

## Hyperbaric Oxygen Therapy in Dermatology

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### Abstract

**Background:** Hyperbaric oxygen therapy (HBOT) is breathing 100% oxygen while under increased atmospheric pressure. As we all know local hypoxia predisposes wounds to infection due to the decrease of free radicals needed for neutrophil-mediated killing of bacteria. Hyperbaric oxygen restores these free radicals and also protects tissue from hypoxia. There are two types of chambers which hyperbaric oxygen may be performed; multiplace and monoplace chamber. Multiplace chambers allow closer monitoring of critical patients, while monoplace chambers are suitable for the treatment of chronic conditions in stable patients.

### Introduction

Hyperbaric oxygen therapy has been shown to be effective in treatment of wound healing [1,2]. It involves recurrent exposure of the body to 100% oxygen at pressures above the atmosphere. The treatment involves boosting the pressure up to 3.0 ATA and the patients spend about an hour daily in the chamber [3]. The primary benefit of HBOT is increasing the oxygen stress on the tissues and blood vessels. Increasing the tissue oxygenation amplifies the leukocyte activity in the wound bed and corrects the transport of anti-microbial radicals into the bacterium [4]. The treatment might last from weeks to months, between 15 to 30 sessions [5]. In the pathogenesis of chronic wounds mainly lies local ischemia or reperfusion injury. The oxygen provided in the hyperbaric chamber enhances the oxygen availability hence promoting tissue healing. As its well-known oxygen is one of the main components involved in oxi-

dativ phosphorylation, one of the main processes involved in providing the cells proper energy. Endothelial progenitor cells play a key role in healing because they participate in the angiogenesis of new blood vessels in areas of hypoxia [6].

HBOT may be performed in a monoplace or multiplace chambers. Monoplace chambers themselves are pressurized with oxygen meanwhile in the latter the air and oxygen are provided using a mask or an endotracheal tube. The pressure provided in the chamber must be systematic, first phase involving compression meaning increasing the atmospheric pressure within the chamber. In the compression phase patients may experience an increase of pressure within the sinuses or ears so Valsalva maneuver or decongestants may be of use. Meanwhile the second phase involves constant pressure period followed by decompression [7]. Hyperoxia induced by HBOT effectively improves endothelial progenitor cells' mobilization but the therapy is not tar-

geted to the wound site and serious systemic adverse events can be associated with HBOT, including seizures and pneumothorax.

### **Diabetic Wounds**

ADiabetic wounds are known to associate with neuropathy, vascular disorders and defective immunity. These patients are associated with high morbidity and mortality and HBOT has proved itself effective in wound healing, limb salvage and lower amputation rates [8]. In an analysis made on patients with Wagner II-IV diabetic ulcers it was proved that there is a significant increase in transcutaneous oxygenation following HBOT [9]. In another study performed with 30 patients in which 15 was control, other 15 being treated with HBOT it was demonstrated that HBOT significantly decreased amputation rates 7 patients being amputated in the control group compared to two patients in HBOT [10].

### **Pyoderma Gangrenosum**

A study was conducted on treatment of pyoderma gangrenosum using HBOT in conjunction with local skin grafting [11]. Pyoderma gangrenosum is a chronic neutrophilic dermatosis which is commonly misdiagnosed and difficult to treat. This disorder has been known to accompany multiple systemic disorders like inflammatory bowels disease, rheumatoid arthritis and other types of rheumatologic or hematologic disorders. In extensive cases primary treatment used to control the disease is mainly early introduction of immunosuppressants like systemic corticosteroids, azathioprine or cyclophosphamide [12]. Hyperbaric oxygen therapy has proved itself useful in treating this condition [13]. On a case report made on a patient suffering from pyoderma, it was proved that HBOT given in conjunction with conventional treatment using prednisone, azathioprine and local surgical skin grafting outcomes were excellent.

### **Crohn's Disease**

Crohn's disease is a chronic granulomatous inflammatory mainly concerning the gastrointestinal tract but is also associated with extraintestinal manifestations which includes cutaneous and anogenital involvement. Extensive disease which is functionally and psychologically distressing may significantly lower the quality of life of the patient. Chiefly

gastrointestinal precedes the skin involvement but there are reports of cutaneous disease predating gastrointestinal disease [14]. A case report was written; on a 60 year old lady with long standing Crohn's disease resistant to conventional therapy (systemic antibiotics, oral corticosteroids, mercaptopurine, infliximab, and adalimumab) who received 40 sessions of hyperbaric oxygen and after 6 months she had significant clinical improvement [15] without major side effects.

### **Livedoid Vasculopathy**

Livedoid vasculopathy is a persistent, painful, thrombo-occlusive vasculopathy that involves the distal lower extremities and feet. Typical clinical features include livedoid skin changes, atrophie blanche (ivory-white plaques), and ulceration. Inflammation, autoimmunity and hypercoagulability are the main pathogenic factors with latter being the most prominent. A report on a 30 year old male patient was recorded who had a 6 year history of recurring ulcers [16]. After several laboratory and histological analysis, diagnosis of livedoid vasculopathy associated with homo cysteinemia was confirmed. The patient showed significant improvement with 15 sessions of HBOT with conventional treatment of pentoxifylline, aspirin, folic acid and local saline dressings.

### **Hidradenitis Suppurativa**

HBOT also proved effective in hidradenitis suppurativa, a chronic inflammatory disease characterised by recurrent, painful abscesses and nodules primarily in intertriginous areas. HS is associated with significant morbidity as a result of chronic mucopurulent discharge and movement disorder due to progressive scarring. First line of treatment being mainly antibiotics like clindamycin or tetracycline and the second line of treatment consists of reconstructive surgery for movement disorders and biological agents for instance infliximab or adalimumab [17]. On a prospective randomised trial with 43 patients, the group of patients treated with HBOT in conjunction with rifampicin and clindamycin showed significant improvement compared to the control group treated only with antibiotics [18].

## Radiation Ulcers

Radiation therapy is one of the main treatments utilised in treating skin cancers. Nonetheless the exposure of the skin to high doses of radiation leads to formation of skin ulcers due to infection and irregular wound healing. The underlying cause of radionecrosis is progressive endarteritis which results in stromal fibrosis and vascular stenosis which later leads to necrosis [19]. In recent history the incidence of radiation ulcers is decreasing due to growing use high technology equipment but if radionecrosis does occur no guideline exists to treat it. Due to high risk of complication surgery is not a first option. As hyperbaric oxygen therapy increases the supply of oxygen, provokes angiogenesis, reduces fibrosis and stimulates stem cell proliferation it is seen as the right treatment option. There have been several studies of hyperbaric oxygen therapy for radiation-induced skin ulcers but most of these are only brief case series. The largest such study included 58 patients and reported an excellent response, with resolution in 25% of the patients and an improvement of 50–90% in half of the patients [20]. Cases have also been reported of a successful response in skin ulcers in the lower limbs, the breast or the anorectal area hence proving that patients with chronic radiation ulcers may benefit from HBOT [21].

## Conclusion

Hyperbaric oxygen therapy has proved itself useful as an adjuvant treatment for chronic ulcers and is highly recommended by several medical associations. HBOT should be preferred in cases of hypoxic wounds which demonstrate reversibility [22]. HBOT has proved itself useful in treating diabetic patients helping them avoid amputation. It also appeared to benefit patients with pyoderma gangrenosum, hidradenitis suppurativa, livedoid vasculopathy and other chronic conditions.

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