

The Efficacy of Near-Infrared Spectroscopy in Evaluation of Healing Potential in Limb Salvage Surgery

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METHOD:

SnapshotNIR near-infrared spectroscopy (NIRS) imaging was used over one month to evaluate pre- and post-operative limb salvage sites. Two limb salvage patients were selected with criteria that included critical limb ischemia. Both had undergone at least one peripheral intervention that was either only partially successful or unsuccessful. Both patients also had infected wounds in need of surgical intervention. Each patient was evaluated pre-operatively with the NIRS device to determine the viability of tissues locally and at proposed amputation sites. Based on the results of NIRS imaging, as well as other vascular studies including ankle-brachial indices and angiography, we determined which wounds were likely to heal and which were likely to require further amputation.

CASE 1

PATIENT HISTORY:

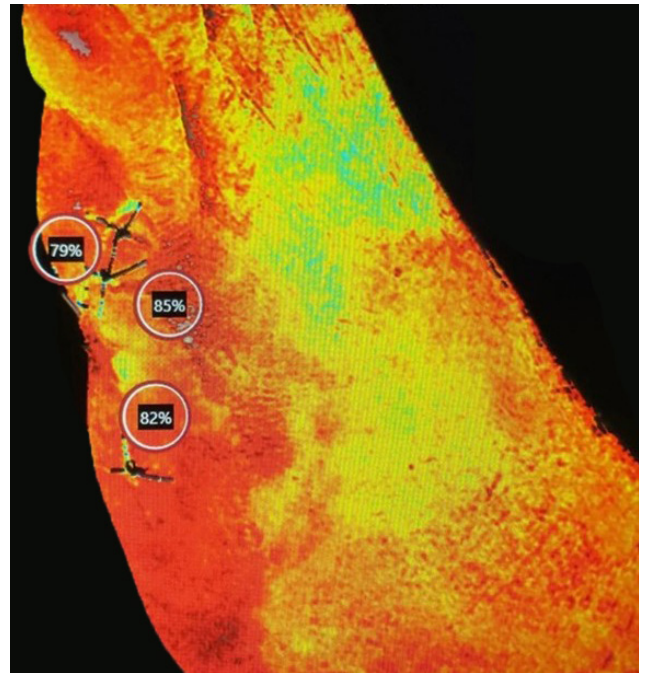
The patient is a 67-year-old male with a history of diabetes, chronic peripheral vascular disease, ischemic cardiomyopathy, and esophageal cancer with a four-month history of a non-healing wound to the left fifth metatarsal head and underlying osteomyelitis (noted on imaging). He was status post a left iliac stent for severe stenosis with a history of bilateral superficial femoral artery occlusion that could not be revascularized. He was found to have monophasic waveforms to pedal arteries with a toe-brachial index of 0.18 representing severe distal disease.

CASE DETAILS:

The patient required fifth toe and metatarsal amputation due to progressive osteomyelitis and the need to eradicate infection before he could undergo chemotherapy for esophageal cancer. SnapshotNIR was used to determine wound oxygenated hemoglobin levels at the proposed operative site to determine the healing potential of the amputation. The device indicated that the proposed site showed adequate oxygenated hemoglobin levels and the amputation was performed. The device was then used post-operatively to evaluate post-operative oxygenation which continued to show adequate oxygenation and tissue perfusion.

IMPACT:

In this instance, SnapshotNIR was able to indicate that the patient, despite having non-operable significant proximal occlusion and severe digital ischemia, had healing potential. As we followed the patient post-operatively, this finding was serially confirmed via the imaging device and the patient went on to heal his wound and obtain much-needed chemotherapy for his esophageal cancer.



S₂O₂ image indicating adequate oxygenation to post-op partial fifth ray amputation site.

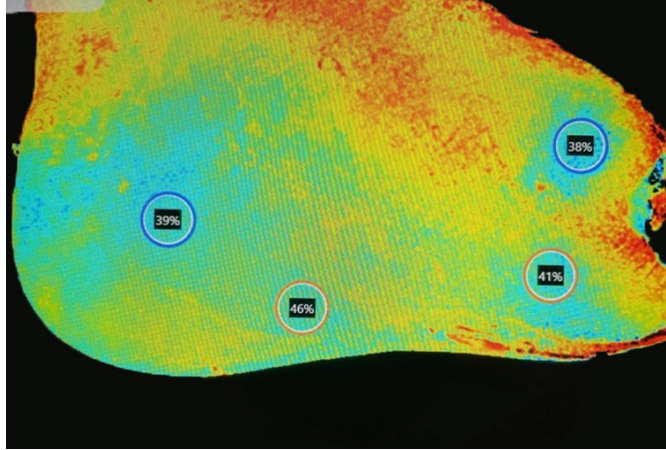
"With continued successful studies, NIRS could one day play an integral part in developing limb salvage protocol."

-Ryan Chatelain, DPM

CASE 2

PATIENT HISTORY:

The patient is a 63-year-old male with a history of diabetes with neuropathy, coronary artery disease, and current cigarette use. He initially presented with monophasic ABIs in the 0.30 range and wet gangrenous second and third toes.



S:O₂ image indicating poor oxygenation to potential midfoot/proximal foot amputation sites.

IMPACT:

SnapshotNIR imaging was able to predict via tissue oxygenation assessment that the foot was non-viable at any level.

CASE DETAILS:

The patient underwent angioplasty of the extremity and amputation of the second and third toes. The angioplasty failed, with toe amputation sites becoming dry gangrenous over a three-day period. A subsequent femoral-popliteal bypass was performed.

The vascular surgeon reported limited perfusion past the ankle level following the bypass but believed that a trans-metatarsal amputation would heal. The trans-metatarsal amputation was performed, and within three days, the site became dry gangrenous at the margins of the stump. At this point, the question became whether a more proximal foot amputation would heal or if the patient required a below-knee amputation (BKA).

SnapshotNIR imaging was used at this juncture with results indicating extremely poor oxygenation in the remainder of the foot. As a result, a more proximal foot amputation was recommended and performed. The patient experienced slow healing at the BKA site with poor microvascular signs even at this level.

Dr. Ryan Chatelain and Dr. Michael McCollum

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CONCLUSION:

SnapshotNIR demonstrates promising results as it reliably, along with other evaluating factors, predicts healing potential both before and after surgery. In this case series, both patients demonstrated critical limb ischemia (CLI) requiring revascularization attempts which experienced complications, limiting optimal, and in some cases adequate flow, to the foot. Both demonstrated evidence of significant small vessel arteriopathy. These factors made determining healing potential difficult with typical evaluative modalities, including ankle-brachial indices, TCOMs, and angiography. This is not an uncommon situation in limb salvage, leaving the surgeon to best estimate viability based on experience.

SnapshotNIR did allow for a more informed decision concerning the likelihood of a surgical site healing, helping to triage these patients more effectively. The device aided in determining if further surgery (more proximal amputation) was needed. The impact on patient morbidity is significant both in terms of preventing unnecessary further surgery in a healable wound and in not performing surgery at a viable level, requiring potential returns to the operating room.

*This information was presented as a poster at IWH 2022.

