

Radiation Induced Hemorrhagic Cystitis and Hyperbaric Oxygen

Radiation induced hemorrhagic cystitis (RIHC) can occur as early as 3 months after radiation or may not become evident for many years. Significant grade 3-4 RIHC occurs in 3 -11% of post pelvic radiation patients despite advances in administration technique and delivery. Historically, severe hemorrhagic cystitis was associated with a 44% mortality rate despite aggressive urinary diversion and cystectomy. Radiation causes chronic fibrosis, endarteritis and progressive tissue hypoxia of the bladder submucosa and muscular tissue with eventual scarring, mucosal sloughing and symptomatic hemorrhagic cystitis. Radiated tissue is rendered hypoxic, hypocellular, and hypovascular to the point that tissue is no longer able to heal spontaneously.

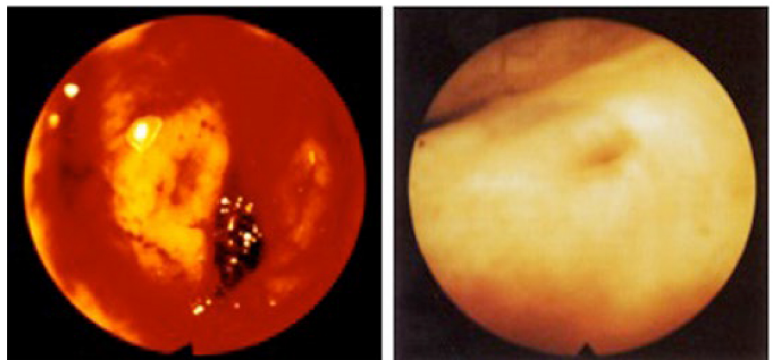
Hyperbaric oxygen therapy is the only intervention that has been proven to increase the number of blood vessels in irradiated tissue.

Hyperbaric oxygen (HBO) therapy is typically administered daily, Monday through Friday. The intermittent hyperbaric oxygenation allows for periods of hypoxia between daily treatments. During these hypoxic periods angiogenesis factors are released from macrophages, which causes capillary budding. New capillaries, however, cannot advance unless they are surrounded by a collagen matrix. HBO raises the oxygen tension in tissue sufficiently for collagen formation to take place at greater distances from damaged/functioning capillaries.

A minimum of 20 mmHg partial pressure of oxygen is required for fibroblast proliferation and collagen production to occur. Irradiated tissue is often far below this level. In normal tissue at atmospheric pressure, this tension of oxygen exists up to 30 microns away from the capillary wall. Under hyperbaric conditions this tension can be maintained up to 280 microns away. This rich collagen matrix allows capillary buds to invade rapidly and form a new advancing vascular system that returns perfusion to within normal limits, thus allowing the irradiated tissue to heal.

Benefits of HBO include:

- Increased collagen and extracellular matrix protein deposition
- Increased oxygen diffusion distance from the capillaries
- Improved leukocyte-bacterial-killing
- Improved local tissue oxygenation
- Decreased local tissue edema
- Increased angiogenesis
- Reduced inflammation



Cystoscopy shows severe radiation cystitis (left) and its reversal (right) following hyperbaric oxygen therapy

References

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