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Case Report

Hyperbaric oxygen therapy a boon for complex post traumatic wounds

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ABSTRACT

Post-traumatic wounds especially after run over accidents are difficult to manage. The vascularity and regenerative potential of the tissues is severely compromised. Surgical intervention is of limited value. A conservative approach with concomitant hyperbaric oxygen therapy (HBOT) serves as a great salvage in such cases. A case of post-traumatic forefoot gangrene in a 27-year-old laborer is presented to highlight and create an awareness of the potential benefit of HBOT in salvage of distal parts of the lower extremity where the blood supply is severely compromised.

Keywords: Hyperbaric, Oxygen, Therapy, Wound, Care

INTRODUCTION

Wound management continues to be the biggest challenge to a general surgeon. Etiology of wounds is multifactorial with both intrinsic and extrinsic factors playing a variable role. There is no specific algorithm for management of wound healing. A variety of topical medications are available for treating wounds. However, the cost and therapeutic efficacy of these products is debatable. HBOT is a traditional method for treating resistant wounds. [1] A case of post-traumatic fore foot gangrene successfully treated by HBOT is presented to highlight the therapeutic efficacy of HBOT in management of such challenging wounds.

CASE REPORT

A 27-year-old man with a partial run over agricultural accident was referred to our surgical unit. There was a sutured contused lacerated wound (CLW) extending along the entire width of the fore foot, extending from the medial malleolus to the 5th metatarsal on the dorsal aspect (Figure 1). The portion distal to this contused lacerated wound was gangrenous including the left big toe. On admission to hospital, the sutures were removed (Figure 2).

The CLW was treated conservatively. Daily irrigation with diluted hydrogen peroxide solution followed by application of povidone iodine ointment was done. The response to local treatment was reassuring (Figure 3). However, the distal part especially the big toe developed changes typical of dry gangrene. Subsequently, the patient was treated as a case of dry gangrene (Figure 4). Rheo-modulatory medications such as phosphodiesterase inhibitors and xantinol nicotinate were administered. As there was no improvement in the color of the distal skin, HBOT sessions were commenced.

As the therapy continued the overlying skin got revascularized. However, there was no improvement in the coloration of the big toe. The patient was administered 17 sessions of HBOT. The left big toe underwent auto-amputation whereas the distal forefoot skin revascularized.

The remaining 4 digits revascularized with some amount of scarring at the site of the previous CLW (Figure 5).

The patient now is able to walk confidently with the left foot.

Figure 1: On presentation.

Figure 2: After immediate removal of sutures on admission to hospital.

Figure 3: After 4 sessions of HBOT.

Figure 4: Dry and mummified appearance with dry gangrene of the left big toe.

Figure 5: After 17 sessions of HBOT.

DISCUSSION

The case presented highlights the important role of HBOT in the management of complex traumatic wounds. In wounds, wherein the vascularity is doubtful or severely compromised it is impossible to achieve healing by commercially available topical preparations or with the help of rheomodulatory agents. HBOT is the use of 100% oxygen at pressure greater than the atmospheric pressure (Greater than 1 atmosphere absolute) [ATA]. The usual therapy comprises administration of 100% oxygen at 2-3 ATA with an average duration of 60-90 min.[1,2] There is no fix protocol with respect to number of HBOT sessions required. It is a matter of individual response of each wound to HBOT that determines the continuation of HBOT sessions.

HBOT has two physical mechanisms of action, hyperoxygenation and a decrease in bubble size.[2,3] Hyperoxygenation takes place in conformity with the Henry's Law which results in increase in the dissolved oxygen content in plasma due to increased partial pressure of arterial oxygen. A pressure of 3 ATA can cause approximately 6 mL of oxygen to dissolve in 100 CC of plasma thereby increasing the oxygen delivery to the tissues by many folds. Decrease in the bubble size is in conformity with the Boyle's Law in which the bubble volume decreases proportionate to increasing pressure. This mechanism is useful to treating patients suffering from arterial gas embolism.

The secondary mechanisms of action of HBOT include vasoconstriction, neo-angiogenesis, proliferation of fibroblast, oxidative killing by leukocyte and inhibition of toxins.[3,4] Increased oxygen content causes vasoconstriction in the normal tissue HBOT, auto-amputation which helps in reducing post-traumatic edema of the tissues as was seen in the case presented. Vasoconstriction contrary to the general belief does not cause hypoxia as it is compensated by increased plasma oxygen content as well as increase in micro-vascular blood flow caused by angiogenesis.[4] Oxygen also helps in hydroxylation of lysine and proline residues which are essential for collagen synthesis as well as for maturation of collagen. Hence the lack of mature collagen formation is corrected by HBOT. At a cellular level there is significant angiogenesis which increases the capillary network thereby increasing the oxygen delivery. [4-6] HBOT also increases the oxygen gradient between central and the peripheral portions of the wound thereby aiding strong angiogenesis. Fibroblast proliferation is also increased which adds to neovascularization. HBOT also leads to generation of free oxygen radicals which typically inhibit bacterial metabolic function, particularly effective against anaerobes which are destroyed. [6-8]

In the case presented vascular doppler reports were equivocal. The removal of the sutures led to decrease in the pressure at the level of the subcutaneous plane. Conservative treatment was the only option as any overzealous surgical intervention could have jeopardized the already compromised blood supply thereby hastening the process of gangrene. The aim of conservative treatment was to maintain the state of dry gangrene which was evidenced by mummification of the affected part (Figure 4). Concomitant HBOT limited the progression of the gangrene.[8] There was an improvement in the vascularity of the distal part after initial sessions of HBOT which was reassuring. Hence the patient was advised further sessions of HBOT. Subsequently there was a decrease in the tissue edema and improvement in the color of the skin. The gangrenous skin was totally replaced by normal skin. However, the big toe did not show improvement. Hence it was decided to continue the same treatment with an aim to achieve auto-amputation. After around 12 weeks of treatment with 17 sessions of HBOT auto-amputation of great toe took place. The small ulcer which developed healed uneventfully. The patient has been following up for over 16 months since discharge from hospital with no further complications. This treatment algorithm can be adopted for post-traumatic wounds wherein there is compromise of blood supply with suboptimal response to medical and surgical therapy. Utmost attempt should be made to salvage major portions of the foot which restricts physical disability.

CONCLUSION

Limb saving approach should be adopted while managing post-traumatic wounds with vascular compromise. Conservative approach comprising of dressings and rheo-modulatory agents help to render the area as dry as possible. Concomitant HBOT results in neovascularization and salvage of the compromised part of the extremity.

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