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Hyperbaric oxygen therapy (HBOT) in andrological practice: A narrative review of the literature.

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Abstract:

Hyperbaric oxygen therapy (HBOT) is defined as the use of oxygen under pressure to increase oxygen levels in different tissues. Nowadays, HBOT is recommended as single therapy or in combination with other medical treatments like surgery or medicine for specific diseases. HBOT has a number of applications in emergency situations such carbon monoxide poisoning, envenomation from spider and snake bites, compartment syndrome, and central nervous system injury and also has a benefit in many chronic illness states like delayed wound healing. There are only a few publications on how HBOT affects erectile function, but many publications reported about its role in fournier's gangrene, radiation-induced cystitis, and interstitial cystitis that considered the principal indications of HBOT in genitourinary medicine. The rational of HBOT rely on how gases with different solubilities, particularly oxygen, behave in tissues and fluids under different pressures and volumes. Few reports about HBOT and erectile function in literature were found. HBOT is safe when performed following accepted standards except for minimal hazards.

Keywords :Hyperbaric oxygen therapy, erectile dysfunction, Andrology

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Introduction:

Hyperbaric oxygen therapy (HBOT) is defined as the use of oxygen under pressure to increase oxygen levels in different tissues. Decompression sickness was the first disease in medicine to be treated by HBOT in 1937 by Behnke and Shaw.[1] The present HBOT technique in the practice that involves breathing oxygen in a pressure chamber, was created in the 1950s.[2]

Nowadays, HBOT is recommended as single therapy or in combination with other medical treatments like surgery or medicine for specific diseases. In a hyperbaric chamber, a patient or patients are being treated. In the mono-place chamber, only one patient can be treated at once. The patient is positioned in the chamber under pressure and directly inhales ambient oxygen. Also multiple patients can be treated at the same time using the multi-place chamber. They enter the chamber under pressure and breathe 100% oxygen with different methods like masks, endotracheal tubes or head hoods.[3]

Although HBOT is recommended for treating decompression sickness, gangrene or carbon monoxide poisoning, there are only a few reports on how it affects erectile function. Fournier's gangrene, radiation-induced cystitis, and interstitial cystitis also can be treated by H-BOT and considered the main indicat-ions for use in genitourinary medicine.(3)

Principles:

Henry, Fick, and Boyle's laws of gas behavior, which describe how gases of different solubilities, most particularly oxygen, behave in tissues and fluids under different pressures and volumes, are considered the rational for use of HBOT.(4)

Cellular respiration depends mainly on both energy and oxygen. So decreased oxygen delivery to cells affect cell viability. Injury or disease decreases the body's ability to supply oxygen to the tissues, increases the demand for that substance on those tissues and may increase the distance that oxygen must travel from the capillary to the cell. Hemolytic anemia, toxicity and bleeding can affect oxygen transport to different parts of the body. The need for oxygen increases with certain conditions like infections and tissue healing. The distance that oxygen must travel from the patent capillaries to the cells is increased with different problems like edema, decreased perfusion and micro thrombosis.(4)

HBOT has clear effects on cellular functions and immune functions. In anaerobic diseases, oxygen has an important antimicrobial effect. That important effect can be explained as free radicals produced from oxygen have bactericidal effects in the reperfusion state. Additionally, HBOT promotes phagocytosis in tissues with infection. Also no one can deny the favorable impacts of HBOT on regulating not only neutrophil activity but also angiogenesis and fibroblast activity.(4)

Equipment:

Three principle types of chambers are present nowadays to deliver HBOT to diseased tissues. High-pressure multi-place and mono-place chambers are the most com-mon in human medicine, while recently low-pressure mono-place chambers were produced. Many patients, each of whom is normally breathing oxygen through a mask or hood can be placed in the multi-place chamber at the same time. The multi-place chamber is intended to be pressurized with air. The multi-place ch-ambers can accommodate a higher volu-me patient load and more seriously ill patients due to the capacity for an attendant to be present in the chamber during therapy to address any comp-lications that may arise.(5)

In the mono-place chambers no mask or hood is necessary as they are designed for a single person, and since oxygen is used as the compressed gas. These are used more frequently in chronic wound therapy clinics because they enable more individualized care and are more prevalent in smaller settings. Most of these chambers, which typically operate in the 2-2.5 ATA range, are made to endure high pressure. More contemporary low-pressure collapsible mono-place chambers that operate between 1.2 and 1.3 ATA are available on the market. These chambers are being used at home by plastic surgeons and patients to hasten the healing process after surgery. (5)

These low pressure mono-place chambers might be more acceptable in particular situations than multi-place chambers due to their portability, lower cost, and increased availability. These low-pressure chambers are still relatively

new, therefore the differences in therapeutic benefits have not been researched; however, based on the HBOT principles, tissue oxygen supply will be enhanced, but not the same degree as with high-pressure units.[5]

General indications of HBOT:

As more chambers become available and awareness of its advantages grows, the usage of HBOT as a treatment option in both human and veterinary medicine is rising despite being a relatively old therapy. It has a numerous uses for both more chronic disease states including slow wound healing and emergency situations like carbon monoxide poisoning, envenomation from spider and snake bites, compartment syndrome and central nervous system injuries.[6]

HBOT and erectile function in literature:

1)- Experimental studies:

Müller et al. studied the effect of HBOT on erectile recovery after cavernosal nerve (CN) compression injury in a rat model in 2008. No crush/no HBOT (C-/H-), no crush/HBOT (C-/H+), and rats receiving bilateral CN crush and HBOT treatment (Crush+/HBOT+) were the other two groups of Sprague-Dawley rats used in the study. HBOT was given daily for 10 days starting on the day of the CN smash, for 90 minutes at three atmospheres.[3]

2)- Clinical studies:

In a clinical study, the effect of HBOT in regaining erectile function after posterior urethral repair was investigated. Prior to and following surgery, erectile function was compared using International Index of Erectile Function (IIEF) values. Each of the 24 patients was randomly allocated to either the HBOT group (n = 12) or the control group (n = 12). Randomization was accomplished by varying the surgical care for succeeding patients. Each individual patient in the HBOT group received HBOT in a multiplace chamber.[7]

In this clinical research, each HBO exposure therapy included a 25-minute gradual start compression phase (from atmospheric pressure to the therapy's target pressure), 90 minutes of 100% oxygen HBOT at the therapy's target absolute pressure of 2.0 ATA, and an extra 25 minutes (from the treatment pressure to atmospheric pressure) of post-treatment decompression. The patients in the control group were also inserted in the same HBOT chamber but administered ineffective oxygenation (21% oxygen at 1 ATA) for 140 min for every "treatment" [7]

Each of the 24 patients received one HBO exposure therapy or inadequate oxygenation treatment for a total of 14 days beginning the day after the first postoperative day. They found that patients who received HBOT after posterior urethral reconstruction had significantly higher total IIEF, IIEF- erectile function, IIEF- overall satisfaction, and IIEF- intercourse satisfaction scores than those who did not, and they came to the conclusion that HBOT could be used to speed up the recovery of erectile function after posterior urethral reconstruction.[7]

HBOT may be a successful supplemental or alternative treatment for erectile dysfunction after finishing a research with 50 participants (ED). We examined the male patients who underwent HBOT for a range of conditions. All patients filled out the IIEF questionnaire as well as form collecting information on their demographics and medical histories both before and after HBOT. Each patient received a total of 30 HBOT sessions over the course of six weekly days. After

HBOT, patients' mean IIEF-EF scores were significantly higher than they were prior to HBOT (15.74 10.52 vs. 19.50 10.91). Additionally, mean post-HBOT IIEF values for intercourse pleasure, orgasmic function, sexual desire, and overall satisfaction were all significantly higher than pre-HBOT scores.[8]

There is also a case report that describes how HBOT was used to treat an open right foot wound on a male patient as part of a comprehensive wound management programme. The patient's medical history included Type 1 diabetes mellitus and chronic ED resistance to past PDE5I trials. The patients received a total of 60 HBO2 sessions over a period of 15 weeks. His ED symptoms had improved after the first 20 hyperbaric treatments, with the first sign of a change being morning tumescence. The patient continued to report morning tumescence 24 weeks after the previous HBOT therapy.[9]

In a clinical trial done in 2017, males who had had nerve-sparing radical prostatectomy were randomized to HBOT and phosphodiesterase enzyme -5 inhibitors (PDE5i) or PDE5i alone, however Chiles et al. were unable to detect any appreciable variations in erectile function after 18 months. It was a prospective, randomized, double-blind trial. Men between the ages of 40 and 65 who underwent bilateral nerve-sparing radical prostatectomy assisted by a robot were randomly assigned 1:1 to the control and treatment groups. Participants were either exposed to 100% oxygen as the treatment or air as the control in hyperbaric environments. The primary finding was 18-month IIEF-measured erectile function.[10]

In this study, 109 powerful men were divided into two groups at random: the HBOT group and the control group. A total of 43 guys in the air group and 40 in the hyperbaric oxygen therapy group finished the 18-month follow-up. The participants in the HBOT group got care over the course of 10 sessions, each lasting 90 minutes at 2.2 ATA. 10 treatment sessions were administered to participants in the control group (90 minutes of air oxygen at 2.2 ATA). There were no statistically significant differences between the 2 groups for any outcome measure.[10]

Potential mechanisms of HBOT in Andrology:

HBOT is hypothesized to improve tissue oxygenation, which then promotes angiogenesis, leukocyte activity, collagen synthesis, and fibroblast proliferation. HBOT can be used to treat hypoxic tissues.[11]

According to preliminary studies, HBOT increases angiogenesis and sets off transduction cascades that release prostaglandins, cytokines, and nitric oxide. But the value of HBOT in the management of andrological problems is still speculative, hopeful, and untested .[12] Later, it was suggested that the mechanism of action was the stimulation of regional growth factors.[13]

There is a theory that HBOT could increase Leydig cell function through hyper oxygenation, which would increase the production of testosterone and decrease hypogonadism.[14]

Adverse effects of HBOT:

When carried out in accordance with approved guidelines, with oxygen pressures no higher than 3 atmospheres and treatment sessions no more than 120 minutes, HBOT is completely risk-free. However, undesirable outcomes are possible. Myopia can become reversible as a result of oxygen exposure, which is a co-

mmon side effect. Cataract is a rare side effect and the patients receiving standard care did not develop cataract.[15]

Due to sudden changes in pressure, barotrauma may develop with rupture of the middle ear, the cranial sinuses, the teeth or the lungs in rare cases, producing mild to severe pain in some people. Generalized seizures may be precipitated by high oxygen concentrations under pressure, however these are uncommon, self-limited and do not result in long-term harm.[15]

As long term exposure to HBOT, reversible tracheobronchial symptoms may develop in some individuals such as coughing, chest tightness, and a burning sensation under the sternum. There is a reversible loss in pulmonary function along with these symptoms. Patients in critical condition who have frequently received HBOT after requiring high doses of norm baric oxygen for an extended period of time are more prone to suffer toxic pulmonary effects. Having a single place to go can make you feel claustrophobic. The link between hyperbaric oxygen and tumor development is not yet established(16). However, HBOT is considered relatively safe as the stated seriousness of these risks is low, and these problems don't occur frequently.[17]

Contraindications:

The only absolute contraindication to HBOT is an untreated pneumothorax. Severe claustrophobia, congestive heart failure, lung disease, and an uncontrolled seizure disorder are a few of relative contraindications. [18]

Conclusion:

For the treatment of ED patients, particularly those with endothelial dysfunction, HBOT is a novel and secure technique. HBOT's primary function is to repair injured endothelium cells through a variety of techniques. Its safety and effectiveness in treating ED patients must be established through numerous randomized controlled trials.

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