How: Imaging to Optimize Outcomes in Venous Stenting

Erin H. Murphy, MD
Rane Center
Disclosure

Speaker name: Erin H. Murphy

I have the following potential conflicts of interest to report:

- [X] Consulting: Medtronic, Boston Scientific, Cook Medical
- [ ] Employment in industry
- [ ] Stockholder of a healthcare company
- [ ] Owner of a healthcare company
- [ ] Other(s)

- [ ] I do not have any potential conflict of interest
Clinical Outcomes in Venous Stenting

Results can be dramatic
Patency – Non-Thrombotic Obstruction

Durability is obtainable and expected

Patency Rates (%) of Primary and Assisted-primary/Secondary treatments over time.
Patency – Thrombotic Obstruction

Durability less but still good

Patency Rates (%)

- Secondary
- Assisted-primary
- Primary

Months

<table>
<thead>
<tr>
<th>Months</th>
<th>Patency Rates (%)</th>
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</thead>
<tbody>
<tr>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>6</td>
<td>90</td>
</tr>
<tr>
<td>12</td>
<td>80</td>
</tr>
<tr>
<td>18</td>
<td>57</td>
</tr>
<tr>
<td>24</td>
<td>86</td>
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<tr>
<td>30</td>
<td>80</td>
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<tr>
<td>66</td>
<td>80</td>
</tr>
<tr>
<td>72</td>
<td>57</td>
</tr>
</tbody>
</table>

Values:

- 303 191 147 123 99 87 74 59 45 35 29 18
- 303 189 144 122 99 87 74 59 45 35 29 18
- 303 184 132 107 89 74 59 45 32 26 21 13
Clinical Outcomes in Venous Stenting

• Results and durability depend on attention to detail and technique

• Imaging essential at **ALL** steps:
  • Access
  • Degree of stenosis & extent of disease
  • Delineation of venous anatomy: Iliocaval confluence, profunda, healthy stent landing zones
  • Detect early stent problems
Access – Duplex Ultrasound

Ultrasound guidance – lateral/below femoral artery

Femoral vein - upper 1/3 of thigh

Enough running room to treat as low as lesser trocanter
Initial Venogram – Roadmap

Evaluate overall patency, collateralization & flow

Iliac

Iliocaval / IVCF occlusion

Initial Roadmap – Target string sign when present
Non-occlusive Disease: **Clues** for underlying pathology
Discrete Lesions or signs of underlying stenosis

Lesions
Collaterals
Pancaking
Initial Venogram

Can **NOT** completely characterize extent of disease or determine degree of stenosis accurately.
Limitations of Venography

• **Rokitansky Stenosis:**
  - Diffuse long segment stenosis w/o focal narrowing
  - May be present in up to 50% of PTS patients

Sensitivity of Venography for identification of iliac lesions ≈50%

+ Findings -> Helpful  - Findings -> Do NOT r/o disease
Intravascular Ultrasound (IVUS)

Gold Standard: Detection and classification of disease
Should be considered mandatory
Diagnostic Sensitivity of 85%

Determine degree of stenosis compared to anatomic normals

<table>
<thead>
<tr>
<th>Segment</th>
<th>Diameter (mm)</th>
<th>Area (mm²)</th>
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<tbody>
<tr>
<td>CIV</td>
<td>16</td>
<td>200</td>
</tr>
<tr>
<td>EIV</td>
<td>14</td>
<td>150</td>
</tr>
<tr>
<td>CFV</td>
<td>12</td>
<td>125</td>
</tr>
</tbody>
</table>

NOT ADJACENT SEGMENTS!
Venogram vs. IVUS

Normal CIV: 200mm²
CIV (PTS): 67 mm²
Degree of Stenosis: 67%
Venogram Versus Intravascular Ultrasound for Diagnosing and Treating Iliofemoral Vein Obstruction

Multicenter, Prospective Study

- July 2014 – June 2015: 100 patients with CEAP 4 – 6
- Pre-intervention multiplaner venography (AP, RAO, LAO) performed
- Intervention strategy planned
- Pre-intervention IVUS performed and final treatment plan decided

Results

- IVUS detected 88% > Lesions (124 vs. 66)
- 29% of patients detected (-) by venography were (+) by IVUS

Inadequacies of Venography

- **Raju & Neglen:** Venography sensitivity 66% (34% with lesions appear normal) vs. IVUS >90% sensitivity

Inadequacies of venographic assessment of anatomic variables in iliocaval disease

- Interventionists reviewed transfemoral venograms obtained in serial CEAP 3 or > patients undergoing intervention for chronic venous disease and compared results with IVUS performed intraoperatively

**Results:** Location (CIV, EIV, CFV) & degree of maximal stenosis (n=159)

- Venogram missed disease in 25% and underestimated degree of stenosis in 69%
IVUS

In rare cases lesions may be missed by IVUS (15%)

Usually at bifurcations – probe not coaxial to lumen

Often appears as missing border

Occasionally will miss webs

Low pressure compliant balloon will identify missed stenoses
Venous Stenting

Determine disease extent and stent landing zones

Must land stents in healthy vein proximally and distally

Most important step to prevent post-op stent occlusion
Proximal Landing Zone – Iliac Confluence

Identify iliac confluence
May appear as missing border
Inadequacies of venographic assessment of anatomic variables in iliocaval disease

Transfemoral venography in serial patients undergoing intervention for chronic venous disease VS IVUS

Location of the iliocaval confluence (n=162)
Inadequacies of venographic assessment of anatomic variables in iliocaval disease

Location of confluence was recorded according to its reference bony location from the bottom of L5 to the top of L3.
Inadequacies of venographic assessment of anatomic variables in iliocaval disease

Identification: IVUS 100% (n=162) & venogram 94% (n=152)

Confluence range: L3 – L5

Correct identification: 11% (n=16/152) of venograms

Avg difference: ONE VERTEBRAL BODY!!
Proximal Landing Zone

Venogram = Lower confluence in 78% (n=118)

Landing \( \downarrow \) = Missed Proximal Lesions

Wallstents at Iliocaval Junction = Collapse

- Stent Compression
- Coning – Stenosis/Occlusion
- Watermelon Seeding Distal Migration
Cava Extension with Wallstents

Venogram = Higher confluence in 12% (18)

Landing ↑ = Risk Contralateral DVT
Cava Extension with Z-stents

Current practice

Z Stent – Caval Extension
IVC Extension with Wallstents vs Z-Stents

Freedom From Contralateral DVT

P < 0.001
Caval Extension of Stents

*Ok to cross renal/hepatic veins*

<table>
<thead>
<tr>
<th>Infrarenal</th>
<th>Suprarenal</th>
<th>Thoracic</th>
</tr>
</thead>
</table>

Thoracic
*Determine landing zones prior to venoplasty*
Proximal Landing Zone – Case Example

*Determine landing zones prior to venoplasty*
Distal Stent Landing Zone

*Must stent to healthy vein: Ok to cross inguinal ligament*

*Required in almost all patients*
Distal Stent Landing Zone

*Must stent to healthy vein: **Ok to cross inguinal ligament***

- Stent Occlusion
- Post – PMT / Lysis
- Stent extension
- Post - Venogram
Inadequacies of venographic assessment of anatomic variables in iliocaval disease

Ideal distal landing zone chosen between IVUS & venogram

1: Common Iliac Vein
2: External Iliac Vein
3-6: Common Femoral Vein
3: Pubic Ramus
4: Bottom Femoral Head
5: Ischi
6: Lesser Trochanter
Inadequacies of venographic assessment of anatomic variables in iliocaval disease

- Ideal landing zone matched in 29% (24/84)
- IVUS determined a lower landing zone in 44/84 (52%) = **RISK OF MISSED DISTAL LESIONS**
Where are we....

• US access: goal -> visualize entire CFV
• Venogram for guidance
• IVUS
  • Need to stent: Disease Severity
  • Proximal and distal Landing zones
• Next: Balloon and Stenting – the easy part
Venoplasty and Stenting

- **Pre-dilate:** Large, noncompliant, high pressure balloons to size of intended stent
- **Stent from inflow to outflow determined by IVUS before ballooning**
- **Large stents:** IVC 20-24 mm, Iliac 16-18 mm
- **Understenting = occlusion!**
- **Post-dilation**
Completion Imaging

- No shelving, thrombus, good flow
- Snowflakes on IVUS—slow flow
Conclusions

• Excellent results and durability is achievable and expected with iliac vein stenting

• Use of imaging is essential for good outcomes

• IVUS remains imperative for accurate diagnosis, disease characterization, & intraoperative treatment guidance including proximal & distal stent landing zones

• New stent technology will hopefully continue to improve ease of stenting and clinical outcomes
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