Surveillance after Endovascular Intervention: When to Re-Intervene and What's the Evidence

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Surveillance in the Vascular Lab

- Duplex ultrasound is well-suited for surveillance - it’s portable, non-invasive and inexpensive
- Duplex ultrasound is an operator-dependent technique with limited visualization in heavily calcified arteries
- Much like testing for de novo disease, the ideal surveillance test should be sensitive and specific for clinically relevant findings
  - A rigid stent in a calcified artery may reduce arterial compliance and elevate Doppler velocities
- The surveillance study should direct re-intervention to prevent a clinically relevant adverse event

Carotid artery stenting

- Rate of restenosis in single-center series and multicenter randomized trials is 2-10%.
- Most of the risk is in the first year and instent restenosis >70% is associated with an increased risk of stroke
- Risk factors:
  - Female gender
  - Active smoker
  - Residual stenosis after CAS
  - Stenting for restenosis after CEA
  - Stenting for radiation-induced stenosis

Disclosures

- None
**Carotid artery stenting**

- Post-stent velocities are higher than for native arteries
- Recommended surveillance:
  - Postop baseline (<1 month)
  - 6 months
  - 12 months then annually
- Re-intervention for >70% stenosis (>300 cm/s or PSVR >3.8) or progressive lesions

**Renal angioplasty or stenting**

- Rate of restenosis after angioplasty or stenting is 15-50% when diagnosed with DUS using criteria for a hemodynamically significant native artery stenosis
  - PSV >200 cm/s and renal artery-to-aorta ratio (RAR) >3.5
- No good data on the risk of recurrent clinical symptoms due to in-stent restenosis
Renal angioplasty or stenting

- Recommended surveillance:
  - Postop baseline (<1mo)
  - 12 months then annually
- Higher velocity duplex velocity criteria appear appropriate for renal artery stents
  - >70% stenosis: PSV ≥ 395 cm/s and RAR ≥ 5.1
- Reintervention is typically reserved for recurrent symptoms
  - Change in eGFR ≥ 20% or worsening blood pressure control (SBP > 140, DBP > 90 or increased medication)

Mesenteric artery stenting

- Similar to renal artery stenting, native artery criteria are frequently used to monitor post-stenting results
- Celiac PSV > 200 cm/s, EDV > 55 cm/s
- SMA PSV > 275 cm/s, EDV > 45 cm/s
- All series are small and based on single-center data, no good data to correlate the risk of symptom recurrence and in-stent stenosis

Duplex velocity criteria for native celiac/superior mesenteric artery stenosis vs in-stent stenosis

43 patients with 62 stents (30 celiac, 32 SMA) followed with ultrasound
3/43 had an angiogram for asymptomatic >50% celiac and SMA stenosis

<table>
<thead>
<tr>
<th>Stenosis Level</th>
<th>Celiac</th>
<th>SMA</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSV</td>
<td>EDV</td>
<td></td>
</tr>
<tr>
<td>&lt;50% stenosis</td>
<td>≥ 274 cm/s</td>
<td>≤ 58 cm/s</td>
</tr>
<tr>
<td>50-69% stenosis</td>
<td>274-362 cm/s</td>
<td>58-104 cm/s</td>
</tr>
<tr>
<td>≥70% stenosis</td>
<td>≥ 363 cm/s</td>
<td>≥ 105 cm/s</td>
</tr>
</tbody>
</table>

Mesenteric artery stenting

- Higher duplex velocity criteria may be appropriate for stented arteries
  - Celiac PSV: ≥ 363 cm/s, EDV: ≥ 105 cm/s
  - SMA PSV: ≥ 412 cm/s, EDV: ≥ 110 cm/s
- Recommended surveillance:
  - Postop baseline (<1mo)
  - 12mo then annually
- Reintervention is typically reserved for recurrent or persistent symptoms
66 year old man with extensive SFA stents for claudication and a previous angioplasty for symptomatic re-stenosis. His Duplex now shows PSV 425cm/s with PSVr 7.7. What next?

A. Angiogram
B. Angiogram if he has symptoms
C. Observe

Lower extremity angioplasty or stent

- Angioplasty and stenting of the lower extremity arteries have binary restenosis rates up to 50% at 1 year
- Residual stenosis at the time of angioplasty is associated with much worse 1 year clinical success rate (15% vs 84%)

Clinical Trials: Restenosis & TLR

- Most clinical trials have used a Duplex ultrasound-based definition of binary restenosis to assess patency (e.g. PSVR 2.0)
- The trials have used clinically-driven Target Lesion Revascularization (TLR) as a safety endpoint and a proxy for clinical effectiveness
- Ultimately, re-intervention is a subjective decision in these trials based on the risks related to the patient’s co-morbidities, the indication (claudication vs CLI) and the patient’s symptom status (healed/improved vs worse)
- No data to correlate surveillance for restenosis and clinical benefit for re-intervention

Clinical consequence of bare metal stent and stent graft failure in femoropopliteal occlusive disease

- 134 femoral-popliteal stents in 100 patients
  - 71 bare metal stents (BMS)
  - 63 stent grafts (SG)
- Routine duplex surveillance was used with recurrent stenosis defined as PSV >300cm/s
- 1 year the restenosis rates: 36% for BMS, 25% for SG

Table V. A summary of major late clinical events in both cohorts

<table>
<thead>
<tr>
<th>Event</th>
<th>BMS</th>
<th>STG</th>
<th>p</th>
</tr>
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<tbody>
<tr>
<td>Any reintervention</td>
<td>61</td>
<td>58</td>
<td>0.01</td>
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<tr>
<td>Number of reinterventions</td>
<td>14</td>
<td>7</td>
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<tr>
<td>RMS</td>
<td>34</td>
<td>38</td>
<td>0.14</td>
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<tr>
<td>Bypass</td>
<td>9</td>
<td>18</td>
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</tr>
<tr>
<td>Thrombolysis</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Thrombolysis + Alteplase</td>
<td>0</td>
<td>10</td>
<td>0.53</td>
</tr>
<tr>
<td>Stage I</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Stage IIa</td>
<td>0</td>
<td>0</td>
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</tr>
<tr>
<td>Stage III</td>
<td>5</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>New lesion at index site</td>
<td>5</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Claudius progressing to CLI</td>
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<td>0</td>
<td></td>
</tr>
<tr>
<td>Claudius progressing to CLI + ALI</td>
<td>5</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

Conclusions

- Surveillance after carotid artery stenting may reduce subsequent strokes
- After renal or mesenteric artery stenting, surveillance is of unclear benefit, as reintervention is typically driven by symptoms
- In the lower extremities, the value of surveillance has not been demonstrated but stent failure is not always benign. Consider reintervention for high grade femoropopliteal stenosis.

Lower Extremity Surveillance

- Recommended surveillance similar to bypass grafts:
  - Postop baseline (<1mo)
  - 3, 6, 9 and 12mo then annually
- After femoropopliteal stenting:
  - >50% stenosis: PSV >190cm/s, PSVr >1.5
  - >70% stenosis: PSV >275cm/s, PSVr >3.5
- After plain or drug-coated balloon angioplasty:
  - >50% stenosis: PSV >180cm/s, PSVr >2
  - >70% stenosis: PSV >300cm/s, EDV >40, PSVr >4
- Reintervention:
  - Femoropopliteal: consider re-intervention for high grade stenosis or progressing lesions
  - Tibials: No data to guide decision making