Interrupted Commissural Band Annuloplasty for Degenerative Mitral Valve Disease

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Background. **Mitral annuloplasty is useful for treating degenerative mitral valve disease. Although the incidence of complications is low, prosthetic ring-related complications can occur. Hemolysis and mitral stenosis are serious complications requiring reoperation. Limited use of prosthetic material could decrease the risk for complications. Commissural annuloplasty has been reported by Kay and Reed; their techniques involve suture plication. To prevent dehiscence, we selected short bands and compared the echocardiographic changes between this method and the Cosgrove ring.**

Methods. **Three sutures are placed in the commissures using two bands, which shortens the annular length by 60%. We performed this interrupted commissural band annuloplasty (iCBA) in 63 patients and used Cosgrove bands for 58 patients.**

Results. **Clinically, for iCBA and Cosgrove groups, respectively, hemolysis with mild mitral regurgitation occurred in 0 and 2 cases ($p = 0.084$), and mitral stenosis due to pannus formation occurred in 0 and 1 case ($p = 0.224$). There was a trend toward a lower ring-related complication rate in the iCBA group. On echocardiography, for the iCBA and Cosgrove groups, respectively, the maximum anterior-posterior distance of the annulus in diastole was 3.1 ± 0.7 mm and 2.6 ± 0.4 mm ($p < 0.001$), maximum opening angle of the posterior leaflet was 85.7 ± 17.3 degrees and 103.4 ± 20.1 degrees ($p < 0.001$), and coaptation distance was 11.6 ± 3.7 mm and 8.4 ± 2.6 mm ($p < 0.001$).**

Conclusions. **The iCBA method prevented posterior leaflet tethering, kept the coaptation distance deep on echocardiography, and was associated with lower trends of ring-related complications. Because the posterior side of the annulus was not reconstructed, iCBA is suitable for fibroelastic deficiency, rather than for Barlow's disease.**

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The conventional repair of degenerative mitral valve prolapse involves annuloplasty. Various rigid/flexible, full/partial rings, and bands are available for this purpose. Although the incidence of complications is thought to be generally low, prosthetic ring-related complications such as hemolysis and mitral stenosis can occur. Hemolysis and mitral stenosis are serious complications and necessitate reoperation. The causes of these complications are related to residual mitral regurgitation and the prosthetic ring. Thus, limited use of prosthetic material could decrease the incidence of complications. Furthermore, a prosthetic ring that effectively secures the mitral valve plasty and prevents recurrent mitral regurgitation also limits the motion of the mitral annulus and induces tethering of the posterior leaflet. Annuloplasty is more effective in the commissures than in the posterior part of the mitral annulus. This concept has been reported previously by Kay and Egerton [1] and Reed and colleagues [2]; however, their techniques involve suture plication, which is associated with the potential for dehiscence of the annular tissue. To prevent dehiscence, we modified Kay's annuloplasty by using short bands to shorten the annulus in the commissural area.

Patients and Methods

This retrospective study involved human subjects. The objective groups were not randomized controlled groups in the same period, but were historical groups. The Ethics Committee in our institute approved the study and waived the need for patient consent.

In our annuloplasty technique, three sutures are placed in the trigones, commissures, and annulus of P1 and P3, sutured to short (15 mm) flexible bands, and tied (Fig 1). We obtained two short bands by cutting the anterior portion of a Tailor Flexible Ring 35 (St. Jude Medical, St. Paul, MN). We selected this material because it does not disintegrate when bands are cut, and it has a low profile. This technique shortens the sutured annular length by approximately 60%, from a length of 2.5 cm to 1.5 cm, only in the commissure position. We used this interrupted commissural band annuloplasty (iCBA) method for 63 patients and used the Cosgrove band (Edwards Life Sciences, Irvine, CA) for 58 patients with degenerative mitral regurgitation who were repaired successfully and whose postoperative echocardiograms were suitable for analysis

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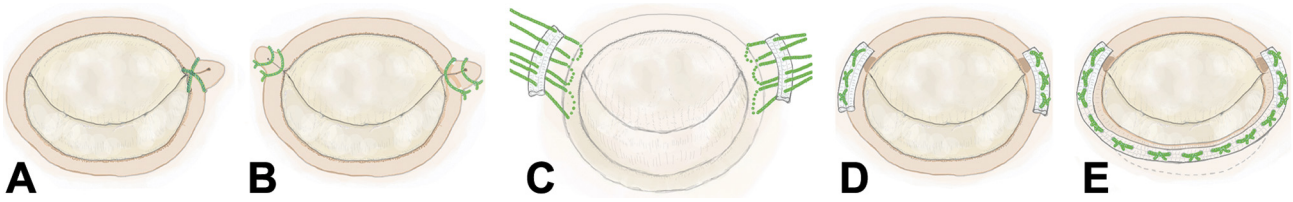

Fig 1. (A) Kay technique. (B) Reed technique. (C) Interrupted commissural band annuloplasty, before. At both commissures, we sutured three stitches from the trigone to P1 or P3. They were then sutured to the short bands and tied. (D) After interrupted commissural band annuloplasty. These areas could be shortened by approximately 60%. (E) Cosgrove band annuloplasty.

(Table 1). The numbers of anterior, bileaflet, and posterior leaflet prolapses were 9, 3, and 51, respectively, in the iCBA group; and 9, 4, and 45, respectively, in the Cosgrove group. The repair techniques in the iCBA and Cosgrove groups, respectively, were resection of the posterior leaflet (n = 51, n = 45), chordal replacement of the anterior leaflet (n = 7, n = 7), resection of the anterior leaflet (n = 3, n = 2), chordal replacement of the anterior leaflet and resection of the posterior leaflet (n = 1, n = 4), chordal replacement of the anterior and posterior leaflets (n = 1, n = 0), and resection of the anterior and posterior leaflets (n = 1, n = 0).

There were no significant differences in the demographic characteristics or preoperative echocardiography data between the two groups (Table 1). The mean follow-up period was 4.2 ± 2.1 years in the iCBA group and 9.1 ± 2.8 years in the Cosgrove group ($p < 0.001$). The follow-up period differed because of the historical selection of the annuloplasty method. All operations were performed by a single surgeon, although the time frame was different. The Cosgrove group underwent operations in the early period, and thus there was a bias in terms of the learning curve of the surgeon. We compared the clinical results and echocardiogram data between the two groups. The clinical postoperative variables included moderate mitral regurgitation, hemolysis, mitral stenosis due to pannus formation, and reoperation. The echocardiogram was analyzed by a single echocardiographer who was blind to the annuloplasty method used. We measured the maximum anterior-posterior distance of the annulus in diastole (rd), minimum distance in systole (rs), maximum opening angle of the posterior leaflet (θ), and coaptation distance (C) in systole. We calculated the percentage annular motion as (rd − rs)/rd × 100 (Fig 2).

Table 1. Patients' Characteristics

Variable	iCBA (n = 63)	Cosgrove (n = 58)	*p* Value
Age, years, mean ± SD	60.8 ± 12.4	61.9 ± 10.4	0.72
Male, %	74.6	62.1	0.14
Barlow's disease, %	17.5	17.2	0.98
LVDd, mm, mean ± SD	55.0 ± 6.8	56.8 ± 6.5	0.12
LVDs, mm, mean ± SD	34.3 ± 7.1	34.4 ± 7.3	0.94
LVEF, %, mean ± SD	66.3 ± 10.5	69.3 ± 11.4	0.13
Valve lesion A/B/P	9/3/51	9/4/45	
NYHA I/II/III	47/14/1	41/16/1	
Accompanied procedure			
Maze	14	12	0.84
TAP	8	5	0.47
AVR	5	2	0.28
CABG	1	2	0.51

AVR = aortic valve replacement; CABG = coronary artery bypass graft surgery; iCBA = interrupted commissural band annuloplasty; LVDd = left ventricular end-diastolic dimension; LVDs = left ventricular end-systolic dimension; LVEF = left ventricular ejection fraction; NYHA = New York Heart Association; TAP = tricuspid annuloplasty.

Statistical Analysis

The data were compared between the two groups using Pearson's χ^2 test for categorical variables and the unpaired *t* test for continuous variables. Statistical analyses were performed with JMP software (SAS Institute, Cary, NC).

Results

All mitral lesions in both groups were repaired successfully, although some complications occurred during the follow-up period. Follow-up echocardiography was performed yearly. The follow-up rate was 100%, and 1 death due to colon cancer occurred in the Cosgrove group. For the iCBA and Cosgrove groups, respectively, hemolysis with mild mitral regurgitation occurred in 0 and 2 cases ($p = 0.084$), moderate recurrent mitral regurgitation occurred in 1 and 2 cases ($p = 0.508$), and mitral stenosis by pannus formation occurred in 0 and 1 case ($p = 0.224$). The ring-related complication rate showed a lower trend in the iCBA group (Table 2). Two patients who had hemolysis underwent reoperations (re-repair) within 1 year. The cause of the residual mitral regurgitation was the oversight of an accompanying lesion, namely, prolapse of the commissural leaflet. We resected or plicated the lesion, the Cosgrove ring was removed, and iCBA was performed using autologous pericardium. The patient who had mitral stenosis underwent reoperation for valve replacement 5 years later. The operative finding was