Rational Selection of Endovascular Options for the SFA and Popliteal: *What Works Where and for How Long?*

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Disclosures
- Consulting, Speakers Program, Advisory Boards or Proctoring:
  - Boston Scientific
  - Medtronic
  - Abbott Vascular
  - Cook Medical

Trends in Revascularization for PAD: *Endovascular*

- 87 yo ESRD, CVA, Ao Stenosis, gangrene of right toes 1-2
- Persistent sciatic artery and popliteal occlusion (to trifurcation)
- Anterior tibial reconstitution at origin, appears to cross the ankle into foot as single discontinuous runoff
Trends in Revascularization for PAD: **Endovascular**

**Benefits of Percutaneous Revascularization:**
- Local / sedation vs general anesthesia
- No need for hospitalization
- Minimal recovery period
- Minimal physiologic stress
- Fewer cardiopulmonary / surgical complications
- **But what about durability??**

Trends in Revascularization for PAD: **Open Surgery**

**Benefits of Open Surgery**
- Well-established outcomes
- Randomized controlled trial data
- Decades of experience
- Ubiquitous principles:
  - Attention to detail
  - Autogenous conduit
  - Circumvent all disease

Endovascular Lower Extremity Intervention: **What Works, and for How Long?**

- Are newer devices closing the patency gap between percutaneous intervention and surgery?
- What is the data to support these devices?
  - Randomized controlled trials
  - Core-lab adjudicated registries
  - **Definitive guidelines vs support for our biases?**
Endovascular Lower Extremity Intervention: What Are the Available Treatment Options?

1. Balloon Angioplasty
2. Laser-cut Nitinol Stents
3. Drug-coated Stents
4. Percutaneous Atherectomy
5. Drug-coated Balloons
6. “Next-generation” Nitinol Stents

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Balloon Angioplasty vs Nitinol Stents

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Endovascular Lower Extremity Intervention: Balloon Angioplasty

- 1964 Charles Dotter introduces concept of arterial remodeling
- 1977 Andreas Gruntzig performs first peripheral angioplasty
- 1980-90’s Development of OTW & RX balloon angioplasty systems

Disadvantages

- Elastic recoil of vessel
- Flow-limiting dissections
- Intimal hyperplasia / Restenosis

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Endovascular Lower Extremity Intervention: Laser-Cut Nitinol Stents

- Biliary stents initially used off-label for the SFA
- Laser cut from nitinol tubes, constrained in deployment catheter
- Preserve flow in cases of flow-limiting dissections and reduces late lumen loss (demonstrated in RCT)
Endovascular Lower Extremity Intervention: *Balloon Angioplasty vs Nitinol Stents*

**Evidence:** RCT data

**Conclusions:**
- Primary stent implantation is associated with improved primary patency at 1-2 years and improved walking distance

**Caveats:**
- Implication for re-interventions
- Little RCT data beyond 2 yrs

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**Endovascular Lower Extremity Intervention: What Works, and for How Long?**

- **Bare Metal Laser-Cut Nitinol Stents in the SFA:** 60-80% Primary Patency
- **Balloon angioplasty in the SFA:** 30-50% Primary Patency

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**BMS Nitinol Stents vs Drug-Coated Stents**
Endovascular Lower Extremity Intervention: 
**BMS vs Drug-Coated Stents (Zilver PTX)**

- Pacitaxol coated Zilver Nitinol stent (Zilver PTX)
- Multicenter RCT
- Primary Randomization:
  - PTA vs Zilver PTX
- Secondary Randomization:
  - Provisional BMS vs Provisional Zilver PTX for Suboptimal PTA

- Primary endpoints included Primary Patency (PSVR 2.0) and Freedom from TLR
- Follow-up of primary endpoints out to 5 years

**Evidence:** RCT data, followed to 5 years

**Conclusions:**
- Primary and bailout stent implantation with ZilverPTX is associated with improved primary patency at 1-5 years compared to BMS
- Caveats:
  - Implication for re-interventions v. non-stent
  - Comparison to BMS Zilver or angioplasty alone
Should we throw open surgery into the mix???

**Prosthetic Bypass vs Drug-Coated Stents**

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**Endovascular Lower Extremity Intervention:**

*Bypass vs Drug-Coated Stents (ZilverPass RCT)*

- Evolution of technologies since Basil Trial
- Differences in assessment of patency rates
  - Bypass: binary (yes/no), pulse / ABI
  - Endo: PSVR 2.0-2.5

**ZILVERPASS Trial:**

ZilverPTX vs Prosthetic Bypass for Fempop TASC C & D Lesions

- Multicenter RCT in Belgium, Germany, Italy, Brazil
- Randomized 1:1 to ZilverPTX vs prosthetic bypass graft
- Enrolled 199 patients, interim results on 119 (LINC 2017, DeLoose)
- Same outcome assessment (PSVR < 2.4 lesion or in bypass)

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**Primary Patency (Interim Results)**

<table>
<thead>
<tr>
<th>Time (days)</th>
<th>Baseline</th>
<th>30 days</th>
<th>6MFU</th>
<th>12MFU</th>
<th>24MFU</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZilverPTX</td>
<td>56</td>
<td>95</td>
<td>93</td>
<td>90</td>
<td>77.4%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>97</td>
<td>94</td>
<td></td>
<td>73.6%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>98</td>
<td>90</td>
<td></td>
<td>67.8%</td>
</tr>
<tr>
<td>DeLoose, LINC 2017</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Freedom from TLR (Interim Results)**

<table>
<thead>
<tr>
<th>Time (days)</th>
<th>Baseline</th>
<th>30 days</th>
<th>6MFU</th>
<th>12MFU</th>
<th>24MFU</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZilverPTX</td>
<td>96</td>
<td>95</td>
<td>94</td>
<td>94</td>
<td>84.6%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>97</td>
<td>94</td>
<td></td>
<td>74.4%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>98</td>
<td>90</td>
<td></td>
<td>74.4%</td>
</tr>
<tr>
<td>DeLoose, LINC 2017</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Endovascular Lower Extremity Intervention: Bypass vs Drug-Coated Stents (ZilverPass RCT)

- **Evidence:** RCT data (in progress)
- **Conclusions:**
  - Interim results suggest equivalent primary patency and TLR rates at one year
- **Caveats:**
  - Study ongoing
  - Long-term data not available
  - Prosthetic bypass only

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**Endovascular Lower Extremity Intervention: Percutaneous Atherectomy: Overview of Data**

<table>
<thead>
<tr>
<th>Excisional</th>
<th>Orbital</th>
<th>Rotational</th>
<th>Laser</th>
</tr>
</thead>
<tbody>
<tr>
<td>TurboHawk (Medtronic)</td>
<td>Diamondback 360 (CSI)</td>
<td>Pathway (Boston Scientific)</td>
<td>TurboElite (Spectranetics)</td>
</tr>
<tr>
<td>Pantheris (Avinger)</td>
<td>Rotablator (Boston Scientific)</td>
<td>Phoenix (Phillips-Volcano)</td>
<td></td>
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</tbody>
</table>
Endovascular Lower Extremity Intervention: *Percutaneous Atherectomy: Overview of Data*

**Excisional Atherectomy – RCT and Registries**

<table>
<thead>
<tr>
<th></th>
<th>DEFINITIVE LE</th>
<th>Zeller 2006</th>
<th>Talon 2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Randomized</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Patients</td>
<td>799 (25% CLI)</td>
<td>84 (45 de novo)</td>
<td>601 (34% CLI)</td>
</tr>
<tr>
<td>Published</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Multicenter</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Location</td>
<td>SFA/pop/ib</td>
<td>SFA/pop</td>
<td>SFA/pop/ib</td>
</tr>
<tr>
<td>Lesion Description</td>
<td>Yes (7.4cm)</td>
<td>Yes (4.3cm)</td>
<td></td>
</tr>
<tr>
<td>Angio Core lab</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Duplex Core lab</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>12mo Primary Patency</td>
<td>Yes (75%)</td>
<td>Yes (84%)</td>
<td>No</td>
</tr>
<tr>
<td>12mo Freedom TLR</td>
<td>Not reported</td>
<td>84%</td>
<td>80% (&lt;15% flu rate at 12m)</td>
</tr>
<tr>
<td>Bailout Stent Rate</td>
<td>3%</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Complications reported</td>
<td>7.6% (3.8% embo)</td>
<td>n/a</td>
<td>4.3% (0.1% embo)</td>
</tr>
</tbody>
</table>

**DEFINITIVE LE Trial (Prospective Registry)**

*Procedural Details: Adjunctive Therapies*

<table>
<thead>
<tr>
<th>Therapy</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Directional Atherectomy PTA</td>
<td>9</td>
</tr>
<tr>
<td>Post-Directional Atherectomy PTA (no stent)</td>
<td>33</td>
</tr>
<tr>
<td>Mean pressure</td>
<td>6.6 atm</td>
</tr>
<tr>
<td>Bail-Out Stent</td>
<td>3%</td>
</tr>
</tbody>
</table>

Atherectomy can act as stand alone therapy with low bail-out stent rate (consistent finding in atherectomy trials)

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**DEFINITIVE LE CLI Patency and Limb-Salvage**

- Primary Patency: 71%
- Limb Salvage: 95%
- Secondary Patency: 88%
- Primary & Secondary Patency and Limb-Salvage Rate in CLI Patients
### Endovascular Lower Extremity Intervention: Percutaneous Atherectomy: Overview of Data

**Orbital Atherectomy – RCT and Registries**

<table>
<thead>
<tr>
<th>Compliance360</th>
<th>Confirm Reg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Randomized</td>
<td>Yes</td>
</tr>
<tr>
<td>Patients</td>
<td>65</td>
</tr>
<tr>
<td>Published</td>
<td>Yes</td>
</tr>
<tr>
<td>Multicenter</td>
<td>Yes</td>
</tr>
<tr>
<td>Location</td>
<td>SFA/pop/tib</td>
</tr>
<tr>
<td>Lesion Description</td>
<td>Yes (5.6cm)</td>
</tr>
<tr>
<td>Angio Core lab</td>
<td>No</td>
</tr>
<tr>
<td>Duplex Core lab</td>
<td>No</td>
</tr>
<tr>
<td>12mo Primary Patency</td>
<td>81% (55% w/12m tu)</td>
</tr>
<tr>
<td>12mo Freedom TLR</td>
<td>No</td>
</tr>
<tr>
<td>Complications reported</td>
<td>n/a</td>
</tr>
</tbody>
</table>

**Laser Atherectomy – RCT and Registries**

<table>
<thead>
<tr>
<th>PATENT Spectranetics Laser ISR Study (German)</th>
<th>EXCITE ISR Trial with Spectranetics Laser</th>
</tr>
</thead>
<tbody>
<tr>
<td>Randomized</td>
<td>No</td>
</tr>
<tr>
<td>Patients</td>
<td>90 patients (83% Claudicants)</td>
</tr>
<tr>
<td>Published</td>
<td>Yes</td>
</tr>
<tr>
<td>Multicenter</td>
<td>Yes (German)</td>
</tr>
<tr>
<td>Location</td>
<td>SFA/pop</td>
</tr>
<tr>
<td>Lesion Description</td>
<td>Yes (12.3cm ISR)</td>
</tr>
<tr>
<td>Angio Core lab</td>
<td>Yes</td>
</tr>
<tr>
<td>Duplex Core lab</td>
<td>Yes</td>
</tr>
<tr>
<td>12mo Primary Patency</td>
<td>38%</td>
</tr>
<tr>
<td>12mo Freedom TLR</td>
<td>n/a</td>
</tr>
<tr>
<td>Complications reported</td>
<td>23% (10% embolization)</td>
</tr>
</tbody>
</table>

### Endovascular Lower Extremity Intervention: Percutaneous Atherectomy

- **Evidence:**
  - RCT for ISR
  - Prospective core lab adjudicated registry data
- **Conclusions:**
  - “Stent-like” primary patency rates at 1 yr *
  - Low rates of “bail-out” stenting
- **Caveats:**
  - No long-term data
  - Embolization remains important consideration
  - * Single device represented in large studies

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### Plain Balloon Angioplasty vs Drug-Coated Balloon Angioplasty
Endovascular Lower Extremity Intervention: Angioplasty vs Drug-Coated Balloon Angioplasty

**LEVANT II Trial**
- U.S. and European RCT of 476 pts
- 2:1 Randomization to DCB v POBA

**IN.PACT SFA Trial**
- U.S. & European RCT of 331 pts
- 2:1 Randomization DCB v POBA

### Patient, Lesion, and Procedural Characteristics

<table>
<thead>
<tr>
<th></th>
<th>LEVANT</th>
<th>IN.PACT SFA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Claudicants</td>
<td>92%</td>
<td>95%</td>
</tr>
<tr>
<td>Mean Lesion Length</td>
<td>6.3cm</td>
<td>8.9cm</td>
</tr>
<tr>
<td>Severe Calcification</td>
<td>10.4%</td>
<td>8.1%</td>
</tr>
<tr>
<td>Total Occlusions</td>
<td>21.0%</td>
<td>23.9%</td>
</tr>
<tr>
<td>Bail-out Stenting</td>
<td>3.9%</td>
<td>7.3%</td>
</tr>
</tbody>
</table>

![Graph showing time to primary patency](image)

**LEVANT: Primary Patency at 12 month timepoint**

- 30% Improvement over Standard PTA
- Delta = 16.7%, p < 0.001

**In-Pact SFA**

- U.S. & European RCT of 331 pts
- 2:1 Randomization DCB v POBA

**Medtronic In.Pact Admiral**

**Bard Lutonix 035**
Endovascular Lower Extremity Intervention: Angioplasty vs Drug-Coated Balloon Angioplasty

**IN.PACT.SFA: Primary Patency at 12 month timepoint**

- **IN.PACT** vs **PTA**
- Primary Patency through 365 Days
- [p<0.001 by log-rank test]
- 69.8% vs 78.4%
- 66.8% vs 49.5%

**DCBs are associated with superior primary patency and reduced TLR rates compared to plain balloon angioplasty in simple lesions represented in IDE trials.**

Endovascular Lower Extremity Intervention: Drug-coated technologies in the SFA

- **IN.PACT SFA Trial** vs **LEVANT II Trial**

Key Lesion Characteristics

- **Length (cm)**
  - LEVANT Global
  - IN.PACT Global
  - PI.PACT Global
  - IN.PACT Global
  - IN.PACT Global
- **CTO (%)**
  - LEVANT Global
  - IN.PACT Global
  - PI.PACT Global
  - IN.PACT Global
  - IN.PACT Global
- **Ga (%)**
  - LEVANT Global
  - IN.PACT Global
  - PI.PACT Global
  - IN.PACT Global
  - IN.PACT Global
- **Primary Patency**
  - LEVANT Global
  - IN.PACT Global
  - PI.PACT Global
  - IN.PACT Global
  - IN.PACT Global
- **Bail-out Stent (%)**
  - LEVANT Global
  - IN.PACT Global
  - PI.PACT Global
  - IN.PACT Global
  - IN.PACT Global

**Continued need for scaffolding in complex lesions**

**Endovascular Lower Extremity Intervention:**

*Angioplasty vs Drug-Coated Balloon Angioplasty*

<table>
<thead>
<tr>
<th>Key Lesion Characteristics</th>
<th>IN.PACT Global Full Clinical Cohort</th>
<th>IN.PACT Global Long Lesion</th>
<th>IN.PACT Global CTO</th>
<th>IN.PACT Global ISR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length (cm)</td>
<td>10.1 cm</td>
<td>12.1 cm</td>
<td>26.4 cm</td>
<td>22.9 cm</td>
</tr>
<tr>
<td>Ca²⁺ (%)</td>
<td>30.6%</td>
<td>35.9%</td>
<td>66.4%</td>
<td>100.0%</td>
</tr>
<tr>
<td>Primary Patency</td>
<td>97.0%</td>
<td>91.1%</td>
<td>84.4%</td>
<td>88.7%</td>
</tr>
<tr>
<td>Bail-out Stent (%)</td>
<td>27.6%</td>
<td>25.3%</td>
<td>40.4%</td>
<td>46.8%</td>
</tr>
</tbody>
</table>

**Endovascular Lower Extremity Intervention: Angioplasty vs Drug-Coated Balloon Angioplasty**

- **Evidence:**
  - 3 RCT IDE Trials (Two published)
  - Prospective adjudicated registry data (complex lesions)
- **Conclusions:** DCBs (vs plain balloon angioplasty)
  - Show improved primary patency rates at 1 yr
  - Demonstrate reduced TLR rates at 1 yr
  - Results maintained at 3yrs and in complex lesions
- **Caveats:**
  - RCT evidence includes selection bias / simple lesions
  - More complex lesions appear to do well based on prospective registries, but w/ high stent rates

*“Next-Generation” Nitinol Stents*

<table>
<thead>
<tr>
<th>Tigris Stent (WL Gore)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tigris vs Lifestent</td>
</tr>
<tr>
<td>Lesion Length</td>
</tr>
<tr>
<td>Stented Length</td>
</tr>
<tr>
<td>Occlusions</td>
</tr>
<tr>
<td>2-yr Primary Patency (KM)</td>
</tr>
<tr>
<td>2-yr Freedom from TLR</td>
</tr>
<tr>
<td>Stent Fractures</td>
</tr>
</tbody>
</table>

**Endovascular Lower Extremity Intervention: Next-generation Nitinol Stents: Tigris (WL Gore)**

- Tigris Stent with nitinol wire scaffold and heparin-bonded PTFE coating
- RCT 3:1 Tigris (Gore) vs Lifestent (Bard)
- 274 patients randomized
Endovascular Lower Extremity Intervention: 
Next-generation Nitinol Stents: Tigris (WL Gore)

<table>
<thead>
<tr>
<th></th>
<th>Tigris</th>
<th>Lifestent</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lesion Length</td>
<td>10.7 cm</td>
<td>11.8 cm</td>
<td>0.29</td>
</tr>
<tr>
<td>Stented Length</td>
<td>12.9 cm</td>
<td>14.9 cm</td>
<td>0.06</td>
</tr>
<tr>
<td>Occlusions</td>
<td>42%</td>
<td>37%</td>
<td></td>
</tr>
<tr>
<td>2-yr Primary Patency (KM)</td>
<td>63%</td>
<td>67%</td>
<td>NS</td>
</tr>
<tr>
<td>2-yr Freedom from TLR</td>
<td>77%</td>
<td>81%</td>
<td>NS</td>
</tr>
<tr>
<td>Stent Fractures</td>
<td>0%</td>
<td>29%</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

- Considerable reduction in stent fractures compared to standard laser-cut nitinol stents
- Failure to achieve improved patency rates despite absence of stent fractures

Endovascular Lower Extremity Intervention: 
Next-generation Nitinol Stents: Supera (Abbott)

SUPERB Trial
- 238 patients, prospective registry IDE trial
- Core-lab adjudication, 78mm mean, 73% Ca	
- No stent fractures, 86% 12m primary patency

Endovascular Lower Extremity Intervention: 
Next-generation Nitinol Stents: Supera (Abbott)

Supera Stent (Abbott Vascular)

- 91% 12mo Primary Patency
- 94% 36mo Freedom from TLR

When nominally deployed:
- 91% 12mo Primary Patency
- 94% 36mo Freedom from TLR

*Data from Superb Trial, Presented at VIVA 2015. 
Endovascular Lower Extremity Intervention:
Next-generation Nitinol Stents: Supera (Abbott)

<table>
<thead>
<tr>
<th>Stent Type</th>
<th>20%</th>
<th>30%</th>
<th>40%</th>
<th>50%</th>
<th>60%</th>
<th>70%</th>
<th>80%</th>
<th>90%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supera</td>
<td>81%</td>
<td>81%</td>
<td>81%</td>
<td>81%</td>
<td>80%</td>
<td>77%</td>
<td>60%</td>
<td>46%</td>
</tr>
<tr>
<td>Zilver® PTX®</td>
<td>83%</td>
<td>83%</td>
<td>83%</td>
<td>83%</td>
<td>83%</td>
<td>81%</td>
<td>80%</td>
<td>77%</td>
</tr>
<tr>
<td>Standard Nitinol Stents</td>
<td>65%</td>
<td>65%</td>
<td>65%</td>
<td>65%</td>
<td>60%</td>
<td>71%</td>
<td>75%</td>
<td>75%</td>
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<tr>
<td>Viabahn®</td>
<td>71%</td>
<td>67%</td>
<td>75%</td>
<td>75%</td>
<td>65%</td>
<td>62%</td>
<td>62%</td>
<td>58%</td>
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<tr>
<td>Atherectomy</td>
<td>33%</td>
<td>33%</td>
<td>33%</td>
<td>33%</td>
<td>33%</td>
<td>33%</td>
<td>33%</td>
<td>33%</td>
</tr>
</tbody>
</table>

Endovascular Lower Extremity Intervention:
Next-generation Nitinol Stents

- **Evidence:**
  - RCT IDE Trial (Tigris)
  - Prospective core-lab adjudicated IDE Registry (Supera)

- **Conclusions:**
  - Decreased stent fracture rates
  - Tigris: disappointing patency rates
  - Supera: 85-90% primary patency, sustained ff-TLR

- **Caveats:**
  - Superb Trial: no comparator arm or any RCT data
  - Superb Trial: 3 yr results sustained for TLR, but no patency data available

Conclusions

- Evidence to judge the effectiveness of old and emerging technology is incomplete but improving
- Plain balloon angioplasty and bare-metal laser-cut nitinol stents are below the standard of care considering today’s treatment options
- Atherectomy is an effective tool for reducing bailout stent rates in fempop interventions
- Paclitaxol coating (on balloons or stents) convincingly reduces rates of restenosis
- As lesion complexity increases, the need for stenting increases and probably should be done with newer “next-generation” devices