

# Cancer Radiation

**Calabro, F. et al. "MRI of radiation myelitis: a report of a case treated with hyperbaric oxygen." *Eur Radiol* 2000;10(7):1079-84.**

Radiation therapy is commonly applied as a primary or adjuvant therapy for malignancies. One of the major complications following radiation therapy is the necrosis of the otherwise normal surrounding soft tissues and/or bone. Post-radiation myelopathy rarely occurs when the spinal cord is included within the radiation field, in cases of high total radiation doses or for high radiation doses per fractionation. Up until the present, no tolerance dose for the spinal cord has accurately been defined and no treatment has proved satisfactory. Hyperbaric oxygen therapy is already currently used as adjuvant treatment for osteoradionecrosis and for radionecrosis of soft tissues with satisfactory results, whereas results for the treatment of post-attinic myelitis were contradictory. The aim of our report is to describe a case of radiation myelitis with a progressive improvement in the clinicoradiologic picture following hyperbaric oxygen treatment.

**Filntisis, G.A., et al. "Laryngeal radionecrosis and hyperbaric oxygen therapy: report of 18 cases and review of the literature." *Ann Otol Rhinol Laryngol* 2000 Jun;109(6):554-62.**

Laryngeal radionecrosis is a difficult late complication of radiotherapy. It is associated with hoarseness, edema, pain, weight loss, and upper airway obstruction. The medical treatment options are limited, and in severe cases, the patient may require tracheostomy or laryngectomy. We report clinical results in 18 patients treated with adjunctive hyperbaric oxygen (HBO) therapy for severe radionecrosis of the larynx. Of these 18 patients, 2 had grade 3 and 16 had grade 4 radionecrosis. The patients received a mean number of 41 HBO treatments (range, 6 to 80) at 2 atmospheres absolute for 2 hours, twice a day, 6 days a week. Thirteen patients (72.2%) had a major improvement after HBO therapy, and none of them required total laryngectomy. All patients preserved their voice and deglutition in good or normal condition. Five patients (27.8%) failed to have a good response to HBO and underwent total laryngectomy. One of these patients had local recurrence of his cancer 4 months later, and the other 3 had significant concurrent medical problems. The remaining patient received only 6 HBO treatments because of emergency heart surgery. These encouraging results are comparable to those of smaller previous studies suggesting that HBO has a beneficial effect in the management of advanced laryngeal radionecrosis.

**Gouello, J.P., et al. "The role of hyperbaric oxygen therapy in radiation-induced digestive disorders. 36 cases." *Presse Med* 1999 Jun 5;28(20):1053-7. (article in French)**

The objective of this investigation was to study the effect of hyperbaric oxygen on chronic irradiation induced digestive disorders. A retrospective study was conducted in 36 patients (mean age 66 years) with chronic digestive tract necrosis which had developed a mean 42 months after irradiation therapy. Hyperbaric oxygen therapy was given a mean 17 months after symptom onset: failing healing (n = 9), rectal bleeding (n = 19), profuse diarrhea (n = 9), recurrent anal abscess (n = 1). The severity of the digestive tract radionecrosis was quantified using the Soma-Lent scale. Hyperbaric oxygen therapy was grade 1 (n = 1), grade 2 (n = 11), grade 3 (n = 16), grade 4 (n = 8). Thirty-six patients underwent a mean 67 hyperbaric sessions (100% O<sub>2</sub>, 2.5 atm, 90 min). Three patients died within one month of the first session due to radiation enteritis, a neoplastic process or another concomitant cause. Immediate outcome after hyperbaric oxygen therapy was cure (n = 3) or improvement (n = 16) in 19 patients (53%) and failure in 17 (47%). Long-term results evaluated in 32 subjects with a mean 52 months follow-up were: cure (n = 9) or improvement (n = 12) in 21 patients (66%) and failure in 11 (34%). Nine patients died within a mean 25 months after the end of the hyperbaric sessions. Death was related to digestive tract radionecrosis in 1 case and neoplasia in 5. The authors conclude that hyperbaric oxygen therapy provides clinical relief in 2 out of 3 patients and can be a useful alternative to conventional treatment in patients with chronic radiation-induced necrosis of the digestive tract.

**Leber, K.A. et al. "Treatment of cerebral radionecrosis by hyperbaric oxygen therapy." *Stereotact Funct Neurosurg* 1998 Oct;70 Suppl 1:229-36.**

Clinically observed adverse radiation effects (ARE) are rather uncommon, but modern imaging reveals that they are more common after radiosurgery than previously believed. Little is known about the pathogenesis, and current treatment is mostly empirical. The benefit of hyperbaric oxygen therapy (HBO) on radiation-induced bone and soft tissue necrosis is known in lesions in the maxillofacial area, the mouth and in the head and neck. HBO raises the tissue pO<sub>2</sub> and initiates a cellular and vascular repair mechanism. This forms the basis for the hypothesis that it might also help alleviate the results of cerebral radionecrosis. This study is a preliminary attempt to test this hypothesis. Two patients with arteriovenous malformations (AVMs) were chosen for the study. They had been treated with Gamma Knife radiosurgery (GKRS) and had developed imaging signs consistent with ARE. They were treated by breathing 100% oxygen at 2.5 atmospheres absolute (250 kPa) in sessions of 60 minutes per day. This treatment was repeated 40 times in cycles of ten sessions. Both responded well to HBO,

one lesion disappeared and the other was reduced significantly in size. No adjuvant steroids were given. These results give evidence that HBO has a potential value in treating but further experience will be needed to confirm its definite benefit.

**London, S.D. et al. "Hyperbaric oxygen for the management of radionecrosis of bone and cartilage." *Laryngoscope* 1998 Sep;108(9):1291-6.**

The authors review the use of hyperbaric oxygen in the management of radionecrosis of the head and neck with a retrospective analysis of patients utilizing chart review and telephone interviews. All patients diagnosed with osteoradionecrosis and chondroradionecrosis of the head and neck and treated with hyperbaric oxygen<sup>1</sup> at the University of Virginia were included. Sixteen patients with osteoradionecrosis and five with chondroradionecrosis were reviewed. All patients showed clinical improvement with decreased pain following HBO therapy. None of the patients with chondroradionecrosis required laryngectomies, and two of the four who were tracheotomy dependent were successfully decannulated. The patient and physician grading scores demonstrated moderate to significant improvement in both groups following therapy. The successful use of hyperbaric oxygen for the management of radionecrosis of the head and neck is supported. The unusual prevalence of chondroradionecrosis may be an early reflection of changes in treatment protocols for patients with head and neck cancer.

**Bradfield, J.J. et al. "Rapid progression of head and neck squamous carcinoma after hyperbaric oxygenation." *Otolaryngol Head Neck Surg* 1996 Jun;114(6):793-7.**

We present four head and neck cancer patients who apparently had rapid progression of clinically occult disease during or soon after undergoing hyperbaric oxygenation. This led us to review existing knowledge about the interaction of HBO with tumors. The literature can be summarized as follows: 1. HBO is a useful tool in several situations commonly encountered by head and neck surgeons—infections, radionecrosis, and wound-healing problems. 2. The use of HBO as a hypoxic cell sensitizer during radiation therapy has been extensively studied, with evidence supporting only marginal advantage to this logistically difficult undertaking. 3. Most reports regarding the interaction of HBO with transplanted tumor cells suggest no effect on tumor growth or metastases. 4. Studies of chemically induced carcinogenesis are less conclusive. Some evidence supports a role for HBO in enhancing growth of preexisting tumors. Better understanding of the interaction of HBO with existing tumors is required to ensure that informed choices—weighing potential risks and benefits of HBO treatment—may be made by head and neck surgeons and their patients. Further research into the interaction between HBO and tumor cells is warranted.

**Ashamalla, H.L. et al. "Hyperbaric oxygen therapy for the treatment of radiation-induced sequelae in children. The University of Pennsylvania experience." *Cancer* 1996 Jun 1;77(11):2407-12.**

**BACKGROUND.** The role of hyperbaric oxygen (HBO) therapy in the treatment of radiation-related sequelae in adults is well known. In contrast, its role in the management of radiation-related sequelae in children has not been well studied. In an effort to define its value better, the authors reviewed the University of Pennsylvania experience and hereby report the results of their analysis. **METHODS.** Between 1989 and 1994, ten patients who underwent radiation therapy for cancer as children were referred for HBO therapy. Six patients underwent HBO therapy as a prophylactic measure prior to maxillofacial procedures; dental extractions and/or root canals (four patients), bilateral coronoidectomies for mandibular ankylosis (one patient), and wound dehiscence (one patient). Therapeutic HBO was administered to four other patients; one patient for vasculitis resulting in acute seventh cranial nerve palsy and the other three after sequestrectomy for osteoradionecrosis (mastoid bone, temporal bone, and sacrum, respectively). Osteoradionecrosis was diagnosed both radiologically and histologically after exclusion of tumor recurrence. The number of treatments ranged between 9-40 "dives" (median, 30 dives). Treatments were given once daily at 2 atmosphere absolutes for 2 hours each. Adjunctive therapy in the form of debridement, antibiotics, and placement of tympanotomy tubes was administered to two patients. Ages at HBO treatment ranged from 3.5 to 26 years (median, 14 years). Six patients were male and four were female. The most commonly irradiated site was the head and neck region (eight patients; brain stem gliomas [one], posterior fossa primitive neuroectodermal tumor [one], rhabdomyosarcomas [three], nasopharyngeal cancer [one], carcinoma of the parotid gland [one], and Hodgkin's disease [one]). The remaining two patients received radiation therapy for pelvic tumors [Ewing's sarcoma and rhabdomyosarcoma]. Radiation doses ranged between 4000 and 6660 centigray (cGy) (median, 5500 cGy). The interval between the end of radiation therapy and HBO treatment ranged between 2 months and 11 years (median, 15 years). The median follow-up interval after HBO therapy was 2.5 years (range, 2 months-4 years). **RESULTS.** Except for two patients who had initial anxiety, nausea, and vomiting, the HBO treatments were well tolerated. In all but one patient, the outcome was excellent. In the six patients who had prophylactic HBO, all continued to demonstrate complete healing of their orthodontal scars at last follow-up. In the four patients who received HBO as a therapeutic modality, all 4 had documented disappearance of signs and symptoms of radionecrosis and two patients demonstrated new bone growth on follow-up computed tomography scan. One patient with vasculitis and seventh cranial nerve palsy had transient improvement of hearing; however, subsequent audiograms returned to baseline. **CONCLUSIONS.** The use

of hyperbaric oxygen for: children with radiation-induced bone and soft tissue complications is safe and results in few significant adverse effects. It is a potentially valuable tool both in the prevention and treatment of radiation-related complications.

**Shafer, M.R. "Use of hyperbaric oxygen as adjunct therapy to surgical debridement of complicated wounds." *Semin Perioper Nurs* 1993 Oct;2(4):256-62.**

The use of hyperbaric oxygen therapy is expanding as research continues to validate its use in a variety of chronic and acute illnesses. High-dose oxygen, delivered under pressures greater than sea level, enables the body to increase diffusion of oxygen into tissues and stimulates angiogenesis and the immune response. These effects improve overall wound healing for those suffering from radionecrosis, peripheral vascular disease, and a variety of complicated infections.

**Kindwall, E.P. "Uses of hyperbaric oxygen therapy in the 1990s." *Cleve Clin J Med* 1992 SepOct;59(5):51728.**

Hyperbaric oxygen can produce a variety of effects in addition to reducing air and gas embolism. It increases the killing ability of leukocytes and is lethal to certain anaerobic bacteria. It inhibits toxin formation by certain anaerobes, increases the flexibility of red cells, reduces tissue edema, preserves intracellular adenosine triphosphate, maintains tissue oxygenation in the absence of hemoglobin. In addition, it stimulates fibroblast growth, increases collagen formation, promotes more rapid growth of capillaries, and terminates lipid peroxidation. These actions of hyperbaric oxygen are useful in treating anaerobic infections that result in gas gangrene, as well as severe aerobic infections such as necrotizing fasciitis, malignant external otitis, and chronic refractory osteomyelitis. Hyperbaric oxygen can help preserve ischemic tissues and facilitates the rapid spread and arborization of new capillaries. It promotes healing in certain problem wounds. Adjunctive hyperbaric oxygen treatment is a new approach to the management of radionecrosis.

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