The angiosome concept; helpful with open and endovascular treatment of CLI

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Disclosures

• WL Gore
• Vascular Flow Technologies
• Cormatrix
• Graftworxx

Angiosome concept

• Angiosome – 3D anatomic unit fed by a source artery
• Defined 40 in the body

Angiosomes of the lower leg and foot

Six distinct angiosomes:
• Anterior tibial artery (1)
  • Dorsalis pedis
  • Peroneal artery (2)
    • Lateral calcaneal
    • Anterior perforator
  • Posterior tibial artery (3)
    • Calcaneal
    • Medical plantar
    • Lateral plantar

Angiosome anatomy

Anterior Tibial Artery (1)

• Dorsalis Pedis

Angiosomes anatomy

Peroneal Artery (2)

Lateral calcaneal
Lateral ankle
Lateral plantar heel
Anterior perforator
Medial ankle

Cadaveric dissection with colored latex injections


Angiosome anatomy

**Posterior Tibial Artery (3)**

- Medial plantar
- Lateral plantar
- Calcaneal
- Lateral ankle/forefoot

**Indirect connections**

- "Choke vessels"
- Importance of intact pedal arch

Angiosome revascularization

**Clinical implications for healing**

- 60 consecutive ischemic lower extremity wounds with bypass for revascularization
- Preoperative arteriograms
  - Arterial anatomy relative to each wound’s angiosome
- Bypass anatomy
  - Bypass anatomy relative to each wound’s angiosome
- Standardized wound care per protocol


Angiosome revascularization

**Direct vs Indirect revascularization**

- **Direct Revascularization (DR)**
  Bypass to the artery *perfusing* the angiosome in which the wound was located
- **Indirect Revascularization (IR)**
  Bypass to an artery *not directly perfusing* the angiosome in which the wound was located

47% Direct
43% Indirect

Angiosome revascularization

**Patient Demographics**

<table>
<thead>
<tr>
<th></th>
<th>DR</th>
<th>IR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>48%</td>
<td>45%</td>
</tr>
<tr>
<td>Female</td>
<td>52%</td>
<td>55%</td>
</tr>
<tr>
<td>Diabetes Mellitus</td>
<td>85%</td>
<td>89%</td>
</tr>
<tr>
<td>Hypertension</td>
<td>42%</td>
<td>48%</td>
</tr>
<tr>
<td>CHF</td>
<td>10%</td>
<td>13%</td>
</tr>
<tr>
<td>CAD</td>
<td>27%</td>
<td>11%</td>
</tr>
<tr>
<td>Renal Failure</td>
<td>52%</td>
<td>35%</td>
</tr>
</tbody>
</table>

Diabetes and ESRD similar between groups

Angiosome revascularization

**Target artery**

- 100% tibial bypasses
- No difference between groups
Angiosomes and healing

Wound Care

No difference in wound care between groups

<table>
<thead>
<tr>
<th>Procedure</th>
<th>DR</th>
<th>IR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary closure / STSG</td>
<td>35%</td>
<td>24%</td>
</tr>
<tr>
<td>Local amputation Ray/TMA/Chopart</td>
<td>60%</td>
<td>69%</td>
</tr>
<tr>
<td>Free flap</td>
<td>5%</td>
<td>7%</td>
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</tbody>
</table>

Angiostome concept and healing

Degree of complete healing

<table>
<thead>
<tr>
<th>Degree of Complete Healing</th>
<th>Complete Healing</th>
<th>Failed to Heal</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-25</td>
<td>91%</td>
<td>62%</td>
</tr>
<tr>
<td>26-50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>51-100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>101-200</td>
<td></td>
<td></td>
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<tr>
<td>&gt;200</td>
<td></td>
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</tr>
</tbody>
</table>

More complete healing with revascularization of the appropriate angiostome

Angiostome concept and healing

Time to healing

Trend for faster healing with angiostome revascularization

Angiostomes and endovascular therapy

- Healing of diabetic ischemic ulcers after endovascular revascularization
  - DR 83% healed
  - IR 59% healed

"An angiostome model of perfusion helps the treatment of diabetic foot ulcers"


Angiostomes and endovascular therapy

- 203 ischemic ulcers
- Procedures
  - Fem PTA 17%
  - SFIA stenting 54%
  - Tibial PTA 82%
- Healing
  - DR 86%
  - IR 69%

Iida, et al. Endo Today 2010;September:96-100

Angiostomes and bypass

Oregon Health Sciences University

- Single center, 106 limbs
- Complete healing (p=.001)
  - DR 70%
  - IR 40%
- Time to healing (p=.002)
  - DR 99 days
  - IR 195 days

"Significant predictor for wound healing and reduced healing time"

Angiosome revascularization for CLI
Jain Institute of Vascular Science, Bangalore, India

- Prospective study
- 64 patients with CLI
- Bypass 61%, Endovascular 39%
- Healing at 3 / 6 months (p<.021)
  - DR 58% / 96%
  - IR 13% / 83%

“Angiosome should be considered whenever possible”

Angiosomes for diabetic ulcers
Helsinki University Central Hospital, Helsinki, Finland

- Single center, 250 patients with ischemic diabetic ulcers
- Infra-popliteal Endovascular revascularization
- Healing at 12 months (p < .001)
  - DR 72%
  - IR 45%

“The angiosome model is important for ulcer healing in diabetic patients”

Summary

*Don’t just take my word for it!*

<table>
<thead>
<tr>
<th>Study</th>
<th>Direct revasc</th>
<th>Indirect revasc</th>
<th>Method</th>
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<tbody>
<tr>
<td>Neville</td>
<td>91</td>
<td>62</td>
<td>Bypass</td>
</tr>
<tr>
<td>Alexandrescu</td>
<td>83</td>
<td>59</td>
<td>Endovascular</td>
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<tr>
<td>Iida</td>
<td>86</td>
<td>69</td>
<td>Endovascular</td>
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<tr>
<td>Kret</td>
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<td>46</td>
<td>Bypass</td>
</tr>
<tr>
<td>Kabra</td>
<td>96</td>
<td>83</td>
<td>Bypass/Endo</td>
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<tr>
<td>Soderstrom</td>
<td>72</td>
<td>45</td>
<td>Endovascular</td>
</tr>
</tbody>
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Over 700 limbs studied

Conclusion

- Revascularization of the appropriate wound angiosome *does result in increased healing*
- The angiosome concept *should be considered* in planning revascularization for healing and limb preservation