

Perfusion angiography for optimizing planning and treatment of diabetic foot

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Disclosure

Speaker name:

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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)
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- I do not have any potential conflict of interest

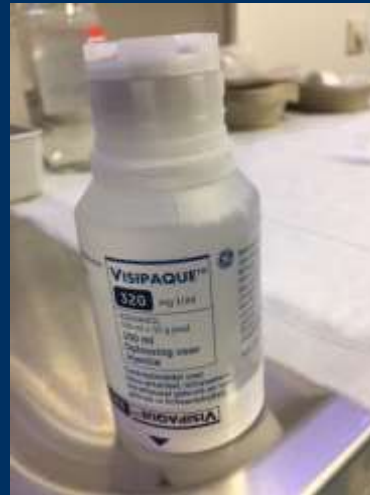
Disclosure

- Institution research grant from philips.

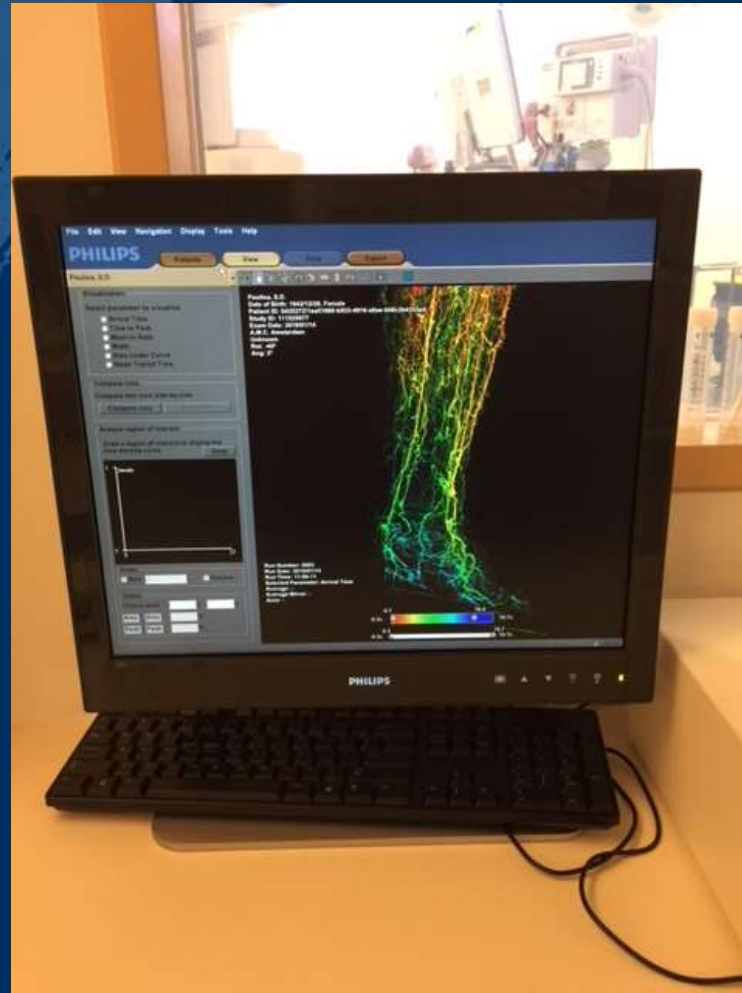
Standardized foot angiography for measuring Total Foot Perfusion.

- Dedicated **foot rest** to immobilize the foot.
- Rotation C-arm ~ **40 degrees contralateral**.
- Contrast injection from the **mid-poplitea** artery.
- High density (320) contrast , iso-osmolar to maintain bolus and to avoid calf cramps. (visipaque)
- **Pump injection** with 9 cc in 3 seconds.
- Pre- and post angiography should be in same position!!

This protocol is mandatory



Post processing



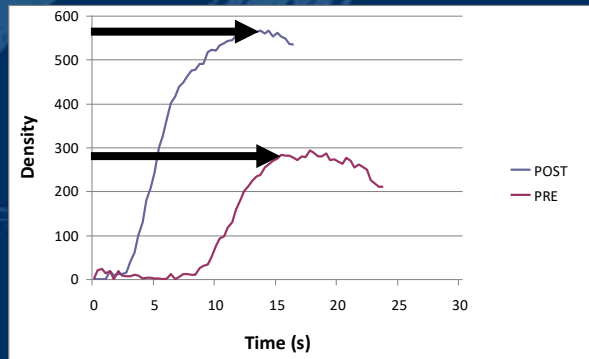
Perfusion angiography measurements in diabetic foot patients.

- 1: The absolute increase in total foot perfusion after revascularization.
- 2: The functionality of the sympathetic nervous system.

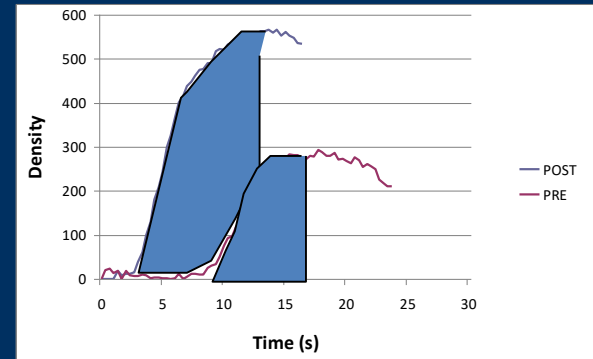
Measuring the absolute increase in
Total Foot Perfusion (TFP) after
revascularization.

Perfusion angiography pre- and post intervention.

How to measure the change in total foot perfusion(TFP) after revascularization?



Measuring the peak



Measuring the area under the curve

Preliminary data

- No increase and or decrease in total foot perfusion has a high correlation with poor outcome.
- Increase in total foot perfusion has a high correlation with good outcome.

Measuring the functionality of the sympathetic nervous system.

Open access Original research

BMJ Open Diabetes Research & Care

Testing the sympathetic nervous system of the foot has a high predictive value for early amputation in patients with diabetes with a neuroischemic ulcer

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Abstract
There is evidence from the literature that dysfunctionality of the sympathetic nervous system of the foot with subsequent loss of local autoregulation could be a predictor of early amputation in patients with diabetes with a neuroischemic ulcer. To confirm this we tested the functionality of the sympathetic nervous system in the foot in a consecutive group of 22 patients with diabetes with critical limb ischaemia and non-healing neuroischemic ulcer.

Research design and methods
Prospective cohort with retrospective analysis after 12 months of routinely acquired clinical data. All patients in the study group underwent angiography of the foot as part of a routine angiography procedure. Primary study endpoint was lower extremity amputation (not survival) at 12 months. Success of the study design to other endpoints could be analyzed. The functionality of the sympathetic nervous system was tested with perfusion angiography.

Results
Twenty-two patients were followed for 12 months. The Capillary Permeability Index (CPI) was used to measure the response of the sympathetic nervous system. CPI < 0.5 led to the cut-off point for a non-responsive sympathetic nervous system. All patients with CPI < 0.5 (n = 12) underwent a major amputation before 12 months. Of all patients with a CPI > 0.5 (n = 10), underwent major amputation. The positive predictive value for major amputation before 12 months for patients with a CPI < 0.5 was 100%.

Conclusions
A non-responsive sympathetic nervous system of the foot is a strong predictor of early major amputation (not survival) after 12 months (OR 14.22; 95% CI 3.6 to 58.23).

Introduction
Diabetes-related foot complications are the major cause of lower limb amputation. The presence of peripheral arterial disease (PAD) in particular is associated with an increased risk of ulceration, failure of ulcer to heal and amputation.¹ Many parameters have been identified as possible predictors for poor outcomes in patients with diabetic foot disease, for example, renal failure, diabetes, tobacco, gangrene and PAD.^{2,3} Prediction models for early amputation such as the Wound, Ischaemia, and Foot Infection classification have been introduced.^{4,5} Of all patients with diabetes who undergo conventional vascularisation or bypass revascularisation, 70% will still undergo major amputation within 12 months,^{6,7} >50% of all amputations are revascularisation is still present at the time of amputation.⁸ This percentage has not decreased over the past decade, despite major advances in percutaneous transluminal revascularisation technologies,^{9,10} as well as microangiopathy has been recognised as an

Significance of this study
What is already known about this subject?
Over the past 20 years some publications have reported that a dysfunctional sympathetic nervous system of the foot could be a predictor for poor outcome of neuroischemic ulcer in patients with diabetes. These papers have never attracted much attention.

What are the new findings?
The ability to reduce the peripheral resistance in the foot with a local alpha-blocker is a predictor for a local dysfunctional sympathetic nervous system of the foot and amputation before 12 months.
Perfusion angiography offers a very simple test to evaluate the functionality of the sympathetic nervous system by measuring change in foot blood flow through the foot.

How might these results change the focus of research or clinical practice?
The initial clinical impact of our findings could be that in patients with diabetes with a Capillary Permeability Index (CPI) < 0.5, and if monitoring of amputation is needed over the neuroischemic ulcer, the amputation is probably to avoid.
Whether in patients with a CPI < 0.5 a revascularisation might be useful. This might be a cost-effective strategy, especially because the test was not only the cost of the intervention.

Check for updates
This study has not been certified by peer review. It is preliminary and should not be used to guide clinical practice.

Supplemental material
Supplemental material for this article is available at <http://dx.doi.org/10.1136/bmjopen-2018-025202>.

Footnotes
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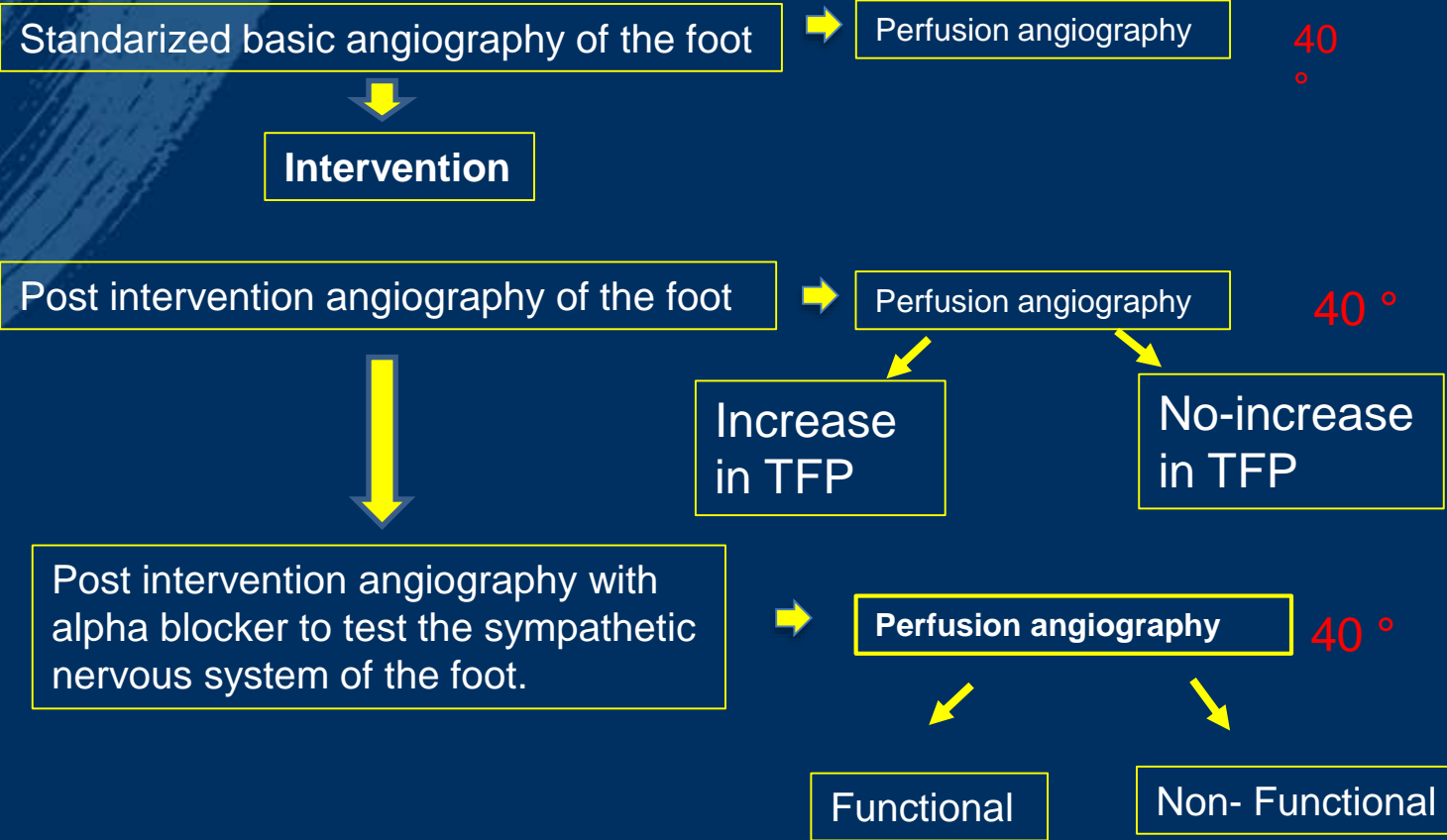
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How to measure the functionality of the sympathetic nervous system?

- Measuring the change in total volume flow after local blocking of the sympathetic nervous system with an Alpha blocker.
(Tolazoline)

How to use perfusion angiography
in planning and treating diabetic
foot disease?

Perfusion angiography algorithm in diabetic foot disease and neuro-ischemic ulcer



Conclusion

- A:** Increase in Total Foot Perfusion (TFP)
- Stop procedure.
 - Good outcome to be expected.
- B:** No increase or a decrease in TFP
- Try to open more vessels to the foot.
 - Iloprost?
- C:** Functional sympathetic nervous system
- Good outcome to be expected.
- D:** Non-functional sympathetic nervous system
- Poor outcome to be expected.
 - Do NOT plan reintervention.

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