Flow-dynamic study for late type 1B endoleaks in thoracic stent grafts

Frans Moll
Impact of TEVAR on pulsatile aortic changes

Background and Significance

• Practice of TEVAR is increasing rapidly\(^1\)
• Stent-grafts are > 100 x stiffer than aortic tissue (55.2 MPa vs. 0.45 MPa)\(^2,3\)

\(^1\)Kleinstreuer Jbiom 2008
\(^2\)Roccabianca JMBBM 2014
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• It is predominantly the \textit{longitudinal} axis that fails in dissection or rupture, resulting in transverse entry tears\textsuperscript{4,5}

\textsuperscript{4}Khanafer JTCVS 2011
\textsuperscript{5}Beller Circ 2004
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Objective

• To quantify the impact of TEVAR on circumferential and longitudinal pulsatile strain (deformation)
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Methods

• All thoracic aneurysm patients with ECG-gated CTA, pre- and post-TEVAR (n=8)
• Age: 71 ± 8 years, 75% male
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Results
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Results
Pulsatile Longitudinal Strain, %

- Increased in the arch

Post-TEVAR

7.1 → 12.5 (+77%)  

\[ p = .04 \]
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Results

Pulsatile Longitudinal Strain, %

- Increased in the arch
- Trend of increase in the ascending aorta

<table>
<thead>
<tr>
<th>Pre-TEVAR</th>
<th>Post-TEVAR</th>
<th>Change</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.6</td>
<td>7.1</td>
<td>9.4</td>
<td>.06</td>
</tr>
<tr>
<td>1.4</td>
<td>2.0</td>
<td>12.5</td>
<td>.04</td>
</tr>
</tbody>
</table>

5.6 → 9.4 (+69%)

1.4 → 2.0 (+43%)
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Results
Pulsatile Circumferential Strain, %

- Ranged from 3.6 – 5.0%
- Comparable throughout the thoracic aorta
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**Results**

Pulsatile **Circumferential** Strain, %

- Increased adjacent to the stent-graft

<table>
<thead>
<tr>
<th>Pre-TEVAR</th>
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</tr>
</thead>
<tbody>
<tr>
<td>3.6</td>
<td>6.2</td>
</tr>
<tr>
<td>(+72%)</td>
<td></td>
</tr>
</tbody>
</table>

\[ p = .02 \]
Results

Clinical outcomes

- One patient developed retrograde dissection at proximal end of the stent-graft, 2 weeks post-TEVAR
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Results

Clinical outcomes

• One patient developed retrograde dissection at proximal end of the stent-graft, 2 weeks post-TEVAR

• No connective tissue disorder, non-severely oversized (12%)
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Results

Clinical outcomes

- One patient developed retrograde dissection at proximal end of the stent-graft, 2 weeks post-TEVAR
- No connective tissue disorder, non-severely oversized (12%)
- Longitudinal strain increased after TEVAR by:
  - + 96% in the ascending
  - + 29% in the arch
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Conclusions

- Pulsatile longitudinal aortic strain was larger than circumferential strain
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- After TEVAR, we observed a significant increase of longitudinal strain proximal to the stent-graft.
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Conclusions

• Pulsatile longitudinal aortic strain was larger than circumferential strain
• After TEVAR, we observed a significant increase of longitudinal strain proximal to the stent-graft
• Circumferential strain also increased adjacent to the device, particularly distally
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Left: directly postoperative CT scan
Middle: drag force calculation with CFD
Right: 1-yr postop CT scan with stent graft migration and type Ib endoleak
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Left: directly postoperative MRI scan
Right: 1-yr postop MRI scan with stent graft migration and type Ib endoleak
RISK for late type 1B endoleaks in TEVAR

Conclusions

• Pulsatile longitudinal aortic strain was larger than circumferential strain
• After TEVAR, we observed a significant increase of longitudinal strain proximal to the stent-graft
• Circumferential strain also increased proximal and distal to the device
RISK for late type 1B endoleaks in TEVAR

Conclusions

• Combination of drag forces and distal circumferential strain are responsible for proximal migration of the distal TEVAR landing zone

• To solve this late complication we need bio compliant stent graft
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