Original Article

BALLOON PULMONARY VALVULOPLASTY IN ADULTS WITH CONGENITAL VALVULAR PULMONARY STENOSIS

Sajjad Ahmad[a*], Asif ur Rehman[a], Deepak kr. Mishra[a], Babar Pasha[a]

ABSTRACT:

BACKGROUND: ***Balloon valvuloplasty is the standard treatment for congenital valvular pulmonary stenosis (PS) in pediatric population. The purpose of this study was to investigate the safety and immediate results of balloon valvuloplasty in Pakistani adults with congenital pulmonary valvular stenosis.***

METHODS: ***Demographic and hemodynamic data was searched retrospectively from hospital record for all patients who underwent pulmonary balloon valvuloplasty between 2009 and 2012. Pre procedure echocardiographic findings and per procedure hemodynamic data were noted.***

RESULTS: ***Thirty one patients (10 males and 21 females) underwent balloon pulmonary valvuloplasty from 2009 to 2012; mean age 25.65 ± 7.24 years and range 16-47 years. Single balloon technique was used in all patients. Right ventricle Systolic pressure decreased from 142.1 ±47.9 to 74.8 ± 33.4 mmHg and Pulmonary valve peak to peak systolic pressure gradient from 115.8 ± 48.5 to 40.5 ±33.9 mmHg. There was also a significant change in pulmonary artery systolic pressure from 24.5±6.7 to 35.03±11.4 mmHg (P= 0.001). All patients had symptomatic improvement and no major complication or mortality was observed.***

CONCLUSION: ***Balloon valvuloplasty is a safe and effective treatment for adult patients having congenital valvular pulmonary stenosis.***

KEYWORDS: pulmonary stenosis, balloon valvuloplasty, adult.

INTRODUCTION

Pulmonary valvular stenosis (PS) is most of the time congenital and accounts for about 5 to 10% of all congenital heart diseases. The vast majority of patients have thick, conical or dome-shaped pulmonary valve due to fusion of commissures. Occasionally, the valve may be dysplastic, which is related to

Noonan's syndrome.[1] severity of pulmonary stenosis is graded in different ways; the most commonly used system is based on trans-valvular peak systolic pressure gradient and four grades are defined as : PG < 25 mmHg - trivial; PG 25 to 49 mmHg- mild; PG 50 to 79 mmHg - moderate; PG e" 80 mmHg- severe.[2] Natural history reveals that severe congenital valvular PS has relatively poor long-term prognosis due to right heart failure, especially when associated with right-to-left shunt. Recommended indications (Class I) for percutaneous intervention include:

[a] Punjab Institute of Cardiology, Lahore-Pakistan
*** Corresponding author:**
Email:drsajjad68@hotmail.com

(J Cardiovasc Dis 2013;11(1):9-13)

1.Asymptomatic patients with a domed pulmonary valve and a peak instantaneous Doppler gradient greater than 60 mm Hg or a mean Doppler gradient greater than 40 mm Hg provided pulmonary regurgitation is less than moderate.

2.Symptomatic patients with a domed pulmonary valve and a peak instantaneous Doppler gradient greater than 50 mm Hg or a mean Doppler gradient greater than 30 mm Hg provided pulmonary regurgitation is less than moderate.[3]

Since 1947 surgical valvulotomy has been performed for critical valvular PS.[4] In 1979, Semb et al. [5] first introduced nonsurgical dilatation of stenotic pulmonary valve by balloon technique in a pediatric patient, and later in 1982; Pepine et al. [6] first described successful balloon pulmonary valvuloplasty (BPV) in an adult patient.

During the past 30 years, both short and long term benefits of this non-surgical procedure in children or infants, have been well established.[7-11] However, similar data in adults, especially old age patients, is relatively scant.[12-15] Here we present our experience of balloon valvuloplasty in adult patients with congenital valvular pulmonary stenosis.

MATERIALS AND METHODS

The study was conducted at Punjab Institute of Cardiology, Lahore, Pakistan. Retrospective data were collected from hospital record for patients who underwent percutaneous balloon pulmonary valvuloplasty (PBV) from 2009 to 2012. Transthoracic echocardiographic findings, especially gradient across stenosed pulmonary valve and cardiac catheterization data (right sided intracardiac pressures) were noted both pre procedure and post procedure.

The procedure of PBV was performed under strict aseptic conditions through right femoral vein. Right ventricle (RV) angiogram was taken in lateral position using pigtail catheter and hemodynamic data including RV pressure and PA pressure were recorded using end-hole catheters. Extra stiff, exchange length Amplatzer Guide wires were used. Single balloon technique (Fig.1) was used in all the patients with balloon size about 1.2-1.3 times the pulmonary annulus diameter. Cordis balloon was used in most of the patients, use of other balloon being less frequent (Fig. 2) In most of the cases, repeated balloon dilation (2-3 times) were performed and each inflation-deflation time was not more than 30 seconds with minimum time interval of 3-5 minutes .After balloon dilation, hemodynamic data were rechecked.

Patients were discharged the next day and advised OPD follow up after 8-12 weeks.

STATISTICAL ANALYSIS

Data were entered to SPSS version 18 for windows. Categorical variable, gender, was expressed as frequency and percentage and continuous variables like age and intracardiac pressures were expressed as mean ± SD (standard deviation). Paired student t test was used to compare data differences and p-valve d"0.05 was considered significant.

Figure 1, single balloon pulmonary valvuloplasty

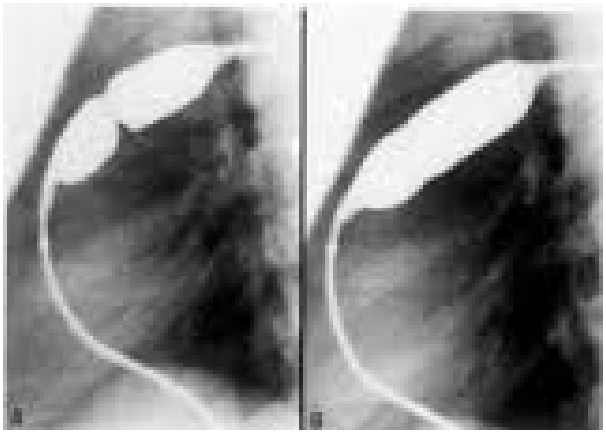


Table 1 : Individual Parameters Of Study Population

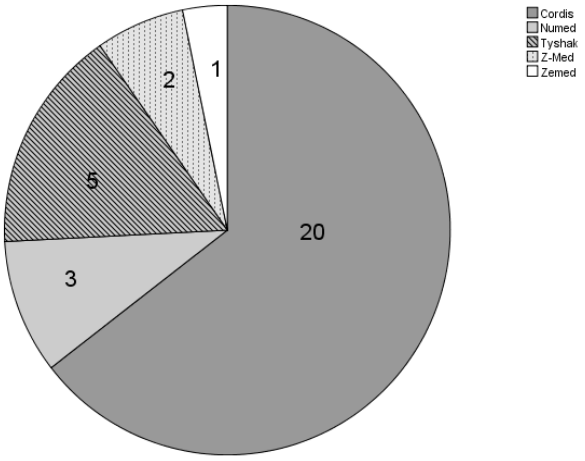
Sr#	Age (years)	Sex	Pre.RVP (mmHg)	Post.RVP (mmHg)	Pre.PAP (mmHg)	Post.PAP (mmHg)	Balloon Type
1	16	F	113	40	22	27	Cordis
2	17	F	106	58	21	31	Cordis
3	20	F	114	55	26	43	Tyshakll
4	23	F	216	85	21	30	Cordis
5	27	F	72	40	30	30	Numed
6	25	F	180	117	25	26	Cordis
7	30	F	62	36	20	29	Zemedll
8	35	F	166	100	20	36	Tyshakll
9	20	F	114	55	26	36	Tyshakll
10	25	F	190	95	25	40	Tyshakll
11	25	F	153	98	15	16	Cordis
12	19	F	133	60	27	45	Cordis
13	40	F	266	160	25	40	Cordis
14	24	F	150	100	24	40	Cordis
15	19	F	98	46	24	26	Cordis
16	30	F	124	44	33	35	Cordis
17	22	F	129	47	21	22	Cordis
18	18	F	155	69	24	35	Cordis
19	47	F	121	75	32	44	Cordis
20	35	F	153	100	18	28	Cordis
21	40	F	266	160	25	40	Cordis
22	24	M	128	60	19	30	Numed
23	24	M	139	79	29	59	Cordis
24	21	M	132	119	18	19	Cordis Maxi
25	21	M	90	40	18	21	Cordis
26	25	M	167	75	50	72	Numed
27	26	M	161	56	22	30	Tyshakll
28	24	M	92	40	21	35	Z-Med
29	28	M	151	95	37	50	Z-Med
30	25	M	93	43	21	37	Cordis
31	20	M	173	71	22	34	Cordis

RVP=Right ventricular pressure, PAP= Pulmonary artery pressure, M= Male, F= Female

RESULTS

Between 2009 and 2012, BPV was performed on 31 patients (10 males and 21 females) with congenital valvular PS. Age of the study population ranged from 16- 47 years with mean age of 25.65±7.24years. Transthoracic Echocardiography showed that all patients had isolated congenital valvular pulmonary stenosis (PS) with no other structural heat diseases, congenital acquired. RV angiogram showed dome shaped pulmonary valve, post-stenotic dilation of main pulmonary artery and trabeculations of RV in all patients. None of the patients had dysplastic valve or organic infundibular stenosis; reactive infundibular stenosis (diastolic dilation on angiography) was, however, noted. After BPV the transvalvular flow became much wider because

Fig 2: Types of Baloons Used



of the opening of valve orifice.

After BPV, right ventricle systolic pressure (RVSP) decreased from 142.2±47.9 to 74.7±33.4 mmHg and pulmonary valve peak to peak systolic pressure gradient decreased from 115.7 ± 48.5 to 40.5 ±33.9 mmHg. There was also a significant rise in pulmonary artery systolic pressure from 24.6±6.7 to 35.03±11.4 mmHg (p= 0.001), Table 2.

All patients had symptomatic improvement (from NYHA class III to NYHA Class I-II). Transient hypotension with SBP <100 mmHg and bradyarrythmias were noted in three cases that resolved spontaneously. There were no major complications such as severe pulmonary regurgitation (PR), tamponade or mortality. None of our patients needed ICU/CCU care post procedure and was discharged the next day within 24 hours.

DISCUSSION

Our results demonstrate that BPV is a safe and effective procedure in treating adult patient with congenital valvular PS. BPV has become the treatment of choice for valvular PS since the first series reported by Kan et al.[16] in 1982, and has almost replaced surgical valvotomy in pediatric patients.

The double-balloon technique was first reported by Al-Kasab et al.[17] in 1987. The use of 2 balloons may permit a small amount of blood flow between them even during full dilatation, and leads to fewer hemodynamic changes.[18-21] Inoue balloon has also been used for this purpose[22] and has advantage of being size-adjustable, making stepwise dilatation possible. It also minimizes the possible injury to RV infundibulum or main PA due to its short and self-positioning characters.[22,23] But Inoue balloon has disadvantages including necessity of a large sheath, rigid property and high cost .Hence the double-balloon technique is now preferred.

Table 2: Mean RVP and Mean PAP Pre & Post Procedure

	Pre-Procedure	Post-Procedure	P-Value
Mean RV Pressure (mmHg)	142.16 ± 47.93	74.77± 33.39	0.001
Mean PA Pressure (mmHg)	24.55±6.74	35.03±11.44	0.001

RVP=Right ventricular pressure; PAP= Pulmonary artery pressure

According to previous studies, the independent predictors of long-term result after BPV in pediatric patients are valve morphology, Ratio of balloon to annulus diameter and immediate post-dilatation pressure gradient across the pulmonary valve.

Poor long-term prognosis is observed if the valve is dysplastic, the ratio of balloon to annulus diameter < 1.2 or residual trans-valvular pressure gradient > 36 mmHg.[24-26] Some authors have claimed that it is not necessary to use a larger balloon (ratio of balloon-to-annulus diameter > 1.2) in adults as in children because adults have a much lower restenosis rate than children (4.8% vs. 19%) and there is no clear relationship between balloon size and hemodynamic results.[22, 26-28]

Most authors suggest that balloon to annulus ratio should not exceed 1.5 due to the higher risk of severe PR or annular laceration, unless there is a residual RV to PA pressure gradient greater than 36 mmHg.[7, 21] Review of literature reveals that the degree of PR was higher in most studies after BPV. The incidence of new PR is 13-39%, but most cases are only mild, [27, 29-33]. PR is less frequent with BPV than following surgical valvotomy, which is about 60%[29-33].

Major complications of BPV have been reported in pediatric patients, [8] including death (0.2%) and cardiac perforation (0.1%). Among adult patients, 1 death was reported by Hermann et al, [36] and 1 case of cardiac tamponade by Kaul et al.[31] In contrast, surgical valvotomy has a higher mortality rate of 1.5 to 2%[35]. In our series, we did not encounter such complications. Only mild hypotension and transient arrhythmias were noted during the procedures. All patients tolerated the whole treatment course very well with good results. According to previous studies, post valvuloplasty decrease in RV systolic pressure ranged from 39 to 71%, and a decrease in trans-valvular pressure gradient ranged from 45 to 93%.[13,18,19,22,23,27,30,34,36,37] Our

results are comparable to these findings: 57-77% reduction of RV pressure and 34% reduction of trans-valvular pressure gradient on the average. Significant infundibular stenosis is a problem which may cause high residual pressure gradient after BPV. It has been suggested by experts that myomectomy should be performed if immediate post-procedure RV pressure exceeds 100 mmHg or pressure gradient is more than 80 mmHg.[38] Reflex tachycardia and improvement of contraction would cause an increase of cardiac output, but also worsen the obstruction of RV outflow tract and raise its pressure gradient.[39]

Cases of infundibular spasm after BPV were reported by Al-Kasab et al.[18] We did not encounter such problem. In addition, RV infundibular hypertrophy secondary to PS usually regresses gradually after BPV and this regression may be accelerated by administration of oral beta-blockers. Thus a sustained improvement in trans-valvular pressure gradient is generally achieved.[15]

CONCLUSION

BPV is a reliable, safe and effective treatment for suitable adult patients with congenital valvular pulmonary stenosis.

REFERENCES

1. Noonan JA, Hypertelorism with Turner phenotype. A new syndrome associated with congenital heart disease. Am J Dis Child 1968;116:373-80.
2. Nugent EW, Freedom RM, Nora JJ, Ellison RC, Rowe DD , Nadas AS. Clinical course in pulmonic stenosis. Circula tion 1977;56(Suppl I):38-47.
3. Warnes CA, Williams RG, Bashore TM, Child JS, Connolly HM, Dearani JA et al. ACC/AHA 2008 guidelines for the management of adults with congenital heart disease: a re port of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Writing Committee to Develop Guidelines on the Management of Adults With Congenital Heart Disease). Developed in Col laboration with the American Society of Echocardiography, Heart Rhythm Society, International Society for Adult Con genital Heart Disease, Society for Cardiovascular Angiog raphy and Interventions, and Society of Thoracic Surgeons. J Am Coll Cardiol 2008;52: e1–e121.
4. Brock RC. Pulmonary valvulotomy for the relief of congeni talstenosis: report of 3 cases. Br Med J 1948;1121-6.
5. Semb BKH, Tjonne S, StakeG, AabyholmG. Balloon valvulo plasty of congenital pulmonary valve stenosis with tricuspid valve insufficiency.CardiovascRadiol1979;2:239-41.
6. Pepine CJ, Gessner IH, Feldman RL. Percutaneous balloon valvuloplasty for pulmonic valve stenosis in the adults. Am J Cardiol 1982;50:1442-5.
7. Stanger P, Cassidy SC, Girod DA, Kan JS , Lababidi Z, Shapiro SR. Balloon pulmonary valvuloplasty: results of the Valvu loplasty and Angioplasty of Congenital Anomalies Registry. Am J Cardiol1990;65:775-83.
8. Rocchini AP, Kveselis DA, Crowley D, Dick M, Rosenthal A . Percutaneous balloon pulmonary valvuloplasty for treatment of congenitalpulmonary valvular stenosis in children. J Am CollCardiol1984; 3:1005-12.
9. Wagner HR, Ellison RC, Keane JF, Humphries Jo , Nadas AS. Guidelines for evaluation and management of common con genital cardiac problems in infants, children and adoles cents: a statement for healthcare professionals from the Committee on Congenital Cardiac Defects of the Council on Cardiovascular Disease in theYoung. Circulation 1994;90:2180-8.
10. Mullins CE, Nihill MR, Vick WG III, et al. Double balloon technique for dilation of valvular or vessel stenosis in con genital and acquired heart disease. J Am CollCardiol1987;10:107-14.
11. Rao PS, Fawzy ME, Solymar L, Mardini MK . Long-term results of balloon pulmonary valvuloplasty for valvular pul monic stenosis.Am Heart J 1988;115:1291-6.
12. Fawzy ME, Mercer EN, Dunn B. Late results of pulmonary balloon valvuloplasty in adults using double balloon tech nique. J IntervenCardiol1988;1:35-42.
13. Sadr-Ameli MA, Sheikholeslami F, Firoozi I, Azarnik H . Late results of balloon pulmonary valvuloplasty in adults. Am J Cardiol1998; 82:398-400.
14. Sherman W, Hershman R, Alexopoulos D,et al. Pulmonic balloon valvuloplasty in adults. Am Heart J 1999;138:950-4.
15. Lababidi Z, Wu JR. Percutaneous balloon pulmonary valvu loplasty. Am J Cardiol1983;52:560-2.
16. Kan JS. White RI, Mitchell SE, Gardner TJ. Percutaneous balloon valvuloplasty: a method for treating congenital pul monary valve stenosis. N Engl J Med 1982;307:540-2.
17. Al-Kasab S, Ribeiro PA, Al-Zaibag M, Halin M, Habbas MA, Shahid M. Percutaneous double balloon pulmonary valvo tomy in adults: One-to-two year follow-up. Am J Cardiol1988;62:822-4.
18. Al-Kasab S, Ribeiro PA, Al-Zaibag M. Use of double bal loon technique for percutaneous balloon pulmonary val votomy in adults. Br Heart J 1987;58:136-41.
19. Park JH, Yoon YS, Yeon KM, et al. Percutaneous pulmonary valvuloplasty with a double-balloon technique. Radiol ogy1987;164:715-8.
20. Van der Berg EJM, Niemeyer MG, Plokker TWM, et al. Newtriple-lumen balloon catheter for percutaneous (pul monary)valvuloplasty. CathetCardiovascDiagn1986;12:352-6.
21. Khan MA, Youssef SA, Mullins CE. Percutaneous transluminal balloon pulmonary valvuloplasty for the relief of pulmonary valve stenosis with special reference to double-balloon technique. Am Heart J 1986;112:158-66.
22. LauKW, Hung JS, Wu JJ, Chern MS ,Yeh KH ,Fu M. Pulmonary valvuloplasty in adults using the Inoue balloon catheter. CathetCardiovascDiagn1993; 29:99-104.
23. Bahl VK, Chandra S, Wasir HS. Pulmonary valvuloplasty using Inoue balloon catheter. Int J Cardiol1994;45:141-3.

24. McCrindle BW. Independent predictors of long-term re sults after balloon pulmonary valvuloplasty.Valvuloplasty and Angioplasty of Congenital Anomalies (VACA) Registry Investigators. Circulation 1994;89:1751-9.
25. Rao PS. How big a balloon and how many balloons for pulmonary valvuloplasty? Am Heart J 1988;116:577-80.
26. Rao PS, Thapar MK, Kutayli F. Causes of restenosis after balloon valvuloplasty for valvular pulmonary stenosis. Am J Cardiol 1988;62:979-82.
27. Chen CR, Cheng TO, Huang T, Zhou YL, Ches JY, Huang YG. Percutaneous balloon valvuloplasty for pulmonic steno sis in adolescents and adults. NEngl J Med 1996;335:21-5.
28. Jarrar M, Betbout F, Farhat MB, Maatonk F, Gamra H, Addad F. Long-term invasive and noninvasive results of per cutaneous balloon pulmonary valvuloplasty in children, ado lescents, and adults. Am Heart J 1999;138:950-4.
29. Fontes VF, Soussa JEMK, Esteves CA, Silva MJD, Bemborn MCB. Pulmonary valvuloplasty: experience of 100 cases. Int J Cardiol1988;21:335-42.
30. Shrivastava S, Shyam SA, Mukhopadhyaya S, Rajani M. Percutaneous transluminal balloon pulmonary valvulo plasty: long-term results. Int J Cardiol1987;17:303-14.
31. Kaul UA, Singh B, Tyagi S, Bhargava M, Arora R, Khalilullah M. Long-term results after balloon pulmonary valvuloplasty in adults. Am Heart J 1993;126:1152-5.
32. O'Connor BK, Beekman RH, Lindauer A, Rocchini A. Inter mediate-term outcome after pulmonary balloon valvulo plasty: comparison with a matched surgical control group. J AmCollCardiol1992;20:169-73.
33. Ray DG, Subramanyan R, Titus T, Tharaban J, Joy . Balloon pulmonary valvoplasty: factors determining short- and long-term results. IntJ Cardiol1993;40:17-25.
34. Fawzy ME, Award M, Galal O. Kleaveland JP, Pepine CJ. Long-term results of pulmonary balloon valvulotomy in adult patients. J Heart ValveDis 2001;10:812-8.
35. Kirklin KW, BarattBoyes BG. Pulmonary stenosis with in tact septum in cardiac surgery. New York John Wiley and Sons 1986; 821-41.
36. Herrmann HC, Hill JA, Krol J, et al. Effectiveness of percu taneous balloon valvuloplasty in adults with pulmonic valve stenosis. AmJ Cardiol1991;68:1111-3.
37. Teupe CHJ, BurgerW, Schrader R, Zeiher AM. Late (5 to 9 years) follow- up after balloon dilation of valvular pulmo nary stenosis in adults. Am J Cardiol1997;80:240-2.
38. Griffith BP, Hardesty RL, Siewers RD, Lerberg DB, Frrson PF, Bahnson HT. Pulmonary valvuloplasty alone for pulmonary stenosis: results in children with and without muscular in fundibular hypertrophy. J Thorac CardiovascSurg1982;83:577-83.
39. Ben-Shachar G, Cohen MH, Sivakoff MC, Portman MA, Riemenschneider TA. Development of infundibular obstruc tion after percutaneous balloon pulmonary valvuloplasty. J Am CollCardiol1984;3:1005-12.