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Case Report

# A non healing wound treated with hyperbaric oxygen therapy

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## Abstract

Problem wounds represent a significant and growing challenge to our healthcare system. The incidence and prevalence of these wounds are increasing in the population resulting in growing utilization of healthcare resources. These problem wounds may arise from excessive pressure, trauma, venous insufficiency, diabetes mellitus, vascular disease, or prolonged immobilization leading to its difficult management with significant increases in cost, disability, and liability. Healing of such wounds is a dynamic pathway requiring the presence of oxygen for optimal restoration of tissue integrity and function needs good building blocks for repair and a good transport system to get the building blocks to the site of action. Hyperbaric oxygen therapy (HBOT) is used as a therapeutic modality which leads to an increase in tissue oxygen pressures at the wound site and hence allowing the reversal of a hypoxic state by increasing the oxygen diffusion within the plasma, consequently promoting angiogenesis, encouraging fibroblastic activity and supporting the tissues to resist against bacteria. It is used as an adjunctive treatment to enhance best-practice wound care and employing HBOT in a directed and appropriate way can significantly enhance wound healing efforts. We review a case of 17 year old girl with Grade I pressure ulcer over her right heel since 6 years and role of hyperbaric oxygen therapy as an adjunctive for its management.

## Keywords

Wound; Healing; Hyperbaric; Ulcer

## 1. Introduction

Wound healing is a complex process involving an immediate sequence of cell migration leading to tissue repair and wound closure.[1] This sequence consists of removal of debris, control of infection, clearance of inflammation, angiogenesis, deposition of granulation tissue, contraction, remodelling of the connective tissue matrix, and maturation. If wounds fail to undergo this sequence, chronic wounds may result. These are wounds that have existed for longer than 3 months and are unlikely to heal by themselves. The longer the wound exists, the less likely it is to heal with repeated uncomfortable cycle of dressings.[2 and 3]

Clinically, chronic wounds are associated with pressure, trauma, venous insufficiency, diabetes mellitus, vascular disease, or prolonged immobilization.[4, 5 and 6] Healing of such wounds needs good building blocks for repair and a good transport system to get the building blocks to the site of action. The normal healing cascade begins with an orderly process of haemostasis and fibrin deposition, which leads to an inflammatory cell cascade, followed by attraction and proliferation of fibroblasts and collagen deposition, and finally remodelling by collagen cross-linking and scar maturation.[7 and 8] despite this orderly sequence of events responsible for normal wound healing, pathologic responses leading to fibrosis or chronic ulcers occur if any part of the healing sequence is altered.[1, 4 and 5]

Currently, standard therapy for lower extremity wounds entails wound debridement, off-loading, systemic antibiotic therapy, and supportive medical therapy in an effort to heal wounds within a reasonable period of time. Hyperbaric oxygen therapy is a systemic treatment option that has emerged as a specialized and effective treatment option to manage such patients. When wound hypoxia is the systemic cause of the healing failure, providing oxygen at the wound site is, essentially, treating the cause. HBOT delivers very high concentrations of oxygen to the wound via the bloodstream, allowing it to kick start the healing process. In normal distal tissue, the partial pressure of oxygen is approximately 40 mmHg, and the partial pressure of oxygen in hypoxic wounds is about 10–20 mmHg. Following HBOT, the partial pressure of oxygen can increase to approximately 200 mm Hg.[1, 2, 3, 4 and 5]

## 2. Case report

We report a case of 17 year old girl who is a known case of myelomeningocele and had undergone laminectomy when she was four month old. She has congenital vertical talus of right foot which was corrected with soft tissue release and tendon transfer (Peronei to Tibialis Posterior transfer) and Tibialis anterior lengthening. When she was 10 years old, Grade I pressure sore over right heel was detected with calcaneal deformity of the same foot. A surgery was performed for release of dorsiflexors of right foot and ankle. In 2006, she was diagnosed with infected corn in the same heel with cellulitis. It was managed with corn excision and full debridement.

The ulcer in her right heel had varied in severity over time and was deteriorating from the past few years. In 2010, there has been a large ulcer in her right foot which was treated by excision of callus. Bacterial culture revealed growth of *Escherichia coli* which was suppressed by antibiotics. Radiographical examination of right foot revealed no calcaneal spur with diminished bone density. In 2011, she was diagnosed with Osteomyelitis of calcaneum with discharging sinus.

She presented to our unit with a non healing infected wound on the heel of her right foot. Since healing was not obtained with topical antibiotic treatment and wound care, she was referred to be evaluated for hyperbaric oxygen therapy (HBOT). On examination, she had excruciating pain estimated as 5 using scale of 0–10, 0 being no pain and 10 being worse pain ever experienced.

### 2.1. Wound profile

Past treatment of her ulcer had included pain management, debridement of wound bed with excision, but her current treatment regimen for ulcer consisted of dressings with T-Bact and betadiene. The cavity of her ulcer had soft slough with visible and deep base (Fig. 1). Wound odour was minimal and exudates presented as yellowish liquid oozing out which was being controlled by daily dressings.

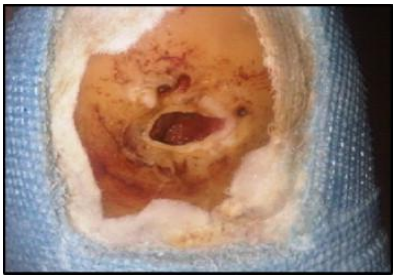

**Fig. 1. Wound on initial assessment.**

### 2.2. Hyperbaric oxygen therapy

She was initially scheduled for 10 HBOT sessions. She responded slowly to the treatment but very promising progress was shown at the completion (Fig. 2). We decided to continue a further 10 treatment. In the 4th week, after 20th HBOT session, wound showed filling of cavity with minimal exudates. The surrounding skin was healthy, soft and granulation tissue in the wound bed has remarkably increased. The wound swab was taken which indicated no organism growth (Fig. 3).

**Fig. 2. After 10th HBOT session, yellow discoloration disappeared with better granulation tissue in the wound bed.**

**Fig. 3. After 20th HBOT session, wound cavity size decreased markedly.**

She completed 25, ninety minute treatment with hyperbaric oxygen at 2.4 ATA HBOT sessions and the wound looked promising to go on to heal (Fig. 4).

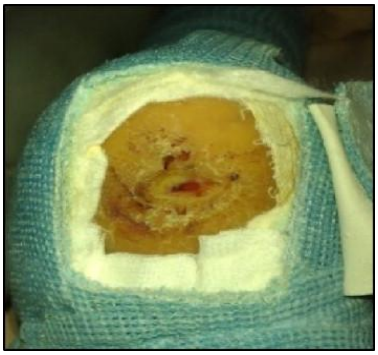

**Fig. 4. After 25th HBOT session, granulation tissue in the wound bed increased remarkably.**

## 3. Discussion

Problem wounds are a significant challenge to the health care system and its professionals.[1] Due to the high cost of treating leg ulcers and pressure ulcers in diabetic and non diabetic patients, the healthcare community has developed new strategies for optimizing the quality and cost effectiveness of traditional wound care paradigms, using strategies that are largely outcome driven.[2,3,4 and 5] The process of normal wound healing involves a carefully regulated sequence of cellular activity that provide the foundation for the mechanisms of wound repair including: extracellular matrix synthesis, angiogenesis, wound contraction.[6,7 and 8]

Systemic diseases such as diabetes mellitus, peripheral vascular disease, autoimmune disease, neuropathy, steroid dependence and venous stasis may alter the normal healing process and contribute to such chronic wounds. The treatment approach to such non healing wounds is based on three principles: a) treating the main aetiology b) locating and removing the delaying factors and c) providing the optimal environment for wound healing.[9 and 11]

**Synergistic wound healing** is combination of certain therapeutic strategies and advanced wound care modalities to achieve this goal.[10] Advanced wound care technology is defined as a treatment that positively impacts the healing process by counteracting, eliminating, or significantly decreasing at least two of the factors that can comprise the orderly transition and progress through the phases of wound healing. When the wound fails to progress despite these optimal conservative therapies, application of HBOT should be considered as an alternative therapy option which is capable of inducing healing in the absence of good wound care (Undersea and Hyperbaric Medical Society 2014).[16] Using both clinical assessment and investigations designed to confirm significant peri-wound hypoxia, hyperbaric practitioners select those wounds where a response to HBOT is considered likely.

Hyperbaric oxygen therapy has emerged as a treatment modality in many of these patients coinciding with optimized patient and local wound care. It is a well-accepted treatment for hypoxic wounds and is recommended by different medical societies, health organizations and healthcare agencies. Boykin et al found that HBO significantly reduced wound size when compared with standard wound care alone and had a higher rate of complete healing as well as a decreased in major amputation rate in diabetic and non diabetic wounds.[12] Oxygen is essential at every stage of healing process and in a hyperbaric chamber; increase in atmospheric pressure amplifies the concentration of dissolved

oxygen in blood plasma, resulting in tissue oxygen levels elevated up to 10-folds. The net result of hyperbaric oxygen exposures is improved local host immune response, clearance of infection, enhanced tissue growth and angiogenesis leading to progressive improvement in local tissue oxygenation and healing of hypoxic wounds.[13,14,15 and 16]

Various studies have concluded that HBO is beneficial in the management of diabetic and non diabetic wounds by facilitating wound healing by increasing oxygen delivery to ischaemic tissue. Thus, as the level of oxygen in the tissue decreases, so does the ability of the body to heal that tissue and fight infection.

By reversing tissue hypoxia, HBOT promotes normal repair mechanisms to stimulate slow or stalled healing. HBOT reduces the need for costly and technically more involved surgical interventions, such as skin flaps and grafts, as well as amputations and debridement.[1,4 and 7]

Though HBOT is not a panacea for all chronic, non healing wounds, but can prove to be a useful adjunct when given along with a multidisciplinary approach and optimal wound treatment that are cornerstones of wound management.

## 4. Conclusion

25 sessions of hyperbaric oxygen therapy proved to be very effective for this patient and hence proves to be a promising therapy for healing such recalcitrant wounds and ulcers that have not responded to standard treatment and deserves further study.

## Conflicts of interest

All authors have none to declare.

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