

The Modern Endovascular Approach to Infrapopliteal Occlusive Disease

Mark W. Burket, MD
University of Toledo Medical Center
Toledo, Ohio



THE UNIVERSITY OF
TOLEDO
HEART AND VASCULAR CENTER

The CLI Team...Not Just a Good Idea



No single specialty can deliver complete, state-of-the-art infrapopliteal care

Wound care, vascular specialist, infectious disease, etc

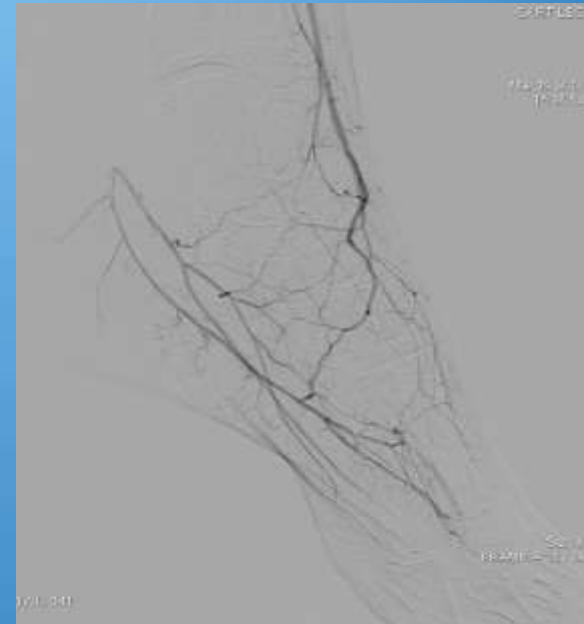
Vascular Specialist Basics



Antegrade Femoral Access

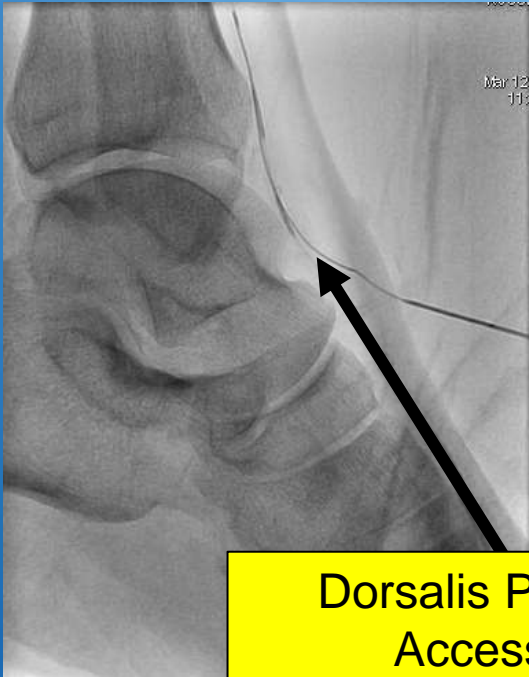


Small Wire Skills

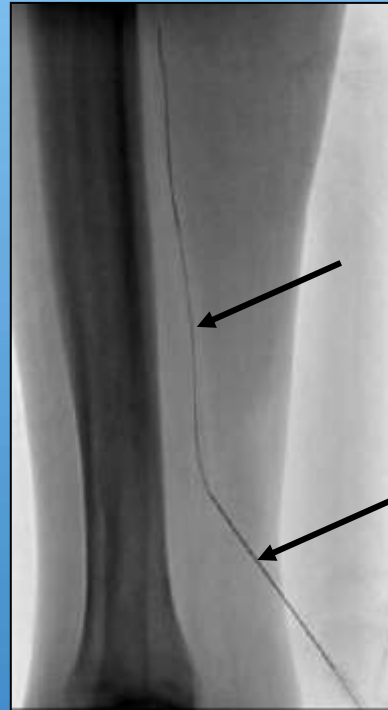


Knowledge of Anatomy

Vascular Specialist Basics



Dorsalis Pedis
Access

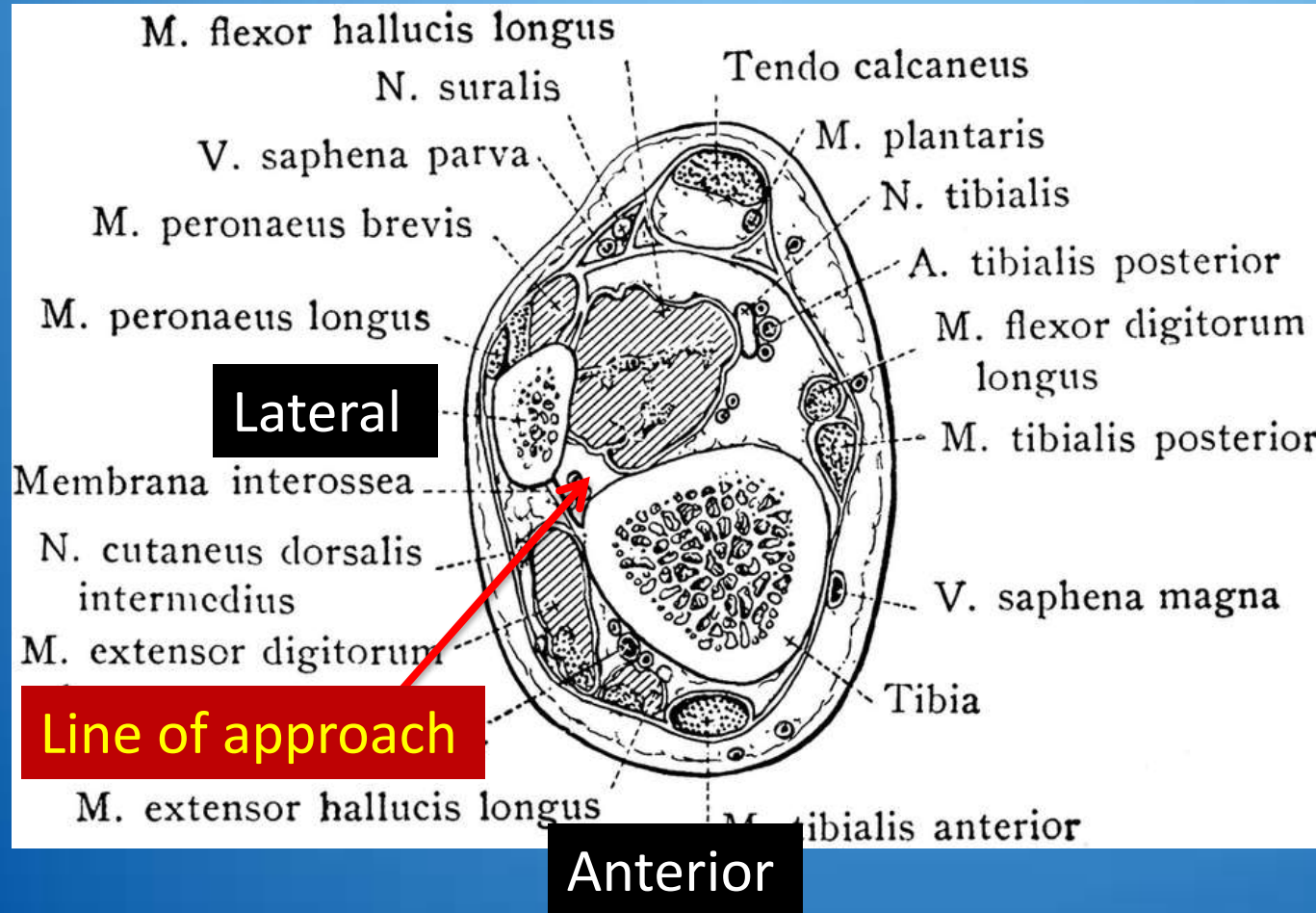


Posterior Tibial
Access

CLI 202: Peroneal Artery Access

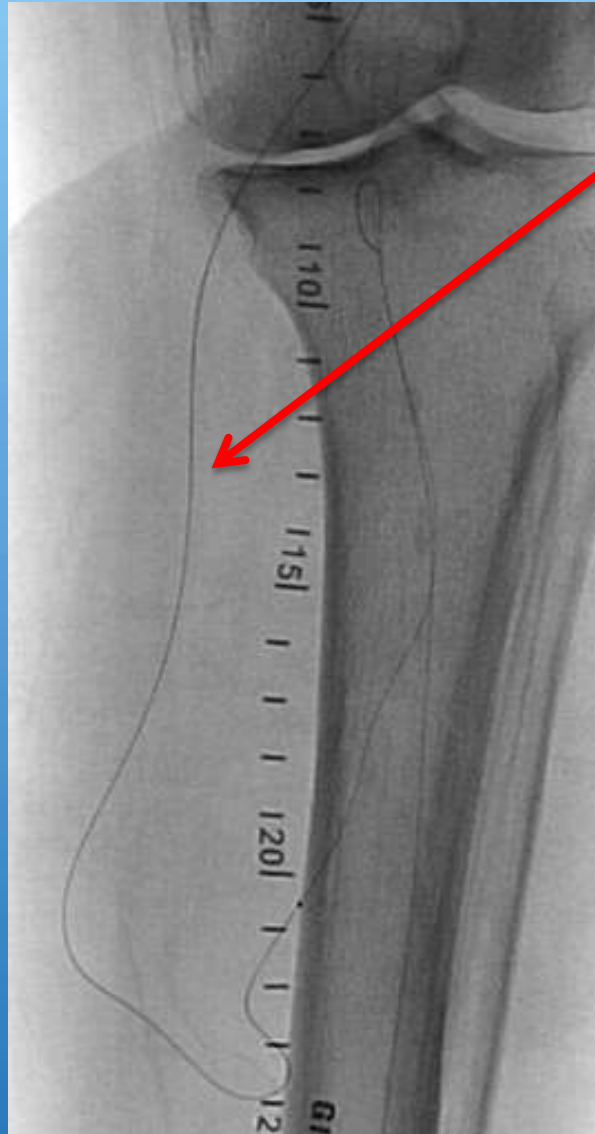
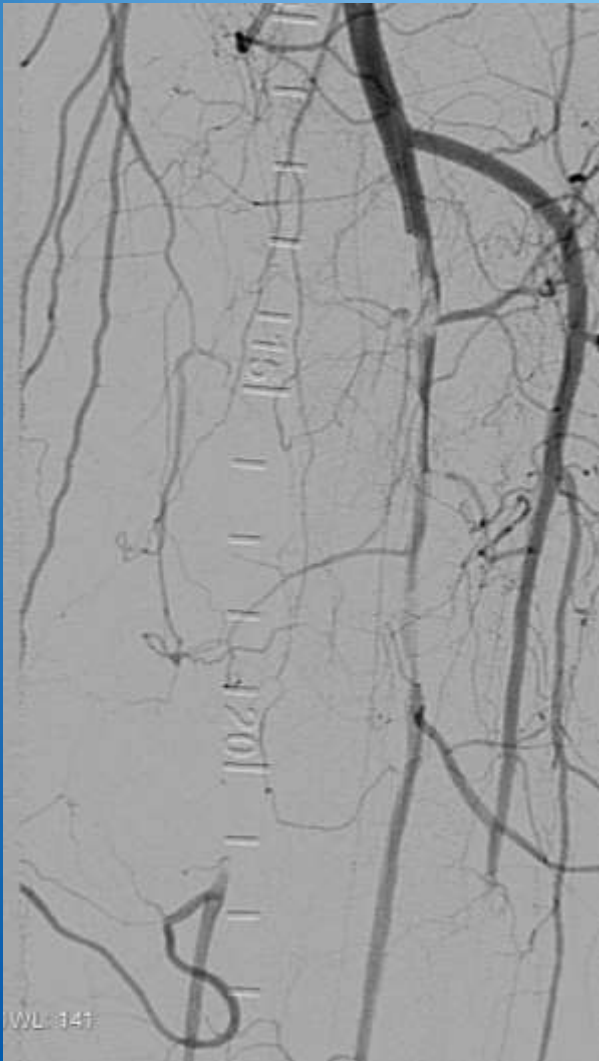


Peroneal Artery Access

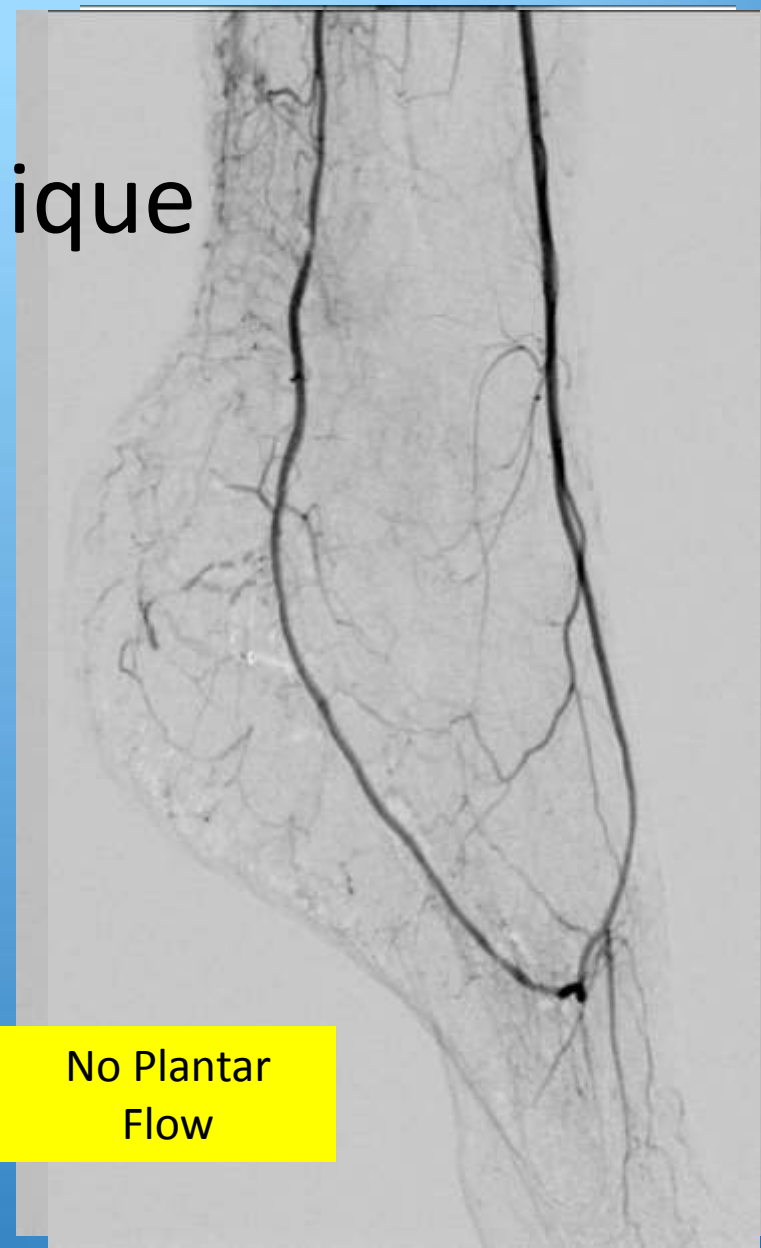


CLI 202: Transcollateral Access

Wire passed through collateral, into PT, through occlusion, and into popliteal

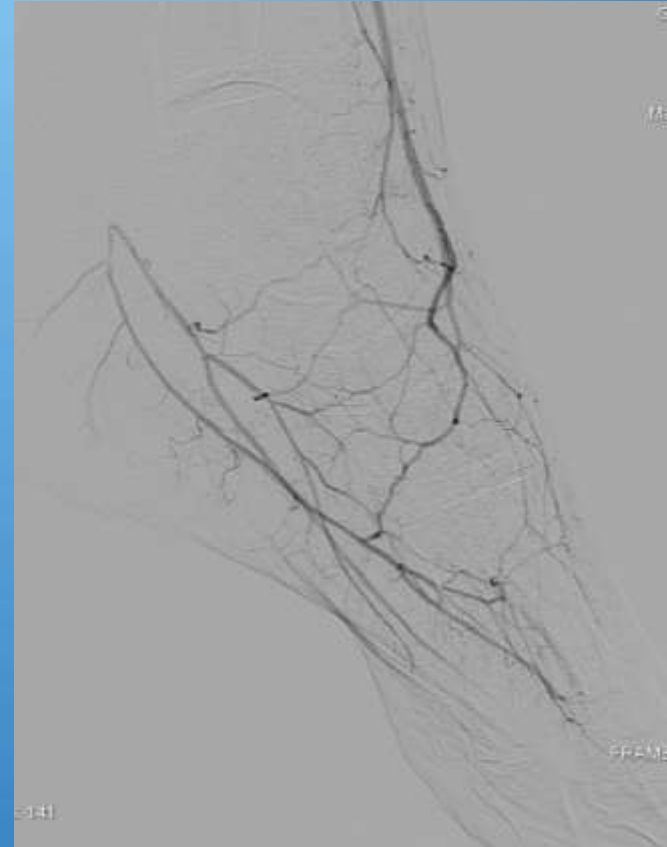
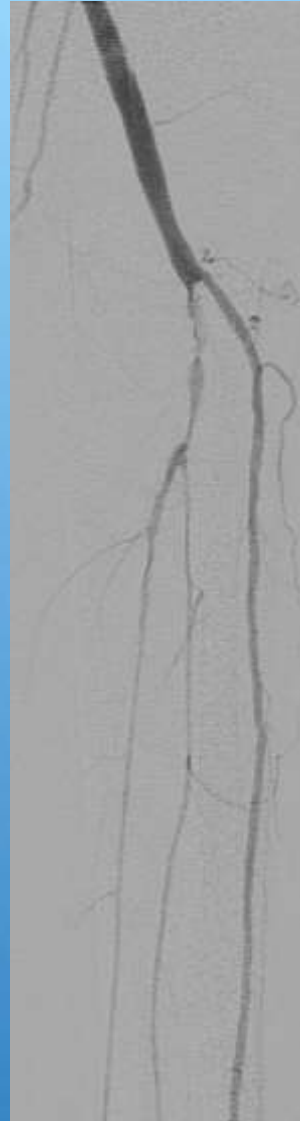
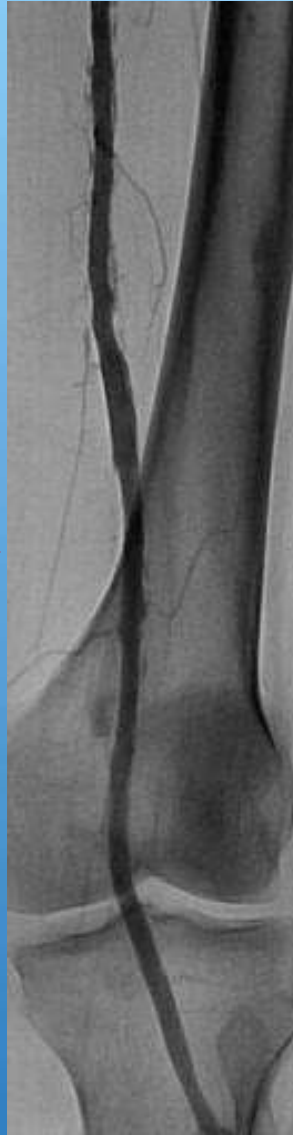


CLI 303: Plantar Loop Technique



*Images courtesy of
Lanfroi Graziani, MD*

Angiograms Are Nice...



Before

After Intervention

But What The Patient Cares About Is Healing...



...and healing requires oxygenated blood delivered to tissue



“The life of the flesh is in the blood” Leviticus 19:11

Going Beyond Arteries and Angiosomes



...to Perfusion

Contrast Angiography

Ideal: In-Line Flow to Affected Angiosome

Reality:

- Your patient's angiosomes may not match the textbook
- In-line flow may be unachievable
- Collateral, plantar arch, wound blush matter

A long, straight asphalt road with a yellow dashed center line and white edge lines winds through a desert landscape. The road is flanked by sparse, dry vegetation and small green shrubs. In the background, there are large, layered red rock formations and a clear blue sky. The text "We Have a Long Way to Go..." is overlaid in white on the left side of the image.

We Have a Long Way to Go...

Blood Oxygenation Level-Dependent CMR-Derived Measures in Critical Limb Ischemia and Changes With Revascularization

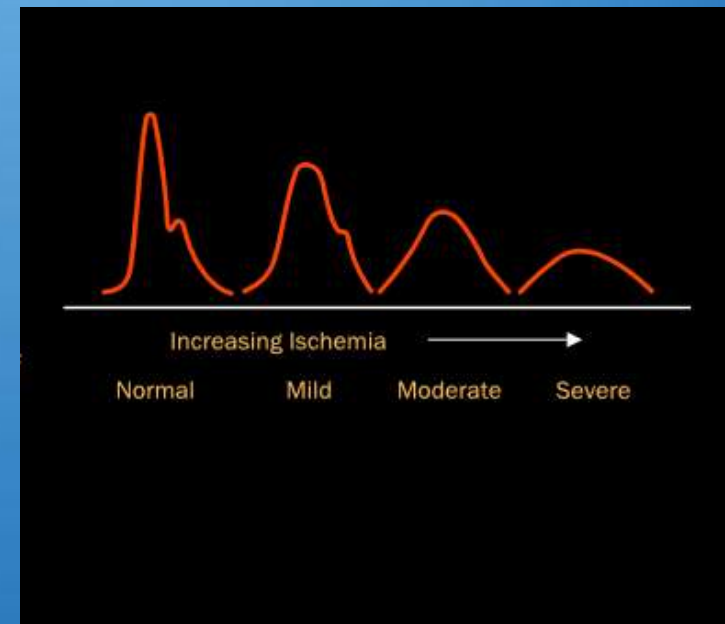
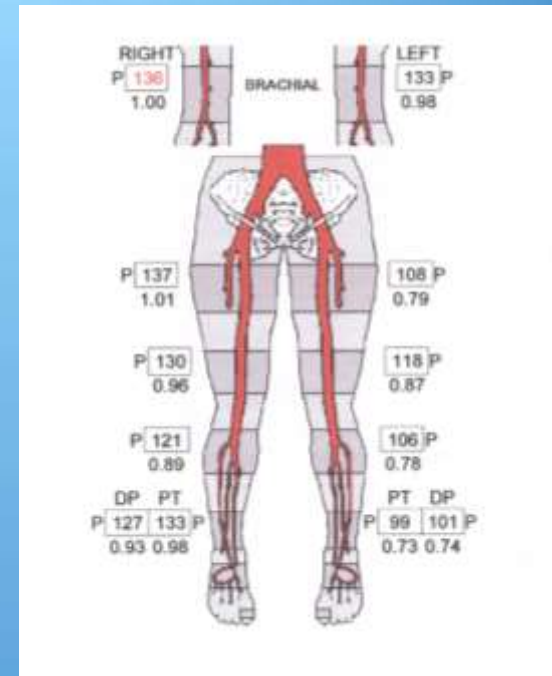


Adnan Bajwa, BSc,^a Roman Wesolowski, PhD,^b Ashish Patel, PhD,^a Prakash Saha, PhD,^a Francesca Ludwinski, PhD,^a Mohammed Ikram, PhD,^a Mostafa Albayati, MBBS, BSc,^a Alberto Smith, PhD,^a Eike Nagel, MD, PhD,^{b,c} Bijan Modarai, PhD^a

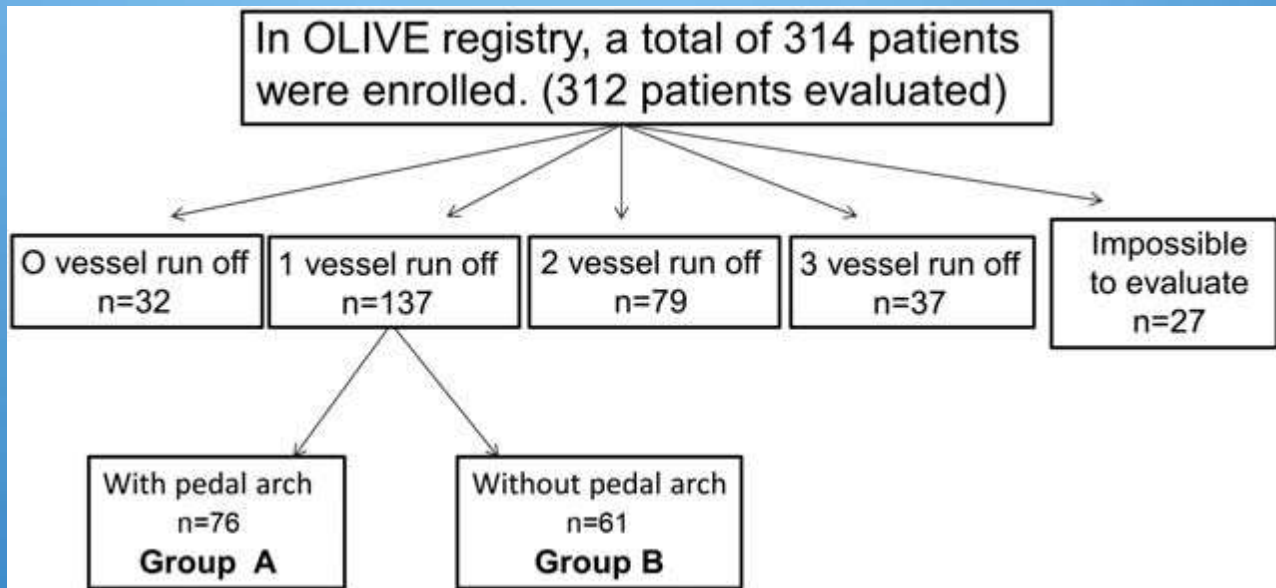
“Currently, no reliable method for measuring the adequacy of lower-limb perfusion exists.”

Noninvasive Methods

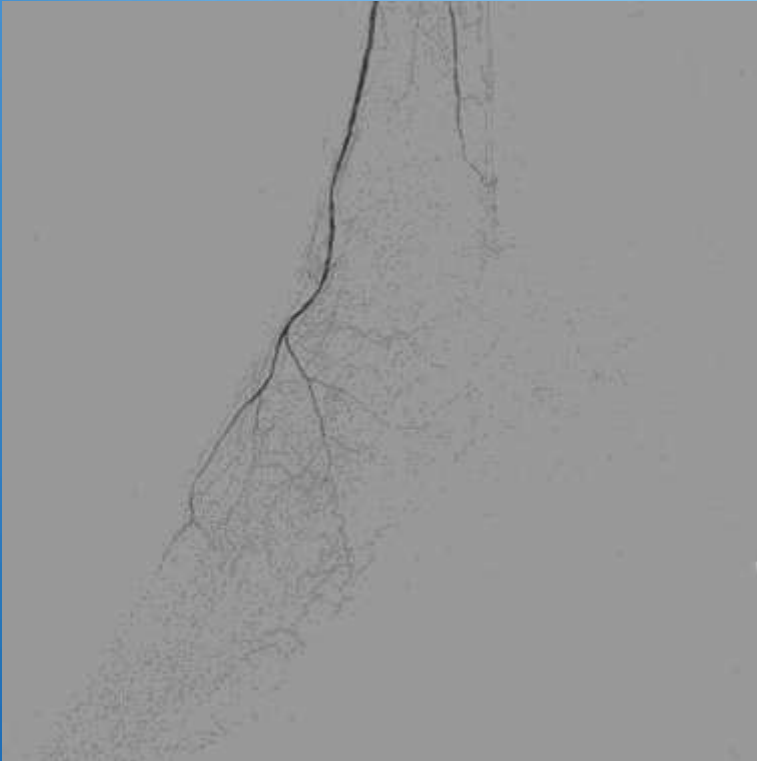
- Physical Exam
- ABI (ankle brachial index)
 - Whole limb
 - Unreliable with calcification
- PVR (pulse volume recordings)
 - Region of limb
 - Qualitative only



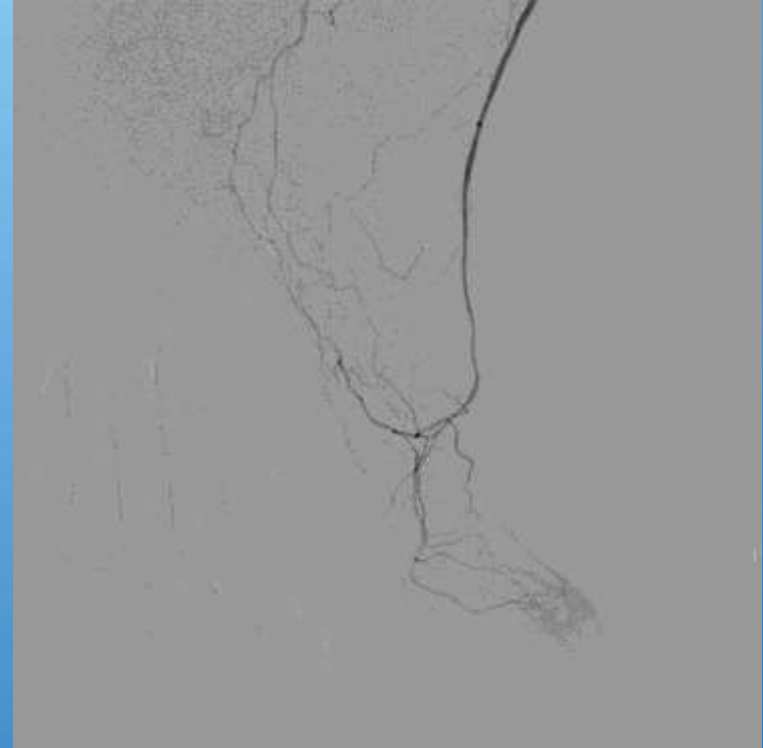
Importance of an Intact Plantar Arch: Data from the OLIVE Registry



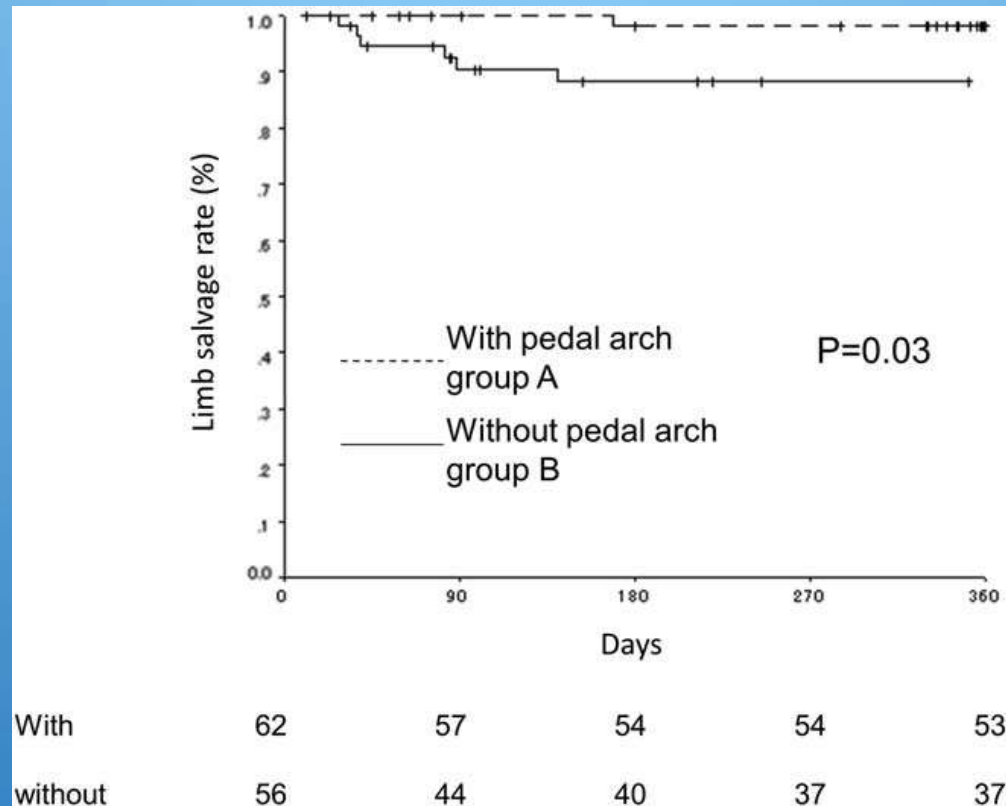
One Vessel Runoff
No Plantar Arch



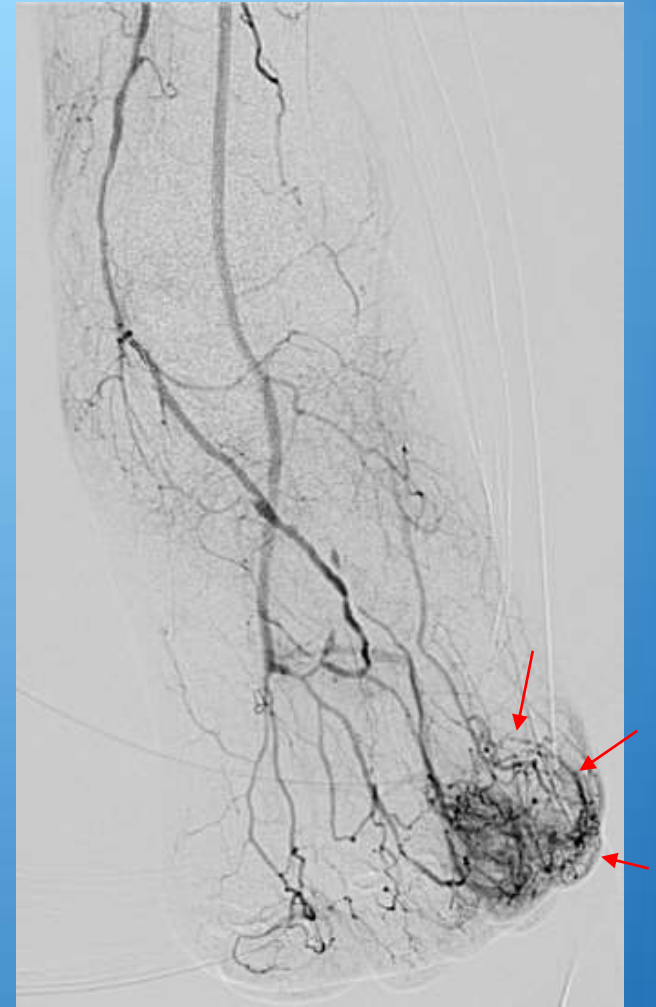
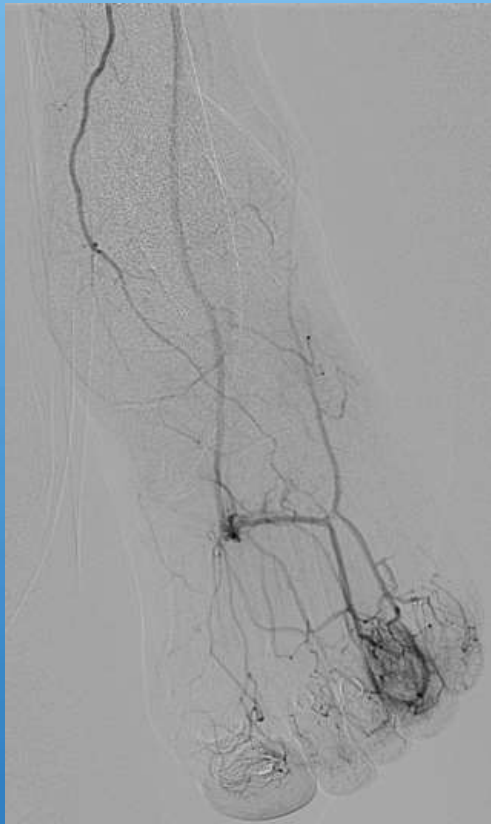
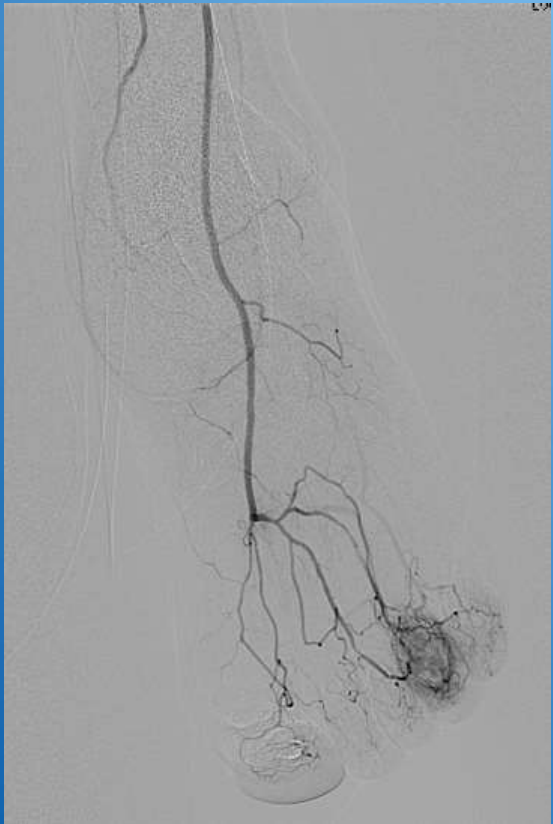
One Vessel Runoff
Plantar Arch Present



Limb Salvage Predicted by Plantar Arch

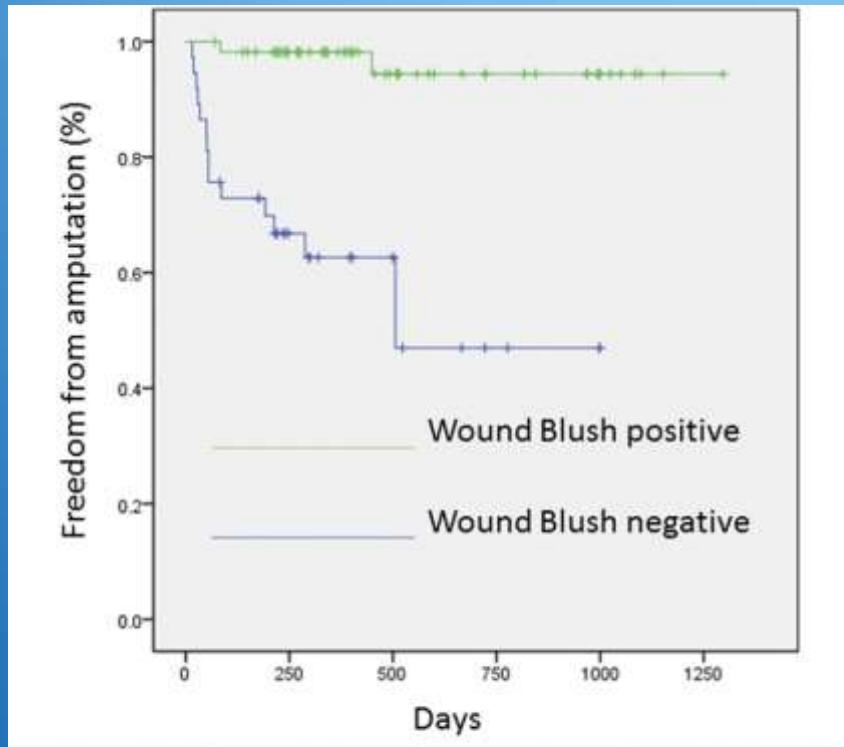


Wound Blush



Slide courtesy of John Rundback, MD

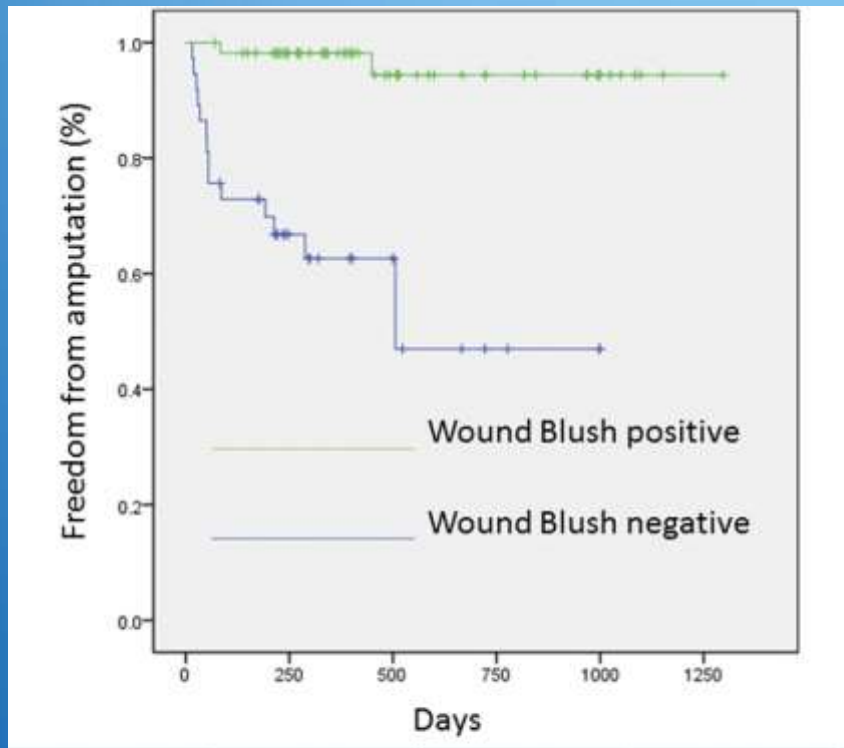
Wound Blush Predicts Limb Salvage...



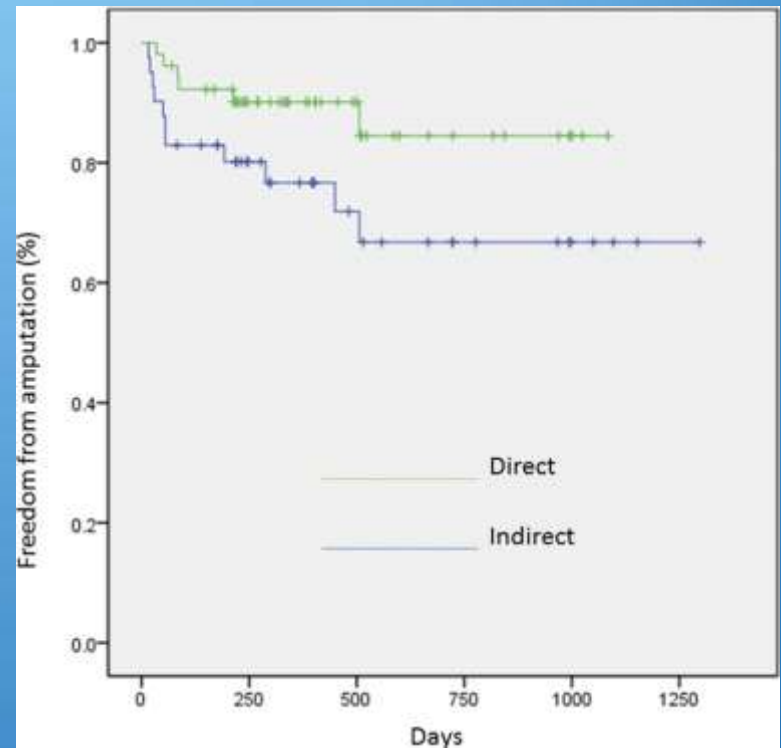
Rutherford 5 or 6
Endovascular therapy

$p = 0.001$

Wound Blush Predicts Limb Salvage... Better Than Direct Flow into Angiosome



$p = 0.001$



$p = 0.063$

Transcutaneous Oxygen Pressure



- First reported 1982
- Electrodes on chest, feet
- Higher values correlate with healing
- Limitations:
 - Small area
 - Superficial

Benitez, E. Seminars in Vascular Surgery. 2014;27:3-15

Bajwa, A. Circ Cardiovasc Imaging. 2014;7:836-843

Transcutaneous Oxygen Pressure



- Highly variable measurements
- Normal ~ 60 mm Hg
- > 40 predicts healing
- < 20 predicts failure
- Falsely low with:
 - Edema
 - Inflammation
 - Cold, vasoconstriction

Benitez, E. Seminars in Vascular Surgery. 2014;27:3-15

Bajwa, A. Circ Cardiovasc Imaging. 2014;7:836-843

Newer Options

- Perfusion angiography
- Methylene blue
- Indocyanine green
- MRI
- PET
- Ultrasound

Perfusion Angiography

- Modification of standard angiography
- Catheter placed in popliteal artery
- Standardized injection (3ml/sec iodixanol)
- Lateral imaging of foot
- Post-processing (Philips Allura Xper FD20)

Perfusion Angiography

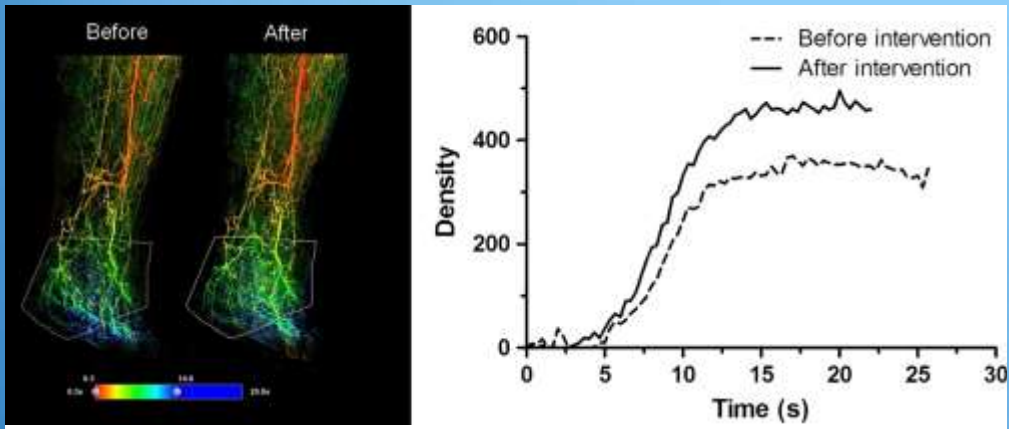
- Hampered by foot motion
- Region of foot
 - Not angiosome
 - Not specific vessel



Jens Cardiovasc Intervent Radiol 2015;38:201-205

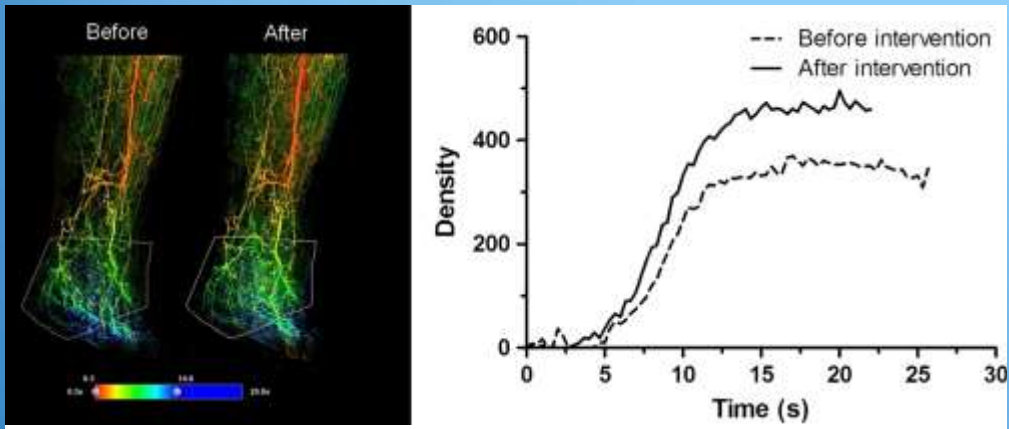
Murray, T. J Endovasc Ther 2016;23:58-64

Perfusion Angiography

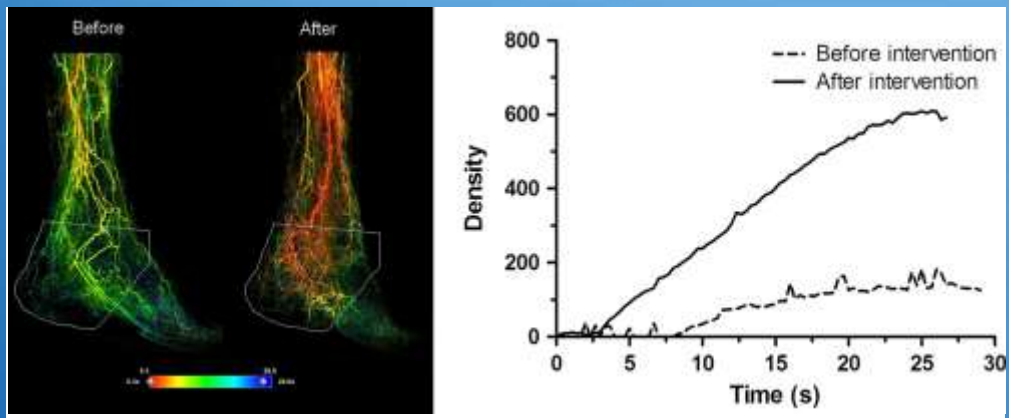


Example:
Successful intervention
Greater contrast density

Perfusion Angiography

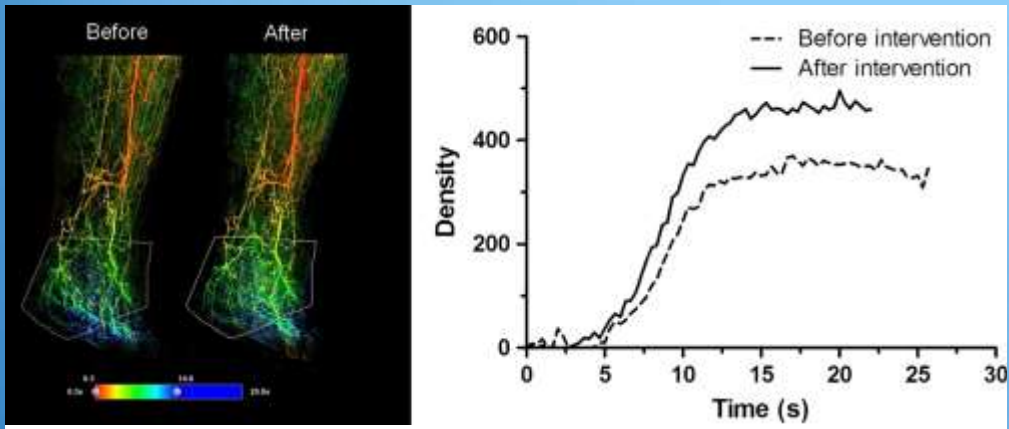


Example:
Successful intervention
Greater contrast density

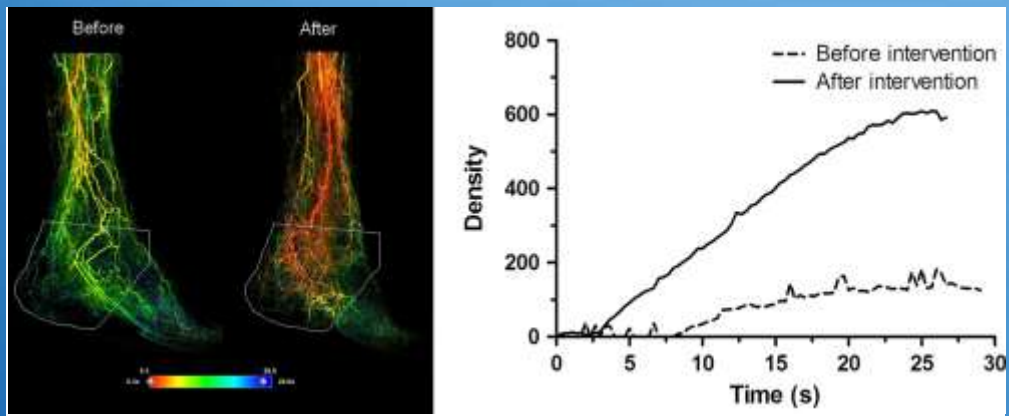


Example 2:
Successful intervention
Earlier appearance of contrast
Greater contrast density

Perfusion Angiography



Example:
Successful intervention
Greater contrast density



Example 2:
Successful intervention
Earlier appearance of contrast
Greater contrast density

Failed intervention: identical before and after curves

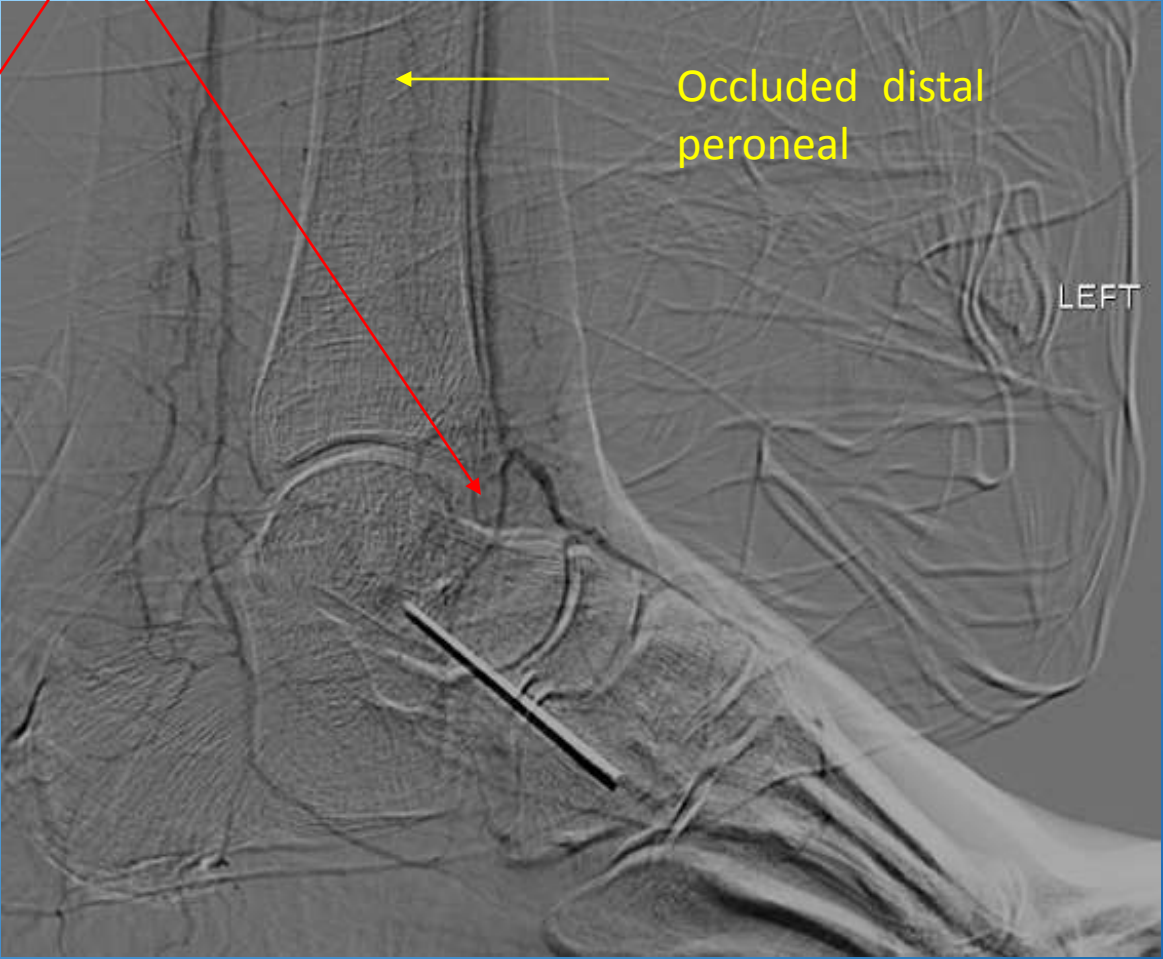
Methylene Blue

Lateral Malleolar Foot Ulcer

Case provided by John Rundback, MD



Lateral tarsal artery



Proximal peroneal injection



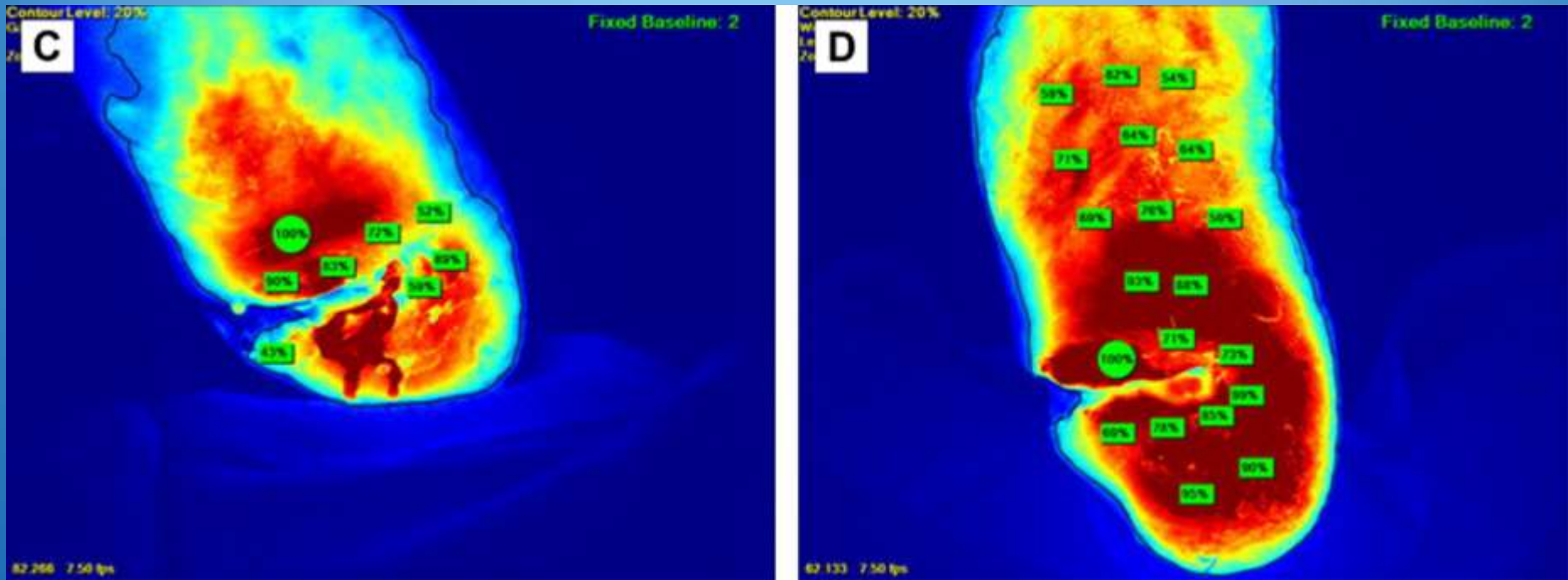
Anterior tibial injection



Anterior Tibial Injection



Indocyanine Green Angiography *Heat-map Images*

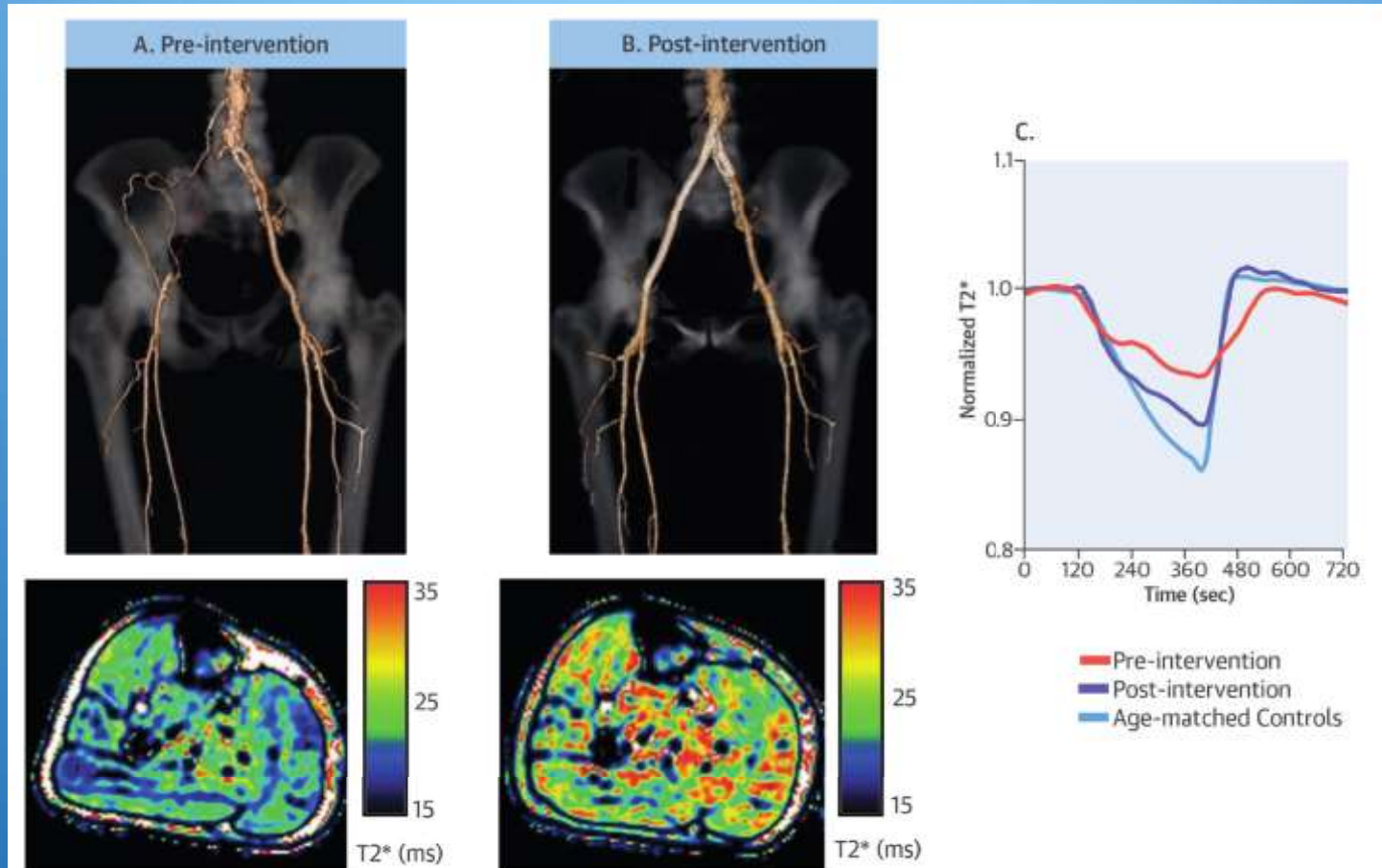


Pre-Intervention

Post-Intervention

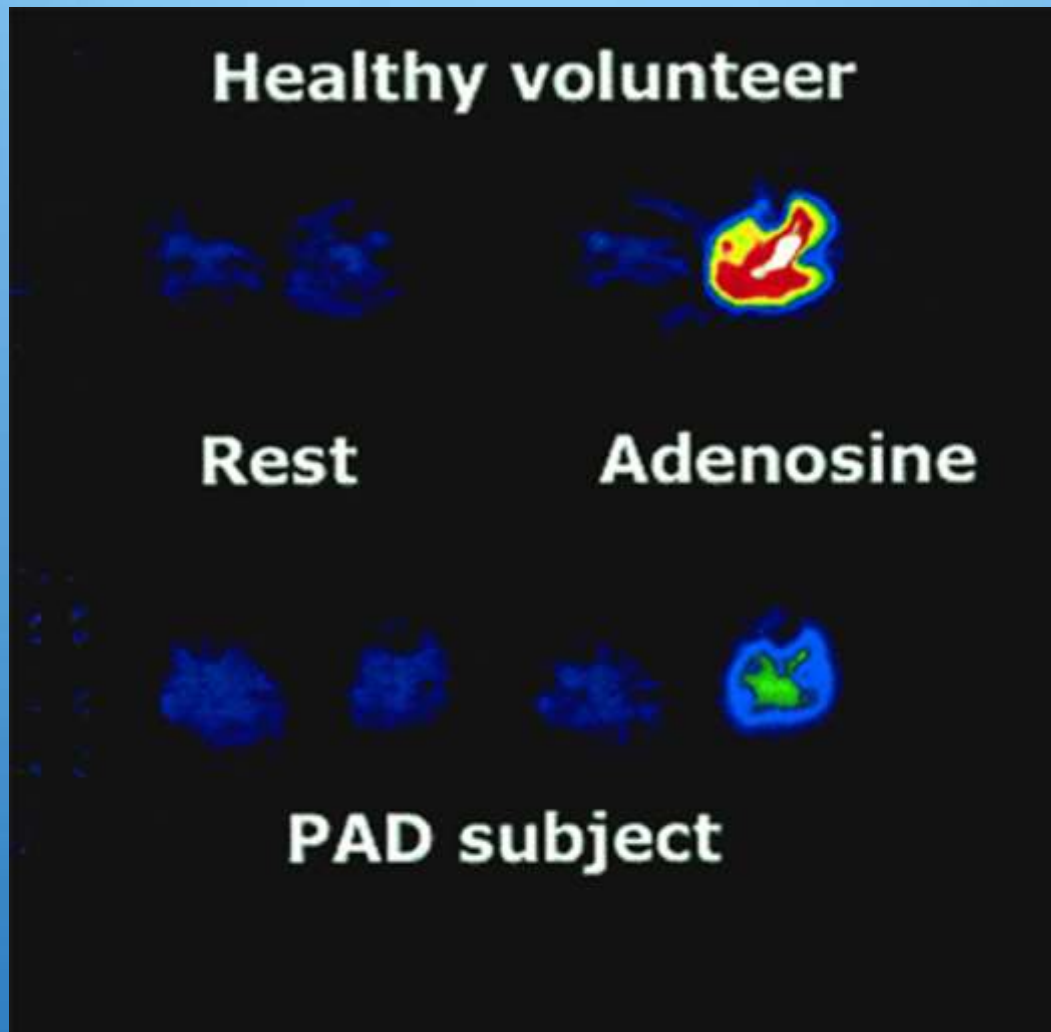
BOLD-CMR

Blood Oxygen Level-Dependent Cardiovascular Magnetic Resonance



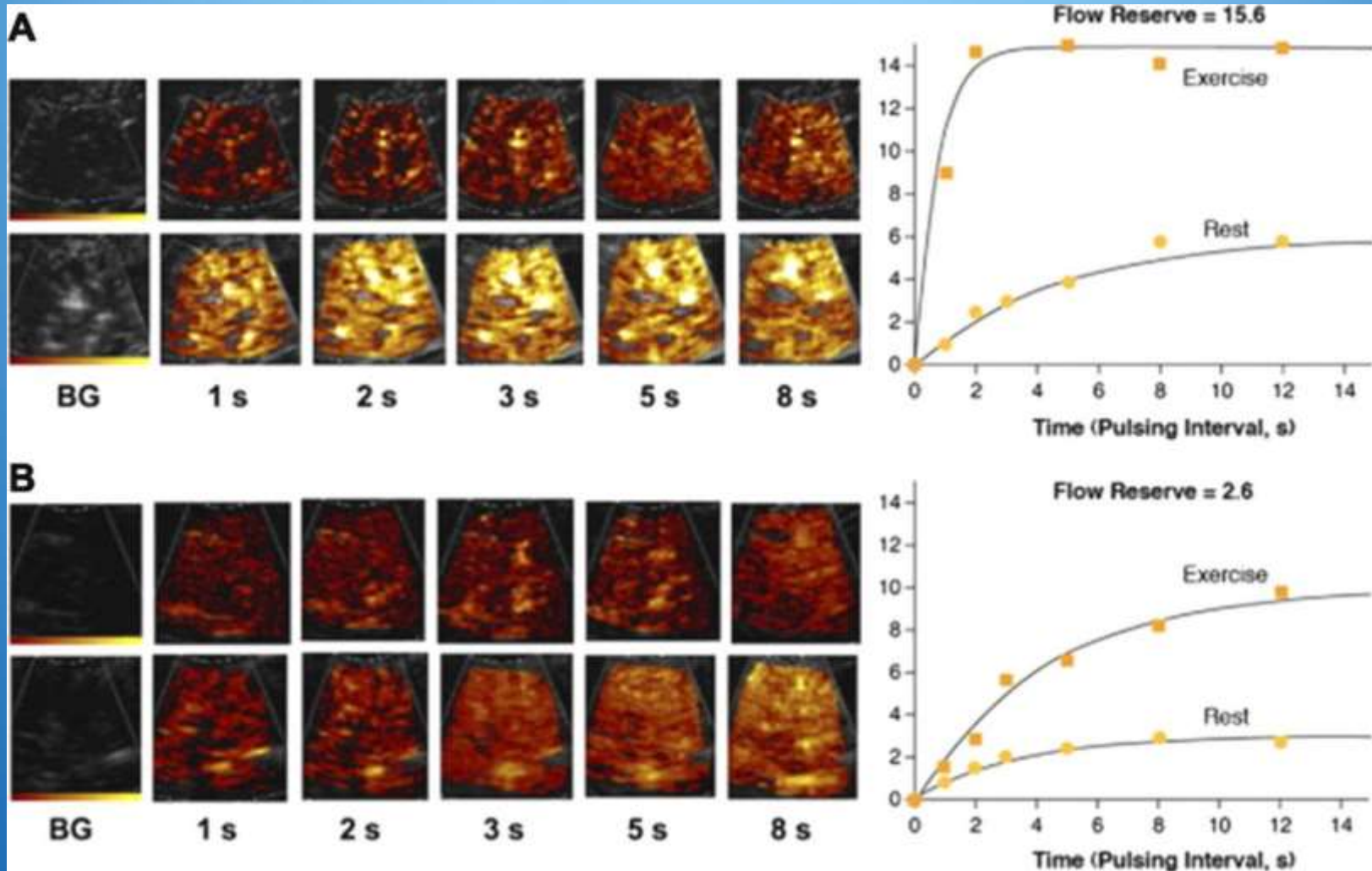
Calf imaging pre and post intervention

Positron emission tomography (PET) of the calf using ^{15}O oxygen-labeled water in healthy volunteers and patients with peripheral arterial disease (PAD).



Adnan Bajwa et al. *Circ Cardiovasc Imaging*. 2014;7:836-843

Contrast-enhanced ultrasound with continuous infusion in a healthy volunteer (A) and patient with peripheral arterial disease (PAD; B).



Adnan Bajwa et al. Circ Cardiovasc Imaging. 2014;7:836-

843

Summary: Modern Endovascular Therapy for Infrapopliteal Disease

- Absolutely requires a CLI team, including wound care
- Requires comfort with complex access and imaging
- Gets best results when attention focuses on tissue perfusion