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Surgical closure of atrial septal defects in adults: effect of age at operation on outcome

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Objective: To determine whether age has an effect on the long term outcome after surgical closure of atrial septal defects in patients aged 35 years and over.

Methods: Retrospective analysis of 89 patients (64 women) operated on between 1989 and 1999. Patients were divided into two age groups: group I (aged 35–50 years, n = 51) and group II (> 50 years, n = 38). Follow up was between 1–11 years.

Results: One operative death and two late deaths occurred in the study period (both in group II). Preoperatively, 29 (57%) patients were in New York Heart Association functional class III–IV in group I compared with 22 (58%) patients in group II (NS). After operation, 44 (86.2%) patients in group I were found to be in class I–II compared with 25 (71.5%, $p < 0.05$) in group II. Group I patients had a lower incidence of preoperative atrial fibrillation than those in group II (12 (23.5%) v 17 (43.6%), $p < 0.05$) and only four (7.8%) patients in group I were in atrial fibrillation requiring long term warfarin after surgery compared with 12 (34%, $p < 0.05$) in group II. Furthermore, echocardiography showed a greater reduction in right ventricular dimension in group I patients (mean (SD) 4.26 (0.82) v 2.71 (0.41) cm, $p < 0.001$) than in group II patients (4.36 (0.43) v 3.87 (0.29) cm, $p = 0.21$). No residual intracardiac shunts were identified during follow up.

Conclusions: Surgical closure of atrial septal defects in adult patients can improve clinical status and prevent right ventricular dilatation. The greatest benefit is seen in younger patients.

Isolated atrial septal defect (ASD) is the most common form of congenital heart disease presenting in adulthood after bicuspid aortic valve and mitral valve prolapse.^{1–3} Its true incidence remains undetermined, as it is often clinically silent. The progression of this congenital defect to congestive cardiac failure follows the onset of pulmonary hypertension, arrhythmias, respiratory infections, and other cardiovascular disease. Hence, the defect is usually discovered when a patient presents with dyspnoea or palpitations or occasionally on routine medical examination.

The optimal treatment for ASDs remains controversial. Traditionally, surgery was recommended even in middle aged and elderly patients with significant left to right shunts.^{4–6} However, more recently studies comparing surgical with medical management have shown comparable mid to long term outcomes.⁷

Several groups have shown the importance of age as a predictor of outcome in surgical patients. Murphy and colleagues⁸ found that patients younger than 25 years experienced normal life expectancy after closure of ASD, while survival was reduced significantly and successively in age groups 25–41 and > 41 years compared with control groups. It is likely that closure of ASD in adults should not be undertaken as a routine procedure but that treatment instead should be tailored to individual cases. We reviewed our retrospective experience of surgical closure of ASD and evaluated the effect of age on clinical and haemodynamic outcome.

METHODS

Patients

This study involved 89 patients operated on between 1989 and 1999. Eighty nine patients (64 women) underwent surgical repair of isolated secundum ASD. The age range was 35–72 years, mean (SD) 48.6 (7.8) years. The diagnosis was established by cardiac catheterisation and transthoracic cross sectional echocardiography in patients between 1989 and

1995 and from 1996 onwards in the remainder by transoesophageal echocardiography only. Coronary arteriography was performed on all patients over 50 years of age at presentation and in younger patients with any risk factors for ischaemic heart disease. No significant changes were observed in the coronary arteries of any of the patients.

All patients were followed up for 1–11 years (mean 4.7). Clinical and haemodynamic echocardiographic factors were assessed.

Surgical procedure

All operations were done using cardiopulmonary bypass and moderate total hypothermia of between 28–32°C. The chest was opened by a median sternotomy. After total cardiopulmonary bypass had been instituted, cold crystalloid cardioplegic solution (St Thomas' Hospital formula) was given antegradely through the root of the aorta. The method used to close the defect depended on its size and anatomical type. Twenty seven patients with an isolated ASD underwent direct suture closure. The remainder required patch closure with either single or double layers of Prolene 5–0 continuous suture. In addition to the primary ASD closure, seven patients underwent tricuspid annuloplasty for tricuspid regurgitation.

Statistical analysis

Differences before and after treatment for ASD were examined. The significance of the differences was calculated by the Wilcoxon test for the paired groupings. Data are expressed as mean (SD). Probability values of $p < 0.05$ were considered significant. Statistical analysis was performed using the SPSS software from SPSS Inc (Chicago, Illinois, USA).

RESULTS

Table 1 shows the clinical features of the 86 patients with complete follow up. There were 51 patients in the age group 35–50 years (group I, range 35–46) and 38 patients aged 51–72

Table 1 Clinical features of patients with complete follow up

	At presentation (n=89)		At last follow up (n=86)	
	Group I (35–50 years)	Group II (51–72 years)	Group I (35–50 years)	Group II (51–72 years)
Number	51	38	51	35
NYHA class (%)				
I	4 (8)	3 (7)	40 (78)*	15 (43)*
II	18 (35)	13 (34)	4 (8)*	10 (28.5)*
III–IV	29 (57)	22 (56)	7 (14)*	10 (28.5)*
Mean (range) PAP (mm Hg)	37.8 (21–49)	40.3 (26–51)	21.3 (12–38)*	35.9 (23–49)
In AF (%)	12 (23.5)	17 (44)*	4 (8)*	12 (34)
Taking diuretics (%)	13 (25.5)	10 (26.3)	11 (21.5)	16 (46)
Taking warfarin (%)	11 (21.5)	17 (44)*	4 (8)*	12 (34.2)

*p<0.05 versus corresponding group at presentation.

AF, atrial fibrillation; NYHA, New York Heart Association; PAP, pulmonary artery pressure.

Table 2 Basic cross sectional echocardiographic variables of the heart chambers and walls

Variable	Before operation (cm)		At last follow up (cm)	
	Group I	Group II	Group I	Group II
Aortic root diameter	2.37 (0.38)	2.72 (0.57)	2.53 (0.39)	2.64 (0.53)
Left atrial dimension	3.16 (0.73)	3.89 (0.29)	2.76 (0.58)	3.19 (0.66)
Right atrial dimension	6.29 (0.94)	6.34 (0.92)	4.92 (0.22)*	6.02 (0.55)
Right ventricular dimension	4.26 (0.82)	4.36 (0.43)	2.71 (0.41)*	3.87 (0.29)
Tricuspid annulus diameter	4.12 (0.13)	4.29 (0.21)	3.51 (0.19)*	4.02 (0.11)
Left ventricular end diastolic dimension	4.03 (0.37)	4.51 (0.44)	4.10 (0.62)	4.33 (0.71)
Left ventricular end systolic dimension	2.59 (0.23)	2.79 (0.36)	2.68 (0.54)	3.01 (0.49)

Values are mean (SD). *p<0.05 versus before operation in corresponding group.

(group II, range 54–72). There was one early postoperative death and two patients died during follow up. The early postoperative death was caused by ischaemic stroke at the time of the procedure and the patient died on day 3. The two late deaths were the result of renal failure and bronchopneumonia. All three patients were in group II.

The preoperative clinical status was identical in the two groups. Postoperatively, overall 48 patients (54%) improved from New York Heart Association (NYHA) functional class III–IV to class I, with 36 (70.6%) belonging to group I and 12 to group II. Only six patients were completely asymptomatic, all in group I.

Group I patients had a lower incidence of preoperative atrial fibrillation than group II (12 (23.5%) v 17 (44.7%), $p < 0.05$) and only four patients in group I (7.8%) were in atrial fibrillation requiring long term warfarin after surgery compared with 12 (34%, $p < 0.05$) in group II.

The mean (range) pulmonary artery pressure before operation was 37.8 (21–49) mm Hg in group I and 40.3 (26–51) mm Hg in group II (NS). At the last follow up, mean pulmonary pressure was significantly reduced in group I patients compared with group II patients (21.3 v 35.9 mm Hg, $p < 0.05$).

Cross sectional echocardiography showed no differences in left and right heart chamber dimensions in either groups before operation. Table 2 summarises values of cardiac indices.

After operation, patients in group I had significantly reduced right atrial and right ventricular dimensions compared with patients in group II. The right atrial wall size had decreased from 6.29 (0.94) cm before to 4.92 (0.22) cm after surgical repair ($p < 0.05$). However, in group II the reduction was much less dramatic (from 6.34 (0.92) cm to 6.02 (0.55) cm, NS). This was also reflected in right ventricular wall size; in group I there was a mean 36.4% reduction (from 4.26 (0.82) cm to 2.71 (0.41) cm, $p < 0.05$) compared with an 11.2% decrease in group II (from 4.36 (0.43) cm to 3.87 (0.29) cm, NS).

Interestingly, tricuspid valve annulus size was also significantly reduced in group I patients after surgical correction of their ASD (from 4.12 (0.13) cm to 3.51 (0.19) cm, $p < 0.05$). This was not the case in group II patients following their ASD closure (from 4.29 (0.21) cm to 4.02 (0.11) cm, NS). The seven patients who underwent additional tricuspid valve repair were in group II. Postoperatively, all had only mild insufficiency, with a mean right atrial size of 6.42 (0.59) cm, right ventricular size of 4.41 (0.59) cm, and tricuspid valve annulus size of 4.53 (0.67) cm at follow up.

No residual intracardiac shunt was identified on echocardiographic follow up.

DISCUSSION

ASDs are relatively common. They account for 10% of all cardiac malformations in childhood.⁹ If left uncorrected, they may lead to premature death from congestive cardiac failure.^{9–10}

Surgical management of these defects became a clinical reality in the 1940s. Indeed the initial experience with extracorporeal circulation was closure of these defects.¹¹ Despite more than 50 years' experience with surgical correction of ASDs there are still unresolved issues. Of concern is the decision to operate on patients in their fifth decade and beyond.

Children with ASDs usually either are asymptomatic or suffer only mild exertional dyspnoea.¹² The resultant increased pulmonary blood flow, right heart overload, arrhythmias, and pulmonary hypertension tend to increase with age.^{10–13} It is, however, generally accepted that life expectancy is shortened.^{10–13–14} Campbell¹⁰ estimated that 25% of all patients with unrepaired ASDs are dead by 27 years, 50% by 37 years, and 90% by 60 years. Traditional teaching is to close these defects in children before they reach school age where the pulmonary to systemic flow ratio exceeds 1.5:1.¹⁵

However, patients are often asymptomatic in childhood and there are reports of patients tolerating their defects beyond

their seventh and eighth decades.^{16 17} Long term follow up after surgical closure suggests that survival is comparable with that of age matched controls if surgery is performed in the first two decades of life or before the onset of pulmonary hypertension.⁸ Results for patients operated on in their third and fourth decades were significantly worse than for controls. Other groups have similarly suggested favourable mid to long term survival with a significant difference in survival in the presence of pulmonary hypertension (systolic pulmonary artery pressure > 30 mm Hg).¹⁸

Comparisons of surgical closure with medical management, particularly when symptoms have developed, have suggested a significant survival benefit in the surgically treated groups, provided that patients are operated on during their second and third decades of life.^{6 19}

The present study compared 51 patients aged 35–50 and 38 patients aged 51–72. Overall, the mortality was 3.3%, all deaths occurring in the older age group. Our results suggest that surgical closure of ASDs provides good improvement in symptoms, with 48 patients (54%) improving from NYHA class III–IV to class I.

The incidence of atrial fibrillation was not surprisingly higher in the older age group.^{8 13} Atrial fibrillation was decreased after closure of the defect but this was also more pronounced in the younger patients (group I). The benefit of reducing right sided overload was also detected in the notable reduction in volume following surgery in the younger patients. Group II patients also had reduced atrial fibrillation and right sided dimensions similarly accompanied by a reduction in pulmonary artery pressure. The reasons why the older patients had a less pronounced reduction in arrhythmias and cardiac dimensions are not clear and warrant further investigation.

Others have suggested that increases in pulmonary artery pressure are not necessarily related to age and shunt size is not related to severity of symptoms.^{14 20} With our results we find a trend to more pathophysiological deterioration in the older patients. The improvement in symptoms and dimensions mirrors this. The suggestion is that surgery should indeed be performed in the younger patient and probably before structural changes in the myocardium or pulmonary vasculature have occurred.

Surgical repair remains the standard for closure of secundum ASD, although more recently satisfactory results have been reported for transcatheter occlusion of these defects with a number of these devices.^{21 22} However, in adults, there is very little evidence to support the benefits of transcatheter closure over surgery. Cowley and colleagues²³ reported on a series of 45 patients with an average age of 23 years who had their ASD closed with an Amplatzer device and compared them with 44 patients treated with surgery. There were significant advantages to transcatheter closure in terms of a fewer complications, avoidance of cardioplegia and cardiopulmonary bypass, shorter hospitalisation, reduced need for blood products, and less patient discomfort. However, they noted that large ASDs with a stretched diameter > 27 mm were not amenable to this type of closure and should be referred for surgery. Certainly, in our unit it is the practice of cardiologists to refer only ASDs > 20 mm in diameter for surgery.

In conclusion, the low mortality and morbidity in patients over 35 years of age who have been operated on for ASD is a strong argument favouring surgical treatment over medical

management. Mid to long term outcome has shown the beneficial effects of surgical correction in terms of clinical status in both age groups; however, in the older age group, haemodynamic benefits are much less pronounced and should be taken into account before surgical treatment is advised.

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