Does Down syndrome affect the long-term results of complete atrioventricular septal defect when the defect is repaired during the first year of life?

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Abstract

Background: Down syndrome is known to affect the natural history of complete atrioventricular septal defect. We analyzed whether Down syndrome affect the long-term results of complete atrioventricular septal defect when the defect is repaired during the first year of life.

Methods: Repairs of complete atrioventricular septal defect were performed in 64 infants. Thirty-four infants were associated with Down syndrome, while the other 30 were non-Down patients.

Results: Complete follow-up rate was 95% with mean follow-up period of 99 G 47 months (maximum 169 months) in Down patients and 80 G 64 months (maximum 213 months) in non-Down patients. There was one operative death in each group (mortality rate of 2.9% in Down patients and 3.3% in non-Down patients), and three patients died at the late phase (one in Down patients and two in non-Down patients). Five patients underwent re-operation due to postoperative left atrioventricular valve regurgitation (one in Down patients and four in non-Down patients). Freedom from re-operation for left atrioventricular valve regurgitation and actuarial survival rate at 13 years were 96 G 4 and 94 G 4% in Down patients and 85 G 7 and 90 G 5% in non-Down patients (not significantly different).

Conclusions: Down syndrome does not affect the long-term results of complete atrioventricular septal defect when the defect is repaired during the first year of life.

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Keywords: Complete atrioventricular septal defect; Infant; Down syndrome; Congenital heart disease; Pulmonary vascular obstructive disease

1. Introduction

Congenital heart disease has an incidence between 33 and 48% in Down syndrome, and atrioventricular septal defect (AVSD) is the most common heart defect [1]. Early progression of obstructive pulmonary vascular disease has been recognized in patients with complete AVSD, especially when associated with Down syndrome [2–4]. There are still arguments about the impact of association of Down syndrome on the clinical outcomes of surgical repair of complete AVSD including the late mortality and morbidity [5–11].

Recently, many surgeons including us recommended early surgical correction of complete AVSD with satisfactory operative results [12–17]. In this study, we evaluated the impact of association of Down syndrome with complete AVSD on early and late results of surgical correction when complete AVSD was repaired during the first year of life.

2. Patients and methods

Sixty-four infants age less than 1 year underwent total correction of complete AVSD at Fukuoka Children’s Hospital between 1981 and 1999. Thirty-four infants were associated with Down syndrome, while 30 were non-Down. Patients combined with tetralogy of Fallot and those with unbalanced ventricle were excluded from this study. Age, gender and body weight at the time of operation was similar in both groups (Table 1). One Down patient and three non-Down patients underwent pulmonary artery banding prior to total correction in early era. Pulmonary-to-systemic pressure ratio and blood flow ratio before total correction were similar in both groups (Table 1). Pulmonary-to-systemic resistance ratio (Rp/Rs) was 0.40 ± 0.24 in Down patients and 0.31 ± 0.14 in non-Down patients. In detail, Rp/Rs was 0.33 ± 0.16 in Down patients below 6 months of age, 0.46 ± 0.28 in Down patients over 6 months of age, 0.29 ± 0.09 in non-Down patients below 6 months of age, and 0.33 ± 0.24 in non-Down patients over 6 months of age. Although Down patients tended to have higher Rp/Rs when compared that in non-Down patients, especially when...
follow-up rate of 95%. Mean follow-up period was 99 months (maximum 213 months) in non-Down patients, 94 months (maximum 169 months) in Down patients and 80 months (maximum 120 months) in non-Down patients. There were two operative deaths (one Down patient and one non-Down patient). There were three late deaths. One non-Down patient died at the time of re-operation for LAVV regurgitation 1 month after the initial correction, and the other non-Down patient died 4 months after repair due to respiratory failure. Actuarial survival rate at 13 years was 94±4% in Down patients and was 90±5% in non-Down patients (not significantly different) (Fig. 1).

Late phase echocardiography was available in all long-term survivors except for one (Figs. 2 and 3). In Down patients, two patients had moderate to severe postoperative LAVV regurgitation, and one patient required LAVV plasty combined with right atrioventricular valve plasty 88 months after the initial correction. Incomplete closure of the cleft was the cause of LAVV regurgitation in this patient. In non-Down patients, four patients had moderate to severe postoperative LAVV regurgitation. All of them required re-operation for LAVV regurgitation 1 month, 1 month, 12 months and 20 months after the initial correction (valve replacement in two and valve plasty in two) with one operative death. The cause of LAVV regurgitation was incomplete closure of the cleft in two patients and dysplastic valve in the other two patients. Freedom from re-operation for LAVV regurgitation at 13 years was 96±4% in Down patients and 85±7% in non-Down patients (P value = 0.079) (Fig. 4).

Right atrioventricular valve regurgitation remained clinically acceptable range except for one Down patient who required plasty of right atrioventricular valve as an additional procedure for plasty of LAVV.

At the last echocardiography, pulmonary pressure was able to be estimated by Doppler on tricuspid regurgitation in 50 patients (28 Down patients and 22 non-Down patients). The mean value of the pressure gradient between the right ventricle and the right atrium was 23.7±8.3 mmHg in Down patients and 20.1±6.1 mmHg in non-Down patients (Fig. 5). Its value was similar between Down patients and non-Down patients when the age of the patients was below 6 months, and was 24.8±9.8 mmHg in Down patients and 22.2±5.7 mmHg in non-Down patients. While there was significant difference between the two groups when the age

patients were over 6 months of age, there were no statistically significant differences between the groups. Down patients also tended to have more Rastelli type C morphology of the atrioventricular valve than non-Down patients did, albeit the difference was not significant.

All patients underwent surgery through median sternotomy using cardiopulmonary bypass with moderate hypothermia. Myocardial protection was achieved with cold crystalloid cardioplegic solution containing 5% albumin (modified Kyushu University solution) combined with topical cooling. Two patch techniques without division of atrioventricular valve were used to repair the defects [12]. In brief, single semilunar shaped velour patch was used to close ventricular septal defect. The commissure between superior and inferior bridging leaflet was closed partially or completely according to the size of left atrioventricular valve and inferior bridging leaflet was closed partially or completely according to the size of left atrioventricular valve

Statistical analysis was made using Stat View software (Abacus Concepts, Inc., Berkeley, CA, USA), an Apple/Macintosh-based computer program. P value ≤0.05 was considered statistically significant.

3. Results

There were two operative deaths (one Down patient and one non-Down patient). There were three late deaths. One Down patient died 3 months after repair due to aspiration.

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<th>Table 1 Patients’ characteristics</th>
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<td>Rastelli type C (%)</td>
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PAB, pulmonary artery banding; Pp, pulmonary arterial pressure; Ps, systemic arterial pressure; Rs, systemic arterial resistance; Rp, pulmonary arterial resistance; Qp, pulmonary blood flow; Qs, systemic blood flow.
of the patients was over 6 months ($P=0.04$), and was $23.0 \pm 6.7$ mmHg in Down patients and $17.0 \pm 5.7$ mmHg in non-Down patients. Pulmonary hypertension defined as a pressure gradient estimated by Doppler on tricuspid regurgitation over 40 mmHg was detected only in one Down patient who underwent correction at his age of 6 months. Early correction below age of 6 months had no significant impact on the late pulmonary hypertension in this study.

4. Discussion

Natural history of complete AVSD was reported to be very poor because of early progression of obstructive pulmonary vascular disease [18]. Recently, remarkable development of patients management including diagnosis, surgical techniques and postoperative cares have improved clinical results of correction of complete AVSD [13,19-24], and many surgeons including us recommended early surgical correction of complete AVSD to prevent irreversible progression of obstructive pulmonary vascular disease [12-17].

Down syndrome is well known to be associated with congenital heart disease with an incident rate between 33 and 48% [1]. Atrioventricular septal defect is the most common heart defects in Down syndrome. Clapp et al. [2] and Yamaki et al. [3] reported that obstructive pulmonary vascular disease could be recognized even in patients less than 1 year of age with complete AVSD, and that Down syndrome was a risk factor for rapid progression of obstructive pulmonary vascular disease. Morris et al. [7] reported that Down syndrome affected the operative results of complete AVSD, and presumed that early progression of obstructive pulmonary vascular disease in patients with Down syndrome might be one of the most important factors of its high perioperative mortality.
However, there are some arguments about the impact of Down syndrome on the early and late outcomes of surgical correction of complete AVSD. In 1994, di Carlo and Marino [9] reviewed the literatures concerning the surgical results of patients with AVSD in relation to a presence of Down syndrome. In their review, less favorable results in patients with Down syndrome were reported by Studer et al. [5], Pozzi et al. [6], and Morris et al. [7], while Rizzoli et al. [8] reported that Down syndrome was not an independent risk factor for operative mortality, and that patients with Down syndrome underwent fewer re-operations. Although Reller and Morris [10] reported higher perioperative mortality in complete AVSD with Down syndrome compared with that of without Down syndrome in 1998, many recent papers using multivariate analysis failed to indicate a presence of Down syndrome as a predictor for operative death [11,13,17,20-22,24]. Tweddel et al. [13] concluded that routine repair of complete AVSD during infancy in recent era resulted better clinical outcomes. Not only progressive obstructive pulmonary vascular disease but also progressive atrioventricular dilatation from volume overload with progressive atrioventricular valve annular dilatation may be avoided by correction of complete AVSD early in infancy. Because postoperative LAVV is still a predictor for early operative death, repair of complete AVSD in infancy might be beneficial not only for Down patients but also for non-Down patients.

Double-orifice LAVV is reported to be an important predictor for early operative death [11,19-21]. In our study, double-orifice LAVV was recognized in two Down patients and in one non-Down patient. We basically leave the accessory orifice in the LAVV intact. As we previously reported that double-orifice LAVV was a significant predictor for postoperative LAVV regurgitation in partial AVSD but not in complete AVSD [25], these three patients fortunately survived operation without further need of re-operation for LAVV regurgitation. Reller and Morris [10] reported higher overall late cardiac mortality in complete AVSD patients with Down syndrome. In the paper of Crawford and Stroud [24], survival at 15 years tended to be slightly better in those without Down syndrome, although this did not reach statistical significance. In our study, however, long-term survival in those with and without Down syndrome was similar. Looking for the previous study carefully, operative mortality in Down syndrome increased total mortality but it did not influence long-term survival. Because Down syndrome is not a risk factor for operative death in recent era, Down syndrome does not have an impact on the long-term survival of surgically corrected complete AVSD, at least when the defect is repaired during the first year of life.

Development of severe LAVV regurgitation is one of the main causes of re-operation in complete AVSD. Dysplastic LAVV is considered to be a predictor of postoperative LAVV regurgitation [11,22]. In our study, freedom from re-operation for LAVV regurgitation tended to be superior in Down syndrome compared with that in non-Down patients, and this result was compatible to those from others [8,11,14,17]. Because dysplasia of LAVV is more common in children with normal chromosomes [11], fewer re-operations might be required in Down syndrome.

This study is a retrospective, single center study and contains relatively small number of patients, so we cannot get a definitive conclusion. However, we believe that Down syndrome does not affect the long-term results of complete AVSD when the defect is repaired during the first year of life.

References


