Oplæg til DFIRs årsmøde 2025

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Agenda

- Baggrund
- Angiosom teorien
- MR sekvenser (BOLD, ASL, DWI with IVIM)
- Studie 1 – raske frivillige
- Studie 3 - CLTI

Baggrund

- Studiet startede mens den international guideline for behandling af CLTI var følgende:

Recommendation 39
Femoral distal bypass outflow vessel

- In a femoral tibial bypass, the least diseased distal artery with the best continuous run-off to the ankle/foot should be used for outflow regardless of location, provided there is adequate length of suitable vein [C].

Nordgren 2007

- Vi har ønsket at undersøge om vi med MR kunne måle ændringer i perfusion i specifikke angiosomer

Aim

- Formålet med PhD projektet var at optimere og validere kvantitative non-contrast MRI sekvenser, der kan måle perfusion i angiosomer og måle perfusionen før og efter revascularisering med PTA behandling hos patienter med kritisk iskæmi.

- Det blev forsøgt opnået med 4 studier. 3 klinisk studier og 1 computersimulationsstudie.

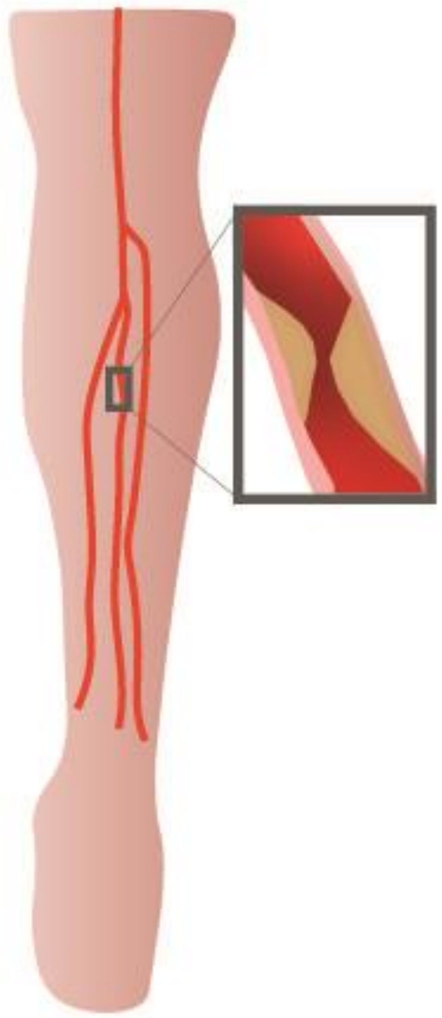
Peripheral artery disease

- Arteriosclerosis in peripheral arteries

➢ Lavt ABI

➢ Claudication Intermittent

➢ Critical Limb-Threatening Ischemia
    - ➢ Hvile smerter
    - ➢ Manglede sårheling
    - ➢ Gangrene

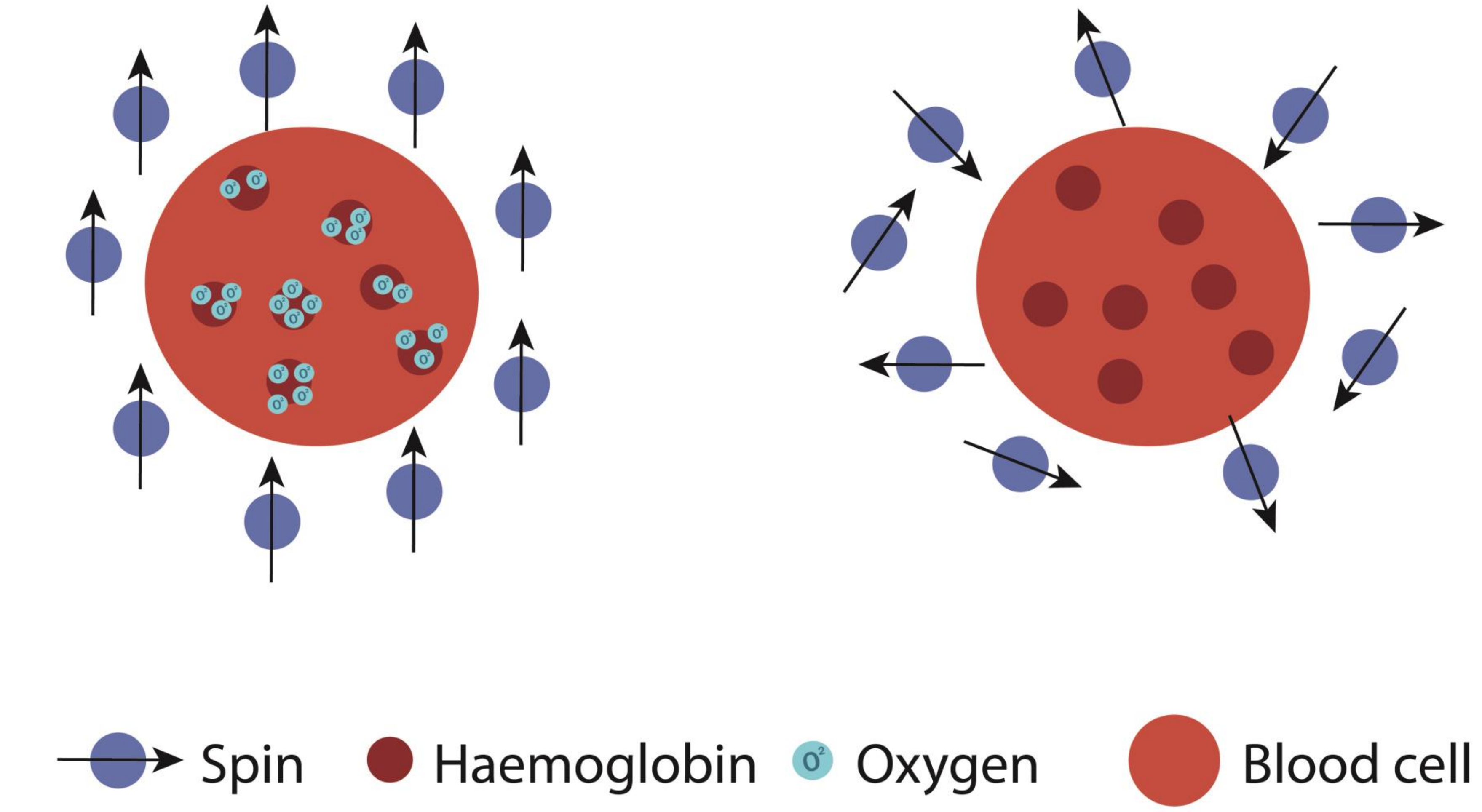


Angiosom teori

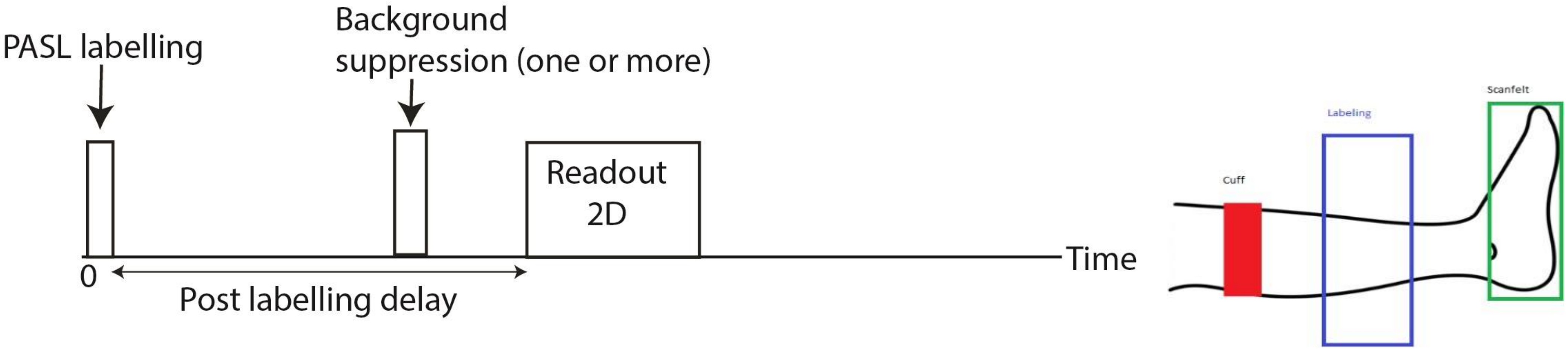
MRI

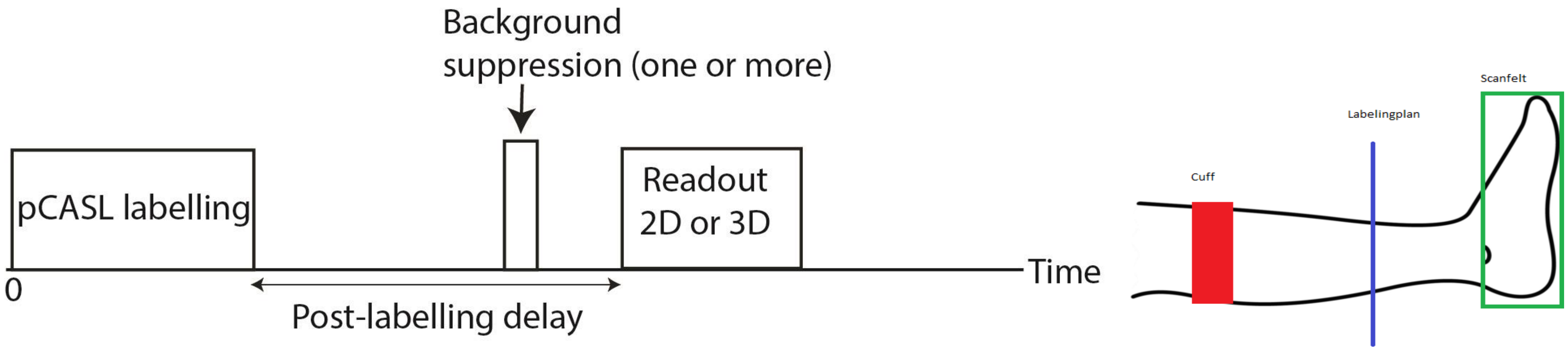
- BOLD
- ASL (PASL and pCASL)
- DWI with IVIM

Blood Oxygenation Level-Dependent (BOLD)

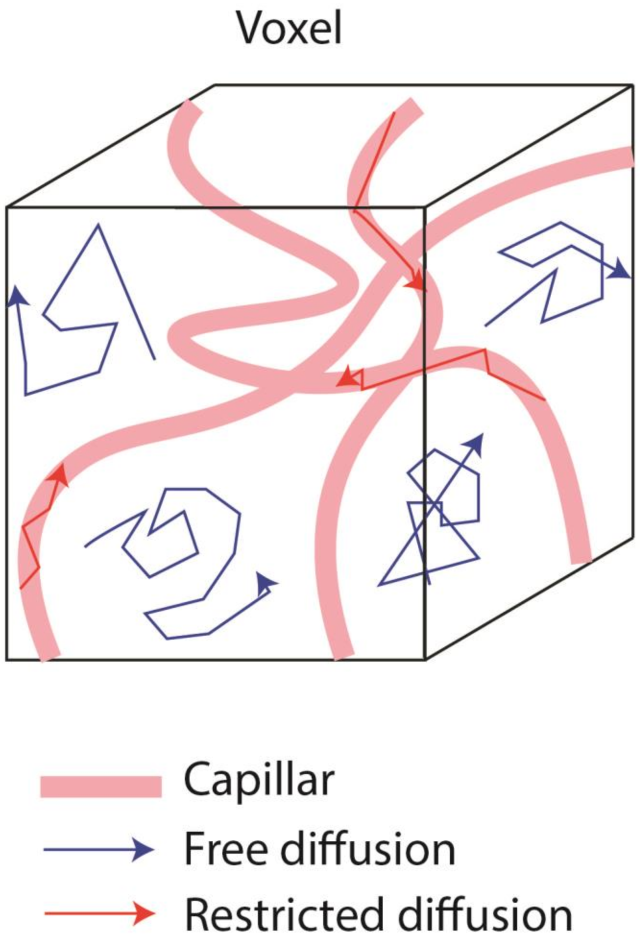


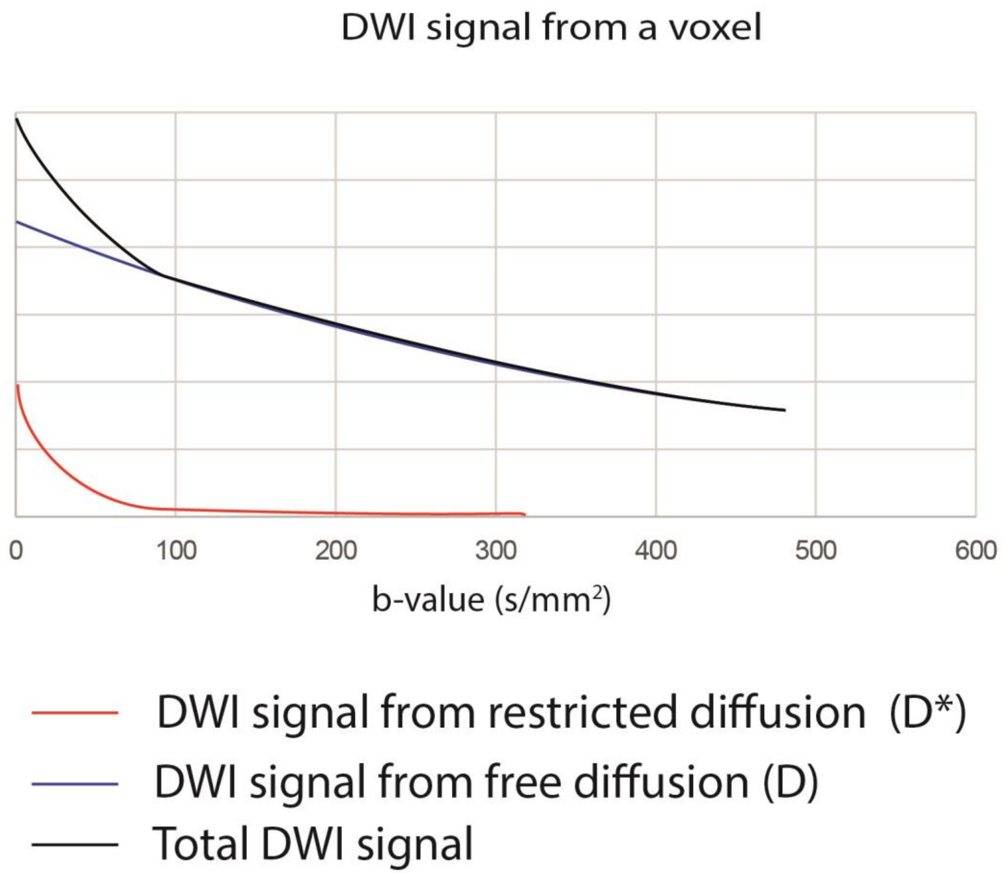
Arterial spin labelling





DWI with Intervoxel Incoherent Motion

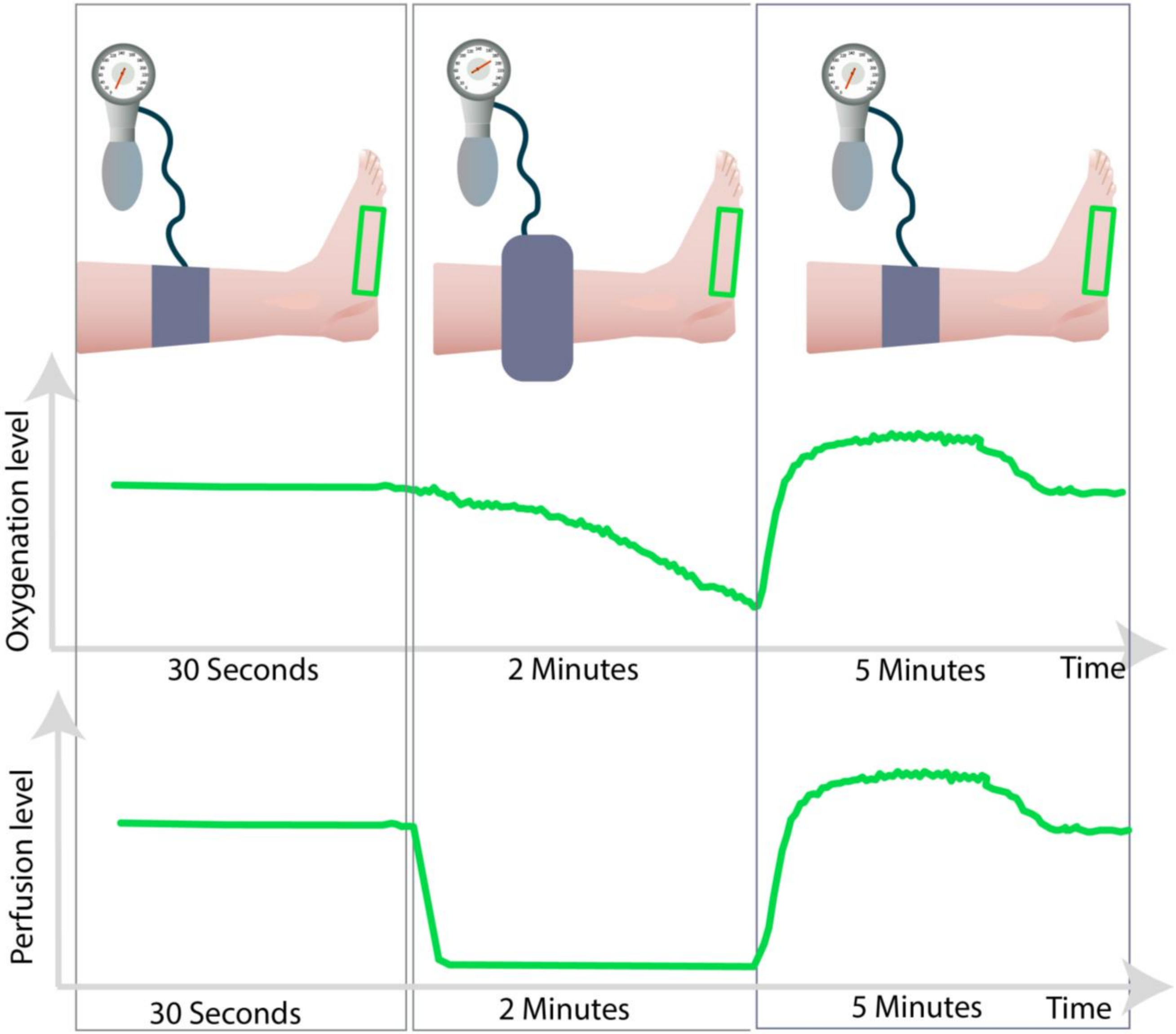




Study I

- **Validation of MRI assessment of foot perfusion for improving treatment of patients with peripheral artery disease**
- Hypotese:

Kvalitative MRI sekvenser kan vise forskel mellem okkluderet blodflow og hyperaktivt response i forskellige angiosomer i foden. Yderligere har sekvenserne høj agreement.

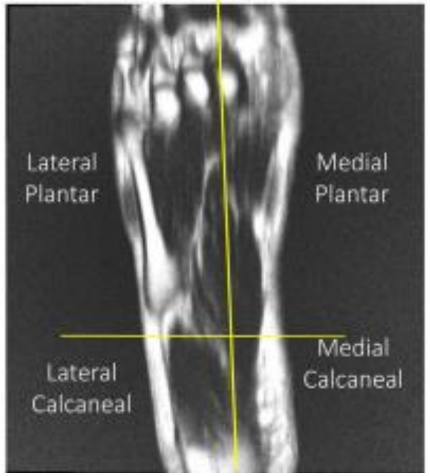


Inkluderede i 1. del studie (test/retest studie)

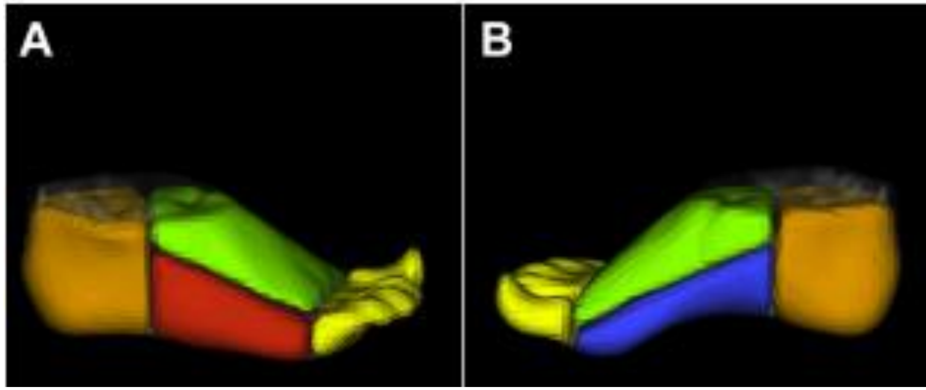
		Female	**Male**
Number of participants		11	5
Age [Year], mean (SD)		30.8 (10.3)	21.6 (3.3)
Height [cm], mean (SD)		169.8 (8.0)	182.0 (4.5)
Weight [cm], mean (SD)		69.5 (15.1)	85.8 (17.8)
ABI, mean (IQR)		1.1 (1.07)	1.0 (0.95)
Smoking	No Yes	10 (91%) 1 (9%)	4 (80%) 1 (20%)

Angiosome - segmentering

Bisgaard 2024, Radiography

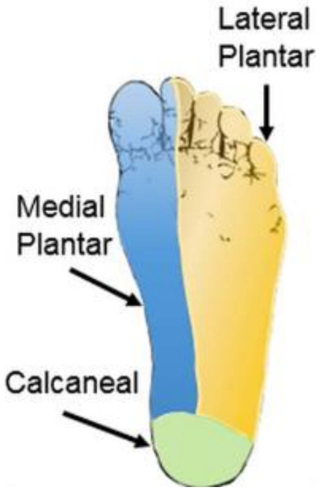


Pantoja (2022), Journal of Vascular Surgery
Cases, Innovations and Techniques

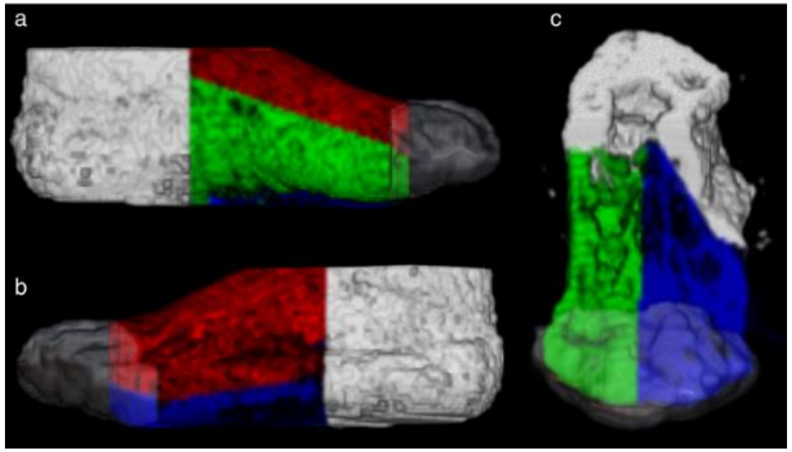


Stacy (2016), Eur J Vasc Endovasc Surg

Zheng (2023),
European Radiology



Zheng (2016),
J. Magn. Reson. Imaging



Edwards (2024), J. Magn. Reson. Imaging

Bland Altmann plot - agreement

Mean difference (95% Limit of agreement). Total (n=16)					
Angiosome	DPA	MCA	MPA	LCA	LPA
BOLD (Signal intensity)	0.56 (-18.28;19.4)	-1.56 (-12.2;9.08)	2.56 (-19.63;24.75)	0 (-7.3;7.3)	2.44 (-11.38;16.26)
FAIR [ml/min/100g]	-	3.8 (-38.8;46.39)	11.33 (-34.2;56.87)	10.2 (-161.27;181.67)	0 (0;0)
2D pCASL [ml/min/100g]	-11.69 (-89.65;66.27)	-0.94 (-44.67;42.8)	-0.13 (-40.91;40.66)	-5.38 (-39.92;29.17)	-0.81 (-39.61:37.98)
3D pCASL [ml/min/100g]	-0.07 (-61.25;61.12)	-19.07 (-104.47;66.34)	-4.73 (-46.24;36.77)	0.73 (-112.89;114.35)	4.6 (-49.98;59.18)
MGRE (T2*) [ms]	0.01 (-0.36;0.39)	-0.05 (-0.89;0.79)	-0.06 (-0.75;0.63)	0.02 (-0.96;1)	-0.06 (-0.8;0.67)
MGRE (TE=42 ms) (Signal intensity)	0.17 (-0.72;1.06)	-0.14 (-0.92;0.64)	0.04 (-1.08;1.16)	-0.2 (-0.96;0.57)	-0.16 (-1.92;1.45)

T-test - validitet

Angiosome	DPA	MCA	MPA	LCA	LPA
BOLD	<0.01 (5.39;11.86)	<0.01 (2.42;6.58)	<0.01 (13.43;22.19)	<0.01 (2.28;4.97)	<0.01 (3.96;12.04)
FAIR	-	<0.01 (60.9;91.76)	<0.01 (32.48;58.19)	<0.01 (58.62;128.84)	<0.01 (44.14;71)
2D pCASL	0,15 (-2.46;14.96)	0,15 (-2.36;14.11)	0,18 (-1.71;8.21)	0,86 (-12.12;10.25)	0,15 (-1.19;7.07)
3D pCASL	0,59 (-5.07;8.54)	0,67 (-21.55;14.35)	0,44 (-15.2;6.93)	0,14 (-4.36;28.36)	0,26 (-4.59;15.79)
MGRE (T2*)	<0.01 (0.17;0.33)	<0.01 (0.14;0.25)	<0.01 (0.25;0.36)	0,19 (-0.03;0.15)	0,21 (-0.08;0.34)
MGRE (TE=42 ms)	<0.01 (0.53;1.02)	<0.01 (0.26;0.51)	<0.01 (0.62;1.28)	0,07 (-0.01;0.26)	0,01 (0.13;0.79)

T-test – validitet (DWI with IVIM)

	DPA	MCA	MPA	LCA	LPA
f mean [%] (SD)	6.5 (2.9)	5.4 (2.5)	3.2 (1.4)	5.7 (2.3)	4.4 (1.3)
D* mean [x 10^{-3} mm^2/s] (SD)	15.3 (4.2)	14.7 (3.3)	13.9 (6.9)	15.0 (3.8)	14.9 (1.9)
D mean [x 10^{-3} mm^2/s] (SD)	1.1 (0.1)	0.8 (0.2)	1.2 (0.1)	0.7 (0.1)	1.2 (0.1)
ADC mean [x 10^{-3} mm^2/s] (SD)	1.2 (0.1	0.9 (0.2)	1.3 (0.1)	0.8 (0.2)	1.3 (0.1)

Resultat

- BOLD og FAIR sekvensen havde den højeste agreement og validitet

Study III

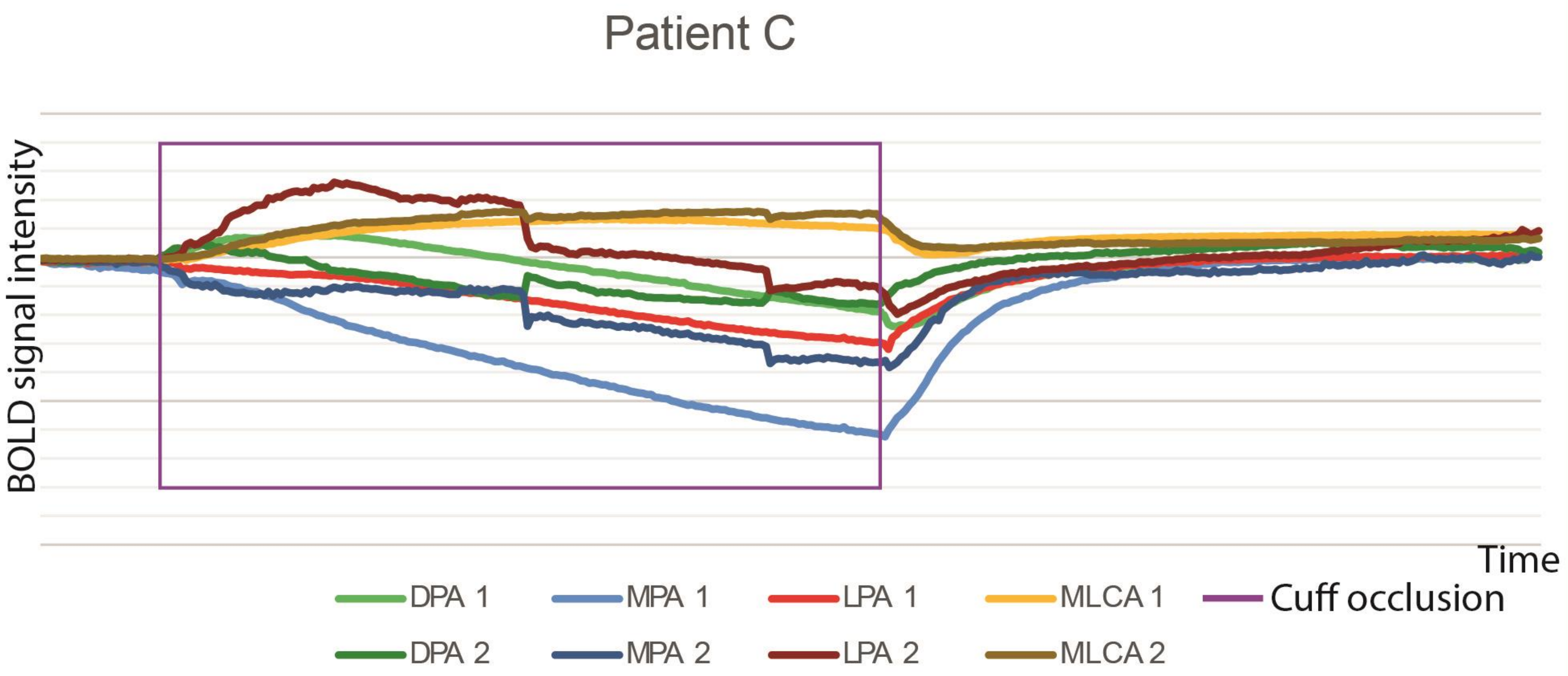
- Changes in MRI BOLD Signal in Angiosomes after Revascularization for Chronic Limb-Threatening Ischemia
- Hypotese:
- Udvalgte kvantitative MR-sekvenser kan vise ændringer i perfusion/iltning i specifikke angiosomer før og efter PTA-behandling hos en patient med CLTI (kronisk kritisk iskæmi i underekstremiteterne).

Inkluderede i 3. delstudie

Number og patients (Female)	**5 (2)**
Age [year] (SD)	63.6 (7.6)
Height [cm] (SD)	172.8 (11.6)
Diabetes	4 (80%)
Smoking	No: 3 (60%) Former: 2 (40%)
Toe pressure before PTA [mmhg](SD)	33.8 (22.0)
Toe pressure after PTA [mmhg](SD)	52.8 (23.3)

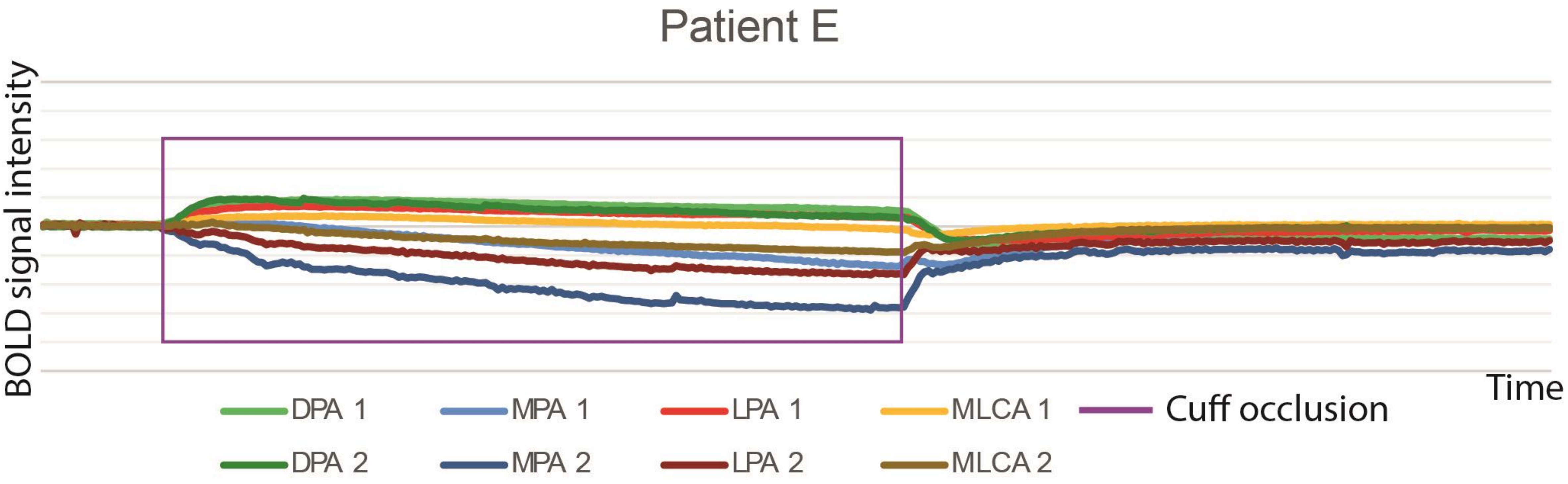
BOLD signal hos en patient

- 69 åring kvinde. PTA af højre ben. Sår på 3. tå.
- Rekanalisering af A. tibialis posterior. Reocclusion efter PTA, men re-occlusion under niveau hvor kollateral udgik, collateral forsynes MPA, LPA og hælområdet (MLCA)



BOLD signal hos en patient

- 59 årlig mand. Højre ben PTA behandlet. Sår på tær.
- Rekanalisering af okkluderet A. tibialis posterior og a. plantaris. A. tibialis posterior og peonea kunne kun åbnes ned til ankelniveau.



Konklusion på delstudie 3

- For få deltager til at lave en reel konklusion, men data antyder at angisome teorien kan være rigtig.

Tak

- **Tak for jeres tid!**

- En særlig tak til min hovedvejleder Helle Precht og mine øvrige vejledere Kim C. Houlind, Anne Dorte Blankholm og Steffen Ringgaard
- Tak til Radiologisk og Karkirurgisk afdeling Sygehus Lillebælt, Kolding

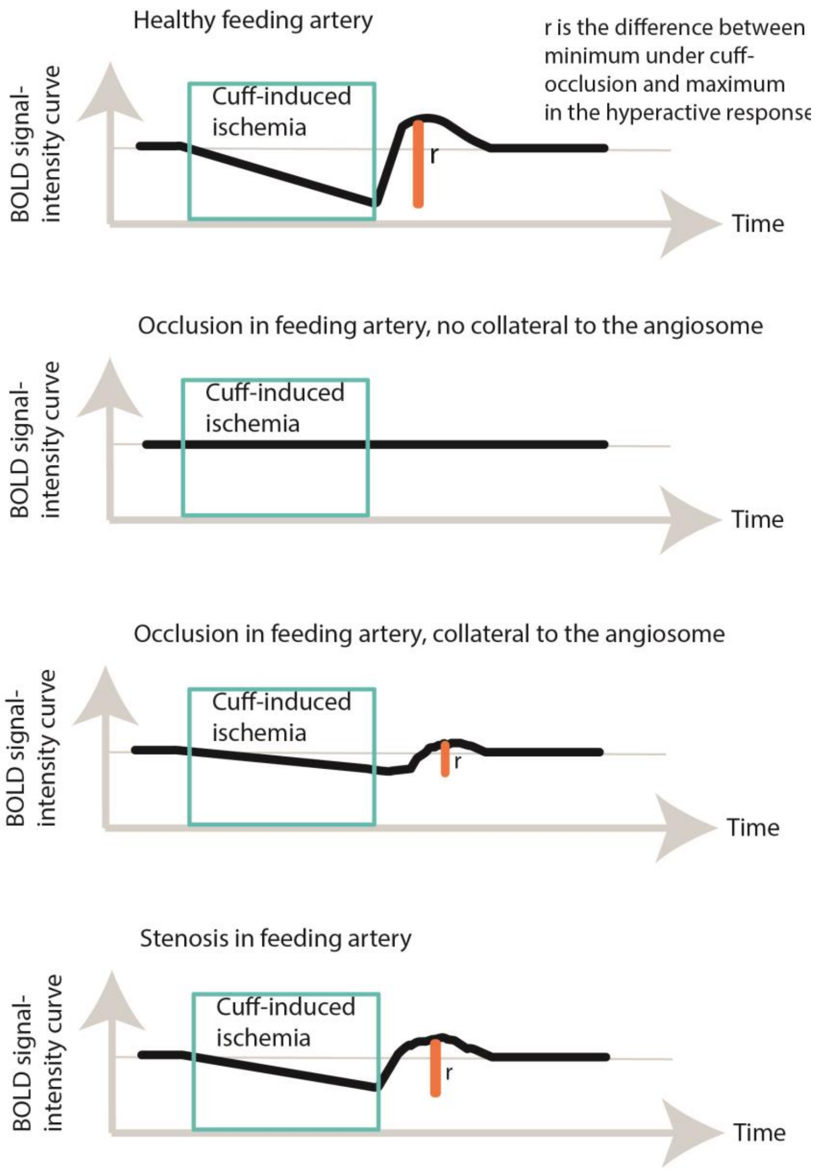
Study II

- Assessment of functional angiosomes with MRI in patients with intermittent claudication
- Hypoteser:
- BOLD MR-sekvenser kan skelne mellem raske frivillige og patienter med intermitterende claudicatio ved måling af perfusion i angiosomer.
- Inklusion: Patienter med intermitterende claudicatio, som kan MR-scannes og raske frivillige.

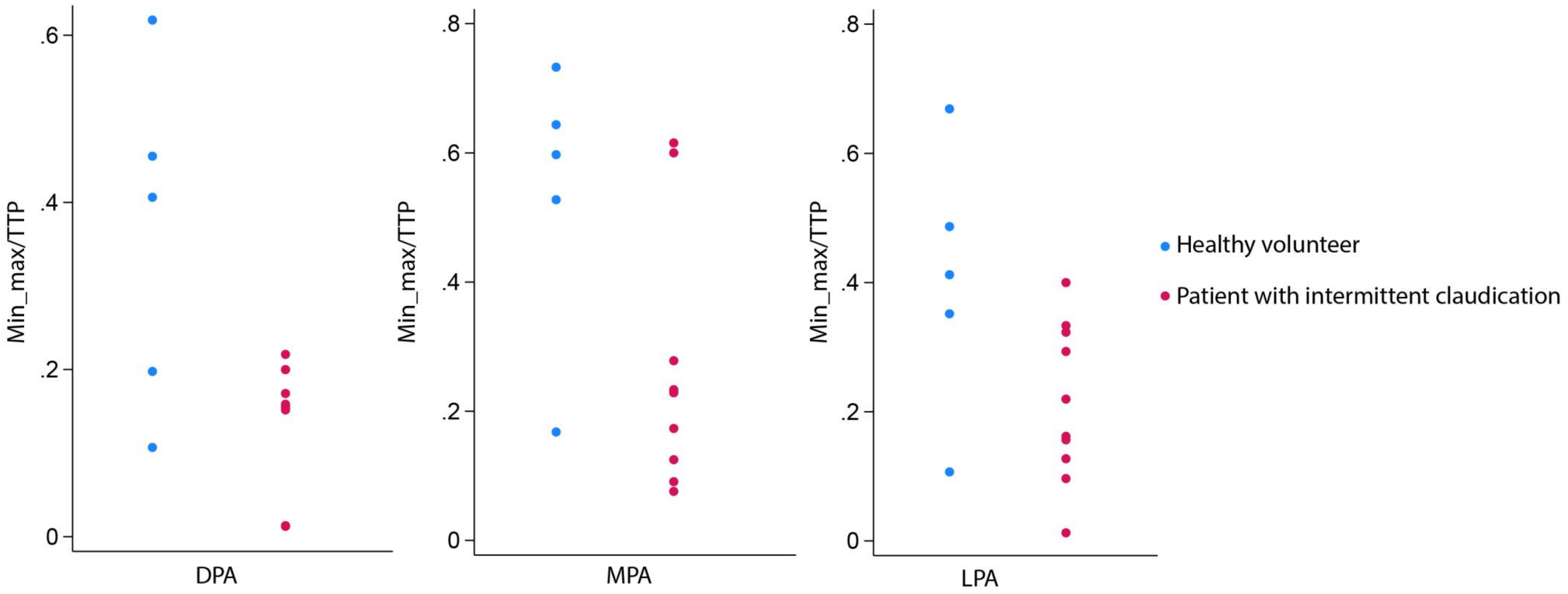
Inkluderede i 2. studie

Participants		**Healthy volunteers**	**Patients with intermittent claudication**
Number (female/male)		5 (4/1)	10 (3/7)
Age [year], mean (SD)		32.4 (7.3)	71.6 (6.9)
Height [cm], mean (SD)		170.2 (10.0)	173.7 (6.2)
Weight [kg], mean (SD)		70.6 (13.0)	77.8 (12.4)
Diabetes	Yes No	0 5	5 5
ABI, mean (SD) (if not diabetes) TBI, mean (SD) (if diabetes)		1.0 (0.1)	0.6 (0.1) 0.5(0.2)
Smoking	Yes No Former	1 4	1 2 7

Angiosome teorien – hvordan den kan se ud hos patienter med claudication intermittent



BOLD forskelle mellem syge og raske deltagere



Konklusion – delstudie 2

- Det var muligt at se forskel mellem syge og raske

Agreement og validitet

Low agreement
Low validity

High agreement
Low validity

High agreement
High validity