We aim to quantify TEVAR decreased bending and diametric deformations of the descending aorta while it exhibits time dependent multiaxial deformations, and the mechanical impact of TEVAR are critical to improve device design.

INTRODUCTION

• While thoracic endovascular aortic repair (TEVAR) is commonly employed to treat thoracic aortic diseases, long-term performance of endograft in dynamic aorta remains a concern.
• We aim to quantify multiaxial pulsatile compliance changes to the thoracic aorta from pre- to post-TEVAR.

METHODS

• Study cohort
8 TEVAR patients with acute (n=4) / chronic (n=3) Type B dissections, or chronic arch aneurysm (n=1)
• Geometric data acquisition
1. Cardiac-resolved CTAs were acquired pre- and post-TEVAR (10 frames each).
2. CTA images were loaded to SimVascular, and aortic centerline, surface lines, and cross-sectional lumen were extracted (Figure 1).
• Quantitative analysis
1. Arclengths and longitudinal curvatures (centerline, inner, outer curves) were computed from aortic centerline and surface lines. Diameter was computed from cross-sectional lumen.
2. Deformation was the difference between the minimum and maximum measurements, and incremental change was the difference between adjacent cardiac frames.

RESULTS

<table>
<thead>
<tr>
<th>Deformation (MAX-MIN)</th>
<th>Ascending aorta</th>
<th>Descending aorta</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arclength (%)</td>
<td>Pre-TEVAR</td>
<td>Post-TEVAR</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>Inner curvature (cm²)</td>
<td>0.10 ± 0.03</td>
<td>0.10 ± 0.05</td>
<td>0.91</td>
</tr>
<tr>
<td>Center curvature (cm²)</td>
<td>0.03 ± 0.01</td>
<td>0.03 ± 0.01</td>
<td>0.34</td>
</tr>
<tr>
<td>Outer curvature (cm²)</td>
<td>0.05 ± 0.04</td>
<td>0.06 ± 0.08</td>
<td>0.54</td>
</tr>
<tr>
<td>Diameter (%)</td>
<td>6 ± 3</td>
<td>6 ± 3</td>
<td>0.96</td>
</tr>
</tbody>
</table>

Table 1. Deformation of ascending and descending aorta at pre- and post-TEVAR, and significance from pre vs. post-TEVAR.

• From pre- to post-TEVAR, the ascending aorta increased arclength deformation. The descending aorta exhibited unchanged arclength deformation but decreased curvature and diametric deformation (Table 1).
• For the ascending aorta, the greatest incremental change in arclength occurred between 10~20% cardiac frames (Figure 2).

DISCUSSION

• TEVAR decreased bending and diametric deformations of the descending aorta while it increased axial deformation of the ascending aorta. This may be due to the increased stiffness and oversizing by the endograft, causing damping of deformation at the stented region and increased deformation of the unstented region.
• The thoracic aorta exhibits time-dependent multiaxial deformations, and the mechanical impact of TEVAR are critical to improve device design.