The Konno aortoventriculoplasty for repeat aortic valve replacement

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Abstract

Objective: To evaluate the outcome of aortic root augmentation by the Konno-aortoventriculoplasty technique as part of reoperative aortic valve replacement.

Methods: Since 1983, 15 patients, 12 males and three females, had repeat aortic valve replacement (AVR) with concomitant Konno aortoventriculoplasty. Age ranged from 1.2 to 18 years (mean 12.5 years). The underlying anatomic diagnoses were valve and subvalvar aortic stenosis in 11, truncal valve insufficiency in one, endocarditis in one, Shone’s complex in one and severe aortic insufficiency associated with a ventricular septal defect in one patient. All patients had had previous AVR. The causes for reoperation were prosthetic valve stenosis due to growth in ten and paravalvular leak in one, homograft failure in two, xenograft failure in one, and left ventricular outflow tract obstruction (LVOTO) after mitral valve replacement in one patient. The mean size of explanted prostheses was 19.2 mm (13–23 mm) while the mean size of the implanted prostheses was 24.3 mm (19–27 mm) (P < 0.01). Previous aortic root enlargement had been performed in 11 patients in conjunction with AVR. The Manougian technique was used previously in two, Konno aortoventriculoplasty in eight, and both techniques in one patient. The newly implanted aortic valves were a homograft in one patient and mechanical prostheses in 14 patients.

Results: There was one operative death (1 of 15 or 6.6%) in a 17.5 year old patient with previous AVR and posterior root enlargement, due to low cardiac output state. Follow-up ranged from 6 months to 17 years (mean 7.2 years). The only late death occurred in an 11.6-year-old patient due to prosthetic valve endocarditis. Two patients had complete heart block and had permanent pacemaker insertion (2 of 15 or 13.3%). One patient had pulmonary valve replacement because of combined stenosis and insufficiency 5 years after operation. All 13-surviving patients are asymptomatic at latest follow up. Conclusion: Konno aortoventriculoplasty with repeat AVR may be safely performed. Excellent results may be achieved despite previous aortic root enlargement. It is a good surgical option for complex LVOTO and may even reduce reoperation in children by allowing placement of a larger prosthesis.

Keywords: Konno; Aortoventriculoplasty; Aortic valve replacement; Reoperation

1. Introduction

Complex multilevel left ventricular outflow tract obstruction (LVOTO) in infants may be treated initially by focusing on the main level of obstruction using a combination of subvalvar muscle resection, balloon or open valvotomy. This approach may achieve temporary palliation before reintervention is needed. More definitive surgical therapy is likely to include aortic valve replacement (AVR) with or without aortic root enlargement. In very young patients, repeat AVR will become necessary at some point following prosthetic AVR.

Until recently, before the pulmonary autograft has emerged as a popular technique for AVR in children and young adults, mechanical, bioprosthetic and homograft valves were the only substitutes available for AVR. The sizing limitation of these valve substitutes, in the presence of small aortic roots, has often necessitated annular root enlargement to accommodate an adequate size valve substitute. Even with enlarging the native aortic annulus, the somatic growth of these children has led to a high incidence of reoperation for repeat aortic valve replacement mainly because of valve outgrowth. In order to successfully insert a larger prosthetic valve, a second annular enlargement is often needed. In this report we present our experience with the use of the anterior root enlargement technique (Konno aortoventriculoplasty) in conjunction with repeat aortic valve replacement (AVR) for children.

2. Patients and methods

Between January 1983 and December 1999, 15 patients, 12 males and three females, had repeat aortic valve replace-
ment (AVR) with anterior root enlargement (Konno aortoventriculoplasty). During that time period a total of 72 Konno aortoventriculoplasties were performed at our institution. Patient data were analyzed retrospectively from hospital records and our cardiac database. Data included preoperative diagnosis, investigations, operative reports, postoperative course and follow-up.

Patient age at reoperation ranged from 1.2 to 18 years (mean 12.5 years) and weight ranged from 8.7 to 89 kg (mean 52.9 kg). The underlying anatomic diagnoses were congenital aortic stenosis in 11 patients, truncal valve insufficiency in one, bicuspid aortic valve endocarditis in one, Shone’s complex with mitral stenosis, LVOTO, bicuspid aortic valve and coarctation of aorta in one, and severe aortic insufficiency associated with a ventricular septal defect in one patient. All patients had prior AVR. Previous interventions are summarized in Table 1.

Previous aortic root enlargement had been performed in 11 of 15 patients, or 73%, in conjunction with first time AVR. The posterior root technique was used previously in two patients, anterior root enlargement extending into the ventricular septum (Konno aortoventriculoplasty) in eight patients, and both techniques in one patient (9 of 15, or 60% of the patients had previous Konno aortic annular enlargement).

The indications for reoperation were prosthetic valve stenosis due to growth in ten patients, paravalvular leak in one, homograft failure in two, xenograft failure in one and left ventricular outflow tract obstruction associated with Shone’s complex after mitral valve replacement in one patient.

Concomitant surgical procedures included ascending aorta replacement with a Dacron graft in three patients, ascending aorta enlargement with a bovine pericardial patch in two patients. One patient previously operated for persistent truncus arteriosus had his right ventricle to pulmonary artery conduit replaced. One patient had a left ventricular aneurysm plicated.

The mean size of explanted prostheses was 19.2 mm (13–23 mm) while the mean size of the implanted prostheses was 24.3 mm (19–27 mm) (P < 0.01) (Fig. 1). The newly implanted aortic valve substitutes were a homograft in one patient and mechanical prostheses in 14 patients. The homograft replaced a previous mechanical valve with paravalvular leak that developed late after AVR and was suspected to involve endocarditis. The time interval between the first AVR and reoperation ranged from 11 months to 13.3 years (mean 7.5 years).

Operative technique included standard cardiopulmonary bypass with bicaval cannulation, moderate hypothermia and multidose antegrade blood cardioplegia. A vertical aortotomy was made and after explanting the old valve substitute, excessive fibrotic tissue was debrided. To relieve subvalvar obstruction and to implant a larger new prosthesis, an incision was made in the right ventricular outflow tract, followed by an incision across the aortic annulus into the ventricular septum to the left of the right coronary artery ostium, as described by Konno et al. [1]. In-patients, who had had a previous Konno procedure, the ventricular septal incision is taken across the previously placed septal patch. A Dacron patch was then used to enlarge the subvalve area and the aortic annulus. The appropriate valve sizers were used to measure the enlarged annulus. The new valve prosthesis was generally secured in place using pledged horizontal mattress sutures. After valve insertion the Dacron patch was used to close the aortotomy with or without additional enlargement of the ascending aorta. Typically, the incision in the right ventricular outflow tract was enlarged with a patch of autologous or bovine pericardium.

### Table 1

<table>
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<tr>
<th>Previous interventions</th>
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<tr>
<td>Open aortic valvotomy</td>
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<td>AVR</td>
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<td>VSD closure and aortic valve suspension</td>
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<td>Persistent truncus arteriosus</td>
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<td>Coarctation repair and MVR</td>
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<td>Mean number for patients</td>
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* AVR, aortic valve replacement; VSD, ventricular septal defect; MVR, mitral valve replacement.

### 3. Results

There was one operative death (1 of 15 or 6.6%) due to low cardiac output and failure to wean from cardiopulmonary bypass. This 17.5-year-old patient had three previous operations: open aortic valvotomy at the age of 6 weeks, AVR with a Bjork Shiley 19 mm prosthesis and posterior root enlargement at 6.5 years, repeat AVR with a Bjork Shiley 23 mm prosthesis and a Konno aortoventriculoplasty at the age of 8 years. The indication for the patients last operation was paravalvular leak.

Two patients had bleeding complications and needed re-exploration. Two patients developed complete heart block.
and had permanent pacemaker insertion. Both patients did not have previous root enlargement.

Follow-up ranged from 6 months to 17 years (mean 7.2 years). The only late death occurred in an 11.6-year-old patient due to prosthetic valve endocarditis nine months after his operation. One patient had pulmonary valve replacement because of combined pulmonary stenosis and insufficiency 5 years following repeat AVR with Konno aortoventriculoplasty. All 13-surviving patients are in New York Heart Association Functional Class 1 as of their latest follow up, none of the patients had any significant LVOT gradient (>20 mmHg).

4. Discussion

Complex multilevel aortic stenosis, usually with a small aortic valve annulus, is the leading indication for aortic valve replacement in children [2,3]. For many years prosthetic valves were the commonly used valve substitute for AVR in children. Although they tend to work well in the immediate term, the potential exists for a number of complications over the long term. Life threatening complications include prosthetic valve endocarditis (which was the cause of the one late death in our report), thromboembolism and bleeding secondary to chronic anticoagulation [4]. Bioprosthetic valves do not require anticoagulation and their hemodynamic performance may be better than mechanical valves. Yet, they degenerate rapidly in children, especially on the left side of the heart [5,6].

When AVR is indicated in young children, the bulky nature of the mechanical prosthetic valves, the limited available sizes, and the reduced hemodynamic performance of smaller sized valves [7] in conjunction with complex multilevel LVOTO often lead to an extensive procedure, including enlargement of the aortic root in addition to AVR. Various methods to achieve this enlargement have been described [1,8,9] and two of them were performed in the majority (11/15) of our patients during their first AVR operation. The successful use of the anterior aortoventriculoplasty with mechanical AVR as described by Konno et al. [1] has been well documented in children and young adults [10,11]. When biologic valves were used the advantage of root enlargement allowing insertion of a larger valve was often negated by early valve failure [6,10].

During their initial AVR, the Konno aortoventriculoplasty was used most frequently in our patients as it achieves optimal enlargement of the left ventricular outflow tract, opening the diffuse subvalve muscular obstruction and enlarging the small valve annulus. Of the three patients who had a posterior root enlargement into the anterior leaflet of the mitral valve [8], one needed immediate addition of the Konno aortoventriculoplasty in order to relieve the outflow tract obstruction. The other two achieved the smallest increase in valve size (1–2) as opposed to the rest of the patient with the Konno type enlargement, during this initial AVR.

In this group of patients the main indication for repeat AVR was outgrowth of the previously implanted valve. In some of these patients, after valve explant and debridment of the fibrous pannus deposited around the annulus, it was still difficult to insert a larger size prosthesis. This difficulty led to the addition of the Konno procedure, and in some cases, a repeat Konno procedure. In the patients who had previously had aortic root augmentation, it was demonstrated that repeat enlargement through the previous patch allows insertion of a larger prosthesis.

The major morbidity after the Konno aortic root enlargement is complete heart block. The incidence of pacemaker insertion following the prosthetic valve/Konno procedure has been from 6 to 12.5% [10,11]. In the present study two out of the 15 patients had complete heart block necessitating pacemaker insertion (13.3%). None of them from the repeat Konno group of patients.

We found two earlier reports about reoperation after previous combined AVR and Konno aortoventriculoplasty. The first, an earlier experience from our institution, described four patients who had bioprosthetic valve degeneration. One patient had successful enlargement of the previous patch in addition to repeat AVR [6]. The second paper reports conversion from mechanical valve to aortic allograft after previous AVR/Konno procedure, prompted by failure of anticoagulation treatment [12]. We have used mechanical valves in almost all our reoperations to avoid early valve degeneration, particularly in view of the low anticoagulation complications these patients had experienced.

In recent years the pulmonary autograft has begun to emerge as the best available valve substitute for AVR, particularly in younger children. It has demonstrated low thrombogenicity, low risk for infection, excellent hemodynamic performance and even growth potential with long term durability [13–15]. This experience has been expanded to the use of the pulmonary autograft combined with the anterior aortoventriculoplasty (Ross/Konno procedure) with good results [16,17]. We have not found any reports using the Ross/Konno procedure for repeat AVR with or without a previous Konno procedure. It may be technically challenging to dissect out the pulmonary valve in these patients, but with increasing experience this will become another option for young patients who previously had prosthetic AVR.

The fact that the Konno procedure allows insertion of a larger prosthesis may reduce the need for repeat reoperations and this advantage may be more significant, with our younger patients. This report suggests that we should have a low threshold to apply the Konno aortoventriculoplasty when inserting a mechanical prosthesis in AVR. Having a previous left ventricular outflow tract enlargement using this technique in no way preclude its repeat use in the future. Our results indicate that the Konno aortoventriculoplasty can be used safely in repeat AVR, even if the patient had previously undergone an AVR/Konno procedure. This can be achieved with low operative mortality and good long-term outcome.
We hope that this experience will also serve as a standard against which the long-term results of the Ross/Konno approach may be compared.

References


