



Utilizing Mobile Multispectral Near-Infrared Spectroscopy Imaging to Inform Amputation Levels : A Case Series



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Objective

Investigate the utility of mobile multispectral near-infrared spectroscopy (NIRS) imaging in guiding amputation levels in diabetic patients.

Introduction

Diabetes is a chronic metabolic disorder that can lead to severe complications, including peripheral arterial disease (PAD) and diabetic foot ulcers (DFUs), which may necessitate amputation. The decision-making process for amputation in diabetic subjects remains complex, as it requires accurate assessment of tissue viability and blood perfusion. For example, the most distal level of amputation is to be selected by physical examination, but further information is required to assess the healing potential at the selected level.¹⁻² Mobile multispectral near-infrared spectroscopy imaging has emerged as a non-invasive and promising tool for evaluating tissue oxygenation levels, thereby assisting in amputation decisions, thereby improving patient outcomes and reducing the incidence of unnecessary limb loss.



Methods & Technology Description

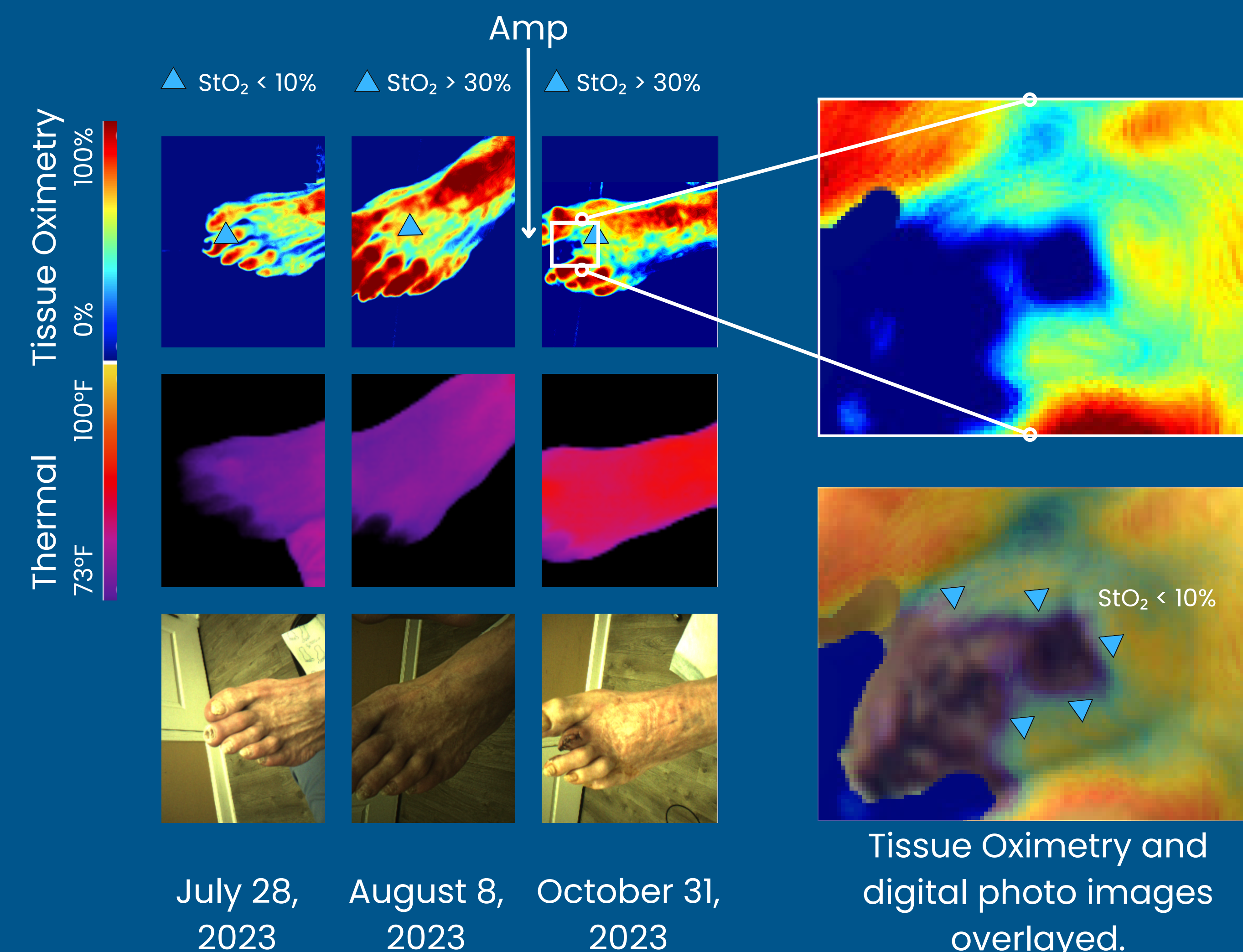
A retrospective case series design was employed, involving diabetic subjects with PAD and DFUs who underwent evaluation using mobile multispectral NIRS imaging. A hand-held multispectral NIRS imaging device (MIMOSA Pro, MIMOSA Diagnostics, Canada) that utilizes near-infrared light to assess tissue oxygenation (StO₂) levels at multiple wavelengths was used. The device also measured temperature. Relevant data, including patient demographics, clinical characteristics, NIRS findings, and subsequent amputation decisions, were collected and analyzed.

Discussion & Conclusions

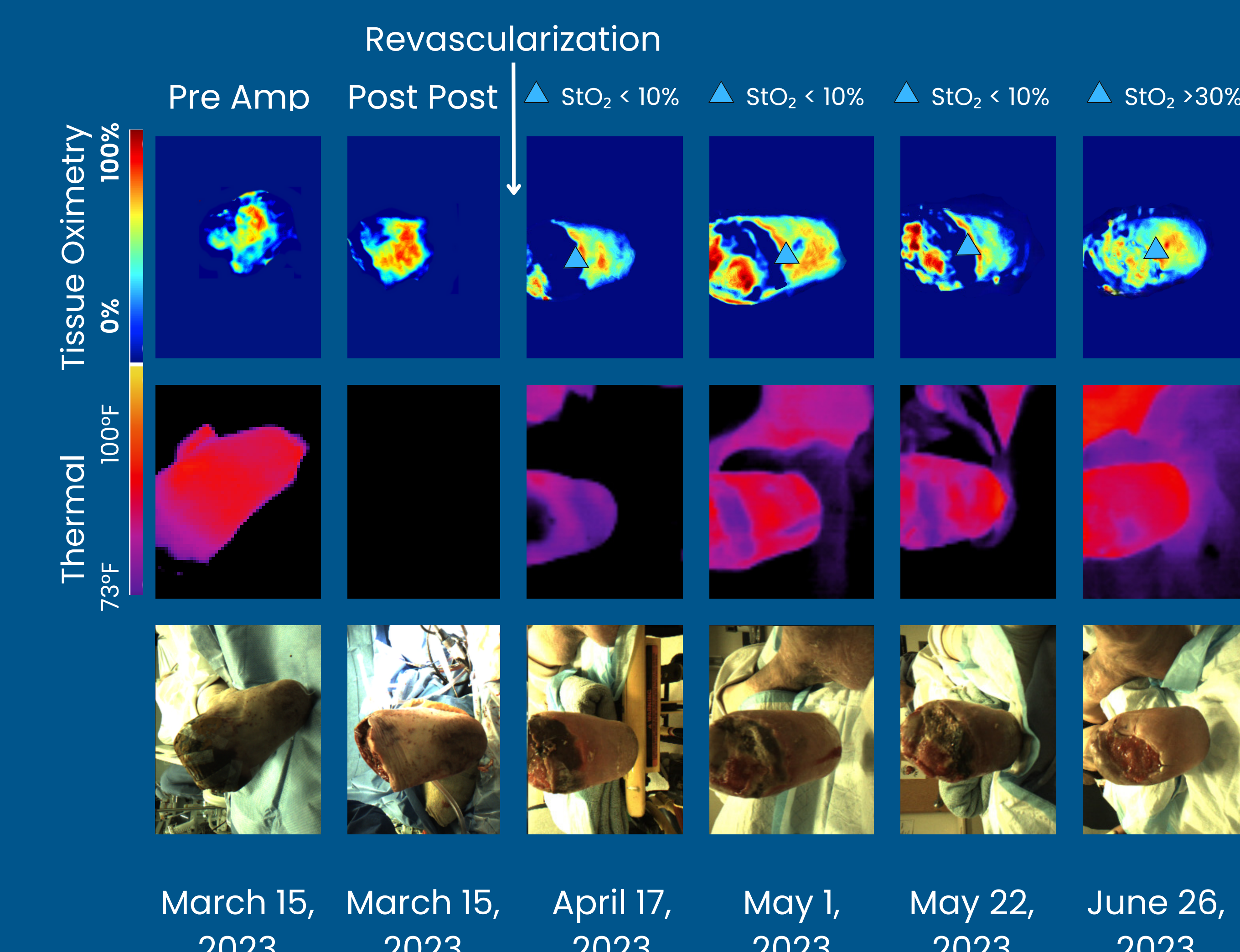
The findings from this case series highlight the potential of multispectral NIRS as a valuable tool in the assessment and decision-making process for amputation in diabetic subjects. By providing real-time and objective data on tissue oxygenation, NIRS can aid clinicians in accurately identifying viable tissue and determining the optimal level of amputation, thereby improving patient outcomes and reducing the incidence of unnecessary limb loss. Furthermore, the portability and ease of use of mobile NIRS devices make them particularly suitable for point-of-care applications in various healthcare settings.

RESULTS

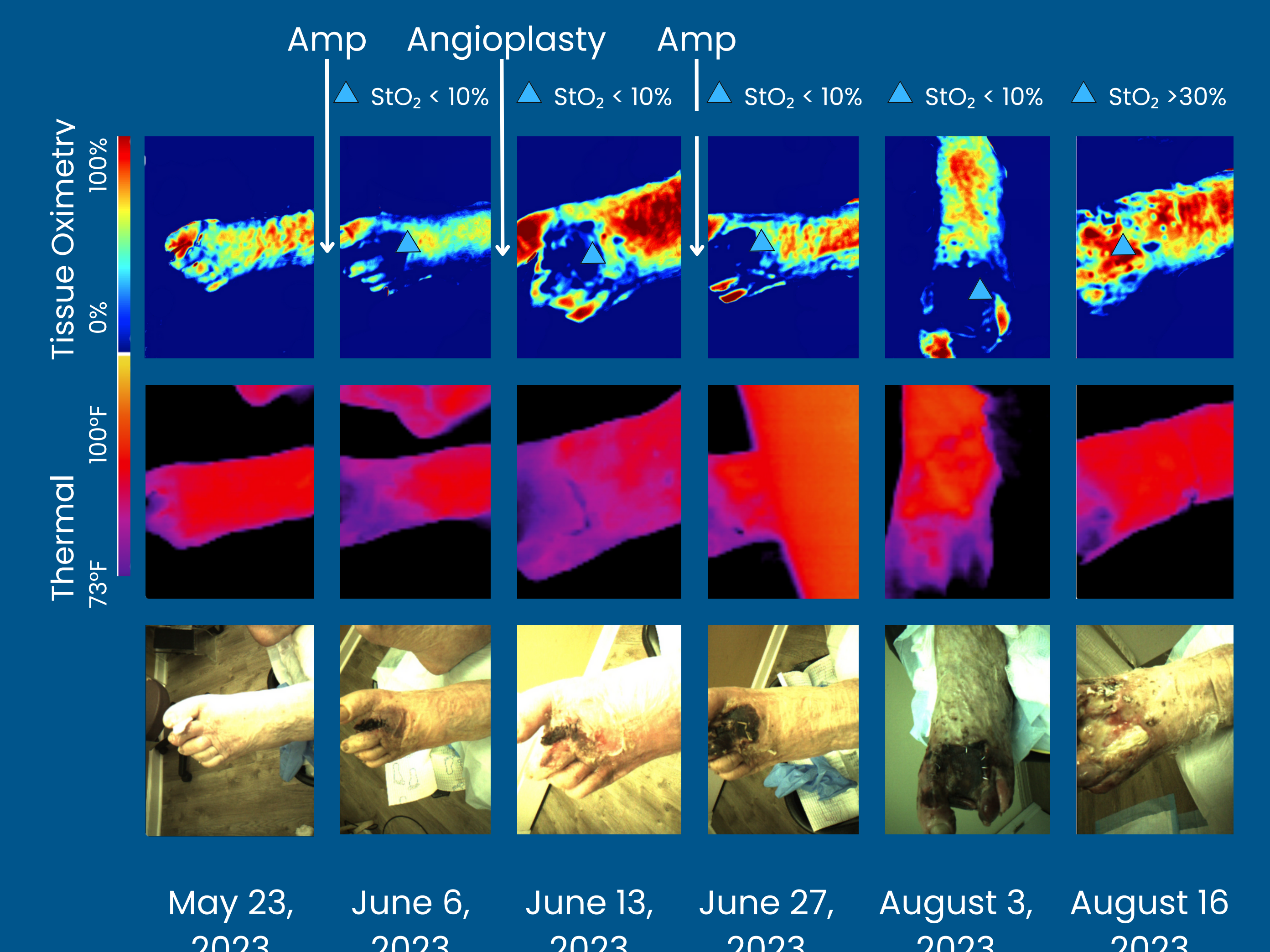
Patient 1 – A 63-year-old man presented with a callus on the distal tip of the 2nd toe of the left foot and pain. The patient had significant risk factors for diabetic lower extremity complications such as type II diabetes, and a history of neuropathy, venous insufficiency, and PVD, previous smoker and alcoholic. The patient was undergoing radiation and chemotherapy for pre-existing lung cancer. Biomechanically he had a 2nd hammer toe but no other deformities. The patient had a history of multiple revascularizations. He experienced acute thrombosis of the previous stent and underwent revascularization in June 2023. A diabetic wound developed on the tip of the 2nd toe. Considering osteomyelitis and deformity, a partial amputation was performed.



Patient 2 – A 76-year-old man with type II diabetes, chronic kidney disease, PVD, and small vessel disease presented with a gangrenous hallux with exposed bone. Despite a comprehensive wound care regimen, including debridement as per the clinic preferences, toe and midfoot amputations became necessary due to persistent healing issues. Revascularization was performed on April 7th, 2023. To address ongoing challenges, a proximal Chopart's procedure and Achilles tenotomy were performed in December 2023, accompanied by grafting and the initiation of hyperbaric oxygen therapy supported by Vacuum-Assisted Closure (VAC) and total contact casting. Following the completion of 40 hyperbaric oxygen treatments, the patient's healing trajectory is showing positive progress.



Patient 3 – A 81-year-old man, post-transmetatarsal amputation on the right foot, developed a 1' x 1' friction wound on his left index toe. The patient underwent a comprehensive wound care and treatment regimen, as per the clinic preferences, including topical oxygen therapy. Gangrene led to the amputation of the index toe (May 2023). An arterial doppler initially showed adequate blood flow, but a tissue oxygenation imaging device revealed no oxygen in the area. During surgery, a significant 5 cm high-grade stenosis on the femoral artery was discovered, prompting angioplasty on June 12, 2023. Gangrene progressed to the middle toe, necessitating a secondary amputation. Post-amputation, the patient entered rehabilitation, with a recent follow-up showing strong oxygenation.



Bibliography
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 2. Dwaars, B. J., van den Broek, T. A. A., Rauwerda, J. A. & Bakker, F. C. Criteria for reliable selection of the lowest level of amputation in peripheral vascular disease. J. Vasc. Surg. 15, 536-542 (1992).

