

Cyclical Pressurized Topical Oxygen Therapy for Limb Preservation and the Treatment of Complex Wounds

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Introduction

As our understanding of wound physiology deepens, evidence based adjunctive wound healing therapies continue to evolve. The more complex the wound, the more difficult it is to heal. The patient with a complex wound often presents with multiple co-morbidities that make healing difficult. The tissue is often hypoxic, with senescent cells and a paucity of the necessary factors and cells needed for wound healing. The resultant tissue is of a poorer quality and prone to reoccur. Hyperoxia has been implicated in facilitating each phase of wound healing. The production of reactive oxygen species (ROS), especially H_2O_2 , exert an essential role in wound healing. ROS derives from O_2 . It exerts an essential role in wound healing by decreasing infection, increasing neutrophil recruitment, activating keratin forming cell regeneration, and promoting vessel formation, thereby restoring microcirculation. It provides for cell motility and extra cellular matrix formation. Hyperoxia induces ROS formation that reduces infection rate in the inflammatory phase of healing (via neutrophil/ROS mediation), enhances angiogenesis, and increases wound collagen tensile strength. Chronic wounds are characteristically hypoxic, with PO_2 in the center of the wound below what is needed to support the processes necessary for tissue repair.¹ Topical oxygen supplementation delivers O_2 deep into the center of the wound bed, raising tissue PO_2 and sustaining it over time to the levels needed to facilitate tissue repair. It promotes the fibroblast activity, collagen synthesis, angiogenesis, granulation tissue formation, and keratinocyte migration necessary for a healthy proliferative phase of healing.²⁻⁴ As a result, the tissue produced in the presence of adequate oxygen is better organized and more durable, reducing the likelihood of wound recurrence.²⁻⁴

Cyclical Pressurized Topical Oxygen Therapy (TWO₂) is a multimodal therapy that delivers concentrated topical oxygen in combination with cyclical pressure and humidification, which results in a 5-fold increase in PO_2 levels in the wound bed.⁴ The increased wound tissue PO_2 levels provide for the inflammatory mediators, immune response, ROS and growth factors that are necessary for wounds, stalled in the inflammatory phase of healing, to progress. PO_2 promotes granulation, angiogenesis, fibroblastic activity and keratinocyte migration, all necessary for a healthy robust proliferative phase of healing. It provides for a more durable tissue that is less likely to allow wound recurrence. The TWO₂ device delivers high concentration oxygen in a boot-like extremity chamber, at pressures that cycle between 7.5 and 37.5 mmHg. Cyclical pressure increases the partial pressure of O_2 , allowing a greater amount to diffuse into the to the wound bed. It also mobilizes blood and lymphatic fluids, reducing edema and further enhancing O_2 diffusion and neovascularization within the wound bed and encouraging granulation from the base. Likewise, the weeping wound can be dried, promoting a more stable wound environment. Edema reduction also decreases the hydrostatic pressure often found in the lymphovascular wound, allowing less restricted arterial flow and further improving wound bed perfusion and encouraging granulation at the wound base.⁵ Humidification counters the drying effect of oxygen and additionally contributes to an ideal wound healing environment. Together, the effects of TWO₂ provide an ideal environment for promoting healthy granulation tissue for faster more durable wound healing.

Materials and Methods

Standard protocol for TWO₂ therapy is for the device to be applied by the patient at home, over existing gas permeable dressings, 5 days a week for 90 minutes per day. The chamber boot can be applied over multi-layer wraps and total contact casts and as an adjunct with skin substitutes and advanced cell products. Topical care and offloading are continued as indicated.

Figure 1



Figure 2



Figure 3



Outcomes

Case 1 (wound progression shown in Figure 1) involved a 52-year-old male with left foot full-thickness burn wounds, present for 5 months. Revascularization failed to stimulate wound progression. After initiating TWO₂ the wound began to fill in with granulation tissue. This provided a healthy base to apply a skin substitute, which was done, and treatment continued in conjunction with TWO₂. The wound resolved at 15 weeks, after only 4 weeks of TWO₂ therapy.

Case 2 (wound progression shown in figure 2) involved a 52-year-old female, s/p revascularization and a failed left 1st ray resection. The surgical site remained non-healing at 8 months and was complicated by chronic lymphedema. After initiating TWO₂ BID the edema reduced and the wound began to progress into the proliferative phase, filling in with healthy granulation tissue. Skin substitute was applied in conjunction with TWO₂. The wound resolved at 16 weeks, after 10 weeks of TWO₂ therapy.

Case 3 (wound progression shown in Figure 3) involved a 64-year-old male with pyoderma gangrenosum resulting in limb threatening circumferential full tissue loss wounds of bilateral lower legs with exposed muscle and tendon, present for 10 months. His wounds failed to progress to the proliferative phase despite immunosuppressive therapy and revascularization. He was not a candidate for hyperbaric O_2 therapy. After initiation of TWO₂ the patient mounted robust granulation tissue. Skin substitute was applied to the healthy, vascular wound bed and he continues to progress.

Conclusion

TWO₂ provided rapid, durable wound healing in 3 complex wound cases. Wounds were able to progress out of the inflammatory phase of healing spending less time stalled in the inflammatory phase of healing. It provided for a more robust proliferative phase of healing, resulting in more durable closed tissue, less likely to allow wound reoccurrence. Advances in wound care are bringing forth exciting new adjunctive evidence-based therapies that continue to redefine the standard of care in wound treatment. TWO₂ is one such adjunctive therapy.

References

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