FILTER-PROTECTED CAROTID ANGIOPLASTY
PROSPECTIVE ANALYSIS OF MICROSCOPIC
FINDINGS OF EMBOLIC MATERIAL AND
CORRELATION WITH CLINICAL AND
MORPHOLOGICAL CHARACTERISTICS IN 400 CASES

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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
  - Merritt Medical
Study Purpose & Design

- To correlate the amount of embolic material captured during filter protected CAS with baseline clinical data, morphological characteristics of stenoses, MRI findings and clinical follow-up.

- Consecutive cases 01/2006-09/2014

- Independent neurological examination
Treatment Characteristics

- Consecutive patients: 426 (de novo stenoses)
- CAS not performed: 26 (6.1%)
- CAS performed: 400
- Stent: Smart/Precise Rx™ 7-9 /20-40 mm
- Protection: Angioguard Rx™ 4-7 mm
- One operator: (P.H.)
- PTA post Stent: 392/400 (98%; 4-6 mm)
Patients Characteristics

- Age: 44-94a
- Male: 72%
- Left side: 58%
- Symptomatic: 43%
- Interval: 
  - $\leq$30d: 83%
  - >30d: 17%
Angiographical Lesion Characteristics

**Shape**
- Concentric: 60%
- Eccentric: 40%

**Margin**
- Smooth: 39%
- Ulcerated: 61%

**Calcification**
- Yes: 81%
- No: 19%

**Grade of Stenoses**
- <90%: 33%
- ≥90%: 67%

**Length of Stenoses**
- <10 mm: 54%
- 10-20 mm: 42%
- >20 mm: 4%
Work-up and Analysis of Embolic Material

- Formalin fixation
- Extraction of material
- Separation of particles
- Light microscopy (x 25)
- Number of particles
- Size of particles
- One operator (G.W.)
MR Imaging day 1 after CAS

- DWI / ADC-Mapping
- Correlation to target/non-target area
- Correlation to age
- Correlation to gender
- Correlation to filter embolic material
Number and Size of Embolic Particles

<table>
<thead>
<tr>
<th>number</th>
<th>Rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>7.5</td>
</tr>
<tr>
<td>1-10</td>
<td>37.5</td>
</tr>
<tr>
<td>11-50</td>
<td>42</td>
</tr>
<tr>
<td>51-100</td>
<td>6.3</td>
</tr>
<tr>
<td>101-150</td>
<td>4.0</td>
</tr>
<tr>
<td>&gt;150</td>
<td>2.7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>max. size [µm]</th>
<th>Rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-50</td>
<td>12.2</td>
</tr>
<tr>
<td>51-100</td>
<td>14.3</td>
</tr>
<tr>
<td>101-200</td>
<td>16.9</td>
</tr>
<tr>
<td>201-300</td>
<td>23.4</td>
</tr>
<tr>
<td>301-400</td>
<td>12.2</td>
</tr>
<tr>
<td>401-600</td>
<td>9.5</td>
</tr>
<tr>
<td>601-800</td>
<td>3.7</td>
</tr>
<tr>
<td>801-1.000</td>
<td>4.2</td>
</tr>
<tr>
<td>&gt;1.000</td>
<td>3.2</td>
</tr>
</tbody>
</table>
Pts. & Lesions Characteristics: Correlation to Embolic Material

<table>
<thead>
<tr>
<th>n=400</th>
<th>criteria</th>
<th>mean number</th>
<th>p</th>
<th>mean size (μm)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient</td>
<td>&lt;80 a =/&gt;80 a</td>
<td>16.5 20.7</td>
<td>0.1</td>
<td>286 373</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td>asymptomatic symptomatic</td>
<td>13.0 24.6</td>
<td>&lt;.01</td>
<td>307 286</td>
<td>0.4</td>
</tr>
<tr>
<td>Stenosis</td>
<td>&lt;90 % =/&gt;90 %</td>
<td>16.9 17.3</td>
<td>0.2</td>
<td>252 360</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td>&lt;10 mm =/&gt;10 mm</td>
<td>16.8 19.6</td>
<td>0.2</td>
<td>240 371</td>
<td>0.08</td>
</tr>
<tr>
<td></td>
<td>concentric excentric</td>
<td>14.9 18.0</td>
<td>0.7</td>
<td>314 290</td>
<td>0.7</td>
</tr>
<tr>
<td></td>
<td>smooth ulcerated</td>
<td>16.2 22.7</td>
<td>0.08</td>
<td>194 315</td>
<td>&lt;.05</td>
</tr>
<tr>
<td></td>
<td>calcified non-calcified</td>
<td>10.3 24.9</td>
<td>&lt;0.05</td>
<td>314 290</td>
<td>0.7</td>
</tr>
</tbody>
</table>
## Correlation of DWI-Lesions

<table>
<thead>
<tr>
<th>Total number of DWI lesions</th>
<th>390</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients with DWI lesions</td>
<td>132 (33%)</td>
</tr>
<tr>
<td>Number of DWI lesions/patient</td>
<td>1-25 (median 3)</td>
</tr>
<tr>
<td>within target areas</td>
<td>280/390 (72%)</td>
</tr>
<tr>
<td>within non-target areas</td>
<td>110/390 (28%)</td>
</tr>
<tr>
<td>in pts. &gt;/=80 yrs.</td>
<td>15/29 (52%)</td>
</tr>
<tr>
<td>in pts. &lt;80 yrs.</td>
<td>117/371 (31%)</td>
</tr>
<tr>
<td>&lt;/=50 filter particles</td>
<td>59/348 (17%)</td>
</tr>
<tr>
<td>&gt;50 filter particles</td>
<td>29/52 (56%)</td>
</tr>
</tbody>
</table>

- p<0.05
## Clinical Outcome

<table>
<thead>
<tr>
<th></th>
<th>asymptomatic (n= 379; 95%)</th>
<th>30d TIA (n= 12; 3.0%)</th>
<th>30d stroke (n= 9; 2.2% )</th>
</tr>
</thead>
<tbody>
<tr>
<td>number of particles (median)</td>
<td>14</td>
<td>23</td>
<td>18</td>
</tr>
<tr>
<td>max. size of particles (median)</td>
<td>300 µm</td>
<td>385 µm</td>
<td>650 µm</td>
</tr>
</tbody>
</table>

P<0.05
Conclusions

- Number of embolic particles during CAS using open cell design stents was increased in symptomatic vs. asymptomatic and in non-calcified vs. calcified carotid artery stenoses.

- Size of embolic particles was larger in ulcerated irregular vs. smooth carotid artery stenoses.
Conclusions

- DWI Lesions were more frequent in target areas vs. non-target areas, in patients older than 79 years and in procedures causing more than 50 particles within the filters.
Conclusions

- Despite filter protection 9 of 400 patients (2.2%) developed stroke during (n=6) and up to 30d after (n=3) CAS.
- Embolic particles were significantly larger in these patients compared to asymptomatic patients.
- Filter protection cannot completely avoid embolic complications in case with massive embolism.
Thank you for Attention!
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