Perfusion Imaging of the Foot in CLI-Patients: Prognostic Value of Pharmacologic Interventions

Preliminary results of an ungoing study

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Disclosure

Speaker name: Peter Huppert, M.D.

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)

X scientific support by Siemens

Evaluation of tissue oxygenation and perfusion in CLI patients

- Tissue Imaging techniques
  - Near infrared imaging[1]
  - CT perfusion imaging[2]
  - Angio perfusion imaging[3]

  peripheral blood volume imaging

- Oxygen and Perfusion Measurement
  - $tcPO_2$ measurement[4]
  - Laser speckle contrast imaging[5]
  - near-infrared spectroscopy[6]
  - indocyanine green fluorescence imaging[7]

1 Boezeman RP et al. 2106 Eur J Vasc Endovasc Surg 52;650-6

2 Hur S et al. 2016 Radiology 279;195-206

3 Reekers JA et al. 2016 Cardiovasc Intervent Radiol 39;183-89

4 Benitez E et al. 2014 Semin Vasc Surg 27;3-15

5 Katsui S et al. 2017 Lasers Surg Med 49;645-51

6 Arnold FJ 2018 Wounds 30;E89-92

7 Patel HM et al. 2018 Ann Vasc Surg 51;86-94

Potential value of peripheral blood volume imaging in CLI patients

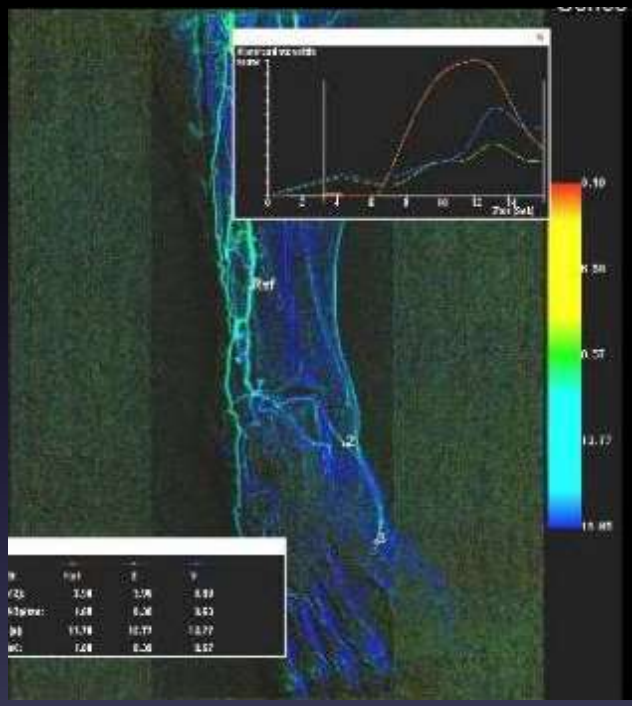
- To evaluate rise of perfusion after intervention
- To show regional changes of perfusion after intervention
- To guide endpoint of intervention in multivessel disease
- To detect irreversible damage to microcirculation
- To add prognostic value in terms of wound healing

Pilot study of peripheral blood volume imaging with pharmacological and catheter-based interventions

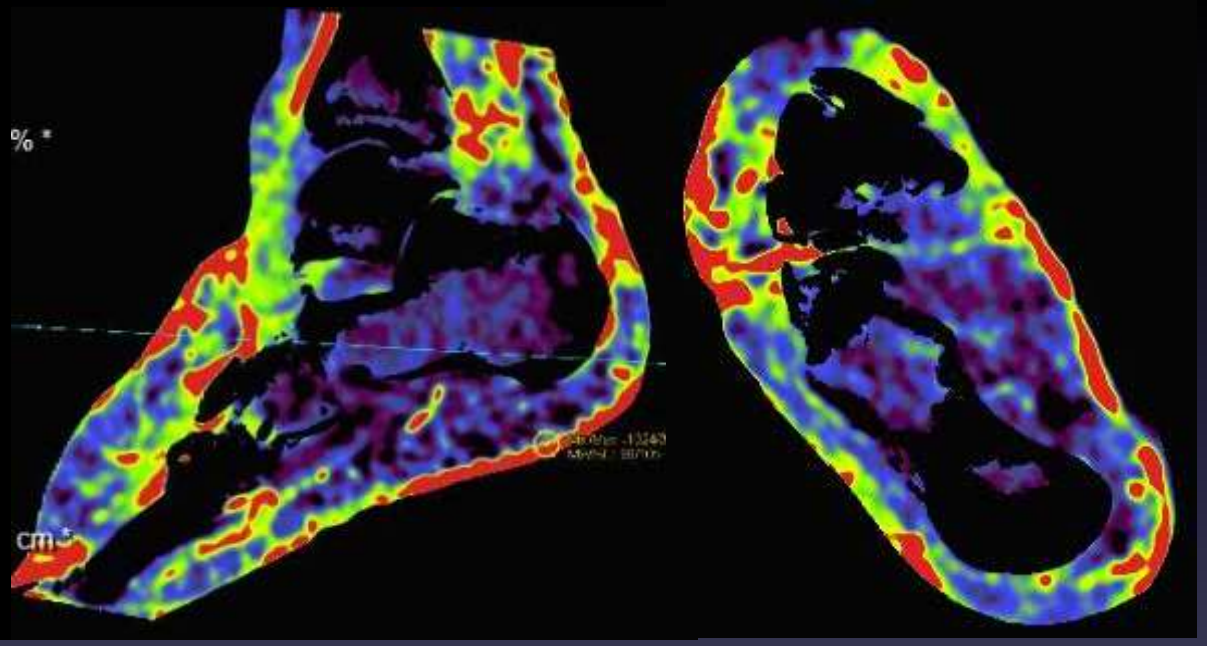
1. 2D /3D imaging for arterial perfusion / tissue blood volume measurements at foot established
2. Standardisation of procedure and data acquisition
3. Testing feasibility of peripheral blood volume imaging at baseline and after interventions
4. Development of rules for comparable measurements
5. Starting prospective evaluation

2D + 3D Imaging of peripheral perfusion

2-D dynamic arterial perfusion
syngo iFlow® (Siemens)



3-D blood volume imaging
syngo PBV® (Siemens)

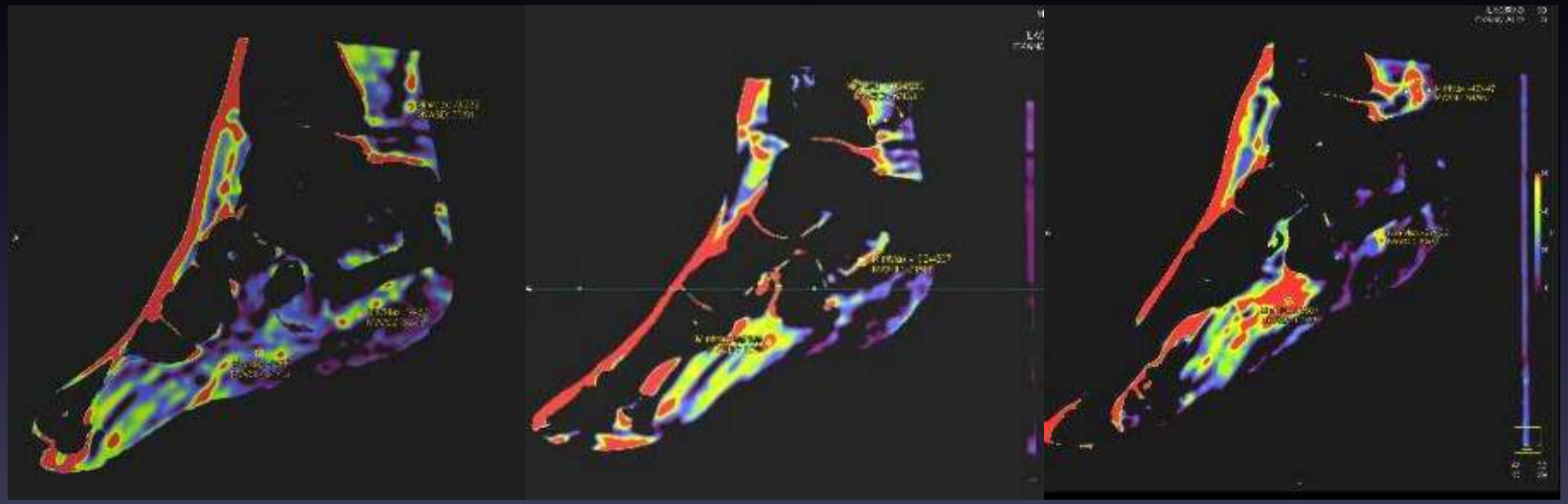


- Time-contrast intensity curves of target arteries
- Time to peak
- Area under the curve

- Voxel based analysis of blood volume / tissue volume
- Colour coding
- Analysis of Max/Min and mean +/- SD within ROI (cc blood volume/1000 cc tissue volume)

Study protocol / Methods

3D blood volume imaging (syngo PBV®)		
1st run	2nd run	3rd run
baseline	post pharmaco-intervention (i.a. 50 mg Papaverin-Hydrochloride)	post catheter-intervention



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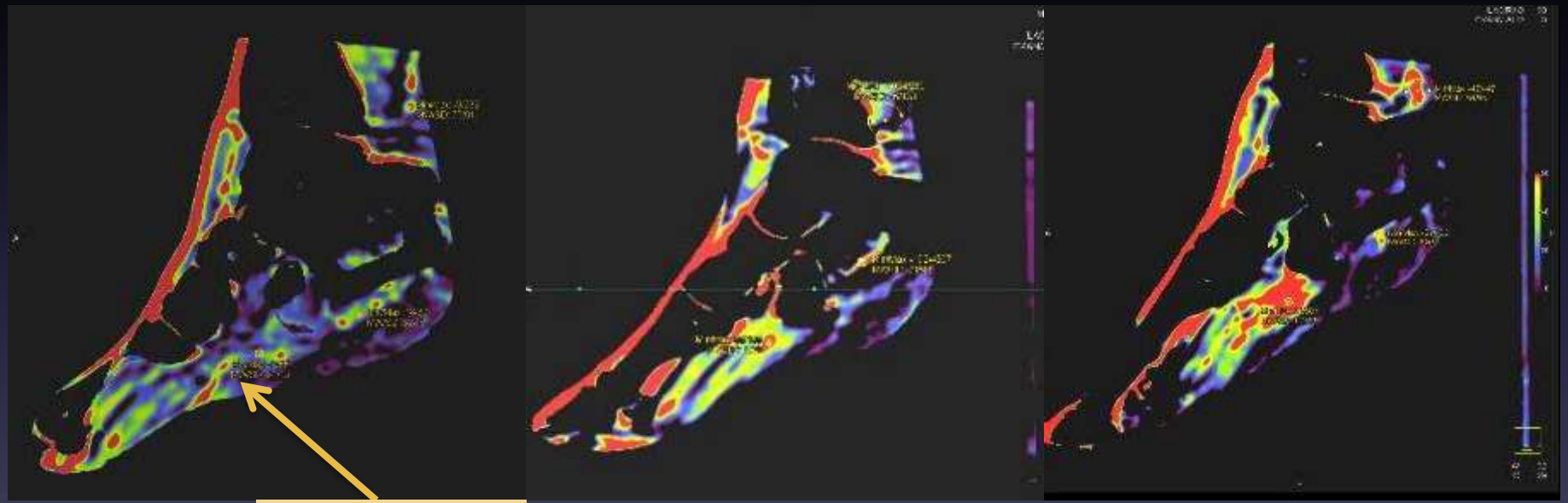
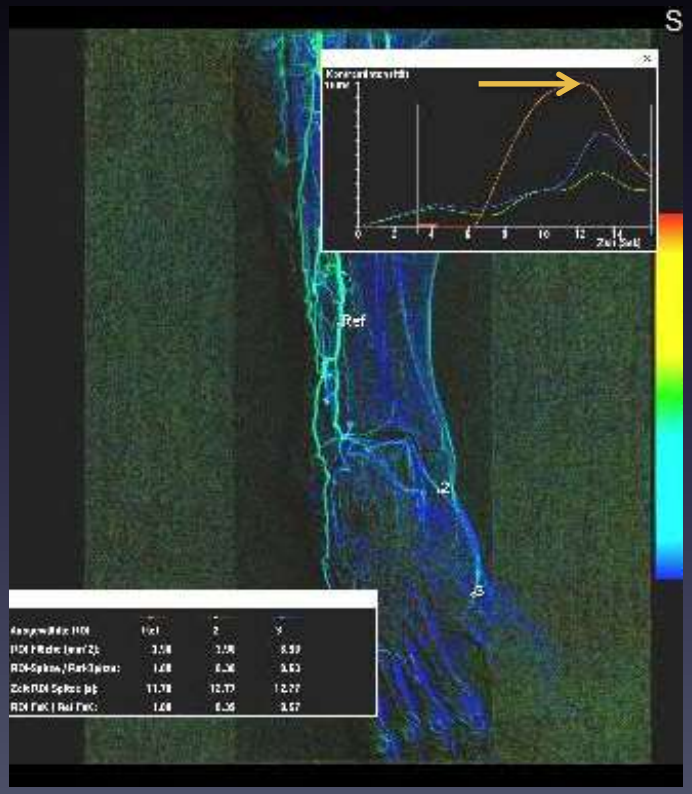


Protocol of PBV run

Contrast injection protocol:

- 15 cc, 3cc/sec, 300 mg iodin/cc, catheter tip (end hole) at PII
- delay= TTP measured by *syngo* iFlow with ROI at target artery



- Flat panel DSA
- Rotational angiography 270 dg.
- Time 5 sec

No inflow lesion at femoropopliteal artery

Results

Patients	20
CLI (Rutherford 5)	20/20
Diabetes mellitus	15/20

Target lesions	20
forefoot	12/20
rearfoot	8/20

PBV runs performed	
baseline	20/20
Post pharmaco intervention	12/20
Post catheter intervention	18/20

Image quality	
sufficient	38/50
Insufficient (motion artifacts)	12/50

Impact of interventions on peripheral blood volume

intervention	impact	Target region	Non-target region
pharmacon	increase	6/9*	4/9
	no increase	3/9	5/9
catheter	increase	12/14*	6/14
	no increase	2/14	8/14

* procedures without motion artifacts

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* procedures without motion artifacts

Post pharmacon Post intervention	Increase 6	no increase 3
Increase	6	1
no increase	0	2

Lessons learned

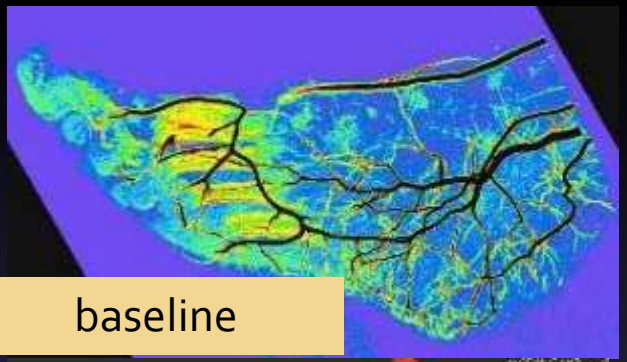
- Only 3 of 5 patients are fit for this protocol (renal insufficiency, pts. compliance).
- Fixation of foot and lower leg is mandatory.
- To compare images of consecutive runs matching of anatomical regions is necessary and needs computer based assistance.

On the learning curve

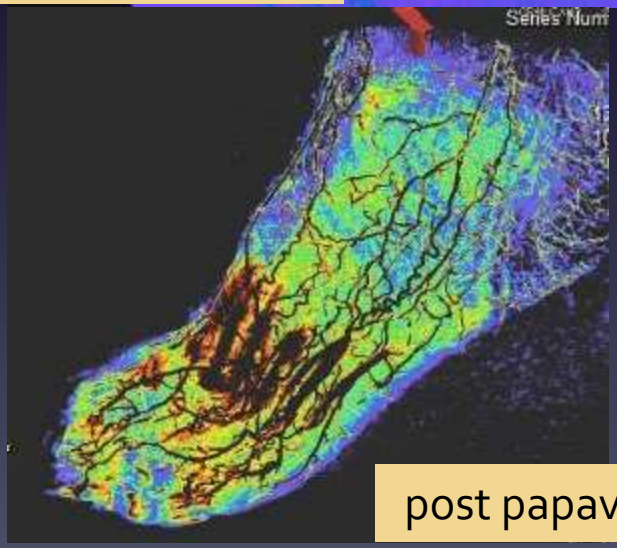
Not comparable

Difficult to compare

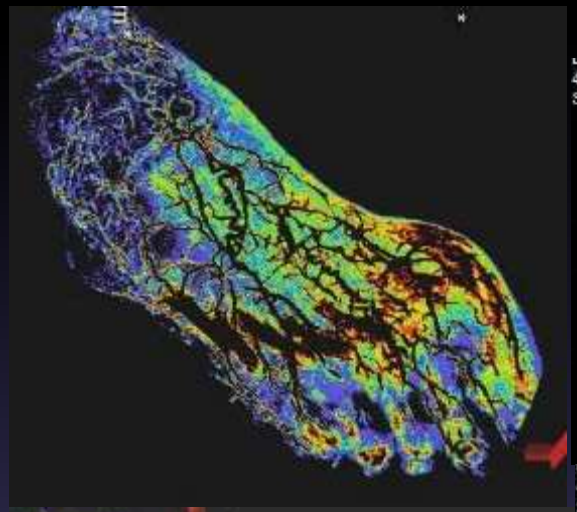
Comparable

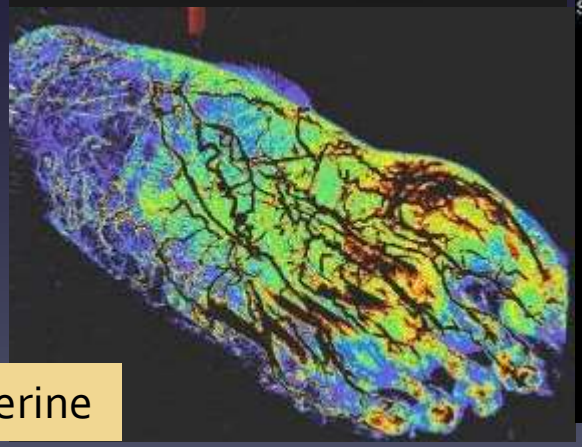


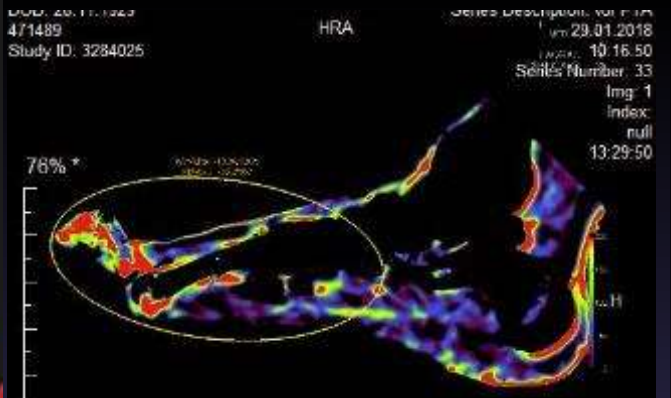
baseline

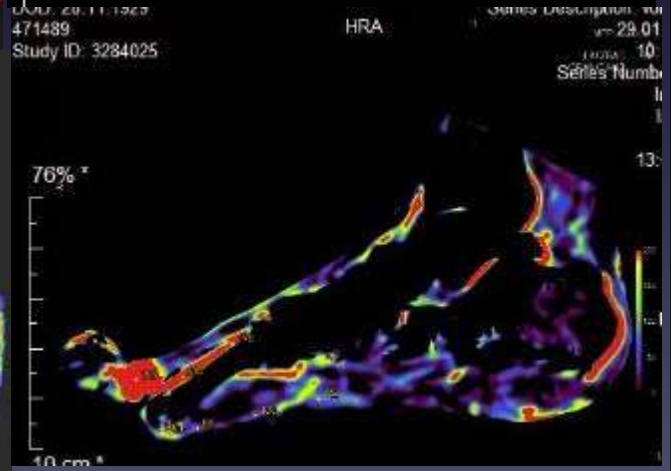


post papaverine



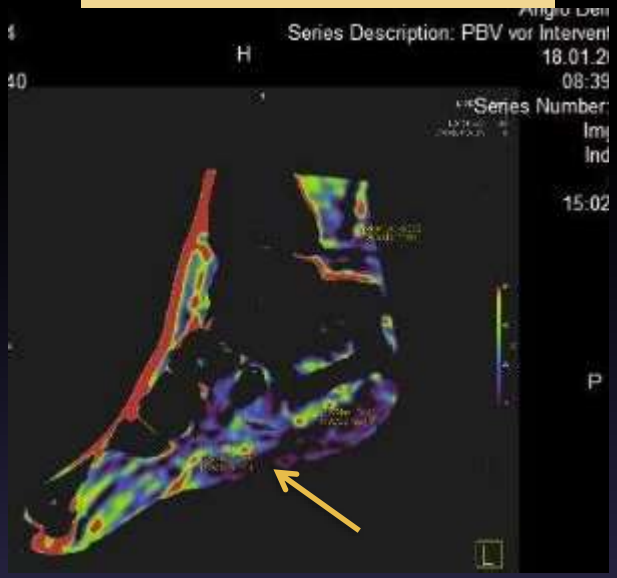






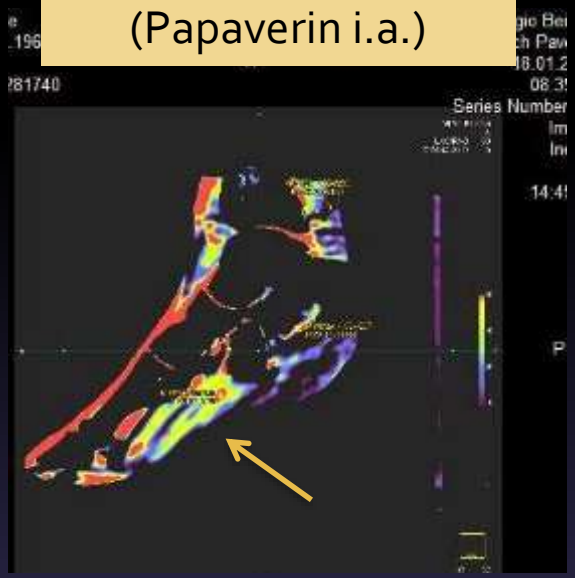
Prediction of Revascularization Benefit

native run



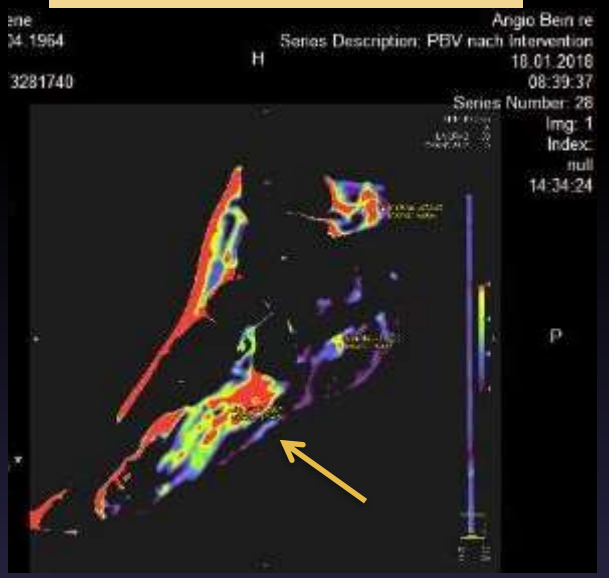
PBV: 60 cc/1.000 cc

post stimulation run
(Papaverin i.a.)



PBV: 120 cc/1.000 cc

post intervention run



PBV: 145 cc/1.000 cc

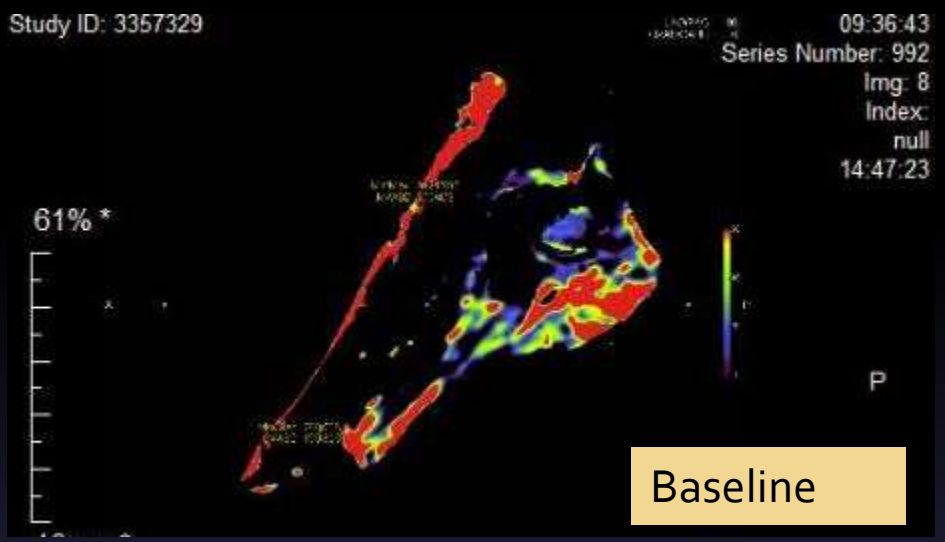
Imaging protocol

- 5 sec run time / 270 degr.
- *syngo* iFlow® 13 sec TTP of target artery
- PBV run delay 13 sec

Contrast injection

- Volume 15 cc
- Flow 3 cc/sec
- Catheter position Pop.II

Prediction of no revascularization benefit



77 years old man
Diabetes
Rutherford 5 at heel

Prediction of no revascularization benefit

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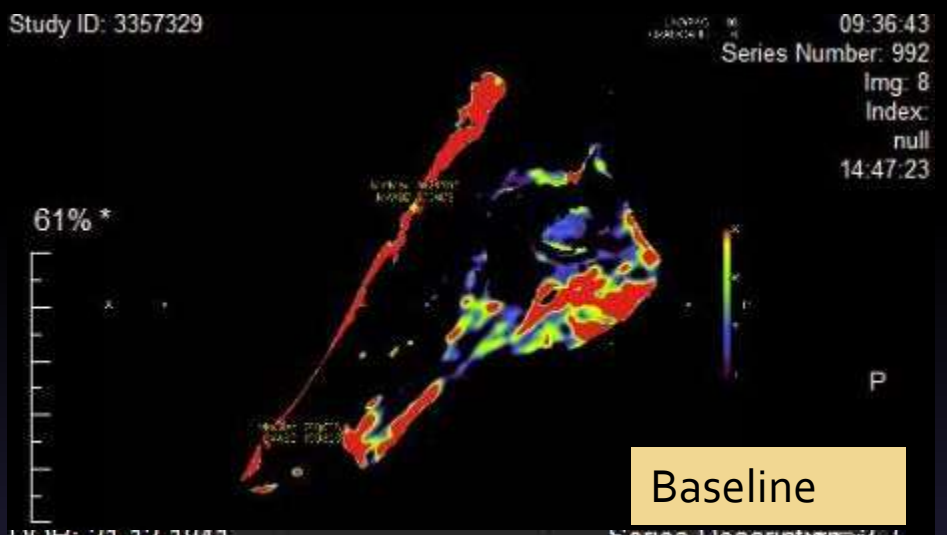
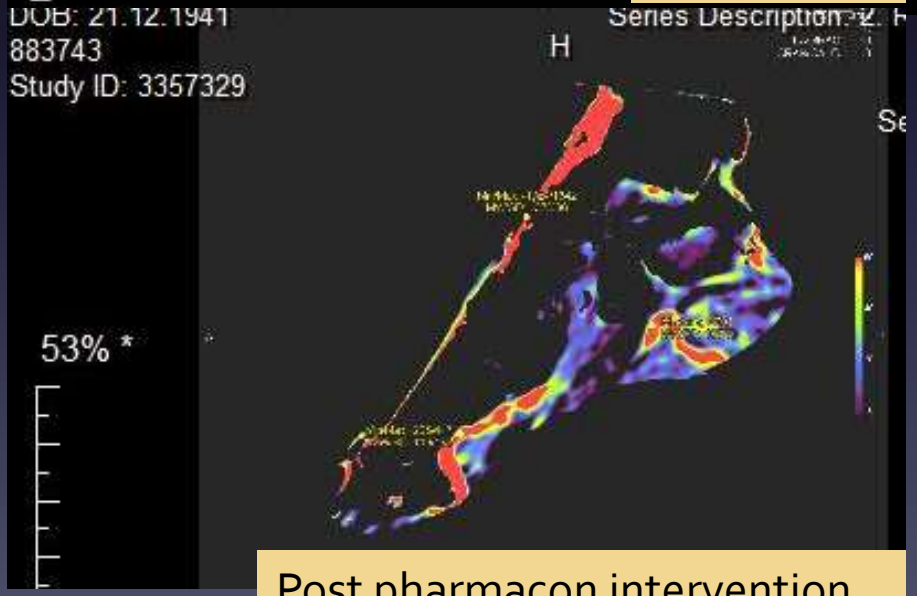
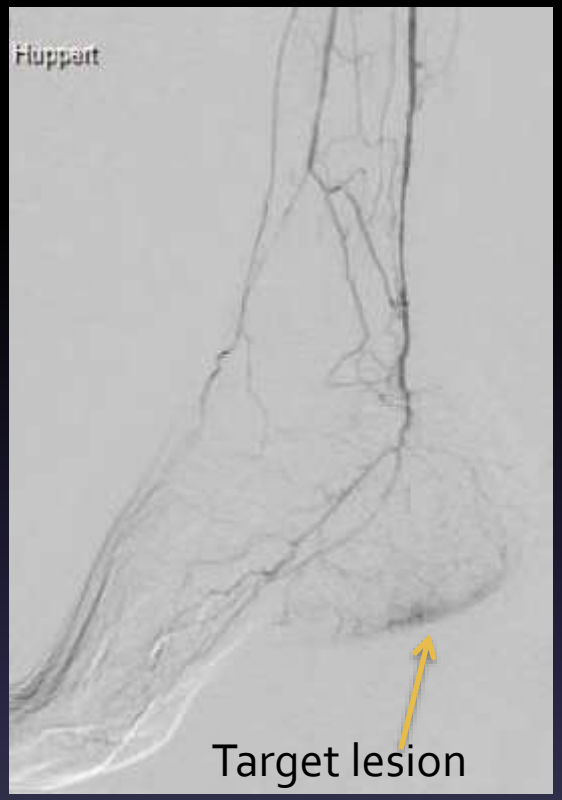


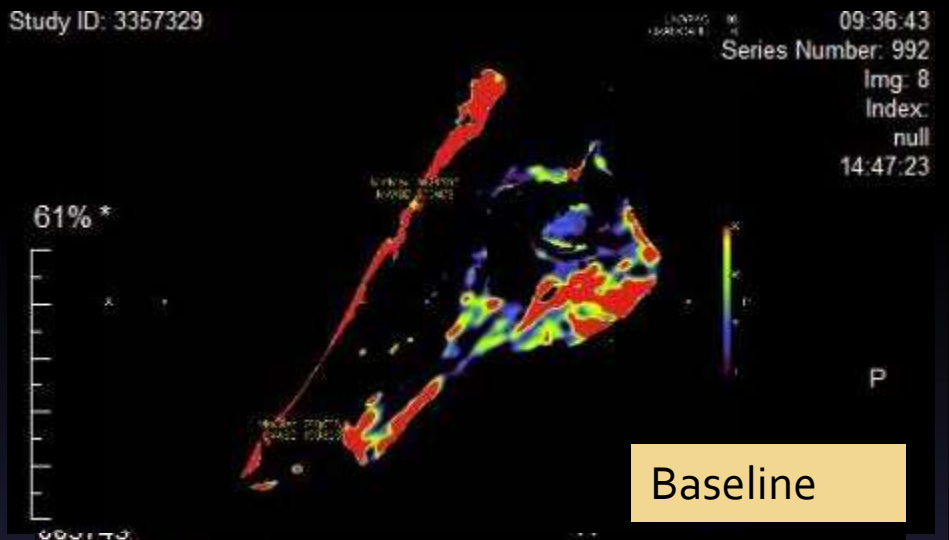
Baseline

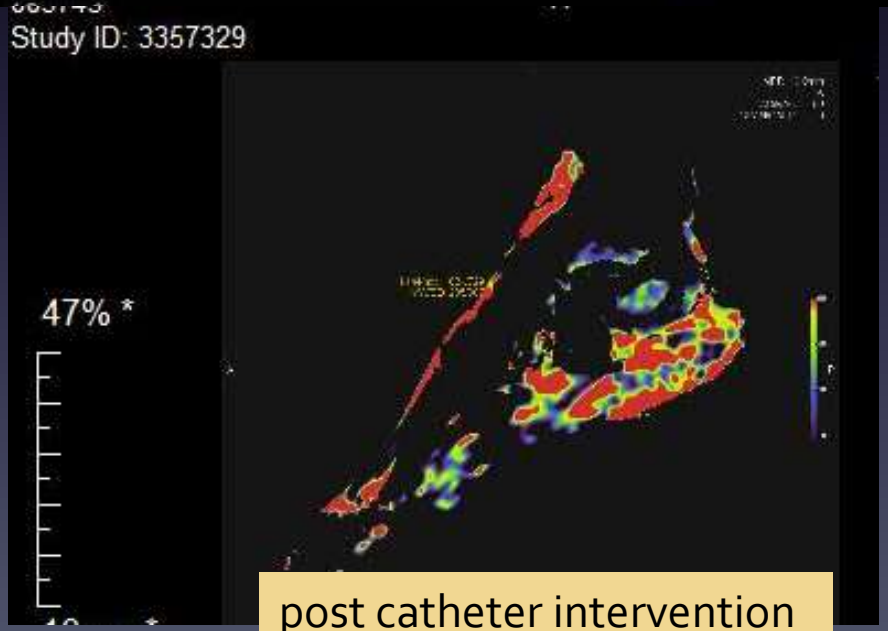


Post pharmacon intervention

Prediction of no revascularization benefit







77 years old man
Diabetes
Rutherford 5 at heel

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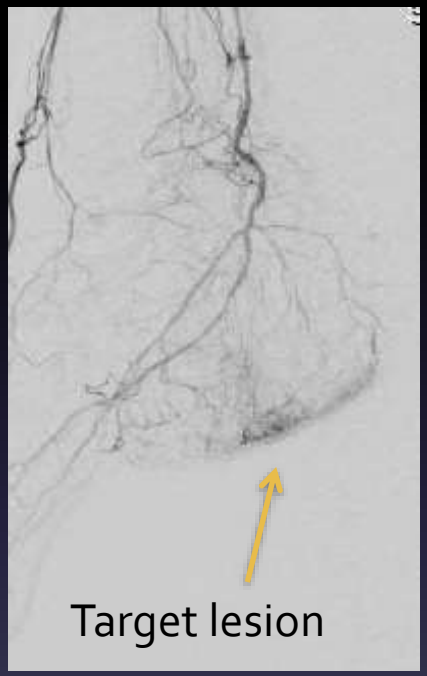

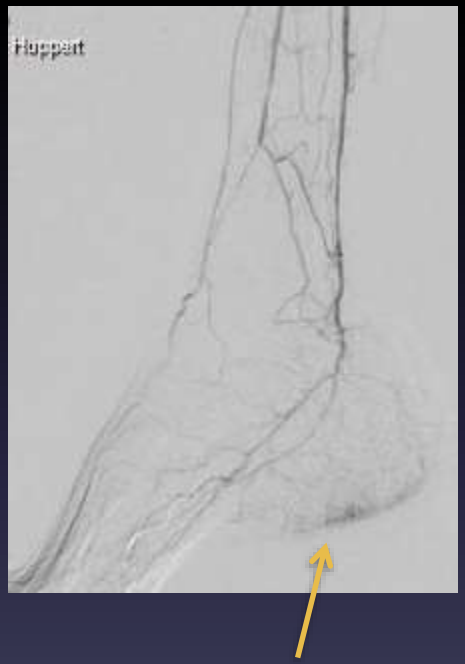

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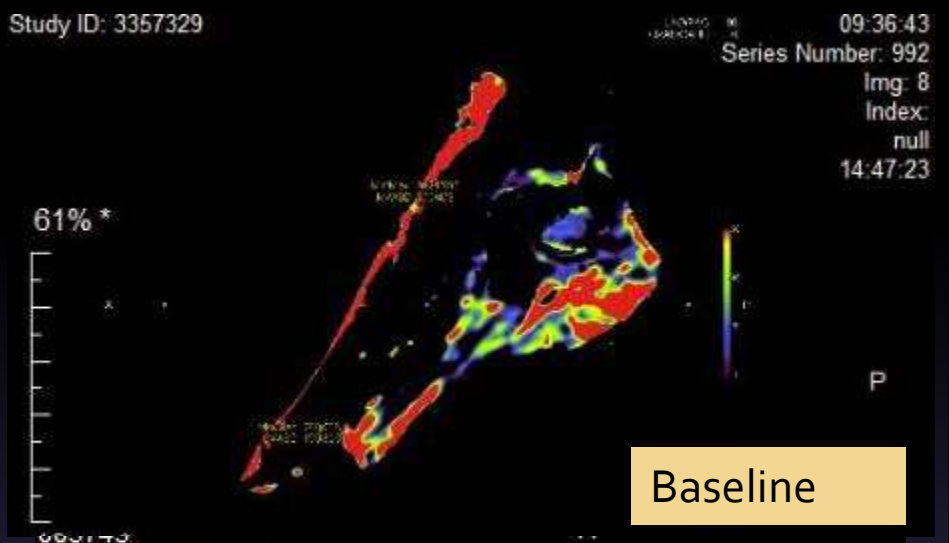

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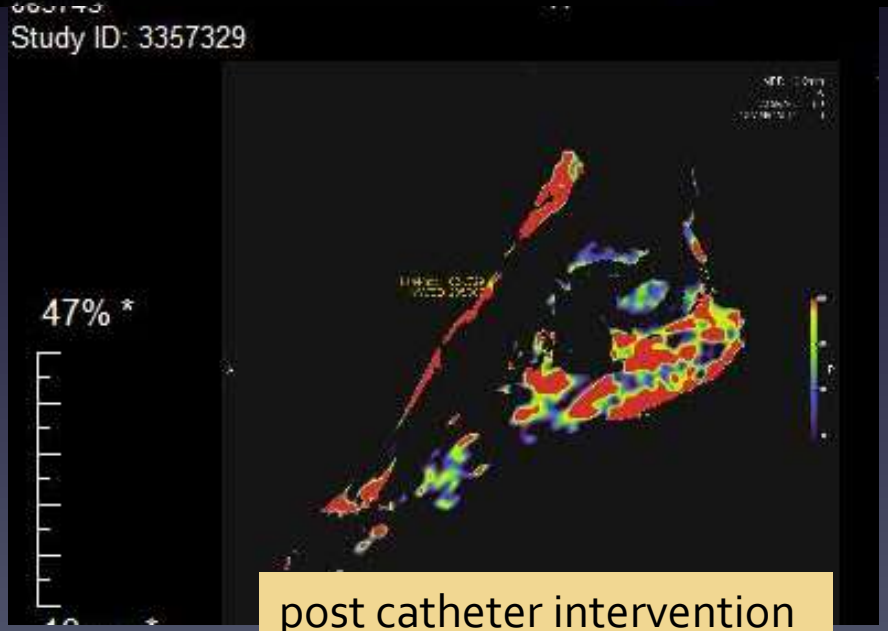
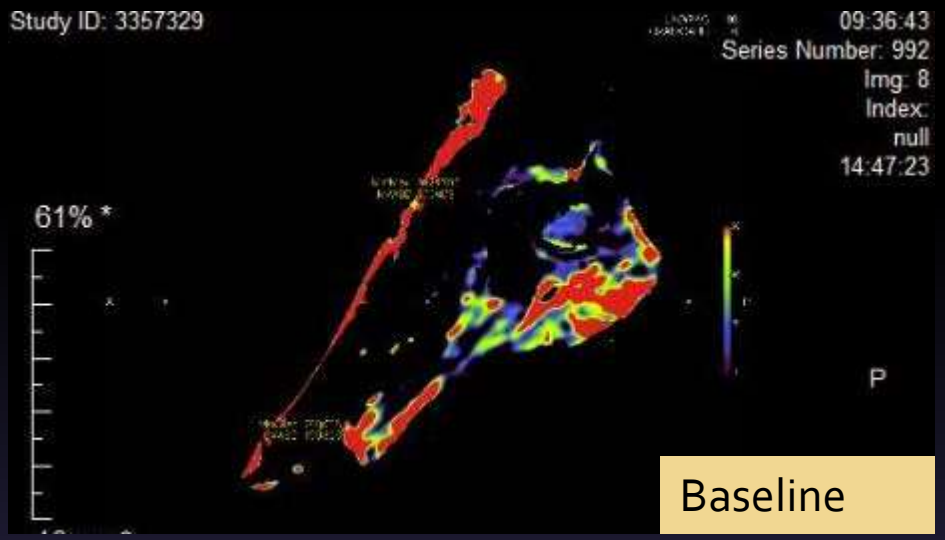
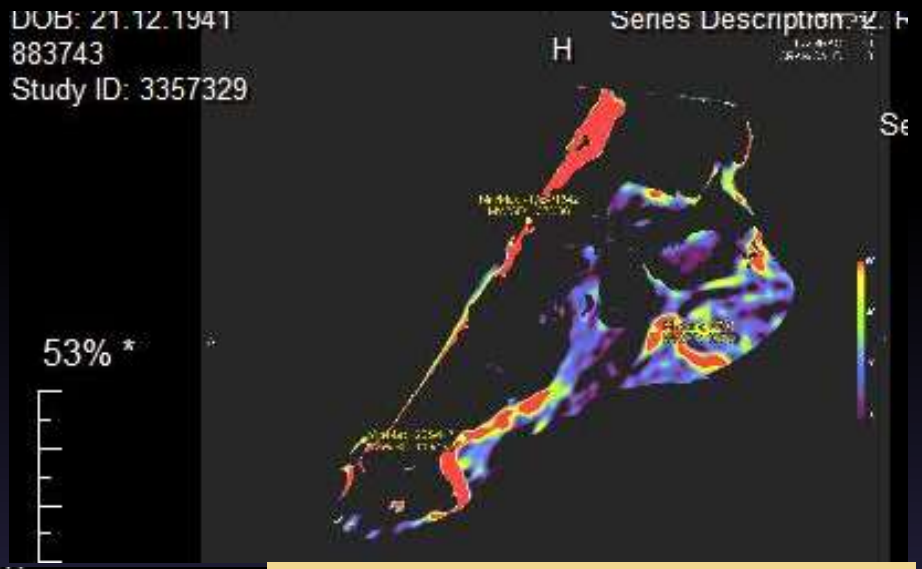


post catheter intervention

Prediction of no revascularization benefit



Baseline



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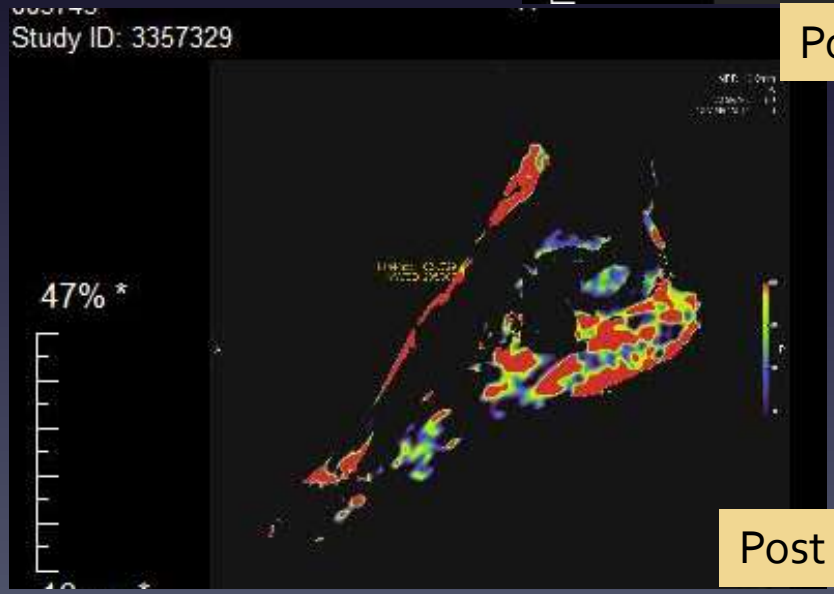


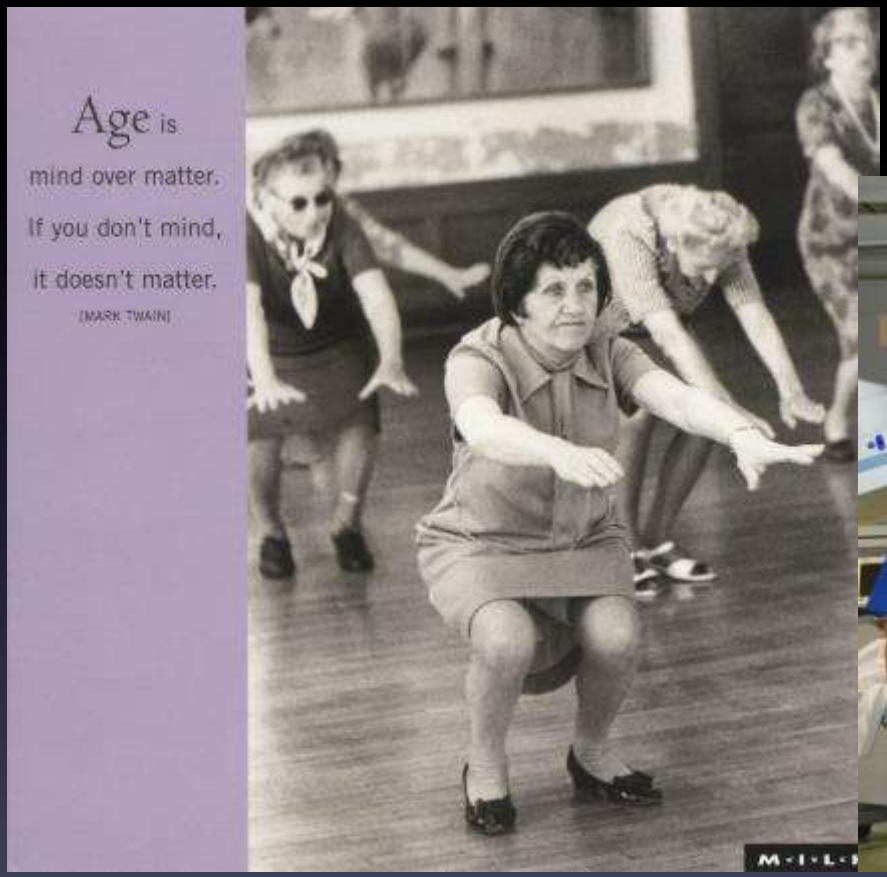
Post catheter intervention

77 years old man
Diabetes
Rutherford 5 at heel

Conclusions

- Syngo iFlow® and syngo PBV® are useful tools of peripheral perfusion imaging during angio and interventions.
- Protocol and measurements need detailed standardization.
- Limitations and challenges:
  - 25% of procedures are non-diagnostic due to motion artefacts
  - additional contrast and radiation exposure is necessary
  - anatomical matching mandatory for comparison
- Correlation of PBV Parameters to wound healing will be finished during next 6 months

Thank You for Attention!



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