Initial experience of using intracardiac echocardiography (ICE) for guiding balloon mitral valvuloplasty (BMV)

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Background and aims: BMV is an established treatment for rheumatic mitral valve stenosis. The procedure is historically guided by fluoroscopy, and the role of intracardiac echocardiogram (ICE) guidance is not well defined. We report our initial experience of using ICE to guide BMV procedures.

Methods: During BMV procedure, ICE catheter was inserted into the right atrium from the right femoral vein, and the septal puncture was monitored by ICE, as well as positioning of the balloon in the mitral valve. Comparisons were made between ICE, transthoracic echocardiography (TTE), and catheterization derived hemodynamic measurements (cath).

Results: Seventeen patients with mitral stenosis underwent the procedure. The mean age was 44.4 ± 21 years. The mean MV area increased from 0.9 ± 0.1 cm 2 to 1.7 ± 0.2 cm 2, P < 0.0001 and the mean gradient decreased from 12.6 ± 5.8 mmHg to 4.9 ± 1.8 mmHg, P < 0.001. Atrial septum puncture and guidance of the balloon into the MV apparatus were obtained in all patients under ICE guidance. Severe MR developed in one patient and was readily detected by ICE. ICE derived gradient measurements were comparable to those obtained by TTE, and cath.

Conclusion: ICE guidance of BMV is feasible, and useful in monitoring safe septal puncture, optimizing balloon positioning, and in detecting complications. The hemodynamic measurements obtained were comparable to those obtained by TTE, and cath.

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Balloon mitral valvuloplasty (BMV) has been a well accepted modality of treatment for symptomatic patients with significant mitral stenosis (MS) [1–3]. Traditionally, the procedure has been monitored by fluoroscopy. In order to achieve better visualization of the intracardiac anatomy and to reduce radiation hazards, on-line transesophageal echocardiography (TEE) also has been used to guide procedures [4,5]. We aimed in our study to explore the feasibility of using ICE during BMV, and compare ICE derived hemodynamic measurements to those derived from TTE, and Cath.

Methods

The study has been approved by our research ethics committee, to be performed in patients with...
symptomatic significant MS, who are indicated for BMV. The procedure was performed under local anesthesia. An 8 French ICE catheter (AcuNav ultrasound catheter, manufactured by Siemens health care) was inserted in the femoral vein, and directed to the right atrium under fluoroscopy guidance.

ICE was used in each patient to inspect the left atrium for the presence of thrombi. The interatrial septum was examined for the presence of aneurysms or shunts. The MV apparatus was examined, and MR severity was assessed and the mitral gradient was obtained.

The procedure was guided by the ICE to facilitate the trans septal puncture, introduce the balloon into the MV apparatus, assess the MR severity after each balloon inflation, and to detect any complications after each balloon inflation. Gradients were measured by (ICE), TTE, and cath before and after balloon dilatation. The BMV was performed by an experienced interventional cardiologist.

**Results**

Seventeen patients undergoing BMV were included in the study, with a mean age of 44.4 ± 21 years. Nine of the patients were females, and 8 were males.

The baseline characteristics of the patients are shown in Table 1.

The procedure was completed successfully in all patients without fatal complications. The MV gradient dropped significantly after the procedure, with the mean gradient decreasing from 12.8 ± 5.8 mmHg to 5 ± 1.8 mmHg (P < 0.001, Fig. 1A), and the mean MV area increasing from 0.9 ± 0.1 cm\(^2\) to 1.7 ± 0.2 cm\(^2\) (P < 0.0001, Fig. 1B).

The hemodynamic measurements obtained by ICE, were comparable to those obtained by TTE Fig. 2A, and cath Fig. 2B.

In one patient, severe eccentric MR developed due to a tear in the anterior leaflet. Another patient developed a pericardial effusion (Fig. 3).

**Table 1. Patient characteristics.**

| Number | 17 |
| Age    | 44.4 ± 21 |
| Gender (M/F) | (8/9) |
| NYHA   | 2.2 ± 1.1 |
| EF (%) | 54.5 ± 6.2 |
| PAP (mmHg) | 62.5 ± 17.1 |
| Echo score | 7.8 ± 1.3 |

Figure 1. Pre and post procedure comparison of mean mitral gradients (A) and mitral valve area (B). This demonstrates a significant reduction in peak and mean mitral valve gradients, and almost doubling of the mitral valve area.

Figure 2. Comparison of ICE derived peak mitral gradient to those derived by TTE (A), and cath (B).
which was managed conservatively. Both complications were detected promptly with ICE.

Discussions

Percutaneous BMV is a safe, effective, less invasive alternative to surgery for selected patients with mitral stenosis [6,7].

It is, however, not without morbidity, the most serious being cardiac perforation, systemic embolization and the development of mitral regurgitation [8]. These potentially fatal complications can be minimized with the use of echocardiography.

Our study, being a feasibility study, included small number of patients, but has shown significant benefits in using ICE during BMV. Historically, the procedure has been guided solely with fluoroscopy. However, there are several limitations to the use of fluoroscopy: radiation exposure to the patient and the physician, poor resolution of soft tissue structures and problems associated with the use of iodinated contrast agents.

During valvuloplasty, TEE has been shown to be an invaluable aid in guiding the trans-septal puncture by visualizing the “Tenting” of the interatrial septum by the Brockenbrough needle [9]. TEE is also useful in guiding the balloon catheter across the mitral valve [9,10] and obtaining a quick and accurate assessment of the mitral valve area and the amount of mitral regurgitation [10]. After valvuloplasty TEE can assess the adequacy of the procedure [10,11].

Recently, an 8 F ICE catheter is available for guiding interventional, and electrophysiology procedures with potential clinical benefits. The advantage of ICE over TEE in guiding interventional procedure is an obviation of general anesthesia or deep sedation, and the discomfort, and prolonged esophageal intubation when using TEE. However, the patient discomfort can be minimized by using the new small size TEE probes that require less sedation.

Both ICE and TEE have the same potential benefits, in guiding BMV.

ICE enables the proper septal puncture at the fossa ovalis, as indicated by tenting of the septum by the Brockenbrough needle (Fig. 4), and enabling proper balloon position, thus avoiding inflation of the subvalvular apparatus (Fig. 5).

Online pressure gradient measurements after each inflation can be obtained readily with ICE (Fig. 6). This was not possible in the past with using fluoroscopy.
Complications are infrequent with this procedure, but early detection is crucial in patient management. In two of our patients who developed complications during the procedure, ICE enabled prompt detection, and facilitated proper management. One patient developed severe, eccentric MR which was detected immediately after the balloon inflation, and was found to be due to a tear in the anterior mitral valve (Fig. 3B).

The other patient developed a pericardial effusion, which was detected before development of tamponade and hemodynamic instability (Fig. 3A). The early detection of intraprocedure complications allows proper management.

ICE has an established role during electrophysiology procedures as has been previously published [12,13].

The limiting factor in using ICE is being relatively expensive, and the need for special training, and achievement of a learning curve in using the technique. The other limiting factor is the need for an experienced echocardiographer to be present in the cath lab for a long period of time during these specialized interventional procedures.

Limitation of the study

There are few limitations of this study which include, the small sample number of patients, lack of comparison between ICE and TEE. The study also did not explore the effect of ICE on procedure time, and radiation dose as compared to historical cohort of patients who underwent BMV under fluoroscopy alone. Larger studies need to be conducted to confirm these findings, and to justify the routine use of this relatively expensive technology.

Conclusion

ICE guidance of BMV is feasible, and useful in monitoring safe septal puncture, optimizing balloon positioning, and enables early detection of procedural complications.

References


