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Review Article

Dentistry Section

Hyperbaric Oxygen Therapy – Can It Be the New Era in Dentistry?

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ABSTRACT

Hyperbaric oxygen therapy is a rapidly developing treatment modality in various fields of dentistry. It is the administration of 100% oxygen to the patient for a specified time period, to increase the oxygen tension in the tissues and also its dissolution in the blood. This review aims to briefly discuss the history, mode of action, indications, contraindications, complications and the applications of hyperbaric oxygen therapy in dentistry.

Keywords: Hyperbaric oxygen therapy, Dentistry, Osteoradionecrosis, Osteomyelitis, Implant failure

INTRODUCTION

Oxygen is the primary requisite for life. It helps in the growth and development of humans. It enhances wound healing by vascular proliferation and cell multiplication. Hyperbaric oxygen therapy is defined as administration of 100% oxygen to a patient who has been placed inside a chamber which has been pressurized to greater than one atmosphere at sea level [1]. Hyperbaric sea oxygen therapy (HBOT) is a systemic treatment option, wherein a patient breathes pure oxygen at greater than one atmospheric pressure for a specified period of time. Therapeutic effects of HBOT are caused by an increase in dissolved oxygen in plasma and tissue oxygen delivery [2].

The concept of hyperbaric oxygen therapy can be traced back to 1600, but as a therapy, HBO began to be given in 1943. Since 1967, hyperbaric oxygen with 100% oxygen, beginning at 2.8 ATA, has been the world's standard for the treatment of decompression sickness among military and commercial divers and aviators [3]. The aim behind writing of this article is to review the various uses of hyberbaric oxygen therapy in dentistry.

MODE OF ACTION

The effects caused by hyperbaric oxygen on the body can be divided into primary or direct effects like increased oxygen tension and diffusion in the tissue; secondary or immediate effects like vasoconstriction, angiogenesis, fibroblast proliferation and increased leukocyte oxidative killing [4]. These effects are based on the gas laws, physiological and biochemical effects of hyperoxygenation.

Henry's Law states that the amount of gas which is dissolved in a liquid or tissue is proportional to the partial pressure of that gas which is in contact with liquid or tissue [5]. In hyperbaric oxygen therapy, the increased amounts of oxygen which is supplied, increases the oxygen tension in the tissues, thus explaining the effects of hyperoxia in hypoxic tissues.

When the oxygen tension decreases, there is influx of neutrophils. The activated neutrophils consume enormous amount of oxygen, leading to further decrease in oxygen levels in the hypoxic tissues. Very low levels of oxygen can cause tissue injuries. Hyperbaric oxygen therapy reverses the hypoxic tissue injuries by increasing the oxygen concentration, thereby helping the neutrophils by supplying oxygen and accelerating the healing process [6,7].

Hyperoxygenation causes vasoconstriction in the normal tissues. This is useful in post-traumatic tissue oedema. This effect of hyperbaric oxygen is used in the treatment of compartment syndrome, crush injuries and burns. There is also a three-fold increase in the diffusion distance of oxygen [8]. According to a study which was done on rabbit ear chambers, it was documented that capillary growth was also influenced by the oxygen concentration. Formation of capillaries increased with increased oxygen tension [9].

INDICATIONS AND USES

According to the Undersea Hyperbaric Medical Society [10], the approved indications of hyperbaric oxygen therapy are

1. Air or Gas Embolism
2. Carbon Monoxide Poisoning

Carbon Monoxide Poisoning Complicated by Cyanide Poisoning

3. Clostridial Myositis and Myonecrosis (Gas Gangrene)
4. Crush Injuries, Compartment Syndrome and Other Acute Traumatic Ischaemia
5. Decompression Sickness
6. Arterial Insufficiencies

Central Retinal Artery Occlusion

Enhancement of Healing in Selected Problem Wounds

7. Severe Anaemia
8. Intracranial Abscesses
9. Necrotizing Soft Tissue Infections
10. Osteomyelitis (Refractory)
11. Delayed Radiation Injuries (Soft Tissue and Bony Necrosis)
12. Compromised Grafts and Flaps
13. Acute Thermal Burn Injuries

Contraindications

The various contraindications of hyperbaric oxygen therapy [11] are:

Absolute contraindications:

Untreated tension pneumothorax

Relative contraindications:

Upper restrictive tract infections

Emphysema with carbon dioxide retentions

Asymptomatic pulmonary lesions which are seen on chest X- ray

History of thoracic or ear surgery

Uncontrolled hyperthermia

Pregnancy

Claustrophobia

Seizure disorder

Applications in Dentistry.

In dentistry, hyperbaric oxygen therapy is used in

- Osteoradionecrosis
- Osteomyelitis of jaws
- Aggressive periodontitis
- Adjunctive therapy for the placement of the implants in irradiated jaws.

Osteoradionecrosis

Osteoradionecrosis is a serious complication of the jaws which occurs after head and neck radiotherapy. Patients are subjected to HBOT to prevent the necrosis of the bone after extraction in irradiated patients [Table/Fig-1]. Necrosis occurs since blood supply is compromised after radiotherapy. Osteoradionecrosis is characterized by hypocellularity, hypovascularity and hypoxia. Due to the increased oxygen tension and blood supply, there is angiogenesis and increased healing of the hypoxic wounds. This leads to effective management of the jaw bone which is affected by Osteoradionecrosis. According to the randomized control trial which was conducted by Marx et al., it was observed that in the group which was treated with only penicillin, the rates of osteoradionecrosis were 30%/patient and 23%/extraction socket, but that in the HBO group, the corresponding values were 5% and 3% which were considerably low [12,13].

Dental implications	Clinical condition	Mode of action of HBOT
Osteoradionecrosis	Decreased oxygen tension- hypotension hypocellularity, hypovascularity	Increases the oxygen tension in the region and promotes angiogenesis and wound healing
Osteomyelitis	Chronic unresponsive wound infection by dormant bacteria	Increases the host response by favouring the action of inflammatory cells.
Implants in irradiated bone	Implants when placed in the irradiated bone lead to failure because of increased susceptibility to infection and compromised bone formation	Stimulates effective bone formation and increases host defense mechanism
Periodontitis	Microorganisms and their toxins affect the periodontium	Inhibits the growth of subgingival obligate anaerobes and facultative anaerobes and promotes healing of the peridontium

[Table/Fig-1]: Summary of dental implications of hyperbaric oxygen therapy

Refractory Osteomyelitis

Osteomyelitis is a chronic, unresponsive bone infection which is caused by bacteria that may remain dormant for years. The treatment of osteomyelitis is surgical debridement and antibiotic prophylaxis [5]. The main complication in osteomyelitis is the presence of a barrier between the host and the infection. This barrier can be suppuration, necrotic bone, but it can limit the action of the host's immune system [14]. In refractory osteomyelitis, antibiotics which are used to destroy the microorganisms in the soft tissues around the sites of infections and surgery are used for the macroscopic removal of necrotic bone. But hyperbaric oxygen therapy aims at the improval of the host response and at making the environment more favourable for the action of the inflammatory cells. In a study which was done on the treatment of chronic refractory osteomyelitis, 11 out of 14 patients were successively treated with hyperbaric oxygen therapy without any complications [15].

Implants in irradiated bone

Dental implants offer an alternative for tooth replacement. Dental implants are directly inserted into the bone which replaces the missing teeth. The adjacent bone around the implant should fuse well into the implant surface by forming new bone. But in an individual who has already undergone radiation therapy, the implant is likely to fail, because the bone formation is compromised after radiation. In an experimental study done on implants inserted into irradiated bone, to assess the effects of hyperbaric oxygen therapy on the capacity of bone formation, hyperbaric oxygen therapy was found to stimulate effective bone formation [16]. According to histomorphometric studies done on effects of bone reactions on titanium implants, it was found that the woven bone was not replaced by lamellar bone in irradiated patients [17].

Periodontitis

The effect of hyperbaric oxygen on aggressive periodontitis and subgingival anaerobes in Chinese patients, documented the effect of hyperbaric oxygen therapy. This assessment was done by measuring plaque index, gingival index, probing depth and attachment loss, two years after hyperbaric oxygen therapy was indicated. It was concluded in this study, that HBO could inhibit the growth of subgingival obligate anaerobes, facultative anaerobes and Bacteroides melaninogenicus, thus promoting healing of peridontium, which could help in the treatment of aggressive periodontitis [18].

The use of hyperbaric oxygen as a adjunct to scaling and root planning in patients with generalized chronic periodontitis, is found to improve the clinical parameters like probing depth and attachment level, thus indicating the beneficial effects of hyperbaric oxygen on the periodontium [19].

In a study, hyperbaric oxygen was found to stimulate the proliferation of osteoblastic cells in vitro, in presence of 10% foetal calf serum (FCS) and an inhibitory effect was observed in presence of 2% (FCS) [20].

Complication

Though hyperbaric oxygen therapy has widespread applications, complications in the usage do occur. In hyperbaric oxygen therapy, there are pressure equalization problems which predominantly affect the middle ear and the nasal sinus, which cause barotraumatic lesions. In a study which was done to analyze the side effects of hyperbaric oxygen therapy, oxygen toxicity and ocular disturbances were reported [21].

Non-emergent patients who are treated routinely with hyperbaric oxygen, with oxygen being administered via a head hood, have a potential risk of CNS oxygen toxicity which is three fold greater than is normally quoted [22]. But the complications which were observed were transient and they were limited mostly within the duration of the treatment.

CONCLUSION

Hyperbaric oxygen therapy has widespread indications in various medical conditions. But the effective use of hyperbaric medicine in dentistry requires established evidences. Researches should be initiated in this field of dentistry, to develop advanced treatment options with hyperbaric oxygen therapy. When it is established, hyperbaric oxygen therapy serves a promising future and a new era of safer treatment modalities.

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