NO……
I SEE THE QUALITY AND NECESSITY FOR STENTING

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I have the following potential conflicts of interest to report:

- [x] Consulting
- [ ] Employment in industry
- [ ] Stockholder of a healthcare company
- [ ] Owner of a healthcare company
- [x] Other(s)

- [ ] I do not have any potential conflict of interest
Disclosures:
In the past 12 months, my spouse or myself have engaged in financial relationships as follows:

- **Consultant:**
  - Boston Scientific, Medtronic
- **Advisory Panel:**
  - Boston Scientific, Medtronic
- **Speakers Bureau:**
  - Abbott, Endologix
- **Research Support**
  - Philips Healthcare, Bard, BTG, Boston Scientific, Penumbra, Angiodynamics, Terumo
- **Clinical Events Committee**
  - Shockwave (Disrupt PAD), Intact Vascular (TOBA-2)
Peripheral Vascular Disease

Safety and Effectiveness of Stent Placement for Iliofemoral Venous Outflow Obstruction
Systematic Review and Meta-Analysis

Mahmood K. Razavi, MD; Michael R. Jaff, DO; Larry E. Miller, PhD
AT PRESENT

• There are no approved iliofemoral venous stents in the US
• Many are currently under investigation
  – COOK VIVO ZILVER VENA
  – VENITE VICI
  – BARD VERNACULAR
  – MEDTRONIC ABRE
  – OPTIMED SINUS
Current Venous Stent Trials in the US

- Wallstent
- Cook Zilver Vena
- Venite Vici
- Venovo
- Sinus Obliquus
- Abre
Physical Properties of Venous Stents: An Experimental Comparison

Darius Dabir¹ · Andreas Feisst¹ · Daniel Thomas¹ · Julian A. Luetkens¹ · Carsten Meyer¹ · Ana Kardulovic² · Matthias Menne² · Ulrich Steinseifer² · Hans H. Schild¹ · Daniel L. R. Kuettting¹
Ideal Venous Stent

- Appropriate Radial Force
- Appropriate Chronic Outward Force
- Appropriate flexibility
- Self-expandable
- Minimal foreshortening on deployment and balloon dilation
- Allow repeated shortening, twisting, and/or bending at the groin
- Sufficient flexibility not to kink at physiological angles
- Longer stents to avoid overlapping of multiple stents.
- Modular stents at the iliac confluence and IVC
Residual compression at the iliac venous crossing

'Arterial' stent - open cell design

Venous Stent - open cell design

Conebeam CT imaging

Venous - hybrid unique ring design

Braided stainless steel stent

Venous Stent - closed cell design
VIRTUS VENOUS STENT Trial

- 30 Sites Worldwide
- 200 Patients
- Key End Points
  - Primary Stent Patency at 12 months
  - Safety
# VIRTUS Trial Design

<table>
<thead>
<tr>
<th>Objective</th>
<th>Assess safety &amp; effectiveness in achieving patency of target venous lesion through 12-M post stent placement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety</td>
<td>MAEs @ 30 days</td>
</tr>
<tr>
<td>Effectiveness</td>
<td>Primary Patency @ 12-M</td>
</tr>
</tbody>
</table>
| Principal Investigators | - Mahmood Razavi, MD  
|                          | - William Marston, MD                                                                                      |
| Study Design | Prospective, multicenter, single arm non-randomized, up to 45 sites worldwide                           |
| Patient Population | 200 subjects with clinically significant chronic non-malignant obstruction of the iliofemoral venous segment – first 30 were feasibility. |
| Core Labs | Venography: Syntactx: IVUS: St. Lukes: DUS: VasCore/MGH                                                  |
VIRTUS Trial

- Pts with non-thrombotic & chronic post thrombotic outflow obstruction enrolled in a pre-defined ratio of NT to PT.
- Acute thrombotic pts excluded up to 90 days after DVT
- Enrollment completed in Nov 2016
- Only study requiring 3 different imaging modalities at baseline and follow up (venography, IVUS, Duplex imaging), all core lab adjudicated
Procedural technical success defined as final residual target vessel diameter stenosis of ≤50% as measured by venogram.
• Primary endpoint was met: Primary patency rate exceeded the performance goal of 72.1% (p<0.0001)\textsuperscript{a,b}

• Primary patency based on venography only\textsuperscript{c}
  • 79.8% Post-thrombotic
  • 96.2% Non-thrombotic

Primary patency defined as stenosis of target lesion ≤50% (based on venogram) without surgical or endovascular intervention on target vessel to restore patency.

\textsuperscript{a}For the primary endpoint, patients who did not have venography performed at 12 months had their result imputed by random selection from subjects with a venogram result who had the same etiology and the same DUS outcome (if available).

\textsuperscript{b}Primary effectiveness analysis based on the combined result from 15 imputations; t-statistic 4.0; p<0.0001.

\textsuperscript{c}12-month venograms were available for 125 patients.
- Self-expanding nitinol
- Dedicated design for venous vessels
- 6 markers at each end (3 nitinol, 3 tantalum)
- Ends flared 3mm to ensure wall apposition
- Stent Diameters: 10, 12, 14, 16, 18, 20 mm
- Stent Lengths: 40-160 mm (in 20 mm increments)
- 8-10 F sheath depending on device diameter

- Tri-axial delivery system
- .035” OTW
- Dual-speed deployment thumbwheel
- Ergonomic handle

VENOVO® Venous Stent System
VENOVO™ Venous Stent

<table>
<thead>
<tr>
<th>Stent Lengths</th>
<th>Stent Diameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 mm</td>
<td>8F, 10 mm</td>
</tr>
<tr>
<td>40 mm</td>
<td>8F</td>
</tr>
<tr>
<td>60 mm</td>
<td>8F</td>
</tr>
<tr>
<td>80 mm</td>
<td>8F</td>
</tr>
<tr>
<td>100 mm</td>
<td>8F</td>
</tr>
<tr>
<td>120 mm</td>
<td>8F</td>
</tr>
<tr>
<td>140 mm</td>
<td>8F</td>
</tr>
<tr>
<td>160 mm</td>
<td>8F</td>
</tr>
<tr>
<td>120 mm</td>
<td>9F</td>
</tr>
<tr>
<td>160 mm</td>
<td>10F</td>
</tr>
<tr>
<td>180 mm</td>
<td>10F</td>
</tr>
<tr>
<td>200 mm</td>
<td>10F</td>
</tr>
</tbody>
</table>
VERNACULAR Trial

- **Design**: Prospective, multi-center study of the VENOVO® venous stent
- **Investigative Sites**: Europe, Australia, and the US
- **Investigator**: Michael Dake MD
- **Patients Eligible**: Acute or Chronic DVT, May-Thurner Syndrome, or any combination of the above
- **Trial Indication**: For the treatment of stenoses and occlusions in the iliac and femoral veins.
- **Primary endpoints**:
  - Primary patency (12 months)
  - Freedom from MAE (30 days)
Results

• Primary Patency at 12 months  88.3%
• Freedom for CD-TLR  92.6%
• Stent fractures at 12 months  0.0%
Cook VIVO IDE Study

- **Purpose**: To evaluate the safety and effectiveness of the Zilver Vena Venous Stent in the treatment of symptomatic iliofemoral venous outflow obstruction
- **Study PI’s**:
  - Anthony Comerota
  - “Rusty” Hofmann
- **Study initiated**: October 2013
- **Target enrollment**: 243 patients
- **To date**: 239 enrolled
Abre™ Venous Self-Expanding stent
Abre™ VENOUS SELF-EXPANDING STENT SYSTEM

- Global Study
- Principal Investigators: Erin Murphy MD and Stephen Black MD
- 200 global patients
- 30 major adverse events
- 12 month primary patency
• Several unique device designs are currently under investigation
  – All nitinol
  – Closed and open cell designs
  – Able to treat 14-20mm diameter
The Effect of Stenting on Venous Hypertension: Results Using a Treadmill Stress Test with Invasive Pressure Measurements in Patients with Iliofemoral Venous Obstruction

Ralph L.M. Kurstjens a,b,c,*, Mark A.F. de Wolf a,b, Helena W. Konijn a, Irwin M. Toonder a, Patricia J. Nelemans d, Jorinde H.H. van Laanen a, Rick de Graaf e, Cees H.A. Wittens a,b,f

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fDepartment of Vascular Surgery, University Hospital Aachen, Aachen, The Netherlands

Table 2. Common femoral vein pressures during walking and in the supine and erect position.

<table>
<thead>
<tr>
<th>Pressure, mmHg</th>
<th>Before intervention</th>
<th>Three months after intervention</th>
<th>Change</th>
<th>Difference between affected and non-affected limb</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFV change during walking</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Affected limb</td>
<td>34.8 ± 23.1</td>
<td>12.6 ± 7.6</td>
<td>−22.3 ± 24.8</td>
<td>−26.2 (95% CI −41.2 to −11.3) .003 a</td>
<td></td>
</tr>
<tr>
<td>Non-affected limb</td>
<td>3.9 ± 5.8</td>
<td>7.9 ± 3.0</td>
<td>4.0 ± 6.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CFV erect</td>
<td></td>
<td></td>
<td></td>
<td>−8.3 (95% CI −23.9 to 7.2) .263</td>
<td></td>
</tr>
<tr>
<td>Affected limb</td>
<td>59.5 ± 12.5</td>
<td>60.5 ± 8.2</td>
<td>1.0 ± 16.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-affected limb</td>
<td>48.5 ± 17.2</td>
<td>57.9 ± 12.4</td>
<td>9.3 ± 25.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CFV supine</td>
<td></td>
<td></td>
<td></td>
<td>−3.5 (95% CI −8.7 to 1.8) .168</td>
<td></td>
</tr>
<tr>
<td>Affected limb</td>
<td>24.0 ± 7.6</td>
<td>22.6 ± 6.7</td>
<td>−2.1 ± 7.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-affected limb</td>
<td>20.0 ± 8.4</td>
<td>21.3 ± 5.9</td>
<td>1.4 ± 7.8</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. Plus–minus values are means ±standard deviation. CI = confidence interval; CFV = common femoral vein.

a Statistically significant.
Figure 2. Effect of stenting on venous hypertension compared with control limbs.

<table>
<thead>
<tr>
<th></th>
<th>Before intervention</th>
<th>After intervention</th>
<th>Difference effect between affected and non-affected limb</th>
<th>( p )</th>
</tr>
</thead>
<tbody>
<tr>
<td>VEINES-QOL</td>
<td>50.3 ± 13.0</td>
<td>75.6 ± 22.2</td>
<td></td>
<td>&lt;.001\textsuperscript{a}</td>
</tr>
<tr>
<td>VEINES-Sym</td>
<td>47.6 ± 14.9</td>
<td>66.6 ± 24.0</td>
<td></td>
<td>.002\textsuperscript{a}</td>
</tr>
<tr>
<td>VCSS</td>
<td></td>
<td></td>
<td>2.6 (95% CI 0.5—4.7)</td>
<td>.019\textsuperscript{a}</td>
</tr>
<tr>
<td>Affected limb</td>
<td>7.7 ± 2.5</td>
<td>5.4 ± 3.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-affected limb</td>
<td>1.3 ± 1.4</td>
<td>1.6 ± 1.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Villalta score</td>
<td></td>
<td></td>
<td>4.5 (95% CI 1.9—7.1)</td>
<td>.003\textsuperscript{a}</td>
</tr>
<tr>
<td>Affected limb</td>
<td>10.2 ± 3.2</td>
<td>6.3 ± 4.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-affected limb</td>
<td>1.8 ± 1.5</td>
<td>2.4 ± 2.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pain free walking time, minutes</td>
<td>9.8 ± 6.5</td>
<td>16.4 ± 9.1</td>
<td>(4 completed test without pain)</td>
<td>.003\textsuperscript{a}</td>
</tr>
<tr>
<td>Maximum walking time, minutes</td>
<td>18.9 ± 7.4</td>
<td>22.3 ± 4.7</td>
<td>(3 completed test without stopping)</td>
<td>.019\textsuperscript{a}</td>
</tr>
</tbody>
</table>

\textsuperscript{a} Plus-minus values are means ± standard deviation. CI = confidence interval; VCSS = Venous Clinical Severity Score.

Note.
DO WE NEED VENOUS STENTS?
In summary

- Numerous Venous stents are being investigated
- The data is now available
- We are currently awaiting FDA approval in US
- More research is needed to identify the appropriate device for specific lesion subsets
  - Anatomic
  - Physiologic
NO......
I SEE THE QUALITY AND NECESSITY FOR STENTING

Robert Lookstein MD MHCDL
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