INDICATIONS AND CONTRAINDICATIONS FOR AORTIC, MITRAL, PULMONARY AND TRICUSPID BALLOON VALVOTOMY

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The advent of coronary angioplasty paved the way for the nonsurgical dilatation of valvular stenosis using the balloon valvotomy technique. This new therapeutic alternative obviates general anesthesia, open thoracotomy, and extracorporal circulation with a prolonged hospital stay. The procedure requires a great deal of skill from the invasive cardiologist.

Currently, balloon valvotomy is the therapeutic procedure of choice for mitral and pulmonary valvular stenosis. There is an important role for aortic balloon valvotomy in children with congenital aortic valve stenosis. In contrast, the indications for balloon dilatation in calcific degenerative aortic stenosis are dwindling. The immediate results are poor and the rate of restenosis at short-term follow-up is prohibitive. The role of balloon valvotomy for rheumatic aortic valve stenosis is currently under investigation. Although balloon valvotomy for rheumatic tricuspid stenosis achieves a marked increase in valve area, few patients will be suitable for this procedure since the majority have concomitant severe tricuspid regurgitation.

Aortic Balloon Valvotomy

The underlying pathology of aortic stenosis will determine if the valve is "balloonable." The manner by which the aortic valve area increases by balloon valvotomy in rheumatic aortic stenosis is commissural splitting. In children with congenital aortic valve stenosis, the successful balloon valvotomy may be secondary to a minor degree of commissural splitting. In calcific degenerative aortic valve stenosis, the mild increase in valve area following balloon dilatation is secondary to calcium leaflet fractures and valve stretching.

The precise definition of the type of valve pathology is of paramount importance; for instance, the results of balloon valvotomy are good in children with congenital aortic stenosis, suboptimal in adolescents with congenital aortic stenosis, and poor for calcific degenerative aortic stenosis. The clinical indications are for those patients with severe calcific degenerative aortic stenosis and intractable heart failure who are not candidates for cardiac surgery. Angioscopy of the aortic valve may in the future play a role in the selection of patients for this type of intervention.

Mitral Balloon Valvotomy

The mitral in vitro studies unequivocally demonstrated that commissural splitting is the mechanism by which the mitral valve area increases after successful balloon valvotomy, and this is similar to surgical valvotomy. The balloon catheter splits both calcified and uncalcified mitral commissures. The systematic analysis of the mitral subvalvular apparatus revealed that the mitral subvalvular splitting plays a minor role, if any, in increasing the mitral valve area by balloon valvotomy. Another observation indicates that the texture of the mitral valve and status of the mitral subvalvular apparatus are major determinants of the final results of the procedure. This finding has important clinical implications in the selection of patients for mitral balloon valvotomy because the mitral valve area results of patients with severe subvalvular mitral fusion are suboptimal.

A great deal of controversy has been generated.
concerning the best technique for mitral balloon dilatation. Until recently, the double-balloon technique initially described by Al-Zaibag et al using two balloon catheters (20 + 18mm or 20 + 20-mm) prevailed. The valve areas achieved are excellent. The greater than 100% increase in the mitral valve area is maintained at one- and two-year follow-up. However, the technique is difficult to master and is cumbersome; it requires two transseptal punctures and the simultaneous alignment of the two balloon catheters' inflated across the mitral valve.

The commercially available Inoue balloon catheter constitutes a landmark for mitral balloon valvotomy. The technique is easy to execute when compared to the double-balloon technique and requires one single transseptal puncture without the need for a sheath; the balloon crosses the mitral valve independently, without the use of a guidewire or a long transseptal sheath. Crossing the mitral valve with an Inoue balloon can be difficult in a few cases. Experience has taught us that the transseptal puncture should be done at or above the fossa ovalis in those cases that have small left atriums and a low puncture in gigantic left atriums. This ingenious device from the pioneer of balloon mitral valvotomy permits sequential dilatation, and the balloon does not slip from the mitral valve during inflation. The device is very expensive and is the main drawback for the use of this technique, particularly in Third World countries where mitral stenosis is prevalent.

We have done 45 cases of balloon valvotomy using the Inoue technique at our institution and the mitral valve areas achieved were similar (1.7 ± 0.5 cm2) to those obtained using the double-balloon valvotomy technique. The incidence of iatrogenic mitral regurgitation in these patients was not great; six patients developed mild mitral regurgitation and three patients increased from mild to moderate. No significant atrial septal defect was detected using this technique, and there were no complications. These results were achieved in a selected population of patients with pliable mitral valves. The suitable valves were selected according to echocardiographic criteria based on Dr. Carlos Duran's two decades of experience with surgical mitral valvotomy: (1) pliable anterior mitral leaflet, (2) absence of significant mitral subvalvular disease, (3) absence of calcification of the mitral commissures, and (4) the mitral valve orifice shape on echocardiography. Randomized studies using the two different techniques are needed.

Presently, we offer balloon valvotomy to all symptomatic patients with severe mitral valve stenosis (mitral valve area ~ 1.1 cm2). The indications include asymptomatic women of child-bearing age with mitral valve areas of ~ 1.2 cm2. Patients with severe mitral restenosis after surgical valvotomy and a calcified mitral valve but with calcium-free commissures may be good candidates for intervention. If we attempt balloon valvotomy in mitral valves with severe subvalvular disease and calcified commissures, residual stenosis will persist (mitral valve area ~ 1.5 cm2) or significant mitral regurgitation will develop in 40% of cases (unpublished data). The presence of left atrial thrombus or moderate-to-severe mitral regurgitation constitutes an absolute contraindication for the procedure. Similar to surgical closed valvotomy, the best mitral valve area results will be achieved in patients with pliable mitral valve leaflets and minimal mitral subvalvular disease.

The mitral valve areas achieved by balloon valvotomy (20 + 20-mm balloon catheters) and the incidence of iatrogenic mitral regurgitation are similar to the results obtained by surgical open valvotomy. The procedure has great potential in the Kingdom of Saudi Arabia. Both the Inoue and the double-balloon valvotomy techniques are currently used in three institutions in Riyadh: Armed Forces Hospital, King Faisal Specialist Hospital and Research Centre, and King Khalid University Hospital. We have learned that the Inoue device can be sterilized several times and hence the need to purchase only the balloon catheter, making this expensive device more affordable.

**Pulmonary Balloon Valvotomy**

Pulmonary balloon valvotomy is now the treatment of choice for both children and adults with severe valvular pulmonary stenosis. The hemodynamic results are excellent which still persist at one-year and two-year follow-up. The technique is relatively easy to perform with...
mal complications. Patients with dysplastic pulmonary valves do not benefit from the procedure and warrant surgical intervention. We prefer the double-balloon technique since this approach appears to minimize hypotension and bradycardia during balloon inflation. However, in adults the largest size balloon available may not be large enough to relieve stenosis. The appropriate balloon size selection is of paramount importance for good results. A number of patients develop infundibular pulmonary stenosis following balloon valvotomy. This particular complication will improve with time and beta-blockers may have a therapeutic role.

**Tricuspid Balloon Valvotomy**

The 150% increase in tricuspid valve area after double-balloon tricuspid valvotomy is similar to the results reported after surgical valvotomy. Moreover, we have demonstrated a striking rise in cardiac output, both at rest and during exercise, after successful balloon tricuspid valvotomy. This finding was corroborated by the patient’s symptomatic improvement. There was no objective evidence of restenosis at a three-year follow-up study.

The echocardiographic features of tricuspid valve stenosis are not precise indicators of hemodynamic significant tricuspid stenosis. A hemodynamic study with provocative maneuvers is required to detect an exposed tricuspid valve stenosis. Patients with severe tricuspid stenosis and mild-to-moderate tricuspid regurgitation are potential candidates for balloon tricuspid valvotomy.

The morphological features of the tricuspid valve include a large annulus, and hence the double-balloon technique is indicated to relieve stenosis. Though the procedure is technically easy to execute, several inflations are usually required to achieve optimal balloon alignment across the tricuspid valve. Therefore, it may be appropriate to use two preshaped transseptal sheaths in order to stabilize the balloons across the tricuspid valve during balloon inflation.

This technique is suitable not only in patients with severe tricuspid stenosis but also for patients with concomitant severe rheumatic mitral and tricuspid valve stenosis. Since the majority of

**Conclusion**

Invasive cardiology is witnessing an exciting area with the advent of balloon valvotomy. The technique is an established alternative to the surgical treatment of mitral and pulmonary stenosis for a few patients with tricuspid stenosis and children with aortic stenosis. For adult patients with calcific degenerative aortic stenosis, the technique is an acceptable procedure as a life-saving measure in patients who are not candidates for aortic valve replacement. The intervention requires a great deal of skill from the invasive cardiologist, particularly for the mitral balloon valvotomy technique. The technique has a learning curve of at least 50 cases and therefore should be initially confined to one invasive cardiologist in anyone institution. The success of the procedure will depend on the appropriate patient and the balloon size selection. Optimal results will only be achieved when intervention is undertaken by a highly disciplined team of cardiologists, nurses, radiographers, and cardiac technicians. We can conclude, as Julius Cesar is said to have summarized his war campaign in Italy: "Veni, Vedi, Vinci"; I arrived, saw and conquered. The very short, but successful story of balloon valvotomy seems to warrant a similar comment.

**References**


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Journal of the Saudi Heart Association, Vol, No.2,