

Assessing the Physiologic Efficacy of Transdermal Oxygen Therapy using Near Infrared Spectroscopy Imaging (NIRS)

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INTRODUCTION

The treatment of chronic hard-to-heal wounds have consistently presented a challenge to wound care clinicians. Identifying the correct cause for wound stagnation is largely a process of trial-and-error, drawing from a large knowledge base of treatments that have been successful in the past. This poses significant strain on the patient and the healthcare system as a whole, demonstrated by the large economic impact created by non-healing ulcerations. A large percentage of non-healing wounds are stalled in the inflammatory phase of healing, characterized by an erythematous wound bed and periwound due to the interaction of reactive oxygen species and healthy tissue. Wound chronicity is also commonly associated with tissue hypoxia which exacerbates inflammation. The application of a transdermal oxygen dressing allows for the slow diffusion of molecular oxygen to the wound bed reversing tissue oxygen deficit, helping to reduce free radical oxygen species and reverse inflammation. Local tissue oxygenation will also facilitate angiogenesis which is critical for delivering growth factors and promoting cellular proliferation and collagen deposition. The physiologic effect of topical oxygen can now be monitored with near infrared spectroscopic imaging providing assessment of wound perfusion, response to treatment and healing progression.

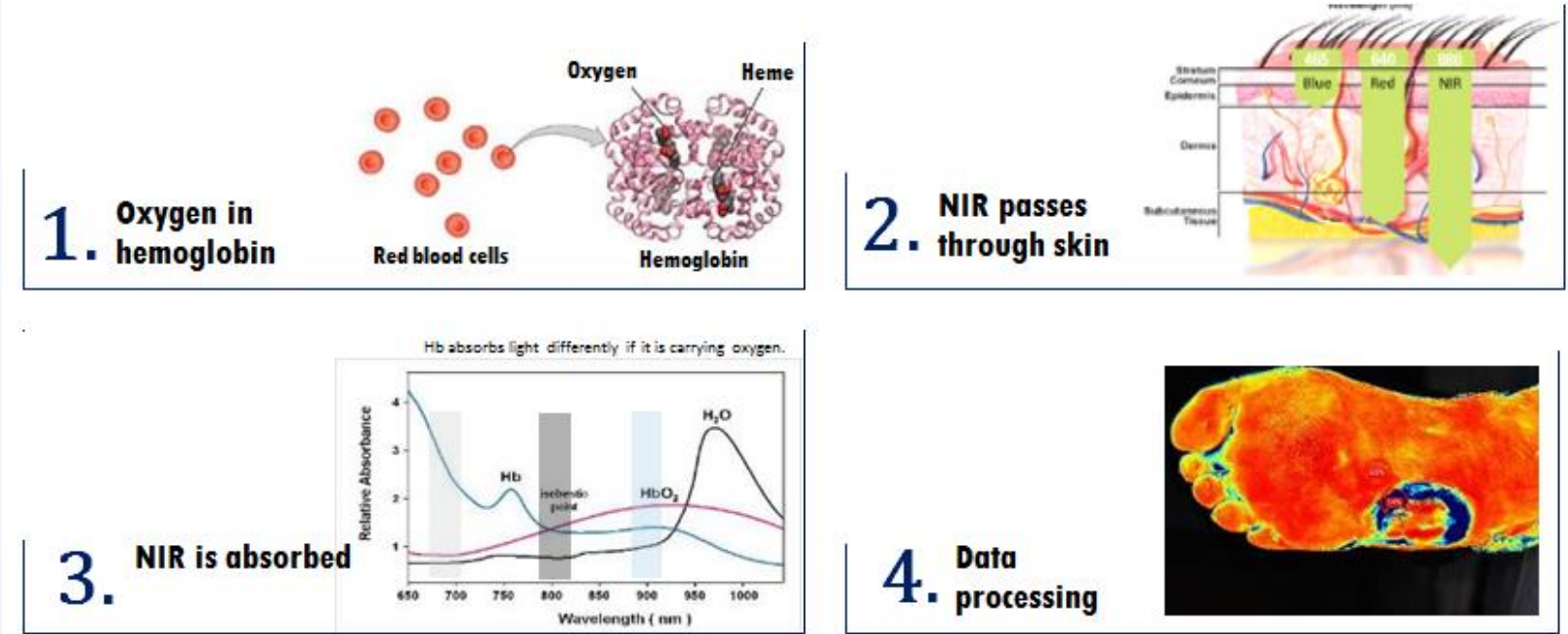
METHODS

NIRS imaging was used to assess tissue oxygen and perfusion in patients with hypoxic chronic wounds that were managed with a comprehensive approach that utilized transdermal oxygen therapy.

Snapshot NIR™ (Kent Imaging, Inc – Calgary Canada) Near infrared spectroscopic imaging technology uses flashes of near infrared light to measure tissue perfusion and oxygenation. On the light spectrum, near infrared light is situated just between visible and infrared light (600nm to 1000nm). The NIRS camera captures light which is absorbed-reflected in this range and measures the difference between two specific values. At 750nm light is absorbed by unbound hemoglobin and at 850nm light is absorbed by oxygenated hemoglobin. The percentage of oxygen perfusion in these tissues is derived from the difference in these absorption coefficients.



Snapshot™ NIRS in bedside clinical utilization

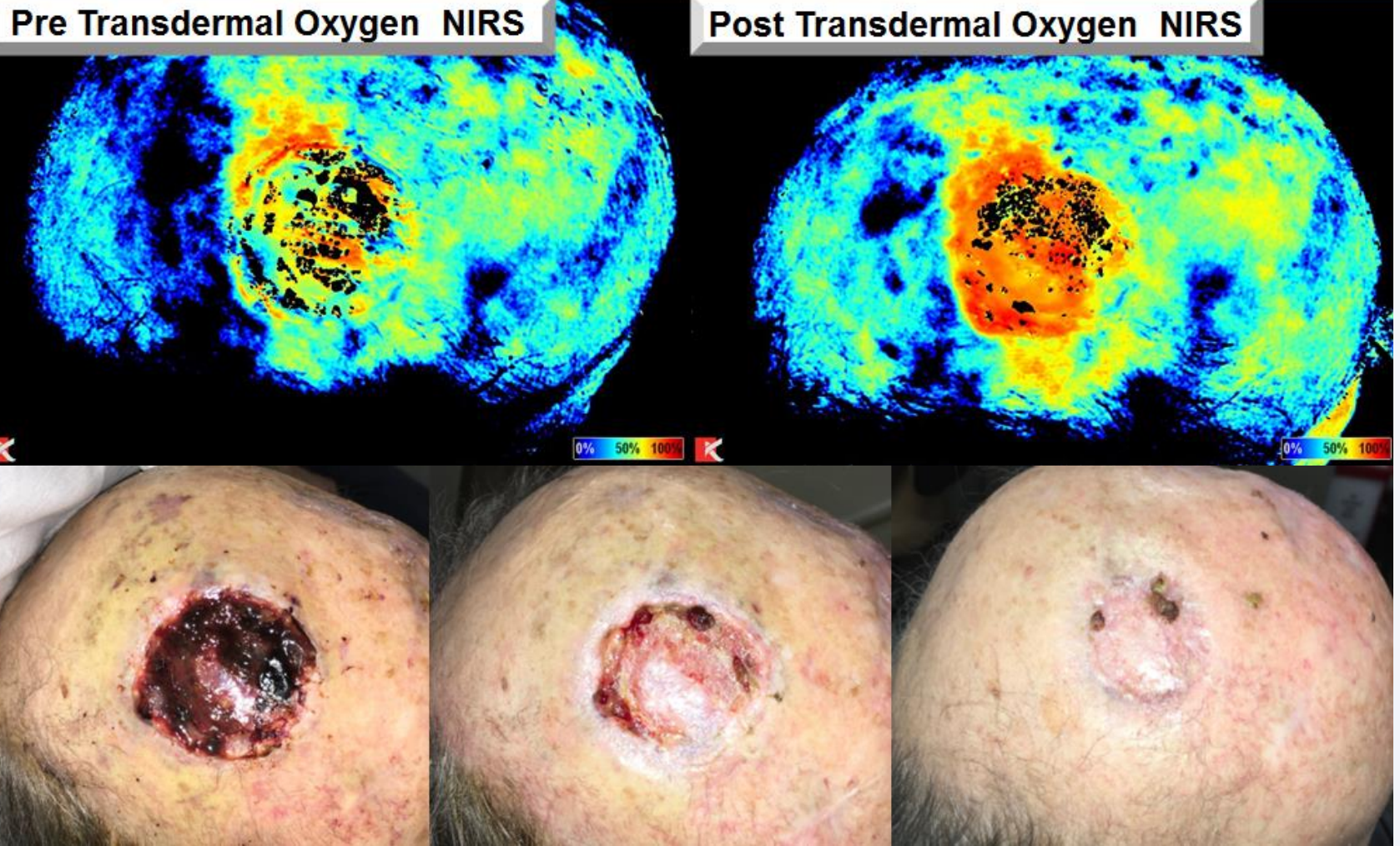


OxyBand™ (OxyBand Technologies – St. Louis, MO) Transdermal Oxygen Therapy incorporates an innovative oxygen delivery technology in a traditional wound dressing that acts like a transdermal patch. The device allows targeted oxygen delivery into the wound as well as sub-ulcer and peri-wound tissues to reverse hypoxia and enhance the healing trajectory. OxyBand has shown clinical promise in all chronic wound types, including surgical wounds, diabetic ulcers, arterial and venous insufficiency ulcers and pressure injury/ulcers.

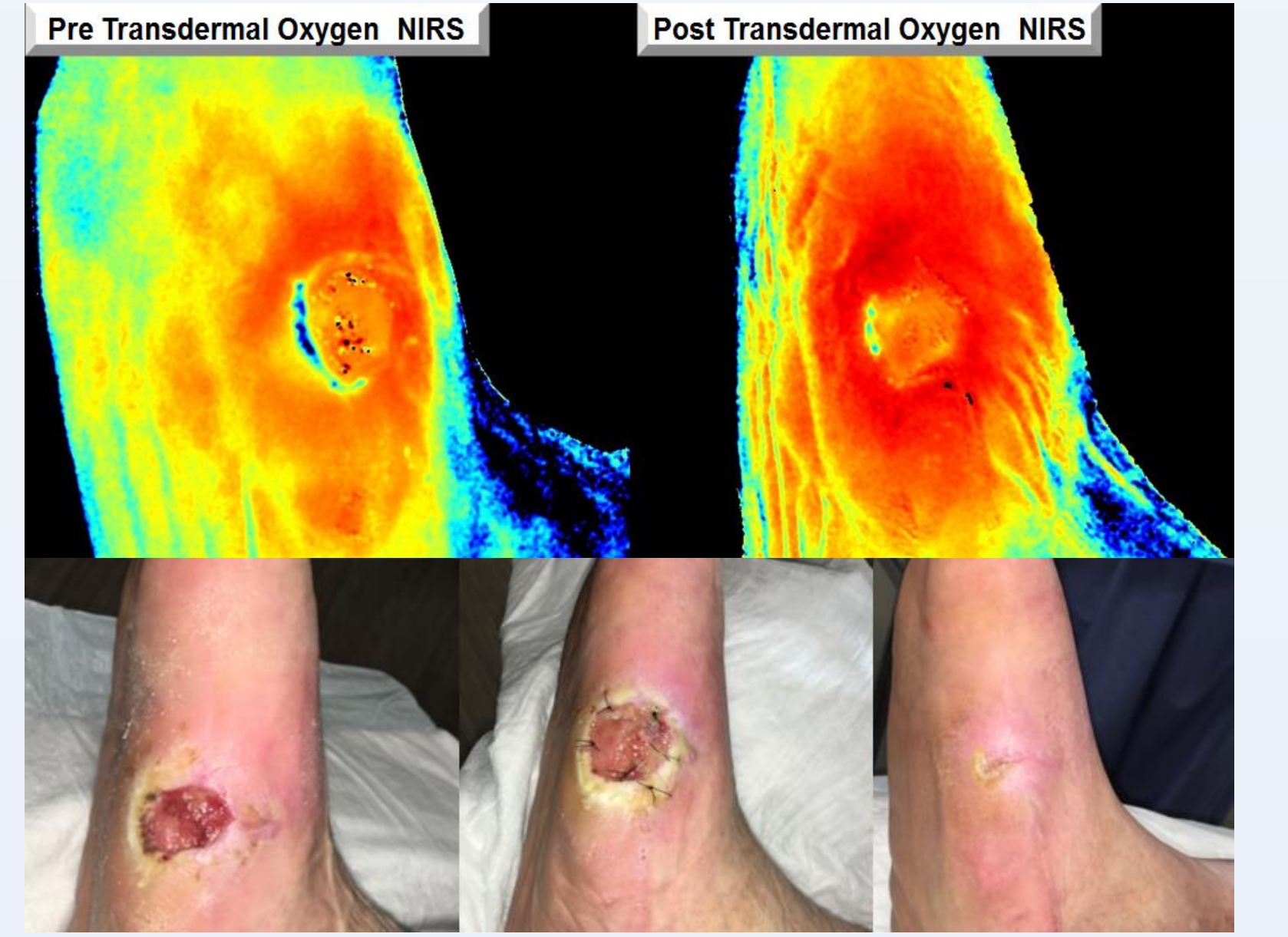


CLINICAL CORRELATION

Case 1
78 year male required Mohs surgery for squamous cell cancer of the scalp, followed by radiation therapy and skin grafting. The patient was seen for flap failure and treated with Transdermal Oxygen Therapy and monitored with NIRS. Significant increases in oxygen saturation were noted after 48 hours of OxyBand. Complete secondary intent healing was achieved.



Case 2
63 year old female with DFU complicated by Charcot Disease presented with a chronic ulcer of over 10 years duration. She was managed with multi-modality therapy which included Transdermal Oxygen Therapy. Significant increases in oxygen saturation were observed and OxyBand was then used in conjunction with ammonic grafting. Complete healing was achieved.



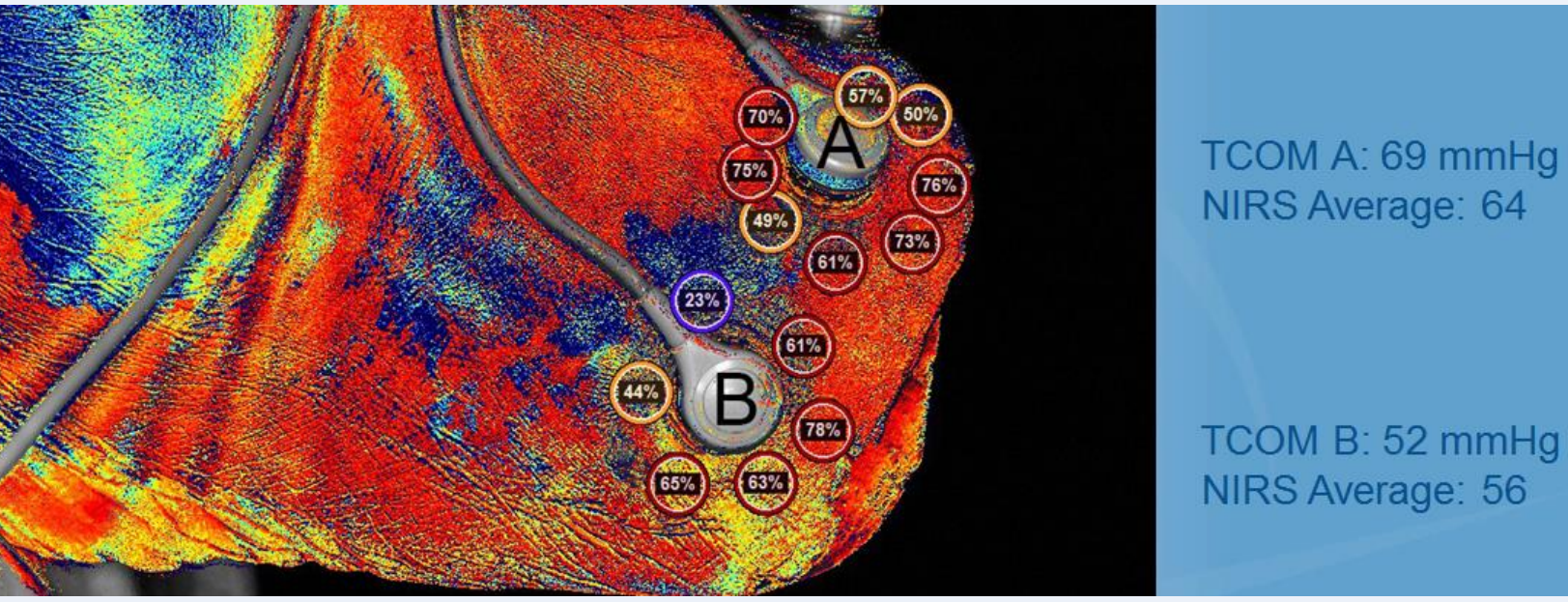
DISCUSSION

Chronic wounds fail to progress through the phases of healing in an orderly and timely fashion due to one or more defects in the healing cascade, including excessive bioburden, uncontrolled inflammation, and inadequate tissue perfusion, resulting in tissue hypoxia and deficient oxygen substrate. Oxygen is essential for maintaining cellular integrity, function, and repair when tissues are injured. Oxygen not only plays an important role in energy metabolism, but also is very important in polymorphonuclear cell function, neovascularization, fibroblast proliferation, and collagen deposition. Research in animals and humans has demonstrated the basic physiology of wound healing is oxygen dependent, and that several aspects of the healing process can be accelerated with oxygen therapy to correct tissue oxygen deficit.

OxyBand is a transdermal oxygen delivery device with the capability of enhancing the wound microenvironment via the sustained delivering of oxygen substrate for an extended period of time (up to 5 days). This benefit is achieved with a single dressing application.



Until recently, the ability to measure local ulcer tissue oxygenation was challenging. Transcutaneous oxygen measurement (TCOM), previously the gold standard was inefficient, often inaccurate and not cost efficacious. NIRS imaging has been shown to be an efficient and effective method of measuring local tissue oxygen saturation and is quickly superseding TCOM.



This study suggests that the utilization of OxyBand has the potential to improve clinical outcomes in the management of chronic wounds based on improvement in the tissue oxygenation of the wound microenvironment as demonstrated by Snapshot. Additional studies evaluating the clinical efficacy of these technologies in the management of chronic-hypoxic wounds is ongoing.

CONCLUSIONS

- *Transdermal Oxygen (OxyBand) can improve tissue oxygenation as observed using NIRS (Snapshot) imaging.
- *NIRS imaging can monitor changes in tissue oxygenation in chronic wounds in response to treatments.
- *Transdermal Oxygen Therapy and NIRS Imaging can be utilized synergistically in treatment of chronic hypoxic wounds.
- * Additional studies evaluating the clinical efficacy of these technologies in the management of chronic-hypoxic wounds is needed.

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Snapshot NIRS Device provided courtesy of Kent Imaging, Inc
<https://www.kentimaging.com>
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