Relationship of Packing Density to Recurrence Rate in Cerebral Aneurysms Treated by Coil Embolization

Aanand Patel
Briarcliff High School
Cerebral Aneurysms

- Balloon-like dilations of blood vessels (Guo et al., 2011)
- Blood-flow expands aneurysm (Li et al., 2006)
- Unruptured Risk
  - Pressure on nerves, and brain
  - Stroke
  - Rupture

http://www.yalemedicalgroup.org/stw/images/161464.jpg
Cerebral Aneurysms

- 14.5 per 100,000 adults
- 12% die before reaching hospital
- 12% misdiagnosis
- 25% die in hospital
- 30-day mortality rate: 45%

Subarachnoid Hemorrhage

- Ruptured aneurysms cause hemorrhage (Melake et al., 2010)

- Ruptured mortality rate: 50%

- Hemorrhage cause 27% of stroke-related deaths (Woo et al., 2002)
Treatment Methods

- **Surgical Clipping**
  - Risky, invasive, not ideal in all patients
  - ~8 hour long procedures

- **Coiling**
  - Less invasive, better outcome, primary treatment method
  - Platinum coils placed in aneurysm (Crobeddu et al., 2012)
The Penumbra Coil 400

- 0.020” outer diameter
  - Faster procedure time, using fewer coils

One PC 400

One 10-system coil

28% packing

7% packing
Research Questions

- Will the Penumbra 400 coils, with softer edges and a larger diameter, attain higher packing density than that of the conventional coils?

- Will procedural time, using the Penumbra Coil 400 system, decrease as compared to cases employing the use of the conventional coils? Moreover, will fewer coils be required for treatment of the aneurysms?
Hypotheses

- $H_1$: The Penumbra Coil 400 System will achieve a higher packing density as compared to conventional coils.

- $H_2$: The Penumbra Coil 400 System will take a shorter procedural time while using fewer coils on average.

- $H_0$: The Penumbra Coil 400 System will show no significant benefits in embolization cases compared to the conventional coils.
Materials and Methods

- Single-center case-review of 111 aneurysms
  - 2005-2011
  - PC 400 (N=16)
  - Controls (N=95)

- Studied:
  - Packing density
    - Calculated with AngioCalc (www.angiocalc.com)
  - Embolization time
  - Number of coils
  - Aneurysm Occlusion
## Background Patient Information

<table>
<thead>
<tr>
<th></th>
<th>PC 400</th>
<th>Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No. of Patients Enrolled</strong></td>
<td>16</td>
<td>94</td>
</tr>
<tr>
<td><strong>Age (years) (mean/SD)</strong></td>
<td>58 ± 10</td>
<td>56 ± 13</td>
</tr>
<tr>
<td><strong>Female</strong></td>
<td>81%</td>
<td>69%</td>
</tr>
<tr>
<td><strong>Ruptured</strong></td>
<td>43.8</td>
<td>57.9</td>
</tr>
<tr>
<td><strong>Vessel Location</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICA</td>
<td>50%</td>
<td>36.9%</td>
</tr>
<tr>
<td>P Comm</td>
<td>31.3%</td>
<td>21.1%</td>
</tr>
<tr>
<td>A.Comm ACA</td>
<td>12.5%</td>
<td>26.3%</td>
</tr>
<tr>
<td>MCA</td>
<td>6.2%</td>
<td>9.5%</td>
</tr>
<tr>
<td>Other</td>
<td>0</td>
<td>6.2%</td>
</tr>
<tr>
<td><strong>Aneurysm Volume (mean) (cc)</strong></td>
<td>204.3*</td>
<td>154.5</td>
</tr>
</tbody>
</table>

*Non-parametric Wilcoxon Ranked Test, significantly different than Controls, P< 0.05
## Coil Information

<table>
<thead>
<tr>
<th></th>
<th>PC 400</th>
<th>Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Aneurysm Volume (cc)</td>
<td>204.3*</td>
<td>154.5</td>
</tr>
<tr>
<td>Mean # of Coils Used</td>
<td>3.9</td>
<td>5.5</td>
</tr>
<tr>
<td>Mean Coil Length (cm)</td>
<td>36.3</td>
<td>46.8</td>
</tr>
</tbody>
</table>

*Non-parametric Wilcoxon Ranked Test, significantly different than Controls, P< 0.05
## Procedural Results

<table>
<thead>
<tr>
<th></th>
<th>PC 400</th>
<th>Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean Procedure Time (min)</strong></td>
<td>46.7</td>
<td>58.8</td>
</tr>
<tr>
<td><strong>Mean Packing Density (%)</strong></td>
<td>36.2**</td>
<td>27.5</td>
</tr>
</tbody>
</table>

** Non-parametric Wilcoxon Ranked Test, significantly different than Controls P <0.005
## Follow Up Results

<table>
<thead>
<tr>
<th>Raymond Scale-Class I Occlusion At 6 months Post Procedure (%)</th>
<th>PC 400 (N=7)</th>
<th>Controls (N=44)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>85.7</td>
<td>61.4</td>
</tr>
</tbody>
</table>
4.28 mm by 4.57 mm by 5.95 mm
PCOMM - SAH

Pre-treatment

1. 5mm x 9cm Soft
2. 3mm x 3cm Curve
3. 2mm x 2cm Curve

Post-treatment

PD: 46.55%
Time: 19 mins
Discussion

- Penumbra coils achieved an approximate 40% packing density, compared to 30% with conventional coils (Sadasivan et al., 2009)

- Significantly fewer coils per case, while still achieving greater packing density

- Significantly shorter procedure time

- Zero worsening occlusion at 6 months
  - No procedure related events
Discussion

- Data shows that the Penumbra coils are suitable replacements

- HydroCoils have an expandable hydrophilic coat (Khan et al., 2012)

- As compared to HydroCoils, the Penumbra coils allowed for more rapid embolization and a higher packing density (Dörfler et al., 2011)
Limitations on Research

- Small number of cases in the study group (~100 cases annually at Mount Sinai)

- The Penumbra coils were mainly being compared to bare platinum coils, rather than an equal mix of second generation coils (HydroCoils)

- Additional procedural time in the Penumbra groups was due to a learning curve associated with the Penumbra coils
Future Research Questions

- Can even greater packing density be achieved?
- Does use of the Penumbra coils reduce procedure cost?
- Is coil compaction reduced because of the greater coil thickness?
- Are patient outcomes equivalent, if not better?
References