Annulus Sizing for TAVR
When Contrast CT is Contraindicated

Mani A. Vannan MBBS FACC FAHA FASE
Chief, Cardiovascular Imaging
Co-Chief, Structural and Valvular Center of Excellence
Piedmont Heart Institute, Atlanta, USA

Conflict of Interest:
Siemens, Abbott- Research Support and Speaker Honorarium
History

• 72 year old man
• Type A aortic dissection
• s/p AA graft repair and AV suspension
• Residual dissection in arch, R brachiocephalic and left subclavian
• Prior AAA repair
• CKD, TIAs, HTN, Home O₂ for obstructive sleep apnea
• Progressive symptomatic AR
• High risk for surgical AVR (SAVR)
• For TAVR/TAVI
Pre-Procedure

2-D TEE
Post AA Repair and Valve Resuspension CT
How to size the annulus?

1) Use non-contrast CT
2) CMR
3) Echo
4) Balloon sizing
Pre-Procedure

3-D TEE
Pre-Procedure

Automated Quantitative Aortic Root Modeling

Ann Min Diam 24.5 mm
Ann Max Diam 30.4 mm
Ann Mean Diam 27.5 mm
Pre-Procedural Automated Quantitative Aortic Root Modeling

- Annulus Perimeter: 85.3 mm
- Annulus Area: 558.4 mm²
- Annulus Diameter (Perimeter derived): 27.1 mm
- Annulus Diameter (Area derived): 26.7 mm
# Recommendations for Valve Sizing

<table>
<thead>
<tr>
<th>Diameter (mm)</th>
<th>Height (mm)</th>
<th>Area (mm²)</th>
<th>Perimeter (mm)</th>
<th>Annulus Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>23</td>
<td>45</td>
<td>415</td>
<td>72.3</td>
<td>TEE (mm)³</td>
</tr>
<tr>
<td>26</td>
<td>55</td>
<td>531</td>
<td>81.6</td>
<td>17 - 19</td>
</tr>
<tr>
<td>29</td>
<td>53</td>
<td>661</td>
<td>91.1</td>
<td>19 - 22</td>
</tr>
<tr>
<td>31</td>
<td>52</td>
<td>754</td>
<td>97.4</td>
<td>22 - 26</td>
</tr>
</tbody>
</table>

- **Diameter** range:
  - 23 mm
  - 26 mm
  - 29 mm
  - 31 mm

- **Height**:
  - 45 mm
  - 55 mm
  - 53 mm
  - 52 mm

- **Area**:
  - 415 mm²
  - 531 mm²
  - 661 mm²
  - 754 mm²

- **Perimeter**:
  - 72.3 mm
  - 81.6 mm
  - 91.1 mm
  - 97.4 mm

- **Annulus Range**:
  - TEE (mm)³
    - 17 - 19
    - 18 - 20
    - 254.5 - 314.2
    - 56.5 - 62.8
  - CT MD (mm)³
    - ≤34
    - 15
    - 25
  - CT Area (mm²)³
    - 314.2 - 415.5
    - 62.8 - 72.3
    - ≤40
    - 15
    - 27
  - CT Perimeter (mm)³
    - ≤43
    - 15
    - 29
  - AsAo Width (mm)³
    - ≤43
    - 15
    - 29
  - Sinus Height (mm)³
    - ≤43
    - 15
    - 29
  - Sinus Width (mm)³
    - ≤43
    - 15
    - 29

**Suggested Values**:
- Diameter: 27.5 mm
- Area: 558.4 mm²
- Perimeter: 85.3 mm

*Kasel AM et al JACC CV Imaging 2013;6:249-262*
TAVR
Trans-aortic, 31 mm CoreValve
TAVR
Trans-aortic, waited 10 min before deployment
TAVR

2-D TEE
TAVR
Trans-aortic, Valve deployed
Post-TAVR

2-D TEE
Post-TAVR

3-D TEE
Post-TAVR

AR Index, No PVL

BP 139/73 mmHg; LVEDP 3 mmHg

AR index = [(DBP-LVEDP)/SBP]*100 = (73-3)/139*100 = 54.7
3-D TEE Vs. CT

Heavy and mild/moderate calcification

Less calcium group: Bias -1.0, LOA 2.5
More calcium group: Bias -0.8, LOA 3.1

Bias -3.4, LOA 8.4
Bias -2.1, LOA 8.7
Bias -23.9, LOA 89.2
Bias -11.1, LOA 109.9

Calcium cut-off value 594.6 mm³
Calcium range 0 ~ 2866.0 mm³
Reproducibility
3D-TEE

<table>
<thead>
<tr>
<th></th>
<th>BIAS</th>
<th>LOA</th>
<th>CV</th>
<th>ICC</th>
<th>CCC</th>
<th>95% CI OF CCC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ANNULUS MEAN DIAMETER</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inter-</td>
<td>0.1</td>
<td>1.8</td>
<td>2.6</td>
<td>0.97</td>
<td>0.97</td>
<td>0.93-0.98</td>
</tr>
<tr>
<td>Intra-</td>
<td>0.4</td>
<td>2.4</td>
<td>4.0</td>
<td>0.95</td>
<td>0.94</td>
<td>0.88-0.97</td>
</tr>
<tr>
<td>Test-retest</td>
<td>0.2</td>
<td>1.8</td>
<td>2.9</td>
<td>0.97</td>
<td>0.97</td>
<td>0.91-0.99</td>
</tr>
<tr>
<td><strong>ANNULUS PERIMETER</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inter-</td>
<td>0.3</td>
<td>5.5</td>
<td>2.6</td>
<td>0.97</td>
<td>0.97</td>
<td>0.93-0.98</td>
</tr>
<tr>
<td>Intra-</td>
<td>1.4</td>
<td>7.0</td>
<td>3.9</td>
<td>0.95</td>
<td>0.94</td>
<td>0.89-0.97</td>
</tr>
<tr>
<td>Test-retest</td>
<td>0.1</td>
<td>4.7</td>
<td>2.0</td>
<td>0.98</td>
<td>0.98</td>
<td>0.94-0.99</td>
</tr>
<tr>
<td><strong>ANNULUS AREA</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inter-</td>
<td>6.0</td>
<td>78.2</td>
<td>5.9</td>
<td>0.95</td>
<td>0.95</td>
<td>0.90-0.98</td>
</tr>
<tr>
<td>Intra-</td>
<td>18.5</td>
<td>82.6</td>
<td>8.1</td>
<td>0.95</td>
<td>0.94</td>
<td>0.87-0.97</td>
</tr>
<tr>
<td>Test-retest</td>
<td>6.1</td>
<td>67.5</td>
<td>4.2</td>
<td>0.98</td>
<td>0.98</td>
<td>0.91-0.99</td>
</tr>
</tbody>
</table>

* n=30 for inter- and intraobserver variability; n=10 for test-retest.

* LOA, limits of agreement; CV, coefficient of variation; ICC, intra-class coefficient of correlation; CCC, concordance correlation coefficient. Unit of Bias and LOA for annulus diameter and perimeter is mm; for annulus area is mm2; unit of CV is %.
History

- 50 years old female
- s/p HM II LVAD as DT in 2012 for chronic SHF
- Robotic mitral valve repair in 2007 and redo with bioprosthetic valve in 2008
- HTN, VT s/p ICD, and DM
- SOB, DOE with minimal activity, and LE edema
- NYHA class III
- Echo: severe AR; MV mean PG 18 mmHg (MS)
- Underwent successful TMVR (Sapien), no MS or MR

TAVR
Pre-Procedure (TAVR)

2D TEE
Pre-TAVR
3-D TEE
Pre-TAVR
Automated Quantitative Aortic Root Modeling
Pre-TAVR
Automated Quantitative Aortic Root Modeling

Ann Min Diam: 21.1 mm
Ann Max Diam: 25.7 mm
Ann Mean Diam: 23.4 mm
Pre-TAVR

Automated Quantitative Aortic Root Modeling

Annulus Perimeter  74.2 mm
Annulus Diam (Perimeter derived)  23.6 mm
Annulus Area  424.3 mm²
Annulus Diam (Area derived)  23.2 mm
Recommendations for Valve Sizing

![Diagram showing valve sizing recommendations with measurements and graphs for diameter, height, area, perimeter, and annulus range.]

Kasel AM et al JACC CV Imaging 2013;6:249-262
Post-TAVR
29 mm CoreValve
Post-TAVR

2D TEE
3-D TEE Vs. CT
Heavy and mild/moderate calcification

Less calcium group: Bias -1.0, LOA 2.5
More calcium group: Bias -0.8, LOA 3.1

Calcium cut-off value 594.6 mm$^3$
Calcium range 0 ~ 2866.0 mm$^3$
Reproducibility
3D-TEE

<table>
<thead>
<tr>
<th></th>
<th>BIAS</th>
<th>LOA</th>
<th>CV</th>
<th>ICC</th>
<th>CCC</th>
<th>95% CI OF CCC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ANNULUS MEAN DIAMETER</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inter-</td>
<td>0.1</td>
<td>1.8</td>
<td>2.6</td>
<td>0.97</td>
<td>0.97</td>
<td>0.93-0.98</td>
</tr>
<tr>
<td>Intra-</td>
<td>0.4</td>
<td>2.4</td>
<td>4.0</td>
<td>0.95</td>
<td>0.94</td>
<td>0.88-0.97</td>
</tr>
<tr>
<td>Test-retest</td>
<td>0.2</td>
<td>1.8</td>
<td>2.9</td>
<td>0.97</td>
<td>0.97</td>
<td>0.91-0.99</td>
</tr>
<tr>
<td><strong>ANNULUS PERIMETER</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inter-</td>
<td>0.3</td>
<td>5.5</td>
<td>2.6</td>
<td>0.97</td>
<td>0.97</td>
<td>0.93-0.98</td>
</tr>
<tr>
<td>Intra-</td>
<td>1.4</td>
<td>7.0</td>
<td>3.9</td>
<td>0.95</td>
<td>0.94</td>
<td>0.89-0.97</td>
</tr>
<tr>
<td>Test-retest</td>
<td>0.1</td>
<td>4.7</td>
<td>2.0</td>
<td>0.98</td>
<td>0.98</td>
<td>0.94-0.99</td>
</tr>
<tr>
<td><strong>ANNULUS AREA</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inter-</td>
<td>6.0</td>
<td>78.2</td>
<td>5.9</td>
<td>0.95</td>
<td>0.95</td>
<td>0.90-0.98</td>
</tr>
<tr>
<td>Intra-</td>
<td>18.5</td>
<td>82.6</td>
<td>8.1</td>
<td>0.95</td>
<td>0.94</td>
<td>0.87-0.97</td>
</tr>
<tr>
<td>Test-retest</td>
<td>6.1</td>
<td>67.5</td>
<td>4.2</td>
<td>0.98</td>
<td>0.98</td>
<td>0.91-0.99</td>
</tr>
</tbody>
</table>

* n=30 for inter- and intraobserver variability; n=10 for test-retest.

* LOA, limits of agreement; CV, coefficient of variation; ICC, intra-class coefficient of correlation; CCC, concordance correlation coefficient. Unit of Bias and LOA for annulus diameter and perimeter is mm; for annulus area is mm²; unit of CV is %.