Results of left atrioventricular valve reconstruction after previous correction of atrioventricular septal defects

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Abstract

Objective: The objective of this study was to determine causes of severe left atrioventricular (AV) incompetence and the factors leading to the success of valve repair later after correction of atrioventricular septal defects (AVSD). Methods: A total of 28 patients aged 5 months to 38 years (mean age 6.7 years) were operated for significant (grade II–III) left AV valve incompetence (LAVVI), two months to twenty-five years (median 1.5 years) after correction of complete (11 patients) or partial atrioventricular septal defects. Fourteen patients had initially undergone surgery during infancy. Results: At reoperation a completely open or partially sutured cleft was found in 16 patients combined with dysplastic valve tissue in four cases, with a fibrotic valve in three cases, with posterior leaflet prolapse in two cases, with a double orifice valve in three cases, and a parachute valve in two cases. Partial or complete reopening of a previously sutured cleft caused by suture dehiscence was found in 12 cases combined with a fibrotic valve in five cases, with a dysplastic valve in one case and with severe deformity of valve in one case. A combination of these anomalies was observed in seven patients in both groups. Left atrioventricular valve repair including cleft closure combined with annuloplasty and other surgical procedures resulted in the disappearance or significant diminishing of LAVI in 18 patients (64%). Severe SAVI persisted in six patients, five of them exhibiting a combination of several additional left AV valve anomalies (fibrotic or dysplastic valve, parachute valve). Five of these six patients underwent successful left AV valve replacement with a mechanical prosthesis 7 days to 2 years after reoperation. The presence of additional left AV valve anomalies was the single statistically significant factor for recurrent major LAVVI after reoperation ($P = 0.0106$). There were two postoperative deaths in patients with mild LAVVI after surgery, and no late deaths. Conclusion: An open cleft is the major factor of late severe SAVVI after correction of AVSD. Although suturing the cleft in conjunction with performing annuloplasty improved valvular function in most of the cases, the presence of severe left AV valve anomalies increased the risk of recurrent LAVVI and the need for valve replacement, thus playing a major role in determining the outcome of valve reconstruction in patients after reoperation. © 1997 Elsevier Science B.V.

Keywords: Atrioventricular septal defects; Valve incompetence; Reoperations

1. Introduction

Despite many modifications in surgical technique and a flexible approach to atrioventricular (AV) valve repair, left AV valve incompetence remains a major factor of postoperative mortality and morbidity and is the most frequent indication for reoperation after correction of atrioventricular septal defects [1,2,6,9,12,16,22,23].
The objective of this study was to identify the causes of significant left AV valve incompetence and the factors which determine the success of valve repair late after correction of atrioventricular septal defects (AVSD).

2. Patients and methods

This study included 28 consecutive patients reoperated for significant left AV valve incompetence after correction of AVSD. The age at presentation ranged from 5 months to 38 years (median age 4.7 years). Complete atrioventricular septal defects (CAVSD) had been previously corrected in 11 patients and partial atrioventricular septal defects (PAVSD) in the remaining 17 patients. A total of eight patients had Down’s syndrome.

Ten patients had undergone initial surgery at other institutions (three with CAVSD/seven with PAVSD). Fourteen patients were infants at the time of the initial operation (six with CAVSD/eight with PAVSD). The septal commissure (cleft) had been completely closed (sutured) during initial surgery in 12 patients, partially sutured in nine patients, and left open in seven patients.

Echocardiographic and angiographic examinations were performed on all patients to determine the severity of left AV valve incompetence which was then graded as 0 (absent or insignificant), I (mild), II (moderate), and III (severe) depending upon the degree of opacification of the left atrium with contrast media and observation under a color Doppler signal [10].

Seven patients exhibited moderate left AV valve incompetence preoperatively; in the remaining 21 patients it was severe (Fig. 1). Left AV valve stenosis with a pressure gradient of 7, 9, 16 and 17 mm was observed in four patients. The goal of reoperation was to treat significant left AV incompetence before symptomatic deterioration began in an attempt to minimize progressive myocardial damage, and thus, prevent premature death [23].

The interval between initial surgery and reoperation ranged from 2 months to 25 years (median 1.5 years). Five patients had to be reoperated a second time 7 days–10 months after the first reoperation.

3. Intraoperative findings

Several causes of left AV valve incompetence were identified during reoperation (Table 1). Among 16 patients with initially unsutured or partially sutured septal commissure (cleft) there were no additional left AV valve anomalies only in seven cases. A total of 14 additional valve anomalies were found in the other nine patients of this group (dysplastic valve tissue in four cases, fibrotic deformities of the valve in three cases, double orificed valve in three cases, parachute valve in two cases and posterior leaflet prolapse in two cases). A combination of these valve anomalies was observed in five of nine patients. Persistent severe valve incompetence after reoperation led to subsequent AV valve replacement in four of these five patients. Cleft suture dehiscence was found in five of nine patients with partially sutured cleft during initial operation.

The partial or complete reopening of a previously sutured cleft because of suture dehiscence was found in 12 patients. Seven additional valve anomalies were found in five patients of this group (dysplastic valve tissue in one case, fibrotic deformities of the valve in five cases). Severe deformity of the valve was noted in
Table 2
Methods and results of left AV valve reconstruction

<table>
<thead>
<tr>
<th>Methods</th>
<th>N</th>
<th>Left AV valve incompetence after reoperation (grade)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Isolated 'cleft' suture</td>
<td>16/1</td>
<td>9</td>
</tr>
<tr>
<td>'Cleft' suture, annuloplasty</td>
<td>4/1</td>
<td>2</td>
</tr>
<tr>
<td>'Cleft' suture, papillary muscle splitting</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>'Cleft' suture, posterior leaflet reduction plasty</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>'Cleft' suture, septal leaflet refixation</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>'Cleft' suture, septal leaflet refixation, annuloplasty</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Septal leaflet refixation, annuloplasty</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Cleft suture, annuloplasty; annuloplasty suture removal</td>
<td>1</td>
<td>13</td>
</tr>
<tr>
<td>Total</td>
<td>28/2</td>
<td></td>
</tr>
</tbody>
</table>

( ), numbers in parenthesis indicate deceased patients. N, number of patients/deaths.
*Subsequent left AV valve replacement performed.

one patient, in whom an ostium primum had been closed directly during initial operation. In this patient, valve replacement with mechanical prosthesis had to be performed early after reoperation.

Sixteen patients of both groups showed complete or partial cleft suture dehiscence, which was combined with partial suture dehiscence between septal leaflet and AV patch in two cases. Isolated suture dehiscence between septal leaflet and AV patch was observed in one additional patient. Ten of 17 patients (59%) with suture dehiscence had undergone initial surgery during infancy.

4. Surgical methods

All reoperations were performed using conventional cardiopulmonary bypass, moderate hypothermia, and antegrade crystalloid cardioplegia. The left AV valve was approached through the right atrium with an atrial septal patch incision, or in cases involving isolated left AV valve incompetence and a large atrium, through the left atrial wall.

Several methods of left AV valve repair were used (Table 2). Every effort was made to preserve valve tissue. Cleft closure with interrupted sutures was performed in 27 patients. Additional annuloplasty was performed in six patients (Kay-Wooer in five patients, comissural in one patient). Annuloplasty sutures had to be removed in one patient, who developed severe left ventricular posterior wall ischemia. Leaflet reduction plasty was performed in two patients with posterior leaflet prolaps. Single papillary muscle splitting and fenestration of interchordal spaces were performed in addition to partial cleft closure in two patients with parachute valve and significant valve stenosis (pressure gradient 16 and 17 mmHg), thus reducing both stenosis and valve incompetence. Partial cleft closure did not eliminate valve incompetence in two other patients with moderate stenosis (pressure gradient 7 and 9 mmHg) resulting in subsequent valve replacement with mechanical prosthesis. Septal leaflet refixation to AV patch was performed in three patients with dehiscence between septal leaflet and AV patch.

Other surgical procedures which were performed concomitantly included direct suture closure of a small ventricular septal defect in four patients, removal of fibrotic subaortic stenoses in two patients, and patch closure of a perforation in the bicuspid aortic valve and ligation of a small patent ductus arteriosus in one patient.

In every case left AV valve repair was evaluated immediately after bypass and during the postoperative period by means of transesophageal and transthoracic echocardiography.

5. Follow-up

Follow-up was possible in all 26 surviving patients. The mean period of follow-up after reoperation was 1.8 years (range: 1 month– 5.1 years). All patients were examined in the outpatient clinic at our institution.

6. Statistical analysis

The computer program Statgraphics (version 2.01, Statistical Graphics, USA) was used for statistical analysis. Twenty-two variables (six preoperative factors, ten intraoperative findings and six surgical methods) were analyzed using Mann-Whitney test for continuous variables and Fisher’s exact test for binary variables to determine risk factors for the recurrence of left AV incompetence after reoperation and for the necessity of valve replacement. The difference was considered significant when P value was 0.05 or smaller.
The following variables were analysed to determine their influence on left AV valve competence after reoperation: anamnestic data: age at first operation, age at reoperation, time interval between operations, type of AVSD, presence of Down’s syndrome, complete cleft closure at initial operation. Intraoperative findings at reoperation: subaortic stenosis, presence of suture or leaflet dehiscence, left AV valve anomalies: fibrotic deformity of valve tissue, dysplastic deformity of valve tissue, double orifice, parachute valve, posterior leaflet prolapse, presence of any left AV valve anomalies, presence of combined left AV valve anomalies. Combined left AV valve anomalies were defined as coexistence of at least two of the above listed AV valve anomalies in one patient. Surgical techniques at reoperation: cleft closure, annuloplasty, septal leaflet refixation, splitting of papillary muscle, resection of subaortic stenosis, closure of residual ventricular septal defect.

7. Results

7.1. Early deaths

Two of the 28 patients died (7.1%). A 3.5 year old child died of myocardial failure and severe arrhythmia 1 day after surgery and an 8 month old infant with systemic pulmonary arterial pressure died 3 days after surgery from low cardiac output. Both had exhibited mild left AV valve incompetence postoperatively.

7.2. Late deaths

There were no late deaths. All 26 of the surviving patients are still alive 3 months–5.1 years after surgery.

7.3. Valve incompetence

Valve incompetence was either absent or mild in 18 patients (64%) after left AV valve repair had been performed. It was moderate in four patients and severe in six others (Fig. 1). Eighteen valve anomalies were observed in 11 of 15 patients with residual left AV valve incompetence after reoperation. This compared to only three such anomalies being observed in the 13 patients who exhibited no valve incompetence ($P = 0.011$) (Table 1).

Five of six patients with persistent severe left AV valve incompetence underwent successful valve replacement with mechanical prosthesis 7 days, 9 days, 1 month, 8 months, and 2 years after the first reoperation, respectively. A combination of severe valve anomalies precluded adequate reconstruction in all of them.

The presence of left AV valve anomalies was a statistically significant risk factor for recurrent AV valve incompetence after reoperation ($P = 0.0106$). The combination of AV valve anomalies was observed in eight patients. It was also considered a risk factor for recurrent AV valve incompetence ($P = 0.0054$). In five of these eight patients subsequent left AV valve replacement with mechanical prosthesis due to severe valve incompetence was necessary. One patient with severe and two with moderate left AV valve incompetence are scheduled for reoperation.

No valve replacement was necessary in patients without ($n = 14$) and patients with single ($n = 6$) left AV valve anomalies. Only one patient of this group is scheduled for reoperation.

No other variables analysed, including presence of Down’s syndrome, were found to be statistically significant risk factors for recurrent left AV valve incompetence after reoperation. Suture dehiscence ($P = 0.0554$) and fibrotic valve deformity ($P = 0.059$) only near missed statistical significance, all other $P$ values were far from significant levels ($0.1169–0.5555$).

8. Discussion

Despite the use of flexible, individualized approaches to left AV valve repair, residual valve incompetence remains a significant factor of postoperative mortality and morbidity and is virtually the only indication for reoperations late after repair of AVSD [1,2,6,9,10,12,16,19]. The incidence of severe preoperative left AV valve incompetence in patients with AVSD is rare [5,7,10,16,25]. However, in some series a higher incidence of preoperative left AV valve incompetence was noted in patients with PAVSD, compared to patients with complete AVSD [1,10,22]. This phenomenon can partially be explained by the fact that a higher incidence of additional left AV valve morphology is observed in patients with PAVSD rather than in patients with CAVSD [1,9].

Although some authors found the degree of preoperative left AV valve incompetence to be the most significant factor for the development of late valve incompetence [1,14,22], others found this not to be the case [5,7,16,25].

Usually mild valve incompetence, which develops immediately after initial surgery, is stable and does not worsen with time [11,14,20,21,25]. Han et al. [10] found that the overall increase of valve incompetence in patients after correction for PAVSD correlated to an increase in mild regurgitation, a tendency towards decrease in moderate regurgitation, and no change in severe regurgitation. Contrarily, regurgitation usually remained mild in patients after correction of CAVSD.

The reported incidence of reoperations for significant left AV valve incompetence after correction of various
types of AVSD, ranges between 10 and 20%. Also it seems to be higher in patients with an initially unsutured cleft [14,16,19,20] (Table 2).

Although some surgeons prefer to leave the cleft unsutured, it has been found that leaving the cleft unsutured leads to unfortunate clinical results leading to significant postoperative left AV valve incompetence [2,19,20,22,24,25].

Dehiscence of cleft or leaflet sutures observed in 17 patients can be explained by the extreme tension on the suture line, especially in patients with fragile valvular tissue. Anomalies of the papillary muscles can contribute to this complication [1]. Ten of 17 patients with suture dehiscence were operated in infancy. A more secure technique of cleft closure in small infants and in patients with fragile valvular tissue is necessary; cleft sutures reinforced with pericardial pledgets should be considered in such cases [2].

At our institution the cleft is usually closed during correction of AVSD [4]. To date the reoperation rate for significant left AV valve incompetence was 9.7% (19 of 195 survivors).

Valve replacement was not necessary during initial surgery in our series of 195 cases of AVSD. The incidence of late left AV valve replacement was 0.8% for CAVSD and 1.4% for PAVSD.

In all cases except one in this series the cleft was found to be open. Subsequent cleft suturing combined with additional procedures eliminated or significantly reduced left AV valve incompetence in only 18 cases (64%) (Table 1), thus indicating that residual valve incompetence was more complex in nature.

Besides an open cleft, several other factors contributing to the presence of late AV valve incompetence have been reported, such as isolated dilatation of the valvular ring, severe valve deformity, dysplastic AV valve with marked loss of leaflet tissue, and a double orifice left AV valve [1,2,10,13,14] (Table 2).

Although the presence of a double orifice valve had no apparent impact on the outcome of valve reconstruction in our series, the number of such patients was too small to make a definite conclusion. Our experience with total correction of CAVSD showed that cleft suture in patients with a competent double orifice valve was safe and precluded valvular stenosis and late incompetence [4].

Because of the wide range of anatomical variants of the atrioventricular valve in AVSD, valve reconstruction is a very delicate procedure [3,11]. There is no single or ideal operation for correcting residual left AV valve incompetence. Various surgical techniques have been suggested, among others, cleft or perforation suturing with or without different types of annuloplasty, triangular or quadrangular leaflet resection, chordal shortening, or resection of secondary chords, and plication of redundant leaflets [2,8,15,17,18], which reflects the complexity of the problem.

The most significant factor for residual left AV valve incompetence after reoperation in our patients seemed to be the presence of additional anomalies of the valve. This was supported by statistical analysis. Despite the fact that individual valve anomalies were not statistically significant for late valve incompetence, the combination of additional valve anomalies was noted in five out of six of the patients who exhibited persistent significant valve incompetence after reoperation. In one of them direct suture of the ostium primum during initial surgery led to severe valve deformity, as was also noted in another study [1]. Severe deformity and anomalies of the left AV valve preclude adequate valve reconstruction in these patients, thus leaving valve replacement, with its well-known drawbacks, especially for small children, as the only alternative [15].

In conclusion, left AV valve incompetence after correction of AVSD has a complex nature. A partially or completely open cleft or the reopening of a previously sutured cleft are the major, but not the only causes of late valve incompetence.

In most cases, suturing the cleft and subsequently performing annuloplasty improved valvular function, however, the presence of severe left AV valve anomalies increased the risk of recurrent valvular incompetence and the need for valve replacement. Thus, one can agree that these anomalies play a major role in determining the outcome of valve reconstruction in patients with AVSD [1].

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References


