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HYPERBARIC OXYGEN THERAPY AND IT'S APPLICATION IN OPHTHALMOLOGY

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ABSTRACT

Background:. Hyperbaric oxygen therapy in it's basics consists of inhalation of 100 percent oxygen under an ambient pressure greater than the atmospheric (1 ATA).Over the past 50 years hyperbaric oxygen therapy has been recommended and used in a wide variety of medical conditions, often without adequate scientific validation of efficacy or safety.

Purpose: To explore the literature for evidence based trials and results from hyperbaric oxygen therapy in certain ophthalmic conditions and to share some of our experience with it.

Settings: Department for Hyperbaric Medicine, Hospital base for active treatment – Varna VMA, Bulgaria.

Methods: Retrospective, non comparative review of the published literature concerning hyperbaric medicine and it's application in ophthalmology.

Conclusions : The discovery of beneficial cellular and biochemical effects has strengthened the rationale for administering hyperbaric oxygen as primary therapy in patients with severe carbon monoxide poisoning, decompression sickness and as adjunctive therapy for some ophthalmic conditions. There aren't a lot of randomized, controlled studies in the field of ophthalmology exploring the effects of HBO. In our practice we found it beneficial in a number of ocular conditions.

Key words: Hyperbaric oxygen therapy, ocular application, ischemic injury, tissue perfusion.

Hyperbaric oxygen therapy (HBOT) in it's basics consists of inhalation of 100% oxygen under an ambient pressure greater than the atmospheric (1 ATA).Over the past 50 years hyperbaric oxygen therapy has been recommended and used in a wide variety of medical conditions, often without adequate scientific validation of efficacy or safety. Consequently a high degree of medical scepticism has developed regarding its use.

The pure physiology behind the healing process stimulated by HBO therapy could be described in few words : Local hypoxia leads to poor wound healing. Adequate oxygen tension is a prerequisite for the formation of collagen matrix, which is essential for angiogenesis. (1, 2, 3) In irradiated tissue, hyperbaric oxygen is more effective than normobaric oxygen in increasing the partial pressure of oxygen to a level that promotes the formation of collagen matrix and angiogenesis.(4) Whether hyperbaric oxygen is superior to 40 percent normobaric oxygen in improving wound healing in nonirradiated tissue is not clear.(3, 5, 6, 7)

Therapeutic uses of hyperbaric oxygen nowadays, along with some subaquatic emergencies is dealing mainly with decompression and it's consequencies. There are strong scientific evidences and extensive follow up for it's application as a first chose of treatment in the following (8):

Decompression sickness
Arterial gas embolism
Severe carbon monoxide poisoning and smoke inhalation
Prevention and treatment of osteoradionecrosis

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Improved skin graft and flap healing
Clostridial myonecrosis
Adjunctive treatment
Refractory osteomyelitis
Radiation induced injury
Acute traumatic ischaemic injury
Prolonged failure of wound healing
Exceptional anaemia from blood loss

Still one of the most common indications for treatment is a non-healing wound due to diabetes.(9)

The ophthalmic and related conditions include: decompression sickness or arterial gas embolism with visual signs or symptoms, central retinal artery occlusion, ocular and periocular gas gangrene, cerebro-rhino-orbital mucormycosis, periocular necrotizing fasciitis, carbon monoxide poisoning with visual sequelae, radiation optic neuropathy, radiation or mitomycin C-induced scleral necrosis, and periorbital reconstructive surgery. Other ocular disorders that may benefit from HBOT include selected cases of ischemic optic neuropathy, ischemic central retinal vein occlusion, branch retinal artery occlusion with central vision loss, ischemic branch retinal vein occlusion, cystoid macular edema associated with retinal venous occlusion, post-surgical inflammation, or intrinsic inflammatory disorders, ocular quinine toxicity, Purtscher's retinopathy, radiation retinopathy, anterior segment ischemia, retinal detachment in sickle cell disease, refractory actinomycotic lacrimal canaliculitis, pyoderma gangrenosum of the orbit and refractory pseudomonas keratitis.(10)

Complications and contraindications:

It is known that prolonged HBO treatments cause a myopic change in refraction. From the published data we know that the myopic shift is usually temporary, reversing back to basic refraction within a few weeks of cessation of the HBO course. There is controversy in the literature regarding the cause of refraction change, but research with animals reinforces the view that the source is the lens nucleus(9). Speeding up the opacification of a already started cataract development is also observed and is dose-dependent.(11) While some authors apply HBO in treatment of multiple sclerosos (MS)(12, 13) it's application is not wide accepted and is still too controversial.

Our own experience with HBO:

We present some retrospective data from Department for Hyperbaric Medicine, Hospital base for active treatment – Varna VMA. The ophthalmic conditions weren't that often that's why we didn't separate them in an individual cell in the table below. They were merged mainly in directories - Infected wounds and Traumas and consisted of optical neuritis, diabetic retinopathy, vascular pathology – thrombosis, artery occlusions, non-healing corneal epithelium wounds., etc.**(tabl.1)**

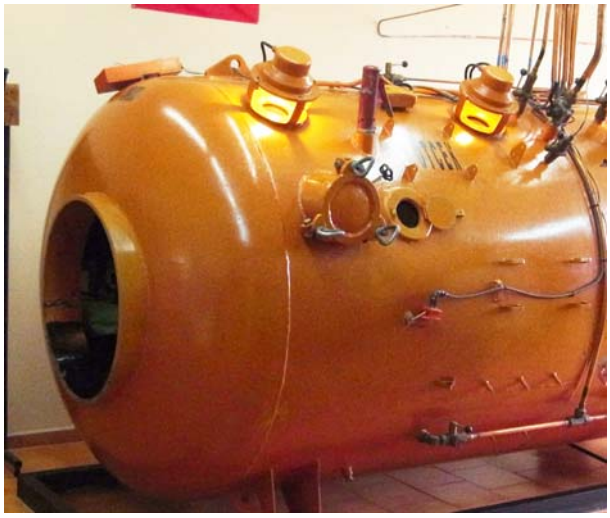
Patients treated in our department

Table. 1. *Number of the patients and distribution by etiology and outcome of the treatment.*

Diseases	**Patients**	**Healed**	**Improved**	**No effect**
Arterial and venous insufficiency	16	8 (50%)	6 (37,5%)	2(12,5%)
Diabetic foot	246	164(66,6)	62 (25%)	20(7,4%)
Atonic and varicous wounds	20	9 (45%)	6 (30%)	5 (25%)
Infected wounds	64	49(76,5%)	12 (18,7%)	3 (4,8%)
Traumas-decubitus ulcus, combustions, congelations, radiation	17	12 (70%)	3 (17,6)	2 (12,4%)
Total	**363**	**242(66,6%)**	**89 (24,5%)**	**32(8,9%)**

The group examined was treated with HBO in a multi-seated hyberbaric chamber **(Fig. 1)** The patients were inhaling 100 percent oxygen through a mask for a time period of 60 minutes every day (5 day a week) for average of 11,4 weeks at ambient pressure of 2,5 ATA..

A



B

Fug. 1. A. One of the hyperbaric chambers in use at Department for Hyperbaric Medicine, Hospital base for active treatment – Varna VMA. **B.** The inside of the chamber.

DISCUSSION

Use of oxygen in treatment of a wound or ischemic injury can be summarized as:

1. A hypoxy condition in a wound could be corrected through oxygen therapy, which varies from inhaling 40% oxygen at normal atmospheric pressure (1 ATA) up to 100% when at 2.5 ATA in a hyperbaric chamber. High pressures are needed to be oxygenated the hypoxic centre of the non-healing wound.(14)

2. An inflammation could increase the hypoxy, slowing down the recovery, so by decreasing the hypoxic state we speed up the healing process. Intermittent correction of wound hypoxy through oxygen therapy increases fibroblast proliferation and collagen synthesis.(15)

3. High oxygen pressure increases the leucocytes potential of destroying pathogenic bacteria and meets the elevated needs of O_2 of the healing wound.

4. And last but not least the oxygen inhaled at 2ATA improves the speed of re-epithelization in ischemic injuries.

CONCLUSIONS

The discovery of beneficial cellular and biochemical effects has strengthened the rationale for administering hyperbaric oxygen as primary therapy in patients with severe carbon monoxide poisoning, decompression sickness, and as adjunctive therapy for some ophthalmic conditions. There are no lot of randomized, controlled studies in the field of ophthalmology exploring the effects of HBO. In our practice we found it beneficial in a number of ocular conditions like diabetic retinopathy, optic neuritis, delayed epithelisation of the cornea, etc. We recon that in diseases for which the use of hyperbaric oxygen is not well supported, the potential benefits must be carefully weighed against the risks of damages.

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