WEARABLE TOE BAND SYSTEM FOR MONITORING OF PERIPHERAL ARTERY DISEASE

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Approximately 8 to 12 million people in the United States suffer from peripheral artery disease (PAD). PAD causes narrowed arteries and reduces blood flow to the lower extremities. People with PAD begin to experience discomfort and pain while walking. Untreated PAD can lead to ulcers, gangrene, and amputation. Before experiencing those severe conditions, detection of narrowing blood vessel enables early diagnosis and treatment. Therefore, accurate and timely diagnosis is necessary.

We have developed a low-cost wearable imaging band system that employs dynamic diffuse optical spectroscopy (dDOS) technique. The system includes 4 different measurement modules that each has a pair of three light-sources and a single Si-photodetector. The three light-source consists of light emitting diodes (LEDs) operating at wavelengths of 530, 655, 940 nm. When an individual light source is on, four detectors at different spots around a toe read the intensities of diffusely reflected and transmitted light. The intensity of light is converted to a voltage and amplified by transimpedance amplifier (TIA). The digitized data is transferred to a computer by microcontroller and embedded system.

We have used the system in a clinical pilot study with 10 PAD patients that undergo an endovascular intervention. The wearable imaging band accesses PAD patients 1 hour before and 1 hour after angioplasty. Thigh pressure cuff occlusions at 60 mmHg and 100 mmHg are applied for 60 seconds each, and the changes in light transmission are recorded. During the thigh cuff occlusion, the blood volume in the extremities is changed leading to a change in the measured signal. An example for a patient whose medial plantar artery (MPA) was treated is shown in Figure 1. The wearable imaging band wrapped around the patient`s toe is shown in Figure 1 (a). Figure 1 (b), (c), and (d) show absorbance changes of wavelengths at 530, 655, and 940 nm respectively during a100 mmHg occlusion. Absorbance before angioplasty (dotted line) reaches the max value more slowly than after receiving an angioplasty (solid line). We hypothesize that in untreated patients the narrowed MPA can only respond slowly to the cuff. The treated MPA has a larger lumen and hence the blood pooling in a toe increases much faster during thigh occlusion. Similar results were found in all 10 patients.

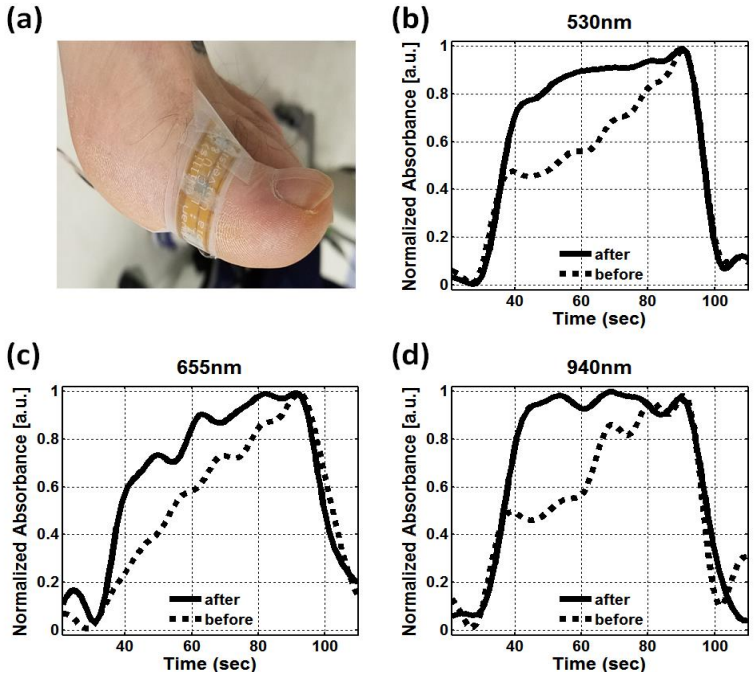

Figure 1. Wearable imaging band wrapped around a toe (a) and change of absorbance of three wavelengths (530 nm(b) , 655 nm (c), 940 nm (d)), measured before and after angioplasty at a thigh cuff occlusion of 100 mmHg from Peripheral Artery Disease (PAD) patient.

We have shown that the wearable imaging band system can detect differences between hemodynamics before and after angioplasty. The wearable form factor should allow for integration in home-based monitoring systems, where it could potentially be used to assess the status of the vasculature. Therefore, early diagnosis and monitoring of PAD in daily life may be possible.