Hyperbaric Oxygen of Kansas City
Hyperbaric Medicine Program
1000 Carondelet Drive
Kansas City, MO 64114

Hyperbaric CASE SERIES

HYPERBARIC MEDICINE PROGRAM
HYPERBARIC OXYGEN OF KANSAS CITY

HyperBaric Oxygen KC
Wound Healing Center of Mid America

The Hyperbaric Oxygen of Kansas City is committed to the safe and effective application of hyperbaric oxygen therapy. Treatments are afforded the full range of patient states, from electively-referred outpatients to those who are critically ill and ventilator-dependent.

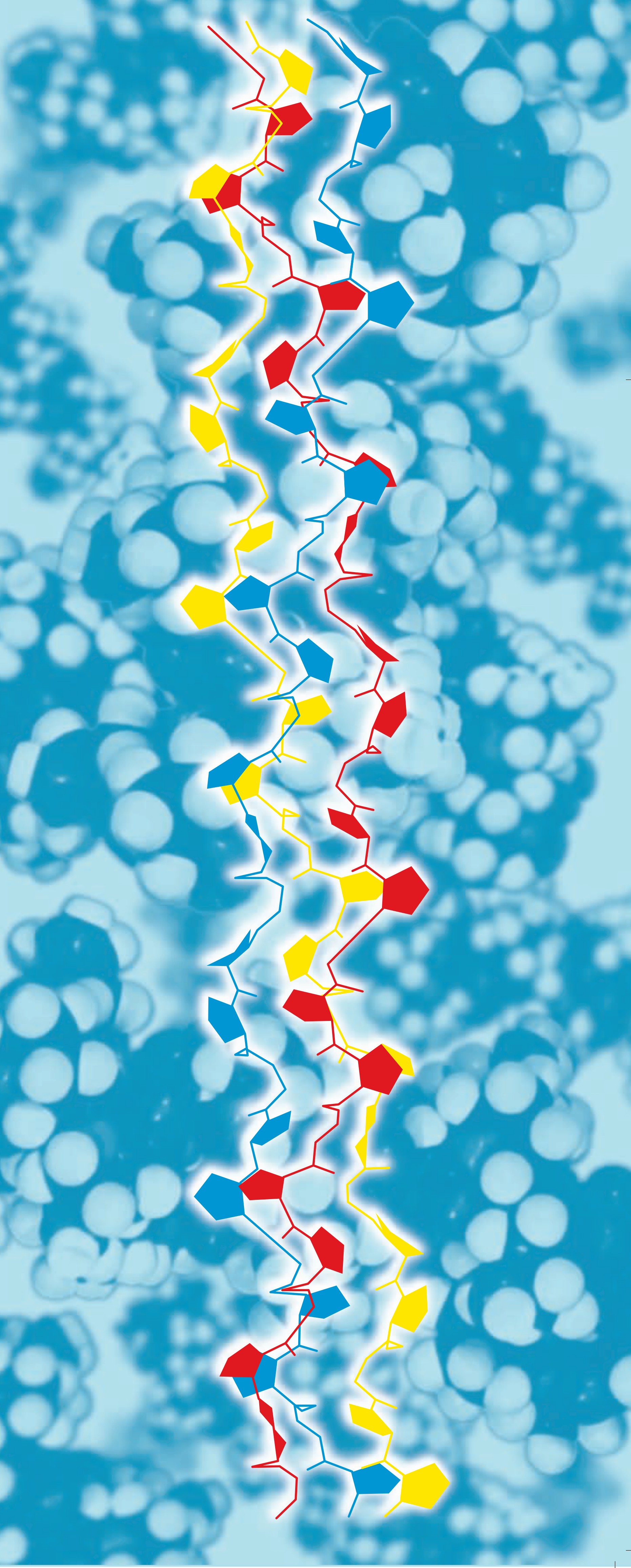
The service is supported by a knowledgeable and dedicated team of health care professionals, with broad experience in the management of the wide range of hyperbarically-referable conditions.

IF YOU WOULD LIKE TO LEARN MORE ABOUT HYPERBARIC MEDICINE, or:

- wish to refer a patient
- visit the facility
- schedule an inservice by one of our team

PLEASE CALL 816.943.4600

FAX 816.943.4736



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HYPERBARIC MEDICINE CASE SERIES

A series of case presentations identifying the improved clinical and cost outcomes that characterize the addition of hyperbaric oxygen therapy to standard medical and surgical measures, in carefully selected patients.

A 64 year old female is referred to the hyperbaric medicine service for evaluation and treatment recommendations. She presents with a right upper extremity compromised skin flap, status-post open reduction fracture repair secondary to rollover MVA.

Relevant Medical and Surgery History:
Open reduction internal fixation of right ulnar fracture; irrigation and debridement of skin, subcutaneous tissue, muscle, fascia and bone associated with the ulna fracture. Open repair of right triceps avulsion. Reattachment- reconstruction of degloving soft tissue injury. Additional traumatic injuries include a C2 vertebral fracture and a C7 right transverse process fracture.

Past Medical History:
Insulin dependent diabetes mellitus; TIA; CVA; Graves disease; hypertension, and hyperlipidemia.

Review of Systems:
Tightness of the neck; numbness overlying right forearm; effected extremity pain well controlled, otherwise unremarkable.

Focused Physical Examination:
Alert and orientated without focal cranial deficits, neck brace in place; HEENT unremarkable; right forearm significant for a curvilinear sutured incision from the right lateral elbow throughout the length of the forearm to the wrist. Hemorrhagic bullae are evident distally, as is a non-blanching maroon discoloration. (Fig. 1) The incision remains grossly intact. The entire forearm is numb although the patient does feel pressure sensation on palpation. Good range of motion is evident in all fingers with intact sensory to light touch.

Assessment:
i. Degloving injury and open right ulnar fracture; status-post surgical debridement; ORIF of ulnar fracture, triceps avulsion repair
ii. Compromised skin-fascia flap with related problem wound
iii. History of rollover MVA with above injury and cervical fractures at C2 and C7
iv. Long-standing diabetes mellitus, hypertension and hyperlipidema

Recommendations:
i. Repeat and stat CT scan of the head to confirm there is no new space occupying lesion related to her recent trauma
ii. Following a careful review of the pros and cons of hyperbaric oxygen (HBO) therapy for the above problem we feel that this patient's risk profile is in favor of immediate institution of HBO in support of her compromised full thickness skin flap.

The above recommendations are agreed to by her surgical and medical teams. The patient likewise agrees and informed consent is obtained. HBO therapy is initiated per compromised skin flap protocol.

Her initial treatment course is tolerated without complaint or side-effect. By treatment number 7 the lesions are improving clinically with essential resolution of all bullae. (Fig. 2) Superficial eschar and underlying necrosis is debrided, with healthy granulation tissue evident by treatment number 16. (Fig. 3) A split thickness skin graft is applied the following day.

Hyperbaric treatments are continued post-operatively in support of the graft, which has been applied to previously avulsed full thickness skin. At eight days post-operatively there was 100% take of the graft. (Fig. 4) HBO is discontinued. Follow-up at four weeks confirmed a complete and enduring response. (Fig. 5)

The patient's hyperbaric treatment course proved entirely uneventful. She was fully compliant and without complaint.

Fig. 1

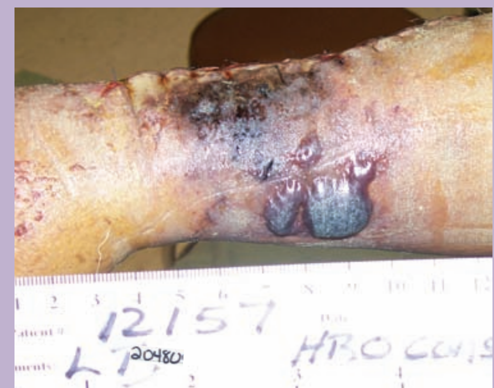


Fig. 2

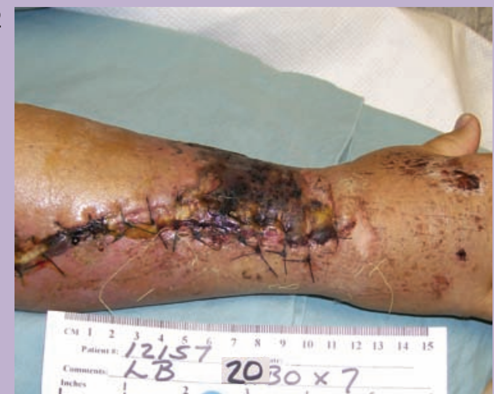


Fig. 3

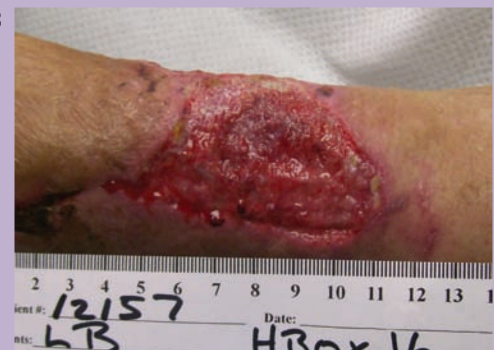


Fig. 4

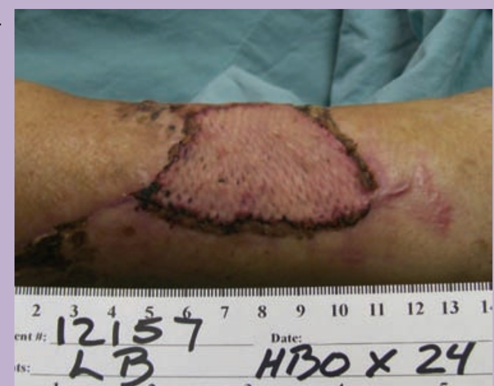
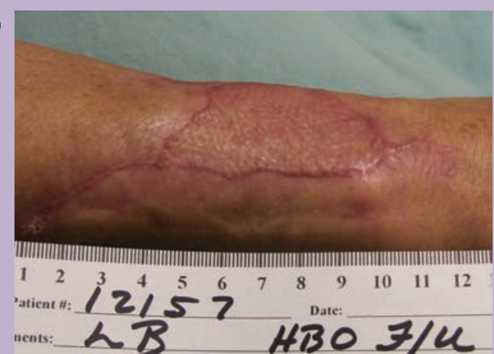


Fig. 5



Discussion:

The patient suffered extensive and complex traumatic injuries. The right upper extremity bore the blunt, with resultant complex fracture, tendon rupture and extensive soft tissue degloving. Surgical repairs were largely successful. However, the replacement and reattachment of the soft tissue defect soon became threatened. This was not too surprising given the degree of the insult and extent of damage to both the larger vessels and microvasculature.

The rate of which normal wounds heal is dependent, in large part, as the amount of locally available oxygen.[1] Local hypo-perfusion and hypoxia, therefore, represent significant impediments to wound repair. A large body of evidence exists to demonstrate that intermittent oxygenation of hypo-perfused wound beds, a process only achievable in selected patients by exposing them to hyperbaric conditions, mitigates many of these impediments and sets in motion a cascade of events that leads to wound healing.[2,3,4]

There is likewise a significant history of the use of HBO therapy in support of compromised skin flaps.[5] In a majority of cases, it should be noted that skin flap compromise is frequently corrected during re-exploration in the operating room. An arterial thrombus, formed or forming, is evacuated. Overly tight suture lines are eased and twisted pedicles corrected. Venous drainage compromise is frequently addressed by leeching. In cases where the above steps do not fully correct the problem, a random pattern ischemia exists, or degloving results in significant microvascular injury, HBO therapy has been successfully employed. A number of models have demonstrated enhanced skin flap salvage when HBO was compared to non-HBO controls.[5,6,7,8]

The published data of HBO therapy in support of compromised skin flaps and skin grafts has recently been reviewed[9] and comprehensively appraised along evidence-based lines.[10] Well controlled animal studies provide largely uniform evidence of HBO's efficacy under various etiologies. Clinical evidence was less robust, with no published 'high level' studies. This shortcoming is common across essentially all surgical and medical methods commonly employed. However, it is the opinion of the authors of the latter review that there is enough animal evidence and observational data to warrant the application of hyperbaric oxygen in selective situations, either alone or in combination with other modalities that enhance survival of compromised skin flaps.[10]

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INDICATIONS AND RATIONALE FOR HBO THERAPY *

Indications	Rationale
Acute carbon monoxide poisoning	Relieve hypoxia; hasten elimination of CO; antagonize brain lipid peroxidation
Acute exceptional blood loss anemia	Increase physically dissolved oxygen; treat hypoxia; support marginally perfused tissues
Acute thermal burns	Relieve hypoxia; decrease fluid losses; limit burn wound extension and conversion; treat edema; promote wound closure
Central retinal arterial occlusion	Hyperoxygenation diffusion from choroidal circulation that may sustain retinal tissue
Cerebral arterial gas embolism	Overcome free gas volume; relieve hypoxia; antagonize leukocyte mediated ischemia-reperfusion injury
Chronic refractory osteomyelitis	Augment host antimicrobial defenses; induce angiogenesis; potentiate leukocytic dismutase superoxide and perioxide production; relieve hypoxia; augment antibiotic therapy; extend post-antibiotic effect; augment osteoclast activity
Clostridial gas gangrene	Reduce size of gaseous bullae; inactivate clostridial alpha toxin; inhibit alpha toxin production; induce bacteriostasis; potentiate leukocytic dismutase superoxide and perioxide production
Compromised skin flaps	Support marginally perfused/oxygenated tissues; antagonize ischemic-reperfusion injury; accelerate angiogenesis
Crush injury; acute ischemia	Provide interim tissue oxygenation in relative states of ischemia; reduce edema; reduce compartment pressures; antagonize ischemic-reperfusion injury; augment limb salvage
Decompression sickness	Overcome free gas volume- induced ischemia; relieve hypoxia; hasten elimination of offending inert gas; treat edema
Intracranial abscess	Hyperoxygenation in a predominately anaerobic flora, edema reduction, enhance host defenses
Late radiation tissue injury	Re-establish wound oxygen gradients; relieve hypoxia; induce angiogenesis; prepare for definitive coverage
Necrotizing soft tissue infections	Induce bacteriostasis of anaerobes; (fasciitis and cellulitis) potentiate leukocytic dismutase superoxide and perioxide production; relieve hypoxia; more closely demarcate potentially viable tissue
Non-healing marginally perfused wounds	Re-establish wound oxygen gradients; relieve hypoxia; reduce edema; induce angiogenesis; correct diabetic-induced leukocyte changes; prepare for definitive coverage

*UNDERSEA AND HYPERBARIC MEDICAL SOCIETY, 2008