Transoesophageal echocardiography in the assessment of percutaneous mitral commissurotomy

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KEY WORDS: Transoesophageal echocardiography, mitral stenosis

The aim of this study was to assess the value of transoesophageal echo (TEE) in comparison with transthoracic echocardiography (TTE) in selecting candidates and evaluating the results of percutaneous mitral commissurotomy (PMC). One hundred and ten patients (pts) were examined by TEE and TTE before PMC. PMC was not performed in eight pts who had a thrombus in the left atrium detected by TEE but not by TTE. Out of the 102 other pts, TEE was better than TTE in detecting mild mitral regurgitation (MR) (84 vs 38, \( P < 0.01 \)). Spontaneous contrast was only shown by TEE in 70 pts. On the other hand, planimetry of the valvular area was only possible with TTE. This technique was also better in the assessment of the commissural area.

During PMC, TEE enabled the interatrial septum to be punctured in two pts. After PMC, MR was trivial in 49 TEE cases compared with 36 by TTE and was moderate in 20 TEE pts compared with 12 by TTE (\( P < 0.02 \)). Transoesophageal colour Doppler showed a trivial atrial shunt in 63% of cases vs 13% by TTE (\( P < 0.01 \)). A small atrial septal defect was found in 30 cases only by TEE, and a spontaneous contrast persisted in all pts but six with moderate MR.

In conclusion, TEE provides useful information in the ultrasonic assessment of PMC in particular with left atrial thrombi, mitral regurgitation, and the post-PMC atrial septal defect. However, both methods are complementary and only TTE enables calculation of valve area.

Introduction

Percutaneous mitral valvuloplasty (PMV) has been shown to be effective in the treatment of patients with mitral stenosis. According to recently published series, the quality of its result depends on the severity of anatomical lesions which are usually assessed by transthoracic echocardiography (TTE). However, TTE has several limitations, in particular in the diagnosis of left atrial thrombi which are a contraindication for the transseptal approach, and in detecting some post-PMV complications. The purpose of this study was to assess the value of transoesophageal echocardiography (TEE) before and after the procedure.

Methods

PATIENTS

We studied 110 consecutive patients with severe symptomatic mitral stenosis who were referred to our echo laboratory before PMV between January and October 1990. There were 78 women and 32 men and their mean age was 51 ± 18 (range 28–83) years. Seventy patients were in sinus rhythm and 40 had atrial fibrillation; 13 had had a previous thromboembolic event.

STUDY PROTOCOL

Haemodynamics. All patients without a left atrial thrombus as assessed by TEE (n = 102) underwent

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PMV by the transseptal approach. Left and right heart pressures were obtained before and after valvotomy, and cardiac output was measured by the thermodilution method. The dilatation was carried out using the double balloon technique. Mitral valve area was calculated from the Gorlin formula, and mitral regurgitation was evaluated by left ventriculography.

Echocardiographic examination. A complete study was performed in all patients with a Hewlett Packard 77020 A echocardiograph equipped with a 2.5 MHz phased-array transducer. Standard images were obtained in the parasternal long and short axis and the apical four-chamber and long-axis views. Special attention was given to imaging the subvalvular apparatus and to defining the location of valvular calcifications (leaflet body or commissure). The degree of regurgitation was graded according to increasing severity, from 0 to 4+. Transoesophageal study using a single plane 5 MHz Hewlett Packard phased-array transducer was carried out according to the technique previously reported. The mitral valve, the left atrium and its appendage and the interatrial septum were carefully examined. The gain setting was adjusted in order to study left atrial spontaneous echo contrast and to allow a differentiation from white noise echo.

All echocardiographic images were recorded on videotape for further analysis and all echo studies were performed within 7 days of, and between 24 and 48 h after, PMV. Transthoracic and transoesophageal studies were performed on the same day.
Statistical analysis. The paired t-test and the chi-square test were used to analyse the results.

Results

Before PMV the main advantage of TEE was the detection of eight thrombi (five in the left atrial appendage and three in the left atrium), all missed by TTE. They were a contraindication for valvotomy and consequently only 102 patients underwent the procedure. Spontaneous contrast within the left atrium could only be detected by TEE in 65 patients (59%). All patients with a left atrial thrombus (n = 8) and/or history of a documented arterial embolism, (n = 13) had spontaneous left atrial contrast. None of the patients without spontaneous echos had a thrombus demonstrated by TEE. There was a statistical correlation between spontaneous contrast and thromboembolism (P<0.001); its sensitivity, specificity, positive and negative predictive values as indicators of thromboembolism were respectively 100, 44.4, 31.4 and 100%. Table 1 shows that patients with spontaneous contrast had a higher incidence of atrial fibrillation, a larger left atrium, a lower cardiac index and a smaller mitral area than the others. In order to assess the influence of atrial fibrillation, we studied patients in sinus rhythm (n = 70): 31 had spontaneous contrast and 39 had echo-free left atrial chambers. The left atrium was significantly larger and cardiac index significantly lower in the first group than in the second group (Table 2). Table 3 shows the results of TTE and TEE in assessing anatomic lesions. The two techniques were equally useful in the assessment of the valvular and subvalvular apparatus with the exception of commissural calcifications, due to the inability of TEE to show these areas. On the other hand, mild mitral regurgitation was easier to detect by TEE than by TTE.

During PMV TEE was used during cardiac catheterization to guide the interatrial septal puncture by visualizing the transseptal needle and catheter in relation to the surrounding cardiac and extracardiac structures in two patients. This ensured that the tip of the needle was in contact with the atrial septum in the region of the fossa ovalis.

After PMV the mitral valve area increased from 1 ±0.3 to 2.1 ±0.5 cm² (P<0.0001) as assessed by catheterization (the values were respectively 1.05 and 1.9 cm² for two-dimensional echo and 1.05 and 2 cm² for Doppler).

Five cases of severe mitral regurgitation required surgery. According to the surgical data, the mechanism of regurgitation was a leaflet tear along a commissural calcification in four cases (posterior leaflet in two and anterior leaflet in two) (Figs 1 and 2) and a torn commissure in one patient.

In each case, TTE was able to show the direction of the regurgitant jet within the left atrium and its origin at or close to the involved commissure, but failed to evaluate the definite mechanism in three cases; TEE demonstrated the torn cusp in all cases, with localized rupture of chordae in two cases, but failed to assess the mechanism of MR in the torn commissure case.

With respect to the other potential post PMV-complication, interatrial shunting, the incidence immediately after the procedure, was 63% by transesophageal colour Doppler (Fig. 3), 13% by

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**Table 1** Comparison of patients with (group 1) and without (group 2) spontaneous echo contrast

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Group 1 (n = 70)</th>
<th>Group 2 (n = 40)</th>
<th>P value ((\leq))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atrial fibrillation (%)</td>
<td>57</td>
<td>0</td>
<td>0.0001</td>
</tr>
<tr>
<td>Left atrial size (mm)</td>
<td>58 ± 9</td>
<td>46 ± 5</td>
<td>0.0001</td>
</tr>
<tr>
<td>Cardiac index (L/min. -1.m -2)</td>
<td>2.59 ± 0.38</td>
<td>3.32 ± 0.54</td>
<td>0.0001</td>
</tr>
<tr>
<td>Mitral area (cm²)</td>
<td>0.96 ± 0.20</td>
<td>1.14 ± 0.24</td>
<td>0.05</td>
</tr>
<tr>
<td>Mean gradient (mmHg)</td>
<td>9.5 ± 4</td>
<td>12.5 ± 6</td>
<td>NS</td>
</tr>
</tbody>
</table>

Values are expressed as group means ± 1 SD.
NS = not significant.

**Table 2** Comparison of patients in sinus rhythm (n = 70) with (group 1) and without (group 2) spontaneous echo contrast

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Group 1 (n = 31)</th>
<th>Group 2 (n = 39)</th>
<th>P value ((\leq))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left atrial size (mm)</td>
<td>54 ± 5</td>
<td>46 ± 3</td>
<td>0.001</td>
</tr>
<tr>
<td>Cardiac index (L/min. -1.m -2)</td>
<td>2.78 ± 0.44</td>
<td>3.42 ± 0.58</td>
<td>0.01</td>
</tr>
<tr>
<td>Mitral area (cm²)</td>
<td>1.05 ± 0.19</td>
<td>1.16 ± 0.28</td>
<td>NS</td>
</tr>
<tr>
<td>Mean gradient (mmHg)</td>
<td>13.5 ± 5</td>
<td>16.5 ± 8</td>
<td>NS</td>
</tr>
</tbody>
</table>

**Table 3** Comparison of TTE and TEE in the assessment of mitral lesions

<table>
<thead>
<tr>
<th></th>
<th>TTE (%)</th>
<th>TEE (%)</th>
<th>P value ((\leq))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pliable leaflet</td>
<td>68</td>
<td>73</td>
<td>NS</td>
</tr>
<tr>
<td>Calcification (leaflet)</td>
<td>22</td>
<td>17</td>
<td>NS</td>
</tr>
<tr>
<td>Calcification (commissure)</td>
<td>15</td>
<td>4</td>
<td>0.05</td>
</tr>
<tr>
<td>Subvalvular disease</td>
<td>74</td>
<td>69</td>
<td>NS</td>
</tr>
<tr>
<td>Mild mitral regurgitation</td>
<td>38</td>
<td>84</td>
<td>0.001</td>
</tr>
</tbody>
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Transcatheter echocardiography: tear (◁) of the anterior mitral leaflet. transthoracic colour Doppler and 14% by oximetry. The QP/QS ratio determined by oximetry was never over 2 and between 1.5 and 2 in 4% of patients. Small atrial septal defects could only be visualized by TEE in 29% of patients with interatrial shunting demonstrated by colour Doppler. It was always smaller than 5 mm in diameter, measuring between 3 and 5 mm in diameter in 18 cases. Fifty patients underwent follow-up examination 6 ± 2 months after PMV. Persistent atrial shunting was found in 16% of patients, always associated with a small defect.

Discussion

PMV has become established as a valuable alternative to surgical commissurotomy for the

Figure 1 Transesophageal echocardiography: tear (◁) of the anterior mitral leaflet.

Figure 2 Transesophageal colour Doppler: same patient as Fig. 1 (OG: left atrium IM: mitral regurgitant jet).
treatment of mitral stenosis. However, this technique has some contraindications, mainly represented by left atrial thrombosis and mitral regurgitation $\geq 2+$. Left ventricular angiography remains the 'gold standard' for assessing the severity of mitral regurgitation and, up to now, TTE has been the technique of choice for detecting left atrial thrombus. In fact, reported series with anatomical correlations $^{5-7}$ unequivocally demonstrate the poor sensitivity of TTE for this purpose due to its inability to image the left atrial appendage.

The superiority of TEE in this context is clear, as shown in several reports $^{8,9}$ and our experience is in total agreement: the eight thrombi in our series were detected only by TEE. Our results are also in agreement with those of Daniel et al. $^{10}$ who stressed that left atrial spontaneous echo contrast was an indicator of thromboembolic risk. In accordance with their results, we found that patients with spontaneous contrast had larger left atrial diameters than those without, and, in addition, we also found that patients with contrast had lower cardiac outputs and more severe mitral stenosis. Interestingly, among the 70 patients who were in sinus rhythm, 44% had spontaneous contrast and three of them had a history of systemic embolism.

According to surgical data indicating that patients with pliable valves and absence of calcification have better initial results and long-term prognosis after commissurotomy $^{11,12}$, morphological characteristics of the mitral valve and subvalvular apparatus, as assessed by two-dimensional echocardiography, have been shown to be predictive of the results of PMV. Our results indicate that TEE does not improve on the accuracy of TTE in assessing the anatomy of the mitral apparatus; it is even inferior to TTE in detecting calcification involving the commissural areas, which seems to be a risk factor for severe post-PMV regurgitation. Their mechanism is mainly a tear of the posterior or anterior leaflets in the para commissural area $^{13,14}$. Both TTE and TEE are complementary in predicting the mechanism of mitral regurgitation: TTE in the short axis view showing which commissure is involved, TEE showing which leaflet is involved and eventual rupture of chordae. The other major potential post-PMV complication is the interatrial shunting. Its incidence is highly variable according to the technique used for its detection. The lack of sensitivity of the oximetric method (shunt rate between 8 and 25%) is now well established $^{15-17}$. The sensitivity of TTE is a little higher $^{18-20}$ but it is not possible to visualize the whole septum by this technique; it also has technical limitations, such as artifactual loss of the echocardiographic signal from the interatrial septum. On the other hand, TEE provides better images of the atrial septum and allows more accurate detection of atrial septal defect (ASD) as reported in several studies $^{21,22}$. It is also the most sensitive method of detecting post-PMV shunting $^{23,24}$; in the majority of cases, the volume of these shunts, as assessed by oximetry, is small and they tend to disappear on follow-up in our experience. Our results indicate that the visualization of an ASD immediately after PMV could be a predictive factor of persistent shunting on follow-up, but this subject remains a matter of discussion. The last point is the utility of transoesophageal echocardiography during PMV: in
our experience, as in the literature\textsuperscript{25-28}, it may be useful for guiding the transseptal needle across the atrial septum in difficult cases (severe enlargement of the left atrium, cardiothoracic deformity).

In conclusion, TEE provides additional information before PMV in diagnosing left atrial thrombi, after PMV in assessing the mechanism of mitral regurgitation and in detecting post-PMV shunting. It may also be used during cardiac catheterization to guide the interatrial septal puncture in difficult cases.

References


[17] Palacios IF, Block PC, Brandi S et al. \textit{Percutaneous balloon valvotomy for patients with severe mitral stenosis Circulation 1987; 75: 775–84.}


