Mechanism of Stent Thrombosis: OCT Findings

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Background

- FDA Recommended duration of dual antiplatelet therapy: 3 mo for SES and 6 mo for PES
- Late stent thrombosis has been reported to be associated with increased mortality and morbidity
- Stent thrombosis is probably caused by delayed reendothelialization
- OCT is a novel imaging modality with a high resolution (~ 10 μm), which might be useful to study surface coverage
Stent: Acute OCT finding
DES: Acute OCT finding
### Comparison of OCT and IVUS Findings Post Stenting

<table>
<thead>
<tr>
<th>Condition</th>
<th>OCT</th>
<th>IVUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dissection</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>Tissue prolapse</td>
<td>29</td>
<td>12</td>
</tr>
<tr>
<td>Incomplete apposition</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Irregular struts</td>
<td>18</td>
<td>18</td>
</tr>
</tbody>
</table>

Bouma, Jang, Heart 2003
BMS Follow up (thick NIH)
ISR after bifurcation stenting

Courtesy of E. Regar, Rotterdam
ISR after bifurcation stenting

Courtesy of E. Regar, Rotterdam
ISR after bifurcation stenting

Courtesy of E. Regar, Rotterdam
OCT: Neointima at 2m FU

BMS

DES
Aim of the study

- To study SES strut coverage and malapposition using OCT at 3 mo
- Compare OCT findings between ACS and stable coronary syndrome
Method

- 21 patients with SES in the native coronary arteries: 9 ACS and 12 stable angina
- 3 mo f/u catheterization including OCT
- OCT system: M2 LightLab, 0.014 inch image wire, occlusion balloon, motorized pull back at 1.0 mm/s (axial resolution 15 μm)
- Image acquisition: 15 frames/s
Analysis

- Image analysis: 1 mm interval (every 15 frames)
- % NIH area = ([stent area-lumen area]/stent area) x 100
- Definitions:
  - NIH: thickness inside stent struts
  - Covered: NIH thickness > 10 µm
  - Malapposition: maximum distance > 160 µm
  - Thrombus: protruding mass
Analysis

Every 15 frames (1 mm interval)
% NIH area = (\frac{\text{stent area} - \text{lumen area}}{\text{stent area}}) \times 100
Stent Struts: OCT findings

A: well apposed and covered
B: well apposed, not covered
C: malapposed, not covered
D: malapposed, but covered
Thrombus
## Results: Angiographic Findings

<table>
<thead>
<tr>
<th></th>
<th>ACS</th>
<th>Non-ACS</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>RD (mm)</td>
<td>2.9 ± 0.3</td>
<td>2.7 ± 0.3</td>
<td>0.15</td>
</tr>
<tr>
<td>Lesion length (mm)</td>
<td>18.1 ± 10.9</td>
<td>27.3 ± 13.7</td>
<td>0.06</td>
</tr>
<tr>
<td>MLD (mm)</td>
<td>3.1 ± 0.4</td>
<td>2.9 ± 0.4</td>
<td>0.20</td>
</tr>
<tr>
<td>ISR @ 3 mo</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Thrombus @ 3 mo</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>
Results: OCT Findings

- 662 images
  - 23 inadequate images
  - 64 overlapping segments
  - 8 side branches
  → Final 567 images (= 4516 struts)

Uncovered struts: 15% (21/21 pts)
Malapposed struts: 16% (20/21 pts)
Uncovered + malapposed: 6% (20/21 pts)

Average NIH thickness: 29 µm (> 100 µm: 7%)
Average % NIH area: 10%
# Results: OCT findings

<table>
<thead>
<tr>
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<th>ACS</th>
<th>Non-ACS</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Struts/images</td>
<td>1616/203</td>
<td>2900/364</td>
<td></td>
</tr>
<tr>
<td>Uncovered struts</td>
<td>18%</td>
<td>13%</td>
<td>0.00001</td>
</tr>
<tr>
<td>Malapposed</td>
<td>19%</td>
<td>14%</td>
<td>0.00001</td>
</tr>
<tr>
<td>Uncovered + malapposed</td>
<td>8%</td>
<td>5%</td>
<td>0.00039</td>
</tr>
<tr>
<td>NIH thickness (µm)</td>
<td>27.6 ± 40.9</td>
<td>30.1 ± 40.8</td>
<td>0.049</td>
</tr>
<tr>
<td>%NIH area</td>
<td>9.2 ± 3.6</td>
<td>10.6 ± 3.9</td>
<td>0.0001</td>
</tr>
<tr>
<td>Stent area (mm2)</td>
<td>9.3 ± 2.4</td>
<td>8.6 ± 2.0</td>
<td>0.0001</td>
</tr>
<tr>
<td>Lumen area (mm2)</td>
<td>8.5 ± 2.2</td>
<td>7.7 ± 1.8</td>
<td>0.0001</td>
</tr>
<tr>
<td>Thrombi</td>
<td>3</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>
Limitations

- Small sample size
- Non randomized
- NIH < 10 μm would not be detected with OCT.
- Non longitudinal study → timing of NIH not known
Conclusion

- Small % of SES struts not covered and malapposed after 3 months.
- % of non covered and/or malapposed struts was higher in pts with ACS.
- Clinical significance of these findings still not known.
Thank You
## Cypher Evaluation by OCT

<table>
<thead>
<tr>
<th></th>
<th>3 mo</th>
<th>6 mo</th>
<th>12 mo</th>
</tr>
</thead>
<tbody>
<tr>
<td>NIH thickness (um)</td>
<td>29</td>
<td>52-96</td>
<td>107</td>
</tr>
<tr>
<td>Uncovered struts</td>
<td>15%</td>
<td>7-10%</td>
<td>5%</td>
</tr>
<tr>
<td>Malapposed struts</td>
<td>16%</td>
<td>1%</td>
<td>0.2%</td>
</tr>
<tr>
<td>Uncovered+ malapposed</td>
<td>6%</td>
<td>1%</td>
<td>0.2%</td>
</tr>
</tbody>
</table>

Takano M. AJC 2007;99:1033