Underestimation of effective aortic orifice area after TAVR due to LVOT ellipticity and Impact on patient-prosthesis mismatch classification: What are we measuring?

Philipp Blanke1, Robert Moss2, Danny Dvir3, Rekha Raju3, Nicolaj Hansson3, Philippe Pibarot4, David A. Wood5, Byarne Nørgaard5, John Webb6, Jonathan A. Leipsic7, Kris Nowakowski8

1St. Paul’s Hospital, University of British Columbia, Vancouver, BC, 2St Paul’s Hospital, Vancouver, British Columbia, 3St Paul’s Hospital, Vancouver, Canada, Vancouver, Canada, 4St. Paul’s Hospital, Vancouver, BC, 5Arhus University Hospital Skejby, Aarhus, Denmark, 6NIH/A, Quebec City, Canada, 7University of British Columbia, Vancouver, Canada, 8Arhus University Hospital Skejby, Aarhus N, Aarhus, 9St. Paul’s Hospital, Vancouver, Canada

Background: Following transcatheter aortic valve replacement (TAVR), the presence of PPM has been reported in up to one third of patients. We sought to define the influence of left ventricular outflow tract (LVOT) geometry on calculation of the effective orifice area (eOA) and classification of patient-prosthesis mismatch (PPM) after TAVR.

Methods: 86 patients status post TAVR underwent both transthoracic echocardiography and contrast enhanced computed tomography. LVOT dimensions were assessed by means of planimetry on systolic CT reconstructions with subsequent calculation of an area-derived LVOT diameter. EOA was calculated according to the continuity equation, based on pre- and post-operative echocardiographic measurements by continuous-wave Doppler and LVOT measurements obtained by pulsed-wave Doppler (EOATTE). In addition, a modified EOA was calculated using the area-based LVOT diameter by CT (EOACT). Moderate and severe PPM were defined as an indexed EOA (eEOA) of 0.85 cm²/m² and 0.65 cm²/m², respectively.

Results: Mean LVOT diameters were 2.4±0.3mm by TTE and 2.0±0.2mm by CT (p<0.001). Mean EOATTE was significantly lower (1.7±0.4cm²) than EOACT (2.4±0.7cm², p<0.001). By EOATTE, 20 patients (29%) were graded as moderate PPM and 4 (6%) as severe PPM. By EOACT, PPM grade was reclassified in 21 patients, with 4 patients (6%) graded as moderate PPM and no patients (0%) graded as severe PPM.

Conclusions: Cardiac computed tomography measures of the EOA results in significant reclassification of the PPM grade. Future investigation is needed to determine whether MDCT derived measurements of eEOA will serve as a more appropriate measure of PPM and correlate more closely with downstream clinical outcomes.

Finite Element Analyses Stent and Leaflet Stresses on 26mm Transcatheter Aortic Valve

Kapil Krishnan1, Jian Ye2, Danny Dvir3, Ali N. Azadani4, Julius Guccione1, Liang Ge5, Elaine Tserng6
1UCSF Medical Center, San Francisco, CA, 2St Paul’s Hospital, Vancouver, British Columbia, 3St Paul’s Hospital, Vancouver, Canada, Vancouver, Canada, 4University of Denver, Denver, CO, 5University of California at San Francisco Medical Center, and San Francisco VA Medical Center, San Francisco, CA

Background: Transcatheter aortic valves (TAV) have revolutionized treatment of severe aortic stenosis in high-risk and inoperable patients. Concern still exists regarding TAV durability, which depends upon design features of the stent, leaflets, Dacron, and suture connections. We previously performed finite element analyses (FEA) of a simplified TAV model of Edwards Sapien; however to date, no detailed FEA have been published using all the design features. The goal of this study was to determine stent and leaflet stresses using exact geometry.

Methods: Edwards Sapien 26mm Edwards Lifesciences, Inc) was obtained and underwent microCT scanning. DICOM images and direct TAV measurements were used to create a precise model with stent, leaflets, Dacron, and suture. FE mesh was generated and simulations were performed using ABAQUS to model crimping, balloon-expansion, and recoiling of TAV and leaflet loading to 80mmHg.

Results: Maximum VonMises stresses on TAV stent after crimping and ballooning were 344MPa and 296MPa, respectively (Figure 1); the plastic strain developed in the stent hinges was 10.3%. Peak VonMises stresses for TAV leaflets were 3.29MPa (crimping) and 2.14MPa (ballooning). Peak leaflet stress at 80mmHg was 3.33 MPa.
Aim of this study was to investigate the potential clinical advantage of adjunctive ICE during TAVI.

Methods: All TAVI cases in which ICE was used as an adjunctive imaging tool were identified through interrogation of our institutional database. Procedural reports, angiographic and ICE images were subsequently analyzed to retrospectively assess the benefit of ICE during TAVI.

Results: Between October 2011 and April 2014, 178 patients were treated for severe aortic valve stenosis by ICE assisted TAVI (routinely used in our institution for transfemoral procedures). All cases comprised transfemoral procedures, apart from 2 transapical cases, 105 (59%) patients received an Edwards SAPIEN and 73 (31%) a Medtronic CoreValve. Adjunctive ICE provided significant benefit during 42 (24%) TAVI procedures (Table 1). Discharge echocardiography showed moderate aortic regurgitation in 11 (6%) patients. Thirty-day mortality was 4.5%.

Table 1. Potential clinical advantages of ICE during TAVI

<table>
<thead>
<tr>
<th>Advantage</th>
<th>N=42</th>
</tr>
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<tbody>
<tr>
<td>Optimizing decision making on post-implantation AR</td>
<td>27 (64%)</td>
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<tr>
<td>Elucidating the mechanism of AR (e.g. frozen leaflet, non-uniform valve expansion)</td>
<td>9 (21%)</td>
</tr>
<tr>
<td>Revealing significant AR severity</td>
<td>18 (43%)</td>
</tr>
<tr>
<td>Detection or exclusion of pericardial effusion</td>
<td>8 (15%)</td>
</tr>
<tr>
<td>Guiding valve crossing with the wire</td>
<td>2 (5%)</td>
</tr>
<tr>
<td>Guiding management of aortic root abnormalities (e.g. aortic mass, dissection)</td>
<td>3 (7%)</td>
</tr>
<tr>
<td>Providing an alternative imaging modality in patients with esophagus pathology*</td>
<td>2 (5%)</td>
</tr>
</tbody>
</table>

* Transesophageal echocardiography, routinely used in transapical procedures, was contraindicated in these patients.

Conclusions: Adjunctive ICE imaging seems a valuable tool during TAVI, providing clinical advantages in approximately one in four procedures. ICE offers detailed and prompt information in TAVI associated adverse scenarios, foremost in post-implantation aortic regurgitation and the onset of pericardial effusion.

Valvular disease - Mitral: Imaging

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HeartNavigator guided transcatheter mitral annuloplasty: will echo guidance remain a must for mitral interventions?

Andrea Guidotti1, Maurizio Taramasso2, Nikola Cesarovic1, Thea Fleischmann1, Fabian Nietlispach3, Volkmar Falk4
1University Hospital of Zurich, Zurich, Switzerland, 2San Raffaele University Hospital, Milan, Italy, 3University Hospital Zurich, Zurich, Switzerland, 4University of Zurich, Zurich, Zurich

Background: Current guiding imaging for structural cardiac interventions includes fluoroscopy and echocardiography. The aim of the study is the evaluation of three-dimensional computed tomography (CT) integration onto the fluoroscopy imaging to guide transcatheter mitral annuloplasty (TMA) procedures (Cardioband, Valtech Cardio, Israel) without the need for echocardiographic monitoring.

Methods: Six adult swine underwent pre-procedural CT angiography. The feasibility and benefit of overlaying CT data onto the procedural fluoroscopic image using the HeartNavigator software (Philips Healthcare, Best, Netherlands) was validated. Segmentation of CT dataset was performed to identify aortic root, left and right ventricles and circumflex artery. Additional 13 markers were put on the segmented mitral annulus, to identify the annular plane and the target zones for the device implantation.

Results: The HeartNavigator provided an overlay imaging showing the live fluoroscopy in relation to the volume rendering of the structures segmented, to improve navigation in the left atrium. The annular markers were used as guidance to deploy sequential fixation elements. TMA was successful performed with procedural time less than 90 min in all animals (68±8min). Echocardiographic guidance was not used in all cases.

Conclusions: Overlay of 3D-CT data onto the real-time procedural fluoroscopy is feasible to provide procedural guidance for complex structural cardiac intervention. This imaging integration may become an alternative to echo guidance in future transcatheter mitral interventions, to allow local anesthesia procedure.