Symposium on HYPERBARIC MEDICINE

Current Trends in Hyperbaric Oxygen Therapy

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Hyperbaric Oxygen (HBO) can be considered as an extension of conventional oxygen therapy with the advantage that a large amount of oxygen can reach the needed area directly via circulation when that is intact or through diffusion from surrounding healthy area if the blood supply is inadequate or even completely cut off. HBO above 3 ATA is not safe due to its toxic effects on central nervous system (CNS). High pO_2 causes vasoconstriction. Despite this, effective oxygen supply to most organs is maintained due to increased availability of O_2 in plasma. Exception may be in case of an ischaemic area in myocardium where O_2 need may not be fully met. Effect of O_2 in IHD has been reported to be equivocal.

Largest number of beneficiaries of HBO therapy are the cases of decompression sickness and aeroembolism arising in flying, diving, caisson work, cardiovascular and neuro-surgery, trauma, haemodialysis, angiographic investigations, etc. Pressure reduces the volume and size of bubbles and high pO_2 assists in their further dissolution. Patency of the obstructed vessel is re-established and high pO_2 sustains the ischaemic areas.

HBO has been found to increase fibroblastic and osteoblastic activities and to enhance neovascularisation, formation of granulation tissue and epithelialisation. This has been taken advantage of in hastening of healing processes in chronic ulcers of skin, chronic refractory osteomyelitis, fractures involving areas of relatively poor blood supply (i.e. scaphoid, lower end of tibia), after osteotomies, in skin and pedicle grafting, radionecrosis etc. Possibly, HBO acts by causing suppression of infection besides increasing oxygen supply.

Monoplace or multiplace chambers are commonly used for administration of HBO.

Monoplace chambers are either made of fibreglass or have large observation windows in a metal body. Advantages are the ease of administration and less cumbersome arrangement. These chambers can be hooked on to central oxygen supply of the hospital and used. However, except for visual observations, little else can be done for the patient during administration of HBO. This is a distinct disadvantage in a critically ill patient.

Multiplace chambers can accommodate a large number of sitting patients for routine treatment. Critically ill patients can be constantly attended to and valuable adjunct therapy administered. Cases of air embolism or decompression sickness, in all probability, will require treatment at higher pressure i.e. 6 ATA with air.

Capital cost is more and arrangements are more complex in multiplace chambers. Air compressors, gas reservoirs, separate oxygen supply, O_2 dump valves etc. would be required. Decompression sickness in attendants breathing air is a rare possibility with the short schedules at comparatively lower pressures, and can be easily avoided with short decompression stops.

Organisation of HBO Facility

Large number of hyperbaric centres are now functioning in advanced countries. They are, in many cases, being organised on regional basis. Some HBO centres have developed in association with a group of specialised units, such as intensive care units, thoracic surgery, neurosurgery, orthopaedic, malignant disease and renal units. A large number of therapeutic chambers have been established in some Air Force and Naval units to meet hazards of decompression associated with flying and diving activities. Commercial diving for offshore oil industry also calls for establishment of a large number of centres all over the world.

Indications

HBO can be considered as an adjunct to established medical care and rarely a cure by itself. Besides its usefulness in critical care it is of proven benefit in a number of chronic conditions. A clearer picture of indications is steadily emerging. A few important indications can be discussed.

Carbonmonoxide Poisoning : HBO appears to be the treatment of choice, if available. Heart is one of the target organs to be affected first. ST depression in leads I, II, V5 and V6 is an indication for HBO therapy. Hypoxia is relieved under HBO. Intracranial pressure is reduced to half and cerebral oedema is reversed. Dissociation of carbonmonoxide (CO) from carboxyhaemoglobin and its elimination are accelerated. HBO at 3 ATA clears 3/4th of CO from blood in 3/4 hours. Thereafter, pressure is lowered to 2 ATA with intermittent air intervals till maximum benefit is obtained Cardiac arrhythmia and organic dementia, as sequelae, are rare after HBO therapy.

Gas Gangrene : HBO is a valuable adjunct to antibiotics, supportive measures and surgery. Advantage in saving both life and tissue as compared to conventional treatment has been consistently reported. Alphatoxin production is suppressed at pO_2 250 mm Hg. At 1400 mm Hg, O_2 is both bacteriostatic and bactericidal to clostridia. A multiplace chamber could be of advantage where a Surgeon-Anaesthetist-Nurse team could render comprehensive care simultaneously with HBO therapy. In a monoplace chamber, it is advisable to have the first exposure at 3 ATA for 90 minutes. This will suppress toxin production and improve general condition. Surgical toilet should be undertaken thereafter. 2-3 exposures a day to a total of 6-15 exposures of 60-90 minutes duration each are usually needed.

Burns : HBO administered in the early stage combats shock significantly. Intense vaso-constriction reduces oedema and plasma loss. Blood pressure is maintained, Sludging and coagulation in microcirculation are prevented. There is marked toning up of microcirculation and the affected areas become dry even after first sitting. Secondary infection is controlled and healing is accelerated. Formation of healthy granulation and epethelialisation progress satisfactorily. Graft failures are minimised.

A long series of HBO exposures of 60-90 minutes each at 2 ATA on the first day followed by 2 similar exposures daily can be recommended.

Decompression Sickness & Aeroembolism : HBO is the treatment of choice in type I bends, i.e., musculoarticular bends which constitute almost 90% of decompression sickness. Decompression sickness and aero-embolism involving central nervous system need immediate relief and are often required to be treated at higher pressure (i.e. upto 6 ATA) with air; low molecular weight dextran, aspirin and heparin are valuable adjuncts. Mannitol and urea will also help in reducing oedema in CNS. Steroids may be administered only in between exposures.

Indolent Ulcers : Pressure sores, varicose ulcers and ulcers due to arterial insufficiency show good response to HBO even when other treatments have failed. Venous ulcers respond better than those due to deficient arterial circulation. Response of diabetic ulcers is poor.

Peripheral Vascular Diseases : Associated ulcers respond well to HBO. Improvement in blood circulation has been in doubt. Recent evidence of significant microvascular proliferation under HBO has renewed interest in its use in peripheral vascular diseases. IAM has reported opening of new vascular channels in Buerger's disease following HBO therapy.

Neurological Conditions : Encouraging results have been reported in ischaemic insults to brain, neurological procedures compromising blood circulation and in comatose patients from post strangulation cerebral oedema. Effects in head injury or spinal injury cases are ambiguous. In senile dementia the use of HBO is still exploratory and appears to be encouraging.

Radio-necrosis & Malignancy : One of the most dramatic results is seen in cases of soft tissue radio-necrosis. HBO may be the only hope in extensive radio-necrosis of bone. Results are gratifying, particularly when facial bones are involved because of the rich blood supply in the region A long treatment schedule involving as many as 60 exposures may be needed. Use of HBO to enhance effect of radiation treatment in malignant diseases has been reported in literature.

Infections : Besides gas gangrene, favourable result in actinomycosis, leprosy and pyogenic infections have already been mentioned. One definite indication appears to be the treatment of refractory osteomyelitis.

Contraindications of HBO Therapy

Viral infections and lung pathology favouring air trapping are absolute contra indications. Untreated and metastatic malignancy tends to flare up. This calls for caution in the use of HBO for treatment of radio-necrosis and as an adjunct to radio therapy. Chronic respiratory diseases with CO_2 retention become worse with HBO which not only removes the hypoxic stimulus which was maintaining the respiration, but also favours CO_2 retention by interfering with its removal by Hb. HBO is better avoided in infants where it is likely to cause blindness due to retrolenticular degeneration. HBO may increase blood pressure in hypertensives by 25-40 mm Hg and, is to be carefully administered if at all considered for use in such cases. Steroids increase oxygen toxicity and should be avoided during exposure. In between exposures they may be of immense value in critical care. Persons with history of epilepsy are not suitable subjects for HBO therapy which may precipitate convulsions in them.

Hazards

Most common hazard is barotitis, causing earache and even ruptured ear drum. This is, however, rarely a deterrent to administration of HBO. Slow increase in pressure, instructions or techniques for pressure equalisation in the middle ear and, in worst cases, myringotomy usually solve the problem.

Convulsive form of oxygen toxicity involving CNS occurs usually at pO_2 higher than 3 ATA. To make HBO effective as an adjunct to radio therapy, it may be required to raise pO_2 to 4 ATA. This is risky Diazepam should be used in these cases to decrease sensitivity of CNS to O_2.

At lower pO_2 (i.e. at pO_2 over 0.5 ATA), lungs may be affected, if the exposures are long. Shorter exposures or intermittent exposures alternating with air breathing guard against lung damage (2 minutes oxygen and 5 minutes air). Finally, fire risks in oxygen rich environment should not be forgotten.

Treatment Schedule

Rule of thumb for HBO treatment is 2 exposures for 2 hours at 2 ATA twice a day. However, in practice, duration of one exposure does not exceed 20 minutes in most cases. Carbon monoxide poisoning, decompression sickness and aeroembolism are usually treated by single exposures Current thinking is repetition of HBO if there is a residual damage. Acute poisoning, severe burns and gas gangrene may be treated at 3 ATA initially. In later exposures and in more chronic cases O_2, at 2 ATA may suffice. Number of exposures and total duration of treatment vary depending on the type of case, its severity and response to HBO. Standard treatment schedule is yet to evolve. However, cases of radio-necrosis, refractory osteomyelitis, and ischaemic ulcers may take 30 exposures or more.