Robotic Mitral Valve Repair in Older Individuals: An Analysis of The Society of Thoracic Surgeons Database

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Background. National outcomes of robotic mitral valve repair (rMVr) compared with sternotomy (sMVr) in older patients are currently unknown.

Methods. From 2011 to 2014, all patients aged 65 years and older undergoing MVr in The Society of Thoracic Surgeons Adult Cardiac Surgery Database linked to Medicare claims data were identified. Patients who underwent rMVr were propensity matched to patients who underwent sMVr. Standard differences and falsification outcome of baseline characteristics were tested to ensure a balanced match. Cox models were used to calculate 3-year mortality, heart failure readmission, and mitral valve reintervention, adjusting for competing risks where appropriate.

Results. After matching, 503 rMVr patients from 65 centers and 503 sMVr from 251 centers were included. There were no significant differences in comorbidities or falsification outcome. Cardiopulmonary bypass and cross-clamp times were longer with rMVr versus sMVr at 125 versus 102 minutes (p < 0.0001) and 85 versus 75 minutes (p < 0.0001), respectively. The rMVr patients had shorter intensive care unit (27 vs 47 hours, p < 0.0001) and hospital stay (5 vs 6 days, p < 0.0001), less frequent transfusion (21% vs 35%, p < 0.0001), and less atrial fibrillation (28% vs 40%, p < 0.0001). Three-year mortality (hazard ratio, 1.21; 95% confidence interval, 0.68 to 2.16; p = 0.52), heart failure readmission (hazard ratio, 1.42; 95% confidence interval, 0.80 to 2.52, p = 0.10), and mitral valve reintervention (hazard ratio, 0.42; 95% confidence interval, 0.15 to 1.18; p = 0.22) did not differ between the groups.

Conclusions. The rMVr procedure was associated with less atrial fibrillation, less frequent transfusion requirement, and shorter intensive care unit and hospital stay, without a significant difference in 3-year mortality, heart failure readmission, or mitral valve reintervention. In older patients, rMVr confers short-term advantages without a detriment to midterm outcomes.

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The Supplemental Tables can be viewed in the online version of this article [https://doi.org/10.1016/j.athoracsur.2018.05.074] on http://www.annalsthoracicsurgery.org.
Patients and Methods

The STS database, previously described in detail [6], was used to identify patients who underwent isolated rMVr for annular or degenerative disease from July 2011 to December 2014. Because the data used for this study represent a limited data set without direct patient identifiers that was originally collected for nonresearch purposes, the Duke University Medical Center Institutional Review Board declared the analysis of these data was research not involving human subjects in accordance with the Common Rule (45 CFR 46.102(f)). Patients who underwent rMVr were then propensity matched for major comorbidities to patients who underwent sMVr.

Preoperative, intraoperative, and in-hospital data were derived from the STS data set. Patients in the STS data set were linked by name and date of birth with data from the CMS records (Supplemental Table 1).

Inclusion and Exclusion Criteria

Only patients aged older than 65 years covered by Centers for Medicare & Medicaid Services (CMS), a federal agency that administers Medicare health insurance to patients older than age 65, were included. To maintain a fairly homogenous population, the analysis was limited to peripheral cannulation for rMVr and central cannulation for sMVr. Patients who had undergone attempted repair that was converted to replacement were also included for an intention-to-treat analysis. The study excluded patients who required planned mechanical assist devices or concomitant procedures other than patent foramen ovale or atrial septal defect repair. Also excluded were cases that were considered urgent, emergent, or emergent salvage. Unplanned mechanical assist devices were included. This analysis did not include patients who underwent MVr using nonrobotic, nonsternotomy approaches.

Statistical Methods

Continuous variables were compared with the Wilcoxon rank sum test, and categoric variables were compared with Pearson $\chi^2$ test. Propensity matching was used to reduce differences in confounders between the two patient groups. A falsification outcome of urinary tract infections was tested to ensure that propensity matching was successful and that there was minimal patient selection bias. The Kaplan-Meier plot and two-sample log-rank test were generated to reveal visual and statistical differences in unadjusted 3-year mortality between groups. Cumulative incidence function plots were generated to compare unadjusted 3-year heart failure readmission and mitral valve reintervention between groups. Adjusted 3-year failure readmission and mitral valve reintervention was calculated using Fine and Gray models to account for competing risk with mortality. All $p$ values reported are two-sided. Statistical analyses were conducted using SAS 9.3 software (SAS Institute Inc, Cary, NC).

Results

Baseline Patient Characteristics

From July 2011 to December 2014, 2,366 (20.03%) rMVrs were performed with 795 patients (33.60%) aged older than 65 years, and sMVrs were performed in 9,446 patients (79.97%), with 4,248 (44.97%) aged older than 65 years. Excluded were 1,805 patients (35.8%) who were not linked to CMS. No variable in the examined data set had missing data in more than 2% of patients. Baseline patient characteristics before propensity matching are listed in Supplemental Table 2.

After propensity matching, 503 rMVr patients from 65 centers and 503 sMVr from 251 centers were included. Thirty centers contributed to both the robotic and sternotomy group. For the 1,006 matched patients, a median number of 4 (quartile [Q]1, 1; Q3, 7) robotic MVrs were performed and 1 (Q1, 1; Q3, 2) sMVr was performed per center during the study period. There were no significant differences in comorbidities or falsification outcome. Average age was 71.9 (SD, 5.5) years, 60.5% (n = 609) were men, 7.4% (n = 74) had cerebral vascular disease, 5.2% (n = 52) had peripheral artery disease, 14.4% (n = 145) had preoperative atrial fibrillation (AF), and the median STS score was 1% (Q1, 1; Q3, 2). Previous mitral repair or replacement occurred in 0.8% (n = 8) of patients (Table 1).

Operative Characteristics

Balloon occlusion of the aorta occurred exclusively in the rMVr group (147 [29.2%]). In the rMVr group, fewer patients received both antegrade and retrograde cardioplegia (42.8% vs 75.4%, $p < 0.0001$), and more received antegrade cardioplegia alone (55.9% vs 22.3%, $p < 0.0001$, Table 2). Cardiopulmonary bypass and cross-clamp times were longer with rMVr than with sMVr (125 minutes vs 102 minutes, $p < 0.0001$) and (85 minutes vs 75 minutes, $p < 0.0001$), respectively.

Repair Characteristics

Compared with sMVr, rMVr more frequently involved triangular resections (83.9% vs 50.36%, $p < 0.0001$) and fewer quadrangular resections (11.7% vs 39.9%, $p < 0.0001$). Sliding plasty was also used less frequently in rMVr (5.3% vs 13.22%, $p < 0.0001$). Neochords were inserted in similar frequency (21.4% rMVr vs 19.6% sMVr, $p = 0.52$) and mean number (2.2 vs 2.4, $p = 0.37$) in both groups. More patients in the sMVr group were converted to mitral valve replacement than in the rMVr group (9.7% vs 1.6%, $p < 0.0001$).

In-Hospital and 30-Day Outcomes

The robotic group had shorter intensive care unit (ICU; 27 hours vs 47 hours, $p < 0.0001$) and hospital stay (5 days vs 6 days, $p < 0.0001$, Table 3). The rMVr group had less AF (28% vs 40%, $p < 0.0001$) but similar rates of stroke (1.0% vs 1.8%, $p = 0.28$), prolonged ventilation (2.6% vs 4.8%, $p = 0.06$), and renal failure (0.8% vs 1.8%, $p = 0.16$). Significantly fewer patients in the rMVr group required red blood cell (RBC) transfusions (20.5% vs 35.2%, $p < 0.0001$), but among those who did require RBC...
transfusion, the mean transfusion number was similar (1.8 [SD, 2.1] rMVr vs 1.5 [SD, 1.4] sMVr, \( p = 0.20 \)). Also similar in both groups were mean postoperative RBC transfusions (2.2 [SD, 2.7] rMVr vs 1.9 [SD, 1.6], \( p = 0.72 \)). Operative (0.6% rMVr vs 1.2% sMVr, \( p = 0.32 \)) and in-hospital mortality (0.6% rMVr vs 1.2% sMVr, \( p = 0.31 \)) both occurred infrequently, with no difference between groups.

### Midterm Outcomes
Median follow-up for mortality was 1.78 (Q1, 0.96; Q3, 2.58) years, for heart failure readmission was 1.60 (Q1, 0.81; Q3, 2.50) years, and for mitral valve reintervention was 1.65 (Q1: 0.90, Q3: 2.54) years. Three-year mortality (hazard ratio, 1.21; 95% confidence interval, 0.68 to 2.16; \( p = 0.52 \)), heart failure readmission (hazard ratio, 1.42; 95% confidence interval, 0.80 to 2.52; \( p = 0.10 \)), and mitral valve reintervention (hazard ratio, 0.42; 95% confidence interval, 0.15 to 1.18; \( p = 0.22 \)) did not differ between groups (Fig 1). Absolute event rates are listed in Supplemental Table 3.

### Comment
Although single-center series have demonstrated the safety and efficacy of rMVr, data that directly compare multiinstitutional short-term and midterm outcomes of rMVr compared with sMVr are lacking [5].

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**Table 1. Baseline Characteristics of Matched Patients**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Overall (N = 1,006)</th>
<th>Robotic (n = 503)</th>
<th>Sternotomy (n = 503)</th>
<th>( p ) Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean (SD), years</td>
<td>71.93 (5.53)</td>
<td>71.88 (5.58)</td>
<td>71.98 (5.49)</td>
<td>0.63</td>
</tr>
<tr>
<td>Female sex, No. (%)</td>
<td>397 (39.46)</td>
<td>194 (38.57)</td>
<td>203 (40.36)</td>
<td>0.56</td>
</tr>
<tr>
<td>Body mass index, mean (SD), kg/m²</td>
<td>26.31 (4.99)</td>
<td>26.15 (4.47)</td>
<td>26.48 (5.47)</td>
<td>0.55</td>
</tr>
<tr>
<td>Health insurance, No. (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Government</td>
<td>963 (95.73)</td>
<td>480 (95.43)</td>
<td>483 (96.02)</td>
<td>0.64</td>
</tr>
<tr>
<td>Commercial</td>
<td>635 (61.12)</td>
<td>328 (65.21)</td>
<td>307 (61.03)</td>
<td>0.15</td>
</tr>
<tr>
<td>None/self-pay</td>
<td>17 (1.69)</td>
<td>13 (2.58)</td>
<td>4 (0.80)</td>
<td>0.03</td>
</tr>
<tr>
<td>Diabetes, No. (%)</td>
<td>13 (1.29)</td>
<td>7 (1.39)</td>
<td>6 (1.19)</td>
<td>0.50</td>
</tr>
<tr>
<td>Hypertension, No. (%)</td>
<td>687 (68.29)</td>
<td>340 (67.59)</td>
<td>347 (68.99)</td>
<td>0.64</td>
</tr>
<tr>
<td>Dyslipidemia, No. (%)</td>
<td>616 (61.23)</td>
<td>305 (60.64)</td>
<td>311 (61.83)</td>
<td>0.70</td>
</tr>
<tr>
<td>Preoperative dialysis, No. (%)</td>
<td>5 (0.50)</td>
<td>3 (0.60)</td>
<td>2 (0.40)</td>
<td>0.65</td>
</tr>
<tr>
<td>CVD-History of CVA</td>
<td>34 (3.38)</td>
<td>11 (2.19)</td>
<td>23 (4.57)</td>
<td>0.11</td>
</tr>
<tr>
<td>Chronic lung disease, No. (%)</td>
<td>40 (3.98)</td>
<td>20 (3.98)</td>
<td>20 (3.98)</td>
<td></td>
</tr>
<tr>
<td>Perforative vascular disease, No. (%)</td>
<td>52 (5.17)</td>
<td>27 (5.37)</td>
<td>25 (4.97)</td>
<td>0.79</td>
</tr>
<tr>
<td>Preoperative atrial fibrillation, No. (%)</td>
<td>145 (14.41)</td>
<td>79 (15.71)</td>
<td>66 (13.12)</td>
<td>0.24</td>
</tr>
<tr>
<td>Previous pacemaker, No. (%)</td>
<td>42 (4.17)</td>
<td>26 (5.17)</td>
<td>16 (3.18)</td>
<td>0.12</td>
</tr>
<tr>
<td>Previous PCI, No. (%)</td>
<td>75 (7.46)</td>
<td>40 (7.95)</td>
<td>35 (6.96)</td>
<td>0.54</td>
</tr>
<tr>
<td>Angina, No. (%)</td>
<td>1 (0.09)</td>
<td>5 (0.99)</td>
<td>5 (0.99)</td>
<td></td>
</tr>
<tr>
<td>CHF within 2 weeks, No. (%)</td>
<td>496 (49.01)</td>
<td>498 (99.01)</td>
<td>498 (99.01)</td>
<td></td>
</tr>
<tr>
<td>Ejection fraction, mean (SD)</td>
<td>0.5946 (0.0831)</td>
<td>0.6000 (0.0828)</td>
<td>0.5893 (0.0831)</td>
<td>0.02</td>
</tr>
<tr>
<td>IABP or inotropes, No. (%)</td>
<td>5 (0.50)</td>
<td>2 (0.40)</td>
<td>3 (0.60)</td>
<td>0.65</td>
</tr>
<tr>
<td>Mitral insufficiency, No. (%)</td>
<td>5 (0.50)</td>
<td>1 (0.09)</td>
<td>1 (0.09)</td>
<td>1.00</td>
</tr>
</tbody>
</table>
| CHF = congestive heart failure; CVA = cerebrovascular accident; CVD = cerebrovascular disease; IABP = intraaortic balloon pump; PCI = percutaneous coronary intervention; STS PROM = The Society of Thoracic Surgeons Predicted Risk of Mortality.
intention-to-treat, propensity-matched analysis of rMVr versus sMVr, we found that rMVr was associated with longer cardiopulmonary bypass and cross-clamp times but shorter ICU and hospital stay. In-hospital morbidity and mortality were similar in both groups, with similar rates of stroke and mortality, but less AF in the rMVr group. Three-year outcomes of mortality, heart failure readmission, and mitral valve reintervention were comparable between the groups.

**Short-Term Outcomes**

Several series on rMVr have demonstrated low in-hospital mortality and complication rates. In-hospital mortality and stroke rates for rMVr in this study were very low, at 0.2% and 0.6%, respectively, consistent with prior reports [7–9] and were not significantly different from the sMVr cohort. Prior studies have found the primary short-term benefits of rMVr are shorter length of stay and fewer RBC transfusions [5, 10–13]. In this analysis, we also found a shorter ICU and overall length of stay for the rMVr cohort. Fewer patients in the rMVr group required intraoperative blood transfusions, but among those who did require transfusions, the mean number of transfusions was similar.

Lastly, we also found a significantly lower incidence of AF in the rMVr cohort (27.8% vs 39.8%). Mihaljevic and colleagues [11] also found a lower incidence of AF with rMVr than with sMVr, and other single-center studies have reported a similarly low incidence of 19% to 21% of new-onset AF after rMVr [8, 9, 14]. This difference in the incidence of new AF may be due to specialized protocols in centers regularly performing MVrs or perhaps a lesser

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**Table 2. Operative Characteristics**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Overall (N = 1,006)</th>
<th>Robotic (n = 503)</th>
<th>Sternotomy (n = 503)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elective surgery status, No. (%)</td>
<td>1,006 (100.00)</td>
<td>503 (100.00)</td>
<td>503 (100.00)</td>
<td></td>
</tr>
<tr>
<td>CPB details</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aortic occlusion, No. (%)</td>
<td></td>
<td></td>
<td></td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>None—fibrillating heart</td>
<td>4 (0.40)</td>
<td>3 (0.60)</td>
<td>1 (0.20)</td>
<td></td>
</tr>
<tr>
<td>None—beating heart</td>
<td>1 (0.10)</td>
<td>1 (0.20)</td>
<td>0 (0.00)</td>
<td></td>
</tr>
<tr>
<td>Balloon occlusion</td>
<td>147 (14.61)</td>
<td>147 (29.22)</td>
<td>0 (0.00)</td>
<td></td>
</tr>
<tr>
<td>Cross clamp</td>
<td>853 (84.79)</td>
<td>352 (69.98)</td>
<td>501 (99.60)</td>
<td></td>
</tr>
<tr>
<td>Cardioplegia delivery, No. (%)</td>
<td></td>
<td></td>
<td></td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Both</td>
<td>589 (58.55)</td>
<td>210 (41.75)</td>
<td>379 (75.35)</td>
<td></td>
</tr>
<tr>
<td>Retrograde</td>
<td>13 (1.29)</td>
<td>4 (0.80)</td>
<td>9 (1.79)</td>
<td></td>
</tr>
<tr>
<td>Antegrade</td>
<td>393 (39.07)</td>
<td>281 (55.86)</td>
<td>112 (22.27)</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>10 (0.99)</td>
<td>8 (1.59)</td>
<td>2 (0.40)</td>
<td></td>
</tr>
<tr>
<td>CPB time, mean (SD), minutes</td>
<td>122.80 (51.15)</td>
<td>135.62 (52.89)</td>
<td>109.97 (45.94)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Cross-clamp time, mean (SD), minutes</td>
<td>87.18 (36.57)</td>
<td>90.52 (34.53)</td>
<td>83.85 (38.24)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Repair details</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annuloplasty, No. (%)</td>
<td>892 (93.99)</td>
<td>475 (95.96)</td>
<td>417 (91.85)</td>
<td>0.01</td>
</tr>
<tr>
<td>Leaflet resection, No. (%)</td>
<td>567 (59.75)</td>
<td>291 (58.79)</td>
<td>276 (60.79)</td>
<td>0.42</td>
</tr>
<tr>
<td>Resection type, No. (%)</td>
<td></td>
<td></td>
<td></td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Other</td>
<td>33 (5.82)</td>
<td>9 (3.09)</td>
<td>24 (8.70)</td>
<td></td>
</tr>
<tr>
<td>Quadrangular</td>
<td>144 (25.40)</td>
<td>34 (11.68)</td>
<td>110 (39.86)</td>
<td></td>
</tr>
<tr>
<td>Triangular</td>
<td>383 (67.55)</td>
<td>244 (83.85)</td>
<td>139 (50.36)</td>
<td></td>
</tr>
<tr>
<td>Resection location, No. (%)</td>
<td></td>
<td></td>
<td></td>
<td>0.38</td>
</tr>
<tr>
<td>Anterior and posterior</td>
<td>23 (4.06)</td>
<td>6 (2.06)</td>
<td>17 (6.16)</td>
<td></td>
</tr>
<tr>
<td>Posterior</td>
<td>521 (91.89)</td>
<td>276 (94.85)</td>
<td>245 (88.77)</td>
<td></td>
</tr>
<tr>
<td>Anterior</td>
<td>23 (4.06)</td>
<td>9 (3.09)</td>
<td>14 (5.07)</td>
<td></td>
</tr>
<tr>
<td>Sliding plasty, No. (%)</td>
<td>86 (9.06)</td>
<td>26 (5.25)</td>
<td>60 (13.22)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Annular decalcification, No. (%)</td>
<td>7 (0.74)</td>
<td>1 (0.20)</td>
<td>6 (1.32)</td>
<td>0.04</td>
</tr>
<tr>
<td>Neochords (PTFE), No. (%)</td>
<td>195 (20.55)</td>
<td>106 (21.41)</td>
<td>89 (19.60)</td>
<td>0.52</td>
</tr>
<tr>
<td>Neochords inserted, mean (SD), No.</td>
<td>2.31 (1.10)</td>
<td>2.23 (1.04)</td>
<td>2.40 (1.17)</td>
<td>0.37</td>
</tr>
<tr>
<td>Chordal /leaflet transfer, No. (%)</td>
<td>24 (2.53)</td>
<td>12 (2.42)</td>
<td>12 (2.64)</td>
<td>0.82</td>
</tr>
<tr>
<td>Leaflet extension/replacement/patch</td>
<td>7 (0.74)</td>
<td>1 (0.20)</td>
<td>6 (1.32)</td>
<td>0.04</td>
</tr>
<tr>
<td>Edge-to-edge repair, No. (%)</td>
<td>58 (6.11)</td>
<td>24 (4.85)</td>
<td>34 (7.49)</td>
<td>0.09</td>
</tr>
<tr>
<td>Replacement details</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repair attempted before mitral valve replacement, No. (%)</td>
<td>57 (5.67)</td>
<td>8 (1.59)</td>
<td>49 (9.74)</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

CPB = cardiopulmonary bypass; PTFE = polytetrafluoroethylene.
inflammatory response to robotic versus sternotomy approaches.

**Midterm Outcomes**

Few studies have reported midterm outcomes in rMVr, and none have directly compared rMVr to sMVr. This analysis found equivalent rates between rMVr and sMVr for 3-year mitral valve reintervention (1.7% vs 0.8%, respectively) and heart failure readmission (3.3% vs 5.5%, respectively). Although there is little information directly comparing rMVr to sMVr, single-center studies of rMVr have reported 0.6% to 3.5% severe MR at 1 year [7, 15]. Paul and colleagues [5] also found a low incidence of mitral valve reoperation with a 1-year probability of 1.2%. This study not only supports the reported low rates of repair failure and mitral valve reintervention but also adds that these rates are not significantly different than in a patient-matched MVr using a sternotomy approach.

**Study Limitations**

This analysis has some limitations. Short-term and midterm outcomes were obtained through CMS coding that may have an inherent coding or capture error rate. Although the rMVr and sMVr patients were propensity matched with a balanced falsification outcome, there may be unadjusted bias in a nonrandomized analysis. We did not examine the effect of operator or institutional experience or volumes with rMVr or sMVr, but these data represent a real-world cross-section of practice across the United States. In addition, this analysis was limited to patients aged older than 65 years with CMS insurance to analyze midterm outcomes. Although we captured outcomes of mitral valve reintervention and heart failure readmission, we did not have echocardiographic follow-up and cannot compare repair quality based on mitral regurgitation. Lastly, we did not adjust for relevant differences, including complexity of mitral valve pathology.

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### Table 3. Short-Term Outcomes

<table>
<thead>
<tr>
<th>Variable</th>
<th>Overall (N = 1,006)</th>
<th>Robotic (n = 503)</th>
<th>Sternotomy (n = 503)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of stay</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hospital, mean (SD), days</td>
<td>6.09 (3.33)</td>
<td>5.26 (2.88)</td>
<td>6.92 (3.54)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>ICU, mean (SD), hours</td>
<td>52.02 (55.60)</td>
<td>41.96 (46.91)</td>
<td>61.81 (61.40)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Red blood cell transfusion</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intraoperative, No. (%)</td>
<td>280 (27.83)</td>
<td>103 (20.48)</td>
<td>177 (35.19)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Intraoperative, mean (SD), U</td>
<td>1.62 (1.71)</td>
<td>1.84 (2.09)</td>
<td>1.49 (1.43)</td>
<td>0.20</td>
</tr>
<tr>
<td>Postoperative, mean (SD), U</td>
<td>2.00 (2.07)</td>
<td>2.23 (2.69)</td>
<td>1.86 (1.56)</td>
<td>0.72</td>
</tr>
<tr>
<td>Reoperation, No. (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bleeding/tamponade</td>
<td>25 (2.49)</td>
<td>15 (2.98)</td>
<td>10 (1.99)</td>
<td>0.31</td>
</tr>
<tr>
<td>Valvular dysfunction</td>
<td>2 (0.20)</td>
<td>0 (0.00)</td>
<td>2 (0.40)</td>
<td>0.16</td>
</tr>
<tr>
<td>Major morbidity, No. (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Permanent Stroke</td>
<td>14 (1.39)</td>
<td>5 (0.99)</td>
<td>9 (1.79)</td>
<td>0.28</td>
</tr>
<tr>
<td>Transient ischemic attack</td>
<td>4 (0.40)</td>
<td>2 (0.40)</td>
<td>2 (0.40)</td>
<td>0.99</td>
</tr>
<tr>
<td>Renal failure</td>
<td>13 (1.29)</td>
<td>4 (0.80)</td>
<td>9 (1.79)</td>
<td>0.16</td>
</tr>
<tr>
<td>Dialysis required</td>
<td>5 (0.46)</td>
<td>1 (0.20)</td>
<td>4 (0.80)</td>
<td>0.52</td>
</tr>
<tr>
<td>New-onset</td>
<td>1 (0.00)</td>
<td>0 (0.00)</td>
<td>1 (0.00)</td>
<td>0.56</td>
</tr>
<tr>
<td>Prolonged ventilation</td>
<td>37 (3.68)</td>
<td>13 (2.58)</td>
<td>24 (4.77)</td>
<td>0.06</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>12 (1.19)</td>
<td>5 (0.99)</td>
<td>7 (1.39)</td>
<td>0.56</td>
</tr>
<tr>
<td>Pulmonary thromboembolism</td>
<td>2 (0.20)</td>
<td>2 (0.40)</td>
<td>1 (0.20)</td>
<td>0.32</td>
</tr>
<tr>
<td>Aortic/iliac/femoral dissection</td>
<td>0 (0.00)</td>
<td>0 (0.00)</td>
<td>0 (0.00)</td>
<td>0.11</td>
</tr>
<tr>
<td>Surgical site infection</td>
<td>4 (0.40)</td>
<td>1 (0.20)</td>
<td>3 (0.60)</td>
<td>0.06</td>
</tr>
<tr>
<td>Cardiac arrest</td>
<td>11 (1.09)</td>
<td>4 (0.80)</td>
<td>7 (1.39)</td>
<td>0.36</td>
</tr>
<tr>
<td>Atrial fibrillation</td>
<td>340 (33.80)</td>
<td>140 (27.83)</td>
<td>200 (39.76)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Mortality, No. (%)</td>
<td>9 (0.89)</td>
<td>3 (0.60)</td>
<td>6 (1.19)</td>
<td>0.32</td>
</tr>
<tr>
<td>Operative</td>
<td>7 (0.70)</td>
<td>1 (0.20)</td>
<td>6 (1.19)</td>
<td>0.06</td>
</tr>
<tr>
<td>Post-op echo performed, No. (%)</td>
<td>334 (33.20)</td>
<td>170 (33.80)</td>
<td>164 (32.60)</td>
<td>0.55</td>
</tr>
<tr>
<td>Highest level mitral insufficiency found, No.</td>
<td></td>
<td></td>
<td></td>
<td>0.26</td>
</tr>
<tr>
<td>Severe</td>
<td>3 (0.90)</td>
<td>1 (0.59)</td>
<td>2 (1.22)</td>
<td></td>
</tr>
<tr>
<td>Moderate</td>
<td>9 (2.69)</td>
<td>2 (1.18)</td>
<td>7 (4.27)</td>
<td></td>
</tr>
<tr>
<td>Mild</td>
<td>41 (12.8)</td>
<td>25 (14.7)</td>
<td>16 (9.76)</td>
<td></td>
</tr>
<tr>
<td>Trace/trivial</td>
<td>123 (36.83)</td>
<td>65 (38.24)</td>
<td>58 (35.37)</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>156 (46.71)</td>
<td>77 (45.29)</td>
<td>79 (48.17)</td>
<td></td>
</tr>
</tbody>
</table>

ICU = intensive care unit.
and complexity of repair between the treatment groups due to limitations on sample size. Although adjustment for these traits is not impossible, definitive comparison between rMVr and sMVr may require a prospective, randomized design with echocardiography follow-up to at least 5 years.

Conclusion
In this retrospective, multiinstitutional, and matched analysis, rMVr was associated with less AF, less frequent transfusion, and shorter ICU and hospital stay without a significant difference in 3-year mortality, heart failure readmission, or mitral valve reintervention. In older patients, rMVr may confer short-term advantages without a detriment to intermediate-term outcomes.

References

Fig 1. Three-year outcomes. Kaplan–Meier and cumulative incidence curves for (A) mitral valve reintervention (p = 0.13), (B) heart failure readmission (p = 0.23), and (C) all-cause mortality (p = 0.52).