A novel and simple technique for correction of posterior leaflet prolapse due to chordal elongation or rupture

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Objective: The study objective was to evaluate the midterm results of a technique for correction of posterior leaflet prolapse without resection or use of artificial chordae.

Methods: From May 2009 to October 2013, 96 patients with isolated posterior leaflet prolapse (n = 36) or bileaflet prolapse (n = 60) with or without chordal rupture underwent posterior leaflet repair at the Prince Sultan Cardiac Center. The novel Uniscallop (''U'') technique was used in 46 patients (group U), based only on scallop suture without resection or artificial chordae application. A conventional approach (quadrangular or triangular resection, focal sliding, artificial chordae) was adopted in the remaining 50 patients (group C). In both groups, the annulus was reshaped using a 40- or 50-mm–long band. Postoperative echocardiography was performed in all patients after a mean follow-up of 18 ± 13 months in group U and 20 ± 9 months in group C.

Results: There were no early or late deaths. No patients in either group showed systolic anterior motion. Both surgical strategies were successful in obtaining a significant reduction in mitral regurgitation grade. Left ventricular function was maintained, and tricuspid regurgitation grade was reduced overall. Moderate mitral regurgitation during follow-up developed in only 1 patient in group C, as the result of dehiscence of a plication stitch.

Conclusions: Although the rationale for the use of the U technique is different from what is generally accepted, the midterm results of this approach are comparable to those obtained with more conventional techniques, remaining stable after a mean follow-up of 18 months. (J Thorac Cardiovasc Surg 2014;148:1407-12)

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Over-reduction of the mitral annulus is commonly used for the surgical treatment of functional mitral regurgitation (MR). In 2006, we proposed to adopt the same concept in mitral valve (MV) repair for degenerative disease.[1] In that report, correction of posterior leaflet (PL) prolapse was performed using conventional techniques, including quadrangular resection with focal sliding,[2] artificial neochordae application, and edge-to-edge repair. With time, we realized that correction of PL prolapse with or without chordal rupture could be achieved by suturing all the scallops together, after reducing excess leaflet height, if any. Annular over-reduction was the final step of the procedure.

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We report the midterm results of this procedure comparing the echocardiographic results with those obtained by using a more conventional technique during the same time frame.

MATERIAL AND METHODS

From May 2009 to October 2013, 96 patients with isolated PL prolapse (n = 36) or bileaflet prolapse (n = 60) with or without chordal rupture underwent PL repair at the Prince Sultan Cardiac Center. There has been a progressive modification of the surgical technique, with a switch from the conventional approach (resection with focal sliding or use of artificial chordae in addition to scallop suturing and longitudinal plication, if required) to a novel technique (without resection or use of artificial chordae) that we have called the Uniscallop (''U'') technique. Patients were divided into 2 groups according to the surgical technique used.

Preoperative data are reported in Table 1. Patients in both groups were similar, because in general, patients with MV prolapse have common characteristics. The institutional review board approved the study and waived patient consent.

Surgical Technique

All patients underwent surgery with a median sternotomy. Perioperative transesophageal echocardiography was obtained in all patients. Patients treated with the conventional technique (group C) underwent operation as previously described.[1] In group U, our strategy aimed at the correction of PL prolapse without resection or use of artificial chordae, and with leaflet fixation in vertical position, changing a bileaflet valve into a unileaflet one. This goal was achieved through the following steps.

Modification of posterior leaflet height. In group C, 1 or more U-sutures (4-0 Prolene) were used for longitudinal plication of the scallop(s) to reduce PL height if exceeding 15 mm.[3] In group U, height

Abbreviations and Acronyms
AL = anterior leaflet
MR = mitral regurgitation
MV = mitral valve
PL = posterior leaflet
SAM = systolic anterior motion
"U" = Uniscallop

reduction was aimed at making the height of the scallops uniform to change the PL from a multiscalloped to a single scalloped leaflet (Figure 1).

Change of posterior leaflet from a multiscalloped to a single scalloped leaflet. Once the height is similar, all scallops are sutured together (4-0 Prolene) to prevent excess leaflet motion at the level where chordal elongation is more pronounced and to limit total PL movement to the portion with a lower degree of chordal elongation (Figure 1). If the prolapse involves all scallops, suturing allows us to consider the PL as a whole and not composed of different segments, independently of any prolapse grade. Scallops are identified by the indentations, which sometimes can be less evident, because they can be of different length.

In patients with chordal rupture, the donor scallop (ie, the scallop with normal or elongated chordae close to the one with ruptured chordae) is positioned below the receiving scallop (ie, the scallop with ruptured chordae) to support it. The rim of the receiving scallop is then sutured to the body of the donor scallop (Figure 2). It is worth noting that the portion of a scallop without chordae will not cause leaflet prolapse, and thus MR, if it is 10 mm or less.

Annular over-reduction. The MV annulus is reshaped using a 40-mm (SMB40) or 50-mm (SMB50) band. The band is flexible, made of radiopaque silicone core, and covered by a knitted polyester fabric coated with Carbofilm (Sorin, Saluggia, Italy). It is inserted from trigone to trigone using multiple imbricated U-sutures to reduce the stress on the annulus. The septal lateral distance obtained is, as a mean, 21 mm[4] for the SMB40 and 24 mm for the SMB50. The choice of the band depends on the anterior leaflet (AL) length. Because the purpose of the correction is to obtain a coaptation length of 5 mm or greater, the SMB40 or SMB50 is used if the AL length is less than 30 mm or 30 mm or more, respectively. The use of these bands is aimed at moving the posterior annulus toward the anterior annulus pivoting on 2 fixed points (the trigones). The PL is then attracted posteriorly with subsequent increased tethering on PL chords, eliminating the possibility of prolapse. The PL then remains fixed in the vertical position and becomes a buttress for the AL. Anatomic systolic anterior motion (SAM) of the AL cannot occur because the 2 leaflets meet at the extremity of the mitral area.

Anterior leaflet prolapse. In patients with associated AL prolapse, 2 or more artificial chordae (polytetrafluoroethylene; 4-0 Gore-Tex, WL Gore & Associates, Inc, Flagstaff, Ariz) are used. The length of neochordae is adjusted as previously described.[5] Any deviant cusp, if present, is sutured with the main body of the leaflet.

Tricuspid regurgitation. Correction of moderate or greater tricuspid regurgitation was performed in all patients, if present, whereas correction of mild tricuspid regurgitation was performed only in patients with annular enlargement.

Echocardiographic Evaluation

All patients underwent standard preoperative echocardiography. MR was graded as mild (grade 1), moderate (grade 2), moderate to severe (grade 3), and severe (grade 4) according to different parameters, including regurgitant jet area and its ratio to the left atrial area, number and direction of regurgitant jets, and vena contracta width. Ejection fraction was calculated using a modified Simpson's biplane method. The severity of tricuspid regurgitation, as assessed by Doppler echocardiography, was graded on a scale from 1 to 4 (1, mild; 2, moderate; 3, moderate to severe; 4, severe). Pulmonary artery systolic pressure was estimated as the sum of the gradient across the tricuspid valve (calculated from the simplified Bernoulli equation) and the right atrial pressure. The latter was estimated using inferior vena cava size and response to respiration in the subcostal view.

Statistical Analysis

Results are expressed as mean value ± standard deviation, unless otherwise indicated. Statistical analysis comparing 2 independent groups was performed with unpaired 2-tailed Student *t* test for the means or chi-square test for categoric variables. Preoperative and postoperative data were compared with paired 2-tailed Student *t* test. SPSS software (SPSS Inc, Chicago, Ill) was used for statistical analysis.

RESULTS

Operative data and surgical techniques for both groups are reported in Table 2. The PL had 3 scallops in 67 patients (69.8%), 2 scallops in 13 patients (13.5%), 4 scallops in 15 patients (15.6%), and 6 scallops in 1 patient (1.1%). A deviant cusp in the AL was present in 28.3% of cases (n = 17). No patient died within 30 days of surgery or during follow-up. All patients underwent echocardiography postoperatively. There was no or trivial residual MR in all but 1 patient in group W, who required a second pump run with successful correction of MR, which was due to intermittent tethering of second-order chords of the AL.[6] Cardiopulmonary bypass and crossclamp times were significantly shorter in group U as a result of the simplicity of the surgical technique.

After a mean follow-up of 19 ± 11 months, all patients underwent transthoracic echocardiography. Length of follow-up was not significantly different between groups (mean, 18 ± 13 [2-36] months in group U; mean, 20 ± 9 [3-38] months in group C; $P = .3799$).

Postoperative echocardiographic data are reported in Table 3. Both strategies were successful in obtaining a significant reduction in MR. The final aspect of the MV was comparable for all techniques (Figure E1). Left ventricular function was maintained, and tricuspid regurgitation grade was overall reduced. Residual MR grade was lower in group U (0.2 ± 0.4 vs 0.4 ± 0.5, $P = .0340$), because a patient in

TABLE 1. Preoperative data

	Group U (n = 46)	Group C (n = 50)	*P* value
Age (y)	38 ± 17	37 ± 13	.7457
Female gender	29	22	.0618
NYHA class	2.3 ± 0.8	2.0 ± 1.0	.3448
Atrial fibrillation	0	0	1.0000
Barlow disease	19	17	.3507
Bileaflet prolapse	32	28	.4602
PL chordal rupture	10	4	.0567

NYHA, New York Heart Association; *PL*, posterior leaflet.