With the emergence of dedicated venous stents, understanding the role of individual design elements (cell architecture, radial strength, flexibility) in performance of the stent and, more importantly, how this therapy improves patient outcomes is critical in continuing the treatment pathway and continued improvement of stents.

**Take Home**

**Key Points**

- For a Given Perimeter...
  - Lumen shape impacts area
  - Lumen shape impacts pressure
  - Aspect Ratio is a better predictor of flow and patient outcomes versus Area

**What is Aspect Ratio? The Degree of Roundness**

<table>
<thead>
<tr>
<th>Shape</th>
<th>Aspect Ratio</th>
<th>Max Diameter 14</th>
<th>Min Diameter 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Round</td>
<td>1.1</td>
<td>14</td>
<td>7</td>
</tr>
<tr>
<td>Oval</td>
<td>1.4</td>
<td>14</td>
<td>3.5</td>
</tr>
</tbody>
</table>

Aspect Ratio = Max Diameter to Min Diameter

**Calculating Area of Shapes with Same Perimeter**

- Circle: A = πR²
- Ellipse: A = πRaRb

- Area Decreases as Shape becomes Flatter

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Disclosure
Lowell S. Kabnick, MD

- Consultant: Bard, Veniti
- Stock: Veniti
Mathematical Calculations of Shape Impact on Area, Flow and Pressure: Holding Perimeter Constant

- Area increases peripherally
- Round shapes have more area and less drag, thus better flow
- Increasing flatness = less area and more drag, thus less flow

Poiseuille's Law:
- Only Applies to a Perfect Circle
- Volume Flowrate and Area are Significantly Impacted by Shape (aspect ratio)

Shape Impact on Flow and Pressure for a Given Perimeter

- Shape directly impacts Area
- Area has an indirect impact on flow and pressure
- The greater the Aspect Ratio the smaller the area
- As shape becomes flatter flow decreases and pressure increases

2015 Publication Demonstrates that:
- Better Patency Associated with Rounder Lumen
- 48 patients with iliac compression and acute DVT followed for avg. of 20 months.
- Follow-up was performed with CT angiography.
- Stent compression considered significant if lumen compression was greater than 50% (aspect ratio 1:2).
- Significant stent compression was inversely correlated with stent patency ($p < 0.001$).

Healthy Veins are not Round: What Shape Results in Better Patient Outcomes?

Healthy veins are highly compliant and change shape dynamically when pressure and flow change.

Early clinical evidence (VIRTUS Feasibility Data) suggests that post crossing – a rounder lumen may result in better VCSS outcomes at 1 year.

A Study of VIRTUS Feasibility Cohort:
- Early Look at Lumen Shape and 12 month Patient Outcomes

IVUS Measurements utilized (pre and post stent):

- Cross-sectional Area
- Maximum Diameter
- Minimum Diameter

Analysis was performed to determine if there is a correlation between Lumen Shape and Patient Outcomes.

Aspect Ratio =
- Maximum Diameter / Minimum Diameter
- Maximum Diameter (Mean Area)
- Minimum Diameter
- Max Diameter

Healthy Veins are highly compliant and change shape dynamically when pressure and flow change.

Early clinical evidence (VIRTUS Feasibility Data) suggests that post crossing – a rounder lumen may result in better VCSS outcomes at 1 year.
VIRTUS Feasibility Cohort: Data Analysis of IVUS Measurements

<table>
<thead>
<tr>
<th>Aspect Ratio (Max Dia : Min Dia)</th>
<th>Area (sq mm) Pre-Stent</th>
<th>Post-Stent</th>
<th>12 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Stent</td>
<td>2.51</td>
<td>1.33</td>
<td>1.23</td>
</tr>
<tr>
<td>Post-Stent</td>
<td></td>
<td>82.68</td>
<td>134.96</td>
</tr>
</tbody>
</table>

• Time Frame: Pre-Stent, Post-Stent and 12 months
• Changes in Aspect Ratio and Area were Calculated

Significantly Rounder Shape (1.1 is a Circle)

- \( R = -0.25 \)
- \( P = 0.21 \)
- \( R = 0.50 \)
- \( P = 0.008 \)

Relationship between post-stent vessel change and 12-month patient outcome

• One would expect a positive correlation between area change and clinical improvement, but not observed
• Looking at the graphs - No clear pattern for area change, while change in Aspect Ratio is clearer
• Moderately positive relationship between decreased ellipticity and clinical improvement
• Patients with greatest luminal change – oval to round – Most likely to exhibit clinical improvement

Why Stent Design Matters

For a Given Perimeter:
• Lumen shape impacts area
• Lumen shape impacts flow and pressure
• Aspect Ratio is a better predictor of stent performance and patient outcomes

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