Advanced Imaging in Percutaneous Valve Intervention:  
*Transcatheter Aortic Valve Replacement as a Test Case*

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Transcatheter Aortic-Valve Implantation for Aortic Stenosis in Patients Who Cannot Undergo Surgery

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Multimodality Imaging in TAVR

- Multidisciplinary approach to optimizing TAVR related outcomes

- Optimal example of use of multimodality imaging – including transthoracic and transesophageal echocardiography; 3D echocardiography; multidetector CT (CT); and angiography – for optimizing TAVR related outcomes

- Pre-procedural performance of MDCT permits identification of patients who may qualify for lower profile catheter delivery systems and may reduce the risk of TAVI-related complications
(1) 3D aortic annular and root morphology / dimension
Accurate measurement of the aortic annulus is essential for determining aortic prosthesis size

- Aortic valve prostheses for TAVR are designed for specific aortic annular sizes

- Aortic annular measurements for TAVI rely upon imaging, traditionally by:
  1. Transthoracic echocardiography (TTE)
  2. Transesophageal echocardiography (TEE)
  3. Aortic angiography
THERE IS OFTEN DISCORDANCE BETWEEN ANNULAR DIMENSIONS BY MDCT VERSUS ECHO

- ECG-gated MDCT observes generally **larger annular sizes** than either TTE or TEE
Example: Pre-procedural and peri-procedural annular measurements vary between 17-24 mm.
The Virtual Basal Ring: What are we trying to measure?

Sinotubular junction
Aortic leaflets
Aortic Annulus

RC = Right coronary cusp; NC = Non-coronary cusp; LC = Left coronary cusp

Source: Leipsic et al JACC Img April 2011
Advantages to MDCT methods
Numerous methods for measurement of the aortic annulus

• Initial published reports: *Coronal and sagittal measurements differ substantially depending on the obliquity of the aortic root plane*

❖ Theoretical or Actual?: Greater reproducibility; Less sensitive to minor changes in obliquity’
Aortic Annular Sizing:
Basal Ring Area-Derived Diameter

Calculation for the Area Derived Diameter

\[
diameter = 2 \sqrt{\frac{\text{area}}{\pi}}
\]
(2) Relationship of AoV to coronary artery ostia
Left main height

16.2 mm

10.0 mm

DIASTOLIC PHASE  SYSTOLIC PHASE
(3) Aortoiliacofemoral Arterial Assessment
ILEOFOEMORAL ASSESSMENT

MDCT allows assessment of a greater breadth of pathologies and anatomical structures:

1. Complete 3D iliofemoral system (incl. DOSA MLD)
2. Tortuosity
3. Calcification
4. Atherosclerosis / stenosis
5. High-risk features (e.g., dissections and complex atheromas)
Iliofemoral Sizing

12.6 mm (2D)
9.7 mm (2D)
7.9 mm (2D)
7.1 mm (2D)
Artery Size

7.2x7.3 mm

6.7 mm (2D)
CT Screening Can Reduce your Vascular Access Complications
## CT Screened Patients

<table>
<thead>
<tr>
<th>Variable</th>
<th>No vascular complication</th>
<th>Vascular complication</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n = 58</td>
<td>n = 8</td>
<td></td>
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<tr>
<td>Minimal lumen diameter (mean)</td>
<td>7.0</td>
<td>6.2</td>
<td></td>
</tr>
<tr>
<td>Minimal diameter &lt; sheath diameter, n (%)</td>
<td>23 (40%)</td>
<td>7 (83%)</td>
<td>0.02</td>
</tr>
<tr>
<td>Moderate or severe calcification, n (%)</td>
<td>9 (15%)</td>
<td>5 (42%)</td>
<td>0.04</td>
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</tbody>
</table>

(4) Optimal angle for aortic valve deployment
Predict Co-axial Angle of Deployment

Find angiographic projections representing perpendicularly to the native valve plane in 3 axes:

1) AP cranial-caudal without RAO or LAO angulation
2) straight RAO to LAO as needed without cranial or caudal angulation
3) LAO 30° with cranial or caudal angulation as needed.

Aaxes chosen based on the preferred working angles in the catheterization lab
CT to Assist Valve Deployment

Connect the Dots
Line of Perpendicularly- Predicted Angles
(5) Prediction of Post-TAVR Complications
Two-Year Outcomes after Transcatheter or Surgical Aortic-Valve Replacement


for the PARTNER Trial Investigators*
CT Annular Measures Can Predict PV Leak

- Valve stent diameter – Mean annular diameter \( \text{MDCT} \) AUC 0.84
- Valve stent diameter – Area-derived annular diameter \( \text{MDCT} \) AUC 0.86
- Valve stent area/ Annular area \( \text{MDCT} \) AUC 0.87
Incidence of PV Leak

Incidence of moderate or severe paravalvular regurgitation (%)

<table>
<thead>
<tr>
<th>THV diameter – mean diameter (mm)</th>
<th>&lt; 1</th>
<th>≥ 1</th>
<th>p &lt; 0.01</th>
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<tr>
<td></td>
<td>21.4</td>
<td>2.2</td>
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<table>
<thead>
<tr>
<th>THV area/annular area</th>
<th>&lt;10%</th>
<th>≥10%</th>
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<tbody>
<tr>
<td></td>
<td>19.1</td>
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</tbody>
</table>

p < 0.01
CONCLUSIONS

1. 3D aortic annular and root morphology / dimension
2. Aortic valve to coronary ostia relationship
3. Aortoiliofemoral arterial assessment
4. Prediction of co-axial angle of deployment
5. Prediction of PVR