Will Mesh Covered Stents Help Reduce The Risk Of Stroke?

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USA
What are the possible causes of stroke in CAS?

• Operator error
  - Technique (balloon sizing, wire misadventure, EPD error, etc.)

• Patient factors
  - Vulnerable plaque (lesion, carotid, aorta)
  - Vascular anatomy or characteristics (calcium, thrombus, etc.)
  - Genetics related to thienopyridine metabolism

• Inadequate technology
  - EPD, stent, procedural pharmacology
Open and closed cell design elements

Pre-deployment shape

Post-deployment shape

Closed cell

Open cell

Crown

Cell
Stent design: open vs. closed cell
Closed cell stent stiffness can lead to kinking
Open cell stent can conform to vessel, but may fish-scale
Differences in cell size by stent
Also need to consider Minimal Circular Unsupported Area (MCUSA)
**Pore (MCUSA) sizes**

No significant difference between OC and CC stents

N.B. filter pore size ~1/10\(^{\text{th}}\) the stent pore size

<table>
<thead>
<tr>
<th>Stent</th>
<th>Pore Size (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wallstent</td>
<td>0.92</td>
</tr>
<tr>
<td>Xact</td>
<td>0.96</td>
</tr>
<tr>
<td>Protégé</td>
<td>1.08</td>
</tr>
<tr>
<td>Precise</td>
<td>1.12</td>
</tr>
<tr>
<td>Acculink</td>
<td>1.06</td>
</tr>
</tbody>
</table>

Xact, PROTÉGÉ RX and Acculink = 8-6mm tapered stents (distal portion)

Precise and Wallstent = 8mm straight stent
Clinical event rates by free cell area

<table>
<thead>
<tr>
<th>Free cell area</th>
<th>Total population</th>
<th>Symptomatic population</th>
<th>Asymptomatic population</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Patients</td>
<td>All events</td>
<td>Post-procedural events</td>
</tr>
<tr>
<td>&lt;2.5 mm²</td>
<td>2107</td>
<td>48</td>
<td>26</td>
</tr>
<tr>
<td>2.5–5 mm²</td>
<td>135</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>5–7.5 mm²</td>
<td>327</td>
<td>16</td>
<td>11</td>
</tr>
<tr>
<td>&gt;7.5 mm²</td>
<td>610</td>
<td>23</td>
<td>21</td>
</tr>
<tr>
<td>Total</td>
<td>3179</td>
<td>90</td>
<td>61</td>
</tr>
</tbody>
</table>

European Registry: no effect of stent type on outcomes

Symptomatic Patients (n=674)

- TIA, stroke&death day 0 to 30: 0% vs. 2%, p=0.43
- Stroke&death day 0 to 30: 4% vs. 6%, p=0.84
- TIA, stroke&death day 0: 6.5% vs. 3.9%, p=0.16
- Stroke&death day 0: 3.1% vs. 1.8%, p=0.32
- TIA, stroke&death day 1 to 30: 0.7% vs. 1.6%, p=0.48
- Stroke&death day 1 to 30: 0.3% vs. 1.3%, p=0.24

Current non-randomized data-sets do not support the superiority of open or closed cell design stents. (Very large) Randomized trials will be needed to clarify this issue.
EXACT (CC) and CAPTURE 2 (OC)
No differences in prospective, adjudicated study

EXACT (N=2145)*
CAPTURE 2 (N=4175)
Combined (N=6320)

EXACT (N=213)
CAPTURE 2 (N=548)
Combined (N=761)

EXACT (N=1931)
CAPTURE 2 (N=3627)
Combined (N=5558)

Lankenau Heart Institute
Main Line Health
Stroke timing paradox: Not all strokes appear on the day of the procedure

Post-procedural **PLAQUE PROLAPSE** through conventional stent struts

Suzuki M et al.  
ESC 2014  
Presentation  
www.escardio.org

81 y.o. Female, Symptomatic

1/3 stents = **Precise**  
2/3 stents = **Carotid Wallstent**

Images: Dr M. Suzuki  
ESC 2014  
www.escardio.org  
*Eur Heart J.* 2014;35(Abst Suppl):178
MRI DWI white matter changes post CAS are greater than CEA: numerically but not by volume
<table>
<thead>
<tr>
<th>Name</th>
<th>RoadSaver <em>aka</em> Casper</th>
<th>Gore® Carotid Stent</th>
<th>CGuard™ Embolic Prevention Stent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stent frame</td>
<td>closed-cell Nitinol</td>
<td>open-cell Nitinol</td>
<td>open-cell Nitinol</td>
</tr>
<tr>
<td>Mesh position in relation to frame</td>
<td>inside</td>
<td>outside</td>
<td>outside</td>
</tr>
<tr>
<td>Mesh material</td>
<td>Nitinol</td>
<td>PTFE</td>
<td>PET</td>
</tr>
<tr>
<td>Mesh structure</td>
<td>braided</td>
<td>inter-woven</td>
<td>single-fiber knitted</td>
</tr>
<tr>
<td>Pore size</td>
<td>375 µm</td>
<td>500 µm</td>
<td>150 - 180 µm</td>
</tr>
</tbody>
</table>
Ideal Pore Size

*165μ 375 500 1050
Closed cell stent

1900
Open cell stent

* Average in lesion at expanded state
Evaluation of PET Mesh Covered Stent in Patients with Carotid Artery Disease

The CARENET-Trial
(CARotid Embolic protection using microNET)

Joachim Schofer (PI)
Piotr Musialek (Co-PI)
On behalf of the CARENET Investigators
Filter-protected CAS procedures

**CARENET vs PROFI:** DW-MRI analysis

**DW-MRI analysis @ 48 hours**

- **CGuard (n=27):** 34.6%
- **Conventional Carotid stent (n=31):** 87.1%

*p < 0.005*

References:
- J. Schofer, P. Musialek et al. *JACC Intv* 2015;8:1229-34
- Bijuklic et al. (manuscript in preparation)
Filter-protected CAS procedures

CARENET vs PROFI: DW-MRI analysis

DW-MRI analysis @ 48 hours

VOLUME

new ipsilateral lesions (mL)

CGuard

0.04

n=27

Conventional Carotid stent (hybrid)

0.59

n=31

p < 0.005

see patient fluxogram

ijuklic et al. JACC, 2012;59

J. Schofer, P. Musialek et al. JACC Intv. 2015;8:1229-34

Bijuklic et al. (manuscript in preparation)
TERUMO: Roadsaver

- Closed cell structure with flexible Nitinol weave
  - Dual layer micromesh design
- Retrievable and repositionable
CASPER/Roadsaver vs. Closed Cell CAS: OCT
Regulatory status of CASPER

- FDA IDE for US investigation is underway, recruiting
WL Gore SCAFFOLD stent
**SCAFFOLD: trial description**

<table>
<thead>
<tr>
<th>Device</th>
<th>Gore SCAFFOLD mesh-covered stent</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Objective</strong></td>
<td>Evaluate the performance of the SCAFFOLD stent in treating bifurcation carotid artery stenosis at high risk for CEA</td>
</tr>
<tr>
<td><strong>Study Design</strong></td>
<td>Prospective, multicenter, single-arm, open label</td>
</tr>
<tr>
<td><strong>Subjects</strong></td>
<td>312 patients with bifurcation carotid artery stenosis</td>
</tr>
</tbody>
</table>
| **Principle Investigators** | William A. Gray MD (IC) Philadelphia PA  
Peter Schneider MD (VS) Honolulu HI |
| **Investigational Centers** | 30 US sites |
| **Evaluation**  | Baseline, Procedure, 1 month, 1 year, 2 years, 3 years |
| **Primary Endpoint** | 30-day death, all stroke, myocardial infarction plus ipsilateral stroke to 1 year |
## SCAFFOLD 1 year Primary Endpoints

<table>
<thead>
<tr>
<th>30 Day Endpoint (N)</th>
<th>ITT</th>
<th>PP</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAE</td>
<td>15 (4.8%)</td>
<td>8 (3.0%)</td>
</tr>
<tr>
<td>Death</td>
<td>2 (0.6%)</td>
<td>1 (0.4%)</td>
</tr>
<tr>
<td>Myocardial infarction</td>
<td>4 (1.3%)</td>
<td>4 (1.5%)</td>
</tr>
<tr>
<td>Q-wave MI</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Stroke</td>
<td>9 (2.9%)</td>
<td>3 (1.1%)</td>
</tr>
<tr>
<td>Major stroke</td>
<td>5 (1.6%)</td>
<td>3 (1.1%)</td>
</tr>
<tr>
<td>Ipsilateral</td>
<td>4 (1.3%)</td>
<td>2 (0.8%)</td>
</tr>
<tr>
<td>Non-ipsilateral</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Hemorrhagic (ipsi)</td>
<td>1 (0.3%)</td>
<td>1 (0.4%)</td>
</tr>
<tr>
<td>Minor stroke</td>
<td>4 (1.3%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Ipsilateral</td>
<td>2 (0.6%)</td>
<td></td>
</tr>
<tr>
<td>Non-ipsilateral</td>
<td>2 (0.6%)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1 Year Endpoint (N)</th>
<th>ITT</th>
<th>PP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ipsilateral Stroke (31-365d)</td>
<td>5 (1.7%)</td>
<td>3 (1.2%)</td>
</tr>
</tbody>
</table>
1-year Target Lesion Revascularization (TLR) ITT

1yr Clinically Driven TLR: 1.4%
1yr Restenosis (≥80%): 1.0%
1yr ECA Patency: 99.6%
One Year Endpoints Compare Favorably to Historical Data

<table>
<thead>
<tr>
<th></th>
<th>SCAFFOLD ITT</th>
<th>SCAFFOLD PP</th>
<th>ARCHER</th>
<th>BEACH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ipsilateral Stroke (31-365d)</td>
<td>1.7%</td>
<td>1.2%</td>
<td>1.3%</td>
<td>2.5%</td>
</tr>
<tr>
<td>Clinically Driven TLR (1 Year)</td>
<td>1.4%</td>
<td>1.6%</td>
<td>2.2%</td>
<td></td>
</tr>
<tr>
<td>TLR (1 Year)</td>
<td>4.9%</td>
<td>4.1%</td>
<td></td>
<td>4.7%</td>
</tr>
</tbody>
</table>
SCAFFOLD Summary

• SCAFFOLD trial is the largest multicenter controlled evaluation of mesh-covered CAS

• The SCAFFOLD trial using the mesh-covered Gore Carotid Stent demonstrated:
  – 100% technical success
  – Low 30d stroke rate (1.1%) when used per protocol
  – Low late stroke rate (1.2%) and clinically driven TLR 1.4%
  – Maintenance of ECA
Summary

Mesh-covered carotid stents (along with integrated embolic protection/filtration, and direct carotid access with high-flow proximal protection) are likely to add benefit in terms of reducing not only minor stroke events but also surrogate DWI lesions.
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