

# The Role of Hyperbaric Oxygen Therapy in Orthopedics and Rheumatological Diseases

Giuseppe Barilaro MD<sup>1\*</sup>, Ignazio Francesco Masala MD<sup>2</sup>, Renato Parracchini MD<sup>3</sup>, Cesare Iesu MD<sup>4</sup>, Giulia Caddia MD<sup>4</sup>, Piercarlo Sarzi-Puttini MD<sup>5</sup> and Fabiola Atzeni MD PhD<sup>6\*</sup>

<sup>1</sup>Department of Internal Medicine, IRCCS San Raffaele Pisana, Rome, Italy

<sup>2</sup>Orthopedic Unit and <sup>3</sup>Maxillofacial Unit, Santissima Trinità Unit Hospital, Cagliari, Italy

<sup>4</sup>Hyperbaric Unit, Marino Hospital, Cagliari, Italy

<sup>5</sup>Rheumatology Unit, Sacco University Hospital, Milan, Italy

<sup>6</sup>IRCCS Galeazzi Orthopedic Institute, Milan, Italy

**ABSTRACT:** Hyperbaric oxygen therapy (HBOT) has been investigated as a primary/adjunctive treatment for a number of injuries and medical conditions including traumatic ischemia, necrotizing soft tissue injuries, non-healing ulcers and osteoradionecrosis, but the results are controversial. There is insufficient evidence to support or reject the use of HBOT to quicken healing or to treat the established non-union of fractures. However, in patients with fibromyalgia, HBOT reduces brain activity in the posterior cortex and increases it in the frontal, cingulate, medial temporal and cerebellar cortices, thus leading to beneficial changes in brain areas that are known to function abnormally. Moreover, the amelioration of pain induced by HBOT significantly decreases the consumption of analgesic medications. In addition, HBOT has anti-inflammatory and oxygenatory effects in patients with primary or secondary vasculitis. This review analyzes the efficacy and limitations of HBOT in orthopedic and rheumatologic patients.

*IMAJ* 2017; 19: 429–434

**KEY WORDS:** hyperbaric oxygen therapy, trauma, ulcers, mandibular fractures, vasculitis

The Undersea and Hyperbaric Medicine Society (UHMS) defines hyperbaric oxygen therapy as, “an intervention in which an individual breathes near 100% oxygen intermittently while inside a hyperbaric chamber that is pressurized to greater than sea level pressure (1 atmosphere absolute [ata])” [1]. Hyperbaric oxygen therapy (HBOT) increases hemoglobin saturation and leads to a tenfold to twentyfold increase in the amount of oxygen dissolved in blood plasma, which is more available to tissues than oxygenated hemoglobin, and makes it possible to deliver greatly increased partial oxygen pressure to tissues. It can be delivered in a high-pressure multi-place, high-pressure mono-place, or low-pressure mono-place cham-

bers. For clinical purposes, the pressure must be  $\geq 1.4$  ata, and typically involves pressurization to between 1.5 and 3.0 ata for periods of 60–120 minutes one or more times daily. The use of HBOT can be traced to the 1600s. The first well-known chamber was built and run by a British clergyman named Henshaw in 1662, but it was not until 1917 that German inventors Bernhard and Heinrich Dräger successfully applied pressurized oxygen to treat decompression illness due to diving accidents. Decompression sickness remained the only indication for a long time, but HBOT has more recently been investigated as a primary or adjunctive treatment for a number of injuries and medical conditions, including traumatic ischemia, necrotizing soft tissue injuries, non-healing ulcers, and osteoradionecrosis. The UHMS and European Consensus Conference have periodically updated the indications [2]. The last revision included 14 indications [Table 1].

The aim of this article is to analyze the evidence of the efficacy of HBOT in orthopedics and rheumatological diseases.

## METHODS

We searched the MEDLINE database (PubMed, National Library of Medicine, Bethesda, MD, USA) and used combinations of the key words “hyperbaric oxygen therapy,” “ulcers,” “vasculitis,” “fractures,” “rheumatologic(al) diseases,” “pain,” and “fibromyalgia.” The reference lists of all of the selected articles were also scanned for references not identified in the initial search. We limited our search to citations from January 1990 to December 2016.

## HBOT AND FRACTURES

The treatment of fractures is intended to re-establish the structural integrity of a fractured bone and restore function to the injured body part; however, the process of fracture healing is sometimes impaired and leads to delayed union or, in some cases, hypervascular (hypertrophic) or avascular (atrophic) non-union (i.e., no healing 6 months after the injury), which often require

\*G. Barilaro and F. Atzeni contributed equally to this paper