

## Refractory Osteomyelitis and Hyperbaric Oxygen

Refractory osteomyelitis is defined as a chronic osteomyelitis that persists or recurs after appropriate interventions have been performed or when acute osteomyelitis has not responded to accepted management techniques. In most cases, the best clinical results are obtained when hyperbaric oxygen (HBO) therapy is administered in conjunction with culture-directed antibiotics and initiated soon after clinically indicated surgical debridement.

Researchers have demonstrated that the decreased oxygen tensions typically associated with bony infections can be returned to normal or above normal levels while breathing 100% oxygen in a hyperbaric environment. Achieving such elevations has important consequences for the hypoxic milieu of osteomyelitic tissue.

Neutrophils require tissue oxygen tensions of 30-40 mmHg to destroy bacteria by oxidative killing mechanisms. Leukocyte-mediated killing of aerobic gram-negative and gram-positive organisms, including *Staphylococcus aureus*, is restored when the low oxygen tensions intrinsic to osteomyelitic bone are increased to physiologic or supraphysiologic levels.

Hyperbaric oxygen increases bone oxygen levels and promotes osteoblastic and fibroblastic division at an accelerated rate, resulting in bone and collagen deposition. Higher oxygen tensions also aid in the transport of aminoglycosides across cell membranes. When given over longer periods, HBO stimulates angiogenesis which results in neovascularization which reverse local ischemia and aids in the delivery of antibiotics. HBO has been found to arrest refractory disease in approximately 60 to 85% of cases. However, HBO is only an adjunctive form of therapy; to be effective, it must be combined with antibiotics, sequestrectomies of necrotic bone, bone grafts, and removal of hardware when possible.

### Benefits of HBO include:

- Increased effectiveness of ABXs which require oxygen for active transport across microbial cell membranes
- Decreased local tissue edema due to vaso constriction of vessels in non-ischemic tissues
- Improved local tissue oxygenation leading to improved cellular energy metabolism
- Increased collagen and other extracellular matrix protein deposition
- Increased oxygen diffusion distance from the capillaries
- Improved leukocyte-bacterial-killing



### References

Moon, R. K. "Undersea and Hyperbaric Medical Society." *Hyperbaric Oxygen Therapy Indications 14<sup>th</sup> Ed.* (2019)

Mader, J. T., et al. "Hyperbaric oxygen as adjunctive therapy for osteomyelitis." *Infectious disease clinics of North America* 4.3 (1990): 433-440.

Park, M. K., Myers, R., and Marzella, L. "Oxygen tensions and infections: modulation of microbial growth, activity of antimicrobial agents, and immunologic responses." *Clinical infectious diseases* 14.3 (1992): 720-740.