Clinical Investigation

Bileaflet versus Posterior-Leaflet-Only Preservation

in Mitral Valve Replacement

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In the present study of mitral valve replacement, we investigated whether complete preservation of both leaflets (that is, the subvalvular apparatus) is superior to preservation of the posterior leaflet alone.

Seventy patients who underwent mitral valve replacement in our clinic were divided into 2 groups: MVR-B (n=16), in whom both leaflets were preserved, and MVR-P (n=54), in whom only the posterior leaflet was preserved. The preoperative and postoperative clinical and echocardiographic findings were evaluated retrospectively.

No signs of left ventricular outflow tract obstruction were observed in either group. In the MVR-B group, no decrease was observed in left ventricular ejection fraction during the postoperative period, whereas a significant reduction was observed in the MVR-P group (P=0.003). No differences were found between the 2 groups in their need for inotropic agents or intra-aortic balloon pump support, or in cross-clamp time, duration of intensive care unit or hospital stays, postoperative development of new atrial fibrillation, or mortality rates.

Bileaflet preservation prevented the decrease in left ventricular ejection fraction that usually followed preservation of the posterior leaflet alone. However, posterior leaflet preservation alone yielded excellent results in terms of decreased left ventricular diameter. Bileaflet preservation should be the method of choice to prevent further decreases in ejection fraction and to avoid death in patients who present with substantially impaired left ventricular function. ***(Tex Heart Inst J 2014;41(2):165-9)***

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Many clinical studies have shown the superiority of completely preserving subvalvular structures during mitral valve replacement (MVR) over the conventional valve-excising MVR technique, which involves the removal of both leaflets by cutting the chordae tendineae and the tip of the papillary muscle.[1-3] Nevertheless, bileaflet preservation has not attracted adequate attention among cardiac surgeons. Currently, most cardiac surgeons prefer to preserve the posterior leaflet alone, because bileaflet preservation is technically more difficult, prolongs surgery, requires a smaller prosthetic valve, and opens the possibilities of both left ventricular outflow tract (LVOT) obstruction and contact between the prosthetic valve and subvalvular structures.[4,5] Although many studies compare bileaflet preservation during MVR with conventional valve-excising MVR, few compare bileaflet preservation with preservation of the posterior leaflet alone. The present study aimed to investigate whether preservation of both leaflets—that is, the entire subvalvular apparatus—is superior to preservation of the posterior leaflet alone, in terms of left ventricular (LV) function.

Patients and Methods

In the present retrospective study, we evaluated 70 patients who underwent MVR in our clinic from March 2010 through March 2011. Written informed consent was obtained from all patients. Data obtained from patient files and outpatient follow-up were evaluated. The patients were divided into 2 groups: MVR-B (n=16), patients in whom both leaflets were preserved; and MVR-P (n=54), patients in whom only the posterior leaflet was preserved. Excluded from the study were patients undergoing coronary bypass concurrent with MVR, reoperation for MVR, simultaneous aortic valve or aortic surgery, or surgical incision other than sternotomy. Patients' preoperative characteristics are summarized in Table I. Preoperative and postoperative clinical

TABLE I. Preoperative Characteristics of the Groups

Variable	**MVR-B** (n=16)	**MVR-P** (n=54)	***P* Value**
Age, yr	56.5 ± 13.1	52.55 ± 13.9	0.311
Female/male sex	9/7	40/14	0.218
Preoperative atrial fibrillation	4 (25)	23 (42)	0.252
Rheumatic/ degenerative cause	2/14	16/38	0.209
NYHA functional class III/IV	9/7	39/15	0.238

MVR-B = mitral valve replacement–bileaflet preservation group; MVR-P = mitral valve replacement–posterior leaflet preservation group; NYHA = New York Heart Association

Data are presented as mean ± SD or as number and percentage. *P* <0.05 was considered statistically significant.

and echocardiographic findings were evaluated retrospectively.

Surgical Technique. All patients underwent median sternotomy, aorto-bicaval cannulation, and antegrade or retrograde cold-blood hyperkalemic cardioplegia. Sixty-six bileaflet mechanical heart valves (the former Sulzer Carbomedics, Inc.; Austin, Texas) and 4 biological heart valves (Medtronic, Inc.; Minneapolis, Minn) were used. The transseptal approach was used in 21 patients in whom both mitral and tricuspid valve intervention were performed. In the other 49 patients, the mitral valve was exposed through a left atriotomy performed parallel to the interatrial groove. In patients whose posterior leaflets alone were preserved, the anterior leaflet was excised 2 to 3 mm from the annulus by cutting the tip of the papillary muscle together with the attached chordae tendineae. The posterior leaflet and its attached chordae were completely preserved. In the MVR-B group, the anterior leaflet was excised 2 to 3 mm from the annulus. Thereafter, the anterior leaflet was divided into 2 parts, lengthwise in the middle. Each of these parts was attached to a point on the annulus close to the commissure, on the same side in order to prevent LVOT obstruction. While these tissues were attached, redundant tissues were excised. The posterior leaflet was also completely preserved together with its chordae tendineae. Pledgeted sutures were placed in such a manner that they passed from the atrium to the ventricle. After the completion of all sutures, the surgeon measured the valve and selected the correct valve size. The sutures were tied by passing them through the prosthetic valve annulus. After the ligation, the valve was cautiously examined to determine whether there was contact with subvalvular structures; then the procedure was completed.

Echocardiographic Examination. Echocardiographic findings on all patients were evaluated preoperatively; then echocardiography was repeated before discharge from the hospital, and again at the 6th postoperative month. On each of these occasions, left atrial diameter (LAD), interventricular septal thickness (IVS), LV end-systolic diameter (LVESD) and LV end-diastolic diameter (LVEDD), LV ejection fraction (LVEF), and pulmonary arterial pressure (PAP) were compared. Valvular function and the presence of LVOT obstruction, pericardial effusion, and intracardiac thrombus were evaluated at the postoperative echocardiographic examinations. When the patient files were reviewed, we compared data regarding cross-clamp time, postoperative need for inotropic agents and intra-aortic balloon pump support (IABP), amount of postoperative drainage, and duration of intensive care unit and hospital stays. Functional capacity and cardiac rhythm of the patients were recorded at the 6th postoperative month visit.

Statistical Analysis

We retrospectively collected preoperative demographic and echocardiographic data, together with operative and postoperative in-hospital data. Postoperative outpatient visits were also evaluated. In the event that patients had missed their follow-up appointments, they were contacted by telephone for outpatient clinical information. Collected data were analyzed with SPSS statistical software (IBM Corporation; Armonk, NY). Continuous variables were expressed as mean ± SD. The Fisher exact test was used to analyze differences between the 2 groups in regard to inotropic agent support, IABP support, atrial fibrillation incidence, and mortality rates. Preoperative and postoperative continuous variables of the groups were compared with use of the *t* test. Preoperative and postoperative values within and between groups were compared with repeated-measures testing in a general linear model. A *P* value of less than 0.05 was considered to be statistically significant.

Results

One patient in the MVR-P group died of neurologic causes in the early postoperative phase. No death occurred during the 6-month follow-up period. No signs of LVOT obstruction were observed on the intra- or postoperative echocardiograms in any of the groups. All valve functions were normal (Table II).

In the MVR-B group, no decrease was observed in LVEF in the postoperative period, whereas a reduction in ejection fraction from a mean of 0.59 to 0.56 was observed in the MVR-P group ($P=0.003$). Significant decreases were observed in IVS, LAD, and PAP in both groups. In the MVR-P group, significant decreases were noted in LVESD and LVEDD. Moreover, a significant decrease was found in LVEF. In the MVR-B group, decreases in the LVESD and LVEDD were observed; however, these were not significant. The LVEF

TABLE II. Operative Characteristics of the Groups

Variable	MVR-B (n=16)	MVR-P (n=54)	*P* Value
Aortic cross-clamp time, min	79.75 ± 34	78.12 ± 37.3	0.877
Postoperative bleeding, mL	365 ± 250	356 ± 234	0.888
Positive inotropic agent support	4 (25)	16 (29)	1
Intra-aortic balloon pump support	1 (6)	1 (1)	0.407
Intensive care unit stay, d	1.31 ± 0.6	1.12 ± 0.3	0.154
Hospital stay, d	7.12 ± 2.2	6.92 ± 2.3	0.767
Postoperative atrial fibrillation	2 (12)	8 (14)	1
In-hospital death	0	1 (2)	1

MVR-B = mitral valve replacement–bileaflet preservation group; MVR-P = mitral valve replacement–posterior leaflet preservation group

Data are presented as mean ± SD or as number and percentage. P <0.05 was considered statistically significant.

TABLE III. Echographic Evaluation of the Groups

Variable	Preoperative	Postoperative	*P* Value
LVEF			
MVR-B	0.48 ± 0.14	0.48 ± 0.12	0.936
MVR-P	0.59 ± 0.10	0.56 ± 0.07	0.003
P value	0.001	0.001	
LVESD, mm			
MVR-B	43.6 ± 9	43.5 ± 8	0.027
MVR-P	37.1 ± 8	35.7 ± 7	<0.001
P value	0.01	0.001	
LVEDD, mm			
MVR-B	58.3 ± 7	57.5 ± 6	0.089
MVR-P	53.9 ± 8	51.8 ± 7	<0.001
P value	0.066	0.003	
IVS thickness, mm			
MVR-B	11.3 ± 1	10 ± 0	0.028
MVR-P	11.4 ± 1	11.1 ± 1	0.027
P value	0.917	0.349	
LA diameter, mm			
MVR-B	54.1 ± 1	48.8 ± 1	<0.001
MVR-P	53 ± 1	47.1 ± 0	<0.001
P value	0.756	0.49	
PAP, mmHg			
MVR-B	47.6 ± 9	35.8 ± 6	<0.001
MVR-P	46.4 ± 1	37.6 ± 8	<0.001
P value	0.664	0.434	

LVEDD = left ventricular end-diastolic diameter; LVEF = left ventricular ejection fraction; LVESD = left ventricular end-systolic diameter; IVS = interventricular septal; LA = left atrial; MVR-B = mitral valve replacement–bileaflet preservation group; MVR-P = mitral valve replacement–posterior leaflet preservation group; PAP = pulmonary artery pressure

Data are presented as mean ± SD. P <0.05 was considered statistically significant.

remained almost unchanged in the MVR-B group. No differences were found between the groups in terms of postoperative need for inotropic agents or IABP, cross-clamp time, duration of intensive care unit or hospital stay, postoperative development of new atrial fibrillation, or mortality rates (Table III).

Discussion

Mitral valve repair is in general superior to mitral valve replacement; however, replacement is the only option in some cases.

In the 1990s, many studies showed the superiority of bileaflet preservation during MVR, over the standard MVR technique.[6-9] However, bileaflet preservation has failed to gain adequate support among surgeons for the reasons mentioned above. Currently, the more frequently accepted and performed technique is MVR that preserves only the posterior leaflet. Although the superiority of bileaflet preservation over conventional valve-excising MVR has been shown by many studies, there are to the best of our knowledge few MVR studies that compare bileaflet preservation with posterior-leaflet-only preservation.[1-3]

The study conducted by Yun and colleagues,[6] one of the rare comparisons of bileaflet preservation and posterior-leaflet-only preservation, revealed no differences between the 2 techniques in terms of LV diameter and LVEF. In their study, Hennein and coworkers[10] compared bileaflet preservation, posterior-leaflet-only preservation, and total resection. When they performed echocardiography during the 6th and 9th postoperative months, they found bileaflet preservation and posterior-leaflet-only preservation to be superior over total resection in terms of exercise capacity, systolic dimensions, and fractional shortening. However, they observed no significant difference between their bileaflet preservation and posterior-leaflet-only preservation groups. Another study[7] compared bileaflet preservation and posterior-leaflet-only preservation with conventional MVR, in which total resection was performed, and examined patients in terms of ventricular volume, wall stress, and ejection fraction. Whereas there was no change in LV end-diastolic volume in the conventional group, the study showed significant increases in LV end-systolic volume and stress, and a significant decrease in LVEF. On the other hand, significant decreases in LV end-diastolic and end-systolic volumes and a reduction in wall stress were observed in the preservation groups; no change was observed in LVEF. A meta-analysis of bileaflet preservation reviewed investigations of different preservation techniques but failed to show the superiority of bileaflet preservation over posterior-leaflet-only preservation.[11] The results of the present study are similar to those of the studies mentioned above. However, we found no decrease in LVEF in the MVR-B group, whereas LVEF decreased from 0.59 to 0.56 in the MVR-P group (P=0.003). The present study was not a prospective randomized study, and bileaflet preservation was performed mostly in patients with lower LVEF and with higher LVESD and LVEDD.

There is an opinion that residual subvalvular tissue after bileaflet preservation in patients with disease of rheumatic origin might lead to aggravation of recurrent rheumatic fever and thus worsen the results of surgery. However, this issue has not yet been clarified.[12]

Both techniques (bileaflet preservation and posterior-leaflet-only preservation) result in significant decreases in LVES and LVED dimensions during the postoperative period. Such a decrease in LV size introduces the possibility, in cases of bileaflet preservation, of contact between subvalvular structures and the mechanical prosthetic valve leaflets, and of consequent LVOT obstruction. Therefore, if bileaflet preservation is to be performed, an appropriate preventive measure should be taken. Many such methods have been published.[8,9,13-15] In the present instance, we divided the anterior leaflet into 2 parts and attached each to a point on the annulus close to the commissure—on the same side, in order to prevent LVOT obstruction. Thus, the subvalvular structures were moved away from the prosthetic valve leaflets. In addition, we reduced the likelihood of contact between subvalvular structures and prosthetic valve leaflets by positioning the leaflets with their hinges close to the atrial side of the valvular orifice. Tissue valves were oriented in such a way that one leaflet of the valve continued aortomitral continuity, in order to avoid obstructing the LVOT. Bileaflet mechanical valves were oriented in a vertical 12- to 6-o'clock plane when the valve size was ≥27 mm, or in a horizontal 9- to 3-o'clock plane when the size was ≤25 mm.

There have been many studies of the adverse sequelae of bileaflet preservation. These sequelae include LVOT obstruction or subvalvular tissue impairment of prosthetic valve function, either of which usually necessitates repeat surgery. In the present study, bileaflet preservation yielded almost perfect results, except for a very small improvement in postoperative LVEFs. In addition, the preservation of the posterior leaflet alone yielded successful results, except for a statistically significant decline in postoperative LVEFs. Despite the lack of complications associated with bileaflet preservation in the present study, there are many reports of LVOT obstruction and hindered prosthetic-valve-leaflet function.[4,5,12] Bileaflet preservation should be chosen to prevent further decrease in LVEF in patients who present with substantially impaired LV function, on the condition that the technical difficulties and postoperative risks of bileaflet preservation are considered. In this manner, the risk of adverse sequelae to bileaflet preservation can be reduced.

Study Limitations. Limitations of this study should be taken into consideration. First, our patients were not randomized into the study groups. The study groups also lack similarity. There was a difference between the groups in terms of preoperative LVEF and LVESD; ideally, LVEF and postoperative decrease in the LV size should be evaluated in patients who present with similar preoperative LVEFs. Because of small sample size, especially for MVR-B patients, our findings are inconclusive. We excluded from the study all patients who underwent additional coronary artery bypass surgery, which particularly affected our small MVR-B group; this reduced the statistical power of the study. Moreover, the present study investigated the results of only one of the bileaflet preservation techniques. Different results might be obtained with the use of other preservation techniques, particularly in regard to LVOT obstruction and contact between mechanical valve leaflets and subvalvular structures.

Conclusion. In light of the studies that we reviewed, we conclude that conventional MVR, in which subvalvular structures are removed together with both leaflets, should not be performed unless absolutely necessary. Bileaflet preservation successfully prevents the postoperative decrease in LVEF, in comparison with preservation of the posterior leaflet alone. Moreover, posterior-leaflet-only preservation yields excellent results in terms of LV diameter. Large-scale prospective randomized studies are needed to obtain more detailed information on this subject.

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