Short term results of balloon pulmonary valvuloplasty in children: a single centre study over a period of 42 months

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(Key words: balloon pulmonary valvuloplasty; BPV; pulmonary stenosis; children)

Abstract

Objectives: To evaluate the efficacy and safety of balloon pulmonary valvuloplasty (BPV) in children.

Design, setting and method: This is a retrospective review of 101 consecutive patients with pulmonary stenosis who underwent BPV at the Lady Ridgeway Hospital for Children over a period of 42 months. Four patients were excluded as they had complex cardiac problems. Data was obtained from Excel based cardiac catheterization reports in the Department of Paediatric Cardiology. Reduction of pressure gradient across pulmonary valve to less than 25 mmHg was defined as a successful procedure.

Results: Ninety seven BPVs were performed in 94 patients. The mean age, bodyweight and height were 19 months, 9.5 kg and 80 cm respectively. Sex distribution was equal. The mean of the balloon to pulmonary annular ratio was 108% (range 50-150%). After the BPV, mean peak to peak pressure gradient across the pulmonary valve dropped from 70±29 mmHg to 24.7±16.8 mmHg. Overall success rate was 55.7%. Mortality was 3.1%. Major complications were haemopericardium (4.1%), bradycardia (2%) endocardial damage (1%) and pulmonary oedema (1%). The correlation between pulmonary annulus on echocardiography and angiography was significant ($p<0.01$).

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Introduction

Congenital pulmonary valve stenosis (PS) has been found in 8-10% of patients with congenital heart diseases[1]. Right ventricular dysfunction, fibrosis or infarction may be seen in patients with severe PS[1-3]. Pulmonary valvuloplasty is the first option in the management of congenital PS[4-8]. The short term results of pulmonary valvuloplasty in children with typical PS have been excellent[9-13].

Complications are lower in children and adults than in infants and neonates. Mortality and morbidity among neonates were 3% and 10% respectively[14].

Studies on balloon pulmonary valvuloplasty (BPV) have not been conducted previously in Sri Lanka.

Objectives

To evaluate efficacy and safety of balloon pulmonary valvuloplasty in children

Method

This is a retrospective study of 101 consecutive patients with pulmonary stenosis who underwent BPV at the Lady Ridgeway Hospital for Children (LRHC) over a period of 42 months from 1st January 2006 to 30th June 2009. Four were excluded as they had complex cardiac problems with pulmonary stenosis. Well designed and maintained Excel based cardiac catheterization reports in this unit were reviewed and the data was collected into a data extraction Excel sheet.

Results

Immediate and short term outcomes of BPV were reviewed. There were 94 children aged 2 days to 12 years (mean 19 months) who underwent BPV. Categorization of cases is shown in Table 1.

Table 1
Categorization of cases

Category		Number (%)
Age	< 1yr	35 (36)
	1-3yrs	23 (24)
	3-<5yrs	14 (14)
	≥5yrs	25 (26)
Sex	Male	49 (51)
	Female	48 (49)
Weight	< 5kg	12 (12.4)
	5-10kg	39 (40.2)
	10-20kg	35 (36.0)
	>20kg	11 (11.4)
Height		83 ±24.5cm
Pressure gradient before pulmonary valvuloplasty(on Echo)		
	<50mmHg	02 (02)
	50 -74mmHg	29 (30)
	75 – 99mmHg	34 (35)
	>100mmHg	32 (31)

The pulmonary annular size on echocardiography and angiography were 12±3.8mm and 12.53±4mm respectively. The correlation between these two was significant at 0.01level as shown in Figure 1.

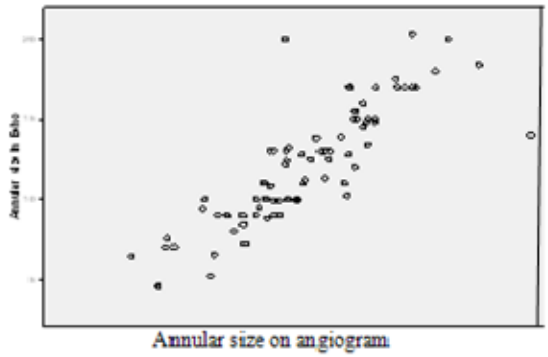

Figure 1: *Correlation between pulmonary annulus on echocardiography (r=0.847) and angiogram (r=0.847)*

Peak-to-peak gradient dropped from 70.50±29.25 to 24.7±16.8mmHg (Paired sample statistics).Three patients underwent repeat BPV. Seven cases were abandoned due to several reasons (mild pulmonary stenosis on catheterization, infundibular pulmonary stenosis and unavailability of suitable balloons). Fifty four patients were successful as residual pressure gradient (PG) after BPV was <25mmHg (60%). The mean balloon/pulmonary annular ratio was 108% (range 47-151%) excluding the failed and abandoned patients (Table 2).

Table 2
Mean balloon/pulmonary annulus ratio

Pulmonary annulus / Balloon ratio x100	Number (%)
<99	09 (11)
100 -119	53 (64)
120 - 139	19 (23)
≥140	02 (02)
Total	**83 (100)**

Failures

The procedure was unsuccessful in 36 patients, 24 of whom had residual pressure gradient between 26-50 mmHg (24.7%) and only five patients had gradient of >50mmHg.The procedure failed in 7 with critical pulmonary stenosis (unable to cross the pulmonary valve in 6, endocardial damage in one). However the numbers are inadequate for statistical analysis and the characteristics of the failures are shown in Table 3.

Table 3
Characteristics of the failures

Characteristic		Failure rate Number (%)
Age	<1yr	17 (49)
	1 – <3yrs	07 (30)
	3-<5yrs	01 (07)
	≥5yrs	11 (44)
Weight	<5kg	08 (66)
	5 -<10kg	13 (33)
	10 -<20kg	08 (23)
	≥20kg	07 (63)

Failure of crossing the pulmonary valve was seen in 2 neonates and 4 infants less than 6 months with critical pulmonary stenosis, two expired, one underwent repeat BPV and three were referred for surgery.

Severe residual stenosis (PG >50mmHg) was seen in infants with hypoplastic pulmonary annulus (2) and severely dysplastic pulmonary valves (3). They were referred for surgery. There were 3 deaths in this cohort. Complications of BPV are shown in Table 4.

Table 4
Complications of BPV

Complications	Number (%)
Death	03 (3.1)
Haemopericardium	04 (4.1)
Endocardial staining	01 (1.0)
Bradycardia	03 (3.1)
Pulmonary oedema	01 (1.0)

Discussion

In a newly established and only paediatric cardiology unit in Sri Lanka, a significant number of patients with moderate to severe pulmonary stenosis underwent BPV over a short period in spite of having limited resources and a new staff with minimal prior experience. The transpulmonary gradient dropped from 70.50±29.25 mmHg to 24.7±16.8 mmHg after the BPV. It is comparable with the other studies[10, 11].

The overall success rate was 55.7%. In this study, procedure failure was mainly due to an inability to cross the severely stenotic valve. The same pattern was reported in other studies and this was overcome by the availability of new instruments. In addition, the experience of staff increased over time. However, the success rate is lower than in the centres with latest facilities which can achieve dilatation in 90-100% patients[1]. Early studies have shown the higher mortality and morbidity in neonates and infants[14]. The mortality rate in our series was 3.1% which is similar to some centres[14]. As seen in other studies, complications were common in neonates and infants[14].

A limitation of this study is that data was obtained from the service records which were not specifically designed for this research.

Conclusions

- Overall success rate of BPV was 55.7%.
- Mortality rate was 3.1%.
- Major complications were haemopericardium, bradycardia, endocardial damage and pulmonary oedema.
- Correlation between pulmonary annulus on echocardiography and angiography was significant ($p<0.01$).

References

1. Allen HD, Moss AJ. Moss and Adams' Heart Disease in Infants, Children and Adolescents: including the Fetus and Young Adult. 7th ed. 2008, Philadelphia; London: Lippincott Williams & Wilkins. 2 v, xxviii; 836: 844.

2. Garson A, Bricker JT, Fisher DJ, Neish SR. The Science and Practice of Paediatric Cardiology 2nd ed.1998Williams & Wilkins; ii: 1225.

3. Rao PS, Galal O, Patnana M, Buck SH, Wilson AD. Balloon Pulmonary Valvuloplasty in Children. *J Invasive Cardiology* 2005; **17**(6): 318-22.

4. Rubio-Alvarez V, Limen-Lason R, Sonj J. Valvotomies intracardiacas por medio de u cateter. *Arch Inst Cordiol Mexico* 1952; **23**:183.

5. Rubio V, Limon-Las on R. Treatment of pulmonary valvular stenosis and tricuspid stenosis using a modified catheter. 2nd World Congress of Cardiology, Washinton, DC, Program Abstract, 1954; 11:205.

6. Semb BKH, Tijonneland S. Stake G et al."Balloon valvotomy" of congenital pulmonary valve stenosis with tricuspid valve insufficiency. *Cardiovasc Radiol* 1979; **2**:239.

7. Kan JS. White RJ. Jr. Mitchell SE. Gardner TJ. Percutaneous balloon valvupoplasty; a new method for treating congenital pulmonary valve stenosis. *New Engl Journal of Med* 1982; **307**:540-2.

8. Gruentzig AR, Senning A, Siegothaler WE. Non-operative dilatation of coronary artery stenosis: Percutaneous transluminal coronary angioplasty. *New Engl J Med* 1979; **301**:61-8.

9. O'Connor BK, Beekman RH, Lindauer A, et al. Intermediate-term outcome after balloon pulmonary valvuloplasty: Comparison with matched surgical control group. *J Am Coll Cardiology* 1992:**20**:169-73.

10. Rao PS, Galal O, Patnana M, et al. Results of three-to-ten-year follow-up of balloon dilatation of the pulmonary valve. *Heart* 1998; **80**:591-5.

11. Masura J, Burch M, Deanfield JE, et al. Five year follow-up after balloon pulmonary valvuloplasty. *J Am Coll Cardiol* 1993; **21**:132-3.

12. Rao PS. Further observations on the role of balloon size on the short-term and intermediate-term results of balloon pulmonary valvuloplasty. *Br Heart J* 1988; **60**:507–11.

13. Jelena M.E. Congenital Pulmonary Stenosis a Restrospective study of 24 cases seen between 1990–1999. *Journal of Veterinary Cardiology* 2001; **3** (2): 13-19.

14. Stanger P,Cassidy SC,Girod DA,et al.Balloon pulmonary valvuloplasty: Results of the valvuloplasty and angiography of congenital anomalies registry. *Amer J Cardiology* 1990; **65**:775-83.