Tips and Tricks in Vascular Imaging
Lower Extremity CTA

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Tips and Tricks in Vascular Imaging

LOWER EXTREMITY CTA

- Clinical context
- Scanning and Contrast Technique
- Postprocessing
- Interpretation & Reporting

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Tip 1: Clinical Context

Role of Imaging in Peripheral Arterial Disease (PAD)
Peripheral Artery Disease (PAD)

- manifestation of atherosclerosis in arteries supplying blood to lower extremities

Clinical Symptoms:

- **At stress**: intermittent claudication perfusion pressure (ABI<0.8) can’t keep up with increased demand when walking; ischemic tissue is muscle

- **At rest**: critical limb ischemia perfusion pressure<baseline demand; ischemic tissues are skin, nerve, connective tissue
Diagnosis and Staging of PAD

- symptoms +
- ankle-brachial-index

- poor correlation of symptoms and ABI with number, location and severity of lesions

→ calf claudication can be caused by isolated vs a combination of iliac or femoropopliteal lesions

Role of Imaging NOT diagnosis / staging

- mapping of lesions to symptoms for treatment planning
Figure 7: Peripheral CTA (16x0.75mm, 2.0mm/1.0mm) of a 73 year old woman with intermittent claudication bilaterally. MIP (a) shows long right femoropopliteal occlusion, and diffuse disease of the left superficial femoral artery with a short distal occlusion. CPR through left ilio-femoral axis demonstrates multiple web-like stenosis of the external iliac artery, a diffusely diseased left superficial femoral artery, and short (<3cm) distal left SFA occlusion. Corresponding selective DSA images (c, d) obtained immediately before PTA/stenting of the left iliac.

73 year old woman with intermittent claudication bilaterally
TASC II Criteria
Transatlantic Society Consensus (2007)

Inter-Society Consensus for the Management of Peripheral Arterial Disease (TASC II)

L. Norgren,* W.R. Hiatt,† J.A. Dormandy, M.R. Nehler, K.A. Harris, and F.G.R. Fowkes on behalf of the TASC II Working Group, Denver, Colorado

INTRODUCTION

The Trans-Atlantic Inter-Society Consensus Document on Management of Peripheral Arterial Disease (TASC) was published in January 2000 as a result of cooperation between fourteen medical and surgical vascular, cardiovascular, vascular radiology and cardiology societies in Europe and North America. This comprehensive document had a major impact on vascular care amongst specialists. In subsequent years, the field has progressed with the publication of the CoC4 document and the American College of Cardiology/American Heart Association Guidelines for the Management of Peripheral Arterial Disease. Aiming to continue to reach a readership of vascular specialists, but also physicians in primary health care who see patients with peripheral arterial disease (PAD), another consensus process was initiated during 2004. This new consensus document has been developed with a broader international representation, including Europe, North America, Asia, Africa and Australia, and with a much larger distribution and dissemination of the information. The goals of this new consensus are to provide an abbreviated document

Process

Representatives of sixteen societies from Europe, North America, Australia, South Africa and Japan were elected from their respective society and were called together in 2004 to form the new Working Group. Specialists in health economics, health outcomes and evidence-based medicine were also included to elaborate on the text for the following sections: history, epidemiology and risk factors; management of risk factors; intermittent claudication; critical limb ischemia; acute limb ischemia; and technologies (intervention/vasculaization and imaging).

The Working Group reviewed the literature and, after extensive correspondence and meetings, proposed a series of draft documents with clear recommendations for the diagnosis and treatment of PAD. Each participating society reviewed and commented on these draft consensus documents. The liaison member from each society then took these views back to the Working Group, where all of the amendments, additions and alterations suggested by each participating society were discussed, and the final Consensus Document was agreed.
**TASC II Criteria**
Transatlantic Society Consensus (2007)

**Type A**  
endovascular

**Type B**

**Type C**

**Type D**  
surgical

*aortoiliac*  
femoropopliteal
Tip 2: Technique
Scanning and CM Injection
Scanning and CM Injection

- no fancy scanner needed: any CT scanner with \(~1\)mm thickness (\(\geq 16\)-slice MDCT);
- ideally isotropic resolution (sub-millimeter)

Account for slow bolus transit in diseased arteries:

- long injection (\(~35\)s)
- scan slow (40s)
- add delayed acquisition, if needed
Peripheral Arterial Enhancement
(20 patients with PAOD)

Aorto-popliteal transit time

<table>
<thead>
<tr>
<th>Transit time</th>
<th>Transit speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>mean: 10 s</td>
<td>65 mm/s</td>
</tr>
<tr>
<td>min: 4 s</td>
<td>177 mm/s</td>
</tr>
<tr>
<td>max: 24 s</td>
<td>30 mm/s</td>
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</table>

\[ t_{\text{APT}} = \text{aorto-popliteal transit time} \]
\[ t_{\text{CMT}} = \text{contrast medium transit time} \]
Peripheral arterial bolus propagation

Table speed (mm/s)

<table>
<thead>
<tr>
<th>Table speed (mm/s)</th>
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<tbody>
<tr>
<td>0</td>
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<td>0.6</td>
</tr>
<tr>
<td>0.8</td>
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<td>1</td>
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</tbody>
</table>

Cumulative proportion of limbs

Relative risk to outrun bolus

Aorto-popliteal transit speed (mm/s)

Fleischmann D and Rubin GD. Radiology 2005, 1076-1082
# Integrated Scanning-Injection Protocol

## 64 - channel Lower Extremities

<table>
<thead>
<tr>
<th>Weight</th>
<th>Biphasic Injection</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;55kg</td>
<td>20 mL (4.0mL/s) + 96 mL (3.2mL/s)</td>
</tr>
<tr>
<td>&lt;65kg</td>
<td>23 mL (4.5mL/s) + 108 mL (3.6mL/s)</td>
</tr>
<tr>
<td>75kg</td>
<td>25 mL (5.0mL/s) + 120 mL (4.0mL/s)</td>
</tr>
<tr>
<td>&gt;85kg</td>
<td>28 mL (5.5mL/s) + 132 mL (4.4mL/s)</td>
</tr>
<tr>
<td>&gt;95kg</td>
<td>30 mL (6.0mL/s) + 144 mL (4.8mL/s)</td>
</tr>
</tbody>
</table>

**Scantime:** 40s for ALL patients (pitch variable) (automated tube current modulation)

**Inj. duration:** 35s for ALL patients

**Delay:** bolus triggering
82 y.o. woman
bilateral claudication re>lt

Scanner: 64 × 0.6mm
Scantime: 40 s

Injection (biphasic): 35 s

20mL (4 mL/s) +
95mL (3.2 mL/s)

Delay: 'CareBolus'
Peripheral CTA

Scanning Range

Scanning Range 1

celiac artery (Th12) → toes
(105 – 130 cm)

Optional Additional Scanning Range 2

above the knees → toes

Always pre-programmed, but only initiated by technologist if no contrast in crural vessels
Arteriomegaly

preprogrammed, optional 2\textsuperscript{nd} acquisition

1st acquisition
Tip 3: Postprocessing
Tips and Tricks for Lower Extremity CTA
Postprocessing

• greatest challenge in lower extremity CTA: difference between quick read vs. painful (literally) scrolling through images

• axial (transverse) images inadequate, except in acute ischemia (i.e. thromboembolic)

• need longitudinal cross sections (MPR/CPR)

• ideally, mapping of lesions needs a ‘map’: ‘multipath curved planar reformations’

• try to delegate (3D-Lab, trained technologist) if routinely performing runoff CTAs
59 year old man with intermittent claudication bilaterally.

Past medical history significant for prior Stent-PTA of right EIA MultiPath-CPR; thin, stretched DSA ThinCPR Right, stretched post kissing stent pre-PTA/re-stent of stent-stenosis
Display on PACS

MIP  Multi-Path CPR  single CPR
Tip 4: Interpretation & Reporting
‘Surgical (endovascular) Segments’

- **aorto-iliac** = ‘suprainguinal’ = ‘inflow’
- **common fem. a.** important landmark; bypass target/source
  - Profunda fem. a. [important collateral if SFA occluded; post amput.]
- **femoropoplital a.** ‘infra-inguinal’ = ‘runoff’ reconstitution of pop. a. (pop.: P1, P2, P3) above (P1) or below (P3) knee
- **below knee aa.** only relevant in CLI, can ignore in claudicants
- **pedal arteries** only CLI, bypass targets
Systematic Approach to Reading Lower Extremity CTA

answer clinical questions rather than listing lesions

• intermittent claudication?
critical limb ischemia?
-- determines how you read scan

• organize first by leg, and then by station

Right/left lower extremity
- aortoiliac (inflow disease [above inguinal lig.])
- (common fem a.); - (deep femoral artery)
- femoropopliteal artery; SFA, P1, P2, P3
- below knee (infrapop.) runoff: 2 vessels cross ankle)
- (pedal)
Tips and Tricks in Vascular Imaging

LOWER EXTREMITY CTA: SUMMARY

- **Clinical context**
  - goal is to map lesions to clinical symptoms
  - ‘stress’ (claudication) vs. ‘resting’ (CLI) ischemia

- **Scanning and Contrast Technique**
  - inject long, and scan slow

- **Postprocessing**
  - curved planar reformats

- **Interpretation & Reporting**
  - don’t read study without knowing symptoms
  - answer clinical question rather listing lesions
SAM Question

Which of the following statements regarding lower extremity CTA is correct?

A. the diagnosis of peripheral artery disease is fundamentally based on imaging

B. symptoms and ankle-pressure-index (ABI) not only establish the diagnosis of peripheral artery disease, but also accurately localize the anatomic level of obstruction

C. the role of imaging in peripheral artery disease is not making the diagnosis, but to map (localize) obstructive lesions for treatment planning

D. in patients with calf claudication, evaluation of the distal below-knee arteries is important for treatment planning
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Reference: Fleischmann D, Hallett RL, Rubin GD. CT angiography of peripheral arterial disease. J Vasc Interv Radiol. 2006;17:3-26
Thank you...

Special thanks: Dominik Fleischmann, MD

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