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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.

R. F., a 73 yo male, was referred to HBO on an urgent basis as an inpatient for support of a complex wound repair, involving muscle flaps and split thickness skin grafting. On the day of referral the patient had undergone extensive salvage surgery for recurrence of a malignancy at his thoracolumbar back and spine. This procedure involved wide excision, decompression laminectomy of L1-S1, a right latissimus turnover flap, right and left gluteus myocutaneous flaps and a 60 cm2 split thickness skin graft. This surgical process was considered at risk secondary to two prior tumor resections and perilesional tissue beds previously exposed to high dose therapeutic radiation.

Significant Medical and Surgical History:
Four year history of recurrent, malignant, fibrous histocytoma of the thoracolumbar back, with initial resection in 2003. This involved removal of a 5kg mass, a right lower lobectomy, removal of four ribs and partial diaphragm resection. Recurrence in 2004 was treated with excision and radiation therapy. No underlying cardiopulmonary diseases, diabetes or vascular disorders.

Review of Systems:
From a hyperbaric medicine risk perspective, significant only for thoracic and pulmonary surgeries.

Assessment:
i. High wound healing risk, secondary to 6,600 cGy of external beam radiation.
ii. Thoracic and pulmonary surgeries represent cause for concern regarding potential for decompression-induced pulmonary barotrauma leading to possible pneumothorax and arterial air embolism. Given the enormity of this surgically-induced defect, its extensive repair and the implications of failure, this patient's hyperbaric risk profile is considered acceptable, with appropriate management precautions.

Recommendations:
i. Immediate hyperbaric oxygen (HBO) therapy per threatened skin flap protocol.
ii. Reevaluate progress in conjunction with scheduled standard wound care and after 20 HBO treatments.

Following informed consent, the patient commenced his hyperbaric oxygen treatment course. When the dressings were first taken down five days later, the skin graft was non-viable. (Fig. 1) HBO was continued in order to generate granulation tissue within this previously irradiated tissue bed; wound vac therapy was started. The patient was discharged to outpatient status. By hyperbaric treatment #16 there was no evidence of granulation tissue. (Fig. 2) At treatment #26 the wound had dehisced to its original incision line, (Fig. 3) however, granulation tissue was now evident throughout the wound bed. As healing responses were clearly apparent, HBO therapy was continued in order to more completely prepare the wound for another attempt at definitive closure. This occurred following treatment #38. Sustainable coverage was finally achieved, and proved enduring. (Fig. 4)

Discussion:

This case represented two distinct conditions for which HBO therapy was considered helpful. One was the irradiated tissue bed. Advances in delivery of therapeutic radiation have markedly diminished but not entirely eliminated the volume and degree of potential damage to healthy 'non-target' tissues.[1] Although the etiology of delayed radiation injuries may vary somewhat between organ systems, its hallmark is one of a progressive obliterative endorteritis. Resulting decreases in perfusion and local hypoxia may result in spontaneous tissue break down. More commonly, it will represent a healing complication when surgical procedures are undertaken within or through the radiation portal.[2] In contrast to more conventional therapies which only address symptoms, hyperbaric oxygen has been shown to reverse the underlying pathophysiology and induce wound repair.[3] Clinical experience at several different anatomic sites is likewise supportive.[4] A recent controlled clinical trial has validated the role of HBO therapy in pelvic radionecrosis.[5] The second component to this patient's care addressed the reconstructive procedure. There are inherent threats to skin flap viability, per se, as well as threats related to compromised surrounding (in this case irradiated) tissue. HBO therapy has been demonstrated to improve survival in several flap models of partial and random-pattern ischemia.[6,7] This topic has recently been extensively reviewed from an evidence-based medicine perspective.[8]

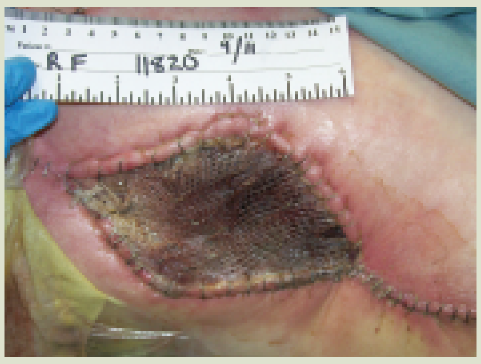

Fig. 1

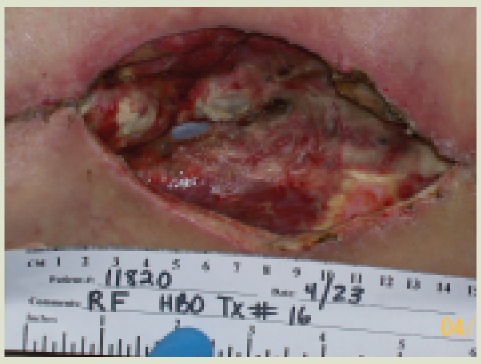

Fig. 2

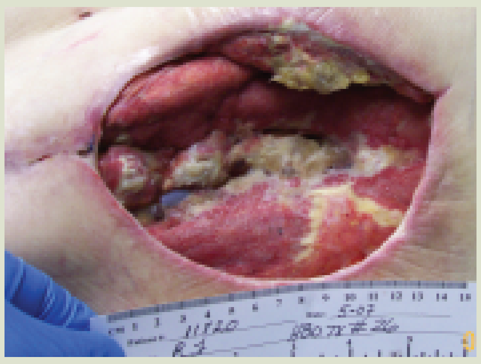
Fig. 3

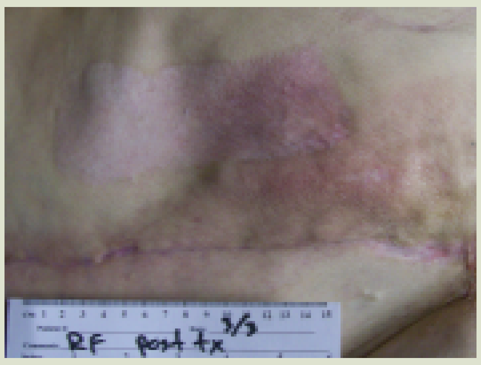

Fig. 4

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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
Cerebral arterial gas embolism	Overcome free gas volume; relieve hypoxia; antagonize leukocyte mediated ischemia-reperfusion injury
Chronic 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
Late radiation tissue injury	Re-establish wound oxygen gradients; relieve hypoxia; induce angiogenesis; prepare for definitive coverage
Late radiation tissue injury prophylaxis	Re-establish wound oxygen gradients; induce angiogenesis prior to surgical wounding
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

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