

Hyperbaric Oxygen for Post-trauma Wound Healing: A Case Report

R Viswanathan¹, M Mohamed Arafath², S Ahmed Yoosuf³

¹Senior Consultant, Department of General Medicine, Shifa Hospitals, Tirunelveli, India, ²Consultant, Department of General Medicine, Shifa Hospitals, Tirunelveli, India, ³Consultant, Department of Orthopedics, Shifa Hospitals, Tirunelveli, India

Abstract

In younger patients, compound humerus fractures are usually caused by high-energy trauma, such as traffic accidents or sporting accidents. Surgical wounds are made in optimum conditions with full anesthetic and operating theater support; traumatic wounds are not, and they may be associated with much more serious underlying injury. These wounds need extensive debridement down to viable tissue and should be left open until healthy granulation tissue has formed; repeated debridement may be necessary. Even after extensive debridement, an infection may develop, requiring antibiotic treatment. Case of post wound debridement LRS fixation was treated with HBOT for 10 sitting improved wound healing. HBOT is the use of 100% oxygen at pressures greater than atmospheric pressure. The patient breathes 100% oxygen intermittently while the pressure of the treatment chamber is increased to greater than 1 atmosphere absolute (ATA). Hyperoxia in normal tissues causes vasoconstriction, which reduces post-traumatic tissue edema, contributing to the treatment of crush injuries, compartment syndromes, and burns.

Key words: HBOT, Hyperbaric oxygen therapy, Trauma, Wound healing

INTRODUCTION

Wound healing is a basic and principle factor in medical treatment. The most important mechanism of wound healing is angiogenesis. Growth factor wound cell origin and cellular and biological effects are stimulated, enhancing the accumulation of endothelial cells, which move to the wound and initiate angiogenesis.^[1,2] New vessels form and each vessel initiates small branches that connect to other new vessels, forming a new vascular plexus through which blood flows into the wound leading to the remodeling phase of wound healing. During remodeling, vessels differentiate and specialize, becoming arterioles or venules. The granulation tissues, enriched with new vessels, form when the wound is open. In some cases, when the situation of patients is very complicated, including the large size of the acute wound, poor complications, or chronic wound, all relevant factors of wound healing are corrected. Nevertheless, the wound could not be satisfactorily improved. Thus, new adjuvant

therapy, which is an alternative treatment for wound healing, is used to treat patients to improve the effectiveness of wound healing. Hyperbaric oxygen increases oxygen supply in the marginally perfused ischemic/hypoxic tissues and improves the cellular metabolism that has been impaired by hypoxia. It relieves the effects of ischemia by promoting angiogenesis and healing.^[3-6]

CASE PRESENTATION

A 20-year-old male patient presented with pain and wound over his right arm following on RTA 3 days before. On examination, there was large 15 × 10 cm wound over anterior distal arm and deformity. Radiograph examination shown Grade 3B compound humerus fracture. Orthopedician opinion was bought and emergency debridement and external fixator were done after doing relevant investigations. Post-operative period was uneventful.

The physician evaluated the patient and finally concluded the treatment plan of HBOT immediately after surgery. Opinion from orthopedician and plastic surgeon was obtained. All vital signs and investigations were normal. Ten sittings of HBOT were given and daily dressing was changed along with antibiotics. We utilize a twice-a-day regimen of 90 min at 2 atmospheres plus descent and

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Corresponding Author: Dr. M Mohamed Arafath, Consultant, Department of General Medicine, Shifa Hospitals, Tirunelveli, India.

ascent time. Treatments typically take 105 min. Patients are carefully monitored during initial treatments until stable and as necessary thereafter. Four weeks after HBOT treatment, wound healing was satisfactory.

Supportive medication and nutritional care were taken adjacent. There was a good improvement in the healing of wounds faster after hyperbaric oxygen therapy. The patient was symptomatically improved and hence discharged. Early oral intake was encouraged and advised to take a high-protein high-calorie diet supplemented with the parenteral administration of intralipid and an essential amino acid formula to reach the calculated daily calorie needs. Patients were instructed to change the dressing on alternate days [Figures 1 and 2].

DISCUSSION

Wound healing is a complex process that requires coordinated repair responses, including inflammation,

matrix production, angiogenesis, epithelization, and remodeling. Many factors may impair wound healing. Systemic factors such as medical comorbidities, nutrition, sympathetic nervous system activation, and age substantially affect the repair process. Local environmental factors in and around the wound, including bacterial load, degree of inflammation, moisture content, oxygen tension, and vascular perfusion, also profoundly affect healing.^[7] Although all of these factors are important, one of the most critical elements is oxygen supply to the wound. Wound hypoxia impairs all the components of healing essentially.^[8] Although the role of oxygen is usually thought of in terms of aerobic respiration and energy production through oxidative phosphorylation, in wound healing, oxygen is required as a cofactor for enzymatic processes and also is required for signaling mechanisms. Oxygen is a rate-limiting component in leukocyte-mediated bacterial killing and collagen formation because specific enzymes require oxygen at high partial pressure (at least 40 mmHg).^[9,10] The mechanisms by which the other processes are oxygen dependent are less clear. Still, these processes also require oxygen at a concentration much greater than that needed for cellular respiration (though not necessarily a high volume).^[11] Wound hypoxia is a common cause of impaired healing, particularly in lower extremity ulcers. Hyperbaric oxygen therapy (HBOT) is a means of correcting wound hypoxia. HBOT usually increases wound oxygen well above the physiologic range (200 mmHg). At these levels, oxygen likely acts like a drug.^[12]

Soft-tissue infections, especially of the lower limb, can be difficult to manage with routine therapy, including antimicrobial agents, anti-inflammatory medications, and surgical drainage or lavage. The addition of HBOT may be useful in bacterial killing by leukocytes and improving antimicrobial function in inflamed, hypoxic tissue. A similar effect can be expected in cases of bone infections in which necrotic bone may be preventing adequate penetration and function of antimicrobial agents. While not every wound needs hyperbaric oxygen treatment, some large wounds with hypoxic injury to the skin, underlying tissues, and large skin flaps may benefit from HBOT. The goal is to minimize tissue necrosis and loss from hypoxia to reduce the time for wound healing.^[13]



Figure 1: Before HBOT



Figure 2: After HBOT

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