Perfusion assessment in CLI-current technologies

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Disclosure

Speaker name: Katja S. Mühlberg

I have the following potential conflicts of interest to report:

☐ Consulting
☐ Employment in industry
☐ Stockholder of a healthcare company
☐ Owner of a healthcare company
☐ Other(s)

☒ I do not have any potential conflict of interest
Perfusion – before measurement...
Epidermis
30-2000µm

Dermis
500-1500µm

Subcutis
500-30000µm

Muscle

... different regions

MICROVASCULATURE

MACROVASCULATURE

nutrition

thermoregulation
Key information: spatial and quantitative assessment of tissue perfusion or oxygenation

... different techniques

**tissue perfusion/blood flow**
- CEUS
- MRI perfusion
- Laser Doppler perfusion LDPI
- Laser Speckle Contrast LSCI
- ICG fluorescence angiography
- Spectrophotometry

**tissue oxygenation**
- Transcstaneous oxygen tcPO₂
- Near infrared spectroscopy NIRS
- Hyperspectral imaging HSI
- Vascular optical tomography VOTI

... at rest or after exercise
- improves sensitivity

→ discordance of tissue perfusion and oxygenation
→ flow-dependent and flow-independent reasons of complications
Hyperspectral Imaging HSI

- spectroscopy of oxy-Hb and deoxy-Hb
- Oxygen saturation of skin is calculated
- visible light illuminates+penetrates skin
- depth 1-2mm
+ non-invasive
+ contact-free
+ strong relationship between tcPO$_2$ and deoxy-Hb
- potential influence from respiratory disease
Laser Doppler Perfusion Imaging LDPI

- laser wavelength 780nm is scattered by skin
- light reflected by RBC changes by Doppler effect
- depth 1,0 – 1,5mm
- non-invasive
- contact-free
- time-consuming (single-point-scanning-technique)
- low temporal resolution in big areas, unsuitable for functional tests
- arbitrary units, no absolute flow properties

Saucy F et al J Vasc Endovasc Surg 2006; 31:401-406.
Laser Speckle Contrast Imaging (LSCI)

- 785nm laser illuminates the tissue
- creating a speckle pattern
- speckle pattern is recorded by camera
- variations of speckle pattern (blurring) due to blood flow are analysed and presented as perfusion images
- depth 0.3-0.5mm
  + non-invasive, contact-free
  + real-time, high sampling rate, fast temporal resolution
  - sensitive to motion artefacts
  - Arbitrary units, no absolute measurement
Spectrophotometry

- laser light for blood flow and white light for oxygen saturation and hemoglobin amount during Pole test
- determines tissue oxygen saturation and represents hemoglobin amount per tissue volume
  - independent from vessel density, lumen, hemoglobin quantity in the blood.
  - independently from edema, mediasclerosis
  - non-invasive
  - non-spatial

Vascular optical tomography VOTI

- uses NIR light for illuminating skin
- produces spatial maps of hemoglobin
- contact-free
- non-invasive
- technical expenditure

ICG fluorescence angiography

- fluorescent ICG dye injected intravenously
- dye activated with NIR (near-infrared laserlight)
- detecting of fluorescence
- depth max. 3mm
+ real-time
- invasive

Indigo Carmine angiography

- Indigo carmin = organic salt used as foot-coloring agent
- invasive
- injected intraarterially
+ real-time immediately after revascularization
- prospective study with CLI RF 5+6

Implantable devices

- injectable phosphorescence biosensor
- implanted within the tissue of interest (sc.)
- measures tissue oxygen
- remains permanently in body
- phosphorescence reader is taped onto the skin
- 3-5mm long device; soft, flexible, biocompatible
- investigational in U.S., CE marked in Europe
- larger studies needed to validate first CLI data
AHA SCIENTIFIC STATEMENT

Perfusion Assessment in Critical Limb Ischemia: Principles for Understanding and the Development of Evidence and Evaluation of Devices
A Scientific Statement From the American Heart Association

A systematic review of diagnostic techniques to determine tissue perfusion in patients with peripheral arterial disease

Kirsten F. Ma, Simone F. Kleiss, Richte C.L. Schuurmann, Reinoud P.H. Bokkers, Çagdas Ünlü & Jean-Paul P.M. De Vries

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