Which method should be the reference method to evaluate the severity of rheumatic mitral stenosis? Gorlin’s method versus 3D-echo

Leopoldo Pérez de Isla a, Carlos Casanova a, Carlos Almería a, José Luis Rodrigo a, Pedro Cordeiro a, Luis Mataix a, Ada Lia Aubele a, Roberto Lang b, José Luis Zamorano a,*

a Unidad de Imagen Cardiovascular, Hospital Clínico San Carlos, Madrid, Spain
b University of Chicago Hospitals, Chicago, USA

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Abstract Introduction: Several studies have shown a wide variability among different methods to determine the valve area in patients with rheumatic mitral stenosis. Our aim was to evaluate if 3D-echo planimetry is more accurate than the Gorlin method to measure the valve area.
Methods: Twenty-six patients with mitral stenosis underwent 2D and 3D-echo echocardiographic examinations and catheterization. Valve area was estimated by different methods. A median value of the mitral valve area, obtained from the measurements of three classical non-invasive methods (2D planimetry, pressure half-time and PISA method), was used as the reference method and it was compared with 3D-echo planimetry and Gorlin’s method.
Results: Our results showed that the accuracy of 3D-echo planimetry is superior to the accuracy of the Gorlin method for the assessment of mitral valve area.
Conclusions: We should keep in mind the fact that 3D-echo planimetry may be a better reference method than the Gorlin method to assess the severity of rheumatic mitral stenosis.
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Abbreviations: MVA, mitral valve area; PISA, proximal isovelocity surface area; PHT, pressure half-time.
* Corresponding author. Tel./fax: +34 91 330 32 90.
E-mail address: jlzamorano@vodafone.es (J.L. Zamorano).
Introduction

The fundamental treatment for rheumatic mitral stenosis is to increase the mitral valve area (MVA) by means of percutaneous balloon valvuloplasty or by surgical valve replacement. In order to establish the time of surgery and an optimal management, it is essential to make an appropriate and accurate assessment of its severity. At present, the invasive measurement of the mitral valve area is based on the Gorlin formula. This method has been used as the invasive reference method to assess the severity of the rheumatic mitral stenosis. However, it is an invasive method that may result in complications and inaccuracies. Recently, real time 3D echocardiography has become an available technique in many echocardiography labs, providing numerous advantages in the assessment of valvular disease.

Our aim was to analyze if 3D-echo planimetry is more accurate than the Gorlin method to quantify the MVA in mitral stenosis.

Methods

Twenty-six patients with rheumatic mitral stenosis were enrolled for the study. All of them were given oral and written information about the techniques they would be performed. They were also informed and gave consent for anonymous use of their data for research purposes.

Echocardiographic studies

All the patients underwent a full echo-Doppler study with a Sonos 7500 ultrasound system and a S3 probe (Philips, Andover, Massachusetts). Three cycles were recorded in patients in sinus rhythm and the final result was the average value. For patients in atrial fibrillation five cycles were used. The images were analyzed by two observers who independently made the assessment.

Conventional echocardiographic studies

The bidimensional images of the mitral valve were obtained from parasternal short axis view and the planimetry of the mitral orifice area was performed from these images (2D planimetry). Spectral continuous Doppler traces of the diastolic transmitral flow were obtained from a four-chamber apical view and the mitral valve area was estimated using the pressure half-time (PHT). The required data to evaluate the mitral valve area by proximal isovelocity surface area method (PISA) were obtained from an apical view.

Real-time tridimensional (RT3D) echocardiographic studies

RT3D echocardiographic studies were performed immediately after each conventional echo-Doppler study using a Sonos 7500 ultrasound system and an X4 probe (Philips, Andover, Massachusetts). This system scans a $60^\circ \times 30^\circ$ tridimensional pyramid of the data. From different acoustic windows, multiple cardiac cycles of the mitral valve were recorded using the ‘zoom’ mode. In the same way, several cycles were acquired using the ‘full volume’ mode obtaining a $60^\circ \times 60^\circ$ pyramid from four cardiac beats. All images were stored in a magneto optical disk or compact disk and transferred for off-line analysis using Tomtec® software (4D Cardio-View RT 1.0 Build 983) (Tomtec Imaging Systems, GmbH, Unterschleissheim, Germany). The planimetry of the mitral orifice was performed en face at the ideal cross-section of the mitral valve during its greatest diastolic opening (3D TR planimetry) (Fig. 1). The ideal cross-section was defined as the most perpendicular view on the plane with the smallest mitral valve orifice. The values used in the final analysis were the average value of the measurements of the two independent observers.

Invasive evaluation of the mitral valve area

The invasive evaluation was always performed within 24 h after the non-invasive evaluation. The MVA was obtained from the catheter-based data and the Gorlin equation. Cardiac output was determined by means of the thermodilution method by using a Swan–Ganz catheter. Left ventricle and left atrium pressure tracings were recorded simultaneously by using a 6F pig tail catheter and a conveniently placed percutaneous trans-septal catheter. The final result was obtained from averaging the planimetry of the area between left atrium and left ventricle pressure tracings for five beats.

Statistical analysis

The statistical package used for this study was SPSS 11.0 (SPSS Inc., Chicago, Illinois). Quantitative data are expressed as absolute number (percentage). Inter-method agreement was evaluated by means of the Intraclass Correlation Co-efficient (ICC) and confidence intervals were calculated.
Results

Twenty-six patients with rheumatic mitral stenosis were included. All of them were women (mean age, 42.8 ± 10.6 years). The determinations of the MVA by the different methods, non-invasive and invasive, are shown in Table 1. Three patients had mild or moderate mitral regurgitation and no patient had mild aortic regurgitation. Mean pulmonary artery systolic pressure was 46 ± 9.3 mmHg.

The median values of the valve areas were calculated for each patient from the results obtained by using the methods PISA, PHT and 2D planimetry. This median value was used as reference method and its agreement degree was evaluated with the values obtained using the Gorlin method and 3D planimetry. The results of that comparison are shown in Table 2. Thus, the agreement degree was better for planimetry based on 3D echocardiography than for the Gorlin method invasive assessment.

Discussion

At present, the invasive assessment of the MVA by means of Gorlin’s method is the reference method. However, this method is not free of limitations. There are numerous non-invasive methods to assess the severity of rheumatic mitral stenosis. At present, several methods are used at the same time for the evaluation of patients with this disease and the final result depends on the results of each method. Each technique has its advantages and limitations.

From a theoretical point of view, 3D echocardiography can be a useful tool to make an accurate anatomical assessment of the anatomical orifice in a rheumatic mitral stenosis. This is due to the

<table>
<thead>
<tr>
<th>Method</th>
<th>2D</th>
<th>PHT</th>
<th>PISA</th>
<th>3D</th>
<th>Gorlin</th>
</tr>
</thead>
<tbody>
<tr>
<td>MVA mean (cm²)</td>
<td>1.1 ± 0.2</td>
<td>1.2 ± 0.4</td>
<td>1.2 ± 0.3</td>
<td>1.1 ± 0.3</td>
<td>1 ± 0.2</td>
</tr>
</tbody>
</table>

2D: bidimensional planimetry; 3D: three-dimensional planimetry; MVA: mitral valve area; and PHT: pressure half-time.
possibility of performing a very accurate approach to the real minimum orifice because of the fact that we can crop the image at any position of the space and, therefore, choose the view that includes the smallest valve area. Up to now, this utility had not been proved. As 3D echocardiography provides a different and better assessment of the mitral valve apparatus, this technique could increase our ability to make non-invasive determination of the stenotic orifice area by means of planimetry. This utility has been proved both by using old methods and new 3D methods.3–5,7–10

In this study, the median value of the three classic methods of non-invasive mitral valve area assessment has been used as the reference method. But it is a method that also has its lacks and limitations. However, this “triple approach” to the assessment of the valve area really self-corrects lots of measurement errors. Undoubtedly, the ideal would have been to use the direct anatomical determination of the mitral valve area, but thanks to the dissemination of the new percutaneous treatments, that aim would have been almost impossible to reach.

The results of the study clearly prove that the determination of the mitral valve area by means of 3D planimetry is closer to the reference method than the determination obtained by means of the Gorlin method. Thus, it is logical to propose that, in future, the reference method may be 3D echocardiography. RT3D determination of valve area represents an improvement of echocardiographic methods and Gorlin’s formula may have lost its role as reference method in this subject.

Conclusions

In patients with rheumatic mitral stenosis, the accuracy for measuring the mitral valve area by means of 3D planimetry is probably superior to the accuracy of invasive Gorlin’s method, using the classic non-invasive methods of assessment as the reference method. Thus, we must keep in mind that the Gorlin method is not a free of limitation technique and that in future, 3D echocardiography might replace it as the reference method to quantify the mitral valve area in rheumatic mitral stenosis.

References