PARAMETERS AFFECTING THE RISK OF EMBOLIZATION DURING CAROTID STENTING

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Disclosures

Speaker name: Huppert, Peter

I have the following potential conflicts of interest to report:

- Consulting:
  - Boston Scientific
  - Abbott Vascular
  - Johnson&Johnson/Cordis
  - Merit Medical
Parameters potentially affecting embolism during CAS

- Symptomatic stenoses
- High-grade stenoses
- Long stenoses
- Calcium load of stenoses
- Stent design
Prospective single center registry of 650 filter protected CAS procedures

- 650 consecutive CAS patients during 2008-2018
- 100% filter protection
- 305 procedures excluded in this analysis
  - 257 no CTA available
  - 48 recurrent stenosis
- 345 CAS procedures included

- Grading of stenoses: 70-79 / 80-90 / >90%
- Length of stenoses: <5 / 5-10 / >10 mm
- Calcium load: <90 / 90-180 / 180-270 / >270 °
Grading of calcium load in CTA

- <90 dg.
- 90-180 dg.
- 180-270 dg.
- >270 dg.
Stent-Design

- Open cell:
  Precise Rx™ (J&J): n= 176

- Closed cell:
  Carotid Wallstent™ (BSC): n= 124

- Micromesh:
  Caspar™ (MV/Terumo), CGuard™ (InspireMD): n= 45
Analysis of embolic plaque material

<table>
<thead>
<tr>
<th>Size of particles</th>
<th>Number of particles</th>
<th>Embolic plaque volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;0 - &lt;= 50 μm</td>
<td>17</td>
<td>17 x 50 μm = 850 μm</td>
</tr>
<tr>
<td>&gt;50 - &lt;= 100 μm</td>
<td>6</td>
<td>6 x 100 μm = 600 μm</td>
</tr>
<tr>
<td>&gt;100 - &lt;= 150 μm</td>
<td>4</td>
<td>4 x 150 μm = 600 μm</td>
</tr>
<tr>
<td>&gt;150 - &lt;= 200 μm</td>
<td>8</td>
<td>8 x 200 μm = 1.600 μm</td>
</tr>
<tr>
<td>.....</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- 1.950 - &lt;= 2.000 μm</td>
<td>1</td>
<td>1 x 2.000 μm = 2.000 μm</td>
</tr>
</tbody>
</table>

**EPVI** * = 850μm + 600μm + 600μm + 1.600μm + 2.000μm = 5.650μm

* Embolic Plaque Volume Index
## Risk of stenosis morphology

<table>
<thead>
<tr>
<th>Grade of stenosis</th>
<th>EPVI (μm) MW (range)</th>
<th>Length of stenosis</th>
<th>EPVI (μm) MW (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;80%*</td>
<td>1.721 (250-9.750)</td>
<td>&lt;5 mm*</td>
<td>2.090 (0-9750)</td>
</tr>
<tr>
<td>80-90%*</td>
<td>4.494 (0-14.650)</td>
<td>5-10 mm</td>
<td>3.662 (0-14.650)</td>
</tr>
<tr>
<td>&gt;90%*</td>
<td>8.125 (300-15.950)</td>
<td>&gt;10 mm*</td>
<td>5.800 (100-15.950)</td>
</tr>
<tr>
<td>*p</td>
<td>&lt;0.05</td>
<td>*p</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Calcium load</th>
<th>EPVI (μm) MW (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;90 dg.</td>
<td>4.825 (0-14.650)</td>
</tr>
<tr>
<td>&gt;90 / &lt;180 dg.</td>
<td>3.450 (0-12.050)</td>
</tr>
<tr>
<td>&gt;180 / &lt;270 dg.</td>
<td>680 (0-14.600)</td>
</tr>
<tr>
<td>&gt;270 dg.</td>
<td>1.650 (100-13.350)</td>
</tr>
<tr>
<td>*p</td>
<td>&gt;0.05</td>
</tr>
</tbody>
</table>
# Risk of clinical activity & stent design

## Clinical activity

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>EPVI (μm) MW (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symptomatic</td>
<td>121</td>
<td>6.270 (100-15.950)</td>
</tr>
<tr>
<td>Asymptomatic</td>
<td>224</td>
<td>2.877 (0-13.050)</td>
</tr>
<tr>
<td>p</td>
<td></td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>

## Stent type

<table>
<thead>
<tr>
<th>Stent type</th>
<th>N</th>
<th>EPVI (μm) MW (range)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open cell</td>
<td>150</td>
<td>9.450 (100-25.600)</td>
<td></td>
</tr>
<tr>
<td>Closed cell</td>
<td>150</td>
<td>4.533 (0-15.950)</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Micromesh</td>
<td>45</td>
<td>250 (0-450)</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>
Side effects of micromesh stenting

Covering of ulcerated plaques

external carotid stenosis
Low volume embolism: EPVI 0-500 μm

asymptomatic
EPVI: 100 μm
Stent: closed cell

asymptomatic
EPVI: 0 μm
Stent: micromesh
High volume embolism: EPVI 5.000-16.000 μm

symptomatic 80-90%
5-10mm
<90 dg. calcified
Stent: closed cell
EPVI: 14.650 μm

symptomatic right ICA closed
>90%
>10mm
high grade calcified
EPVI: 15.950 μm
Stent: closed cell
Conclusions

- Embolic plaque volume during CAS has typical risk factors and can be estimated but not predicted.
- High embolic plaque volume is associated with symptomatic, long, soft plaque stenoses.
- Combinations of these factors cause high risk procedures.
- Using micromesh stents plaque embolism is reduced compared to open and closed cell stents.
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