USE OF HYPERBARIC OXYGEN THERAPY IN DENTISTRY

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Abstract
Background: Hyperbaric oxygen therapy (HBO) provides an increased supply of oxygen to the tissues, thereby promoting healing processes and regeneration.
Objectives: The aim of this study was to identify the possibility of using HBO in the dental practice.
Methods: In the review article we present findings from studies published in electronic databases and journals until the end of 2015 aimed at the effect of HBO in dental indications.
Results: HBO, as an adjuvant therapy of patients after the head and neck irradiation, significantly improves the reparative capacity of the damaged hypoxic, hypovascular and hypocellular tissue and reduces implant failures in these environs. HBO´s beneficial effect was also observed in the treatment of refractory osteomyelitis. HBO´s effect as an adjuvant therapy of aggresive periodontitis is probably due to a significant reduction of number of anaerobic microorganisms.
Conclusion: HBO provides the most benefit in tissues with vessels which have good blood flow. The anatomical structure of the mouth with its rich vascular beds is an advantage to benefit from the treatment. Results of the studies show that its use in dentistry is beneficial.

Key words: Hyperbaric oxygen therapy, Dentistry, Osteoradionecrosis, Implant failure

Introduction

The aim of Hyperbaric Oxygen Therapy (HBO) is to promote healing processes and regeneration of body´s individual cells and tissues. With an increased oxygen partial pressure the following effects are described most often: increase of oxygen content in the blood (when the oxygen is inhaled at the pressure of 2-3 ATA, the amount of dissolve oxygen in the plasma increases 10-15 times), increase of the diffusion distance of oxygen from the capillaries, accellerated dissolution of gas bubbles, swelling reduction and improved wound healing in ischemic tissue [1]. HBO can reduce inflammation by reducing the release of inflammatory mediators [2, 3,4]. Use of HBO is also justified in cases of soft tissue swelling, its application before the tourniquet method surgery can minimze the inflammatory response which results in a post-operative swelling [5]. Although the mechanisms of HBO in the human body are not fully understood their effects, with proper indication, have been confirmed through extensive research [6].

In dentistry, HBO is indicated for the following diagnoses: [7]

1. Osteoradionecrosis
2. Conditions after radiotherapy
3. Mandibular osteomyelitis, chronic refractory osteomyelitis
4. Periodontitis
5. Infected implants

Osteoradionecrosis

Head and neck cancer is a major health problem worldwide. It is a major global health unit, with about half a million new cases diagnosed per year, and their incidence appears to be increasing in developing countries. Patients with oral cancer are commonly treated by a combination of radiotherapy and ablative surgery. Acute oral complication of head and neck radiation appeares 1-2 weeks after radiation starts, it depends on dose and site of radiation also [8].

Acute complication: Oropharyngeal mucositis, change in salivary composition, alteration of taste, infection (bacterial, fungal, viral), periodontium pain.

Chronic complication: Trismus and fibrosis, malnutrition, osteoradionecrosis, dental caries xerostomia.

Osteoradionecrosis (ORN) is a condition of a nonvital bone in the site of radiation injury. It is one type of complex wound. Patients with history of radiation therapy were associated with 5 folds higher risk of having delayed wound healing. Wound healing process is accelerated by HBO. 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. Clinically, ORN may initially present as bone lysis under gingiva and mucosa. If soft tissue breakdown, the bone becomes exposed to saliva and secondary contamination occurs. Sepsis may also be introduced by dental extraction or surgery producing a more aggressive form. This progressive form may produce severe pain or fracture and require extensive resection. Clinical manifestations of ORN may include orocutaneous fistula, which is difficult to treat and requires staged surgery.

Partial mandibulectomy may be necessary in severe cases of ORN, mandible can be reconstructed for esthetics and function [9]. The incidence of ORN of the mandible varies from 5% to 15%, and the incidence of ORN of maxilla is much lower [10].

Sulaiman et al. [11] reviews the records of 1194 patients during 1998–2001. Meantime for follow-up was 22.9 months. They reported that selected tooth extraction before radiation therapy reduced the risk of necrosis when teeth had periodontal disease, particularly mandibular molars and furcation involvement.

Osteoradionecrosis may be prevented by extracting these teeth at least 2 weeks before radiotherapy, (periodontally involved teeth, unerupted teeth). Prevention of dental caries and periodontal disease and their sequelae can prevent ORN in most cases [12].

Increased oxygen tension in HBO leads to angiogenesis and improvement of hypoxic wounds healing [13]. David et al. [14] applied HBO as an adjuvant therapy in patients with mandibular ORN with good effect. However, HBO does not replace quality wound care. HBO should be used in additon to, but not as a replacement of aggressive wound treatment. HBO is used not only in treatment but also in prevention of ORN. Therefore, patients after head and neck radiotherapy are before the tooth extraction indicated for HBO to prevent osteonecrosis [15].

A randomized, placebo controlled trial showed statistically significant improvement in wound healing with HBO in patients with late radiation tissue necrosis compared to patients receiving normal air at 2 ATA [16].

In the prospective cohort study 40 patients with complex wounds were included, all patients received HBO. The mean wound size was 16.72 cm² in diameter. Thirty-one patients with complex wounds were healed after the completion of a series of HBO (77.5%). Two orocutaneous fistulas were completely closed without further surgery. Significant wound size reduction was noted after 5 HBO. Because the biggest reduction in wound size occurred within the first 10 HBO, it is important to conduct these first treatments without interruption. HBO is an effective and safe treatment modality for complex wounds [17].

Refractory Osteomyelitis

The jaw bone osteomyelitis represents about one third of all diagnosed cases of osteomyelitis. This is due to the presence of the teeth which are often the source of infection. 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 [18].

Implants in irradiated bone

Dental implants are metal screws introduced into the bone in the sites of missing teeth. The implant serves as an artifical root onto which a crown or a bridge can be made or prosthesis supported which then holds firmly. The adjacent bone around the implant should fuse into the implant by forming new bone. After surgical treatment of malignant tumors of the head and neck approximately 60%-80% of patients receive radiotherapy. Among the different restorative methods, implants are widly chosen for their good functional and aesthetic effects [19]. Until 1986 patients after radiotherapy for tumors of the head and brain implantation was not recommended as the damage to hard and soft tissue was seen as an obstacle to succesful osseointegration. While the inability of many patients to tolerate conventional removable prostheses has been widely documented, dental implants often increase both patient´s satisfaction and quality of life by allowing a removable prostheses and a reduction of the overload of vulnerable soft tissues [20]. Ihde et al. [21] report that implant failure is a more significant risk (up to 12 times greater) in irradiated bone rather than in non-irradiated bone. The cause are later effects which involve bone changes leading to demineralization, fibrosis, increased susceptibility to infection and finally, avascular necrosis [22]. Mancha et al. [23] studied 225 implants placed in 30 patients who had received radiotherapy, and reported that irradiated patients had a significantly higher implant loss than non-irradiated patients. The 5-year survival rate in the ORN group was 48.3% and that in the non-ORN group it was 92.3%. Succesful osseointegration is mainly affected by total dose of radiation: while doses lower than 45 Gy are not associated with implant failure, doses in the 50-60 Gy range are usually not a contraindication for implantology and doses higher than 60-65 Gy are related to a higher failure rate. A close collaboration between dentists and radiotherapists concerning the site and the radiation dose is desirable already before radiation. Impairment of cortical and trabecular bone remodeling by radiation varies, it also depends on quantitative and qualitative changes in the cells [24]. Maxillary implants placed within irradiated jaws exhibited a 496% increase in the risk of loss compared with mandibular implants [25]. The optimal timing of implant placement in radiotherapy patients is controversal. Although implant placement is performed generally no earlier than 6 months after irradiation, Sammartino et al. [26] recommend waiting at least 12 months to achieve the best clinical results. In the study of Pompa et al. 27] the time interval from radical oral cancer surgery through radiation therapy until implant placement ranged from 11-89 months (mean: 39.58).

HBO can improve the implant survival rate and achieve the ideal efficacy [28]. Granstrom et al. 29] retrospectively evaluated the implant survival of 631 implants installed in irradiated cancer patients over a 25-year period. The implant failure rate in HBO-treated patients was 8.5%, compared with 40.2% of the non-HBO-treated group. In summary, HBO has the potential to improve the implantation survival rate of patients received radiotherapy; however, the timing and indications for the use of HBO should be in accord with specific conditions clinically [30].

Periodontitis

Periodontitis is probably the most common chronic infection in adults. It is a bacterial infection of the supporting tissues of teeth at which bacteria, mostly anaerobic, multiply in dental plaque. The amount of subgingival bacteria (especially anaerobic) closely correlates with the periodontitis severity. The inflammatory process involves the tissues around the teeth; there is a loss of collagen which fixes the tooth in alveolar bone thereby causing a slow progressive loss of the alveolar bone. Untreated periodontitis can lead to the loosening and subsequent loss of the teeth. HBO has a detrimental effect on anaerobes. Significant differences were observed in clinical indices, gingival blood flow and subgingival anaerobe number by comparison of hyperbaric oxygen+scaling and scaling alone groups. HBO has beneficial therapeutic effects on severe periodontitis, which can last more than one year [31]. The most significant studies on the effect of HBO on aggressive periodontitis come from China where there are more than 5000 hyperbaric oxygen chambers [32] and a high prevalence of aggressive periodontitis. Experimental work indicates that hyperbaric oxygen can inhibit the growth of anaerobes in the periodontal pockets of humans [33] and animals [34].

Sixty cases of patients with aggressive periodontitis were randomly divided into two groups – the HBO group (30 cases) and the control group (30 cases). Their pockets could be probed to 4 mm or more and approximetely one quarter or more of the original alveolar bone height had been lost. All patients had at least 20 remaining teeth and had not received any irradiation and other periodontal therapy in the past 3 years. The initial two groups of patients were each divided into two additional sub-groups based on different treatment. The HBO group was divided into the HBO group and HBO + scaling group. The non-HBO group was divided into the scaling group and the control group. Patients of HBO group were exposed to a pressure of 2.5 ATA breathing pure oxygen a day for 90 minutes. The subjects received a total 10 treatment sessions. For all patients, clinical parameters (gingival index, probing depth, attachment loss, Plaque index and tooth odontoseisis) and number of subgingival anaerobes were recorded during the first clinical visit, immediately after the last HBO and 2 years after HBO. HBO combined with scaling and root planing was the most beneficial in the treatment. The therapeutic effect of HBO on aggressive periodontitis is most likely through inhibition of the growth of subgingival anaerobes. Clinical follow-ups suggest that the effect could last more than 2 years [35].

Discussion and conclusion

An increasing number of studies on various medical fields that objectify the effect of HBO reflect the wide range of use of this method in medical practice. With the higher number of hyperbaric chambers also the range of indications expanded. Some hyperbaric oxygen therapy indications are quite well documented in clinical studies but many of them are only supported studies which do not comply with modern criteria and thier results do not have high scientific value [36]. HBO provides the most benefit in tissues with vessels which have good blood flow. The anatomical structure of the mouth with its rich vascular beds is an advantage to benefit from the treatment, which supports the intent to use this therapy in dentistry [37]. HBO proved its worth as an adjuvant therapy in multiple dental indications. High incidence of the head and neck cancer treated with surgery followed by radiation therapy can cause bone hypocellularity, hypovascularity and hypoxia which is a risk of ORN formation. The increased oxygen tension in HBO leads to angiogenesis and better healing of hypoxic wounds which is probably the reason for the good effect of HBO in ORN treatment. HBO application also proved its preventive worth in case of tooth extraction at the site after irradiation. Tissue devastation after the head and neck tumors treatment requires functional and aesthetic reconstruction. Success of implants retention in the given site is significantly higher after HBO application. As an adjuvant therapy, HBO proved its worth in treatment of refractory osteomyelitis. HBO inhibits the growth of anaerobes in gingival pockets which is probably the cause of the effect in the treatment of aggressive periodontitis.

HBO is non-invasive, well tolerated treatment. In a series of 782 patients undergoing HBO, 17% experienced ear pain with 3.4% having visually confirmed barotraumatic otitis. In another series of 44 patients, HBO was extremely well tolerated with only one patient who stopped HBO for reversible myopia [38].

Despite several proven positive effects, HBO should not become a substitute for other, commonly used and succesful therapeutic measures [39]. Studies evaluating the positive effect of HBO in dentistry mostly recommend it as an adjuvant therapy. Despite promissing results of experimental works, the use of HBO in dentistry still has room for improvement. The effect objectification for its more extensive use will require further studies.

Acknowledgements

This publication was created in the frame of the project "Completion of the technical infrastructure for the development of science and research at Alexander Dubček University of Trenčín through Hyperbaric Oxygen Therapy", ITMS code 26210120019, based on the Operational Programme Research and Development and funded from the European Social Fund.

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