Hyperbaric oxygen therapy: Use and applications in veterinary practice

Liza Schneider

212 Fraser Street, Tauranga

Introduction

Hyperbaric Oxygen Therapy has been used in human medicine since the beginning of the 20th century. Based on sound scientific principles, it is now an accepted treatment modality for several conditions including non-healing wounds, compromised skin grafts, refractory infections, gas gangrene, crush injury, carbon monoxide poisoning and thermal burns. There are currently three operating veterinary hyperbaric units in New Zealand located at well known veterinary clinics and a small number overseas.

Hyperoxygenation provided by HBOT facilitates the optimization of a number of physiological processes. It assists in the resolution of infection (directly and indirectly), supports neovascularisation, enhances osteoblast and osteoclast activity and stimulates tissue regeneration. Additionally there is some research to suggest that it may be of benefit in halting the progression of certain neoplastic conditions.

There is extensive scientific information as well as controlled studies - probably more than many of our better known treatment modalities - supporting the use of HBOT, many having been conducted with animal subjects in order to justify the use in humans. Basically any ischaemic condition may benefit from this form of therapy alone or in conjunction with conventional therapies.

Hyperbaric oxygen therapy

In a pressurized chamber humans and animal patients breathe 100% oxygen. Under this increased pressure (usually two atmospheres), the partial pressure of oxygen is greatly increased in the body leading to the increased carriage of oxygen by haemoglobin but most importantly the dissolution of oxygen in the plasma (a 12-15 fold increase) which is carried to areas which may be too poorly perfused with oxygen to heal efficiently under normal circumstances. This raised level of oxygen remains in tissues for up to four hours post treatment and healing activity is promoted.

Hyperoxygenation facilitates the oxidative white blood cell killing mechanism as well as improves basic leukocyte function. Growth of anaerobic bacteria such as clostridia and pseudomonas is inhibited thereby limiting the production of deadly toxins and aiding in the resolution of clostridial cellulitis as well as myonecrosis. Together with this action, the activity of aminoglycocides and other anti-microbial agents is enhanced (their transport across the bacterial cell wall is oxygen dependent) making HBOT a very useful adjunctive treatment modality for chronic and deep infections.

With HBOT neovascularization is supported as the necessary pO2 to support collagen deposition, angiogenesis and capillary budding is provided. Vasoconstriction is induced by hyperoxic conditions and the reduction in blood flow together with the restoration of endothelial integrity

decreases oedema formation while still achieving sufficient oxygenation of tissues.

Since the diffusion of oxygen into tissues is often impaired by oedema, scar tissue and vessel damage, HBOT is an effective means of delivering oxygen to target tissues as it overcomes these barriers. The amount of oxygen reaching superficial tissues is easily quantified in humans using transcutaneous measurements making this a useful non-invasive tool for wound assessment and its likely response to treatment with HBOT.

Osteoclast, osteoblast and fibroblast activity is greatly enhanced by hyperoxygenation thereby promoting rapid healing of bone fractures. Non healing fractures studied in animals since the 1960's have confirmed faster healing and remodeling of bone.

Case studies done in the 60's together with controlled animal studies conducted in the 80's indicate that chronic refractory osteomyelitis treated with HBOT had an increased success rate of up to 85%.

HBOT's applications in veterinary medicine are extensive. It may be used as a primary or an adjunctive therapy for a variety of conditions. Animals have demonstrated improved vitality and healing from a number of conditions including trauma such as crush injury, skin grafts, fracture healing, cellulitis, nerve injury, severe infection, muscle and tendon damage and many more conditions. Studies have been performed investigating the use of HBOT in Equines, especially for aiding in the recovery of injured athletes.

A number of human and animal studies have been conducted showing the effects of HBOT on malignant tumours using a variety of treatment protocols. Just less than half of these showed a regression of the tumour growth while half showed no effect and a few showed that tumour progression appeared to be enhanced. The different protocols used as well as the type of tumour treated may have influenced results. Animal studies using HBOT to treat sarcomas reported the most beneficial effect. HBOT used in combination with radiotherapy or chemotherapy has been shown to be more successful in controlling or reversing tumour growth.

Additional practical uses for HBOT are pre-anaesthetic treatment sessions, especially for geriatric animals and animals with high anaesthetic risk as well as post operatively to assist healing, minimise and enhance the reduction of post surgical swelling.

Oxygen toxicity, as a result of hyperbaric oxygenation inducing neurological symptoms, is rare but may occur when pressures higher than three atmospheres are used for prolonged periods. A potential negative effect of hyperoxygenation is the formation of oxygen derived free radicals which may be counteracted with the administration of anti-oxidants. Additionally, HBOT augments host cell enzyme activity to assist in the degradation of free radicals minimising their negative effects.

Potential complications of HBOT include tympanic membrane rupture and generalized discomfort because of the increased pressure. Development of a pneumothorax due to the presence of lung bullae is also possible, therefore a thorough examination, especially of the thorax of the patient should be conducted before therapy is begun. Unstable patients should not be treated.

Clinical experience suggests that most animals tolerate the hyperbaric chamber without the use of sedatives and experience very little discomfort for the duration of therapy. Treatment generally lasts sixty to ninety minutes (usually fifteen minutes of compression, sixty minutes at the desired pressure and fifteen minutes of decompression) and may be used once or twice a day depending on the severity of the condition being treated. The number of treatments required is also dependent

on the nature of the condition but animals typically respond very well to one to five treatment sessions, although up to ten sessions may be required for severe conditions.

References

Depenbusch FL, Thompson RE, Hart GB. Use of hyperbaric oxygen in chronic osteomyelitis. *Journal of Trauma* 12, 807-812, 1972

Elkins AD. Hyperbaric Oxygen Therapy: Potential Veterinary Applications. *The Compendium* May 1997

Esterhai JL, Clark JM, Morton HE *et al*. Effect of hyperbaric oxygen exposure within medullary canal in the rabbit tibial osteomyelitis model. *Journal of Orthopaedic Research* 4, 330-336, 1986

Hosgood G, Elkins AD. Hyperbaric Oxygen Therapy: Mechanism and potential applications. *The compendium* May 1990

Jain KK. *Textbook of Hyperbaric Medicine*. Seattle, Hogrefe & Huber, 1996

Kerwin SC, Hoggood G, Strain GM *et al*. The effect of hyperbaric oxygen treatment on a compromised axial pattern flap in the cat. *Veterinary Surgery* 22, 31-39, 1992

Lian QL *et al*. Effects of hyperbaric oxygen on S-180 sarcoma in mice. *Undersea Hyperbaric Medicine* 22, 153-160, 1995

Mader JT, Brown GL, Guckian JC *et al*. A mechanism for the amelioration by hyperbaric oxygen of experimental staphylococcal osteomyelitis in rabbits. *Journal of Infectious Diseases* 142, 915-922, 1980

Morrey BF, Dunn JM, Heimback RD, Davis JC. Hyperbaric oxygen and chronic osteomyelitis. *Clinical Orthopaedics and Related Research* 144, 121-127, 1979

Wallyn RJ, Gumbiner SH, Goldfein S, Pascale LR. Treatment of anaerobic infections with hyperbaric oxygen. *Surgical Clinics of North America* 44, 107-112, 1964