USING DYNAMIC VASCULAR OPTICAL SPECTROSCOPY TO MONITOR PATIENTS WITH PERIPHERAL ARTERIAL DISEASE – THREE EXEMPLARY CASES

Alessandro Marone, Department of Biomedical Engineering, Columbia University, USA
am4072@columbia.edu
Jennifer W. Hoi, Department of Biomedical Engineering, Columbia University, USA
Christopher J. Fong, Department of Biomedical Engineering, Columbia University, USA
Youngwan Kim, Department of Electrical Engineering, Columbia University, USA
Hyun K. Kim, Department of Radiology, Columbia University, USA
Danielle R. Bajakian, Division of Vascular Surgery and Endovascular Intervention, Columbia University Irving Medical Center, USA
A.H. Hielscher, Depts. Biomed. & Electrical Engineering and Radiology, Columbia University, USA

Key Words: PAD, Optical Spectroscopy, blood flow.

In this study, Dynamic Vascular Optical Spectroscopy (DVOS) was used to monitor the blood flow in patients affected by peripheral arterial disease (PAD) who underwent lower extremity revascularization procedures. Four different angiosomes on the foot were considered, collecting point-based measurements of the vascular dynamics during a venous cuff occlusion (@ 60 mmHg) in the lower extremity with the system shown in Fig. 1. Over 70 patients were monitored from before the intervention to up to one year later. Among them, we selected 3 exemplary cases that can highlight different hemodynamics flows in the foot of these patients. The general idea behind our research is that if a patient has a healthy vasculature, when we interrupt the venous return using a thigh cuff occlusion the saturation of the blood in the foot will be swifter than in the case of a patient in which its arterial tree is occluded and less blood can pool in the lower extremities.

In the first example, the patient had a very poor blood flow in the foot which caused an ulcer to develop. After the intervention (angioplasty of MPA) this ulcer completely healed in less than 3 months. It is possible to see from Fig. 2-A that the difference between the state pre-intervention and two hours later was mostly maintained after 1 and 3 months. In the second case, the patient had to have a 2nd intervention (bypass surgery) 5 weeks after the 1st intervention since the first by-pass failed. It is in fact possible to see from Fig. 2-B that the situation 1 month after the first intervention deteriorated and the optical data suggested a situation even worse than before the first intervention.

Finally, in the third case (Fig. 2-C), the patient showed a good recovery and few months of wellbeing after an angioplasty of the LMP. But after about 6 months, the situation reverted to the pre-intervention state and in fact the patient started claudicating and feeling pain in the foot comparable to the situation before the intervention. This is reflected by the optical signal reverting back to the pre-intervention state.

![Figure 1](Image of the system used to obtain DVOS measurements.)

![Figure 2](Three exemplary cases (A,B,C) of PAD patient who had an endovascular intervention. In the graphs, the normalized total hemoglobin concentration reconstructed from the optical signals collected with our DVOS system are shown.)

As shown in these three cases, there is a direct correlation between the optical signals collected with DVOS and the hemodynamic responses to a venous cuff occlusion in the foot of the patients affected by PAD: lower blood flow causes longer times for the optical signal to saturate and reflects a state of poor vascular conditions.