due to severe preoperative characteristics, such as advanced symptoms of heart failure, higher frequency of coronary artery disease, and associated comorbidities. This has led to a more conservative approach for elderly patients who suffer from mitral valve disease and sometimes an alternative technique, such as percutaneous treatment, is selected.

In terms of surgical techniques, mitral valve repair was initially considered to be an unnecessary procedure in elderly patients, but the repair rate continues to grow due to improvement in surgical techniques. Detaint, et al. reported that the repair rate has increased with time and exceeds 80% even in the elderly. Some authors compared the surgical outcomes of repair and replacement and concluded that mitral valve repair was superior to replacement. Nloga, et al. compared the surgical outcomes of mitral valve repair with those of replacement in octogenarians. They concluded that mitral valve replacement was an independent predictor of higher operative mortality. Despite these consistent results, the feasibility and efficacy of mitral valve repair in the elderly are controversial because high levels of evidence are lacking to enable reliable comparison. The cohort of patients undergoing repair widely differs from the cohort referred for replacement in terms of patients' characteristics and etiology of MR, thus jeopardizing any statistically compelling comparison. Moreover, any randomized prospective study would be ethically questionable.

The advantage of repair over replacement may be the lesser degree of loss of left ventricular function due to preservation of the subvalvular apparatus. However, repair can be technically demanding and time consuming and associated with failure both in the early period and in the long term. On the other hand, a new generation of bioprosthetic valves, which diminish residual gradients and improve late durability, have been launched. Thus, the efficacy of repair over replacement must be shown in terms of early outcome, late durability, and impact on cardiac function.

In our institution, we attempted aggressive mitral valve repair in treating MR. Some complex cases such as rheumatic valve or ischemic valve diseases are included. For degenerative MR, which is the most common type of MR in developed countries, our repair rate has been 100% since 1991. We reported favorable outcomes of mitral valve repair for bileaflet prolapse. This surgical strategy is also applied to elderly patients. In this study, as Detaint, et al. reported, elderly patients had higher operative risks than younger patients because elderly patients had a higher NYHA class and higher incidence of persistent atrial fibrillation, pulmonary hypertension, and progression of tricuspid regurgitation.

In our series, 30-day mortality was 1.8% and was due to intraoperative stroke. This was lower than that reported in previous reports. Ailawadi, et al. reported that 30-day mortality after mitral valve repair in patients aged ≥75 years was 7.1% of 70 patients and Nloga, et al. reported that the in-hospital mortality after mitral valve repair was 2.7% of 75 octogenarian patients.

![Fig. 3](image_url) The chronological changes of the mean left ventricular diastolic diameter (LVDd) and the mean left ventricular ejection fraction (LVEF) after operation. “Pre” represents the value before surgery.
Due to the high rate of follow-up, we were able to obtain a large amount of clinical and echocardiographic data. In terms of late cardiac function, left ventricular reverse remodeling was well achieved. The left ventricular diastolic dimension became significantly smaller than the previous value and was maintained at the same level over time. Left ventricular ejection fraction was reduced compared with the previous value, although this may have been because of loss of work burden on the left ventricle. The late mean left ventricular ejection fraction was approximately 60% over time. This meant that the decline of ejection fraction was not clinically important. Some patients required readmission for congestive heart failure. However, this condition was not due to recurrence of MR, but rather was due to pneumonia-associated pulmonary congestion or symptomatic bradycardia. Except for a single failure of repair due to technical reasons, we have not encountered any cases of recurrence of severe MR or reoperation on the mitral valve. Hence, the durability of mitral valve repair is satisfactory even in the elderly. In terms of postoperative quality of life, >50% patients had NYHA class I. About 80% patients were in sinus rhythm, which meant that they did not require warfarin. This can lead to freedom from severe complications arising from warfarin therapy, which are sometimes lethal in elderly patients.

**Study Limitations**

A possible limitation of this study is that it was a retrospective single-institution review of collected data, and was therefore influenced by typical biases. Second, clinical and postoperative transthoracic echocardiography follow-up was incomplete in some cases. Finally, the most significant limitation was the lack of a control cohort of mitral valve replacement for degenerative MR.

**Conclusions**

Although the patients aged ≥75 years had high operative risks, the early and long-term surgical outcomes after mitral valve repair for degenerative MR were satisfactory. Mitral valve repair can preserve left ventricular function and provide excellent durability even in patients aged ≥75 years. We consider that this surgery should not be denied or unduly delayed on the basis of age alone and can carefully be offered earlier, without waiting for severe or intractable heart failure.

**Acknowledgement**

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Disclosure Statement

The authors have no conflicts of interest to disclose.

References