The Turkish Journal of Pediatrics 32: 25-31, 1990

PERCUTANEOUS TRANSLUMINAL BALLOON PULMONARY VALVULOPLASTY : IMMEDIATE AND MEDIUM-TERM RESULTS*

*Şencan Özme MD**, Alpay Çeliker MD***, Süheyla Özkutlu MD**
*Sema Özer MD****, Kemal Baysal MD*****

Summary: Özme Ş, Çeliker A, Özkutlu S, Özer S, Baysal K. (Pediatric Cardiology Unit, Department of Pediatrics, Hacettepe University Faculty of Medicine, Ankara, Turkey). Percutaneous transluminal balloon pulmonary valvuloplasty: immediate and medium-term results. Turk J Pediatr 32: 25-31, 1990.

Ten patients with pulmonary stenosis, (six males and four females) whose ages ranged between five and ten years (mean age 7 years) underwent cardiac catheterization and balloon valvuloplasty. Right ventricular systolic pressure before valvuloplasty ranged from 90 to 200 mm Hg (mean 133.5±33.3 mm Hg). It fell to 50-90 mm Hg (mean 64.5±13.8 mm Hg) immediately after the procedure. The peak systolic gradient across the pulmonary valve before valvuloplasty ranged from 70 to 180 mm Hg (mean 114.5±35.4 mm Hg) and decreased significantly to 30-70 mm Hg (mean 43.0±13.8 mm Hg) immediately after dilation. Doppler echo studies confirmed these results. At repeat cardiac catheterization in three patients, five to 15 months after valvuloplasty, restenosis was noted in one patient while there was no change in the others. All patients had been followed up by Doppler echocardiography. Patients with isolated valvular pulmonary stenosis can be adequately and safely treated with balloon valvuloplasty which results in excellent immediate and medium-term results. *Key words: balloon valvuloplasty, pulmonary valvular stenosis, children, immediate and medium-term results.*

Percutaneous transluminal balloon pulmonary valvuloplasty is widely used for the treatment of moderate to severe pulmonary valvular stenosis in children[1-3]. This invasive method, which was found to be effective by long-term follow-up studies,

* From the Pediatric Cardiology Unit, Department of Pediatrics, Hacettepe University Faculty of Medicine, Ankara.

** Professor of Pediatrics and Pediatric Cardiologist, Hacettepe University Faculty of Medicine.

*** Associate Professor of Pediatrics and Pediatric Cardiologist, Hacettepe University Institute of Child Health.

**** Associate Professor of Pediatrics and Pediatric Cardiologist, Hacettepe University Faculty of Medicine.

***** Associate Professor of Pediatrics and Pediatric Cardiologist, Ondokuz Mayıs University Faculty of Medicine, Samsun.

has a very low complication rate[2,3] and is now used for palliative therapy of congenital cyanotic heart disease with pulmonary valvular stenosis[4].

In this article, we report our experience in treating ten cases with pulmonary stenosis by using balloon valvuloplasty. We comment particularly on the effectiveness of this method, and we review the related literature.

Material and Methods

During an 18 month period, ending in October 1988, ten patients aged between five and 15 years (mean age 7.0±3.7 years) underwent therapeutic percutaneous balloon pulmonary valvuloplasty in the Pediatric Cardiology Unit of Hacettepe University Children's Hospital. The patients were diagnosed by physical examination, electrocardiography and telecardiography. Pulmonary valvular stenosis was evaluated by Doppler echocardiography and finally cardiac catheterization and angiography. Continuous wave Doppler flow velocity recordings from the right ventricular outflow tract and main pulmonary artery were obtained as previously described. The systolic peak flow velocity from three consecutive beats were measured and averaged. A Doppler estimate of the transvalvar gradient was calculated by using the modified Bernoulli equation[1]. The diameter of the pulmonary annulus was measured by two - dimensional echocardiography. The patients, who had a 60 mm Hg or higher transvalvar gradient, underwent cardiac catheterization. Trefoil balloon catheters were used for the pulmonary valvuloplasty. The size of the catheter depended on the size of the pulmonary valve annulus which was measured on the angiogram. This technique is similar to that used by other investigators[2,3].

The patients were followed up by Doppler echocardiography. Three patients underwent a second cardiac catheterization at five to 18 month (mean 13.0±6.8 months) intervals following balloon valvuloplasty. Student's *t* test was used to compare data obtained prior to and following balloon valvuloplasty. The level of statistical significance was set at $p<0.05$.

Results

Nine patients showed good results following balloon valvuloplasty (Fig. 1). The peak systolic gradient across the pulmonary valve before valvuloplasty ranged between 70 – 180 mm Hg (mean 11.4±35.4 mm Hg) and decreased significantly to between 30 and 70 mm Hg (mean 43±13.8 mm Hg) immediately after dilation ($p<0.001$). Right ventricular peak systolic pressure before valvuloplasty ranged between 90 and 200 mm Hg (mean 133.5±33.3 mm Hg) and this value fell to 50 – 90 mm Hg (mean 64.5±13.8 mm Hg) immediately after the procedure ($p<0.001$; Table I).

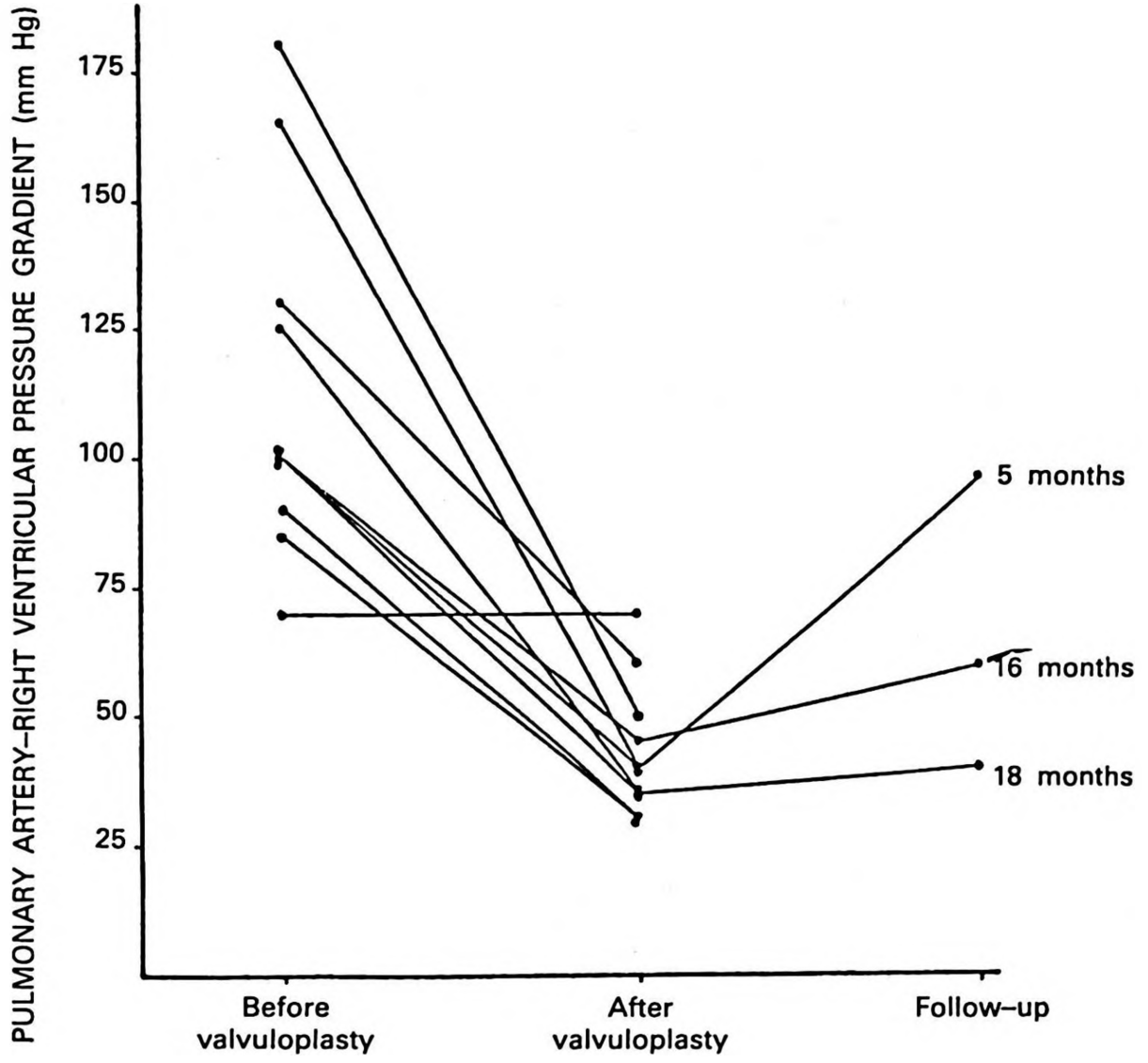

Fig. 1: Pulmonary valve peak systolic pressure gradients in ten patients with catheterization data. Note the fall in the gradient immediately after dilation. In one patient, the gradient remained unchanged. In the repeat study, the gradient increased and restenosis developed in one patient.

TABLE I: Balloon Pulmonary Valvuloplasty-Hemodynamic Data

		Before Valvuloplasty	After Valvuloplasty	
Right ventricular peak systolic pressure (mm Hg)	Range	90 – 200	55 – 90	$p < 0.001$
	mean ± SD	133.5 ± 33.3	64.5 ± 13.8	
Pulmonary artery right ventricular pressure gradient (mm Hg)	Range	70 – 180	30 – 70	$p < 0.001$
	mean ± SD	114.5 ± 35.4	43.0 ± 13.8	

In the subgroup of patients (three patients), in which long term catheterization (five to 18 months) follow – up data were available, one presented with restenosis (Fig. 1), and in the remaining two patients minimal changes were observed. Echo Doppler follow – up data were available in all patients. The duration of follow – up was three to 18 months (mean 7.0±5.2 months). Transvalvar gradients before valvuloplasty fell from 55 – 160 mm Hg (mean 97.3±37.21 mm Hg) to 30 – 51 mm Hg (mean 50.6±17.84 mm Hg) ($p<0.001$) (Fig. 2; Table II). Six patients with a long-term follow-up showed the same results after balloon valvuloplasty (Fig. 2).

Pulmonary insufficiency was detected in one patient by Doppler echocardiography while in the remaining patients there were no findings associated with this complication.

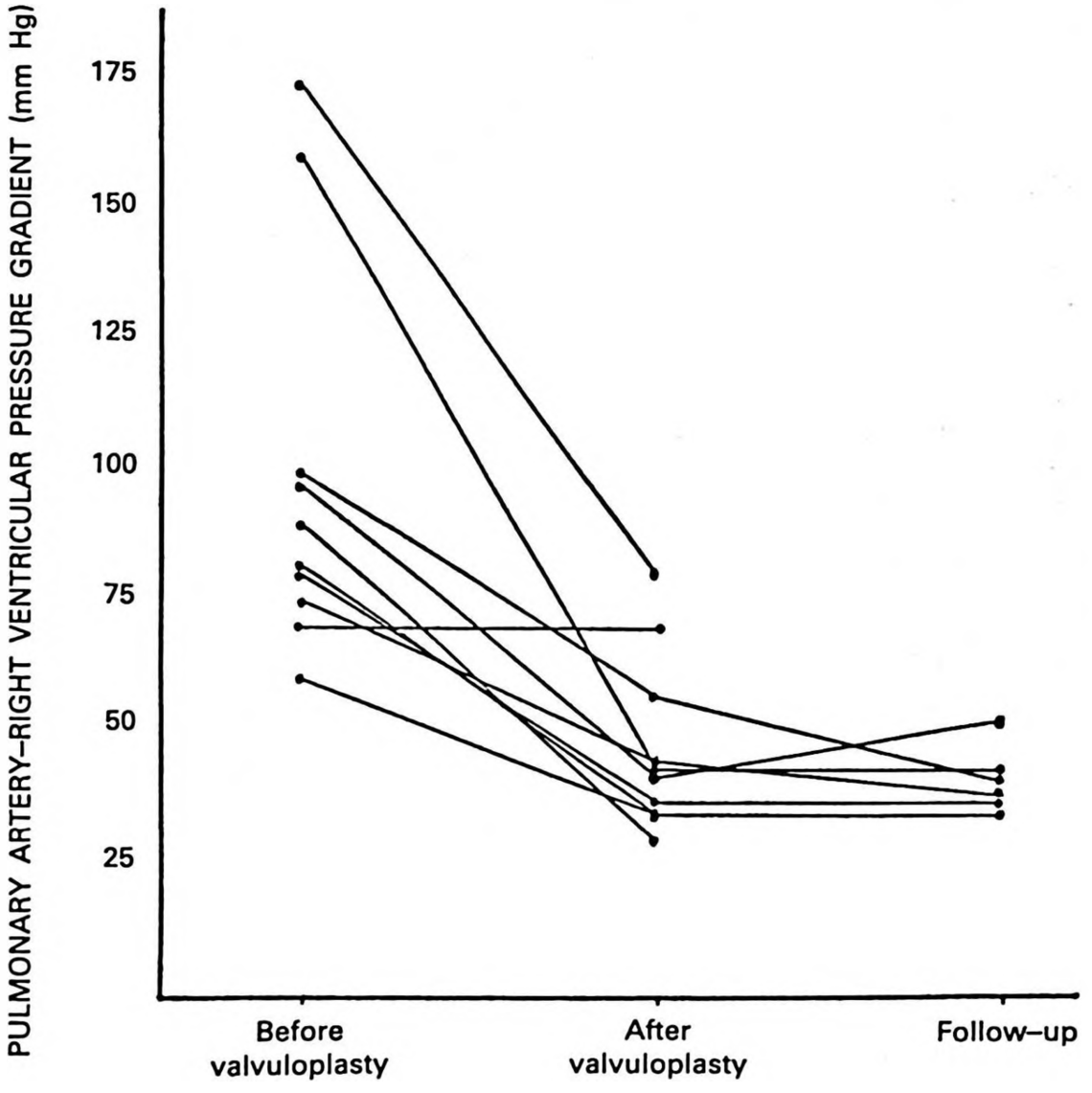

Fig. 2: Pulmonary artery-right ventricular pressure gradient before, immediately after, and at follow-up (six patients) following balloon dilatation. Doppler echocardiographic data.

TABLE II: Balloon Pulmonary Valvuloplasty: Doppler Echo Data

		Before Valvuloplasty	After Valvuloplasty	
Pulmonary artery right ventricular pressure gradient (mm Hg)	Range	55 – 160	30 – 81	
	mean ± SD	97.3 ± 37.21	50.6 ± 17.84	$p < 0.001$

Discussion

The degree of obstruction and right ventricular dysfunction represent the indications for surgical therapy in pulmonary valvular stenosis[1]. Since the mortality rate of 3 percent and the non-fatal complications rate of 12 percent are not low[1], less complicated techniques have been investigated. Kan et al[5] performed balloon valvuloplasty for the treatment of pulmonary valvular stenosis in 1985. This effective and safe technique has been employed in the Pediatric Cardiology Unit of Hacettepe University Children's Hospital since April 1987.

Ten patients with moderate to severe pulmonary valvular stenosis underwent balloon valvuloplasty in which immediate success was achieved in all but one patient who had infundibular stenosis. Balloon dilation with appropriate size balloons was attempted in this patient, but failed.

After balloon valvuloplasty, the patients were followed up by Doppler echocardiograpy and cardiac catheterization. In various studies restenosis has been detected in some patients[2,3,6,7]. These patients underwent repeat balloon dilation with a larger balloon, and successful results were obtained[2,3]. Infundibular stenosis can also be reduced to a lower degree by a repeated dilation[2]. Our three patients were followed up by cardiac catheterization; one of them had restenosis. This patient will undergo a repeat valvuloplasty.

Doppler echocardiography has been reported to be a simple and accurate non-invasive technique for quantitating the pressure gradient[8-11], and two-dimensional echocardiography has been used to evaluate the anatomical and functional status of the pulmonary valve after balloon dilation[7-9]. Kveselis et al[8] confirmed that after balloon valvuloplasty, Doppler echocardiographic studies produced results similar to cardiac catheterization.

Six patients were followed up with Doppler echocardiography at long-term intervals; the late results were consistent with the immediate results. We suggest that Doppler echocardiography be employed to follow-up patients who undergo balloon valvuloplasty.

Pulmonary insufficiency may be detected by physical examination and Doppler echocardiography[2,3,6,7]. Of a total 30 patients. Rao et al[2] reported pulmonary insufficiency in 12 patients clinically, and in 21 patients using Doppler echocardiography. Doppler evidence of pulmonary insufficiency was detected in one of our patients.

The balloon size is the most important factor in determining the success of valvuloplasty[1-3]. In their report, Rao et al[2] recommended that for effective valvuloplasty, the size of the balloon be from 1.2 to 1.4 times the pulmonary valve annulus. If restenosis is present, excellent results can be obtained by attempting a repeat dilation with a larger balloon[2]. Appropriate balloons were used for our patients, and the results were satisfactory. Infundibular stenosis and dysplastic pulmonary valves are usually the reasons for unsuccessful balloon valvuloplasty[2,6].

In conclusion, percutaneous balloon pulmonary valvuloplasty used in the treatment of moderate to severe pulmonary valvular stenosis is a very successful technique[2,3,7]. Long-term noninvasive studies, such as Doppler echocardiography seem to accurately detect hemodynamic improvement following balloon pulmonary valvuloplasty[2,8]. Despite these positive results, follow-up data taken over a much longer period (five to ten years) are necessary to further confirm the long-term effectiveness of balloon pulmonary valvuloplasty for relief of valvular pulmonary stenosis.

REFERENCES

1. Anderson RH, Macartney FJ, Shinebourne EA, Tynan M. *Paediatric Cardiology.* Edinburgh: Churchill Livingstone, 1987, pp. 959-977.
2. Rao PS, Fawzy ME, Solymar L, Mardini MK. Long-term results of balloon pulmonary valvuloplasty of valvar pulmonic stenosis. *Am Heart J* 115:1291, 1988.
3. Shrivastava S, Sundar AS, Mukhopadhyaya S, Rajani M. Percutaneous transluminal balloon pulmonary valvoplasty–long-term results. *Int J Cardiol* 17:303, 1987.
4. Qureshi SA, Kirk CR, Lamb RK, et al. Balloon dilatation of the pulmonary valve in the first year of life in patients with tetralogy of Fallot: a preliminary study. *Br Heart J* 60:232, 1988.
5. Kan JS, White RI JR, Mitchell SE, Gardner TJ. Percutaneous balloon valvuloplasty: a new method for treating congenital pulmonary-valve stenosis. *N Engl J Med* 307:540, 1982.
6. Ettedgui JA, Ho SY, Tynan M, et al. The pathology of balloon pulmonary valvuloplasty. *Int J Cardiol* 16:285, 1987.
7. Robertson M, Benson LN, Smallhorn JS, et al. The morphology of the right ventricular outflow tract after percutaneous pulmonary valvotomy: long-term follow-up. *Br Heart J* 58:239, 1987.
8. Kveselis DA, Rocchini AP, Snider AR, et al. Results of balloon valvuloplasty in the treatment of congenital valvar pulmonary stenosis in children. *Am J Cardiol* 56:527, 1985.

9. Frantz EG, Silverman NH. Doppler ultrasound evaluation of valvar pulmonary stenosis from multiple transducer positions in children requiring pulmonary valvuloplasty. *Am J Cardiol* 61:844, 1988.

10. Sundar AS, Bahl VK, Shrivastava S. Continuous wave Doppler assessment of patients subjected to pulmonary balloon valvoplasty. *Int J Cardiol* 16:257, 1987.

11. Oto A, Oram E, Oram A, Uğurlu Ş. Percutaneous balloon valvuloplasty for pulmonic value stenosis. *Hacettepe Medical Journal* 20:105, 1987.