Imaging for Percutaneous Valve Therapy

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Multi-Modality Imaging for Percutaneous Valve Therapies

- Multimodality imaging plays an integral role in our understanding of the pathophysiology of valvular heart disease
- Different imaging modalities are complementary and confirmatory
- Multimodality imaging is the standard of care for transcatheter device implantation for valvular heart disease

Imaging for TAVR
Trans-catheter Aortic Valve Replacement (TAVR)
Clinical History

• 80 year old male
• Class III CHF
• Medical History:
  – CABG 4v 1995, PCI
  – EF 40%
  – Hypertension
  – PPM for bradycardia
  – h/o Prostate Cancer s/p radiation
  – Calcified Aorta
• STS: 3.9 %
Clinical History

• Frailty Index
• Albumin: 4.1
• Katz ADL: 6 /6
• Grip Strength: 21.2 kg (≤ 32 kg abnl)
• 5-Meter Walk: 5.5 sec (≥ 7 sec abnl)
CTA Thoracic and Abd Ao
CTA Runoff

Ao Bifurc
Rest TTE

EF 40%
Ao V max 3.3 m/s
Mean 24 mmhg
AVA 0.9 cm²
Criteria for Grading Aortic Stenosis

- “Echocardiography has become the standard means for evaluation of aortic valve stenosis. Cardiac cath is no longer recommended except in rare cases when echo is non diagnostic or discrepant with clinical data”

Bonow, JACC 2006

<table>
<thead>
<tr>
<th>Quantitative Parameters (Flow-dependent)</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
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<tbody>
<tr>
<td>Peak velocity</td>
<td>&lt; 3 m/s</td>
<td>3-4 m/s</td>
<td>&gt; 4 m/s</td>
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<tr>
<td>Mean gradient[^]</td>
<td>&lt; 20 mmHg</td>
<td>20-40 mmHg</td>
<td>&gt;40 mmHg</td>
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</table>

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<tr>
<th>Quantitative Parameters (Flow-independent)</th>
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</thead>
<tbody>
<tr>
<td>Doppler velocity index</td>
<td>&gt; 0.5</td>
<td>0.25-0.5</td>
<td>&lt; 0.25</td>
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<tr>
<td>AVA</td>
<td>&gt; 1.5 cm²</td>
<td>0.8-1.5 cm²</td>
<td>&lt; 0.8 cm²</td>
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<tr>
<td>AVA Index</td>
<td>&gt; 0.85 cm²/m²</td>
<td>0.6 – 0.85 cm²/m²</td>
<td>≤ 0.6 cm²/m²</td>
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Patient Selection - Echo

• Assess severity of AS
  – Exclude basal septal hypertrophy, HCM, bicuspid, etc.
• LV systolic and diastolic function
• Associated lesions – AR, MR, Pulm HTN, RV dysfunction
  – Exclude Aortic atheroma, radiation valve disease, etc.
• Aortic annulus sizing (18 – 25 mm annulus only)
• Low Gradient – Low EF
  – Define severity of AS
  – Inotropic Contractile Reserve (is the primary reason for poor LV performance LV afterload?)
Dobutamine
20 mcg

EF 50%
Ao V max 4.5 m/s
Mean 49 mmhg
AVA 0.8 cm²
TTE Ao Annulus
23 mm *
TEE Ao Annulus
25 mm *

* Measurements are made in systole at the hinge points of the leaflets in the LVOT
Patient Selection - Echo

• Assessment of annular size and shape
• Number of aortic valve cusps, degree of calcification, and aortic valve area (planimetry)
• Measurement of distance between aortic valve and coronary ostia
• Assessment of aortic root dimensions and atherosclerosis

Potential Pitfall of Echo

Off axis or inaccurate measurements of annulus
Annular Measurement
Pearls

• The scalloped configuration of the hinge-lines of the leaflets leave fibrous inter-leaflet triangles or trigones between the sinuses
Annular Measurement

Pearls

• The scalloped configuration of the hinge-lines of the leaflets leave fibrous inter-leaflet triangles or trigones between the sinuses
Annular Measurement Pearls

• The scalloped configuration of the hinge-lines of the leaflets leave fibrous inter-leaflet triangles or trigones between the sinuses

• The maximum diameter of the annulus bisects a trigone on one side and a cusp on the other side (yellow arrow)
Annular Measurement Pearls

- The scalloped configuration of the hinge-lines of the leaflets leave fibrous inter-leaflet triangles or trigones between the sinuses.
- The maximum diameter of the annulus bisects a trigone on one side and a cusp on the other side (yellow arrow).
  - When equal cusps are imaged in the LAX view, the LVOT and annular diameters may be underestimated (Red arrow).
Aortic valve annular dimensions: Biplane TEE

- Because the trigone between the left and non-coronary cusp is imaged, be careful not to measure too high into the aortic root (red arrow)

LVOT Diameter:
- = 2.2 cm TTE
- = 2.3 cm TEE

Use of biplane imaging to align the annulus
Aortic Valvular Complex: Annulus Diameter

• Transthoracic echo (TTE) is generally considered the first approach in assessing the annulus diameter due to ease and non-invasive approach
• TTE may underestimate the annulus diameter
  – A difference up to 4 mm between TTE and TEE measurements can occur and may lead to a change in device size
For Annulus Size “in the middle” (ie 21-22 mm)

Select 23 mm Edwards SAPIEN valve if:

- Severe annular calcification
- Narrow root and low coronary ostia
- Narrow or calcified ST junction
- Mitral valve calcification
- Porcelain aorta
- Bulky leaflets and low coronary ostia

To mitigate risk:

- Annular rupture
- Coronary obstruction
- Valve movement during deployment
- Mitral perforation
- Aortic rupture or dissection
- Coronary obstruction

If none of the above conditions, 26 mm Edwards SAPIEN valve can be considered
Reconstruction of the aortic annulus by Cardiac CT

- The minimum annular diameter significantly increased in systole
- Ellipticity index decreased in systole
- The cross sectional area increased in systole
- Perimeter increase was negligible in calcified valves

Diameter = Perimeter / 3.14

JACC 2012: 59: 119-127
Aortic Annulus  24.9 cm
Eccentric Annulus
Minor Axis 25.5
Major Axis 29.5
TTE Ao Annulus
23 mm *
TEE Ao Annulus
25 mm *

* Measurements are made in systole at the hinge points of the leaflets in the LVOT
TAVR Deployment
Intra-procedural Considerations

• Confirm aortic annulus dimensions
• Balloon aortic valvuloplasty
  – Degree of aortic regurgitation after BAV
• Guide optimal positioning and deployment of prosthesis
• Assessment of procedural related complications
  – Valvular (guidewire vs “crimped leaflet” vs “stuck leaflet”) and para-valvular regurgitation (velocity aliasing superior to prosthesis, jet extension below LVOT)
  – Decision re possible “re-ballooning” or 2nd valve
• Post procedural wall motion abnormalities, effusion, LVEF
Second Valve Deployed
“Valve in Valve” technique
- Valvular AI resolved
- Paravalvular AI – mild
- Valve likely undersized
- Echo annulus 25 mm (max)
- CTA: Area method and minor axis both suggested 26 mm valve too small
Role of TEE
Post TAVR Imaging
Percutaneous Mitral Valve Therapies
Edge-to-Edge (Alfieri) Repair

double orifice repair
Intra-Procedural: 5 2D Echo Views
Role Of TEE

- Trans-septal puncture
- Advancing the clip delivery system
- Position and Orient Clip
- Grasping the Leaflets
- Post-deployment assessment
Accurate Localization of Mitral Regurgitant Defects Using Multiplane Transesophageal Echocardiography

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Advantages to 3D:

- More intuitive imaging of 3D structures
- More accurate assessment of valve anatomy
- Rapid/accurate guidance of catheter/clip position
- Rapid/accurate assessment of procedural results