Emerging Role of MRI evaluation prior to Transcatheter Aortic Valve Implantation

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Disclosure

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Background

- **VHD**: 20% of cardiac surgical procedures.
- **TAVI**: established treatment for high surgical risk patients with severe AS.
- Pre-procedure imaging plays an important role towards assessing the anatomy.
- Preoperative assessment is performed using
  1. ECG-gated CTA of the chest.
  2. Non-gated CTA of abdomen & pelvis.

Emerging Indications for MRI

1. Severe allergy to iodinated contrast.

2. Impaired renal function (acute kidney injury or chronic kidney injury with serum creatinine 2mg/dL).

3. Evaluation of severity of AS in patients with poor acoustic window, low cardiac output/low gradient AS (aortic stenosis) with reduced left ventricular ejection fraction (LVEF).

4. Evaluating severity of aortic stenosis in patients with moderate stenosis by TTE but symptomatic and who have contraindications for stress echocardiography.
Advantages of MRI

• Noninvasive and radiation-free.

• Detailed anatomic assessment of the aortic valve and performing planimetry.

• Detailed visualization of cardiac structures and provides superior characterization of the ventricular mass and function.

• Depicts pathologic conditions of the ascending aorta.

• MRI provides numerically similar measurements in terms of annulus size, left ventricular outflow tract (LVOT), and AVA when compared to TTE.

• LGE!

<table>
<thead>
<tr>
<th>Valve</th>
<th>Native Annular size TEE: Diameter/Area (mm/mm²)</th>
<th>Mean Aortic Annulus Diameter (mm)</th>
<th>Aortic Annulus Perimeter</th>
<th>Aortic Annulus Area (mm²)</th>
<th>Area derived Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sapien 23 mm</td>
<td>18-22/338-430</td>
<td>19-22</td>
<td>60-69</td>
<td>300-380</td>
<td>20.7 – 23.4</td>
</tr>
<tr>
<td>Sapien 26 mm</td>
<td>21-25/430-546</td>
<td>23-25</td>
<td>72-78.5</td>
<td>415-490</td>
<td>23.4 – 26.4</td>
</tr>
<tr>
<td>Sapien 29 mm</td>
<td>24-28/540-683</td>
<td>26-28</td>
<td>81.5-88</td>
<td>530-620</td>
<td>26.2 – 29.5</td>
</tr>
<tr>
<td>Sapien3: 20 mm</td>
<td>16-19</td>
<td></td>
<td></td>
<td>273-345</td>
<td>18.6-21</td>
</tr>
<tr>
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</tbody>
</table>
## Core Valve

<table>
<thead>
<tr>
<th>Valve</th>
<th>Aortic Annulus Diameter (mm)</th>
<th>Aortic Annulus Area (mm²)</th>
<th>Aortic Annulus Perimeter</th>
<th>Ascending Aortic Diameter</th>
<th>Sinus of Valsalva: Height/Width (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CoreValve 23</td>
<td>18-20</td>
<td>254.5-314.2</td>
<td>56.5-62.8</td>
<td>≤34 mm</td>
<td>≥15/≥25</td>
</tr>
<tr>
<td>CoreValve 26</td>
<td>20-23</td>
<td>314.2-415.5</td>
<td>62.8-72.3</td>
<td>≤40 mm</td>
<td>≥15/≥27</td>
</tr>
<tr>
<td>CoreValve 29</td>
<td>23-26</td>
<td>415.5-572.6</td>
<td>72.3-84.8</td>
<td>≤43 mm</td>
<td>≥15/≥29</td>
</tr>
<tr>
<td>CoreValve 31</td>
<td>26-29</td>
<td>530.9-660.5</td>
<td>81.7-91.1</td>
<td>≤43 mm</td>
<td>≥15/≥29</td>
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<tr>
<td>Sequence</td>
<td>Purpose</td>
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<tr>
<td>Three plane localizer</td>
<td>Localize aortic valve plane</td>
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<tr>
<td>Axial SSFP non-gated without contrast</td>
<td>Identify potential ascending aorta and subclavian access sites, determine size, calcification, and presence of aneurysmal dilatation of aorta</td>
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<tr>
<td>Breath held/free breathing 2D ECG-gated SSFP: Coronal Aorta, LVOT and Aortic Root</td>
<td>Evaluate aortic annulus, aortic valve structure, and sinus height Planimetry valve orifice area</td>
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<tr>
<td>SSFP gated images: short axis stack</td>
<td>Calculate ejection fraction, ventricular volumes and mass</td>
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<tr>
<td>Breath held/free breathing phase contrast at aortic orifice</td>
<td>Calculate blood flow velocity, pressure gradient and flow volume across the aortic valve Calculate aortic regurgitant volume</td>
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<tr>
<td>3D Navigator assisted SSFP</td>
<td>Coronary ostia height</td>
<td></td>
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<tr>
<td>T2 Black Blood</td>
<td>Useful in presence of susceptibility artifacts from sternal wires or prosthetic valves</td>
<td></td>
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<tr>
<td>Sequence</td>
<td>Flip Angle</td>
<td>TE/TR</td>
<td>Slice Thickness/Gap (mm)</td>
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<td>-------------------------------------------------------------------------</td>
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<tr>
<td>Axial SSFP non-gated without contrast</td>
<td>45</td>
<td>1.4/3.4</td>
<td>6/0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Breath held/free breathing 2D ECG-gated SSFP: Coronal Aorta, LVOT and Aortic Root</td>
<td>45</td>
<td>1.4/3.4</td>
<td>5/0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T2 Black Blood</td>
<td>90</td>
<td>41/1791</td>
<td>8/0</td>
<td></td>
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</tr>
<tr>
<td>Breath held/free breathing phase contrast at aortic orifice</td>
<td>25</td>
<td>2.7/5.6</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3D Navigator assisted SSFP</td>
<td>75</td>
<td>1.8/4</td>
<td>2</td>
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</table>
### Evaluation of the aortic annulus and root
- Measurement of aortic annular minimal and maximal diameter, perimeter, and area
- Measurement of distance between annular plane and origin of coronary ostia
- Measurement of the diameter at the aortic-root, sino-tubular junction and proximal aorta
- Aortic root angle

### Valvular and ventricular function analysis
- Planimetry of the AVA
- Leaflet morphology
- Assessment of ejection fraction
- Ventricular volume and mass

### Evaluation of the Thoracic Aorta
- Measurement of ascending aorta, aortic arch, and descending aorta
- Distance between access site and aortic annulus

### Evaluation of LV Apex
- Evaluation of scar/prior infarct, thrombus
- Location of the LV apex
Aortic Annulus

587.2 mm²

590.9 mm² (3D)
Coronary Ostia
Aortic Stenosis
Noncalcified atherosclerotic plaque burden of the thoracic aorta may increase the risk for ARF.

Aortic wall thickness that exceeded ≥ 2 mm is defined as a diseased segment.

Sinus of Valsalva Height

M1 21.7 mm (3D)

M1 21.1 mm (3D)

M1 21.0 mm (3D)

LP 21.4 mm (3D)
Valve Leaflets
Aortic Root Angle

- Aortic root orientation is critical for precise positioning of the device.
- Inappropriate alignment is associated with post-procedural complications such as stent embolization.

- If root angle > 30°, subclavian approach cannot be used.

Trans Aortic Access

- Right lateral side of aorta
- No calcification/thrombi
- No dissection or prior surgery
- 1 cm from graft

Minimal distance from the aortic annulus 5 cm

Transapical Access

LV Apex:

Scar/prior infarct and thrombus
Localize
Late Gadolium Enhancement

• None
• Transmural Low LV EF
• Subendocardial
• Mid Wall: syncopal, low RV EF
• RV insertion points

Major Adverse cardiac event: mid wall

Role of myocardial scar on 30 day outcome after TAVI. Britta Butzbach. J Cardiovasc Magn Reson. 2015
Post Implantation PVL

TTE:
- Higher variability
- Significantly underestimates AV annulus size
- Underestimates AR
Conclusion

• Non-contrast MRI may play a pivotal role in assessment of aortic valve in patients who cannot undergo a CTA or stress Echo.

• It provides hemodynamic information with high accuracy.

• MRI can accurately provide the critical measurements needed for identifying the most appropriate prosthesis.
References:
