TAVR: A Fresh Look at Aortic Stenosis

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Disclosures

• I have no specific conflicts of interest pertaining to this presentation.

• I will discuss valves not currently available/approved for use in the United States.
Aortic Stenosis
• Etiology/Pathophysiology
• Clinical course/symptoms
• Assessment – Echocardiography

Transcatheter Aortic Valve Replacement - Imaging
• Echo and CT
• Safety of valve placement
  – Echocardiography (TEE) and CT
• Procedural guidance
  – Implant angle (CT)
  – Final valve size and complications (TEE)
Aortic Stenosis

calcific (older pts)

bicuspid (younger pts)
Pathology

- Similar to atherosclerosis
  - Cellular proliferation, inflammation, lipid and increased macrophages and T-lymphocytes

- Congenitally deformed valves
  - Turbulent flow leads to disruption of endothelium and collagen -> calcium deposit

- Rheumatic AS
  - Inflammation leads to organization and fibrosis of the valve with fusion of the commissures
Aortic Stenosis

- Greater than 65 yoa
  - 26% with sclerosis, 2% with severe stenosis
- Greater than 75 yoa
  - 37% with sclerosis, 3% with severe stenosis
- Greater than 85 yoa
  - 52% with sclerosis, 7% with severe stenosis
- RF: Age, male gender, cigarette, HTN
- Takes decades to occur — once moderate, area decreases by 0.1-0.2 cm²/yr (although variable).

Stewart et al. JACC 1997;29:630–4)
Aortic Stenosis

- Normal
- Rheumatic
- Calcific
- Bicuspid

US and Europe
Worldwide
Younger patients
Aortic Stenosis

- Surgery under 50 yoa
  - 2/3 bicuspid
  - 1/3 unicuspid
- 50-70 yoa
  - 2/3 bicuspid
  - 1/3 tricuspid, calcified
- >70 yoa
  - 60% tricuspid
  - 40% bicuspid

Pathophysiology

- When AVA reduced by 50%, LV pressure starts to increase
- Increased pressure -> increased LV wall thickness ->LV wall stress remains normal
- If hypertophic process is inadequate -> wall stress increases and high afterload leads to depressed LVEF
Pathophysiology

- Left atrial contraction responsible for large portion of LV filling.
- Loss of LA contraction -> clinical deterioration.
  - Risk of worsening clinical status when patients develop atrial fibrillation.
Natural History

Angina

- Increased oxygen demand
  - Increased muscle mass
  - Increased wall stress
  - Reduced oxygen supply due to elevated LV diastolic pressure reducing coronary perfusion gradient
Exertional syncope

- Exercise leads to vasodilation in peripheral muscles
- LV unable to augment output enough for exercise – unable to increase cardiac output
Congestive heart failure

- Contractile dysfunction due to high afterload
- Marked LA pressure, increasing pressures in lungs and associated edema
Aortic Stenosis Murmur

harsh, late peaking systolic, ↓S2
carotid pulse “parvus (small/weak) et tardus (late)”
AV area = \( \frac{A1V1}{V2} \)

AV Area = \( \frac{3.14 \times 1.1 \times 1.1 \times 76}{471.87} \)

AV Area = 0.62 sq cm
Echocardiography
Aortic Stenosis Severity

• Mild
  – Area $1.5\text{cm}^2$, mean gradient $< 25\text{mmHg}$, jet velocity $< 3\text{ meters per second}$

• Moderate
  – Area $1.0-1.5\text{cm}^2$, mean gradient $25-40\text{mmHg}$, jet velocity $3-4\text{ meters per second}$

• Severe
  – Area $< 1.0\text{cm}^2$, (critical $<0.8$) mean gradient greater than $40\text{mmHg}$, jet velocity $> 4\text{ meters per second}$
Medical Therapy for **Severe AS**

- No medication can alter natural history
- Maintain euvolemia, sinus rhythm
- Digitalis with decreased EF
- Caution with beta blockers, ACE inhibitors, nitroglycerin or any agents that decrease CO or decrease systemic vascular resistance (SVR)
Surgery for AS
Gold Standard

• Indicated for critical AS, or for severe AS if patient has any symptoms attributable to AS
Transcatheter aortic valve implantation (TAVI) vs standard therapy: a randomized controlled trial

Death from Any Cause (%)

Hazard ratio, 0.55 (95% CI, 0.40–0.74)
P<0.001

Months

No. at Risk
TAVI 179 138 122 67 26
Standard therapy 179 121 83 41 12
Multimodality Imaging

Transcatheter Aortic Valve Replacement - Imaging
• Echo and CT
• Safety of valve placement
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• Procedural guidance
  – Implant angle (CT)
  – Final valve size and complications (TEE)
Valve Size to Annulus Diameter

Annulus diameter by TEE
- 18 mm
- 19 mm
- 20 mm
- 21 mm
- 22 mm
- 23 mm
- 24 mm
- 25 mm

- 23 mm valve
- 26 mm valve

Effective Orifice Area
- 23 mm valve
- 26 mm valve
Cross-Sectional Computed Tomographic Assessment Improves Accuracy of Aortic Annular Sizing for Transcatheter Aortic Valve Replacement and Reduces the Incidence of Paravalvular Aortic Regurgitation

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Objectives
In an effort to define the gold standard for annular sizing for transcatheter aortic valve replacement (TAVR), we sought to critically analyze and compare the predictive value of multiple measures of the aortic annulus for post-TAVR paravalvular (PV) regurgitation and then assess the impact of a novel cross-sectional computed tomographic (CT) approach to annular sizing.

Background
Recent studies have shown clear discrepancies between conventional 2-dimensional (2D) echocardiographic and CT measurements. In terms of aortic annular measurement for TAVR, such findings have lacked the outcome analysis required to inform clinical practice.

Methods
The discriminatory value of multiple CT annular measures for post-TAVR PV aortic regurgitation was compared with 2D echocardiographic measures. TAVR outcomes with device selection according to aortic annular sizing using a traditional 2D transesophageal echocardiography-guided or a novel CT-guided approach were also studied.

Results
In receiver-operating characteristic models, cross-sectional CT parameters had the highest discriminatory value for post-TAVR PV regurgitation: This was with the area under the curve for [maximal cross-sectional diameter minus prosthesis size] of 0.82 (95% confidence interval: 0.69 to 0.94, p < 0.001) and that for [circumference-derived cross-sectional diameter minus prosthesis size] of 0.81 (95% confidence interval: 0.7 to 0.94, p < 0.001). In contrast, traditional echocardiographic measures were nondiscriminatory in relation to post-TAVR PV aortic regurgitation. The prospective application of a CT-guided annular sizing approach resulted in less PV aortic regurgitation of grade worse than mild after TAVR (7.5% vs. 21.9%; p = 0.045).

Conclusions
Our data lend strong support to 3-dimensional cross-sectional measures, using CT as the new gold standard for aortic annular evaluation for TAVR with the Edwards SAPIEN device. (J Am Coll Cardiol 2012;59:000–000)
3-Dimensional Aortic Annular Assessment by Multidetector Computed Tomography Predicts Moderate or Severe Paravalvular Regurgitation After Transcatheter Aortic Valve Replacement

A Multicenter Retrospective Analysis

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Objectives

This study sought to analyze multidetector computed tomography (MDCT) 3-dimensional aortic annular dimensions for the prediction of paravalvular aortic regurgitation (PAR) following transcatheter aortic valve replacement (TAVR).

Background

Moderate or severe PAR after TAVR is associated with increased morbidity and mortality.

Methods

A total of 109 consecutive patients underwent MDCT pre-TAVR with a balloon expandable aortic valve. Differences between transcatheter heart valve (THV) size and MDCT measures of annular size (mean diameter, area, and circumference) were analyzed concerning prediction of PAR. Patients with THV malposition (n = 7) were excluded. In 50 patients, MDCT was repeated after TAVR to assess THV eccentricity (1 – short diameter/long diameter) and expansion (MDCT measured THV area/nominal THV area).

Results

Moderate or severe PAR (13 of 102) was associated with THV undersizing (THV diameter – mean diameter = −0.7 ± 1.4 mm vs. 0.9 ± 1.8 mm for trivial to mild PAR, p < 0.01). The difference between THV size and MDCT annular size was predictive of PAR (mean diameter: area under the curve [AUC]: 0.81, 95% confidence interval [CI]: 0.68 to 0.88, area: AUC: 0.80, 95% CI: 0.65 to 0.90, circumference: AUC: 0.76, 95% CI: 0.59 to 0.91). Annular eccentricity was not associated with PAR (AUC: 0.58, 95% CI: 0.46 to 0.75). We found that 35.3% (36 of 102) and 45.1% (46 of 102) of THVs were undersized relative to the MDCT mean diameter and area, respectively. THV oversizing relative to the annular area was not associated with THV eccentricity or underexpansion (oversized vs. undersized THVs; expansion: 102.7 ± 5.3% vs. 106.1 ± 5.6%, p = 0.03; eccentricity: median: 1.7% [interquartile range: 1.4% to 3.0%] vs. 1.7% [interquartile range: 1.1% to 2.7%], p = 0.28).

Conclusions

MDCT-derived 3-dimensional aortic annular measurements are predictive of moderate or severe PAR following TAVR. Oversizing of THVs may reduce the risk of moderate or severe PAR. (J Am Coll Cardiol 2012;59: 000–000) © 2012 by the American College of Cardiology Foundation
**Figure 2** Three-Dimensional MDCT Aortic Annular Measurements

(A) Short and long diameters provide a mean annulus diameter and annular eccentricity. (B) Annular area. (C) Annular circumference. MDCT = multidetector computed tomography.

**Figure 6** Area as a Measure of Balloon Expandable THV Size

- **23mm**: 4.15 cm², Increase in area
- **26mm**: 5.31 cm², 28%
- **29mm**: 6.61 cm², 24%
SAFETY OF IMPLANTATION CT
Cardiac Gated CT – Coronary height
<table>
<thead>
<tr>
<th>Edwards SAPIEN Valve</th>
<th>RetroFlex 3 Sheath</th>
<th>Minimum Vessel Diameter</th>
<th>RetroFlex 3 Sheath OD</th>
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</thead>
<tbody>
<tr>
<td>23 mm</td>
<td>22F</td>
<td>7.0 mm</td>
<td>8.4 mm</td>
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<tr>
<td>26 mm</td>
<td>24F</td>
<td>8.0 mm</td>
<td>9.2 mm</td>
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PROCEDURAL
Deployment angle lining up all the cusps
Transesophageal Echo

• Annulus assessment prior to opening seal on valve.
• Baseline TEE (valves, function, ?effusion, working views).
• Valve placement (secondary)
• Ongoing assessment for complications.
Recognition of complications
Pre and post post-dilation of AV
Conclusions/Summary

• Aortic stenosis is quite common in our aging population.
• Percutaneous aortic valve therapies provide patients who are not operative candidates the benefit of valve replacement.
• Echocardiography and Cardiac CT are complementary modalities in assessment of patients undergoing TAVR.
Thank you

- Questions?