Ultrasound for Initial Evaluation of Lower Extremity Arterial Occlusive Disease: WHY?

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Lower Extremity Artery: Physiologic Testing

Ankle Brachial Index
Exercise Testing
Segmental Pressures/Waveforms
Phylesmography (Pulse Volume Recordings)

Left foot ulceration
Left leg claudication

Sudden Onset left lower leg and foot pain

Left foot ischemic pain

Left foot ulceration
Misconceptions:
Lower Extremity Arterial Duplex Scanning
- Time consuming
- Difficult
- Adds little to physiologic testing

Reality of Modern Arterial Duplex Scanning
- Efficient / Practical
- ↓ $ CTA / MRA
- Accurate
- More information than physiologic testing.
- More accurate than physiologic testing.
- Better follow-up info.
- Techs prefer it to physiologic testing.

2016:OHSU Lower Extremity Vascular Lab Arterial Testing
- Still do ABIs to establish presence of disease.
- Rare exercise testing for unclear cases claudication.
- Almost no segmental pressure studies.
- More than 2000 lower extremity arterial duplex studies.
Duplex Mapping
(Clinical Categories from History/Physical Exam)

- 150 patients with duplex and angiography
- Group A: No significant occlusive disease
- Group B: Aortoiliac occlusive disease
- Group C: Infrainguinal occlusive disease
- Group D: Multilevel occlusive disease

Duplex Mapping
Indication for Angiography

Clinical Classification of Occlusive Disease

- No significant occlusive disease (A)
- Aortoiliac Inflow (B)
- Femoro-popliteal-tibial Outflow (C)
- Multilevel (D)

288 Lower Extremities
**Duplex Mapping: Proximal Arteries**

- Visualization
- Distinguish $<50\%$ vs. $>50\%$ stenosis (PSV, velocity ratios, waveform analysis)
- Distinguish stenosis from occlusion
- Overall and according to disease category

**Duplex Mapping: Tibial Arteries**

- Visualization
- Predict continuous patency to the ankle
- Overall and according to clinical disease category
**Duplex Mapping: Suprageniculate Arteries**

(Sensitivity/Specificity/PPV/NPV)

<table>
<thead>
<tr>
<th>Clinical Group</th>
<th>Artery</th>
<th>Iliac</th>
<th>Common Femoral</th>
<th>Profunda</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (80 limbs)</td>
<td></td>
<td>100/100/100</td>
<td></td>
<td>40/89/67</td>
</tr>
<tr>
<td>B (44 limbs)</td>
<td></td>
<td>94/100/100</td>
<td>82/100/100</td>
<td>100/97/83</td>
</tr>
<tr>
<td>C (117 limbs)</td>
<td></td>
<td>71/99/83</td>
<td>71/98/71</td>
<td>89/95/80</td>
</tr>
<tr>
<td>D (45 limbs)</td>
<td></td>
<td>92/95/87</td>
<td>80/100/100</td>
<td>83/97/91</td>
</tr>
<tr>
<td>TOTALS (266 limbs)</td>
<td></td>
<td>89/99/94</td>
<td>76/99/93</td>
<td>83/97/83</td>
</tr>
</tbody>
</table>

*Analysis not performed if less than 5 high-grade lesions

In 98% of comparisons duplex successfully distinguished stenosis from occlusion!

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**Duplex Mapping: Suprageniculate**

(Sensitivity/Specificity/PPV/NPV)

(≥ 50% STENOSIS OR OCCLUSION)

<table>
<thead>
<tr>
<th>Clinical Group</th>
<th>Artery</th>
<th>Superficial Femoral</th>
<th>Popliteal</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (80 limbs)</td>
<td></td>
<td>67/99/80</td>
<td>100/99/80</td>
</tr>
<tr>
<td>B (44 limbs)</td>
<td></td>
<td>77/99/81</td>
<td></td>
</tr>
<tr>
<td>C (117 limbs)</td>
<td></td>
<td>92/95/99</td>
<td>67/99/96</td>
</tr>
<tr>
<td>D (45 limbs)</td>
<td></td>
<td>78/97/98</td>
<td>69/96/75</td>
</tr>
<tr>
<td>TOTALS (266 limbs)</td>
<td></td>
<td>87/99/97</td>
<td>67/99/93</td>
</tr>
</tbody>
</table>

*Analysis not performed if less than 5 high-grade lesions

---

**Duplex Mapping: Tibial Arteries**

(Sensitivity/Specificity/PPV/NPV for predicting continuous patency)

<table>
<thead>
<tr>
<th>Artery</th>
<th>Anterior Tibial</th>
<th>Posterior Tibial</th>
<th>Peroneal</th>
</tr>
</thead>
<tbody>
<tr>
<td>(80 limbs)</td>
<td>85/80/96</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B (44 limbs)</td>
<td>100/100/100</td>
<td>100/100/100</td>
<td>73/100/100</td>
</tr>
<tr>
<td>C (117 limbs)</td>
<td>96/73/85</td>
<td>100/75/88</td>
<td>76/72/79</td>
</tr>
<tr>
<td>D (45 limbs)</td>
<td>81/65/89</td>
<td>99/71/92</td>
<td>57/58/71</td>
</tr>
<tr>
<td>TOTALS (266 limbs)</td>
<td></td>
<td>93/75/88</td>
<td>97/74/91</td>
</tr>
</tbody>
</table>

*Analysis not performed if less than 5 noncontinuous arteries

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**Duplex Mapping: Stenosis vs. Occlusion**

(Iliacs, Superficial Femoral, Popliteal)

- Duplex Detected ≥ 50-99% Stenosis
  - 87 Segments
  - 28 iliac, 53 SFA, 6 popliteal

- Duplex Detected Occlusion
  - 252 Segments
  - 43 iliac, 176 SFA, 33 popliteal

In 98% of comparisons duplex successfully distinguished stenosis from occlusion!
Duplex vs. Segmental Pressures

Technical Success: Examination of Iliac-Femoral-Popliteal Arteries

- Angiography 100%
- Segmental Pressures 100%
- Duplex Mapping 99.8%

Sensitivities and Positive Predictive Values (50-100% Stenosis, 151 Extremities)

<table>
<thead>
<tr>
<th>Arterial Segment</th>
<th>Sensitivity (%)</th>
<th>PPV (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SDP</td>
<td>ADM</td>
</tr>
<tr>
<td>Iliac/CFA</td>
<td>59</td>
<td>88</td>
</tr>
<tr>
<td>Proximal SFA</td>
<td>73</td>
<td>95</td>
</tr>
<tr>
<td>Distal SFA/Popliteal</td>
<td>48</td>
<td>78</td>
</tr>
<tr>
<td>SFA / Popliteal</td>
<td>85</td>
<td>93</td>
</tr>
</tbody>
</table>

Specificities and Negative Predictive Values (50-100% Stenosis, 151 Extremities)

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<th>Sensitivity (%)</th>
<th>PPV (%)</th>
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<td>ADM</td>
</tr>
<tr>
<td>Iliac/CFA</td>
<td>86</td>
<td>97</td>
</tr>
<tr>
<td>Proximal SFA</td>
<td>80</td>
<td>100</td>
</tr>
<tr>
<td>Distal SFA/Popliteal</td>
<td>56</td>
<td>99</td>
</tr>
<tr>
<td>SFA / Popliteal</td>
<td>53</td>
<td>100</td>
</tr>
</tbody>
</table>
**Duplex vs Segmental Pressures**

Missed 50-100% Stenosis By SDP and ADM in Patients/Limbs With (A) and Without (B) Diabetes, Renal Failure or Previous Vascular Surgery

<table>
<thead>
<tr>
<th>Arterial Segment</th>
<th>Segmental Pressures</th>
<th>Arterial Duplex</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A(%)</td>
<td>B(%)</td>
</tr>
<tr>
<td>Iliac/CFA</td>
<td>33</td>
<td>43</td>
</tr>
<tr>
<td>Proximal SFA</td>
<td>32</td>
<td>22</td>
</tr>
<tr>
<td>Distal SFA/Popliteal</td>
<td>50</td>
<td>33</td>
</tr>
</tbody>
</table>

**Total Agreement with Angiography**

(151 Limbs)

<table>
<thead>
<tr>
<th>Segmental Doppler Pressures</th>
<th>Arterial Duplex Mapping</th>
</tr>
</thead>
<tbody>
<tr>
<td>52 (34%)</td>
<td>123 (82%)</td>
</tr>
</tbody>
</table>

\[ P < 0.0001 \]

**ABI and Progression of Atherosclerosis**

- ABI is relatively insensitive to detect progression of atherosclerosis
- Duplex is better

- 114 patients
- 193 extremities
- Mean follow-up: 3.3 years
- 76% of arteries initially patent by angiography
Duplex Mapping: Conclusions

• Highly accurate

• Better than segmental pressures and ABI

• Preferred initial examination for evaluation of PAD