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HYPERBARIC OXYGEN THERAPY IN DENTISTRY – A REVIEW

Dental Science

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ABSTRACT

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

KEYWORDS

INTRODUCTION:

Hyper means increased and baric means pressure. Hyperbaric Oxygen (HBO) is defined as the inhalation of oxygen at increased pressure for potential therapeutic benefit in variety of clinical situations. The committee on hyperbaric medicine defines HBO therapy as "a mode of medical treatment in which the patient is entirely enclosed in a pressure chamber and breathes 100% oxygen at a pressure >1 atmosphere absolute (ATA). ATA is the unit of pressure and 1ATA is equal to 760mm of mercury or pressure at sea level.

Oxygen is the primary requisite for life. It helps in growth and development of humans. It enhances wound healing by vascular proliferation and cell multiplication. Therapeutic effects of HBOT are caused by increase in the dissolved oxygen in plasma and tissue oxygen delivery.

History:

The concept of hyperbaric oxygen 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 2.8ATA, has been the worlds standard for the treatment of decompression sickness among military and commercial divers and aviators.

Mechanism 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 tissues; secondary or immediate effects like vasoconstriction, angiogenesis, fibroblast proliferation and increased leukocyte oxidative killing.

These effects are based on gas laws, physiological and biochemical effects of hyperoxygenation.Henry laws states that 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. In hyperbaric oxygen therapy, the increased amount 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. Activated neutrophils consume enormous amount of oxygen, leading to further decrease in oxygen levels in the hypoxic tissues.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.

EQUIPMENT [4, 8]

There are two types of hyperbaric chambers, monoplace and multiplace chambers (Table 1).

Table 1: Features of monoplace and multiplace chamber

	Monoplace	Multiplace
Patient	Claustrophobic environment limited access to patient.	More room assistance to deal with some acute problems.
Administration of HBO	Inhaled in the atmosphere or through an endotracheal tube in the monoplace chamber.	Inhaled through mask, tight fitting hoods or endotracheal tubes in a larger multi-occupant chamber.
Cost	Lower cost.	Higher cost.
Infection	Less spread of infection.	Risk of cross infections when used for ulcers.
Portability	Portable more common worldwide. (5-32)	Large device not portable.
Treatment on patient	Usually one patient at a time and is used to treat patients with chronic medical conditions.	Required for critically ill patients who require an attendant within the chamber and is usually used for acute problems.
Risk	Increased risk of fire.	Reduced risk of fire.

Monoplace chambers have a small air tight cylinder for patient placement. The chamber is then filled with pressurised pure oxygen. Only auditory and visual communication is possible and patient cannot be physically examined. In multiplace chambers several patients can be treated at the same time and the patient just breaths the hyperbaric oxygen through endotracheal tube or air tight mask and they can be clinically monitored by nurses or physicians throughout the procedure.

Indications And Uses :

According to the Undersea Hyperbaric Medical Society , the approved indications ofHyperbaric 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
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

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.
- Oral submucous fibrosis

Osteoradionecrosis: Osteoradionecrosis of the jaw is commonly a death of the jaw bone and bone within the head and neck region because of the decreased oxygen tension-hypotension hypocellularity and hypovascularity. Osteoradionecrosis is a serious complication of the jaws whichoccurs after head and neck radiotherapy. Symptoms of osteoradionecrosis include mouth pain, jaw swelling, poor smelling breath, mouth sores, and difficulty opening the jaw.

In 2013, a study was done regarding HBOT and mandibular osteoradionecrosis during tooth extractions. It was determined that HBOT provided adequate prevention. HBOT in conjunction with penicillin proceeding tooth extraction proved to have a more efficient and longer lasting recovery in comparison to the patients exclusively treated with penicillin. Time sensitivity is imperative – if the treatment of HBOT is administered 2 weeks prior to the dental treatment, complications arise in 1.5% to 4.2% of the patients.23 If the treatment

is prolonged to six months prior to the dental treatment, the percentage of complications increases to 15.8%

A Marx protocol was created for the treatment of ORN within the jaw, that includes three critical stages. Stage I of this process requires setting the HBOT level to 2.4 ATA for a total of 90 minutes. After a third of the session is completed, it is necessary to inspect the targeted area for softening of exposed bone and granulation tissue. If the following are present, it is suggested to follow up with non-surgical debridement and follow up with an addition of 10 HBOT sessions.

Stage II is necessary only if little or no response is observed after the previous 30 sessions of treatment. Stage II requires peripheral resection of non-vital bone to bleeding bone margins, followed by 10 postoperative sessions of HBOT.

Stage III recommends resection of the mandible after 30 ineffective sessions of HBOT. Add plates and pins and covering the soft tissue deficit will help to stabilize the mandible. The 10 subsequent treatments of HBOT and 3 months of healing are recommended. At this point, bone remodeling can be completed.

Osteomyelitis Of Jaws:

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. 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. 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.

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 .

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.

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)

Oral submucous fibrosis: is a constant debilitating disease as a result of juxta epithelial fibrosis of the oral cavity. Although success of treatment is rare, HBOT is commonly executed. This requires the patient to inhale 100% oxygen at increased atmospheric pressure often ranging between 2.0 and 2.5 atm (1 atm = 101.325 kPa) for 60–120 seconds. HBOT works to increase oxygen tension and flow to impaired tissue. HBOT also has the ability to prevent inflammation which helps expedite the healing process.

Table 2: Therapeutic doses of HBO [4, 17]

Condition	Dosage	Duration
Carbon Monoxide Poisoning	2.5 - 3.0 atmospheres	4 - 6 hours
Decompression sickness	2.5 - 3.0 atmospheres	2 - 4 hours
Arterial Gas Embolism	2.5 - 3.0 atmospheres	2 - 4 hours
Radiation Induced Tissue Injury (ORN)	2.4 atmospheres	90 minutes (30 preoperative sessions)
ClostridialMyonecrosis	3 atmospheres	90 minutes (with antibiotics and surgery)
Necrotizing Fasciitis	3 atmospheres	90 minutes (with antibiotics and surgery)
Refractory Osteomyelitis	2.0 - 2.5 atmospheres	90 - 120 minutes (after debridement and antibiotic therapy)
Acute Traumatic Ischemic Injury	2.0 - 2.8 atmospheres	2 hours
Anemia due to Exceptional Blood Loss	Hyperbaric oxygen used successfully to treat hemorrhagic shock in patients who refused transfusion or for whom suitable blood was not available.	
Comprised skin grafts and Flaps	2.0 - 2.5 atmospheres	90 - 120 minutes
Thermal Burns	2.0 - 2.5 atmospheres	90 - 120 minutes

Contraindications

- The various contraindications of hyperbaric oxygen therapy 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

Complications : 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.

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. 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 e 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.

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