Evaluation of Dynamic Intimal Flap Movement in Acute Stanford Type B Aortic Dissections (ATBD) and the Effects of Thoracic Endovascular Stent Grafting

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Sanger Heart & Vascular Institute
Carolinas Medical Center
Charlotte, NC
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• No disclosures.
Introduction: Type B Aortic Dissection

- 3 per 100,000 persons per year
  - 9,000 new cases annually
  - 25% treated with TEVAR

- Acute, complicated type B dissection (TBD)
  - Mortality rates up to 50%
  - TEVAR: decreased in-hospital morbidity and mortality

- Uncomplicated or chronic dissection
  - Traditionally treated with optimal medical management
  - Aneurysmal degeneration or rupture in 20–50%
Background

Thoracic endovascular aortic repair (TEVAR) offers patients with difficult pathology and limited options a potential treatment.

Evidence supports TEVAR in complicated Stanford type B aortic dissections.

Short term outcomes of TEVAR and Stanford type B aortic dissections have shown low morbidity and mortality.

Long–term results remain relatively unknown including knowledge of the specific structural changes of the aorta over time following endograft placement.

False Lumen Status

- Chronically patent False Lumen is independent risk factor:
  - Aneurysmal degeneration and dilatation
  - Dissection–related rupture and death
  - False lumen thrombosis (FLT) predicts better long-term prognosis

- Goals of endovascular stent graft placement
  - Cover proximal intimomedial tear
  - Re–expand the true lumen
  - Post–operative false lumen thrombosis

- Unable to reliably predict FLT after TEVAR
Strategies that lead to true lumen volume expansion and false lumen flow reduction indicate successful therapy.

TEVAR forces considerable volumetric changes in the aorta.

Clinical responses appear to directly relate to these volumetric changes and intra-arterial flap stiffness.
Preliminary findings in quantification of changes in septal motion during follow-up of type B aortic dissections

Using two-dimensional phase contrast MRI, chronicity yields considerable reduction of intra-arterial septum compliance and contraction

Potential ability to define chronicity by examining behavior of the diseased aorta and determine suitability for TEVAR
Motion characterization of aortic wall and intimal flap by ECG–gated CT in patients with chronic B–dissection


- aortic diameter differences
- oscillation of the intimal flap
Intimal flap movement in aortic Stanford type–A dissection visualized by 64-slice computed tomography

Chris Probst a,*, Wolfgang Schiller a, Armin Welz a, Attila Kovacs
Purpose

To evaluate and characterize the intimal flap of the visceral aorta prior to and immediately following thoracic endovascular stent graft placement in acute Stanford type B aortic dissections.
Methods

- Between Sept 2011 and Aug 2012, 48 consecutive patients were treated with thoracic stent grafts for aneurysms (n=24), dissections (n=19), and transections (n=5).
- Of those with type B aortic dissections 11 were chronic and 8 acute (less than 14 days).
- Intravascular Ultrasound was utilized to record the aortic flap movement at the superior mesenteric artery during one RR-interval of the ECG.
- Flap movement was recorded pre and post thoracic endovascular stent graft placement which was extended from coverage of the entry tear to the level of the celiac artery in all 8 acute TBAD.

INSERT: IVUS at SMA picture

PRE-TEVAR vs POST-TEVAR
Intravascular ultrasound Volcano 8.35 MHz catheter

Left renal vein identified for correct orientation

A 10-second data loop of aortic wall and intimal flap motion was then recorded for further analysis prior to and following TEVAR.
Post-processing of IVUS Data
Area and Diameter

- Original IVUS images captured frame by frame throughout the cardiac with a DICOM viewer with gain set at 40
- Allowed for area/diameter measurements
SCION imaging software used to invert each image to its negative, gain threshold changed to 140 allowing evaluation and shading of aortic wall and intimal flap during cardiac cycle.
**Methods**

- Measurements from inner – inner wall in short (AP) and long (lateral) axes through epicenter of true lumen and the aortic wall
- Mean, minimum, and maximum diameters recorded during cardiac cycle
- Lumen bounded to assess area (cm$^2$)
- Frames independently reviewed by two blind observers
Continuous variables indicated as mean +/- SD

Changes in area and diameters were analyzed using the Student’s t-test

Changes of the same variable (aortic wall motion and intimal flap movement) were compared using analysis of variance for repeated measurements.

P-value <0.05 was considered statistically significant

Analysis of measurement method comparison data according to Bland and Altman performed to analyze repeatability & compare measurements b/w observers.
Methods

Flap Movement Index (FMI)
• \[ FMI = \frac{\left( \frac{TD_{\text{max}}}{AD_{\text{max}}} - \frac{TD_{\text{min}}}{AD_{\text{min}}} \right)}{TD_{\text{min}}/AD_{\text{min}}} \times 100\% \]

Flap Area Index (FAI)
• \[ FAI = \frac{T_{\text{Amax}} - T_{\text{Amin}}}{T_{\text{Amin}}} \times 100. \]
## IVUS True Lumen Diameter and Area Measurements and Aortic Wall Measurements

<table>
<thead>
<tr>
<th></th>
<th>PRE-TEVAR</th>
<th>POST-TEVAR</th>
<th>p-value</th>
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</thead>
<tbody>
<tr>
<td><strong>ACUTE (n=8)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TD min (mm)</strong></td>
<td>11.25 +/- 1.7</td>
<td>16.00 +/- 1.8</td>
<td>p=0.0001</td>
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<tr>
<td><strong>TD max (mm)</strong></td>
<td>14.50 +/- 1.29</td>
<td>19.25 +/- 2.2</td>
<td>p=0.0001</td>
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<tr>
<td><strong>TA min (cm²)</strong></td>
<td>1.38 +/- 0.21</td>
<td>2.97 +/- 0.33</td>
<td>p=0.0001</td>
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<tr>
<td><strong>TA max (cm²)</strong></td>
<td>2.70 +/- 0.42</td>
<td>3.53 +/- 0.22</td>
<td>p=0.0001</td>
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<tr>
<td><strong>AD min (mm)</strong></td>
<td>22.75 +/- 1.5</td>
<td>22.75 +/- 1.5</td>
<td>p=0.947</td>
</tr>
<tr>
<td><strong>AD max (mm)</strong></td>
<td>24.5 +/- 2.08</td>
<td>24.75 +/- 2.2</td>
<td>p=0.81</td>
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</tbody>
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*Intraobserver & Interobserver repeatability coefficients revealed no significant difference within or b/w observers.*
Results

- Of the 8 patients treated in this study with TEVAR
  - No mortality
  - No SCI
  - No Stroke
- All patients had complete thrombosis of the false lumen at 1 month
Intimal Flap Movement As Measured by Flap Movement Index and Flap Area Index

Flap Movement Index (FMI)

- FMI = [(TDmax/ADmax − TDmin/ADmin)]/TDmin/ADmin X 100(%)  

FMI (Pre-TEVAR) = 19.63 +/- 2.3%  

FMI (Post-TEVAR) = 10.66 +/- 1.9%  

Flap Area Index (FAI)

- FAI = TAmax − TAmin/TAmin X 100(%)  

FAI (Pre-TEVAR) = 95.65 +/- 21%  

FAI (Post-TEVAR) = 18.85 +/- 4.2%  

*Intraobserver & Interobserver repeatability coefficients revealed no significant difference within or b/w observers
PRE-TEVAR

POST-TEVAR
Presentation (8/29/2012)

Post-TEVAR (11/9/2012)
Discussion

- TEVAR offers a promising solution to patients with acute Stanford type B aortic dissections

- This is the first study to evaluate and characterize the dynamic aortic flap movement in acute aortic dissections of the visceral aorta before and after TEVAR

- Aortic morphologic changes occur immediately after TEVAR
  - There is an immediate and significant increase in the true lumen diameter and area.
  - TEVAR significantly minimizes the movement of the intimal flap with no significant changes in overall aortic wall motion.
This stabilization of the intimal flap has been associated with complete thrombosis of the false lumen in these cases without distal reperfusion at 1 month follow-up.

Further studies to determine the clinical significance of flap stabilization are required, however, the use of intravascular ultrasound to measure the flap intimal index and area may be a useful adjunct to predict false lumen thrombosis.
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