Relationship of Aortic Annular Eccentricity and Paravalvular Regurgitation Post Transcatheter Aortic Valve Implantation with CoreValve

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I have nothing to disclose.
Severe AS – Percent of Patients Treated

* EuroHeart Survey: Single Valve Disease (AS, MR)

Lung B et al. European Heart Journal 2003;24:1231-1243
Transcatheter Aortic Valve Implantation (TAVI)

Current indications:
• Severe AS
• Highly symptomatic patients
• High surgical risk or non operable

Background

• Paravalvular aortic regurgitation (PAR) is common after TAVI
• Reported incidence of at least moderate PAR is between 7-20% \(^1,2,3\)
• PAR is associated with worse short term outcomes, increased in-hospital mortality \(^4\) and 2 year mortality

1 Grube E et al J Am Coll Cardiol 2007
2 Webb JG et al Circulation 2007
3 De Jaegere et al EuroIntervention 2008
4 Abdel-Wahab M et al Heart 2011
Aortic Annulus Assessment

- Aortic annulus is a complex 3D structure;
- It is assessed at the lowest hinge point of the AV leaflets;
- Oval configuration in approximately 50% of patients evaluated for TAVI.

Tops LF et al. JACC Imaging 2008.
Leipsic J et al. JACC Imaging 2011.
Aortic Annulus Assessment

Echocardiography

CT

MRI
Computed Tomography
Eccentricity Index

\[ \text{Eccentricity Index} = 1 - \frac{D_{\text{min}}}{D_{\text{max}}} \]
• **Predictors of PAR have been described:**

  ➢ Prosthesis/annulus discongruence (Cover index) \(^1\)
  
  ➢ Angle of LVOT to ascending aorta \(^2\)
  
  ➢ Implantation depth \(^2\)
  
  ➢ Aortic valve area \(^3\)
  
  ➢ Annular calcification

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1 Detaint et al JACC Cardiovasc Interv 2009
2 Sherif et al J Am Coll Cardiol 2010
3 Abdel-Wahab et al Heart 2011
Aims

• Compare and determine the best predictor of PAR after TAVI
Methods

• Severe aortic stenosis patients underwent MDCT before successful TAVI with Medtronic CoreValve bioprosthesis

• Primary end-point was early occurrence of significant PAR defined as ≥ grade III PAR by post procedural aortography

1 Sherif et al J Am Coll Cardiol 2010
Grading of PAR On Aortography

- 0 – No AR
- Grade I – Trivial / Mild
- Grade II - Moderate
- Grade III – Moderate - severe
- Grade IV - Severe
## Baseline and Procedural Characteristics

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>All (n = 84)</th>
<th>AR ≤ 3 (n=64)</th>
<th>AR ≥ 3 (n=20)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Patient characteristics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>83 ± 4</td>
<td>83 ± 4</td>
<td>83 ± 5</td>
<td>0.717</td>
</tr>
<tr>
<td>Male (57%)</td>
<td>48</td>
<td>39</td>
<td>9</td>
<td>0.212</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>1.6 ± 0.9</td>
<td>1.6 ± 0.1</td>
<td>1.6 ± 0.1</td>
<td>0.914</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>73.5 ± 13.2</td>
<td>74.1 ± 12.6</td>
<td>72.1 ± 14.7</td>
<td>0.621</td>
</tr>
<tr>
<td><strong>Echo parameters</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AVA (cm²)</td>
<td>0.73 ± 0.17</td>
<td>0.74 ± 0.17</td>
<td>0.72 ± 0.19</td>
<td>0.659</td>
</tr>
<tr>
<td>Peak pressure gradient (mmHg)</td>
<td>80.3 ± 24.7</td>
<td>79.4 ± 23.7</td>
<td>83 ± 28.0</td>
<td>0.568</td>
</tr>
<tr>
<td>EF</td>
<td>57.9 ± 11.2</td>
<td>57.2 ± 11.4</td>
<td>60.2 ± 10.6</td>
<td>0.298</td>
</tr>
<tr>
<td>Baseline AR grade</td>
<td>0.7 ± 0.6</td>
<td>0.7 ± 0.6</td>
<td>0.5 ± 0.5</td>
<td>0.16</td>
</tr>
<tr>
<td><strong>MDCT parameters</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annulus (mm)</td>
<td>25.9 ± 2.1</td>
<td>25.9 ± 2.1</td>
<td>26.1 ± 2.2</td>
<td>0.066</td>
</tr>
<tr>
<td>Severe leaflet calcification</td>
<td>53 (63%)</td>
<td>39 (61%)</td>
<td>14 (70%)</td>
<td>0.666</td>
</tr>
<tr>
<td><strong>Procedural parameters</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depth to NCC (mm)</td>
<td>10.7 ± 4.8</td>
<td>4.4 ± 0.57</td>
<td>13.0 ± 5.1</td>
<td>0.015</td>
</tr>
<tr>
<td>Depth to LCC (mm)</td>
<td>11.2 ± 4.2</td>
<td>10.7 ± 4</td>
<td>12.5 ± 4.4</td>
<td>0.11</td>
</tr>
<tr>
<td><strong>Valve size</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>29 mm (60%)</td>
<td>50</td>
<td>41</td>
<td>9</td>
<td>0.134</td>
</tr>
<tr>
<td>26 mm (40%)</td>
<td>34</td>
<td>23</td>
<td>11</td>
<td>0.134</td>
</tr>
</tbody>
</table>
Results

• Paravalvular aortic regurgitation
  - Nil  13 patients (16%)
  - Grade I  33 patients (39%)
  - Grade II  18 patients (21%)
  - Grade III  20 patients (24%)
  - Grade IV  None
Results

- Eccentricity Index >0.25 was related to significant PAR: Sensitivity 80%, Specificity 86%, NPV 95% ($P < 0.001$)
## Results

<table>
<thead>
<tr>
<th>Variable</th>
<th>Univariate</th>
<th>Multivariate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Estimated Coefficient, $\beta_1$</td>
<td>$P$ value</td>
</tr>
<tr>
<td>Eccentricity-index &gt;0.25</td>
<td>-3.2</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Depth to NCC, mm</td>
<td>0.145</td>
<td>0.015</td>
</tr>
<tr>
<td>Depth to LCC, mm</td>
<td>0.098</td>
<td>0.11</td>
</tr>
<tr>
<td>Severe annulus calcification</td>
<td>0.774</td>
<td>0.666</td>
</tr>
<tr>
<td>Cover index</td>
<td>-4.6</td>
<td>0.24</td>
</tr>
<tr>
<td>Prosthesis diameter, mm</td>
<td>-0.234</td>
<td>0.134</td>
</tr>
<tr>
<td>Baseline AR</td>
<td>0.521</td>
<td>0.16</td>
</tr>
<tr>
<td>Baseline ejection fraction, %</td>
<td>0.025</td>
<td>0.298</td>
</tr>
<tr>
<td>Ascending aorta diameter, mm</td>
<td>-0.045</td>
<td>0.345</td>
</tr>
<tr>
<td>Sinus of Valsalva diameter, mm</td>
<td>-0.069</td>
<td>0.384</td>
</tr>
</tbody>
</table>
Eccentricity Index = 0.1
Eccentricity Index = 0.28
Limitations

- Post-procedural aortography as primary end-point as previously described \(^1\) but PAR may improve with expansion of the CoreValve over time.

- We evaluated CoreValve devices only, therefore validation of eccentricity index for other devices requires further study.
Conclusions

• The eccentricity-index, a measure of the eccentricity of the aortic annulus, is related to significant paravalvular aortic regurgitation after TAVI with Medtronic CoreValve.

• Further larger studies are required to confirm our findings and determine the utility of this novel index in screening patients pre-procedurally.
As I Have Opened A Can Of Worms

• “Before you criticise someone,
• You should walk a mile in their shoes.
• That way when you criticise them,
• You are a mile away and you have their shoes”
Acknowledgements

Team At Work

• **Supervisors**
  - Stephen Worthley
  - Matthew Worthley
  - Ian Meredith

• **Co-Authors**
  - Angela Bertaso
  - Gary Liew
  - Viji Thomson
  - Michael Cunnington
  - James Richardson
  - Robert Gooley
  - Siobhan Lockwood

Team At Home
AR index

- AR index = DBP-LVEDP/SBP X 100
- AR index ≥ 25 is associated with higher PAR and 1-year mortality
- AR index varies with
  - Systemic BP
  - Concomitant diastolic dysfunction
  - Significant myocardial ischaemia during balloon valvuloplasty and valve deployment

Sinning et al JACC 2012
VARC criteria for PAR

• Echo criteria, no definition for angiographic criteria
• Semi-quantitative Doppler parameters best applied for central AR
• May not be ideal for diffuse and eccentric PAR with circumferential extent
**Cover Index**

- **Cover index**:
  \[100 \times (\text{Prosthesis diameter} - \text{annulus diameter}) / \text{prosthesis diameter}\]

- **Undersizing** = \text{Prosthesis diameter} - \text{mean diameter}^2 (Edwards-Sapien valve)

In our study, this was not a predictor \(P=0.815\)

- Oversizing prosthesis vs annular diameter difference > 1mm and annular area >10% related to lower moderate or severe PAR

2 Willson AB JACC 2012
Oversizing Prosthesis Is It The Answer?

• Oversizing for balloon expandable prosthesis – 8-20%

• Oversizing for self-expandable prosthesis – 5-15%

• (Prosthesis perimeter – Annulus perimeter) / Annulus Perimeter) x 100

Myloitte et al JACC 2012