



APPLICATIONS OF HYPERBARIC OXYGEN THERAPY IN OSTEOPOROSIS

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Article Received on
27 October 2021,

Revised on 17 Nov. 2021,
Accepted on 07 Dec. 2021

DOI: 10.20959/wjpps20221-20850

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ABSTRACT

Introduction: Hyperbaric Oxygen Therapy (HBOT) is a recommended treatment for all hypoxic pathologies. Hyperbaric Oxygen Therapy (HBOT) consists of breathing 100% oxygen or enriched mixtures at pressures higher than atmospheric pressure, in a suitable environment. HBOT has been used for decades as a recommended treatment for hypoxic-ischemic and infectious disorders. The pressures utilized vary from 2.2 to 2.8 ATA. **Materials and Methods:** 20 Osteoporosis patients treated underwent HBOT at 1.5 ATA and 100% oxygen for a total of 15 sessions. **Results:** 20 postmenopausal women with osteoporosis aged between 38 -64 with a

median age of 60.5 are treated with HBOT. They are assigned for 15 sessions; 5 sessions per week; 1 hour per session then repeated after 15 days rest for 15 sessions for 3 sessions per week. The bone mineral density (BMD) findings before and after the sessions show a significant value increase of 18.5% with a 1% margin of errors. 19 out of 20 patients show a high reduction in lumbar spasms. 17 out of 20 patients marked a significant drop from high to moderate and low pain. 15 out of 20 patients manifest a clinical improvement with a range of motion in the lumbar spine. **Conclusions:** Osteoporosis patients treated with HBOT were demonstrated. No side effects were observed in any of the women who were treated.

KEYWORDS: The bone mineral density (BMD) findings before and after the sessions show a significant value increase of 18.5% with a 1% margin of errors.

INTRODUCTION

Osteoporosis is a severe bone disease characterized by low bone mineral density (BMD),

microarchitectural deterioration of bone tissue, compromised bone strength which weakens the bones and considerably increases the fractures, particularly in the hip, spine, and wrist.^[1-11]

Known as the silent epidemic, the risk of fractures increases with age after peak bone mass reaches its maximum in the late third or early fourth decade of life.^[2,7,9,10,12,13] However, fractures happen in one in three women versus one in five men.^[2,3,7,9,14,15] Past the age of 50 years following the onset of menopause, osteoporosis is mainly pronounced in postmenopausal women^[5,10,16] due to an imbalance between bone resorption (osteoclasts) and formation (osteoblasts), responsible for the disruption in the bone remodeling cycle.^[5,9,17,18,19]

This skeletal disease reduces the quality of life and increases morbidity and mortality in persons.^[1,8,20-25] Therefore, all patients with existing fractures at the spine or the hip should be screened for osteoporosis as having a BMD T-score of less than or equal to 2.5 standard deviations (SDs), and it is usually measured via dual-energy x-ray absorptiometry (DXA).^[2,3,8-11,20,21,26-28]

Osteoporosis is acknowledged as a worldwide public health problem, affecting 50 million Americans in the United States.^[2,7,21,29] In addition, more than 90,000 hip fractures per year are reported in patients over 50 years in Italy.^[30,31] Osteoporotic patients are incurable because no treatment can fully restore the reduced BMD caused by the disease.^[2,21] Thus, to maintain and promote bone health, adequate exercise and protein, calcium, and vitamin D supplementation reduce the risk of fracture and the financial burden of osteoporosis in society.^[9,11,20] In addition, several treatments such as alendronate, risedronate, zoledronic acid, or denosumab can be initiated and recommended for osteoporotic patients at high risk of fracture.^[20,30,32-35]

Hyperbaric Oxygen Therapy (HBOT) is a non-invasive method that consists of breathing 100% oxygen or enriched mixtures at pressures higher than atmospheric pressure in a suitable environment (hyperbaric chamber). Thus, the forces utilized vary from 2.2 to 2.8 ATA.^[36-42]

HBOT has been used as an alternative or adjunct treatment that can effectively treat chronic osteomyelitis, rheumatoid arthritis, transient osteoporosis of the hip (TOH), avascular necrosis, orthopedic disorders, femoral head necrosis, osteoradionecrosis, bone grafts and dental implants compromised skin grafts/flaps, hypoxic-ischemic, crush injuries, diabetic foot

problems, infectious disorders, gas gangrene, autism, arterial gas embolism, carbon monoxide poisoning, decompression sickness and other medical areas with strong evidence.^[43-82]

Several studies demonstrated the mechanism of action of HBOT on the skeleton and bone formation in orthopedics.^[18,19,43-82] It:

- 1- Improves oxygen supply in bone tissue
- 2- Induces vasoconstriction and reduce bone marrow pressure
- 3- Stimulates cellular proliferation and collagen synthesis
- 4- Improves bone healing
- 5- Stimulates angiogenesis and osteogenesis
- 6- Alleviates the pain
- 6- Produces free radical, synthesis of cytokine and modulate the immune response
- 7- Enhances osteoclast and osteoblast function for remodeling and repair

Therefore, the present study evaluated HBOT effectiveness in postmenopausal women with osteoporosis for accelerated recovery, identified the incidence of complications among patient treatments, and assessed HBOT as a recommended treatment.

MATERIALS AND METHODS

Twenty menopausal patients with osteoporosis, aged between 38 to 73 years, underwent HBOT. During the study, all pharmacological treatments for osteoporosis were discontinued. The study protocol was approved by institutional review boards (IRB) of the hospitals before study initiation. In addition, written informed consent was obtained from each participant.

Patients with untreated pneumothorax or severe chronic obstructive pulmonary disease (COPD), epilepsy, hyperthermia, hypoglycemia, panic disorder, drug abuse, or other diseases were excluded.

Oxygen at 100% was administered at a pressure of 2.2 ATA. All patients underwent an entire course of treatment consisting of 15 daily sessions, five times per week followed by 15 days off, then 15 additional sessions every other day and every three weeks. The sessions took place over a total period of 60 minutes.

To evaluate bone mineral density, an ACM GAMMA dual-photon absorptiometry (DPA) with gadolinium 153 was performed before and after the complete sessions of HBOT. Densitometric BMD measurements were taken at the level of 304 between L1 and L4 of lumbar vertebrae unless there is clinical indication for the study of the last dorsal vertebrae.

In addition, patients experiencing certain clinical signs such as active and passive mobility of the spine and limbs, spinal or osteoarticular pain, the feeling of "more relaxation" of the patient, joint and limb pain is relieved.

For further research, it is expected that a third mineralometry dual photon will be performed fourmonths after the second one and that half of the patients will receive daily treatment with calcitonin spray. In contrast, the other half will refrain from a specific medical treatment for osteoporosis.

This is to evaluate the effects of exposure to HBOT on the bone remodeling cycle via osteoclast inhibition and osteoblast activation.

RESULTS

20 post-menopausal women with osteoporosis aged between 38 -64 with a median age of 60.5 were treated with HBOT. They were assigned for 15 sessions; 5 sessions per week; 1hour per session then repeated after 15 days rest for 15 sessions for 3 sessions per week. The BMD findings before and after the sessions showed a significant value increase of 18.5% with a 1% margin of errors. 19 out of 20 patients showed a high reduction in lumbar spasms. 17 out of 20 patients marked a significant drop from high to moderate and low pain. 15 out of 20 patients manifest a clinical improvement with a range of motion in the lumbar spine.

DISCUSSION

As we age, we lose vital bone capacity and impair oxygen utilization. Pressurized oxygen can correct bone pathologies such as chronic osteomyelitis, aseptic necrosis, and poorly consolidated fractures. Our current finding shows that treating osteoporotic patients with HBOT can significantly improve BMD, promote recovery of the lumbar spine reducelumbar spasms and pain. These results are consistent with previous studies. HBOT can significantly increase calcium, collagen deposition, significant components of bone matrix, and essential framework for bone mineralization. HBOT can gradually restore osteoprogenitor cells (osteocytes activity) and bone microcirculation, improve ischemia and hypoxia at the fracture sites through time, and extend the degradation phase, which increases bone hardness and flexibility, thereby preventing and treating osteoporosis.^[18,19,45,47,48,49,51,55,56,60,76,83,84]

Assessment of osteoporotic risk factors and measurement of bone mineral density may help identify patients who will benefit from HBOT intervention and potentially reduce the morbidity and mortality associated with osteoporosis-associated fractures in this population.

CONCLUSIONS

Osteoporosis patients treated with HBOT were demonstrated in this study. No side effects were observed in any of the women who were treated. The results of this research suggest that HBOT is an acute treatment with high efficacy, capable of inducing a rapid increase in bone calcium tone. However, the duration of the effect remains to be specified, since hyperbaric O₂ does not intervene on the causal factors of osteoporosis, but only on the possible mechanisms that regulate the function of osteocytes. Our study was done over a period of three months. It is planned to examine the duration of BMD improvement over a two-year period along with the possible enhancement of the action of the physical hyperbaric treatment and the pharmacological treatment.

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