Journal of Medical Sciences

ISSN 1682-4474

science alert

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Short Communication

JMS (ISSN 1682-4474) is an International, peer-reviewed scientific journal that publishes original article in experimental & clinical medicine and related disciplines such as molecular biology, biochemistry, genetics, biophysics, bio-and medical technology. JMS is issued eight times per year on paper and in electronic format.

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J. Med. Sci., 8 (3): 321-324
1st April, 2008

Is Conservative Repair an Acceptable Way for Treatment of the Regorgitant Bicuspid Aortic Valve

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From August 1997 to December 2000, 19 patients with aortic regurgitation due to congenital aortic valve underwent aortic valve repair (17 men and 2 women with a mean age of 42±17 years; range, 16 to 70 years). The mean preoperative aortic regurgitation grade was 3.1±0.8 on a scale of 1 to 4. Mean preoperative New York Heart Association functional class was 1.9±0.8. Fourteen patients had pure aortic regurgitation, 2 also had infectious endocarditis, 1 had angina pectoris and 2 had an ascending aortic aneurysm. There was 1 hospital death (5.2%) and 1 patient required re-operation due to recurrent infectious endocarditis. Mean aortic regurgitation grade at discharge was 1.1±0.9 and functional class was 1.1±0.2. All patients were followed for a mean duration of 40±23 months (range, 0.5 to 84 months). There was 1 late death and two patients required aortic valve replacement. The 5-year survival rate was 90±7%. The 1 and 5-year re-operation-free rates were 87±12 and 76±23%. Bicuspid aortic valve repair is a safe procedure with good early postoperative results. However midterm results are not satisfactory. Re-operation is a promising alternative and progress aortic regurgitation were complications. Bicuspid aortic valve repair to valve replacement that requires additional study to individualize treatment.

Key words: Bicuspid aortic valve, aortic valve repair, postoperative complications

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INTRODUCTION

Among open intra-cardiac procedures, Aortic valve repair was one of the first (McMullan *et al*., 2007; Ruzmetov *et al*., 2006). However, the availability of safe valve prostheses led cardiac surgeons to abandon the use of aortic valve repair. More recently, greater awareness of the long-term complications associated with currently available prostheses and the standardization and acceptance of repair techniques for atrio-ventricular valves, have renewed interest in aortic valve repair. Bicuspid aortic valves permitting aortic insufficiency are the lesions most amenable to this intervention (Spataro *et al*., 2008).

Although several institutions have reported their experience with aortic valve repair (Casselman *et al*., 1999; Fraser and Cosgrove, 2001). This procedure remains controversial. The present study describes our techniques for repairing congenital bicuspid aortic valve and reports early and midterm results.

MATERIALS AND METHODS

Patients: Between August 1997 and December 2000, 19 consecutive patients with Aortic Regurgitation (AR) due to congenital bicuspid aortic valve underwent surgery at Shariati Hospital. Eighty-nine percent were male. Patients' ages ranged from 16 to 70 years (mean age, 42±17 years). Preoperatively, 6 patients were assigned to New York Heart Association (NYHA) class I, 8 to class II and 5 to class III. All patients had a pre and postoperative 2-D (B and M-mode) echocardiography to determine left ventricular function, as reflected by the left ventricular end-diastolic (LVEDD) and end-systolic diameter (LVESD) and the left ventricular fractional shortening (%FS). Using continuous wave and pulsed Doppler signals, we assessed maximum velocity across the valve and the presence of residual regurgitation. The presence of residual AR was graded from 1 to 4 on the basis of the ratio of jet height/left ventricular outflow tract height (Perry *et al*., 1998). AR was graded as 1+ in 1 patient, 2+ in 2 patients, 3+ in 11 patients and 4+ in 5 patients. Fourteen patients had pure AR. Two patients had active infectious endocarditis, 1 of whom also had mitral valve regurgitation (MR). The other patient had a Ventricular Septal Defect (VSD) and tricuspid valve regurgitation (TR). One patient had angina pectoris and 2 had an ascending aortic aneurysm.

Mid-term follow-up data was obtained by postal questionnaires sent to referring physicians between July and August 2000. And then, a transthoracic echocardiography was performed in our hospital. Information was collected on the patients' current status, medication, morbidity and mortality by questionnaire.

Surgical procedure: After standard median sternotomy, cardiopulmonary bypass (CPB) was established. A left ventricular vent and moderate systemic hypothermia were used in all patients. After aortic cross-clamping, a transverse aortotomy was performed and cold cardioplegic solution was infused directly into the coronary ostia.

Following valve repair and resuscitation of the heart, the patient was weaned from CPB. At this time, the repaired valve was evaluated by transesophageal echocardiography (TEE). We did not accept an intraoperative result worse than grade +2 AR. When necessary, the heart was rearrested and aortic valve replacement or repair was performed.

Operative technique: The details of our technique for aortic valve repair have been described elsewhere (Kawazoe, 1997; Izumoto *et al*., 1995; Kawazoe *et al*., 2001). Basically, following resection of the raphe, any redundant or prolapsing cusp is repaired by a few interrupted stitches placed in the middle of the prolapsing leaflet; the leaflet itself is not resected. A subcommissural annuloplasty is performed. The reinforced annuloplasty technique was used in 2 patients, employing an approximately 2 mm-wide Gore-Tex strip (WL Gore and Associates, Flagstaff, AZ).

Concomitant procedures included mitral valve replacement in 1 patient, VSD patch closure and tricuspid valve annuloplasty in another patient, patch angioplasty of the left main trunk in 1 patient and replacement of the ascending aorta in 2 patients. Operative techniques for aortic valve repair and concomitant procedure are shown in Table 1.

Concomitant procedures: mitral valve replacement (n = 1), patch angioplasty of left main trunk (n = 1), ventricular septal defect patch closure + tricuspid valve annuloplasty (n = 1), replacement of the ascending aorta (n = 2).

Table 1: Operative techniques for aortic valve repair and concomitant procedures

Correction level	Technique	No.	%
Cusps	Cusp plication	16	84
	Cusp patching	3	16
	Resection of raphe	5	26
	Cusp shaving	3	16
	Endoaneurysmorrhaphy	1	5
Commissure	Subcommissural annuloplasty	17	89
	Commissurotomy	1	5
	Reinforced annuloplasty	2	11

Statistical analysis: All data are expressed as the mean±Standard Deviation. For statistical analysis, the unpaired Student's F-test was used. Results were considered significant at $p<0.05$. Survival curve and freedom from reoperation were calculated using the method of Kaplan-Meier.

RESULTS

No patients required valve replacement, but 2 patients developed aortic stenosis. The left ventricular-aortic mean pressure gradients (mPG) were 48 and 60 mmHg intraoperatively. One hospital death occurred due to superior mesenteric artery thrombosis (5-2%). In this series, the mean CPB time was 134±50 min and the mean aortic cross-clamp time was 94±43 min.

Short-term assessment: One patient required AVR 25 days following the initial procedure due to a recurrence of infective endocarditis. Based on echocardiography performed just prior to hospital discharge, AR was graded as 0 in 6 patients, 1+ in 7 patients, 2+ in 3 patients and 3+ in one patient. Two patients who were diagnosed with aortic stenosis intraoperatively had mPGs of 19 and 13 mmHg. Postoperatively 17 patients have NYHA class 1 and 1 was class 2 ($p<0.05$). The LVEDD decreased from 67±12 to 58±8 mm, the LVESD decreased from 43±10 to 40+7 mm. The echocardiographic ejection fraction changed from 59±12 to 55±9 and fractional shortening decreased from 37±7 to 30±4 (Table 2).

Midterm assessment: Mean duration of follow-up was 40±23 months (range 0.5 to 84 months) and available for all patients.

Two patients underwent aortic valve re-operation at 24 and 50 months following the initial procedure. One re-operation was due to dehiscence of the subcommissural annuloplasty and the other was the result of leaflet suture dehiscence. Both patients underwent AVR without complication. There was 1 late death due to congestive heart failure. This patient had undergone AVP + patch angioplasty of the LMT.

Table 2: Preoperative changes in echocardiographic left ventricular hemodynamic parameters

Parameters	Preoperative (n = 19)	Prior to discharge (n = 17)	Midterm (n = 14)
AR grade	3.0±0.8	1.1±0.9	1.8±1.0
LVEDD (mm)	67.9±12.7	58.0±8.1	52.8±5.9
LVESD (mm)	43.9±10.9	40.5±7.2	37.2±7.2
FS (%)	35.6±7.3	29.8±4.3	33.2±5.0
LVEF (%)	59.2±12.8	55.8±9.1	61.4±7.3

AR: Aortic Regurgitation; LVEDD: Left Ventricular End-Diastric Dimension; LVESD: Left Ventricular End-Systolic Dimension; LVEF: Left Ventricular Ejection Fraction; FS: Fractional Shortening

Actuarial survival rate was 90+7% at 5 years. Actuarial freedom from aortic re-operation was 87±12% at 3 years and 76±23% at 5 years.

DISCUSSION

Valvoplasty for bicuspid AR generated generally satisfactory early and midterm postoperative results. The 5-year survival rate was 90±7%, which is comparable to results reported following valve replacement (Kawazoe *et al*., 2001). The freedom from re-operation rate was 76±23% for the first 5 years after surgery. Casselman *et al*. (1999) reported an 87% 5-year free from re-operation rate in a group of patients with bicuspid valve regurgitation who underwent valve repair. In this study, the re-operation rate and the worsening of AR require careful re-examination of our procedures.

Bicuspid aortic valve repair creates a non-physiologic valve form. The line of coaptation of the bicuspid valve does not form an arch, but is straight and the reconstructed bicuspid valve does not form a true tricuspid valve. Subcommissural annuloplasty increases the coaptation tension and helps prevent reflux, but restricts the size of the valvular opening and increases the risk of stenosis. Furthermore, considering that the line of coaptation is supported at only two points along the commissure, the reconstruction must take into account tissue durability at the line of coaptation and the area of plication. It is evident that reconstructive procedures for tricuspid AR are fundamentally different from those for bicuspid AR.

Two patients developed aortic stenosis after valvuloplasty. We think there are at least two causes. One is overly aggressive subcommissural annuloplasty to connect the cusp, another is, in the systolic phase, the leaflet that was repaired by a few interrupted stitches may have restricted motion and this could cause the reduced opening area. In both patients, the extent of stenosis as determined intra-operatively depended on systemic hemodynamics. The cardiac indices were 4.6 and 4.0 $1/min/m^2$, which reflect a hyperdynamic state. However, the interpretation of these data depended on the surgeon. In this series, there were no criteria for determining the extent of stenosis after repair. However, the data showed that the pressure gradient tended to have improved by the time of discharge and the patients were asymptomatic. No patient who required re-operation developed aortic stenosis during follow-up.

Two patients required re-operation for complications related to dehiscence of the repair. This class of problems has been discussed by Fraser and Cosgrove (2001). We have reported several modifications of techniques for aortic valve repair.

Compared with annuloplasty using a pledget, this technique does a better job of reinforcing the commissure and reducing tension in this area through the use of Gore-tex material (Izumoto *et al*., 1995). The philosophy underlying this approach is that extra care must be taken to protect tissue damaged by previous surgery.

Izumoto *et al*. (1995) found that only slight or no calcification occurs in 96% of cases of bicuspid aortic insufficiency. However, it is widely accepted that a bicuspid aortic valve develops severe stenosis with shortened, hypertrophic and calcified cusps, with aging. It is also believed that aortic stenosis progresses rapidly once the cusps become calcified. In addition, a bicuspid aortic valve is often associated with other aortic pathology, such as dilatation, coarctation, cystic medial necrosis and dissection. The present series did not document a similar progression of cusp calcification.

There may be some limitations in this study. One of the most important limitations is the fact that this is a single institutional study of a relatively small number of patients.

Our experience suggests that treatment must be individualized to obtain maximum benefit. We believe our data argues aortic valve repair should continue to be a viable option for aortic valve repair in selected cases.

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