

CASE REPORT

Hyperbaric oxygen (HBO₂) treatment for a failing facial flap

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Hyperbaric oxygen (HBO₂) is an approved treatment for 13 pathological entities. One of these indications—a failing facial flap—is presented in this case report of a traumatic wound to the face and right axilla after an unprovoked pit bull attack on a 4 year old girl. Surgical repair was started acutely but the facial flap became congested and ischaemic, indicating deterioration of the blood supply. HBO₂ treatments were initiated twice a day, resulting in remarkably decreased swelling and discomfort after the first treatment. Leeching was also used to assist with reduction of venous congestion in the flap. The patient was discharged 5 days later with a well perfused, mostly intact, incision with minimal tenderness. Surgical repair was required for a small area of wound dehiscence. Photographs documenting the patient's progress with HBO₂ are presented. A discussion of the mechanisms of action of HBO₂ and its beneficial effects is provided in this case.

Hyperbaric oxygen (HBO₂) treatment is currently recognised as an approved indication for 13 pathological entities.¹ These are conditions for which HBO₂ has substantial scientific support, demonstrating therapeutic benefit. One of these indications, compromised skin grafts and flaps is presented in this case report of a traumatic wound to the face of a child.

CASE REPORT

The patient was a 4 year old girl who received multiple wounds secondary to an unprovoked pit bull attack. She sustained a large stellate laceration to the left side of her face and puncture wounds to her right axilla. There was no loss of consciousness. Her facial bones were not exposed and she did not have any fractures. She was transported to our emergency room on the date of injury, where our oral and maxillofacial surgery (OMS) department performed initial surgery about 5 hours after the original injury. The facial wound was reapproximated using a large flap with a small pedicle attachment.

During surgery her facial wound was irrigated with copious amounts of saline containing Bacitracin and debrided using a pulse-vac. Before closure, the integrity of the parotid duct was tested with a lachrymal probe. The facial wound was dressed with a non-adherent dressing and gauze sponges secured with tape. The wound at the right axilla was dressed with a non-adherent dressing and gauze in the operating room. Shortly after surgery the facial flap became very dusky and congested (fig 1). There was significant concern about the viability of the flap so the OMS surgeon requested emergency HBO₂ treatments to assist in salvaging the flap. The patient received 1 g Rocephin intravenously in the emergency department and tetanus prophylaxis in the operating room. She underwent surgery about 3 hours after the initial injury and was transported to the hyperbaric medicine department about 8 hours after the initial injury (5 hours after surgery). HBO₂ treatments were initiated within 45 minutes based upon the clinical appearance of the flap. Doppler and TcPO₂ testing was

not available and treatment was not delayed to obtain this information.

The patient's past medical history was unremarkable, with no complaints or symptoms except for some mild seasonal allergic rhinitis before this injury. There were no contraindications to receipt of HBO₂ in this patient. Contraindications could have included current or past use of certain drugs associated with poor outcomes (doxorubicin, bleomycin, disulfiram, cis-platinum, or Sulfamylon), untreated pneumothorax or known malignancies.²

Physical examination showed a scared young girl, crying intermittently, but alert and oriented and willing to follow commands. Her pulse oximetry on room air measured 98%. The wound at the left side of her face was sutured with good wound edge approximation but was very dark and dusky in appearance, indicative of poor perfusion and venous congestion. The flap was pierced with a sterile syringe needle with resultant bleeding. The wound at her right axilla disclosed small puncture wounds with erythema and swelling but intact neurological functions at the right upper extremity.

A chest x ray examination was performed before initiating dives. This was done routinely during her admission but is usually done before initiating hyperbaric treatments to rule out a pneumothorax or air trapping in the lungs. The patient was treated for a compromised facial flap with hyperbaric oxygen twice a day for 2 days, then once more before her discharge from our facility. Our standard wound care treatment protocol was employed, using a modified US Air Force Treatment Table 9 at 2.46 atmospheres absolute (45 feet of sea water) for 90 minutes for each HBO₂ treatment. A slow descent to treatment depth was used to decrease the risk of barotraumas



Figure 1 Failing flap before HBO₂. (Parental consent was given for publication of all the photographs in this paper.)

Abbreviations: HBO₂, hyperbaric oxygen; OMS, oral and maxillofacial surgery; PMNs, polymorphonuclear cells



Figure 2 Failing flap after first HBO₂ treatment.

to her ears. She did have some difficulty clearing her ears during the first treatment so she was premedicated with Afrin for subsequent treatments, with no further ear problems. The patient had significantly decreased swelling and discomfort at her face after the first treatment.

Improved tissue perfusion and improved colour were observed after the first treatment (fig 2), which continued to improve with each subsequent HBO₂ treatment.

The patient was placed on antibiotics prophylactically after her surgery. Leeching was used after the first HBO₂ treatment to assist with reduction of venous congestion. The dusky appearance of the flap suggested venous engorgement. The combination of leeching and HBO₂ treatments for venous occlusion has been shown to significantly improve flap survival over leeching alone.³ This leeching was described as “special medicine” to the patient by her parents, and the leeches were covered with a cloth during these applications. Surgical debridement of her right axilla wound was done on the third day of admission.

The patient was discharged 5 days after initiating HBO₂ treatments, having received a total of five treatments. The incision was intact, well perfused and well approximated except for a small portion at the superior aspect which dehisced and had to be repaired surgically. There was minimal tenderness at the suture line and her facial oedema was nearly resolved. The patient continued to improve after her discharge. She was



Figure 3 Healed flap.

observed several weeks later and her appearance was excellent (fig 3). She was expected to undergo scar revision at some point in the future.

DISCUSSION

HBO₂ is neither necessary nor recommended for the support of normal, uncompromised skin grafts or flaps. However, in tissue where there is decreased perfusion or hypoxia, HBO₂ has been shown to be extremely useful in graft/flap salvage.⁴ HBO₂ can help to maximise viability of the compromised tissues by counteracting trauma related tissue hypoxia and oedema and their related consequences. A number of studies have shown the efficacy of HBO₂ on enhancement of flap and graft survival in a variety of experimental and clinical situations.⁴

The immediate effect of HBO₂ is hyperoxygenation of ischaemic tissues that results from an increase in the dissolved plasma, which varies directly with the partial pressure of inhaled oxygen.⁵ Hyperoxia can be of great benefit through numerous mechanisms: improvement of oxygen delivery and preservation of tissue viability in ischaemic areas,^{6,7} vasoconstriction with reduction in local oedema but preservation of oxygenation,^{8,9} prevention of ischaemic/reperfusion injury syndrome,^{10,11} enhancement of host response to local infections,^{12,13} and enhancement of the wound healing process through stimulation of angiogenesis and tissue growth and support.¹⁴

Injuries associated with trauma arise from ischaemia, venous outflow obstruction, tissue hypoxia, and external compression. There is a potential for self perpetuation of the injury in these cases through the reperfusion injury cascade. HBO₂ is an effective intervention that counteracts the pathophysiological events that occur in these conditions.

Studies show statistically significant reductions in loss of muscle function, metabolites associated with muscle injury, oedema, and muscle necrosis with use of HBO₂.¹⁵ Flaps and grafts are compromised by tissue hypoxia. Studies demonstrate that flap/graft viability is enhanced by HBO₂ through a reduction of the hypoxic insult.⁴ Other mechanisms of action whereby HBO₂ enhances flap survival include the enhancement of fibroblastic activity and collagen synthesis, stimulation of angiogenesis,^{16,17} and possible closure of arteriovenous shunts.^{18,19} HBO₂ also exerts favourable effects on the microcirculation, with greatly increased diffusion distance in damaged tissues and prevention of the ischaemia reperfusion injury through reduced adherence of polymorphonuclear cells (PMNs) along the venule wall. PMN adherence results in release of vasoactive substances, which can cause constriction of the adjacent arterioles.¹⁰

HBO₂ treatments for acute injuries are usually given at a pressure of 2.0–2.5 atmospheres absolute and range from 90 to 120 minutes. Initial treatments are usually done twice daily. Once the graft or flap appears more viable and stable, single daily treatments are sufficient. To be of maximum benefit, HBO₂ treatment should be started as soon as signs of flap compromise appear. Flap/graft viability can be assessed by clinical judgment as well as by a variety of non-invasive and invasive techniques, including transcutaneous oximetry and laser Doppler studies.⁴

Failed flaps and grafts are costly and are associated with significant morbidity to the patient.⁴ This case report demonstrates that adjunctive HBO₂ can reduce costs and lead to a better patient outcome when flap compromise appears imminent.

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The opinions, interpretations, conclusions, and recommendations are those of the authors and not necessarily endorsed by the United States Air Force.

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