Angiosome concept – myth or truth? Does it make a real difference in “real world” cases?

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I have the following potential conflicts of interest to report:

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

☒ I do not have any potential conflict of interest
Different comorbidities in CLI but almost comparable amputation-free survival

### Key baseline characteristics

<table>
<thead>
<tr>
<th></th>
<th>OLIVE</th>
<th>PRVENT III</th>
<th>CIRCULASE</th>
<th>BASIL</th>
<th>CRITISH</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EVT</td>
<td>BSX+Drug</td>
<td>Drug</td>
<td>EVT/BSX</td>
<td>EVT</td>
</tr>
<tr>
<td>Age&gt;80 yrs</td>
<td>26%</td>
<td>18%</td>
<td>18%</td>
<td>26%</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>65%</td>
<td>65%</td>
<td>79%</td>
<td>66%</td>
<td>63%</td>
</tr>
<tr>
<td>DM</td>
<td>71%</td>
<td>62%</td>
<td>51%</td>
<td>39%</td>
<td>48%</td>
</tr>
<tr>
<td>Hemodialysis</td>
<td>52%</td>
<td></td>
<td></td>
<td></td>
<td>10%</td>
</tr>
<tr>
<td>Tissue loss</td>
<td>88%</td>
<td>74%</td>
<td>69%</td>
<td>75%</td>
<td>78%</td>
</tr>
<tr>
<td>Isolated BTK lesions</td>
<td>41%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>One-year AFS</td>
<td>74%</td>
<td>74.0% - 79.9%</td>
<td>75%</td>
<td>72%</td>
<td></td>
</tr>
</tbody>
</table>

Despite heterogeneity characteristics, 1-year AFS reveals around 75%. But, it is clinically difficult to simply compare to each study.
Angiosome concept is important?

Despite an aggressive approach for revascularization, amputation rates of up to 20% can occur despite a patent bypass in patients with CLI and tissue loss.

This has led to the proposal of an angiosome-based revascularization strategy (where the specific artery perfusing the corresponding diseased territory is revascularized).

74 years, Male, tissue loss at heel (R6) DM, ESRD on HD

Severe stenosis presented at ATA to DPA
Poor flow to the calcaneal region was observed. (from DPA-pedal arch)
74 years, Male, tissue loss at heel (R6) DM, ESRD on HD

Poor flow to calcaneal region despite ATA-DPA revascularization (1-straight line)
74 years, Male, tissue loss at heel (R6) DM, ESRD on HD

Major amputation (BK amputation)
Angiosome is an anatomical concept, defined as the blood supply from a main, secondary or distributing artery to a specific tissue area.

Meta-analysis of angiosome concept

Forest plot for effectiveness in wound healing

Forest plot for effectiveness in limb salvage

### 9.1.1. Endovascular Revascularization for CLI

<table>
<thead>
<tr>
<th>COR</th>
<th>LOE</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>B-R</td>
<td>Endovascular procedures are recommended to establish in-line blood flow to the foot in patients with nonhealing wounds or gangrene (242, 243).</td>
</tr>
<tr>
<td>IIa</td>
<td>C-LD</td>
<td>A staged approach to endovascular procedures is reasonable in patients with ischemic rest pain (261, 262).</td>
</tr>
<tr>
<td>IIa</td>
<td>B-R</td>
<td>Evaluation of lesion characteristics can be useful in selecting the endovascular approach for CLI (263, 264).</td>
</tr>
<tr>
<td>IIb</td>
<td>B-NR</td>
<td>Use of angiosome-directed endovascular therapy may be reasonable for patients with CLI and nonhealing wounds or gangrene (245, 247-249, 251-253, 255-257).</td>
</tr>
</tbody>
</table>
1) The decision of revascularization should also consider the angiosome concept, targeting the ischaemic tissues.

2) The angiosome model should not be used as an absolute strategy for interventions on patients with CLTI.

3) Further, well-structured prospective studies are needed to assess the value of the angiosome concept.
Why angiosome is clinically important?

-1) Know limitations of BTK angioplasty

Repeat EVT @ 1 year: 40%

Restenosis @ 3 months: 70%

Early Recoil @ 15 min.: 97%


We should consider endovascular revascularization as absolute strategy providing blood flow efficiently because of presence of limitations of BTK angioplasty.
## Why angiosome is clinically important?

- 2) Impact of angiosome differs from studies -

<table>
<thead>
<tr>
<th>Publication</th>
<th>Country</th>
<th>Limbs (Pts)</th>
<th>Outcomes</th>
<th>DM</th>
<th>ESRD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alexandrescu, 2008</td>
<td>Retro</td>
<td>124 (98)</td>
<td>Wound Healing</td>
<td>124 (100%)</td>
<td>27 (22%)</td>
</tr>
<tr>
<td>Iida, 2010</td>
<td>Retro</td>
<td>203 (177)</td>
<td>Limb Salvage</td>
<td>120 (68%)</td>
<td>96 (54%)</td>
</tr>
<tr>
<td>Alexandrescu, 2011</td>
<td>Retro</td>
<td>232 (208)</td>
<td>WH, LS, Mortality</td>
<td>232 (100%)</td>
<td>42 (18%)</td>
</tr>
<tr>
<td>Blanes Orti, 2011</td>
<td>Retro</td>
<td>34 (32)</td>
<td>Wound Healing</td>
<td>27 (73%)</td>
<td>13 (35%)</td>
</tr>
<tr>
<td>Iida, 2012</td>
<td>Retro</td>
<td>369 (329)</td>
<td>LS, Mortality</td>
<td>172 (73%)</td>
<td>149 (63%)</td>
</tr>
<tr>
<td>Soderstrom, 2013</td>
<td>Retro</td>
<td>250 (226)</td>
<td>Wound Healing</td>
<td>250 (100%)</td>
<td>39 (16%)</td>
</tr>
<tr>
<td>Fossaceca, 2013</td>
<td>Retro</td>
<td>201 (201)</td>
<td>WH, LS</td>
<td>201 (100%)</td>
<td>15 (7.4%)</td>
</tr>
<tr>
<td>Acin, 2014</td>
<td>Retro</td>
<td>101 (92)</td>
<td>WH, LS, Mortality</td>
<td>101 (100%)</td>
<td>0 (0%)</td>
</tr>
</tbody>
</table>

More effective, Less effective

Angiosome-guided angioplasty is more or less effective depending on the patient characteristics.
Association of cardiovascular risk factors with pattern of lower limb atherosclerosis
Renal insufficiency is independently associated with a distal distribution pattern.

Diffuse severe calcification: (A) along the SFA; (B) occlusion of the distal ATA and proximal PA and complete occlusion of the PTA; and (C) occlusion of the plantar and dorsal arterial arches at the foot level.

Diseased “A-A (Artery-Artery) connection” attributable to presence of DM and dialysis

A-A connection from PA (peroneal artery)
1. Communicating branch to PTA
2. Calcaneal branch to PTA
3. Perforating branch to ATA

Pedal arch
ATA⇔PTA
We should seek determinants of patients with CLI who derive the most clinical benefit from **direct revascularization (DR)**.

- In clinical practice, moderate limb salvage rates (**68-76%**) were obtained by **indirect revascularization (IR)** in earlier studies.
- However, it remains unclear which patients derive the most clinical benefit from **direct revascularization (DR)**.
Worse limb prognosis for IR vs. DR only in patients with CLI complicated with wound infection and DM (N=718)

Indirect EVT & CRP ≥ 3 mg/dl

<table>
<thead>
<tr>
<th>DM</th>
<th>n</th>
<th>Hazard ratio for MALE</th>
</tr>
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<tbody>
<tr>
<td>—</td>
<td>159</td>
<td>1.00 (Ref)</td>
</tr>
<tr>
<td>—</td>
<td>443</td>
<td>0.88 [0.67, 1.15]</td>
</tr>
<tr>
<td>●</td>
<td>21</td>
<td>1.05 [0.54, 2.04]</td>
</tr>
<tr>
<td>●</td>
<td>95</td>
<td>2.17 [1.54, 3.06]**</td>
</tr>
</tbody>
</table>

CLI complicated with both wound infection and DM, when IR has a poorer outcome.

Case: 97 yrs, female

- CC: rt dorsalis gangrene
  - Rutherford 6, W3I3FI2
  - *Severe wound infection*

- PMH: HTN, DM, Aortic valve stenosis (AS)

- ADL: Ambulatory

- Skin perfusion pressure
  - Dorsal 17mmHg
  - Plantar 30mmHg
Isolated Below-the-knee Lesion
US-guided Puncture for DPA

**System**

**Guiding Sheath:**
- Parent Plus 4.5Fr, 55cm

**Guide Wire:**
- Cruise 0.014, 235cm
- Gladius 0.014, 200cm

**Back-up Catheter:**
- Prominent 1.8/2.6Fr, 110cm
- Corsair PV 2.6Fr, 135cm

**EVT Balloon:**
- Coyote MR 2.0*220mm
- Ultraverse 3.0*300mm
Bidirectional Wiring for ATA

**System**

**Guiding Sheath:**
- Parent Plus 4.5Fr, 55cm

**Guide Wire:**
- Cruise 0.014, 235cm
- Gladius 0.014, 200cm

**Back-up Catheter:**
- Prominent 1.8/2.6Fr, 110cm
- Corsair PV 2.6Fr, 135cm

**EVT Balloon:**
- Coyote MR 2.0*220mm
- Ultraverse 3.0*300mm
Rendezvous Technique

**System**

**Guiding Sheath:**
- Parent Plus 4.5Fr, 55cm

**Guide Wire:**
- Cruise 0.014, 235cm
- Gladius 0.014, 200cm

**Back-up Catheter:**
- Prominent 1.8/2.6Fr, 110cm
- Corsair PV 2.6Fr, 135cm

**EVT Balloon:**
- Coyote MR 2.0*220mm
- Ultraverse 3.0*300mm
Balloon Angioplasty for BTA

**System**

**Guiding Sheath:**
- Parent Plus 4.5Fr, 55cm

**Guide Wire:**
- Cruise 0.014, 235cm
- Gladius 0.014, 200cm

**Back-up Catheter:**
- Prominent 1.8/2.6Fr, 110cm
- Corsair PV 2.6Fr, 135cm

**EVT Balloon:**
- Coyote MR 2.0*220mm
- Ultraverse 3.0*300mm
Final Angiography

BTK

BTA
After revascularization
The angiosome-oriented revascularization for CLI patients without concurrent wound infection and DM

There was no significant difference in terms of AFS and freedom from MALE for patients without concurrent wound infection and DM.

The angiosome-oriented revascularization for CLI patients without concurrent wound infection and DM

Propensity matching

Angiosome Targeted PTA is More Important in patients with diabetes

In diabetic patients, indirect endovascular revascularization leads to the poorest wound healing and leg salvage rates. Endovascular procedures should be targeted according to the angiosome concept.

Case: 83 yrs, female

- CC: rt 1\textsuperscript{st} digit gangrene Rutherford 5, W1I2F10] *wound infection (-)
- PMH: HTN, ESRD in dialysis Cerebral infarction (CI) *Diabetes mellitus (-)
- ADL: wheel chair
- Skin perfusion pressure
  - Dorsal 21mmHg
  - Plantar 31mmHg
Isolated Below-the-knee Lesion
Angioplasty for Dorsal

**System**

**Guiding Sheath:**
- Parent Plus 3Fr, 55cm

**Guide Wire:**
- Cruise 0.014, 175cm
- Gladius 0.014, 235cm

**Back-up Catheter:**
- Prominent 1.8/2.6Fr, 110cm

**EVT Balloon:**
- JADE 2.5*120mm
- ULTRAVERSE 3.0*300mm
Final Angiography
Why angiosome is clinically important?

-3) Aggressive wound care by angiosome Tx-

- Skin perfusion pressure
  - Dorsalis pedis side: 21mmHg ⇒ 75mmHg
  - Plantar side: 31mmHg ⇒ 39mmHg

POD 21 days
Think about “the Angiosome Concept”

DM
With Infection

Non-DM
With Infection

DM
Without infection

Non-DM
Without infection

Based on our analysis and experience, revascularization for wound-related artery is best way to achieve better clinical outcomes.
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