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Atrial Septal Defect with Failure to Thrive in Infancy: Hidden Pulmonary Vascular Disease?

Rachel Andrews,[1] Robert Tulloh,[1] Alan Magee,[2] David Anderson[1]

[1]Department of Congenital Heart Disease, Guy's and St. Thomas' Hospital, London, UK

[2]Department of Congenital Heart Disease, The Royal Brompton Hospital, London, UK

Abstract. Atrial septal defects are usually asymptomatic, and are closed surgically or by a catheter implanted device in preschool age children. Rarely, they may cause symptoms in infancy, and management at this age is debated. We report our experience of six infants who underwent surgical closure, with variable outcomes. Five of these had significant extracardiac pathology. Our data suggest the need to exclude other causes of symptoms, both cardiac and non-cardiac. The question should be asked as to whether surgery is of benefit in these children, and particularly whether they may have underlying primary pulmonary vascular disease.

Key words: Atrial septal defect — Infancy — Heart failure — Failure to thrive — Pulmonary hypertension — Pulmonary vascular disease

Secundum atrial septal defects (ASD's) are amongst the commonest forms of congenital heart disease, representing approximately 7.5% of the total [1]. They are usually asymptomatic, presenting with a murmur in infancy or early childhood. If large, they can cause a significant left to right shunt with volume overload of the right heart and elevated pulmonary artery (PA) pressures. Although this presentation is very rare in infancy [6], such cases may be resistant to medical therapy [2, 4, 5], and there is debate about the benefits of surgical closure at this age [2, 4, 5]. In this article we describe six infants who underwent secundum ASD repair in the first year of life, because of concerns over failure to thrive and pulmonary hypertension, and report on the varied outcome.

Correspondence to: R.M.R. Tulloh; *email:* robert. tulloh@gstt.sthames.nhs.uk

Patients and Methods

Surgical records were reviewed to identify all children undergoing secundum ASD repair at Guy's Hospital between 1995 and 1999 inclusive. Cases in which repair of an ASD was undertaken as part of a larger procedure were excluded, as were cases involving device closure at cardiac catheter. Over this five-year period, 90 children underwent surgery at a median age of four years (range three months to 16 years). Of these, four were under one year at the time of surgery (4.4%).

Two further children were included in the study, who underwent ASD repair in infancy at other centres, whose care was subsequently transferred to Guy's Hospital. One of these had a large inferior ASD in addition to a secundum defect; this case was included as the combined hemodynamic effect of the two defects is indistinguishable from that of a large isolated secundum defect, although they do represent distinct anatomical variants.

All six cases showed signs of heart failure in the first few months of life, with difficulty completing feeds, breathlessness, and poor weight gain. Diagnosis was made by two-dimensional echocardiography. In the five cases who were treated medically, the symptoms did not improve, and at cardiac catheter, all six cases had evidence of a significant left to right shunt with elevated PA pressures (Table 1). Surgery was undertaken in the expectation of improved symptoms and weight gain (Table 2). These 6 cases are described below.

Case 1. A four-month-old boy presented with breathlessness and failure to thrive, weighing 5.2 kg (< third centile), compared to a birth weight of 3.4 kg (< fiftieth centile). An echocardiogram showed a large secundum ASD with marked right ventricular volume overload but no other structural abnormalities. He underwent complete surgical closure at 11 months, and has since made a full recovery with significantly improved weight gain. Now six years old, his weight is just < fiftieth centile.

Case 2. This infant was diagnosed antenatally with a small apical ventricular septal defect (VSD), confirmed postnatally. She had dextroposition of the heart, but with atrial situs solitus, and apex to the left. There was a large interatrial communication, a small right PA, and normal pulmonary venous drainage. At cardiac catheter, a collateral vessel arising from the coeliac axis supplying the lower lobe of the right lung was occluded with coils. Her ASD was closed at three months of age, but postoperative echocardiography showed left pulmonary vein stenosis and a leak across the atrial septum, requiring re-operation, which was successful. She has remained well since, with slowly improving weight gain. At four years, her weight has reached the third centile.

Table 1. Presentation and catheter details

Case number	Age at presentation	Weight and centile at presentation	Initial treatment	Size of left to right shunt	Mean PA: systemic pressure	Pulmonary vascular resistance
1	4 months	5.2 kg < 3rd	frusemide, spironolactone	2.1:1	1/3	0.7 U.m^2
2	birth	2.7 kg < 3rd	frusemide, captopril	2.4:1	4/5	3.0 U.m^2
3	6 weeks (36 weeks gestation)	3.0 kg < 3rd	frusemide, spironolactone, digoxin	2.8:1	2/3	1.1 U.m^2
4	birth (36 weeks gestation)	2.2 kg < 10th	frusemide, spironolactone	2.6:1	1/2	2.5 U.m^2
5	7 weeks	4.0 kg < 3rd	frusemide, spironolactone	3.5:1	1/2	0.6 U.m^2
6	3 days (37 weeks gestation)	3.1 kg < 50th	none	2.5:1	2/3	3.0 U.m^2

Table 2. Surgical details

Case number	Age at time of surgery	Weight and centile	Type of repair	Surgical complications	Outcome
1	11 months	7.8 kg < 3rd	direct	none	well
2	3 months	3.1 kg $\ll$ 3rd	direct	secondary patch repair	well
3	4 months	4.2 kg $\ll$ 3rd	patch	none	died
4	8 months	5.0 kg $\ll$ 3rd	direct + bronchopexy	none	multiple medical problems
5	5 months	6.0 kg < 3rd	direct	none	died
6	10 months	6.9 kg $\ll$ 3rd	patch	required 4mm fenestration	pulmonary hypertension

Case 3. This dysmorphic infant of consanguinous parents had a normal female karyotype, and no recognizable syndrome. Echocardiogram showed a large secundum ASD, a small apical VSD, and an arterial duct. As she remained ventilator-dependent following an episode of cytomegalovirus pneumonitis, with high PA pressures on echocardiogram, she underwent duct ligation and a lung biopsy, which showed medial hypertrophy and intimal proliferation, indicative of potentially reversible pulmonary vascular disease. There was no improvement postoperatively, so she was catheterized, and subsequently underwent surgical closure of her ASD. However she remained ventilator-dependent, despite evidence of lower PA pressures on echocardiogram. Treatment was eventually withdrawn by mutual consent, and she died at five months of age. A post mortem examination was not performed at her parents' request.

Case 4. This baby was antenatally diagnosed with a right congenital diaphragmatic hernia, which was repaired at three days of age. He was mildly dysmorphic but had a normal male karyotype. An echocardiogram showed a large interatrial communication and bilateral superior vena cavae, but no other structural abnormality. He had pulmonary hypoplasia, and remained oxygen-dependent postoperatively. Subsequent echocardiograms showed pulmonary hypertension with right ventricular hypertrophy and a bidirectional atrial shunt. At cardiac catheter his pulmonary vascular resistance (PVR) was elevated (2.5 U.m^2 in 35% oxygen, reducing to 0.1 U.m^2 in 100% oxygen with 20 parts per million nitric oxide), and it was decided to close his ASD to reduce his PA flow through an abnormal pulmonary vascular bed. At operation a bronchopexy was performed to relieve narrowing of the left main bronchus. He was discharged six weeks later on home oxygen and nasogastric feeds. Since then his weight gain has been poor, and he remains oxygen-dependent. Now 21 months old, he has global developmental delay, gastro-esophageal reflux, and has developed hypertrophic obstructive cardiomyopathy, raising the possibility of Noonan's syndrome. His PA pressure remains moderately elevated despite complete occlusion of his ASD.

Case 5. This baby had a small secundum ASD and a large inferior ASD on echocardiogram, with normal pulmonary venous drainage. He was treated medically, but developed repeated episodes of respiratory failure, secondary to infection and tracheo-bronchomalacia. Subsequent echocardiograms showed high PA pressures and a dilated right ventricle. After catheterization he underwent repair of both ASD's, but his pulmonary hypertension persisted postoperatively, despite coil occlusion of two systemic to pulmonary collaterals at a second catheter. He subsequently developed recurrent ventricular tachycardia, requiring frequent resuscitation, and died of multiple organ failure complicated by candida sepsis at seven months of age.

Case 6. This baby was diagnosed antenatally with bilateral superior vena cavae and hypertrophic cardiomyopathy. Postnatal echocardiography showed a large interatrial communication, and marked right ventricular hypertrophy. She was catheterized because of worsening pulmonary hypertension, and subsequently underwent patch closure of her ASD. However at surgery she could not be weaned from bypass, so a 4 mm fenestration was left in the patch.

A lung biopsy showed medial hypertrophy and intimal proliferation, indicative of potentially reversible pulmonary vascular disease. Since then, her weight gain has been poor, and she has developed phenotypic features of Noonan's syndrome. In addition she developed severe stenosis of the left coronary artery, which was successfully stented. Subsequent catheters have shown worsening pulmonary vascular disease, with a PVR of 13.7 $U.m^2$ in 35% oxygen, falling to 9.2 $U.m^2$ in 100% oxygen with 5 ug iloprost, at three years of age. She is currently on home oxygen and nebulized iloprost, in addition to nifedipine and dipyridamole.

Discussion

This paper reports the clinical course of six children undergoing ASD closure under one year of age, who showed signs of heart failure and failure to thrive. All six patients in this series had a significant left to right shunt at atrial level, with evidence of elevated PA pressures on echocardiogram and at cardiac catheter. Two patients also had small apical VSD's, which were not felt to be hemodynamically significant. In five of the six cases surgery was performed following a trial of medical therapy, which had failed to improve the clinical situation. Surgery was undertaken in the expectation of improved symptomatology and weight gain.

Previous reports have documented the unusual phenotype of secundum ASD presenting with heart failure and failure to thrive in the first year of life [2–6], which can be resistant to medical management [2, 4, 5]. Although the numbers are small, experience with surgical closure in this age group has generally been favorable [2, 4 ,5] when other causes for failure to thrive have not been found [3]. In view of the high incidence of pulmonary hypertension, one author has suggested that pulmonary vascular obstructive disease may be the primary abnormality in many of these patients [2], which would seem to be so for case six in this series, and possibly others as well.

This paper differs from most previous reports in that only one of the six cases (Case 1) had an isolated secundum ASD, the other five having extracardiac pathology which probably contributed to their failure to thrive and pulmonary hypertension. In three infants, lung pathology was likely to have been a significant factor: following infection in Cases 3 and 5, and secondary to hypoplasia in Case 4. Another infant, Case 2, was found to have left pulmonary vein stenosis following her ASD repair; once this was corrected, her symptoms improved. Interestingly, occlusion of systemic to pulmonary collaterals in Cases 2 and 5, and duct ligation in Case 3, did not improve the clinical situation significantly, indicating that these were not the main causes of pulmonary hypertension in each case.

From this small series we suggest that if an infant with a secundum ASD presents with heart failure and failure to thrive, a careful search should be made for other causes of symptoms. It is particularly important to eliminate abnormal pulmonary venous drainage, pulmonary vein stenosis, or lung pathology, and the possibility of primary pulmonary vascular disease should be considered. If no other cause is found, or if symptoms persist despite successful treatment of other pathology, surgical closure is recommended. However if there is persistence of other pathology, the data from this and a previous paper [3] suggest that little benefit may be derived from ASD closure, and the parents should be counselled accordingly. In cases where there is persistent or progressive pulmonary hypertension, the presence of an ASD may actually be beneficial, to allow for right to left shunting during pulmonary hypertensive crises.

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References

1. Bosi G, Scorrano M, Tosato G, Forini E, Chakrokh R (1999) The Italian multicentric study on the epidemiology of congenital heart disease: first step of the analysis. Working Party of the Italian Society of Pediatric Cardiology. *Cardiol in the Young 9*:291–299
2. Bull C, Deanfield J, De Leval M, Stark J, Taylor JFN, Macartney FJ (1981) Correction of isolated secundum atrial septal defects in infancy. *Arch Dis Child 56*:784–786
3. Mainwaring RD, Mirali-Akbar H, Lamberti JJ, Moore JW (1996) Secundum-type atrial septal defects with failure to thrive in the first year of life. *J Card Surg 11*:116–120
4. Phillips SJ, Okies JE, Henken D, Sunderland CO, Starr A (1975) Complex of secundum atrial septal defect and congestive heart failure in infants. *J Thorac Cardiovasc Surg 70*:696–700
5. Spangler JG, Feldt RH, Danielson GK (1976) Secundum atrial septal defect encountered in infancy. *J Thorac Cardiovasc Surg 71*:398–401
6. Toews WH, Nora JJ, Wolfe RR (1975) Presentation of atrial septal defect in infancy. *JAMA 234*:1250–1251