FLOW DIVERSION FOR POSTERIOR CIRCULATION
THE SURPASS EXPERIENCE

25th Annual Meeting SIMI

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Ajay K. Wakhloo, M.D., Ph.D., FAHA
Department of Radiology, Neurology and Neurosurgery
Division Neuroimaging and Intervention
University of Massachusetts Medical School
DISCLOSURES

- Stryker Neurovascular (Consultant)
- Codman J&J (Consultant)
- InNeuroco (Stockholder, CMO)
- Pulsar (Bridge loan)
- EpiEp (Stockholder)
- Medtronic (Stockholder)
- Philips (MAB, Research Grant, Equipment support)
- Postgraduate Course Harvard Medical School (Speaker)
- Baptist Hospital, Miami, Florida (Speaker)
- Mayo Clinic, Jacksonville, Florida (Speaker)
- NIH (R01 NS45753-01A1; 1R21EB007767-02; 5R01 NS045753-02; 1R21NS061132-01A1; 1R01NS091552-01A1)
Posterior Circulation - Surpass Study Group

- Christian Taschner, Julia Bernardy; Freiburg, Germany
- Joost de Vries, Jeroen Boogaarts; Nijmegen, The Netherlands
- Nobuyuki Sakai, Kobe, Japan
- Pedro Lylyk, Buenos Aires, Argentina
- Alessandra Biondi, Besancon, France
- Istvan Szikora, Budapest, Hungary
- Bernd Eckert, Hamburg, Germany
- Bruening, Hamburg, Germany
- Ralph Siekmann, Kassel, Germany
- Peter Kan, Tampa, Florida, USA
- Patrick Brouwer, Rotterdam, The Netherlands
- Ajay K. Wakhloo, Ajit S. Puri, Matthew Gounis; Worcester, USA
Surpass Flow Diverter

- Self-expandable braided device
- 48 - 96 Chrome-Cobalt wires
- FD preloaded in an over-the-wire microcatheter delivery system
- Navigated over 0.014” microwire
<table>
<thead>
<tr>
<th>Length (mm)</th>
<th>Diameter: 2mm</th>
<th>Diameter: 3mm</th>
<th>Diameter: 4mm</th>
<th>Diameter: 5mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>12mm</td>
<td>✔️</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15mm</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>20mm</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
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<tr>
<td>25mm</td>
<td></td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>30mm</td>
<td></td>
<td></td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>40mm</td>
<td></td>
<td></td>
<td></td>
<td>✔️</td>
</tr>
<tr>
<td>50mm</td>
<td></td>
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</tbody>
</table>
Surpass FD currently not FDA approved
Surpass FD currently not FDA approved
6 month fu
Flow Diversion

Why is *Mesh Density* important?

- Consistent flow diversion across vessels that taper
Currently available Flow Diverters

Mesh Density
Flow Diversion

Why is *Mesh Density* important?

- Mesh density and braid angle affect fluid velocity
- Increasing wire count from 48 to 72
  - Reduces aneurysm inflow rate by 24%
  - Shrinks the impact zone by almost 90%

<table>
<thead>
<tr>
<th></th>
<th>Inflow Rate (mL/S)</th>
<th>Aneurysmal Inflow</th>
<th>Turnover Time</th>
<th>Impact Zone (mm² / %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before Stenting</td>
<td>2.241</td>
<td>42%</td>
<td>0.099s</td>
<td>137 / 74%</td>
</tr>
<tr>
<td>48 wires 33 microns</td>
<td>1.302</td>
<td>25%</td>
<td>0.171s</td>
<td>92 / 50%</td>
</tr>
<tr>
<td>72 wires 32 microns</td>
<td>0.991</td>
<td>19%</td>
<td>0.217s</td>
<td>10 / 6%</td>
</tr>
<tr>
<td>96 wires 32 microns</td>
<td>0.779</td>
<td>15%</td>
<td>0.277s</td>
<td>10 / 6%</td>
</tr>
</tbody>
</table>

Images courtesy of Gainluca De Santis and Matthieu De Beule, FEOps
Dissecting Basilar Trunk Aneurysm

16-year young boy with stroke, speech problems, hemiparesis and inability to walk

Progressive deterioration on dual antiplatelet treatment and anticoagulation

P. Kan et al. JNIS 2015 - Compassionate use – Surpass is not FDA approved
Dissecting Basilar Trunk Aneurysm –
16-year young boy with stroke, speech problems, hemiparesis and inability to walk
Progressive deterioration on dual antiplatelet treatment and anticoagulation

P. Kan et al. JNIS 2015 - Compassionate use – Surpass is not FDA approved
60-year-old male with a history of a right middle cerebral artery ischemic infarction and new lower cranial nerve deficit associated with a fusiform basilar artery aneurysm.
Single 4.4 mm x 80mm long 1\textsuperscript{st} Gen SURPASS FD

Surpass FD is currently not FDA approved
2-day FU

Intra-arterial use of tPA

Single 4.4 mm x 80mm long 1st Gen SURPASS FD
Role of contralateral VA occlusion

- Symptomatic Vertebro-basilar fusiform aneurysm
- Coil occlusion of left Vertebral artery to avoid “endoleak”
Study Objective

Presence of dense perforators
### SURPASS FD multicenter registry

#### Patient Data

<table>
<thead>
<tr>
<th>General information</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients</td>
<td>52</td>
</tr>
<tr>
<td>Aneurysms</td>
<td>52</td>
</tr>
<tr>
<td>Women (%)</td>
<td>21 (41%)</td>
</tr>
<tr>
<td>Mean age (yr) [range]</td>
<td>54 [16-79]</td>
</tr>
<tr>
<td>General information</td>
<td></td>
</tr>
<tr>
<td>---------------------------------------------------------</td>
<td>--------</td>
</tr>
<tr>
<td>Acute SAH</td>
<td>7/52 (13%)</td>
</tr>
<tr>
<td>Stroke/TIA</td>
<td>7/52 (13%)</td>
</tr>
<tr>
<td>Cranial nerve deficit/mass effect</td>
<td>14/52 (27%)</td>
</tr>
<tr>
<td>Incidental findings/headaches</td>
<td>20 (38%)</td>
</tr>
<tr>
<td>Recurrent after coiling/stenting/failed clipping</td>
<td>16 (31%)</td>
</tr>
</tbody>
</table>
Baseline mRS (n=52)

- mRS 0–2: 38 (73%)
- mRS 3-5: 14 (27%)

### Distribution

- mRS: 0: 21
- mRS: 1: 13
- mRS: 2: 4
- mRS: 3: 10
- mRS: 4: 4
Aneurysm location (n=52)

- Vertebral artery: 20 (38%)
- VB Junction: 11 (21%)
- Basilar trunk: 15 (29%)
- PCA: 6 (12%)
## Aneurysm sizes (n=52)

<table>
<thead>
<tr>
<th>Size</th>
<th>Count (Percentage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 5 mm</td>
<td>4 (8%)</td>
</tr>
<tr>
<td>5 – 9.9 mm</td>
<td>13 (25%)</td>
</tr>
<tr>
<td>10 – 20 mm</td>
<td>17 (33%)</td>
</tr>
<tr>
<td>&gt; 20 mm</td>
<td>17 (33%)</td>
</tr>
</tbody>
</table>
Aneurysm type (n=52)

- Fusiforme: 39 (75%)
- Wide-neck Saccular: 12 (23%)
- Blood-blister type: 1 (2%)
Aneurysm characteristics

Pretreated (Coil, Stent, Clip, failed surgery) 16 (31%)

Partially thrombosed 14 (27%)
Symptomatic basilar tip aneurysm

29-y-o-m w progressive incapacitating headaches and gait disturbance
Symptomatic basilar tip aneurysm
Symptomatic basilar tip aneurysm
Combined use of coils
Symptomatic basilar tip aneurysm

24 hour follow-up
## Aneurysm treatment

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<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Technical success rate</td>
<td>51/52 (98%)</td>
</tr>
<tr>
<td>Average # of FD / case</td>
<td>1.4 (range 1 – 3)</td>
</tr>
</tbody>
</table>
Malapposition of telescoping FDs
...requiring post dilation
6 months follow-up
6-month follow-up
Requirement: Intraoperative placement of a shunt due to hydrocephalus via burr hole

Before shunt

After shunt
Requirement: Placement of a shunt due to hydrocephalus

Before shunt

After shunt
Requirement: Placement of a shunt due to hydrocephalus

Before shunt

After shunt
Aneurysm treatment

Procedural complications 9 (17.3%)  
(binary; 95% CI: 8.2% - 30.3%)

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<table>
<thead>
<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Aneurysmal rupture</td>
<td>1/52</td>
</tr>
<tr>
<td>Dissection target vessel</td>
<td>2/52</td>
</tr>
<tr>
<td>Thrombus formation</td>
<td>6/52</td>
</tr>
</tbody>
</table>

Procedure complications correlated with patient age \( p < 0.05 \)

Procedure complications did not correlate with location \( p = 0.304 \)

Procedure complications did not correlate with # of FDs \( p < 0.2 \)
Aneurysm treatment

New neurological deficit @ 24h follow up
(binary; 95% CI: 15.6%-41%)

<p>| | |</p>
<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Death</td>
<td>1/52</td>
</tr>
<tr>
<td>Tetraparesis</td>
<td>1/52</td>
</tr>
<tr>
<td>Hemiparesis</td>
<td>2/52</td>
</tr>
<tr>
<td>Cranial nerve deficits</td>
<td>6/52</td>
</tr>
</tbody>
</table>

New neurological deficit correlated with:

- Baseline mRS (p=0.0018)
- Location (p=0.028)
- # of FDs (p=0.0266)
- Aneurysm size (p=0.0071)
- Neck size (p=0.0359)
## Complications during hospital stay

<table>
<thead>
<tr>
<th>Neuro</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ischemia</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Asymptomatic ICH</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>SAH</td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Clinical status</th>
<th>Count/Total (Percentage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinically stable</td>
<td>39/52 (75%)</td>
</tr>
<tr>
<td>Clinically improved</td>
<td>7/52 (13%)</td>
</tr>
<tr>
<td>Clinically deteriorated</td>
<td>4/52 (8%)</td>
</tr>
<tr>
<td>Death</td>
<td>2/52 (4%)</td>
</tr>
</tbody>
</table>
Clinical Outcome

Follow-up: mean 11.3 months (range 6 – 12.7)
Angiographic outcome (n=44; 85%)

Follow-up: mean 11.3 months (range 1 – 23)
All cause mortality rate of 17.3% (95% CI: 7%-27.6%); 13.5% directly related to procedure. Morbidity 13.9% (95% CI: 3.6%-24.3%);
mRS at follow-up

Baseline mRS

mRS 0 (n=13)
- mRS 0: 12
- mRS 1: 1

mRS 1 (n=5)
- mRS 1: 3
- mRS 2: 1

mRS 2 (n=0)

mRS 3 (n=1)
- mRS 3: 1

mRS 4 (n=0)

mRS shift: Vertebral artery aneurysm (n=19)

- Improvement mRS 2/3
- Improvement mRS 1
- Stable mRs
- Deterioration mRS 1
- Deterioration mRS 2/3
mRS shift: Basilar artery/VB junction aneurysm (n=26)

Baseline mRS

mRS at follow-up

mRS 0 (n=7)
- mRS 0: 7

mRS 1 (n=5)
- mRS 0: 1
- mRS 1: 2
- mRS 2: 1
- mRS 3: 1

mRS 2 (n=4)
- mRS 0: 1
- mRS 1: 1
- mRS 2: 1
- mRS 3: 1

mRS 3 (n=6)
- mRS 0: 1
- mRS 1: 5

mRS 4 (n=4)
- mRS 0: 2
- mRS 1: 2

Legend:
- Improvement mRS 2/3
- Improvement mRS 1
- Stable mRS
- Deterioration mRS 1
- Deterioration mRS 2/3
Summary

Treatment of aneurysms located in the posterior circulation with the Surpass FD is feasible.

It shows a variable safety profile.

Good clinical outcomes were observed in patients bearing aneurysms of the vertebral artery.

Worst outcome was observed in symptomatic patients with fusiform aneurysms of the basilar artery and the VB junction.
Conclusion

In patients with fusiform basilar and VB junction aneurysms the clinical outcome seemed better in asymptomatic patients when compared to symptomatic patients.

Overall morbidity and mortality 27%

Asymptomatic patient: morbidity 5%  mortality 0%
Symptomatic patient: morbidity 44%  mortality 28%
Conclusion

Mortality was positively correlated with

- Baseline mRS (p=0.0001)
- Age (p=0.018)
- Aneurysm location (p=0.02)
- Aneurysm size (p=0.0098)
- Neck diameter (p=0.06)
- Number of FDs (p=0.0002)
Discussion Points

1. Classification of basilar trunk aneurysms?

2. Time for a multicenter study for large/giant basilar trunk/VB junction aneurysm?