Direct Planimetry of Mitral Valve Regurgitation Orifice Area by Real-time 3D Transesophageal Echocardiography

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Conflict of Interest - Disclosure

Within the past 12 months, I have had a financial interest/arrangement or affiliation with the organization(s) listed below.

<table>
<thead>
<tr>
<th>Affiliation/Financial Relationship</th>
<th>Company</th>
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</thead>
<tbody>
<tr>
<td>1. Honoraria for lectures</td>
<td>no</td>
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<tr>
<td>2. Honoraria for advisory board activities</td>
<td>no</td>
</tr>
<tr>
<td>3. Participation in clinical trials</td>
<td>no</td>
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<tr>
<td>4. Research funding</td>
<td>no</td>
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Background

Quantification of mitral valve regurgitation (MR) including calculation of the effective regurgitant orifice area (EROA) is performed using proximal isovelocity surface area (PISA) method.

However, quantification by this method may be limited in eccentric regurgitation or non-circular regurgitant orifice area.

Enriquez-Sarano, JACC 1995
Aim

To compare measurements of direct planimetry of anatomic regurgitant orifice area (AROA) by 3D TEE with effective regurgitant orifice area (EROA) by the PISA method.
Patients and Echocardiography System

- 72 consecutive patients (mean age 71 ± 13 years) with significant mitral valve regurgitation (EROA>0.1 cm² by PISA method).

- Echocardiographic system (iE 33, Philips Medical Systems, Andover, MA, USA) with a matrix-array TEE probe (X7-2t).
Quantitative Methods to Define Mitral Regurgitation Severity

EROA by PISA method:
Effective regurgitant orifice area (EROA) was determined by PISA method with conventional 2D color Doppler TEE.

AROA by 3D TEE planimetry:
Anatomic mitral valve regurgitant orifice area (AROA) was measured directly with commercially available Software (3DQ, QLAB-Version 7.0, Philips Medical Systems).
## Patient Characteristics

<table>
<thead>
<tr>
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<th>N=72</th>
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<tbody>
<tr>
<td>Age, years</td>
<td>70.6±13.3</td>
</tr>
<tr>
<td>Male/ female</td>
<td>37/35</td>
</tr>
<tr>
<td>NYHA* class I, n (%)</td>
<td>9 (13)</td>
</tr>
<tr>
<td>II, n (%)</td>
<td>26 (36)</td>
</tr>
<tr>
<td>III, n (%)</td>
<td>28 (38)</td>
</tr>
<tr>
<td>IV, n (%)</td>
<td>9 (13)</td>
</tr>
<tr>
<td>Ejection fraction, %</td>
<td>48.9±13.6</td>
</tr>
<tr>
<td>4-chamber left atrial area, cm²</td>
<td>25.0±5.8</td>
</tr>
<tr>
<td>4-chamber color Doppler jet area, cm²</td>
<td>7.4±3.4</td>
</tr>
<tr>
<td>Etiology of mitral regurgitation</td>
<td></td>
</tr>
<tr>
<td>Ischemic heart disease / dilated cardiomyopathy, n (%)</td>
<td>22 (30)</td>
</tr>
<tr>
<td>Mitral valve prolapse / flail leaflet, n (%)</td>
<td>25 (35)</td>
</tr>
<tr>
<td>Rheumatic heart disease / others, n (%)</td>
<td>25 (35)</td>
</tr>
<tr>
<td>Regurgitant volume by convergence method, ml</td>
<td>48.2±32.8</td>
</tr>
</tbody>
</table>
EROA by PISA Method

\[ 2 \pi r^2 \times V_{\text{aliasing}} / \text{Peak} V_{\text{Reg}} = EROA \]

\[ \rightarrow 2 \pi \times 1,0 \text{ cm}^2 \times 35.6 \text{ cm/s} / 580 \text{ cm/s} = 0.39 \text{ cm}^2 \]

LVOT view

Intercommissural view
Mitral Valve by 3D TEE with Zoom Mode

View from left ventricle

View from left atrium
Analysis of 3D TEE Volume by Quantification Software (QLAB, Philips)
Visualization of Mitral Valve Regurgitant Orifice in Mid- to Endsystole after Adjusting Cut Planes
Planimetry of Anatomic Regurgitant Orifice Area by 3D TEE with Zoom Mode

AROA – planimetry of anatomic regurgitant orifice area (0.43 cm²)

Ratio $d_1/d_2 = 4.03$ (non-circular)

d1 – distance medial-lateral (1.49 cm)

d2 – distance anterior-posterior (0.37 cm)
Intraobserver and Interobserver Variability of Re-Measurements of AROA by 3D TEE (n=26)

Intraobserver

Interobserver
# Results

EROA by PISA method vs. direct planimetry of anatomic mitral valve regurgitant orifice area (AROA)

<table>
<thead>
<tr>
<th></th>
<th>EROA (by 2D TEE PISA method)</th>
<th>AROA (by 3D TEE direct planimetry)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All patients (n=72)</td>
<td>0.30±0.20 cm²</td>
<td>0.30±0.20 cm²</td>
</tr>
<tr>
<td>Circular AROA (n=14)</td>
<td>0.33±0.25 cm²</td>
<td>0.32±0.24 cm²</td>
</tr>
<tr>
<td>Non-circular AROA (n=58)</td>
<td>0.30±0.19 cm²</td>
<td>0.29±0.20 cm²</td>
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</tbody>
</table>
EROA by PISA Method vs. Direct Planimetry of Anatomic Mitral Valve Regurgitant Orifice Area (AROA)

All patients (n=72)

r=0.96
SEE= 0.058 cm²
Non-Circular vs. Circular Regurgitation
Orifice Area

Non-Circular AROA (n=58)  Circular AROA (n=14)

- Non-Circular AROA: r=0.95, SEE= 0.061 cm²
- Circular AROA: r=0.99, SEE= 0.036 cm²
Comparison between Groups with EROA < 0.2 cm² and EROA ≥ 0.2 cm²

EROA < 0.2 cm² (n=30)

EROA ≥ 0.2 cm² (n=42)

$r=0.60$

$\text{SEE} = 0.021 \text{ cm}^2$

$r=0.95$

$\text{SEE} = 0.063 \text{ cm}^2$
Limitations

- Limited frame rate of RT 3D TEE with Zoom Mode impairs MR quantification in rapidly changing regurgitant orifice areas.
- Very calcified valvular leaflets, severely distorted valvular apparatus as well as flail leaflets present difficulties for direct planimetry of the AROA.
- Quantification of MR due to perforation of a mitral leaflet or in case of multiple regurgitant orifices may be challenging.
Limitations

- Measurements by 3D TEE were compared with an echocardiography based technique (PISA method) and not with an independent method.
Conclusions

- Measurements of anatomic regurgitant orifice area by 3D TEE correlate well with the EROA by PISA method.

- Agreement between methods is better in patients with a circular mitral regurgitation orifice compared to patients showing a non-circular orifice.
Thank You.