3D VS 2D ECHOCARDIOGRAPHIC ASSESSMENT OF THE LEFT VENTRICULAR OUTFLOW TRACT

IMPLICATIONS FOR THE ASSESSMENT OF AORTIC STENOSIS

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LVOT IMAGING MODALITIES

2D ECHO

LVOT = \pi \left(\frac{d}{2}\right)^2

3D ECHO

CMR
SOURCE OF ERRORS

LVOT\textsubscript{CSA} = \pi \left(\frac{d}{2}\right)^2

- CSA is circular
- Squared power magnify any inaccuracy
- Image quality
STUDY AIM

• Accuracy of **RT3DE** in the assessment of **LVOT CSA** by direct measurement in patients without aortic valve pathology.

• Reference method: Cardiac Magnetic Resonance (**CMR**)
POPULATION

• 57 patients referred to King’s College Hospital (London) for CMR

• Exclusion criteria:
  – Aortic valve or root pathology (1pt)
  – More than mild valvular regurgitation (1pt)
  – Poor windows for 3D acquisition (2pt)
  – Non suitability for MRI calculation (3pt)
  – Exclusion criteria for CMR (PPM or ICD, intracranial vascular clips, claustrophobia) (1pt)

• 49 patient enrolled: 28 male, mean age 52±18 years.
The LVOT diameter was measured in the PLAX in mid systole from the white black interface of the septal endocardium to the anterior mitral leaflet parallel to the aortic valve plane and within 0.5 to 1.0 cm of the valve orifice (EAE/ASE)
METHODS

- **3D RT TTE** (Philips iE 33 X1-3 matrix array transducer) focusing on a 3D zoom of the aortic LVOT.

- The **LVOT CSA** was calculated offline using **QLAB software**.
CMR
LVOT = 3.14 \left( \frac{d}{2} \right)^2

LVOT 2D Area = 3.14 \text{ cm}^2

Area = 3.98 \text{ cm}^2

Area = 4.005 \text{ cm}^2

LVOTdiam = 2 \text{ cm}
## RESULTS

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
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<tbody>
<tr>
<td>2D LVOT CSA</td>
<td>$3.7 \text{ cm}^2 \pm 0.6 \text{ cm}^2$</td>
</tr>
<tr>
<td>3D LVOT CSA</td>
<td>$4.6 \text{ cm}^2 \pm 1 \text{ cm}^2$</td>
</tr>
<tr>
<td>MRI LVOT CSA</td>
<td>$5.1 \text{ cm}^2 \pm 1 \text{ cm}^2$</td>
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</tbody>
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$N=49$
2D v.s. 3D LVOT CSA

$\text{r=0.7605 p<0.001}$
3D v.s. MRI LVOT CSA

$r=0.7389 \ p<0.001$
2D v.s. MRI LVOT CSA

$r=0.6642 \ p<0.001$
VARIABILITY

INTEROBSERVER

<table>
<thead>
<tr>
<th>Variability</th>
<th>2D</th>
<th>3D</th>
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<tbody>
<tr>
<td>7.2</td>
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<tr>
<td>5.6</td>
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<table>
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<tr>
<th>ICC</th>
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<tbody>
<tr>
<td>3D INTEROBSERVER VARIABILITY</td>
<td>0.96</td>
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<tr>
<td>3D INTRAOBSERVER VARIABILITY</td>
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INTRAOBSERVER

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<tr>
<th>Variability</th>
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<th>3D</th>
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<td>4.9</td>
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<th>Variability</th>
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<td>5.6</td>
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CONCLUSION

• **2D TTE underestimates** the LVOT CSA compared to CMR

• **RT3DE:**
  – Is **more accurate** for measuring LVOT CSA than 2D TTE compared to CMR
  – Short learning curve, **repeatable**
  – **Feasible** in the majority of patients
CONCLUSION

RT3D Echocardiography may be a more accurate method for the assessment of aortic valve area
<table>
<thead>
<tr>
<th>EXCLUSION CRITERIA</th>
<th>nº pt</th>
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<tbody>
<tr>
<td>Aortic valve or root pathology</td>
<td>1</td>
</tr>
<tr>
<td>More than mild valvular regurgitation</td>
<td>1</td>
</tr>
<tr>
<td>Poor windows for 3D acquisition</td>
<td>2</td>
</tr>
<tr>
<td>Non suitability for MRI calculation</td>
<td>3</td>
</tr>
<tr>
<td>Exclusion criteria for CMR (PPM or ICD, intracranial vascular clips, claustrophobia)</td>
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<tr>
<td>Severe septal hypertrophy with intraventricular gradient</td>
<td>0</td>
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<tr>
<td>Age &lt; 16 years old</td>
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<tr>
<td>Not rate controlled atrial fibrillation</td>
<td>0</td>
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<tr>
<td>LVOT obstruction</td>
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</table>
LIMITATIONS

• Lack of a gold standard technique for LVOT measurement

• Relatively small number of patients

• The study population include only subjects without aortic valve pathology (technique not tested in patient with aortic valve calcification or severely sigmoid septum)
3D REAL TIME TRANSTHORACIC ECHOCARDIOGRAPHY

- The 3D dataset avoids any geometrical assumption
- Possible to **crop** into cardiac structures along many different planes
- Tool now used in routine clinical practice
CONTINUITY EQUATION

\[
AVA = \frac{CSA_{\text{LVOT}} \times VTI_{\text{LVOT}}}{VTI_{\text{AV}}}
\]
ASSUMPTIONS

• LVOT cross sectional area (CSA)
  – CSA is circular
  – CSA remains constant during systole

• Flow
  – occurring in a rigid circular tube
  – uniform in velocity
  – Sample volume remains in a constant position