

# Post Occlusion Reactive Hyperaemia (PORH) assessments using moorVMS-LDF and moorVMS-PRES

## Application note #106

### Application

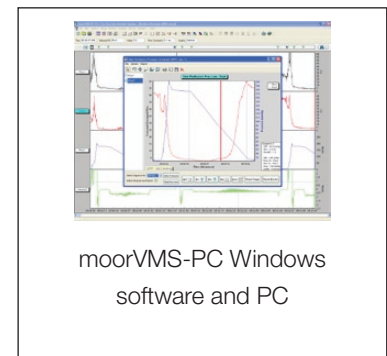
The increase in microvascular blood flow following arterial occlusion, Post Occlusion Reactive Hyperaemia (PORH), can be assessed using the non-invasive laser Doppler technique (Castronuovo et al, 1987). Following release of the arterial occlusion there is a marked transient increase in microvascular blood flow to the ischaemic tissues.

Laser Doppler derived PORH measurements have been shown to be highly reproducible (Yvonne-Tee et al, 2005). The mechanisms behind PORH are believed to be a combination of: myogenic relaxation of the vessels (Patterson, 1956), release of local mediators and metabolites from the ischaemic tissue (Kontos et al, 1965), and more recently the involvement of sensory nerves (Minson & Lorenzo, 2007). As a result of unknown mechanisms behind PORH there is extensive research in this area. Previous studies have shown the PORH response to ischaemia shows distinct patterns that are associated with cardiovascular risk i.e. area under curve (AUC) and peak flux following the period of ischaemia (Strain et al, 2005. Yamamoto-Suganuma et al, 2009)

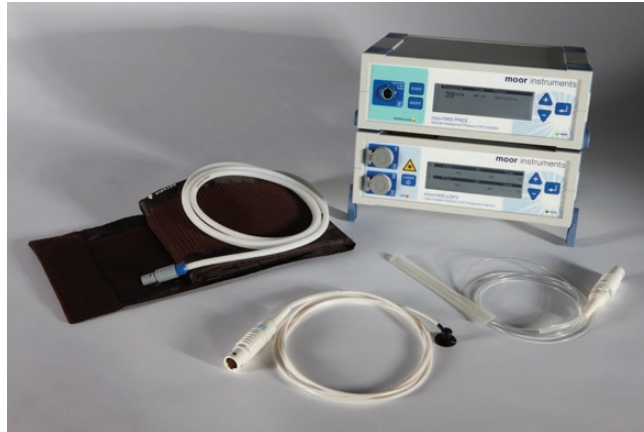
The combined moorVMS-PRES and moorVMS-LDF systems enable simple rapid and reproducible measurement of PORH. The user friendly PC software enables protocols to be written which exactly match user requirements for individual experimental conditions – the user is in no way limited to pre-defined protocols.

### Equipment Required

The following equipment is required for PORH assessments: -



## Method



- Refer to the 'Practical Suggestions' section of this application note for environmental and patient recommendations.
- Ensure your moorVMS-LDF module is calibrated and with an in-date service record.
- Measurements should be made with the patient in the supine position with the limb to be measured at heart level.
- Place skin probes on the measurement sites (control and test sites).
- Place a pressure cuff around the limb.
- Referencing the moorVMS-PC user guide, set the moorVMS-PC software using the settings shown below (adjust for preferred simple protocol – a more detailed protocol can also be performed – ask your Moor Instruments representative for further details):

moorVMS Protocol Simple Setup

Select Protocol

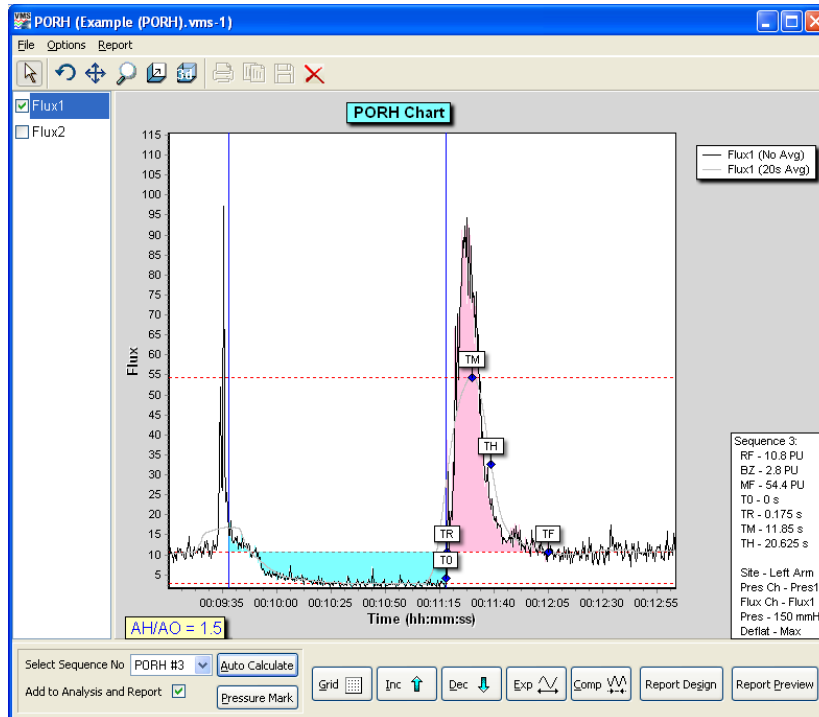
PORH

Period	Protocol	Duration (sec)	Pressure/Rate
1	Pre-inflation	20	
2	Inflation		180
3	Hold Time	180	
4	Deflation		Max
5	Post-deflation	360	
6			
7	Measure Site		Left Arm
8			
9			
10			
11			
12			
13			
14			
15			

Limits: 0-600sec 20-250mmHg 1-10mmHg/s or Max

- Measure the resting baseline blood flow for a period of 10 minutes (if FFT analysis is required, but can reduce if FFT not required, here a 5 minute baseline is sufficient) .
- Arterial occlusion: Set the moorVMS-PRES pressure module to inflate the cuff to 200 mm Hg for a period of 3 minutes (Clough et al, 2009), whilst monitoring blood flow with the moorVMS-LDF.
- The moorVMS-PRES pressure monitor will then deflate the cuff (at maximum rate) whilst the moorVMS-LDF continues to monitor blood flow.
- Ensure the file is saved for analysis. Use a filename that corresponds in some way to patient/study ID and date to ease file management.
- If you are making comparisons over time, or wish to repeat the PORH measurement, ensure the setup and protocol are the same – you can save the moorVMS-LDF/moorVMS-PRES protocol for future use.

# Analysis



The parameters of interest for PORH are typically:

- Resting flux (RF).
- Time to resting flux level (TR).
- Maximum flux during reactive hyperaemia (MF).
- Time to maximum flux (TM).
- Time to half recovery (TH).
- Time to full decay (TF).

The software also enables the user to:

- Correct for baseline i.e. to exclude area of movement artefact.
- Two averaging methods can be chosen for calculating fast and slow responses.
- Data can be saved in a Report format.
- Statistics can be saved and exported to Excel using the File, Save Statistics option in the PORH chart window.

## Practical Suggestions

Microvascular blood flow can be affected by many things. The following practical suggestions are provided as a guide and are not exhaustive:

- Perform measurements in a quiet room whilst maintaining a comfortable temperature (typically 22°C). Ensure the patient is acclimatised to the room temperature for 30 minutes prior to measurements.
- Patients should avoid caffeine, high salt food, alcohol, vigorous exercise, and smoking for 24 hours prior to the study.
- During measurements ask the patient relax and to breathe normally. Coughing, talking and yawning can all affect microvascular blood flow readings.
- The patient should be in a comfortable, relaxed position and avoid undue movement during all measurements.
- Where appropriate use a cushion and limb supporter to aid comfort and limit movements.

## Publications

1. De Mul FF, Morales F, Smit AJ, Graaff R. A model for post-occlusive reactive hyperemia as measured with laser-Doppler perfusion monitoring. *IEEE Trans Biomed Eng.* 2005 Feb;52(2):184-90.
2. Castronuovo, J. J., Pabst, T. S., Flanigan, D. P., Foster, L. G. (1987) Non invasive determination of skin perfusion pressure using a laser Doppler. *Journal of Cardiovascular Surgery*, 28, pp 253-257
3. Clough, G., Chipperfield, A., Byrne C., de Mul, F., Gush, R.G. (2009) Evaluation of a new high power, wide separation laser Doppler probe: Potential measurement of deeper tissue blood flow. *Microvascular Research*, 78 (2), pp 155-161
4. Kontos, H. A., Mauck, H. P. Jr., Patterson, J.L. Jr. (1965) Mechanism of reactive hyperemia in limbs of anesthetized dogs. *American Journal of Physiology*, 209, pp 1106-1114
5. Minson, T., Lorenzo, S. (2007) Human Cutaneous reactive hyperaemia: role of BKCa channels and sensory nerves. *Journal of Physiology*, 585, pp 295-303
6. Patterson, G. C. (1956) The role of intravascular pressure in the causation of reactive hyperaemia in the human forearm. *Clin Sci (Lond)*, 15 (1), pp 17-25
7. Strain W. D., Chaturvedi N., Bulpitt, C. J., Shore A. C. 2005 Albumin excretion rate and cardiovascular risk: could the association be explained by early microvascular dysfunction? *Diabetes*, 54 pp1816-1822
8. Yamamoto-Suganuma R., Aso Y. 2009 Relationship between post-occlusive forearm skin reactive hyperaemia and vascular disease in patients with Type 2 diabetes – a novel index for detecting micro- and macrovascular dysfunction using laser Doppler flowmetry. *Diabet Med* 26, pp 83-88
9. Yvonne-Tee G. B., Rasool A. H. G., Halim, A. S., Rahman A. R. A. (2005) Reproducibility of different laser Doppler fluximetry parameters of postocclusive reactive hyperemia in human forearm skin. *Journal of Pharmacological and Toxicological Methods*, 52, pp 286-292.

## Further Reading

moorVMS-LDF, moorVMS-PRES and moorVMS-PC user manuals for instrument operation and cleaning and handling of optic probes.

[www.moor.co.uk](http://www.moor.co.uk) - information about moorVMS-LDF, moorVMS-PRES, optic probes and pressure cuffs.

Clinical advice courtesy of Prof G.Clough.

Please feel free to consult [sales@moor.co.uk](mailto:sales@moor.co.uk) for further advice or support with issues not covered in this application note and details of other application notes using the moorVMS-PRES.

**Important Disclaimer:** This information is provided to further clinical research into diagnostic capabilities of laser Doppler. The moorVMS-LDF and moorVMS-PRES are CE marked for human use but not specifically for clinical diagnosis of PORH assessments. Calibrated equipment with a current service record should only be used.

