Original Article

Neonatal Isolated Critical Aortic Valve Stenosis: Balloon Valvuloplasty or Surgical Valvotomy☆

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Background: **Open surgical valvotomy and transcatheter balloon valvuloplasty are recognised treatments for neonatal critical aortic stenosis.**

Methods: **A retrospective analysis was undertaken of all newborns with critical aortic valve stenosis between 1990 and 2000 presenting to a tertiary centre and who required intervention. The initial catheter and surgical intervention was generally based on the preference of the attending cardiologist and the anatomy of the aortic valve and in consultation with the cardiothoracic surgeon. The two groups were therefore not strictly comparable. Twelve were subjected to balloon valvuloplasty and thirteen to surgical valvotomy at a median age of 11 days (2–42 days) and 3.5 days (1–19 days) respectively. There was no significant difference in the timing of the procedure, weight of the infant, aortic annulus or left ventricular dimensions in either group.**

Results: **There was one unrelated hospital death in the balloon group compared to two in the surgical group both of whom had endocardial fibroelastosis. Mild to moderate aortic regurgitation was seen after both procedures. Four patients in the balloon valvuloplasty group, developed femoral artery thrombosis and two had cardiac perforation that resolved with non operative management. The mean Doppler gradient was reduced from 44 ± 14 mmHg to 13.4 ± 5 mmHg ($p < 0.01$) in the valvuloplasty group compared to a reduction from 42 ± 15 mmHg to 27 ± 8 mmHg ($p < 0.05$) in the surgical group. Five patients in the balloon group required re-intervention within 3 weeks to 21 months after the initial procedure. Two patients in the surgical group required a pulmonary autograft and Konno Procedure 3 and 5 years following surgical valvotomy.**

Conclusion: **Both aortic valvulopasty and valvotomy offered effective short and medium term palliation. Balloon valvuloplasty patients had a higher re-intervention rate but shorter hospital and intensive care stay, reduced immediate morbidity and were associated with less severe aortic regurgitation.**

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Keywords. Aortic Valve Stenosis; Valvuloplasty; Valvotomy; Newborn

Introduction

Neonatal critical aortic stenosis is potentially life threatening with a high morbidity and significant mortality despite early intervention.[1–7] It is uncommon and accounts for 1–3% of neonates with significant congenital heart disease.[3] Infants may present in cardiac failure and/or in a low output state, many requiring ventilation, inotropic support and prostaglandin E1 infusion, the latter to maintain patency of the arterial duct to assist systemic circulation.[2] Cross-sectional echocardiography is able to define the diagnosis accurately and determine other abnormalities.[1] Open surgical valvotomy and transcatheter balloon valvuloplasty of the aortic valve are recognized treatment modalities with favorable results.[8–9] A neonatal Ross procedure has been advocated by some authors.[10]

Previous comparisons of the outcome of balloon valvuloplasty and surgical valvotomy have been published though the numbers were limited, not randomized or from different time periods.[8–9] Other series of critical aortic valve stenosis have included additional malformations with outcomes focussed on predicting mortality arising from multiple anatomical variables.[1–2]

The purpose of this study was to compare the short and medium term outcome of neonates with isolated critical aortic stenosis who required intervention during the same

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time period at a single tertiary institution, to determine their immediate morbidity, the re-stenosis rate and the need for re-intervention. Their duration of hospitalization and intensive care stay were also determined. The procedure selected depended on the preference of the attending cardiologist after discussion with the attending cardiac surgeon, and taking into account the anatomy of the aortic valve. The two groups were therefore not comparable, the surgical group including somewhat sicker infants.

Materials and Methods

The study group comprised neonates who presented to a tertiary centre with isolated critical valvar aortic stenosis with atrio-ventricular concordance and no associated left heart malformation. All patients required intervention within 6 weeks of life due to heart failure and/or shock. Their records were reviewed and the cross sectional echocardiogram of each infant was studied in detail. The outcome of each patient was determined and their serial Doppler velocities across the aortic valve documented to highlight the progress of the disease and the need for re-intervention. The duration of the overall hospitalization and intensive care stay were reviewed.

All balloon valvuloplasties were done under general anaesthesia. The aortic valve was approached retrogradely via the femoral artery in 10 patients. In one it was done through the carotid artery and in the remaining patient the valve was crossed antegradely. The aortic valve was crossed with a catheter over a wire in all cases. The balloon to aortic annulus ratio used was 0.8–1.0.[13] Heparin was administered as a routine either intravenous or intraarterially at the beginning of the procedure.

The surgical valvotomies were performed under cardiopulmonary bypass with moderate hypothermia and cardioplegic arrest. The valve was approached through an oblique aortotomy extended into the non-coronary sinus. Bilateral commisuroplasty or commissurotomy was performed to achieve the best possible opening without compromising the competence of the valve, with extension into the aortic wall itself if need be. In one patient with a monocuspid valve, a commisurotomy was done to achieve a functional bicuspid valve. Thinning of the leaflets was done whenever it was deemed necessary to improve valve mobility.

Statistics

The results were expressed as frequencies, median with a range, mean and standard deviation. Student's *t*-test and a *p*-value of less than or equal to 0.05 was determined as a significant level for continuous data.

Results

Between 1990 and 2000, 25 neonates with critical aortic stenosis required intervention. There were 12 patients in the balloon group and 13 in the surgical group.

Clinical Features

The patient characteristics are described in Table 1. There was no significant difference between the age and weight in both groups. All patients presented with varying degrees of congestive heart failure as evidenced by tachypnoea, cardiomegaly and hepatomegaly. Four patients (33%) in the balloon group required assisted ventilation, two (16%) needed an inotropic infusion and three (25%) a prostaglandin infusion for maintenance of a patent duct. In contrast nine (69%) patients in the surgical group presented in moderate to severe congestive heart failure and required assisted ventilation while 7 (54%) needed inotropic support and 9 (69%) a prostaglandin infusion. There were significant differences between the two groups for the need of a prostaglandin infusion and ventilation.

At presentation there was no significant difference in the echocardiographic findings of both groups (see Table 2). The majority of patients had bicuspid aortic valves morphology (18/25, 72%) while the rest were tricuspid (6/25, 24%) except for one that was monocuspid (1/25, 4%). Only one patient in the balloon group had endocardial fibroelastosis echocardiographically as compared to six in the surgical group, again statistically different, two of whom subsequently died.

Outcome

The mean gradient measured by Doppler estimation before and after intervention, but prior to discharge, is summarized in Table 3. There was no significant difference in the mean gradient in both groups before intervention ($p = 0.45$) with a more rapid rise in the balloon group following intervention (Fig. 1).

Aortic regurgitation as determined by echocardiography was not a significant feature prior to intervention. However, in the surgical group, five patients subsequently developed moderate to severe regurgitation. In contrast, none of the patients in the balloon group developed significant aortic regurgitation following valvuloplasty (Table 3).

Table 1. *Clinical Features and Presentation*

	Balloon Group ($n = 12$)	Surgical Group ($n = 13$)	*p*-value
Sex	11 male, 1 female	9 male, 4 female	
Median age at procedure, days	Median 11 days (range 2–42 days)	Median 3.5 days (range 1–19 days) ($p = 0.11$)	
Weight (kg) (mean ± S.D.)	3.2 ± 1 (BSA 0.2 m^2)	3.2 ± 1 (BSA 0.24 m^2)	
Heart failure	12/12	13/13	
Patients requiring ventilation	4/12 (33%)	9/13 (69%)	0.07
PGE_1	3/12 (25%)	9/13 (69%)	0.05
Inotropes	2/12 (16%)	7/13 (54%)	