Supravalvar mitral stenosis: risk factors for recurrence or death after resection

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Abstract

Objective—To assess the medium term outcome in infants and children after surgical resection of supravalvar mitral stenosis with special reference to risk factors for mortality or recurrence of supravalvar mitral stenosis. No detailed follow up has been previously reported in this uncommon condition.

Design—Prospective cross sectional clinical and echocardiographic follow up.

Setting—Paediatric cardiothoracic unit.

Patients and methods—23 consecutive children (14 male, nine female, mean age 3 years 2 months at surgery) who underwent resection of supravalvar mitral stenosis between 1978 and 1993.

Results—Follow up was for a mean of 58 months (range 0.5–167) after resection of supravalvar mitral stenosis. Four patients developed recurrent supravalvar mitral stenosis: this has not been reported previously. This was recognised 14–108 months after resection and confirmed at repeat operation. Three of these patients had successful reoperations but one died. Five other patients died. On multivariate analysis the only variable associated with survival free of recurrent supravalvar mitral stenosis was older age (18 months or more) at time of surgery (hazard ratio 0.17, 95% confidence interval (CI) 0.03 to 0.95, $P < 0.05$). Five year actuarial survival free of recurrent obstruction when supravalvar mitral stenosis was resected at age less than 18 months was only 39% (95% CI 9 to 69%) compared with 73% (95% CI 24 to 93%) in older patients.

Conclusion—Supravalvar mitral stenosis is part of a spectrum of obstructive lesions affecting the left heart. Recurrent supravalvar mitral stenosis can develop after surgical resection. The prognosis in those who require resection within the first 18 months of life is poor: mortality is high, as is the risk of recurrent supravalvar mitral stenosis in survivors, probably because of continuing turbulent flow across a small left ventricular inflow tract.

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Keywords: supravalvar mitral stenosis, surgical resection, recurrence

Supravalvar mitral stenosis is an uncommon lesion and not many cases have been reported since its original description.¹ The development of cross-sectional echocardiographic diagnosis allowed supravalvar mitral stenosis to be distinguished from isolated mitral valve stenosis before operation^{2,3} which up to then had been extremely difficult. Though the early postoperative course after resection of supravalvar mitral stenosis may be satisfactory, particularly in the absence of major associated mitral valve abnormality,⁴ there are no medium term follow up data available. The purpose of this report is to document medium term follow up after surgical resection of supravalvar mitral stenosis in infancy or childhood with special reference to the identification of risk factors for death or recurrence of supravalvar mitral stenosis.

Patients and methods

The surgical records for all 26 infants and children who underwent resection of supravalvar mitral stenosis between August 1978 and March 1993 at the Hospital for Sick Children were reviewed. Three patients with supravalvar mitral stenosis who also had parachute mitral valve deformities requiring mitral valve replacement at their initial intracardiac operation were excluded from the follow up study. The 23 remaining patients (14 male, nine female) ranged in age from 4 days to 3 years (mean 0.7 years) at the time of presentation (table 1). Supravalvar mitral stenosis was correctly diagnosed before operation in 16/23 (70%) overall, including all of those seen since 1984. A diagnosis of supravalvar mitral stenosis was made by echocardiographic visualisation of a ridge in the left atrium below the left atrial appendage and usually adherent to the mitral valve.³ Twelve (52%) had a normal mitral valve on visual morphological assessment at the time of the initial intracardiac operation. Associated lesions (number of patients) which occurred more than once in the group were ventricular septal defect (12 (52%)), abnormal mitral valve (11 (48%)), subaortic stenosis (9 (39%)), coarctation of the aorta (8 (35%)), left superior vena cava (6 (26%)), aortic valve stenosis (2 (9%)), and persistent ductus arteriosus (2 (9%)).

STATISTICAL ANALYSIS

The dates of birth, operation, reoperation for recurrence of supravalvar mitral stenosis, death, and last follow up visit were obtained.

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Table 1 Data on patients

Case	Age at operation (y)	Mitral valve	Other lesions	Time to FU or death (month)	Outcome
1	0.1	NI	—	22	Died, respiratory sepsis
2	0.3	Abn	—	17	Symptom free
3	0.4	Abn	ASD, VSD	0.5	Died, respiratory sepsis
4	0.5	Abn	VSD, LSVc	25	Died at home with MS and MR
5	0.7	Abn	SAS, VSD	94	Symptom free
6	0.7	Abn	—	5	Symptom free
7	1.1	NI	SAS, VSD	87	Recurrent SVMS + SAS; reoperation
8	1.3	NI	SAS, CoA	10	Died; reoperation for MVR
9	1.3	Abn	VSD, BAV, CoA	23	Died; reoperation for recurrent SVMS + MVR
10	1.3	Abn	SAS, CoA	167	Recurrent SVMS; reoperation
11	1.5	Abn	PAPVC, LSVc, ASD	114	Pulmonary hypertension
12	1.5	Abn*	VSD, SAS, LSVc	14	Recurrent SVMS; reoperation
13	1.7	NI	VSD	38	Symptom free
14	1.8	NI	SAS, VSD	24	Symptom free
15	2.6	NI	SAS, DORV, LSVc	47	Died, after cardiac catheter
16	3.1	NI	CoA	9	Symptom free
17	3.8	NI	VSD, CoA	86	Symptom free
18	5.0	NI	CoA	40	Symptom free
19	6.3	NI	VSD	20	Symptom free
20	7.1	NI	SAS, AS	14	Symptom free
21	9.1	NI	SAS, CoA	15	Symptom free
22	9.3	Abn	VSD, LSVc	147	Symptom free
23	13.0	Abn	CoA, LSVc	133	Symptom free

Abn, abnormal; ASD, atrial septal defect; BAV, bicuspid aortic valve; CoA, coarctation; DORV, double outlet right ventricle; LSVc, left superior vena cava; MR, mitral regurgitation; MS, mitral stenosis; NI, normal; PAPVC partial anomalous pulmonary venous connection; SAS, Sub-aortic stenosis; SVMS, supraaortic mitral stenosis; VSD, ventricular septal defect.

*Double orifice mitral valve.

We used the Kaplan-Meier method to calculate overall survival and survival free of death or need for reoperation for recurrent supraaortic mitral stenosis.⁵ We explored predictors of death or need for reoperation for recurrence of supraaortic mitral stenosis using a Cox proportional hazards model⁶; the presence of subaortic stenosis, concomitant mitral valve abnormality, previous coarctation repair, and age at operation (below and above 1.5 years) were entered into the multivariate model. Patients lost to follow up were censored as alive without recurrent supraaortic mitral stenosis at the time of last visit. Two children who returned overseas were lost to follow up.

Analyses were performed using the Egret package (Epidemiological Graphics Estimation and Testing Package; Statistics and Epidemiology Research Corporation 1991). Hazard ratios and survival data are presented with 95% confidence intervals where appropriate.

Results

FOLLOW UP

The mean age at resection of supraaortic mitral stenosis was 3.2 years (range six weeks to 13 years) (table 1). In 21 patients the obstructing lesion was adherent to the underlying valve leaflets. Associated intracardiac defects were repaired at the same operation. Seven children had already had extracardiac operations (six coarctation of the aorta, one banding of the pulmonary trunk). Mean overall follow up of the 23 children was 58 months (range two weeks to 167 months).

MORTALITY

There was echocardiographic and symptomatic relief of the supraaortic inflow obstruction

immediately after resection of supraaortic mitral stenosis in all survivors. A total of six (26%) infants and children died during the follow up period. One died two weeks after surgery having never left the intensive care unit: death was attributed to pulmonary sepsis (table 1, case 3). In one the first operation was to resect the supraaortic mitral stenosis (case 8) but she required repeat operation to replace the mitral valve 10 months later at which she died. One child died at repeat operation for recurrent supraaortic mitral stenosis (case 9) at which it was necessary to replace the mitral valve. Three further children died during the follow up period: one moved abroad and died of respiratory infection without information available about the possibility of recurrent supraaortic mitral stenosis (case 1); one underwent cardiac catheterisation at another institution (case 15) during which she suffered cardiac arrest with resulting hemiplegia and death one month later; one other died suddenly at home with known mitral valve stenosis and incompetence (case 4). Of those six children who were aged less than 9 months at the time of presentation (cases 1–6), five had abnormal mitral valves and three died; none of the three survivors developed known recurrent supraaortic mitral stenosis.

RECURRENCE OF SUPRAAORTIC MITRAL STENOSIS

Recurrence of supraaortic mitral stenosis was seen in four children at 14, 23, 81, and 101 months after the original operation (fig 1). Three of the four had subaortic stenosis, which in one (table 1, case 7) recurred after previous surgical resection performed at the same time as resection of supraaortic mitral stenosis (fig 2). The age at first surgical resection of supraaortic mitral stenosis in these patients was 1.1–1.5 years (mean 1.3 years). At reoperation the fibrous supraaortic mitral rings were not distinguishable from “native” supraaortic mitral stenosis (fig 3) and were resected by sharp dissection. We took care not to damage the underlying mitral valve. Three children improved but one, in whom concomitant mitral valve replacement was required, did not survive surgery.

SURVIVORS

Twelve children are alive without recurrent supraaortic mitral stenosis and under current review (table 1). One patient (case 11) aged 18 months at resection of supraaortic mitral stenosis had raised left atrial pressure after closure of an atrial septal defect and repair of partial anomalous pulmonary venous connection at the same procedure. Surgical atrial septostomy was performed and her symptoms improved; however pulmonary vascular obstructive disease developed.

RISK FACTORS

Older age (≥ 18 months) at resection of supraaortic mitral stenosis was the only variable protective against death or recurrence of supraaortic mitral stenosis on multivariate analysis (hazard ratio 0.17, 95% CI 0.03 to

Figure 1 Parasternal echocardiographic views in (A) diastole and (B) systole showing recurrent supravulvar mitral stenosis (arrows) (case 12). Subaortic stenosis had previously been resected and there was also double orifice mitral valve (C) and a persistent left superior vena cava. In the postoperative echocardiographic view (D) the left atrium is reduced in size and supravulvar mitral stenosis is no longer visible. Ao, aorta; CS, coronary sinus; LA, left atrium; LV, left ventricle; RV, right ventricle; 1 and 2, separate mitral valve orifices.

Figure 2 Long axis parasternal echocardiographic views in (A) diastole and (B) systole in a child who developed recurrent supravulvar mitral stenosis (arrowhead) and also recurrent subaortic stenosis (arrows) (case 7). See legend to fig 1 for abbreviations.

Figure 3 Intraoperative photograph of the same child as in fig 1. Surgeon's view of the left atrium: the mitral valve is obscured by the supralvalvar fibrous tissue which has recurred after previous resection.

0.96, $P = 0.045$). The increased risk of death or recurrent supralvalvar mitral stenosis in the younger children did not correlate with the presence of subaortic stenosis, coarctation of the aorta, or abnormal mitral valve (table 2). Those who were aged ≥ 18 months at resection of supralvalvar mitral stenosis had 73% (95% CI 24% to 93%) actuarial survival at 5 years compared with 39% (95% CI 9% to 69%) in those ≤ 18 months at resection of supralvalvar mitral stenosis (fig 4).

Discussion

Supralvalvar mitral stenosis is typically part of a range of obstructive lesions affecting the left heart.⁷ Ventricular septal defect and left superior vena cava are other commonly associated lesions. Mortality was high after resection of supralvalvar mitral stenosis in this series, and recurrence of supralvalvar mitral stenosis after surgical resection, not previously reported, was also common. Older age (≥ 18 months), at resection of supralvalvar mitral stenosis was the only variable that was predictive of survival free of recurrent supralvalvar

mitral stenosis on multivariate analysis. The need for surgical resection of supralvalvar mitral stenosis in infancy is indicative of severe obstruction of the left ventricular inflow tract: most of these infants had mitral valve stenosis as well as supralvalvar mitral stenosis. This is the likely explanation for the high mortality in this age group, despite the failure to identify "abnormal mitral valve" as a predictor of death or recurrent supralvalvar mitral stenosis. The categorisation into "normal" or "abnormal" mitral valves takes no account of the severity of mitral valve stenosis, which is likely to have been more severe in the younger patients. The poor outcome in the young patients could not be attributed to an association with subaortic stenosis or coarctation of the aorta. Interestingly, all 4 (17%)

Table 2 Multivariate analysis (Cox proportional hazard) for predictors of death or reoperation for recurrence of supralvalvar mitral stenosis

Multivariate analysis	Hazard ratio	95% CI
No subaortic stenosis	1	
Subaortic stenosis	0.86	0.19 to 3.94
Mitral valve normal	1	
Mitral valve abnormal	1.16	0.28 to 4.82
No coarctation	1	
Coarctation present	0.72	0.16 to 3.20
Age at operation:		
<18 months	1	
≥ 18 months	0.17	0.03 to 0.96

Figure 4 Percentage of patients alive without recurrence of supralvalvar mitral stenosis according to age at surgical resection. At 5 years, recurrence free survival was 73% (95% CI 24% to 93%) in patients ≥ 18 months, compared with 39% (95% CI 9% to 69%) in patients <18 months at resection of supralvalvar mitral stenosis.

patients who developed recurrent supralvalvar mitral stenosis were aged between 13 and 18 months old at initial resection of supralvalvar mitral stenosis. It could be argued that some of the patients who required resection of supralvalvar mitral stenosis in infancy would have been likely to have developed recurrent supralvalvar mitral stenosis had they survived long enough to do so. The importance of age at surgery as the major determinant of prognosis is emphasised by the lower hazard ratio for death or recurrence of supralvalvar mitral stenosis in those who required resection of supralvalvar mitral stenosis at ≥ 18 months. The only patient from this older group who died was a girl with double outlet right ventricle who was two years old at resection of supralvalvar mitral stenosis and who died of complications at cardiac catheterisation nearly four years later.

These data provide evidence that supralvalvar mitral stenosis can be an acquired lesion. To our knowledge, "acquired" supralvalvar narrowing of a native left atrioventricular valve has been described only once before, in a 9 year old boy with atrioventricular discordance and an Ebstein type malformation of the left (morphologically tricuspid) valve, eight years after previous surgical annuloplasty.⁸ Subaortic stenosis is an acquired condition^{9,10} that commonly coexists with supralvalvar mitral stenosis. Subaortic stenosis can also recur after surgical resection.^{11,12} There is strong circumstantial evidence that persisting flow disturbance in the left ventricular outflow tract may be responsible for recurrence of subaortic stenosis,¹³ and, by implication, for its development in the first place.

Though there is no direct evidence, it seems likely that a similar flow disturbance in the left ventricular inflow tract may be the most important factor in the development, and in recurrence after surgical resection, of supralvalvar mitral stenosis. The "native" flow disturbance may be most often the result of congenital mitral valve stenosis. However, even an enlarged coronary sinus restricting the mitral orifice may be important, and could explain the unusually high incidence of persistent left superior vena cava draining to the coronary sinus in our patients. The patients in this series in whom recurrent supralvalvar mitral stenosis developed were young survivors of resection of supralvalvar mitral stenosis and, by inference, those with the smallest left ventricular inflow orifices. The oldest of

these patients to develop recurrent supralvalvar mitral stenosis postoperatively had a double orifice mitral valve that was not stenotic but which may well have provided an unusual basis for the flow disturbance necessary to stimulate "regrowth" of the fibrous supralvalvar tissue. Individual predisposition may also be a factor. Three of the 4 patients in whom recurrent supralvalvar mitral stenosis developed also had subaortic stenosis—indeed in one recurrence of both supralvalvar mitral stenosis and subaortic stenosis developed after previous surgical resection of both (fig 2). Possibly individual susceptibility to fibrous tissue proliferation in response to localised flow disturbance is variable.

If resection of supralvalvar mitral stenosis is required at a young age prognosis is poor: mortality is high, and there is a high incidence of recurrent supralvalvar mitral stenosis in survivors, probably because of persistence of disturbed flow in a small left ventricular inflow tract. Careful postoperative follow up to detect recurrence is mandatory, especially if surgery is required in the first two years of life.

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