

Pulmonary Artery Banding in Patients with Ventricular Septal Defect and Secondary Pulmonary Hypertension: a Ten-Year Study

Mohammad Yousef Arabi, MD; Mahmoud Meraji, MD; Paridokht Nakhostin Davari, MD; Akbar Shahmohammadi, MD; Mahmoud Samadi, MD

Abstract

Pulmonary artery banding (PA banding), part of a two stage- repair strategy popular in the 60s and 70s, is now largely reserved for critically ill infants with multiple ventricular septal defects (VSDs) or those with associated anomalies such as straddling atrioventricular valves.¹ Because of our limitations for total surgical correction in infants, we had to do PA banding in patients with VSD-pulmonary hypertension (PH) or VSD and atrial septal defect (ASD)-PH. Consequently, we decided to report our surgical experience during a ten-year period. To assess these results, we reviewed our ten-year experience with 108 patients with the diagnosis of VSD-PH or VSD - ASD-PH who had undergone PA banding in our institution. Twenty-three of these patients, however, were excluded from the study because of a lack of information and follow-up.

Based on the age at which PA banding was performed, we divided patients in three groups. In the first group, there were 11(13%) patients, on whom PA-banding was performed when they were under 6 months of age. There were 38 patients (44.5%) in the second group, who had undergone PA banding when they were between 6-12 months of age. And finally, 36 (42.5%) patients made up the third group, who had had PA band performed on them when they were over one-year old. Effective PA banding was performed in 64% of Group I, 75% of Group II and 64% of Group III.

In this study, we showed that the best time for PA banding in patients with VSD-PH or VSD-ASD-PH in our institution is between 6-12 months of age, and that age more than one year is not an absolute contraindication for PA banding. (*Iranian Heart Journal*. 2002, 2003; 3(2&3): 54-58)

Keywords: pulmonary artery banding < ventricular septal defect < pulmonary hypertension

Palliative surgery for left to right shunts with congestive heart failure was recommended by Muller and Damman in 1952 and was popular in the 1960s as part of a two- stage repair of VSD. Improved techniques and operative survival even for small infants with definitive repair have rendered the two- stage approach for simple VSD obsolete in most centers.² Now pulmonary artery banding is reserved for special situations, such as rapid two-stage arterial switch operations,³

univentricular heart and pulmonary nonobstructive blood flow,⁴ and critically ill infants with multiple ventricular septal defects.¹

At present, there are ongoing experiments on percutaneously adjustable pulmonary artery banding,⁵⁻⁷ or dilatable prostheses by balloon angioplasty for banding the main pulmonary artery.⁹⁻¹⁰

This report is a review of our experience in PA banding in patients with VSD-PH or VSD-ASD-PH during the period 1992-2001.

Material and Methods

The medical records of all patients who underwent PA banding for VSD-PH or VSD-ASD-PH at our department between 1992-2001 were reviewed. There were 108 patients in the study group, but because of a lack of information and follow-up, 23 patients were excluded from the study. The remaining 85 patients included 41(48%) males and 44(52%) females. Based on the age of the patients at which PA banding was performed, we divided the patients into three groups (under 6 months, 6-12 months and more than 12 months of age).

Preoperative cardiac catheterization and angiography were performed for all the patients. We evaluated and compared the efficacy of PA banding and mortality rate in these groups. There are different methods to define an effective and tolerable degree of pulmonary artery banding intraoperatively and postoperatively:

- 1) Intraoperatively, the systolic blood pressure rises. In instances of complex mixing, the arterial oxygen saturation should be 80% to 85% (pulse oximetry). If bradycardia or cyanosis develops, the band must be loosened slightly. If the narrowing is insufficient, as judged by the pressure difference across the band (distal pulmonary artery pressure should be less than 50% of systemic pressure), the band is tightened.¹¹⁻¹³

A Simultaneous measurement of the pressure above and below the band can be accomplished with a commercially available double-lumen central venous pressure monitoring catheter. This catheter is inserted through the outflow tract of the right ventricle and positioned so that the band will be between the two lumens. Gradual tightening of the band can be accomplished while monitoring the

pressure proximal and distal to the band.¹⁴

- 2) Epicardial echocardiography can be used intraoperatively to assess pulmonary artery banding procedures. Intraoperative echocardiographic estimates of the transband pressure gradients (median, 57mmHg; range 52 to 71mmHg) correlated well with those obtained at subsequent transthoracic echocardiography (median gradient, 66mmHg; range 52 to 67mmHg).^{13, 15}
- 3) When the band circumference is <90% of the standard pulmonary valve ring circumference, as calculated with an equation derived from normal pulmonary valve dimensions, best results are obtained.¹⁶
- 4) We can adjust the pulmonary artery banding at surgery by monitoring the mitral valve flow velocity, which is indirectly indicative of the pulmonary flow. The transducer of the Doppler echocardiography is placed along the left sternal border. The band is tightened gradually until the maximum velocity of the mitral valve flow decreases to around 70% of the previous level.¹⁷

In order to evaluate the efficacy of PA banding in our study, we had two groups of patients. The first group consisted of patients that had a second catheterization and angiography after PA banding. In these patients, if PA pressure (after band) was about half systemic, the PA banding was effective. The other group of patients comprised those for whom a second catheterization and angiography was not performed after PA banding. In this group, based on the clinical findings, the CXR pattern and data of transthoracic echocardiography, the efficacy of PA banding was evaluated.

Results

Of 108 patients who underwent PA banding for VSD-PH or VSD-ASD-PH at

our department between 1992-2001, there were 12 patients for whom PA banding was performed when they were below 6 months of age (Group I). One of them, however, was excluded from study. The remaining 11 patients were comprised of 4 (36%) males and 7 (64%) females. Among these patients, 2 (18%) deaths were reported. Two patients (18%) had non-effective PA banding, one of them being based on the second catheterization data and the other on the clinical findings, CXR and echocardiographic data. Seven patients (64%) had effective PA banding (Table I), five of them being based on second catheterization data and two of them clinical findings, CXR and echocardiographic data.

In the second group of patients, on whom PA banding was performed when they were between 6-12 months of age, there were 44 patients. Six patients were excluded from the study, and the remaining 38 patients were made up of 18 (47%) males and 20% (53%) females. In this group, six (15.5%) deaths were reported. Four patients (10.5%) had non-effective PA banding, two of them being based on second catheterization data and the other two on the clinical findings, CXR and echocardiographic data. Twenty-eight (74%) patients had effective PA banding (Table I), fifteen of them being based on second catheterization data and the remaining thirteen on clinical finding, CXR and echocardiographic data.

Of the 52 patients in the third group, 16 patients were excluded from the study. Nineteen (53%) males and 17 (47%) females made up this group, among whom one (3%) death was reported. Twelve (33%) patients had non-effective PA banding, 8 of them being based on second catheterization data and the other 4 on the clinical findings, CXR and echocardiographic data. Twenty-three (64%) patients had effective PA banding, 20 of them being based on second catheterization data and the other 3 on

clinical findings, CXR and echocardiographic data (Table I).

Eighty five patients were reviewed in this study, 41 (48%) of them males and 44 (52%) females. Nine (10.5%) deaths, those of 6 males and 3 females, were reported. In the remaining 76 patients, 18 (21%) patients had non-effective PA banding, 11 of them being based on second catheterization data and the other 7 on the clinical finding, CXR and echocardiographic data. Fifty eight (68.5%) patients had effective PA banding, 40 of them being based on second catheterization data and the other 18 on the clinical findings, CXR and echocardiographic data (Table I).

Table I.

	Number of patients	Mortality rate	Non effective PA band	Effective PA band
Group I	11	2 (18%)	2 (18%)	7 (64%)
Group II	38	6 (16%)	4 (10%)	28 (74%)
Group III	36	1 (3%)	12 (33%)	23 (64%)
Total	85	9 (10.5%)	18 (21%)	58 (68.5%)

Discussion

Among the 85 patients who were reviewed in this study, nine (10.5%) deaths were reported. Six cases were early or hospital mortality, and all of them were below the one year age. Therefore, the hospital mortality in the first year of life in our study is $\frac{6}{49}$ (12.5%), which is similar to that in the others studies which report hospital mortality (16%) in the first year of life.^{11,18}

The mortality rate being $\frac{2}{11}$ (18%) in the first group (those under 6 months of age); $\frac{6}{38}$ (15.5%) in the second group (those of 6-12 months of age), and $\frac{1}{36}$ (3%) in the third group (those over 12 months of age), we conclude that the mortality rate is lower in the third group. Nevertheless, since 16 patients of this group were excluded from the study as a result of the absence of a follow- up, it is difficult to

accept this conclusion. But we can definitely say that the hospital mortality rate in the third group is lower than that in the others groups.

The rate of non-effective PA banding in our study is $18/85$ (21%), which is similar to that in the reports in the literature.¹⁸

PA banding was non-effective in 18% in the first group; 10.5% in the second group, and 33% in the third group. Therefore, non-effective PA band is lower in the second group. Other studies have also shown that non-effective PA banding is more common if banding is necessary before 3 months of age.¹⁸

Effective PA banding was 64% in the first group; 74% in the second group, and 64% in the third group; consequently, the best results were in the second group of the patients.

In this study, we have shown that the efficacy of PA banding is higher in patients between 6-12 months of age than that in others. Although the hospital mortality rate is lower in patients over one year of age, many patients in this group were excluded from the study. On the other hand, the rate of non-effective PA banding in this group is higher than that in the other groups.

Another interesting result in our study is that PA banding was effective in $23/36$ (64%) in the third group, so age more than one year is not an absolute contraindication for PA banding.

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