Pain management and hyperbaric oxygen therapy

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Chronic pain is very common in the general population. Hyperbaric oxygen therapy has been studied in various chronic pain syndromes, including fibromyalgia syndrome, complex regional pain syndrome, myofascial pain syndrome, migraine and cluster headaches. Although the results of these studies are promising, routine management of these chronic pain syndromes with hyperbaric oxygen therapy cannot be justified at this time. However, hyperbaric oxygen therapy may be used in selected patients unresponsive to other treatments, where facilities are available, after carefully weighing potential benefits against the risks of treatment. Further large-scale, good-quality, randomized, controlled studies are required to clearly demonstrate efficiency, cost–effectiveness, optimal treatment protocol and safety of hyperbaric oxygen therapy in the management of chronic pain.

The most frequent symptom leading to applications to health institutions is pain [1]. Pain is a crucial physiological sensation, since it gives warning to the nervous system that it must protect itself against a probable danger as the result of a chemical, thermal or mechanical stimulus. However, pathological pain may be a symptom of a disease when it is acute or turn into a distinct phenomenon when it becomes chronic, leading to intermittent or continuous pain for several months or years [2]. The prevalence of chronic pain in the general population is very high [3]. The effectiveness of various pharmacological and nonpharmacological methods of treating chronic pain is under investigation, since no completely satisfactory results have been obtained [4]. There are an increasing number of articles studying hyperbaric oxygen therapy (HBOT) as an adjunct in the treatment of various chronic pain syndromes [5–19]. The aim of this article is to highlight the role and effectiveness of HBOT in the management of chronic pain.

Hyperbaric oxygen therapy

Hyperbaric oxygen therapy is defined as the inhalation of 100% oxygen intermittently in a hyperbaric chamber at a pressure higher than 1 atmosphere absolute (ATA; 1 ATA = 760 mmHg, which is the normal atmospheric pressure at sea level) [20]. HBOT is usually administered at 2–3 ATA and the duration of HBOT varies from 60 to 300 min, depending on the indication [20]. The frequency and total number of HBOT sessions are not standard among hyperbaric medicine centers.

HBOT causes mechanical and physiological effects. Its mechanical effects emerge as a result of the inverse proportion between pressure and volume as a requirement of Boyle's law. This effect is used in the treatment of decompression sickness and arterial gas embolism. The physiological effects of HBOT are related to the hyperoxia it establishes in the tissues. HBO at 3 ATA increases the level of oxygen dissolved in plasma from 0.3 to 6 ml/dl [21]. At rest and with good perfusion, tissues require 5–6 ml/dl of oxygen. Therefore, with HBOT at 3 ATA, all the oxygen required by the tissues can reach them dissolved in plasma, without the need for oxygen attached to hemoglobin [22].

HBOT exerts different biochemical and cellular effects. By providing adequate oxygen tension, HBOT increases collagen synthesis, maturation and fibroblast proliferation and promotes angiogenesis and wound healing in hypoxic wounds [23]. HBOT reduces leukocyte adhesion in reperfusion injury, preventing release of proteases and free radicals that cause vasoconstriction and cellular damage [24]. HBOT augments oxygen-dependent killing of organisms by polymorphonuclear leukocytes [25]. In addition, HBOT is bactericidal for anerobes such as *Clostridium perfiringens* and inhibits production of clostridial α-toxin [26,27]. Although HBOT reduces regional blood flow by hyperoxia-induced vasoconstriction, resultant oxygen tension is hyperoxic owing to the increased oxygen content of the blood [28].

The Undersea and Hyperbaric Medicine Society has confirmed 13 indications with proven scientific evidence, controlled animal or clinical

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