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Transcatheter balloon valvuloplasty

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Authors describe percutaneous balloon valvuloplasty in congenital and acquired heart disease. In pulmonary, mitral and aortic stenotic valve, balloon valvuloplasty splits fused commissures and fractures calcific deposits. Since 1987 we performed 13 pulmonary, 26 mitral and 5 aortic valve dilatation. The method is recently used as a method of choice in isolated pulmonary valve stenosis, and as an alternative to surgical commissurotomy in mitral valve stenosis. Aortic valvuloplasty is performed in patients who are not candidates for surgery or for whom surgery carries a very high risk.

Key words: heart valve diseases-therapy; angioplasty, balloon; percutaneous balloon valvuloplasty; pulmonary, mitral and aortic valve

Introduction

The idea that catheter could be used to treat pulmonary valve stenosis was first proposed by Limon Larson in 1960, but Dotter and Judkins first described a catheter technique to dilate peripleural arteries stenosis in 1964.[1] In 1974, Andreas Gruntzig developed a noncompliant balloon and performed the first coronary angioplasty in 1977.[2] Kan et al., in 1982 performed fist balloon valvuloplasty for pulmonary stenosis,[3] Inoue et al. for mitral valve stenosis[4] and Lababidi et al. for aortic valve stenosis.[5] In our institution percutaneous valvuloplasty has been performed since 1987.[6, 7]

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Material and methods

Pulmonary valve

Between 1987 and April 1993 balloon valvuloplasty was used to treat congenital pulmonary valve stenosis (PS) in 13 patients. Their age ranged from 10 days to 18 years. All patients had isolated pulmonary valve stenosis with no associated cardiac defects. PS diagnosed by sector scan, pulsed, continuous and colour Doppler echocardiography underwent cardiac catheterisation and angiography. A pullback pressure recording across the pulmonary valve was performed. The mean peak systolic pulmonary valve gradient was 75 ± 26 mm Hg.

The right sided 5-French catheter through the pulmonary valve was then replaced over 0.035 inch guide wire with balloon catheter (Meditech, Schnider or Balt). The balloons

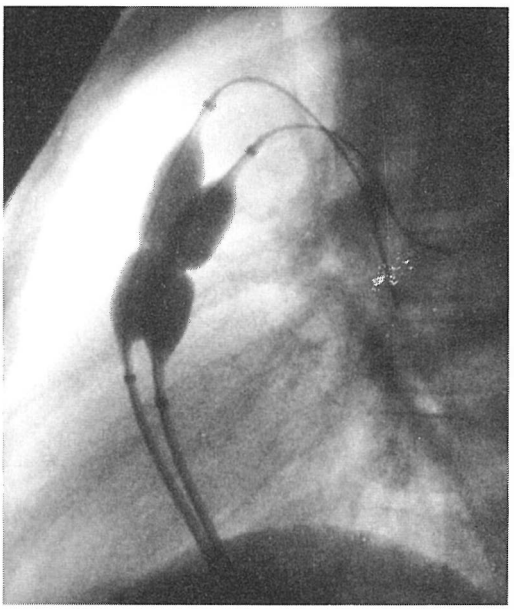

Figure 1. Two balloons of 8 mm in diameter centred across the stenotic pulmonary valve in an early phase of inflation – lateral view.

were from 6 mm to 18 mm in diameter. Balloon diameters were approximately 10 % larger than the diameter of the pulmonary valve annulus. It can be used as single or double balloon technique (Figure 1).

Mitral valve

Between 1988 and May 1993, we undertook balloon dilatation of mitral stenosis in 16 female and 10 male patients. In this group of 26 patients the mean age was 46 years (range: 31–75 years), left atrium diameter (echo) was 4.5 ± 6.7 mm × 7.5 ± 5.5 mm. Patients presented with severe symptoms: 3 patients were in NYHA class II, 19 patients in class III and 4 patients in class IV.

Echocardiographic evaluation showed mild regurgitation (n = 6, Sellers grade 1).

Fluoroscopy documented evidence of valve calcification in 6 patients. Babič's retrograde transarterial approach with double balloon technique[8] was performed in 11 patients and Inoue single balloon technique[4] with transeptal approach in 15 patients.

The Inoue technique is simple and takes the shortest time in comparison with all other techniques. A curved guide wire of 0.025 inch is inserted in the left atrium after transseptal puncture. The septum is then dilated by a 14-French dilator. A single balloon (Toray Medical Co., Tokyo) which fits well into the annulus is inflated until waist disappears.

Haemodynamic parameters (PCW, MG, PT and CO) and echocardiography (MVA) were compared before and after procedure. Statistical analysis was made. The long term observation of clinical state and measurement were performed in 15 patients.

Aortic valve

Percutaneous balloon valvuloplasty was performed between 1989 and 1993 in 5 patients. One patient, 22 years of age, had congenital aortic valve stenosis and 4 patients (mean age 81 years) had severe calcified aortic stenosis, and were not candidates for surgery. The technique of dilatation is grossly similar to that mentioned above. Left heart catheterisation is done by the femoral route, the aortic orifice is crossed with standard 0.038 inch or 0.035 inch guide wire. Over the wire a standard 7-French catheter is introduced into the left ventricle and left ventricular and aortic pressures are recorded to measure the transvalvular systolic gradient. Then 300 m long 0.038 inch guide wire is positioned through the 7-French catheter into the left ventricle, the catheter is removed and the balloon catheter (Meditech or Balt) is introduced over the wire across the aortic valve. Balloons are 40 mm long and inflated diameter is up to 30 mm. The balloon is inflated with diluted contrast medium for a few seconds.

Results

Pulmonary valve

Technically successful dilatation was achieved in 12 of the 13 patients. In one case we were

not able to cross the critical stenosis with a guide wire, and the patient later underwent surgery. In 12 patients dilatation was successful. Transvalvular gradient was reduced from 75 ± 26 mm Hg to 29 ± 16 mm Hg after valvuloplasty ($p < 0.001$).

We had one complication – perforation of the right ventricle outflow tract with a 0.021 inch e 1982, the efficacy and safety of this pulmonary valve stenosis in an attempt to perform balloon dilatation of the pulmonary valve. The complication was diagnosed by contrast injection into the pericardium. The infant was followed by sector scan echocardiography and recovered completely from the injury. The dilatation was successfully repeated a few days later with a soft tipped wire to cross the pulmonary valve.

Mitral valve

Successful dilatation produced a functional improvement in 24 of the 26 patients. In those cases valvuloplasty resulted in significant decrease in PCW from 24.3 ± 5.2 mm Hg to 14.5 ± 4.2 mm Hg ($p < 0.0001$), mitral gradient from 15.7 ± 4.1 mm Hg to 6.9 ± 3.1 mm Hg ($p < 0.0001$). Mitral valve area increased from 1.00 ± 0.002 cm^2 to 1.8 ± 0.03 cm^2 ($p < 0.0001$).

Follow up of 15 patients revealed slight reduction of MVA in all patients. In 3 patients replacement of mitral valve after 12–16 months was done. Twelve patients are still in good haemodynamic and clinical state (36 months).

At the end of the hospital stay 18 patients were in NYHA clas I or II, 6 in class III and two in class IV.

We had some mild complications as menshened bellow, but no death or embolic phenomena occurred in this serie. Four patients had insignificant left to right shunt of atrial septum.

There were two unsuccessful procedures. Mitral regurgitation developed in one patient with calcified valve and in another pulmonary oedema developed. Mitral valve replacement was necessary.

Aortic valve

In all five patients dilatation of the valve was successful, transvalvular gradient was reduced. In patients with congenital aortic valve stenosis the transvalvular pressure gradient was reduced from 75 to 30 mm Hg. In this case a mild aortic regurgitatation increased from I to stage II after procedure. One additional aortic regurgitation was noted in the remaining 4 patients. No further complications occurred. Redilatation was performed in one patient with residual stenosis.

Discussion

Pulmonary valve

Pathology that occurs in congenital pulmonary valve stenosis is characterized by commissural fusion of the cusps. In cases with central or lateral perforation a tipical dome shaped deformity is recognizable. In such valve deformity, balloon dilatation can be successfully applied with low risk.[9] Significant reductions of pulmonary valve pressure gradients immediately after percutaneous balloon valvuloplasty and at follow-up studies indicate that the relief of pulmonary stenosis from commissural splitting or cusp teating is almost permanent.[10] When infundibular stenosis accompanied pulmonary stenosis the procedure was less efficient.[9]

Since 1982, the efficacy and safety of this technique has been fully established and more than 1000 cases have been reported. It is considered a procedure of choice for the pulmony valve stenosis. It is the most common interventional procedure performed on cardiac catherizations in children.[10]

Mitral valve

Mitral valve stenosis remains the commonest of all cardiac valve disorders as a result of rheumatic heart disease in the developing countries.

Since 1983 three technique have been developed. Antegrade double balloon technique, re-

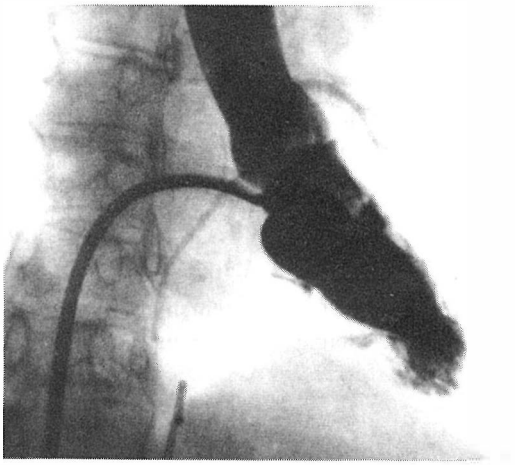

Figure 2. Inoue balloon mitral valvuloplasty. Inflated balloon across the narrow mitral valve.

trograde double balloon technique and Inoue balloon technique.[4, 8, 9] *Antegrade double balloon technique* was in the past the most widely used technique. Besides complications resulting from transseptal puncture, embolic phenomenon or mitral regurgitation which can happen in all the techniques, left to right shunting is frequent in this technique as the atrial septum has to be dilated to insert dilation balloon catheters. During follow-up period, most of the shunts disappear. A well conducted study has shown that about 10 % of all the patients who underwent this technique, had a significant shunt after a period of 6 months.[11, 12] We never used this technique in our hospital.

Retrograde double balloon technique. In this technique, the balloons are inserted through the femoral arteries over long guide wires which are inserted in the femoral vein and brough into the aorta through a transseptal puncture and exteriorised through femoral arteries by the help of a snare. This procedure has the advantage of not producing any left to right shunt. This technique is relatively complex. Local complications at the site of femoral arteries are more frequent.[13] This technique was used in our hospital in 11 patients.

Inoue balloon technique. Inoue who has performed more than 1000 cases of mitral balloon valvuloplasties has named this procedure as percutaneous transluminal mitral commissurotomy (PTMC). This technique has a lot of advantages over other techniques, however, the major drawback has been the short time available for the procedure in order to minimize the complications rate[14] (Figure 2).

Closed mitral commissurotomy was for a long time the only effective treatment for mitral stenosis.[15] Balloon mitral valvuloplasty is undoubtedly an attractive alternative to surgical commissurotomy. Initially, it was limited to young patients with pliable non-calcified valves. Mitral valvuloplasty has now been extended to calcified valves and in patients with moderate involvement of the subvalvular apparatus. The commissural splitting is a mechanism in successful balloon technique. A good haemodynamic stability was achieved in 70 % of patients for five years if one commissure was split and in 89 % of patients if both commissures were split. In patients with calcified valves dilatation improves valve area through commissural opening and fracturing the nodular depozit.[16, 17]

Its use in recurrent mitral stenosis is safe and effective.

The main contraindications for this technique is presence of fresh thrombus and significant mitral regurgitation.

Aortic valve

The clinical improvement of dilated patients is often dramatic, but restenosis note is considerably high.[18] It is unknown which patients will receive long term benefits from balloon dilatations.[19]

It appears to be a technique of choice in patients who are not surgical candidates or for whom surgery carries a very high risk, i.e. mainly in elderly patients. It is also considered as an effective and less invasive alternative to surgical valvotomy in infants and children particularly in the cases of restenosis after surgical valvotomy where the need for the implantation of a prosthetic valve is otherwise mandatory.

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