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A New Treatment Modality for Fibromyalgia Syndrome: Hyperbaric Oxygen Therapy

Ş YILDIZ[1], MZ KIRALP[1], A AKIN[1], I KESKIN[1], H AY[1], H DURSUN[1] AND M CIMSIT[2]
[1]GATA Haydarpaşa Military Hospital, Istanbul, Turkey;
[2]Istanbul University Medical Faculty, Istanbul, Turkey

Fibromyalgia syndrome (FMS) is characterized by longstanding multifocal pain with generalized allodynia/hyperalgesia. There are several treatment methods but none has been specifically approved for this application. We conducted a randomized controlled study to evaluate the effect of hyperbaric oxygen (HBO) therapy in FMS (HBO group: *n* = 26; control group: *n* = 24). Tender points and pain threshold were assessed before, and after the first and fifteenth sessions of therapy. Pain was also scored on a visual analogue scale (VAS). There was a significant reduction in tender points and VAS scores and a significant increase in pain threshold of the HBO group after the first and fifteenth therapy sessions. There was also a significant difference between the HBO and control groups for all parameters except the VAS scores after the first session. We conclude that HBO therapy has an important role in managing FMS.

KEY WORDS: ALGOMETER; HYPERBARIC OXYGEN THERAPY; FIBROMYALGIA; PAIN THRESHOLD; VISUAL ANALOGUE SCALE

Introduction

Fibromyalgia syndrome (FMS) is a chronic musculoskeletal disorder. It is characterized by widespread pain, tenderness at specific anatomical sites (i.e. tender points) and clinical manifestations such as fatigue, sleep disturbance and irritable bowel syndrome.[1,2] Its prevalence is 1 – 3% and it occurs predominantly in females, commonly between the ages of 40 and 50 years.[3]

The most frequently reported musculoskeletal or fibrous connective tissue symptoms are aches and pains, stiffness, swelling in soft tissues, tender points and muscle spasms or nodules.[2] There is a global decrease in pressure pain threshold rather than specific changes limited to the tender points.[4] The aetiopathology of FMS is still not known although it is thought that the disease is caused by several interacting factors such as muscle overload, poor spinal posture, disturbed sleep, psychogenic factors, local hypoxia[5,6] and reduced concentrations of high-energy phosphate. Fassbender and Wegner have hypothesized that local hypoxia causes degenerative changes in the muscles in FMS.[5]

There is no proven effective long-term management programme for FMS.[2] Hyperbaric oxygen (HBO) therapy has been used

worldwide for the past 30 years to treat many diseases, including conditions caused by local hypoxia or ischaemia such as diabetic wounds, chronic non-healing wounds, compromised skin grafts and flaps, and cerebral ischaemia.[7] HBO therapy involves breathing 100% oxygen via an endotracheal tube, mask or hood in a pressure chamber at pressures higher than 1 atmosphere absolute (ATA). During HBO therapy, the increased concentration and the partial pressure of oxygen provide increased oxygenation to the whole body. Oxygen tension is raised to 10 – 13 times above its normal level when a patient breathes 100% oxygen at 2.8 ATA.

When the circulation is compromised, the resultant ischaemia lowers the concentration of adenosine triphosphate (ATP) and increases the concentration of lactic acid. Increased oxygen delivery to the tissue with HBO may prevent tissue damage in ischaemic tissues by decreasing the tissue lactic acid concentration and helping maintain the ATP level.

The aim of HBO therapy in patients with FMS is to reduce muscle hypoxia and increase levels of high-energy phosphate.

Patients and methods

We carried out a randomized, double-blind controlled study of HBO therapy in patients with FMS.

PATIENTS

Patients with FMS (meeting the American College of Rheumatology diagnostic criteria[8]) who had persistent symptoms in spite of medical and physical therapy were included in the study. Patients were randomized (alternately) to receive HBO therapy (HBO group) or normal air (control group). After randomization, patients were evaluated for their suitability to receive HBO therapy. Patients with contraindications were excluded from the study by the evaluating physician. The evaluating physician did not know which therapy the patient was to have received. The physician administering therapy was the only one to know which therapy the patients received. This disclosure was necessary for evacuation purposes in the event of an emergency during a therapy session.

The HBO group underwent 15 90-min sessions of HBO therapy at 2.4 ATA. There was one session per day for 5 days of the week. The control group breathed air at 1 ATA for 90 min following the same schedule as the HBO group. During the study period no other therapeutic modalities were used.

All patients gave informed consent and the GATA Military Medical Faculty Ethical Committee approved the study.

ASSESSMENT PROCEDURE

The patients were examined just before and after the first and fifteenth therapy sessions. At each examination the number of tender points was determined by palpation and the number of tender points was noted. The pain threshold was measured with an algometer and pain evaluated using a visual analogue scale (VAS).

To measure the pressure pain threshold the top of the algometer was placed on the tender point and the pressure was increased until the patient confirmed that they felt pain.[9] The contact area was 1 cm^2 and covered with 2-mm thick rubber to minimize irritation of the skin. The compression pressure was increased gradually by approximately 1 kg/s. The patient was asked to say 'yes' when he or she began to feel pain or any discomfort. A needle on the manometer scale recorded the pressure pain threshold in kilograms.

STATISTICAL ANALYSIS

Numerical variables are presented as mean ± SD. The Wilcoxon test and Student's *t*-test were used for within group (HBO group only) and between group comparisons. A *P*-value of < 0.05 was accepted as statistically significant. SPSS version 11.0 software (SPSS Inc., Chicago, IL, USA) was used for all statistical calculations.

Results

There were 26 patients (17 female, nine male; mean age 40.46 ± 4.79 years) in the HBO group and 24 (18 female, six male; mean age 39.88 ± 4.71 years) in the control group. The symptoms of FMS had been present for an average of 4 ± 1.1 years (range 1 – 30).

The number of tender points, pain threshold (as measured by the algometer) and the VAS pain scores for both groups before and after treatment are given in Table 1.

In the HBO group there was a statistically significant difference between the results of all parameters after the first and fifteenth sessions ($P < 0.001$). There was also a significant difference between the HBO group and control group for all parameters ($P < 0.001$) except the VAS scores after the first session.

Discussion

Fassbender and Wegner studied the clinical features, symptoms and pathogenesis of FMS, and postulated that local hypoxia has an aetiological role in the development and symptomatology of FMS.[5] Recently published reports on FMS are compatible with the theory of chronic hypoxia. Relative hypoxia has been demonstrated in patients with FMS,[5] and symptoms of FMS have improved following aerobic conditioning. The oxygen pressure in the tissues of tender muscles and the total mean oxygen pressure in the subcutaneous tissue of patients with FMS are significantly lower than in normal controls.[10] This suggests that the hypoxic condition is not limited to the tender muscles. Jeschonneck *et al.*[11] studied tender points in patients with FMS and concluded that vasoconstriction occurs in the skin above the tender points. This supports the hypothesis that FMS is related to local hypoxia in the skin covering the tender points. Bengtsson and Henriksson[12] thought

TABLE 1:
Mean ± SD of the number of tender points, pain threshold and visual analogue scale (VAS) pain scores of patients with fibromyalgia syndrome in the group receiving hyperbaric oxygen (HBO group) and control group

	Before treatment		After first session		After 15 sessions	
	HBO (n = 26)	Control (n = 24)	HBO (n = 26)	Control (n = 24)	HBO (n = 26)	Control (n = 24)
No. of tender points	14.96 ± 1.50	15.25 ± 1.18	12.46 ± 1.10[a,b]	13.75 ± 1.07[b]	6.04 ± 1.18[a]	12.54 ± 1.10
Pain threshold	0.71 ± 0.09	0.75 ± 0.13	0.93 ± 0.09[a,b]	0.81 ± 0.12[b]	1.33 ± 0.12[a]	0.84 ± 0.12
VAS score	64.62 ± 10.28	68.33 ± 10.28	59.23 ± 8.44[a]	60.42 ± 8.58	31.54 ± 8.34[a]	55.42 ± 6.58

[a]Statistically significant difference between first and fifteenth sessions of HBO therapy ($P < 0.001$).
[b]Statistically significant difference between study and control group ($P < 0.001$).

that any condition, such as establishment of abnormal motor patterns, that could lead to constant muscle hypoxia might be a possible cause of fibromyalgic pain. Another study concluded that in patients with primary FMS, the muscle oxygenation is abnormal or low, at least in the trigger point area of the muscle as shown by an oxygen multipoint electrode on the muscle surface.[6]

Patients with FMS have been found to have a lower density of capillaries in muscles,[13] thicker capillary endothelium, derangement of muscle capillaries after tourniquet-induced ischaemia and more frequent endothelial changes,[14] and lower values of muscle blood flow.[10] These changes are either caused by localized hypoxia or cause the hypoxia.[15]

A study of pain in patients with FMS produced data consistent with the hypothesis that the intensity of pain experienced in patients with FMS is associated with increased synthesis of nitric oxide (NO).[16] Another study, based on the recent evidence that NO is involved in hyperoxic vasoconstriction, tested the hypothesis that decreased NO availability to brain tissue during hyperbaric oxygen exposure contributes to decreases in regional cerebral blood flow. We think that HBO therapy may be effective for treating patients with FMS because of the decreasing NO effect.[17]

In clinical experience, HBO therapy often stimulates production of red granulation tissue consisting mainly of new blood vessels and the supporting collagenous matrix. The vascular endothelial growth factor (VEGF) concentration significantly increases with HBO. If VEGF concentration directly responds to hyperoxia, it may be possible for VEGF to stimulate angiogenesis.[18] This is another reason why HBO therapy may be effective in FMS and may play an important role in its management.

There is no information about HBO therapy for managing FMS in the current literature. The proposed role of hypoxia in FMS, however, prompted us to evaluate the effectiveness of hyperoxia provided by HBO therapy. In our study, we think that HBO therapy was successful in breaking the pain–hypoxia vicious cycle since it decreased the number of tender points and VAS pain scores by increasing the pain threshold. HBO may be an effective and relatively cheap (US$15/h) alternative treatment modality for patients with FMS, especially for those with chronic pain.

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Address for correspondence
Ş Yildiz
GATA Haydarpasa Egt Hast. Deniz ve Sualti Hekimligi,
81010 Kadikoy, Istanbul, Turkey.
E-mail: senolyildiz@hotmail.com