A study of chronic refractory tibia osteomyelitis treated with surgery and adjuvant hyperbaric oxygen

BY VISHAL MAGO, MOHD RASHIM, ALTAF MIR MOHD AND MOHIT DHINGRA

Introduction

Chronic tibial osteomyelitis is a difficult problem to eradicate and often fails to respond to surgical treatment. Orthopaedic surgeons find it difficult to treat these infections which reside as a nidus in dead bone. There is always a risk of recurrence after treatment.

Various types of alternative therapies have been tried. Hyperbaric oxygen has shown promise in enhancing bone and soft tissue healing. Hyperbaric oxygen (HBO2) is delivered to patients who breathe 100% oxygen in a hyperbaric chamber that has been pressurised to greater than atmospheric pressure (1 atmosphere absolute, ATA). In accordance with Dalton and Henry's laws, the amount of oxygen dissolved in plasma increases as the fraction of inhaled oxygen (FiO2) and pressure increases. This therapy increases the partial pressure of oxygen (pO2) in plasma and also, critically, in the osteomyelitic bone.

The aim of this study was to report our experience with HBO2 therapy in the treatment of pyogenic tibial osteomyelitis in a prospective case series and review this modality.

Methods

This study was done in the Hyperbaric Unit of the Department of Burn and Plastic Surgery, AIIMS, Rishikesh in collaboration with the department of orthopaedics. The study group were patients with chronic tibial osteomyelitis. A complete medical history, laboratory data, culture, antibiotic therapy, and operative treatment data was recorded in all enrolled patients. Image studies included x-ray, cultures and computerised tomograms. Chronic refractory osteomyelitis was defined as bone infections that persisted longer than six months.

All patients enrolled in this study had the following three inclusion criteria:

1. Infection for at least six months
2. Had received surgical procedures to eradicate the infection
3. Treatment with parenteral antibiotics

Exclusion criteria was:

1. Presence of untreated pneumothorax
2. Radiologically indicated bullae or bleb
3. Pregnanc
4. Severe emphysema and chronic obstructive pulmonary disease (COPD)
5. Uncontrolled seizure disorders
6. Cardiovascular instability

HBO2 therapy was administered in a multiplace hyperbaric chamber once a day for five days a week during the range of two to twelve weeks. The treatment pressure was between 2-2.4 ATA and each session consisted of three 25-minute oxygen periods with five-minute intervals of breathing air to reduce the risk of oxygen toxicity. The HBO2 sessions were conducted by trained healthcare personnel under the supervision of the hyperbaric medicine specialist. Success of treatment was defined as patients who had good wound healing with no discharge and no recurrence of infection during the follow-up period after HBO therapy.

Results

Four patients with chronic osteomyelitis who were treated with surgical debridement and impregnation of antibiotic beads were subjected to adjuvant hyperbaric therapy for 10 cycles of 2ATA for 90 minutes five days in a week. All patients responded well to hyperbaric sessions. No recurrence of infection or sinus formation was seen. No complications of the procedure were recorded. Two patients were given gastrocnemius muscle flaps after debridement and saucerisation with antibiotic bead placement. One patient was subjected to saucerisation with preservation of posterior cortex in upper one third of right tibial defect. Defect was covered with superiorly based fasciocutaneous flap after implantation of antibiotic impregnated beads. Removal of the K wire with the antibiotic beads was performed four weeks later. Postoperative x-rays showed no recurrence of infection. All flaps healed uneventfully after hyperbaric oxygen therapy.

Discussion

Soft tissue reconstruction or osteocutaneous transfer is necessary when there are soft tissue or bone defects. However, optimal surgical results are not always achieved, and this is one of the common causes of refractory infection. The recurrence rate in chronic refractory osteomyelitis is relatively high.

HBO therapy promotes tissue oxygenation and hastens bone and soft tissue healing in ischaemic tissue.

Thirty-eight patients with chronic non-haematogenous osteomyelitis were treated by local wound debridement, prolonged parenteral administration of antibiotics and an average of 48 daily treatments with hyperbaric oxygen. Of these 38 patients, 34 remained free of clinical signs of osteomyelitis for an average of 34 months (range, 24-59 months) after this regimen of treatment [1].

The risk of chronic osteomyelitis is increased in patients with chronic diseases such as diabetes mellitus, peripheral vascular disease, and chronic renal

insufficiency caused by poor wound healing and increased susceptibility to infection [2].

Reported treatment regimens for various series typically vary from between 10–40 sessions in total [3-6].

Patients have to be counselled about the long-term benefits of this therapy and more sessions may be needed to get the desired result [7]. This study showed 82.6% of patients treated with hyperbaric therapy responded for chronic refractory osteomyelitis (n=23).

Chen showed in his study that debridement and parenteral antibiotic treatment combined with HBO therapy at 2.5 atmospheres ATA for 120 minutes, and five days per week regimen was beneficial in all 14 patients. There were no complications of therapy [8].

The mechanisms of action are enhanced leukocyte oxidative killing, osteogenesis, angiogenesis, and synergistic antibiotic activity. Complications of treatment are infrequent, and the only absolute contraindications are pneumothorax and previous bleomycin therapy.

This study throws light on the clinical benefits of hyperbaric medicine therapy in chronic osteomyelitis. Hyperbaric therapy is useful for patients with primary treatment resistance, help reduce long hospital stays, repeated surgeries, and morbidities. Awareness of this information will help to decrease the costs of pyogenic bone infections to patients and the healthcare system.

References

1. Morrey BF, Dunn JM, Heimbach RD, Davis J. Hyperbaric oxygen and chronic osteomyelitis. *Clin Orthop Relat Res* 1979;**144**:121-7.
2. Davis JC, Heckman JD, DeLee JC, Buckwold FJ. Chronic non-hematogenous osteomyelitis treated with adjuvant hyperbaric oxygen. *J Bone Joint Surg Am* 1986;**68(8)**:1210-17.
3. Esterhai JL, Pisarello J, Brighton CT, et al. Adjunctive hyperbaric oxygen therapy in the treatment of chronic refractory osteomyelitis. *J Trauma* 1987;**27**:76-8.
4. Onen MR, Yuvruk E, Karagoz G, Naderi S. Efficiency of hyperbaric oxygen therapy in iatrogenic spinal infection. *Spine* 2015;**40**:1743-8.
5. Larsson A, Engström M, Uusijärvi J, et al. Hyperbaric oxygen treatment of postoperative neurosurgical infections. *Neurosurgery* 2008;**62**:652-71.
6. Ahmed R, Severson MA, Traynelis VC. Role of hyperbaric oxygen therapy in the treatment of bacterial spinal osteomyelitis. *J Neurosurg Spine* 2009;**10**:16-20.
7. Skeik N, Porten BR, Isaacson E, et al. Hyperbaric oxygen treatment outcome for different indications from a single center. *Ann Vasc Surg* 2015;**29(2)**:206-14.
8. Chen CE, Shin ST, Fu TH, et al. Hyperbaric oxygen therapy in the treatment of chronic refractory osteomyelitis: a preliminary report. *Chuang Gung Med J* 2003;**26(2)**:114-21.

AUTHORS

Vishal Mago,

Additional Professor and HOD, Department of Burn and Plastic Surgery, AIIMS, Rishikesh, India.

Mohd Rashim,

Senior Resident, Department of Burn and Plastic Surgery, AIIMS, Rishikesh, India.

Altaf Mir Mohd,

Assistant Professor, Department of Burn and Plastic Surgery, AIIMS, Rishikesh, India.

Mohit Dhingra,

Associate Professor, Department of Orthopedics, AIIMS, Rishikesh, India.

Declaration of competing interests: None declared.