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[Intervention Review]

Hyperbaric oxygen therapy for the adjunctive treatment of traumatic brain injury

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ABSTRACT

Background

Traumatic brain injury is a common health problem with significant effect on quality of life. Each year in the USA approximately 0.56% of the population suffer a head injury, with a case fatality rate of about 40% for severe injuries. These account for a high proportion of deaths in young adults. In the USA, 2% of the population live with long-term disabilities following head injuries. The major causes are motor vehicle crashes, falls, and violence (including attempted suicide). Hyperbaric oxygen therapy (HBOT) is the therapeutic administration of 100% oxygen at environmental pressures greater than 1 atmosphere absolute (ATA). This involves placing the patient in an airtight vessel, increasing the pressure within that vessel, and administering 100% oxygen for respiration. In this way, it is possible to deliver a greatly increased partial pressure of oxygen to the tissues. HBOT can improve oxygen supply to the injured brain, reduce the swelling associated with low oxygen levels and reduce the volume of brain that will ultimately perish. It is, therefore, possible that adding HBOT to the standard intensive care regimen may reduce patient death and disability. However, a concern for patients and families is that using HBOT may result in preventing a patient from dying only to leave them in a vegetative state, entirely dependent on medical care. There are also some potential adverse effects of the therapy, including damage to the ears, sinuses and lungs from the effects of the pressure and oxygen poisoning, so the benefits and risks of the therapy need to be carefully evaluated.

Objectives

To assess the effects of adjunctive HBOT for traumatic brain injury.

Search methods

We searched CENTRAL, MEDLINE, EMBASE, CINAHL and DORCTHIM electronic databases. We also searched the reference lists of eligible articles, handsearched relevant journals and contacted researchers. All searches were updated to March 2012.

Selection criteria

Randomised studies comparing the effect of therapeutic regimens which included HBOT with those that did not, for people with traumatic brain injury.

Data collection and analysis

Three authors independently evaluated trial quality and extracted data.

Main results

Seven studies are included in this review, involving 571 people (285 receiving HBOT and 286 in the control group). The results of two studies indicate use of HBOT results in a statistically significant decrease in the proportion of people with an unfavourable outcome one month after treatment using the Glasgow Outcome Scale (GOS) (relative risk (RR) for unfavourable outcome with HBOT 0.74, 95% CI 0.61 to 0.88, $P = 0.001$). This five-point scale rates the outcome from one (dead) to five (good recovery); an 'unfavourable' outcome was considered as a score of one, two or three. Pooled data from final follow-up showed a significant reduction in the risk of dying when HBOT was used (RR 0.69, 95% CI 0.54 to 0.88, $P = 0.003$) and suggests we would have to treat seven patients to avoid one extra death (number needed to treat (NNT) 7, 95% CI 4 to 22). Two trials suggested favourably lower intracranial pressure in people receiving HBOT and in whom myringotomies had been performed. The results from one study suggested a mean difference (MD) with myringotomy of -8.2 mmHg (95% CI -14.7 to -1.7 mmHg, $P = 0.01$). The Glasgow Coma Scale (GCS) has a total of 15 points, and two small trials reported a significant improvement in GCS for patients treated with HBOT (MD 2.68 points, 95% CI 1.84 to 3.52, $P < 0.0001$), although these two trials showed considerable heterogeneity ($I^2 = 83\%$). Two studies reported an incidence of 13% for significant pulmonary impairment in the HBOT group versus 0% in the non-HBOT group ($P = 0.007$).

In general, the studies were small and carried a significant risk of bias. None described adequate randomisation procedures or allocation concealment, and none of the patients or treating staff were blinded to treatment.

Authors' conclusions

In people with traumatic brain injury, while the addition of HBOT may reduce the risk of death and improve the final GCS, there is little evidence that the survivors have a good outcome. The improvement of 2.68 points in GCS is difficult to interpret. This scale runs from three (deeply comatose and unresponsive) to 15 (fully conscious), and the clinical importance of an improvement of approximately three points will vary dramatically with the starting value (for example an improvement from 12 to 15 would represent an important clinical benefit, but an improvement from three to six would leave the patient with severe and highly dependent impairment). The routine application of HBOT to these patients cannot be justified from this review. Given the modest number of patients, methodological shortcomings of included trials and poor reporting, the results should be interpreted cautiously. An appropriately powered trial of high methodological rigour is required to define which patients, if any, can be expected to benefit most from HBOT.

PLAIN LANGUAGE SUMMARY

Does hyperbaric oxygen therapy improve the survival and quality of life in patients with traumatic brain injury?

Traumatic brain injury is a major cause of death and disability. Not all damage to the brain occurs at the moment of injury; a reduction of the blood flow and oxygen supply to the brain can occur afterwards and cause further secondary brain damage that is itself an important cause of avoidable death and disability. In the early stages after injury, it is therefore important that efforts are made to minimise secondary brain damage to provide the best chances of recovery.

Hyperbaric oxygen therapy (HBOT) has been proposed as a treatment for minimising secondary brain damage by improving the oxygen supply to the brain. Patients undergoing HBOT are placed inside a specially designed chamber in which 100% oxygen is delivered at a greater than normal atmospheric pressure. It is sometimes used as a treatment to increase the supply of oxygen to the injured brain in an attempt to reduce the area of brain that will die.

The effectiveness of HBOT on the recovery of brain-injured patients is uncertain. There is also concern regarding potential adverse effects of the therapy, including damage to the ears, sinuses and lungs from the effects of pressure, temporary worsening of short-sightedness, claustrophobia and oxygen poisoning.

In an attempt to address the uncertainty surrounding the use of HBOT, the authors of this review identified all studies which were randomised controlled trials investigating the effects of HBOT in traumatically brain-injured people of all ages.

The authors found seven eligible studies involving 571 people. The combined results suggest that HBOT reduces the risk of death and improves the level of coma; however, there is no evidence that these survivors have an improved outcome in terms of quality of life. It is possible, therefore, that the overall effect of hyperbaric oxygen is to make it more likely that people will survive with severe disability after such injuries. The authors conclude that the routine use of HBOT in brain-injured patients cannot be justified by the findings of this review.

Due to the small number of trials with a limited number of people, it is not possible to be confident in the findings. Further large, high quality trials are required to define the true extent of benefit from HBOT.

