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ORIGINAL ARTICLE

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Investigation of the effects of pool-based exercise on fibromyalgia syndrome

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Abstract *Objective*: The aim of this study was to compare pool-based exercise and balneotherapy in fibromyalgia syndrome (FMS) patients. *Methods*: Fifty female patients diagnosed with FMS according to the American College of Rheumatism (ACR) criteria were randomly assigned to two groups: group 1 ($n=25$) with pool-based exercise, and in group 2 ($n=25$) balneotherapy was applied in the same pool without any exercise for 35 min three times a week for 12 weeks. In both groups, pre- (week 0) and post-treatment (weeks 12 and 24) evaluation was performed by one of the authors, who was blind to the patient group. Evaluation parameters included pain, morning stiffness, sleep, tender points, global evaluation by the patient and the physician, fibromyalgia impact questionnaire, chair test, and Beck depression inventory. Statistical analysis was done on data collected from three evaluation stages. *Results*: Twenty-four exercise and 22 balneotherapy patients completed the study. Pretreatment (week 0) measurements did not show any difference between the groups. In group 1, statistically significant improvement was observed in all parameters ($P<0.01$) except for the chair test at both weeks 12 and 24. In group 2, week 12 measurements showed significant improvement in all parameters ($P<0.01$) except for the chair test and Beck depression inventory. Week 24 evaluation results in group 2 showed significant improvements in pain and fatigue according to visual analogue scale (VAS), 5-point scale, number of tender points, algometric and myalgic scores, and patient and physician global evaluation ($P<0.01$ and $P<0.05$, respectively), while improvements were nonsignificant in morning stiffness, sleep, fibromyalgia impact questionnaire (FIQ), chair test, and Beck depression inventory parameters in this group. Comparison of the two groups based on the post-treatment (weeks 12 and 24) percent changes and difference scores relative to pretreatment (week 0) values failed to show a significant difference between the groups for any parameter except Beck depression inventory ($P<0.01$). *Conclusion*: The results of our study showed that pool-based exercise had a longer-lasting effect on some of the FMS symptoms, but statistical analysis failed to show a significant superiority of pool-based exercise over balneotherapy without exercise. While we believe that exercise is a gold standard in FMS treatment, we also suggest in light of our results that balneotherapy is among the valid treatment options in FMS, and further research regarding the type and duration of the exercise programs is necessary.

Keywords Balneotherapy · Fibromyalgia syndrome · Pool-based exercise

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Introduction

Fibromyalgia syndrome (FMS) is a chronic musculoskeletal system disorder predominantly affecting young and middle-aged women. It is characterized by pain and stiffness, and various symptoms such as fatigue, sleep disturbance, headache, and impaired muscular performance are frequently observed [1]. Treatment of FMS is usually symptomatic due to the lack of understanding of its etiology and pathophysiology, and several treatment modalities ranging from antidepressant therapy to biofeedback and electroacupuncture have been suggested since the definition of the entity [2]. Exercise programs were reported to be helpful in FMS patients in several studies, and programs including stretching, strength maintenance, and aerobic conditioning were accepted as

a standard treatment protocol [3, 4, 5, 6]. However, the standardization of the type, intensity, and duration of exercise has not yet been delineated [5].

While a majority of the exercise studies in FMS are land-based, a number of studies investigating the effect of pool-based exercise were also reported. Mannerkopi et al. [7] showed the positive effect of temperate pool exercises in FMS patients, and Jentoft et al. [8] found significant improvement in both the land-based and pool-based exercise groups and some additional effects on the symptoms in the latter group. However, the independent effect of warm water on the symptoms was not mentioned in these studies. The traditionally known utility of warm water in various rheumatoid disorders has been supported by several recent studies including the investigation of the efficiency of balneotherapy in FMS [9, 10, 11, 12, 13, 14, 15]. Balneotherapy was shown to provide significant and longer-lasting improvement compared to control groups in the symptoms of pain, fatigue, and sleep disturbance and in the fibromyalgia impact questionnaire (FIQ) results [12, 13, 14, 15]. In our study, we compared the effect of pool-based exercise on FMS vs a control group which received balneotherapy alone without exercise, using a blind prospective study model.

Patients and methods

A total of 50 female patients aged 31 to 56 years old (mean 43.9) who were admitted to our Rheumatology Clinic with the diagnosis of FMS according to the American College of Rheumatism (ACR) criteria [16] were included in the study. None of the patients had accompanying rheumatoid disease, unstable hypertension, severe cardiopulmonary problems, heat intolerance, or any psychiatric disorder affecting patient compliance. Routine blood count and chemistry, erithrocyte sedimentation rate, and urinalysis were performed for each patient, and those with abnormal results were excluded. All patients were instructed to discontinue nonsteroidal anti-inflammatory drug medication throughout the study period. The patients who had begun with antidepressive and/or sedative drugs at or prior to 1 month before the start of the study were allowed to continue their medications. The patients were fully informed about the nature and purpose of the study, and informed consent was obtained from each of them.

Treatment protocol

All patients were given two educational sessions of 1 h each for 2 days by a a physiatrist about the description and available diagnosis and treatment methods of FMS. Next, they were assigned randomly into two groups by the researcher other than the one who performed the evaluation throughout the study.

In group 1, a pool-based exercise program was given by a physiotherapist to 25 patients in a therapeutic pool at 37°C for 35 min a day three times a week for 12 weeks. The program included warming (walking back and forth in the pool), activity (jumping in the pool and active joint motion range and stretching of the neck and the extremities), relaxation (lying supine on the water and slow swimming), and out-of-pool exercises (bending back and forth, squatting, and relaxing with deep breaths) for a period of 35 min.

In group 2, 25 patients received balneotherapy sessions of 35 min three times a week for 12 weeks in the same pool, but they were instructed not to perform any exercise during the sessions. The mineral content of the therapeutic pool used for both groups in our study is shown in Table 1.

Evaluation parameters

Evaluations were performed just before (week 0), immediately after (week 12), and 12 weeks following the treatment (week 24) by the same researcher who was totally unaware of the patient groups, and all patients were requested not to give information to the examiner about their treatment protocol.

Pain

Evaluation was done according to both the visual analogue scale (VAS) and the 5-point scale. In the former, the patients were asked to indicate their pain severity on a scale 10 cm long, and the distance from point 0 was measured. In the latter, they were asked to choose one of the following: 0 = no pain, 1 = mild, 2 = moderate, 3 = severe, and 4 = unbearably severe.

Morning stiffness

The existence and duration of stiffness were asked and recorded according to a 4-point scale: 0 = no stiffness, 1 = less than 15 min, 2 = between 15 to 30 min, and 3 = more than 30 min.

Fatigue

Evaluation of fatigue was done according to VAS and a 5-point scale: 0 = no fatigue, 1 = mild, 2 = moderate, 3 = severe, and 4 = unbearably severe.

Table 1 The mineral content of the therapeutic pool

Anions	mg/L	mval/L
HCO_3^{-2}	528.87	0.67
Cl^-	12.27	0.35
F^-	5.46	0.29
SO_4^{-2}	277.0	5.77
Total	823.6	13.08
Cations	mg/L	mval/L
Ca^{+2}	91.98	4.59
Mg^{+2}	7.41	0.61
Na^+	222.5	9.68
K^+	23.0	0.59
Li^{+2}	0.68	0.10
Total	823.6	13.08

Sleep

Sleep problems were evaluated using sleep disorder parameters of the Hamilton depression scale [17]: going to sleep (1 = no problems, 2 = occasional difficulty lasting half an hour, 3 = difficulty all night long), waking up at night (1 = none, 2 = nocturnal unrest, 3 = waking and getting up without purpose at night), and waking up early in the morning (1 = none, 2 = waking up and sleeping again, 3 = failure to sleep again and getting up). Total sleep score was calculated as the sum of the scores from these three parameters.

Tender points

The number of tender points was obtained by applying 4 kg/cm^2 of pressure on 18 different points described in the ACR criteria using a standard pressure algometer (Force Dial FDK 60) [18]. Then the algometer score was calculated as the average of the minimum pain-generating pressure values obtained from 18 points [19, 20]. Besides that, the patients were asked to describe the perceived pain during the application of the algometer to those 18 points at the constant force of 4 kg/cm^2 according to a 4-point scale: 0 = no pain 1 = mild pain, 2 = moderate pain (evidenced by mimicking or gestures), and 3 = severe pain (withdrawal). Then the myalgic score ranging from 0 to 54 was calculated as the sum of measurement results [20].

Global evaluation of the patient

The patients were asked to mark the level of the effect of their disease on daily life on a 10-cm scale ranging from 0 (no disturbance) to 10 (severely disturbing).

Global evaluation of the physician

The examiner marked the level of the general status of the patients on a 10-cm scale ranging from 0 to 10.

Fibromyalgia impact questionnaire

Current health status of the patients were assessed using the 10-item, self-administered fibromyalgia impact questionnaire (FIQ), which is known to have adequate reliability and validity [21]. (The higher the FIQ score, the greater the effect of FMS on the patient).

Chair test

Lower extremity endurance of each patient was evaluated by recording the number of repetitive and fast movements of sitting down and standing up from a chair in 1 min [22].

Beck depression inventory

This questionnaire was used to evaluate the level of depression in the patients because of its previously reported validity and ease of application [23].

Statistical analysis

The mean values of the percent changes and difference scores calculated for both groups were compared using the Student's *t*-test for comparison between the groups and the paired *t*-test for comparison of the pre- and post-treatment values within the groups.

Results

One patient in group 1 left the study without an excuse, and three in group 2 were excluded due to the development of hypertension in one and cardiac arrythmia in the other two. Table 2 shows the data about the ages and week 0 values for the evaluation parameters in both groups. In group 1, statistically significant improvement was observed for all parameters except the chair test at both weeks 12 and 24 ($P < 0.01$) (Table 3). In group 2, week 12 measurements showed significant improvement in all parameters except for chair test and Beck depression inventory ($P < 0.01$) (Table 4). Week 24 evaluation in group 2 showed significant improvement for pain and fatigue according to VAS, 5-point scale, number of tender points, algometric and myalgic scores, and patient and physician global evaluations of ($P < 0.01$ and $P < 0.05$, respectively), while improvement was non-significant for morning stiffness, sleep, FIQ, chair test, and Beck depression inventory parameters in this group

Table 2 Pretreatment values measured for the evaluation parameters in groups 1 and 2. *P* values were not significant in any case. *VAS* visual analogue scale, *FIQ* fibromyalgia impact questionnaire

	Group 1 ($n = 24$)	Group 2 ($n = 22$)
Age (years)	43.14 ± 6.39	43.91 ± 6.26
Pain (VAS)	7.91 ± 1.81	7.5 ± 1.82
Pain (5-point scale)	3.08 ± 0.83	2.86 ± 0.71
Fatigue (VAS)	7.54 ± 2.48	7.41 ± 2.66
Fatigue (5-point scale)	2.79 ± 1.02	2.77 ± 1.02
Morning stiffness	1.91 ± 1.02	2.18 ± 0.91
Sleep	5.58 ± 1.71	5.27 ± 1.80
Number of tender points	15.29 ± 2.21	15.95 ± 1.59
Algometric score	137.70 ± 28.56	137.03 ± 22.55
Myalgic score	26.71 ± 10.14	27.14 ± 6.59
FIQ	62.58 ± 13.14	57.47 ± 11.67
Patient's global evaluation	8.31 ± 2.15	7.25 ± 2.09
Physician's global evaluation	7.62 ± 2.18	7.27 ± 1.69
Chair test	24.95 ± 3.19	27 ± 5.71
Beck depression inventory	14.08 ± 5.20	14.59 ± 5.86

Table 3 The results and statistical comparisons of the pretreatment (Week 0), and posttreatment (weeks 12 and 24) evaluation parameters in group 1.*VAS* visual analogue scale, *FIQ* fibromyalgia impact questionnaire

	Week 0	Week 12	Week 24	*P* (week 12 vs week 0)	*P* (week 24 vs week 0)
Pain (VAS)	7.91 ± 1.81	5.81 ± 2.7	5.39 ± 2.84	$P < 0.01$	$P < 0.01$
Pain (5-point scale)	3.08 ± 0.83	2.16 ± 1.01	1.96 ± 1.04	$P < 0.01$	$P < 0.01$
Fatigue (VAS)	7.54 ± 2.48	4.96 ± 2.84	5.37 ± 2.99	$P < 0.01$	$P < 0.01$
Fatigue (5-point scale)	2.79 ± 1.02	1.79 ± 1.18	2.04 ± 1.19	$P < 0.01$	$P < 0.01$
Morning stiffness	1.91 ± 1.02	1.08 ± 1.17	1.29 ± 0.91	$P < 0.01$	$P < 0.01$
Sleep	5.58 ± 1.71	4.5 ± 1.84	4.58 ± 1.84	$P < 0.01$	$P < 0.01$
Number of tender points	15.29 ± 2.21	8.46 ± 3.71	8.79 ± 3.80	$P < 0.01$	$P < 0.01$
Algometric score	137.7 ± 28.56	155.15 ± 27.91	160.39 ± 29.21	$P < 0.01$	$P < 0.01$
Myalgic score	26.71 ± 10.14	12.04 ± 7.25	14.08 ± 8.9	$P < 0.01$	$P < 0.01$
FIQ	62.58 ± 13.14	48.29 ± 19.4	49.37 ± 20.35	$P < 0.01$	$P < 0.01$
Patient's global evaluation	8.31 ± 2.15	5.89 ± 2.88	5.33 ± 3.33	$P < 0.01$	$P < 0.01$
Physician's global evaluation	7.62 ± 2.18	4.79 ± 2.81	3.91 ± 3.17	$P < 0.01$	$P < 0.01$
Chair test	24.95 ± 3.19	24.41 ± 3.82	24.91 ± 2.87	NS	NS
Beck depression inventory	14.08 ± 5.20	9.21 ± 6.97	10 ± 7.57	$P < 0.01$	$P < 0.01$

Table 4 The results and statistical comparisons of the pretreatment (week 0) and post-treatment (weeks 12 and 24) evaluation parameters in group 2. *VAS* visual analogue scale, *FIQ* fibromyalgia impact questionnaire

	Week 0	Week 12	Week 24	*P* (week 12 vs week 0)	*P* (week 24 vs week 0)
Pain (VAS)	7.5 ± 1.82	5.63 ± 1.62	6.36 ± 2.33	$P < 0.01$	$P < 0.05$
Pain (5-point scale)	2.86 ± 0.71	2 ± 0.62	2.23 ± 0.81	$P < 0.01$	$P < 0.01$
Fatigue (VAS)	7.41 ± 2.66	6.18 ± 2.54	6.59 ± 2.54	$P < 0.01$	$P < 0.05$
Fatigue (5-point scale)	2.77 ± 1.02	2.13 ± 0.89	2.18 ± 1.05	$P < 0.01$	$P < 0.01$
Morning stiffness	2.18 ± 0.91	1.36 ± 0.95	1.77 ± 1.11	$P < 0.01$	NS
Sleep	5.27 ± 1.80	4.63 ± 1.99	4.91 ± 2.09	$P < 0.01$	NS
Number of tender points	15.95 ± 1.59	10.04 ± 3.18	10.77 ± 4.96	$P < 0.01$	$P < 0.01$
Algometric score	137.03 ± 22.55	156.4 ± 18.19	150.42 ± 22.32	$P < 0.01$	$P < 0.01$
Myalgic score	27.14 ± 6.59	13.77 ± 6.76	18.22 ± 11.2	$P < 0.01$	$P < 0.01$
FIQ	57.47 ± 11.67	50.17 ± 11.95	52.96 ± 16.92	$P < 0.01$	NS
Patient's global evaluation	7.25 ± 2.09	5.70 ± 1.94	5.93 ± 2.28	$P < 0.01$	$P < 0.01$
Physician's global evaluation	7.27 ± 1.69	4.36 ± 1.94	4.86 ± 2.19	$P < 0.01$	$P < 0.01$
Chair test	27 ± 5.71	28.59 ± 4.56	25.77 ± 4.82	NS	NS
Beck depression inventory	14.59 ± 5.86	13.95 ± 5.79	14.86 ± 9.45	NS	NS

(Table 4). However, comparison of the two groups on the basis of the post-treatment (weeks 12 and 24) percent changes and difference in scores relative to pretreatment (week 0) values failed to show a significant difference between the groups for any parameter except the Beck depression inventory ($P < 0.01$) (Table 5).

Discussion

The effect of exercise on FMS has been investigated in an increasing number of studies since publication of the report of Moldfsky and Scarisbrick [24] about the relationship of exercise to sleep deprivation. They showed that interference with stage IV sleep led to an increase in musculoskeletal symptoms in sedentary individuals, while trained athletes were spared this effect of sleep deprivation. In another study by Bennett et al. [25], FMS patients were found to be unfit compared to sedentary healthy individuals. The role of exercise in chronic fatigue syndrome was shown in a study in which the rate of reduction of high-energy phosphates was found to be higher in the muscles of exercising patients compared to a sedentary control group using nuclear magnetic resonance spectroscopy [26]. Martin et al. [4] observed improvements in the parameters of aerobic fitness, tender points, and total myalgic score with an exercise program of 6 weeks compared to a relaxation program group, and they suggested that even better results could be obtained with longer exercise periods. Aerobic endurance exercises for 12 weeks were found to have a positive effect on the fitness and well-being of FMS patients [3]. Ramsay et al. [27], on the other hand, failed to show any superiority of supervised aerobic exercise for 12 weeks over a home exercise program in any parameter except psychological well-being. Unfortunately, development of a standard exercise protocol in FMS has not yet been possible owing to the variability of type, duration, follow-up period, and selection of evaluation parameters among the above studies.

The mechanisms responsible for the analgesic effect of exercise are not clearly understood, despite the results of several studies which consistently showed an increase in pain tolerance and threshold and a lowered rate for the intensity of a given pain stimulus following exercise [28]. While it is a widely accepted hypothesis that activation of the endogenous opioid system during exercise plays a key role in the analgesic response mechanism,

Table 5 Comparison of the two groups on the basis of the posttreatment (both weeks 12 and 24) percent changes and difference scores relative to pretreatment (week 0) values. *VAS* visual analogue scale, *FIQ* fibromyalgia impact questionnaire

	Week 12			Week 24		
	Group 1	Group 2	*P* value	Group 1	Group 2	*P* value
Pain (VAS)	−0.27 ± 0.28	−0.23 ± 0.22	NS	−0.30 ± 0,34	−0.13 ± 0.31	NS
Pain (5-point scale)	−0.27 ± 0.35	−0.28 ± 0.23	NS	−0.35 ± 0.31	−0.18 ± 0.37	NS
Fatigue (VAS)	−0.33 ± 0.39	−0.15 ± 0.19	NS	−0.16 ± 0.79	−0.11 ± 0.28	NS
Fatigue (5-point scale)	−0.37 ± 0.38	−0.19 ± 0.23	NS	−0.29 ± 0.38	−0.24 ± 0.32	NS
Morning stiffness	−0.83 ± 1.4	−0.82 ± 0.96	NS	−0.62 ± 1.28	−0.41 ± 1.37	NS
Sleep	−0.16 ± 0.32	−0.11 ± 0.19	NS	−0.16 ± 0.24	−0.06 ± 0.22	NS
Number of tender points	−0.43 ± 0.27	−0.36 ± 0.2	NS	−0.41 ± 0.26	−0.33 ± 0.29	NS
Algometric score	0.14 ± 0.13	0.16 ± 0.19	NS	0.19 ± 0.23	0.11 ± 0.19	NS
Myalgic score	−0.52 ± 0.31	−0.46 ± 0.28	NS	−0.40 ± 0.49	−0.33 ± 0.39	NS
FIQ	−0.21 ± 0.32	−0.11 ± 0.19	NS	−0.18 ± 0.36	−0.07 ± 0.27	NS
Patient's global evaluation	−0.29 ± 0.29	−0.19 ± 0.22	NS	−0.35 ± 0.35	−0.18 ± 0.22	NS
Physician's global evaluation	−0.36 ± 0.35	−0.4 ± 0.23	NS	−0.49 ± 0.37	−0.34 ± 0.3	NS
Chair test	−0.01 ± 0.14	0.09 ± 0.21	NS	−0.009 ± 0.13	−0.03 ± 0.13	NS
Beck depression inventory	−0.33 ± 0.38	−0,01 ± 0.33	$P < 0.01$	−0.3 ± 0.38	0.008 ± 0.47	$P < 0.05$

several researchers have also suggested a multiple analgesic system including nonopioid mechanisms mediated by other substances such as growth hormone and corticotropin [28, 29]. An analgesic effect of exercise may also help break the vicious cycle of "pain-immobility-pain" by encouraging patients to participate in the exercise programs [3]. Exercise may also increase the well-being of patients by preventing muscular hypoxia in FMS patients [30]. Another positive effect of regular exercise is the improvement in sleep [31]. Sleep disorders play an important role in FMS etiology, and better sleep may contribute to improvement in the symptoms.

The effects of pool-based and land-based exercise were compared by Jentoft et al. [8]. The authors concluded that pool-based exercise can also be effective in increasing physical capacity and may have some additional effects on the symptoms. Mannerkopi et al. [7] found significant improvement in FIQ total score, 6-min walking test, physical function, pain severity, social functioning, psychological distress, and quality of life in a group of patients who received a combination treatment of pool-based exercise and education for 6 months compared to a control group with no treatment. Our study was also planned to investigate the effect of pool-based exercise in FMS patients; however, we applied balneotherapy in the same pool to the control group, taking into account the therapeutic effect of warm water on FMS patients.

The results of our study show that significant improvement was obtained in both the pool-based exercise and balneotherapy-alone groups in the parameters of pain, fatigue, morning stiffness, sleep, FIQ, and global examination of the patient and physician when pre- and post-treatment measurements were compared. However, comparison of the two groups did not show a significant superiority of pool-based exercise over balneotherapy, except for the parameter of Beck depression inventory. Exercise has previously been reported to improve this score, which is believed to be due to its regulatory effect on the seratonergic, dopaminergic, and noradrenergic systems as well as to analgesia and sleep regulation [32, 33, 34].

The role of balneotherapy in FMS was assessed in several reports [12, 13, 14, 15, 35]. Neumann et al. [13] found significant improvement in quality of life as well as other FMS symptoms at the end of 10-day balneotherapy at a Dead Sea spa. In another study by the same authors, patients in a balneotherapy group had more substantial and longer-lasting improvement in FMS symptoms, physical functions, and tender points than a control group [35]. Spa water has been traditionally important in the treatment of rheumatic diseases in Turkey, which is rich in underground mineral water sources. In a previous study performed in our clinic, a positive effect of balneotherapy on pain and algometric score parameters of FMS was reported [11].

The mechanism of action of balneotherapy is not clearly defined. Sukenik et al. suggested the anti-inflammatory effect of sulphur on inflammatory diseases such as rheumatoid and psoriatic arthritis [9, 10]. However, in our therapeutic pool, the concentration of sulphide (H_2S), the sulphur form best absorbed through the skin, is 0.36 mg/L (below the minimum effective concentration of 1 mg/L suggested for anti-inflammatory action) [10, 36]. Thus, we believe that other mechanisms played a role in the positive results obtained in our study. Muscle tone, joint mobility, and pain intensity are known to be affected by thermal and hydromechanical stimuli [37]. Besides, thermal stimulus may decrease the perception of pain according to the gate control theory and also by counteracting the muscular spasm in FMS. The vasodilatory effect of heating may improve the muscular ischemia and help in the clearance of algesic mediators in FMS [37]. While it was suggested that balneotherapy may stimulate secretion of opioids [38], we failed to show any increase in blood endorphin levels following balneotherapy in a previous study performed in our clinic [39].

In conclusion, the results of our study did not a show a significant superiority of pool-based exercise over balneotherapy without exercise. However, since the evaluation results at the end of 6 months showed that improvements in the parameters of sleep and morning stiffness were maintained in the exercise group vs the control group, we suggest that pool-based exercise has a longer-lasting effect on at least some of the symptoms of FMS.

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References

1. Bennett RM (1989) Fibrositis. In: Kelly WN, Harris ED, Ruddy S, Sledge CB (eds) Textbook of rheumatology. Saunders, Philadelphia, pp 541–550
2. Wolfe F (1996) The fibromyalgia syndrome: a consensus report on fibromyalgia and disability. J Rheumatol 23:534–539
3. Meiworm L, Jakop E, Walker UA, Peter HH, Keul J (2000) Patients with fibromyalgia benefit from aerobic endurance exercise. Clin Rheumatol 19:253–257
4. Martin L, Nutting A, Macintosh BR, Edworthy SM, Butterwick D, Cook J (1996) An exercise program in the treatment of fibromyalgia. J Rheumatol 23:1050–1053
5. Clark SR, Jones KD, Burckhardt CS, Bennet R (2001) Exercise for patient with fibromyalgia: risks versus benefits. Curr Rheumatol Rep 3:135–146
6. Gowans SE, deHueck A, Voss S, Richardson M (1999) A randomized, controlled trial of exercise and education for individuals with fibromyalgia. Arthritis Care Res 12:120–128
7. Mannerkopi K, Nyberg B, Ahlmen M, Ekdahl C (2000) Pool exercise combined with an education program for patients with fibromyalgia syndrome. A prospective, randomized study. J Rheumatol 27:2473–2481
8. Jentoft ES, Kvalvik AG, Mengshoel AM (2001) Effects of pool-based and land-based aerobic exercise on women with fibromyalgia/chronic widespread muscle pain. Arthritis Rheum 45:42–47
9. Sukenik S, Buskila D, Neuman L, Kleiner-Baumgarten A, Zimlichman RS, Horowitz J (1990) Sulphur bath and mud pack treatment for rheumatoid arthritis at the Dead Sea area. Ann Rheum Dis 49:99–102
10. Sukenik S, Flusser D, Abu-Shakra (1999) The role of spa therapy in various rheumatic disease. Rheum Dis North Am 25:883–897
11. Yurtkuran M, Yurtkuran MA, Dilek K, Güllülü M, Karakoç Y, Özbek L et al (1999) A randomized, controlled study of balneotherapy in patients with rheumatoid arthritis. Phys Rehab Kur Med 9:92–96
12. Sukenik S, Baradin R, Codish S, Neumann L, Flusser D, Abu-Shakra M et al (2001) Balneotherapy at the Dead Sea area for patients with psoriatic arthritis and concomitant fibromyalgia. IMAJ 3:147–150
13. Neumann L, Sukenik S, Bolotin M, Abu-Shakra M, Amir M, Flusser D et al (2001)The effect of balneotherapy at the Dead Sea on the quality of life of patients with fibromyalgia syndrome. Clin Rheumatol 20:15–19
14. Evcik D, Kızılay B, Gökçen E (2002) The effect of balneotherapy on fibromyalgia patients. Rheumatol Int 22:103–106
15. Yurtkuran M, Çeliktas M (1996) A randomized, controlled trial of balneotherapy in the treatment of patients with primary fibromyalgia syndrome. Phys Rehab Kur Med 6:109–112
16. Wolfe F, Smythe HA, Yunus MB, Bennett RM, Bombardier C, Goldenberg DL et al (1990) The American College of Rheumatology 1990 criteria for the classification of fibromyalgia. Arthritis Rheum 33:160–172
17. Williams BW (1978) A structured interview guide for the Hamilton Depression Rating Scale. Arch Gen Psychiatr 45:742–747
18. Fisher AA (1986) Pressure threshold meter: its use for quantification of tender spots. Arch Phys Med Rehabil 67:836–838
19. Tunks E, McCain GA, Hart LE, Teasell RW, Goldsmith CH, Rollman GB et al (1995) The reliability of examination for tenderness in patients with myofascial pain, chronic fibromyalgia and controls. J Rheumatol 22:944–952
20. Hewett JE, Buckelew SP, Johnson JC, Shaw SE, Huyser B, Fu YZ (1995) Selection of measures suitable for evaluating change in fibromyalgia clinical trials. J Rheumatol 22:953–958
21. Burckhardt CS, Clark SR, Bennett RM (1991) The Fibromyalgia Impact Questionnaire: development and validation. J Rheumatol 18:728–733
22. Mannerkopi K, Svantesson U, Carlsson J, Ekdahl C (1999)Tests of functional limitations in fibromyalgia syndrome: a reliability study. Artritis Care Res 12:193–199
23. Goldenberg DL (1989) Psyciatric and psychologic aspects of fibromyalgia syndrome. Rheum Dis North Am 15:105–114
24. Moldofsky H, Scarisbrick P (1976) Induction of neurasthenic musculoskeletal pain syndrome by selsctive sleep stage deprivation. Psychosom Med 38:35–44
25. Bennett RM, Clark S, Goldberg L, Nelson D, Bonafede RP, Porter J et al (1989) Aerobic fitness in the fibrositis syndrome. A controlled study of respiratory gas exchange and xenon 133 clearence from exercising muscle. Arthritis Rheum 32:454–460
26. Wong R, Lopaschuk G, Zhu G, Walker D, Catellier D, Burton D et al (1992) Skeletal muscle metabolism in the chronic fatigue syndrome. In vivo assessment by 31P nuclear magnetic resonance spectroscopy. Chest 102:1716–1722
27. Ramsay C, Moreland J, Ho M, Joyce S, Walker S, Pullar T (2000) An observer-blinded comparison of supervised and unsupervised aerobic exercise regimens in fibromyalgia. Rheumatology 39:501–505
28. Koltyn KF (2000) Analgesia following exercise. A review. Sports Med 29:85–98
29. Kjaer M (1992) Regulation of hormonal and metabolic responses during exercise in humans. Exerc Sport Sci Rev 20:161–184
30. Drewes AM, Andreasen A, Schroder HD, Hogsaa B, Jennum P (1993) Pathology of skeletal muscle in fibromyalgia: a histo-immuno-chemical and ultrastructural study. Br J Rheumatol 32:479–483
31. Sharpio CM, Bortz R, Mitchell D, Bartel P, Jooste P (1981) Slow-wawe sleep: a recovery period after exercise. Science 214:1253–1254
32. Gowans SE, de Hueck A, Voss S, Silaj A, Abbey SE, Reynolds WJ (2001) Effect of a randomized, controlled trial of exercise on mood and physical function in individuals with fibromyalgia. Arthritis Rheum 45:519–529
33. Ahmadi J, Samavatt F, Sayyad M, Ghanizadeh A (2002) Various types of exercise and scores on the Beck Depression Inventory. Psychol Rep 90:821–822
34. Meeusen R, De Meirleir K (1995) Exercise and brain neurotransmission. Sports Med 20:160–188
35. Buskila D, Abu-Sharka M, Neumann L, Odes L, Shneider E, Flusser D et al (2001) Balneotherapy for fibromyalgia at the Dead Sea. Rheumatol Int 20:105–108
36. Karagülle Z, Dönmez A (2002) Letter to the editors. Rheumatol Int 21:210–211
37. Lehmann JE (1990) Diathermy and superficial heat, laser and cold therapy. In: Kottke EJ, Lehmann JE (eds) Krusen's handbook of physical medicine and rehabilitation. Saunders, Philadelphia
38. Jezova D, Vigas M, Tatar P, Jurcovicova J, Palat M (1985) Rise in plasma β-endorphin and ACTH in response to hyperthermia in sauna. Horm Metab Res 17:693–694
39. Yurtkuran M, Ulus H, İrdesel J (1993) The effect of balneotherapy on the plasma-endorphine level in patients with osteoarthritis. Phys Rehab Cur Med 3:130–132