Foot Perfusion Measurements Are The Best Method To Evaluate Treatment Effectiveness For CLTI: What Methods Are Available And Best

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DISCLOSURES: NONE

Perfusion imaging and guidelines

2019 Global Vascular Guidelines on the Management of CLTI,

Wound, Ischaemia and foot Infection, WIfI

rely on ABI, TBI, TP and TcPO2

as non-invasive markers of foot perfusion

$TcPO_2$

Diffusion of oxygen molecules – no direct measurement

Heating is necessary to avoid blood vessel reactivity

Long measuring time

- Heating phase appr. 20 minutes
- Resting level: change less 2 min following 10-min response time

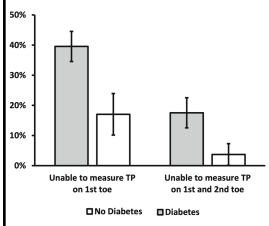
Ambient temperature

Problem: Skin changes as necrosis and inflammation

Evidence in guidelines: conditional, low [1]

[1] The Intersocietal IWGDF, ESVS, SVS guidelines on peripheral artery disease in patients with diabetes mellitus and a foot ulcer. www.iwgdfguidelines.org 2023

Toe Pressure (TP)



High rate of patients unable to undergo non-invasive testing

32% of limbs were unable to undergo first toe TP

12.9% were unable to undergo 1st and 2nd TP

Wound Rep Reg. 2023;31:779–782

Preferred methods of perfusion imaging

- Laser Doppler imaging
- White light spectrometry
- ICG perfusion imaging

Different probes and measurements

Pilot assessment of the effect of negative pressure wound therapy on microperfusion of chronic and acute wounds

Ulrich Rother•, Mona Theuns, Werner Lang and Alexander Meyer

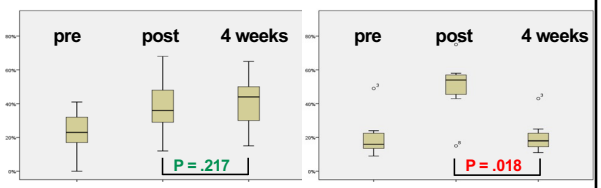
Safety of medical compression stockings in patients with diabetes mellitus or peripheral arterial disease

Flap perfusion monitoring with an attached surface probe in microvascular reconstruction of the oral cavity

Angiosomes | **Wounds** | **Studies** | **Monitoring**

J Vasc Surg 2017;65:422-30 | Clinical Hemorheology and Microcirculation 79 (2021) 455–462 | BMJ Open Diab Res Care 2020;8:e001316 | Clinical Oral Investigations (2023) 27:5577–5585

SO2 with O2C after angioplasty



Without restenosis | **Restenosis**

Tissue perfusion and graft follow-up

The predictive value of microperfusion assessments for the follow-up of tibial bypass grafts

Alexander Meyer, MD, Shatlyk Yagshyyev, Werner Lang, MD, *and* Ulrich Rother, MD, *Erlangen, Germany*

J Vasc Surg 2022;75:1008-13

Postoperative microperfusion assessment showed significantly decreased values in patients developing a graft occlusion during later follow-up

perfusion parameters

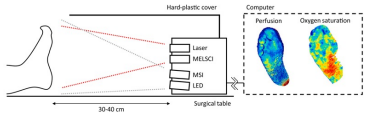
SO2 (P < .011) and FLOW (P < .001)

Laser speckle contrast imaging

Comprehensive imaging of microcirculatory changes in the foot during endovascular intervention – A technical feasibility study

Martin Hultman[a,*], Sofie Aronsson[a], Ingemar Fredriksson[a,c], Helene Zachrisson[b,d], Håkan Pärsson[a], Marcus Larsson[c], Tomas Strömberg[c]

Microvascular Research 141 (2022) 104317
https://doi.org/10.1016/j.mvr.2022.104317



Challenging: Motion artifacts

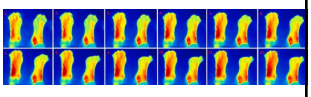
Multi-exposure laser speckle contrast imaging (MELSCI)
Multi-spectral imaging (MSI) used with white light illumination

Thermal imaging

Assessment of chronic limb threatening ischemia using thermal imaging

Tromppa Pakarinen[a,*], Arte Jounen[a], Niku Oksala[a,b], Antti Vehkaoja[a]

Journal of Thermal Biology 112 (2023) 103467
https://doi.org/10.1016/j.jtherbio.2023.103467



Link between thermography and tissue perfusion is unclear

Most studies focus on static acquisition

Even dynamic TI cannot connect to clinical parameters

Motion artifacts

More research is needed

Perfusion parameters and ICG (Metaanalysis)

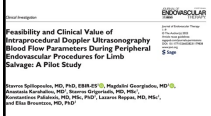
Parameters:
- Intensity-related
- Time-related
- Relative

Quantification
- Static analysis
- Absolute dynamic
- Normalized dynamic

- **26 perfusion parameters** [1)]
- **11 software programs** [2)]
- **None can apply all three methods** [2)]
- **Subject to camera- and patient related settings (distance, angle)** [2)]

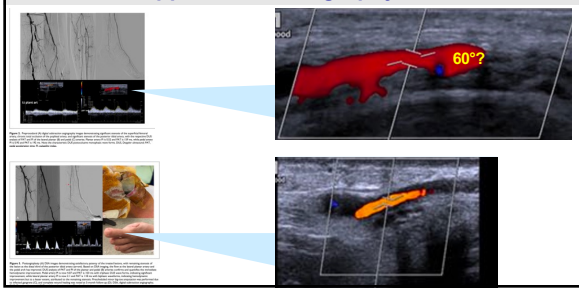
1) Goncalves, L. N. et al. Perfusion Parameters in Near-Infrared Fluorescence Imaging with Indocyanine Green: A Systematic Review of the Literature. *Life* 2021, *11*, 433. https://doi.org/10.3390/ life11050433
2) Van den Hoven, P. et al. Quantitative perfusion assessment using indocyanine green during surgery — current applications and recommendations for future use. Langenbeck's Archives of Surgery (2021) 406:47 https://doi.org/10.1007/s00423-021-02128-6

Doppler Ultrasonography

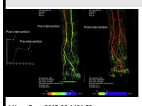

Feasibility and Clinical Value of Intraprocedural Doppler Ultrasonography Blood Flow Parameters During Peripheral Endovascular Procedures for Limb Salvage: A Pilot Study

- Difficult to enroll every case
- Enrollment of 28 cases (out of 106)
- Parameters of tissue blood flow
  - PI (pulsatility index)
  - PAT (pedal acceleration time)

Doppler Ultrasonography - errors



2D color-coded DSA


J Vasc Surg 2017;66:1464-72

- wide variation across patients
  - e.g. catheter placement, BP, volume status
- no standardized protocols
- poor outflow limits washout
- no threshold for healing

Cross-section imaging

- CT perfusion techniques
- MRI perfusion techniques

- Most studies show healthy/patients
- Muscle/compartment studies more than CLTI
- Lack of cut-off values for CLTI
- May demonstrate immediate effect of Tx
- N/A for f-up in clinical routine practice

Conclusion

- Foot perfusion measurements are necessary to evaluate the effect of revascularization in CLTI
- May predict failure of Tx
- Lack of precise cut-off values
- Intraindividual comparison of values may be helpful for follow-up