Aortic Valve Repair for Aortic Regurgitation: Intermediate-term Results in Patients with Tricuspid Morphology

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Background and aim of the study: **Surgical results after aortic valve repair in patients with aortic regurgitation (AR) of tricuspid valve morphology and with no evidence of aortic root disease have not yet been clarified.**
Methods: **Between January 1994 and June 2001, aortic valve repair was performed in 40 patients (eight females, 32 males; mean age 61.0 ± 10.5 years) of this type. Surgical results and follow up data were summarized after aortic valve repair (for AR) in these patients.**
Results: **One patient died in hospital (mortality 2.5%). The mean cardiopulmonary bypass time was 143.5 ± 47.4 min, and mean aortic cross-clamp time 99.8 ± 34.3 min. At follow up, the mean AR grade was 1.5 ± 0.8 and mean NYHA class 1.0 ± 0; both parameters showed significant improvement compared to preoperative status (p <0.0001). Survival was 94.9% at one year and 82.6% at five years. The five-year reoperation-free rate was 87%.**
Conclusion: **Aortic valve repair for AR in patients with tricuspid valve morphology is a safe procedure that provides good intermediate-term results.**

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When treating aortic regurgitation (AR), aortic valve replacement (AVR) has become by far the most common approach, with good and consistent postoperative results being obtained. By contrast, aortic valve repair has been performed only sporadically in specific situations, for example in patients with AR with ventricular septal defect, in those with AR of the bicuspid valve (1), or with AR resulting from acute or chronic aortic root pathology (2). As aortic valve-sparing surgery is of great interest to cardiac surgeons, valve repair has been utilized in the treatment of patients with AR. Several reports on aortic valve repair have been made during the past decade, but these have included experience with repair for bicuspid aortic valve (3), or for patients with root pathology (aneurysm, dissection) (4). In the present study, surgical results were summarized following aortic valve repair in patients with tricuspid morphology and with no evidence of aortic root pathology.

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Clinical material and methods

Patients

Between January 1994 and June 2001, aortic valve repair was performed in 40 patients (eight females, 32 males; mean age 61.0 ± 10.5 years) with AR of tricuspid valve morphology, and with no evidence of aortic root disease. Patients with rheumatic heart valve disease were excluded from the study, as were those with annular or cusp calcification. Likewise, patients with root pathology (ascending or root aneurysm, annuloaortic ectasia, or dissection) were excluded. Two patients had aortitis syndrome, but with no evidence of aortic root deformity.

During the same study period, 91 patients (28 females, 63 males; mean age 57.1 ± 15.1 years) with dominant AR underwent AVR. Patients with aortic root pathology were excluded from this group.

Echocardiography and surgical approach

All patients underwent intraoperative transesophageal echocardiography (TEE) to assess the repair. Residual AR equal or greater than grade 2 resulted in a second pump-run to repair or replace the valve. The present authors' principal philosophy for aortic valve repair is to repair every possible defect of the valve mechanism; consequently, multiple reparative techniques were used in combination in many

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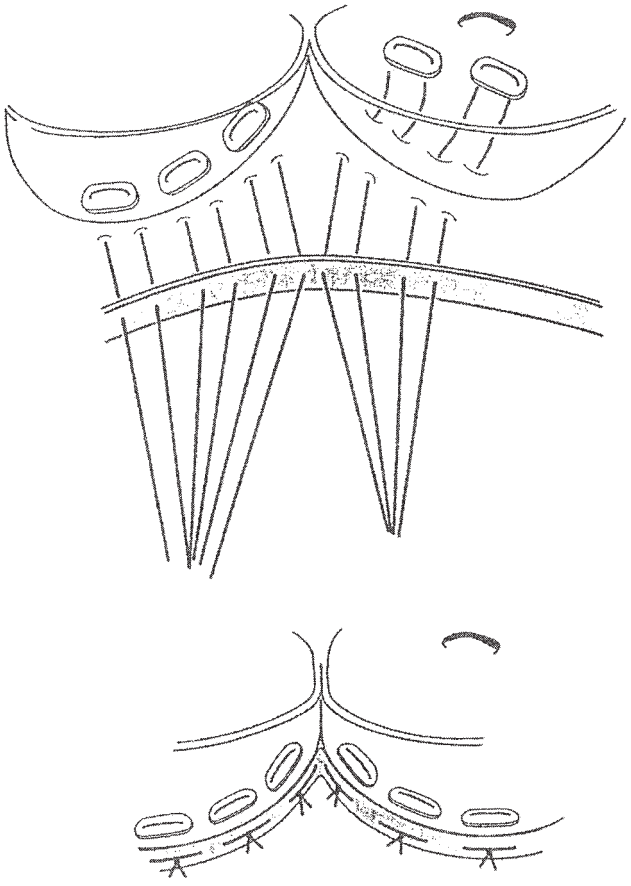

Figure 1: Schematic representation of the subvalvular circular annuloplasty. (Reproduced from Izumoto et al. (6).)

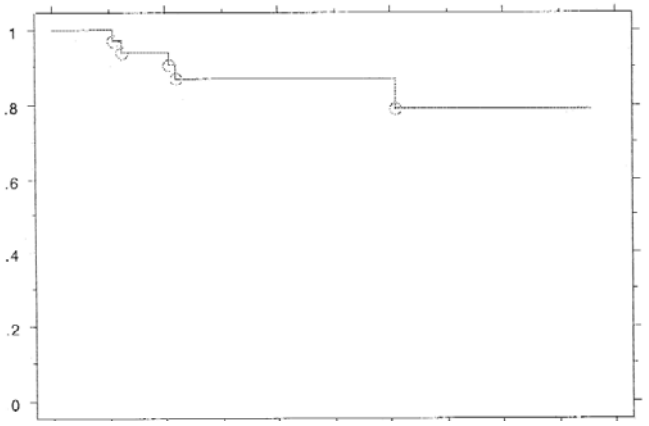

Figure 2: Survival curve after aortic valve repair. Time after surgery (x-axis) in months; reoperation-free rate (y-axis) as proportion.

patients. The reparative methods used, classified according to anatomical site and morphological abnormality, are listed in Table I. Among these methods, leaflet plication was performed in 18 patients, subcommissural annuloplasty in 15, patch repair of the cusp perforation in five, commissural suspension in five, subvalvular circular annuloplasty in 16, sinotubular junction tailoring in nine, and leaflet suspension in nine. Details of some of these reparative techniques have been described elsewhere (5,6). A schematic representation of the subvalvular circular annuloplasty is shown in Figure 1.

Data acquisition

The operative records and full charts of all patients were reviewed. Perioperative changes in NYHA functional class, echocardiographic findings including AR grading (grade 1 to 4), ejection fraction (EF), fractional shortening (FS), left ventricular end-diastolic dimension (LVEDD) and left ventricular end-systolic dimension (LVESD) were also retrieved from the database. A variety of operative methods was used in the study population. All patients were followed up, with intermediate-term follow up data being obtained by postal questionnaire to the local cardiologist between July 2000 and August 2000. The survival rate and reopera-

Table I: Reparative procedures.

Anatomical site	Defect	Procedure(s)
Annulus	Dilatation	Subcommissural annuloplasty
		Subvalvular annuloplasty
Leaflet	Prolapse	Leaflet plication
		Leaflet suspension
		Bicuspidization
	Perforation	Patch repair
	Thickened	Slicing
	Shortened	Cusp elongation
Commissure	Detached	Commissural suspension
	Fused	Commissurotomy
STJ	Dilatation	STJ tailoring

STJ: Sinotubular junction.

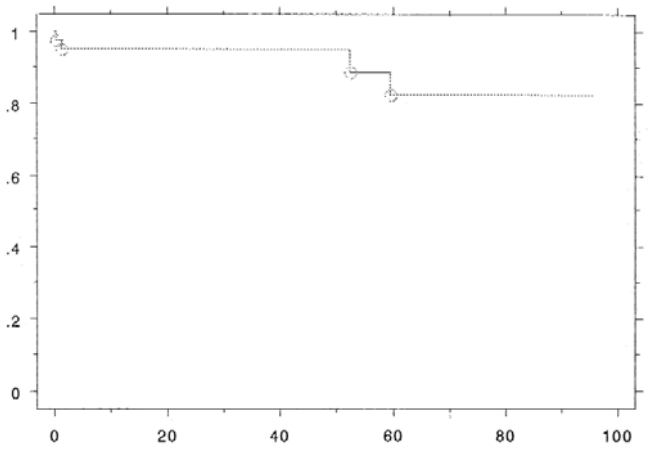

Figure 3: Reoperation-free curve after aortic valve repair. Time after surgery (x-axis) in months; reoperation-free rate (y-axis) as proportion.

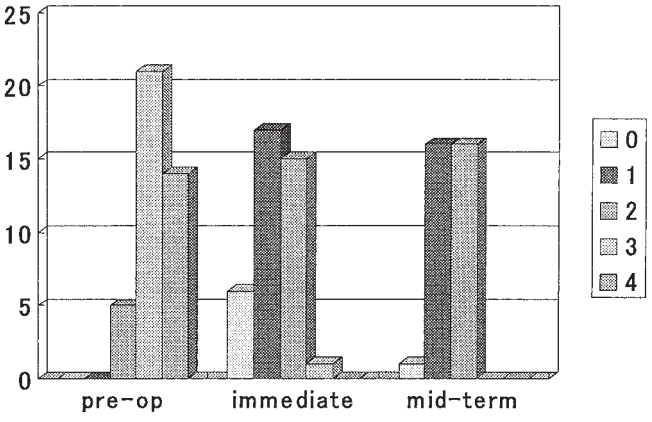

Figure 4: Changes in echocardiographically monitored AR grade. (x-axis indicates numbers of patients.)

tion-free rate were calculated using the Kaplan-Meier method.

Statistical analysis

The collected data were entered into a database in prospective manner and analyzed retrospectively. Continuous variables were expressed as mean ± SD. Survival and reoperation-free rates were expressed as mean ± SE. Comparisons were performed using a paired *t*-test for continuous data. Survival and reoperation-free rates were analyzed according to the Kaplan-Meier method. Perioperative changes in AR grade and NYHA status were examined using the repeated measures ANOVA. A p-value <0.05 was considered to be statistically significant.

Results

Operative results

There was one in-hospital death (mortality 2.5%). The mean cardiopulmonary bypass time was 143.5 ± 47.4 min, and the mean aortic cross-clamp time 99.8 ± 34.3 min. The mean intensive care unit stay was 2.5 ± 1.6 days. Perioperative changes in echocardiographic indices (e.g. EF, LVEDD, LVESD and FS) are listed in Table II. Postoperatively, left ventricular size was significantly decreased, while immediately after surgery the mean AR grade improved to 1.3 ± 0.8 (versus 3.2 ± 0.8 preoperatively) (p <0.0001) and the mean NYHA class improved to 1.0 ± 0 from 1.8 ± 0.6 (p <0.0001).

Follow up was 97.5% complete; the mean follow up period was 43.0 ± 28.9 months. The survival rate was 94.9 ± 5.1% at one year and 82.6 ± 17.4% at five years (Fig. 2). During follow up one patient died from malignancy, one from cerebral bleeding and one from an arrhythmic event. The reoperation-free rate was 94.1 ± 5.9% at one year and 87.0 ± 13.0% at five years (Fig. 3). Five patients required reoperation during the follow up period; all of these underwent AVR. At follow up, the mean AR grade was 1.5 ± 0.8 and mean NYHA class 1.0 ± 0, with both parameters showing significant improvement compared to the preoperative status. Changes in echocardiographic AR grades are illustrated graphically in Figure 4.

Five reoperations were required due to AR deterioration. Three of these cases were related to technical

Table II: Perioperative changes in echocardiographic findings.*

Parameter	Preoperative	Postoperative	p-value
AR grade	3.2 ± 0.8	1.3 ± 0.8	<0.0001
EF (%)	65.3 ± 8.6	54.0 ± 10.4	<0.0001
FS (%)	37.3 ± 6.8	28.1 ± 7.4	<0.0001
LVEDD (cm)	6.3 ± 0.7	5.2 ± 0.8	<0.0001
LVESD (cm)	4.0 ± 0.7	3.8 ± 0.9	0.012

*Values are mean ± SD.
AR: Aortic regurgitation; EF: Ejection fraction; FS: Fractional shortening; LVEDD: Left ventricular end-diastolic dimension; LVESD: Left ventricular end-systolic dimension.

failure of the subcommissural annuloplasty and leaflet plication, and two to the progression of cusp disease in patients with aortitis syndrome.

Discussion

Although aortic valve repair is one of the oldest procedures in the history of cardiac surgery (7), in recent years it has been largely abandoned following the introduction of reliable valve prostheses. Aortic valve repair has been performed only in specific situations. During the early years of valve repair, most patients had rheumatic valve disease (8), but recently there has been a marked reduction in the incidence of this condition. Haydar et al. (9) reported aortic valve repair techniques and outcome in patients with AR in 1997, while in 1999 Casselman et al. (3) showed that valve repair for bicuspid prolapsing valve provided a good intermediate-term outcome. Despite these reports, few data are available regarding aortic valve repair and its outcome in a subset of patients with degenerative AR of tricuspid morphology.

The present authors have been performing aortic valve repair since 1993, their practice being to repair only in specific patient groups and under the following conditions: (i) the pathology of the valve is dominant or pure regurgitation; (ii) the valve leaflet (cusp) is pliable; and (iii) the leaflet size is fairly well preserved (10).

It is believed that the key to successful aortic valve repair is a thorough understanding of the aortic valve mechanism (annulus, aortic valve cusp, commissures, sinus of Valsalva and sinotubular junction). Every defect in the mechanism has been corrected in the present series, and consequently multiple reparative techniques were applied in many cases. The techniques continue to evolve, and in this context the present results should perhaps be viewed as results obtained after a combined reparative aortic valve procedures rather than after a single procedure.

Annulus dilatation was dealt with by subcommissural annuloplasty during the early phase of the study. However, as reoperation cases were encountered where the cause of reoperation may have been related to failure of the technique, a new method of subvalvular circular annuloplasty was developed (6). This has been used successfully, either in solitary aortic valve repair or in combination with Yacoub's procedure. The procedure proved to be a good alternative when the cusp was prolapsing, with the choice of repair being leaflet plication or suspension, using 5-0 GoreTex suture. In the present study, two of the aortitis syndrome patients required late reoperation due to deterioration of the cusp (which is characteristic of this condition), although subsequently aortitis patients were excluded from aortic valve repair.

Among the present patients, the survival rate was 94.9% at one year and 82.6% at five years. The five-year reoperation-free rate of 87% was comparable to that of 87% by Casselman et al. (3) and of 82% by Haydar et al. (9). While these results show promise, they may be inferior to those obtained after mechanical AVR. Although definite conclusions on aortic valve repair in this subset of patients should await longer-term results, the present authors believe that there is a definite group of patients who would benefit from aortic valve repair or who sincerely wish to undergo the procedure. For this reason, the aim is to continue exploring the feasibility of aortic valve repair in this subset of patients, with the durability of repair being closely monitored.

In conclusion, aortic valve repair was performed in patients with dominant AR, the candidates for this procedure having a pliable and well-preserved leaflet area. Aortic valve repair for AR in patients with tricuspid valve morphology seems to be a safe procedure with good intermediate-term results, though a combination of reparative procedures may be necessary to obtain the best possible results.

Acknowledgements

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Meeting discussion

DR. DAVID H. ADAMS (Mount Sinai, USA): I do not understand your exclusions - you excluded root pathology, but most of the repairs were annuloplasties. What pathology affects the annulus but not the root? I thought that was all part of the same anatomical structure?

DR. HIROSHI IZUMOTO (Iwate, Japan): Root pathology means that the disease includes annuloaortic ectasia or aneurysmal dissections that may have a dilated annulus or root diameter. The reason we performed an annuloplasty is that the patients had a fairly dilated annulus compared to normal subjects - the mean root diameter was about 25 mm. In the normal Japanese population the mean annulus diameter is 20-22 mm, so we performed annuloplasties. I would not say that patients with a 24-25 mm diameter had root pathology.

DR. ADAM SZAFRANEK (Poland): Your patients were not especially sick, so would you recommend repair for a patient who needs an emergency operation? Or are they left with poor left ventricular function or in NYHA class III or IV?

DR. IZUMOTO: We did not exclude patients with a poor left ventricular ejection fraction or with an acute disease process from valve repair. We try to perform a valve repair whenever possible.

DR. GIULIO RIZZOLI (Italy): Is there any risk of heart block when performing the circular annuloplasty?

DR. IZUMOTO: We had no problems with the conduction systems - there was no postoperative AV block in any of the patients.

DR. YUKIKATSU OKADA (Japan): Did most of the patients on which you performed this procedure have valve prolapse, with or without perforation?

DR. IZUMOTO: Yes - the majority had prolapse of either one or two of the cusps.

DR. OKADA: Do you perform echocardiography before surgery?

DR. IZUMOTO: Yes.

DR. OKADA: You use many procedures at the operation. Can you predict which procedure you will use for a particular patient, depending on preoperative echocardiography?

DR. IZUMOTO: When there is prolapse of the cusp, we tend to perform a leaflet suspension. In the first phase of the study we used leaflet plication, but when we analyzed the reoperation data there were some problems with failure of the plication stitch. So, we switched to the leaflet suspension as described by Dr. David in 1990.

DR. OKADA: Do you use subannular fixation routinely, nowadays?

DR. IZUMOTO: Yes.

DR. MOHAMED ELAMIN AHMED (Sudan): Was the reduction in ejection fraction statistically significant? If so, how do you explain that?

DR. IZUMOTO: It was statistically significant, but that may be due to the reduction in end-diastolic volume being greater than that of the end-systolic volume.

DR. ADAMS: In studies of aortic repair I have difficulty understanding the failure rates compared to using a pericardial valve in the same patient population. What might the reoperation rate be if you used a bioprosthesis?

DR. IZUMOTO: I admit that, compared to results with pericardial valves, our results are slightly poorer. But we are exploring the *feasibility* of this repair technique here.

DR. ADAMS: Congratulations - your series is very similar to that presented by Dr. Schaff - and your repair results seem to be identical. But your failure rate is still fairly high compared to biological valves for people aged over 60. Perhaps in 40- or 50-year-olds it is a different argument?

DR. IZUMOTO: One mistake we made was to include aortitis syndrome patients - there were two reoperations due to this condition. Excluding those patients might have produced better results.