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ORIGINAL RESEARCH

Effectiveness of Pulse Electromagnetic Field Therapy in Patients With Subacromial Impingement Syndrome: A Double-Blind Randomized Sham Controlled Study

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Abstract

Objectives: To evaluate the 3-month effects of pulsed electromagnetic field therapy (PEMF) in the treatment of subacromial impingement syndrome (SIS).

Design: Planned analysis of a randomized controlled trial with 4- and 12-week follow-ups.

Setting: Physical medicine and rehabilitation clinic, treatment unit.

Participants: Of the 250 individuals screened for eligibility, participants with a diagnosis of SIS (N=80) were randomized to intervention or control groups.

Intervention: The first group received PEMF + exercise and the second group received sham PEMF + exercise 5 days a week for a total of 20 sessions.

Main Outcome Measures: Visual Analog Scale (VAS), Constant Murley Score (CMS), Shoulder Pain and Disability Index (SPADI), Short Form-36 (SF-36) Quality of Life Questionnaire, and shoulder muscle strength measurement with an isokinetic dynamometer. Evaluations were performed before treatment (T0), after treatment (T1), and 12th week (T2).

Results: Evaluation at T1 and T2 showed improvement in most parameters in both groups compared with baseline. In the comparison between the 2 groups at T1 and T2, more improvement was found in the PEMF group in most parameters.

Conclusions: In our study, PEMF was found to be superior to sham PEMF in terms of pain, ROM, functionality, and quality of life at the first and third months.

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Shoulder impingement syndrome (SIS), defined as compression of the rotator cuff and subacromial bursa between the humeral head and the coracoacromial arch, is one of the most common causes of shoulder pain.[1] Conservative treatment of SIS includes analgesics, nonsteroidal anti-inflammatory drugs, exercise, physical therapy (PT), and steroid injections.[1,2] Pulsed electromagnetic field therapy (PEMF), which is a non-invasive, safe technique easily applied to the usually painful and inflamed area, is among the PT methods. PEMF, which generates proliferative, migratory, and biosynthetic responses, plays a prominent role in soft tissue repair in cells and tissues.[3] Studies on the effectiveness of PEMF in the treatment of various musculoskeletal system problems and pains such as osteoarthritis, low back pain, fibromyalgia, and SIS are available in the existing literature. However, data on its evidence-based efficacy and superiority over other PT agents are conflicting and limited.[4] The aim of our study was to investigate the effectiveness of PEMF on shoulder pain and function, muscle strength, and quality of life in the treatment of SIS.

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Methods

Ethics

This study was approved by the Ethics Committee of Afyonkarahisar University of Health Sciences in Turkey (approval no. 2021/36). The current study is registered with ClinicalTrials.gov, number NCT05057871. CONSORT statements were used to conduct and report the trial. The study was conducted in accordance with the principles of the Declaration of Helsinki. Written informed consents were obtained from all patients who were included in the study before participating.

Study design and patients

In the study, we used the pain variable (visual analog scale [VAS]) to calculate the sample size.[5] G*POWER 3.1.9.4. package program[a] was used to determine the sample size in the study. Considering 85% power, 0.05 error, and 0.25 effect size, it was calculated that a minimum of 32 patients should be included for each group.

A first example was created by recruiting 250 people. One hundred seventy people who did not meet the inclusion criteria and refused to participate were excluded. A total of 80 patients aged 30-65 years who attended to our outpatient clinic with the complaint of shoulder pain lasting for at least 6 weeks between January 2021 and January 2022 and were diagnosed with SIS by history, physical examination, and magnetic resonance imaging were included in our study. Figure 1 depicts a flowchart of participant recruitment during the study.

Exclusion criteria for the study

To have received treatment for the shoulder region in the last 6 months, evidence of adhesive capsulitis or calcification of the rotator cuff tendons exceeding 2 cm, magnetic resonance imaging findings of full-thickness total rotator cuff rupture and labral pathologies, presence of systemic inflammatory rheumatic diseases, neurologic diseases (multiple sclerosis, history of previous cerebrovascular disease, myopathic diseases), having a cardiac pacemaker, history of malignancy, bleeding diathesis, presence of acute infection.

Study groups

Patients were randomized into 2 groups: PEMF and sham PEMF, by closed envelope method. No sex factor was considered in patient selection. HY generated the allocation sequence, OK enrolled participants, and NE assigned participants to interventions. SA who evaluated outcomes and NE who appointed interventions were blinded. Patients were planned to be eliminated from the evaluation if they used analgesics and nonsteroidal anti-inflammatory drugs during the treatment process. Both groups underwent a total of 20 sessions, 5 days a week, for 4 weeks in our hospital, under the supervision of a therapist trained in PEMF application and experienced in PEMF application for at least 5 years. Under the guidance of an experienced therapist, each group completed 10 minutes of range of motion (ROM) (Codman pendulum, shoulder wheel, wall-climbing), 10 minutes of stretching, and 10 minutes of isometric and isotonic strengthening activities for the shoulder girdle muscles. Each exercise was performed as 10 repetitions and 3 sets.

The PEMF group was treated with an electromagnetic field device[b] (30 minutes/day, 5 days/week, 20 sessions) on the painful shoulder area (ASA Pmt Quatro Pro, ASA Srl Via A. Volta 9-36057, May 2012 Arcugnano (VI)-Italia) 50 Hz frequency, 85 Gauss intensity treatment was applied. In the sham PEMF group, the same application was performed with the device off. Patients in both groups were not informed whether the device was on or off. All evaluations were performed by a physiatrist blinded to the groups and the patient's previous evaluations before treatment (T0), after treatment (week 4, T1), and at the end of the study (week 12, T2).

List of abbreviations:

CMS	**Constant Murley Score**
PEMF	**pulsed electromagnetic field therapy**
PT	**physical therapy**
ROM	**range of motion**
SF-36	**Short Form-36**
SIS	**shoulder impingement syndrome**
SPADI	**Shoulder Pain and Disability Index**
VAS	**visual analog scale**

Evaluation parameters

Pain

Shoulder pain intensity at rest, with movement, and at night was evaluated with VAS. VAS measurement was performed by the patient indicating the severity of pain on a straight line with numbers from 0 to 10.[6]

Joint range of motion

Measurements were made with the help of a standard goniometer, including active-passive flexion, abduction, and shoulder internal and external rotation measurements in the supine position with the shoulder in 90° abduction and elbow in 90° flexion, and the degree of ROM was recorded.

Muscle strength

Measurement of muscle strength during shoulder internal rotation and external rotation of the shoulder in all patients was performed with an isokinetic dynamometer[c] by a therapist who was trained in using the device and had at least 5 years of experience. To measure maximal isokinetic forces in shoulder internal rotation and external rotation, the concentric-concentric contraction was evaluated at 3 different speeds of 120°/s, 180°/s, and 210°/s for 10 repetitions. To avoid fatigue, the shoulder was first evaluated at 120°/s, then 180°/s, and finally 210°/s with rest periods. To increase reliability, the measurements were performed in 10 repetitions. The first movement and last movement with the least patient compliance were excluded to increase reliability.[7]

Functional capacity

It was evaluated using the Constant Murley Score (CMS) and the Shoulder Pain and Disability Index (SPADI). The CMS consists of a total of 4 sub-parameters, 2 subjective, including pain and activities of daily living related to shoulder pathologies, and 2 objectives, assessing ROM and strength. Pain and activities of daily living are assessed by the patient and ROM and strength by the physician. It is evaluated over 100 points in total, a high total score indicates that the patient's functionality is good.[8] The

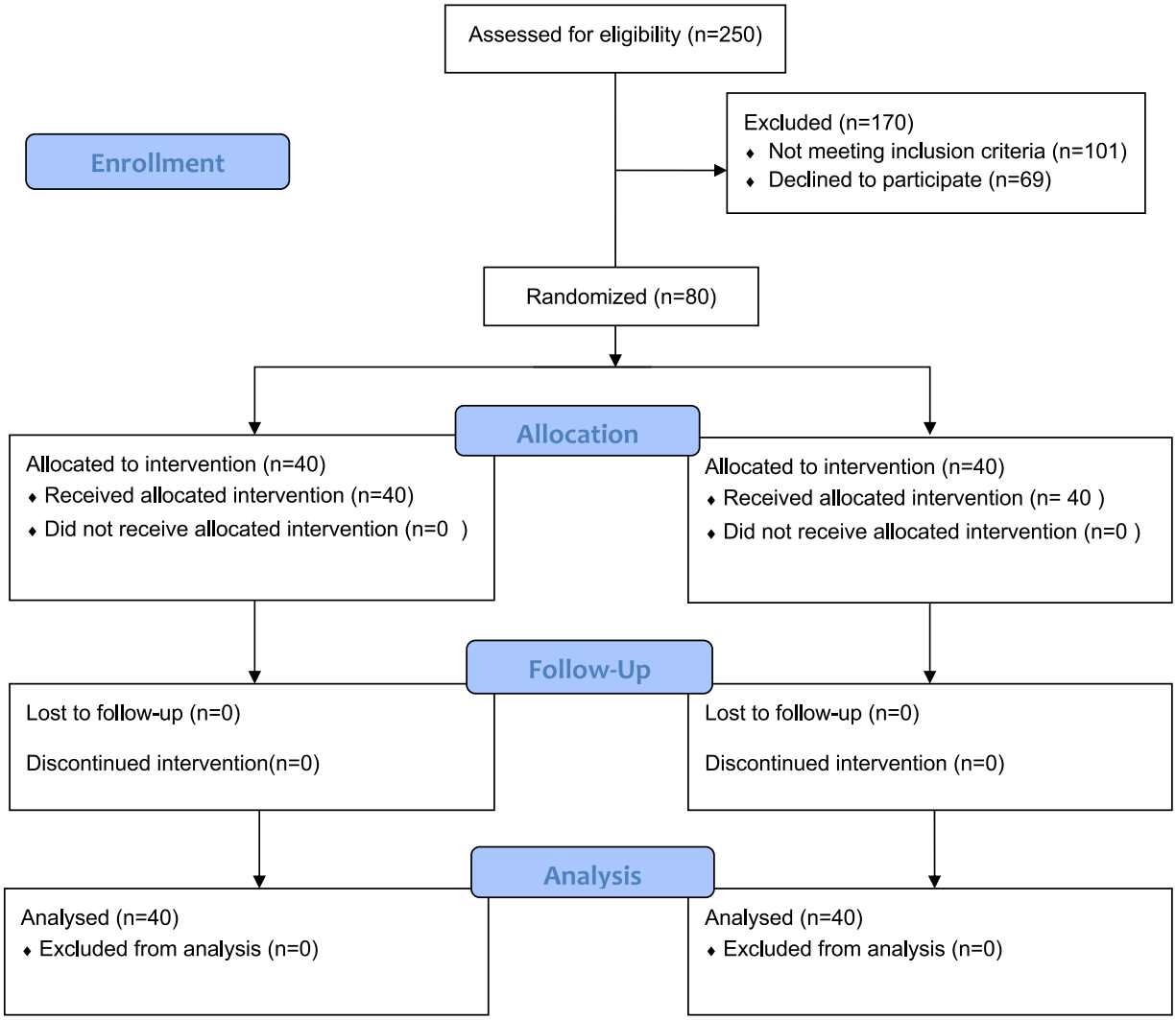

Fig 1 Flow diagram of patient recruitment following CONSORT guidelines.

SPADI is a 2-part scale assessing pain and function. The first part questions pain and the second part questions disability. The 5-item pain section measures the pain felt during activities of daily living, and the 8-item disability section measures the difficulty encountered during activities of daily living using a 10-unit VAS. The score for both sections and the total score are calculated with a special formula.[9] Turkish validity and reliability studies of CMS and SPADI were conducted.[9,10]

Quality of life

Evaluated with Short Form-36 (SF-36). SF-36 consists of 36 items measuring 8 dimensions: Physical function, physical role limitation, pain, general health, fitness, social function, emotional role limitation, and mental health. The subscales assess health on a 0-100 scale and the higher the score, the better the quality of life. Turkish validity and reliability study was conducted.[11]

Statistical analysis

All statistical analyses were performed using SPSS version 22[d] for Windows. In the evaluation of the data, normal distribution was examined using Kolmogorov-Smirnov and Shapiro-Wilk tests to make test selection when comparing means between groups. The Mann-Whitney *U* test was used for descriptive statistics and the significance of the difference in the median between groups, the Wilcoxon signed-rank test was used for repeated measurements of the same group, and the chi-square test was used to evaluate 2 categorical data.

Results

Demographic characteristics

Of the 80 patients included in the study, 49 were women (61.3%) and 31 were men (38.7%). The mean age, painful shoulder side, dominant shoulder involvement, and symptom duration of the patients included in the study are shown in table 1, and there was no difference between the groups in terms of baseline data ($P>.05$).

Pain

There was no statistically significant difference between the 2 groups in the baseline VAS values of the patients included in the

Table 1 Characteristics of the study participants

	PEMF Group (Mean ± SD) (n=40)	Sham PEMF Group (Mean ± SD) (n=40)	*P*
Women/Men	25/15	24/16	>.999
Age	49.82±8.05	49.62±9.40	.919
Painful shoulder side	Right 22/left 18	Right 23/left 17	>.999
Dominant shoulder involvement	%65	%60	.644
Symptom duration (months)	8.42±7.96	8.12±7.34	.592

study (*P*=.142). In the PEMF group, statistically significant improvement was found in all VAS values in the evaluation performed at T1 and T2 compared with the T0 evaluation (*P*<.05). VAS-movement and VAS-night values continued to improve at T2 compared with T1 (*P*<.05) at the same time. In the sham PEMF group, statistically significant improvement was found in all VAS values in the evaluation performed at T1 and T2 compared with the T0 evaluation (*P*<.05). In the comparison between the groups at T1 and T2, VAS scores were lower in the PEMF group (*P*<.05) (table 2).

ROM

There was no statistically significant difference between the 2 groups in all passive ROM and active abduction and external rotation ROM values at T0. Active flexion (*P*=.011) and internal rotation (*P*=.001) were different between groups at T0. There was no difference in passive ROM values at T1 and T2 compared with T0 within the group. There was a statistical improvement in active ROM values at T1 and T2 compared with T0 (*P*<.05). Comparison between groups showed statistically greater improvement in active flexion (*P*=.002) and abduction (*P*=.006) at T2 in favor of the PEMF group (table 3).

Table 2 Pain values measured by VAS in the groups

VAS		PEMF Group (Mean ± SD) (n=40)	Sham PEMF Group (Mean ± SD) (n=40)	*P**
VAS-rest	T0	4.12±1.32[a]	3.65±1.16[a]	.142
	T1	0.70±1.04[b]	2.10±1.61[b]	**P<.001**
	T2	0.17±0.50[b]	1.60±1.49[b]	**P<.001**
	P†	**P<.001**	**P<.001**	
VAS-movement	T0	6.82±1.58[a]	6.65±1.61[a]	.707
	T1	2.72±1.72[b]	4.55±1.89[b]	**P<.001**
	T2	0.90±1.46[c]	3.85±1.99[b]	**P<.001**
	P†	**P<.001**	**P<.001**	
VAS-night	T0	7.62±1.44[a]	6.70±2.12[a]	.063
	T1	2.97±2.32[b]	4.60±2.39[b]	**.003**
	T2	1.15±1.53[c]	3.95±2.41[b]	**P<.001**
	P†	**P<.001**	**P<.001**	

NOTE. Different letters in the same column indicate within-group difference (a,b,c).
Abbreviations: T0, pre-treatment; T1, week 4; T2, week 12.
* Significance level of data between groups.
† Significance level of intragroup data.

Table 3 Evaluation of joint range of motion in groups

ROM		PEMF Group (Mean ± SD) (n=40)	Sham PEMF Group (Mean ± SD) (n=40)	*P**
Passive flexion	T0	173.40±16.34	176.05±11.91	.385
	T1	179.00±4.77	179.90±0.63	.539
	T2	178.52±9.32	180.00±0.00	.317
	P†	.394	.865	
Passive abduction	T0	166.12±24.88	170.27±18.45	.537
	T1	177.97±7.83	179.35±3.79	.388
	T2	178.77±7.12	180.00±0.00	.155
	P†	.057	.151	
Passive internal rotation	T0	86.87±10.33	89.55±1.99	.354
	T1	89.62±1.74	90.00±0.00	.155
	T2	89.75±1.58	90.00±0.00	.317
	P†	.053	.135	
Passive external rotation	T0	87.75±8.08	89.25±2.66	.630
	T1	89.87±0.79	90.00±0.00	.317
	T2	89.87±0.79	90.00±0.00	.317
	P†	1.000	1.000	
Active flexion	T0	139.00±25.51[a]	152.97±21.86[a]	**.011**
	T1	174.22±12.87[b]	173.20±9.84[b]	.152
	T2	177.92±9.77[b]	175.72±7.82[b]	**.002**
	P†	**P<.001**	**P<.001**	
Active abduction	T0	126.87±29.29[a]	137.40±32.55[a]	.080
	T1	169.60±18.35[b]	165.25±17.61[b]	.054
	T2	175.62±13.08[b]	170.02±14.95[b]	.006
	P†	*P*<.001	*P*<.001	
Active internal rotation	T0	67.97±16.88[a]	79.22±11.57[a]	**.001**
	T1	83.70±8.42[b]	85.45±6.4[b]	.393
	T2	86.10±7.19[b]	86.90±5.49[b]	.876
	P†	**P<.001**	**P<.001**	
Active external rotation	T0	73.67±15.4[a]	79.20±12.39[a]	.077
	T1	85.27±6.36[b]	83.97±12.48[b]	.950
	T2	88.10±4.54[b]	87.00±4.91[b]	.163
	P†	**P<.001**	**P<.001**	

NOTE. Different letters in the same column indicate within-group difference (a,b).
Abbreviations: T0, pre-treatment; T1, week 4; T2, week 12.
* Significance level of data between groups.
† Significance level of intragroup data.

Muscle strength

There was no difference between the groups in terms of peak torque values measured at 3 different speeds at T0 (*P*>.05). In the evaluation made at the time of T1 and T2 within the group, there was a statistically significant difference in internal and external rotation muscle strength at 120°/s in the PEMF group (*P*<.05). No statistically significant difference was found between the groups at T1 and T2 (table 4).

Disability

At T0, CMS total (*P*=.037) and SPADI pain (*P*=.043) sub-parameters were different between the groups, but the other sub-parameters were not different between the groups (*P*>.05). In intragroup evaluation at T1 and T2, there was a significant improvement in most parameters compared with T0 (*P*<.05). In the comparison between the groups at T1 and T2, there was a statistically

Table 4 Peak torque values measured by isokinetic dynamometer in groups

Peak Torque		PEMF Group (Mean ± SD) (n=40)	Sham PEMF Group (Mean ± SD) (n=40)	P*
Internal	T0	13.45±8.55[a]	16.77±13.0	.385
rotation	T1	16.77±11.42[ab]	17.02±11.37	.881
120˚/minutes	T2	19.52±11.52[b]	19.45±16.67	.473
	P†	**.003**	.468	
Internal	T0	11.95±8.08	12.57±10.84	.851
rotation	T1	11.95±7.36	14.25±9.93	.439
180˚/minutes	T2	13.92±8.82	17.55±15.57	.685
	P†	.398	.063	
Internal	T0	10.57±6.57	13.45±11.26	.304
rotation	T1	12.70±6.80	14.60±10.07	.768
210˚/minutes	T2	13.07±6.91	16.07±15.62	.616
	P†	.06	.825	
External	T0	7.07±4.73[a]	9.20±6.71	.125
rotation	T1	9.15±5.99[a]	9.27±6.50	.900
120˚/minutes	T2	11.0±6.37[b]	9.05±6.67	.084
	P†	***P*<.001**	.874	
External	T0	8.32±5.48	8.00±4.92	.923
rotation	T1	9.32±6.12	9.52±5.78	.580
180˚/minutes	T2	9.70±5.20	9.87±6.07	.907
	P†	.100	.070	
External	T0	9.57±6.78	9.50±5.89	.739
rotation	T1	9.80±5.94	9.45±5.66	.854
210˚/minutes	T2	9.12±4.85	8.75±6.22	.507
	P†	.524	.972	

NOTE. Different letters in the same column indicate within-group difference (a,b).

Abbreviations: T0, pre-treatment; T1, week 4; T2, week 12.

* Significance level of data between groups.

† Significance level of intragroup data.

significant improvement in favor of PEMF in most parameters ($P<.05$) (table 5).

Quality of life

At T0, there were differences between the groups in the subparameters of physical role limitation ($P=.049$), emotional role limitation ($P=.024$), and pain ($P=.03$), but not in the other subparameters ($P>.05$). In intragroup evaluation at T1 and T2, there was a significant improvement in most parameters compared with T0 ($P<.05$). In the comparison between the groups at T1 and T2, there was a statistically significant improvement in favor of PEMF in most parameters ($P<.05$) (table 6).

Discussion

The treatment of SIS aims to reduce inflammation, heal the rotator cuff and improve function by reducing pain.[12,13] Various conservative treatment methods are applied for this purpose. In a review conducted by Page et al, it was concluded that the level of evidence of PT agents applied in rotator cuff disease is low, and high-quality placebo-controlled studies are needed to confirm their effects.[14] PEMF, targeted corticosteroid injection, and ultrasound therapy was suggested in a review investigating the efficacy of conservative PT agents in SIS.[15]

There are few studies in the literature on PEMF in patients with shoulder pain and the oldest clinical study was conducted by Binder et al in 1984.[16] The main evaluation parameters in the studies were ROM, pain, functionality, and muscle strength. Again, PEMF is the main treatment modality evaluated in these studies, but exercise, which has been proven to be more effective, is an integral part of the treatment.[5,12,13,17,18]

Pain is often the first symptom of problems with the locomotor system. According to studies conducted, pain in SIS increases most in activities involving abduction, internal rotation movements, and as a result of lying on the affected shoulder.[19] Pain can lead to loss of strength and functional status.[20] Therefore, early pain control is important. In our study, we found that there was a decrease in pain in both groups, but there was statistically more improvement in the PEMF group. We saw that this improvement in the PEMF group continued in the third month. Although our study showed that PEMF was effective in pain control, similar to the studies conducted by De Freitas et al[12] and Klüter et al[13] in the literature, more pain reduction was found in the PEMF group. However, in the study conducted by Yelkovan et al, the effect of PEMF on pain was found to be higher than that of the sham group and was found to have a similar effect to US treatment.[17] Some studies conclude that PEMF does not provide additional benefits on pain.[5,18] Consequently, the effect of PEMF on pain is contradictory in the literature. This difference may be attributable to differences in treatment duration and dosages.

It is important to evaluate ROM in patients both in terms of functionality and in terms of monitoring response to treatment. It is conceivable that the patient with more pain will have less active ROM or may avoid shoulder movements.[21] Yelkovan et al found a significant increase in abduction and internal rotation ROM in all groups at the end of treatment but did not find any difference between the groups.[17] In our study, no difference was found between the groups in passive ROM. In our 3-month follow-up in active ROM, flexion and abduction increased significantly more in the PEMF group. This difference may be related to the fact that our treatment duration and the follow-up period was longer and the PEMF intensity we applied was higher. We concluded that PEMF, which we applied with exercise, may also contribute to the increase in ROM with its effects on pain and inflammation. Besides, we think that the long duration of treatment may have increased the efficacy of PEMF and exercise. Our study is the first to show the effect of PEMF added to exercise therapy on ROM in SIS.

Rotator cuff muscle weakness is also a known risk factor in SIS.[22] The isokinetic dynamometer is considered the criterion standard of muscle strength testing. The most common outcome measure reported in isokinetic studies evaluating SIS is usually peak torque.[23] Considering the studies evaluating the effect of PEMF on muscle strength in SIS in the literature, there was no study evaluating with an isokinetic dynamometer. Only in the study conducted by De Freitas et al, the shoulder muscle strength of the patients evaluated with a manual hand dynamometer and they found an increase in internal and external rotation muscle strength in the group that received exercise with PEMF after the third week.[12] In our study, we found an increase in internal and external rotation peak torque at 120˚/s at the end of treatment and an increase in external rotation peak torque at 120˚/s at week 12 in the PEMF group. However, there was no difference between the groups. Although there are studies in the literature evaluating that PT methods such as microwave diathermy and laser can contribute to the strength of the muscles around the shoulder in SIS, there are

Table 5 Comparison of CMS and SPADI values in groups

CMS/SPADI		PEMF Group (Mean ± SD) (n=40)	Sham PEMF Group (Mean ± SD) (n=40)	P*
CMS-pain	T0	2.75±2.51[a]	3.87±2.65[a]	.067
	T1	10.12±2.88[b]	7.75±2.98[b]	**P<.001**
	T2	13.62±2.26[c]	8.87±3.48[b]	**P<.001**
	P†	**P<.001**	**P<.001**	
CMS-ADL	T0	11.30±3.49[a]	12.62±3.59[a]	.100
	T1	18.97±2.03[b]	15.90±2.91[b]	**P<.001**
	T2	19.72±1.21[b]	16.50±2.88[b]	**P<.001**
	P†	**P<.001**	**P<.001**	
CMS-ROM	T0	25.87±6.45[a]	28.65±5.55[a]	.056
	T1	35.65±3.91[b]	34.20±4.70[b]	.161
	T2	38.00±3.56[c]	35.55±4.33[b]	**.002**
	P†	**P<.001**	**P<.001**	
CMS-strength	T0	13.97±2.25[a]	14.32±3.09[a]	.877
	T1	16.90±1.93[b]	15.75±3.77[a]	.312
	T2	19.07±2.22[c]	17.15±4.42[b]	.145
	P†	**P<.001**	**P<.001**	
CMS-total	T0	53.80±11.48[a]	59.22±12.3[a]	**.037**
	T1	81.65±8.33[b]	73.60±11.29[b]	**.001**
	T2	90.42±6.94[c]	78.07±12.86[b]	**P<.001**
	P†	**P<.001**	**P<.001**	
SPADI-pain	T0	63.75±14.27[a]	55.70±16.73[a]	**.043**
	T1	19.80±14.80[b]	32.70±17.34[b]	**.001**
	T2	6.85±9.99[c]	25.70±18.48[b]	**P<.001**
	P†	**P<.001**	**P<.001**	
SPADI-disability	T0	48.48±17.20[a]	42.98±19.11[a]	.187
	T1	14.20±13.36[b]	21.86±16.81[b]	**.042**
	T2	4.63±10.42[c]	14.26±15.33[c]	**P<.001**
	P†	**P<.001**	**P<.001**	
SPADI-total	T0	54.34±15.28[a]	47.86±17.35[a]	.110
	T1	16.34±13.14[b]	26.01±16.36[b]	**.007**
	T2	5.48±9.72[c]	18.65±15.99[b]	**P<.001**
	P†	**P<.001**	**P<.001**	

NOTE. Different letters in the same column indicate within-group difference (a,b,c).
Abbreviations: ADL, activity of daily living; T0, pre-treatment; T1, week 4; T2, week 12.
* Significance level of data between groups.
† Significance level of intragroup data.

also contradictory results.[24,25] It has been shown that these PT methods can increase the strength of the muscles around the shoulder by increasing the compliance to exercise together with analgesic effect, and anti-inflammatory effects.[24] Increasing muscle strength is an important part of treatment because it helps patients with everyday activities and the etiopathogenesis of SIS. Therefore, we think that methods with analgesic and anti-inflammatory effects such as laser and PEMF may be preferred in terms of increasing muscle strength by increasing exercise compliance.

Because shoulder pain affects many activities during daily life activities, it causes loss of function and impaired quality of life in the patient.[26,27] Studies have shown that shoulder pain on the dominant side that occurs during active movement of the shoulder affects upper extremity function.[27] In our study, we found improvements in CMS and SPADI parameters in both groups, and we found that these improvements were greater in the PEMF group in the short and long term. Considering the literature, similar to our results, De Freitas et al[12] and Klüter et al[13] also found more improvement in shoulder functionality in the PEMF group. However, some studies conclude that there is no additional benefit in shoulder functionality.[5,17,18] We think that the improvement we obtained is associated with a decrease in pain intensity and an increase in active ROM in accordance with the literature. However, considering the literature, we can say that the results of PEMF on disability are contradictory.

It is observed that patients have difficulty participating in many daily living activities because of shoulder pain and a decrease in their quality of life. The importance of quality of life measurements in determining the effectiveness of the treatment given to patients and the physical and mental status of the patient has been shown in studies and quality of life questionnaires appropriate for pathology have been organized.[28] In a study conducted by MacDermid et al, it was reported that physical health (pain, physical role, and physical function) is primarily affected by SF-36 subparameters in patients with rotator cuff tendinopathy.[29] This may be because pain is the most important symptom and that pain and

Table 6 Quality of life assessment measured with SF-36 in groups

SF-36		PEMF Group (Mean ± SD) (n=40)	Sham PEMF Group (Mean ± SD) (n=40)	*P**
Physical function	T0	69.25±16.66[a]	65.37±21.10[a]	.356
	T1	85.62±12.41[b]	71.12±18.86[b]	**P<.001**
	T2	93.25±10.03[c]	74.50±18.35[b]	**P<.001**
	P†	**P<.001**	**P<.001**	
Physical role limitation	T0	26.87±40.97[a]	48.12±48.16[a]	**.049**
	T1	76.87±26.18[b]	68.12±39.21[ab]	.755
	T2	97.50±15.81[c]	80.62±32.26[b]	**.001**
	P†	**P<.001**	**P<.001**	
Emotional role Limitation	T0	29.16±42.82[a]	52.49±46.46[a]	**.024**
	T1	75.84±26.13[b]	69.16±38.78[ab]	.896
	T2	97.50±15.81[c]	79.99±31.85[b]	**.001**
	P†	**P<.001**	**P<.001**	
Vitality	T0	61.62±13.12[a]	59.25±16.31	.513
	T1	67.00±9.85[b]	61.00±14.64	**.045**
	T2	70.47±8.32[b]	58.50±11.33	**P<.001**
	P†	**P<.001**	.172	
Mental health	T0	65.20±12.75[a]	61.60±14.98	.390
	T1	70.20±9.79[b]	62.00±13.25	**.007**
	T2	73.30±7.75[b]	62.40±11.62	**P<.001**
	P†	**P<.001**	.359	
Social function	T0	69.37±19.80[a]	74.06±17.98[a]	.352
	T1	86.56±12.13[b]	78.75±13.33[a]	**.008**
	T2	96.25±7.59[c]	85.00±11.39[b]	**P<.001**
	P†	**P<.001**	**P<.001**	
Pain	T0	47.00±14.16[a]	54.25±11.82[a]	**.030**
	T1	77.75±15.15[b]	64.87±13.43[b]	**P<.001**
	T2	91.62±12.55[c]	69.12±15.75[b]	**P<.001**
	P†	**P<.001**	**P<.001**	
General health	T0	63.75±14.62[a]	62.25±14.36	.651
	T1	69.50±10.17[b]	62.25±13.91	**.006**
	T2	74.75±6.59[c]	61.37±12.24	**P<.001**
	P†	**P<.001**	.305	

NOTE. Different letters in the same column indicate within-group difference (a,b,c).
Abbreviations: T0, pre-treatment; T1, week 4; T2, week 12.
* Significance level of data between groups.
† Significance level of intragroup data.

disability affect patients' life activities and work performance. A detailed assessment of the patient's quality of life will facilitate the selection of appropriate treatment.[30]

We observed that there are studies in the literature evaluating the effects of PT methods such as US, TENS, and laser applied to patients with SIS on quality of life, but there are conflicting results in the studies. We did not find any study investigating the effect of PEMF on quality of life in patients with SIS.[24,31-33] In our study, we used the SF-36 questionnaire to evaluate the quality of daily life of the patients. Significant improvements were found in SF-36 sub-parameters in both groups. In physical and emotional role limitation, only the PEMF group showed better improvement in the evaluation made at the third month, while all other sub-parameters showed better improvement in the PEMF group at all evaluation times. Our study is the first to show that PEMF is also effective on quality of life in SIS. Within this scope, we think that we will contribute to the literature.

Because PEMF in SIS is a relatively new treatment method and there is a limited number of studies in the literature, there are no standard protocols. The most important methodological difference between the studies was the PEMF intensity and duration of treatment. The most important methodological difference in the studies in which PEMF was found to be more effective compared with the control group was the high intensity of PEMF applied. Considering this effect, we used the maximum field strength of 85 gauss (8.5 mT) and 50 Hz frequency values of our device in our study and applied a total of 20 sessions of treatment. In our opinion, the greater improvement in the PEMF group is due to the higher severity of PEMF we applied.

Limitations

The major limitation of the study is the lack of longer-term follow-up to determine whether PEFT with supervised treatment produces a lasting improvement in shoulder impingement symptoms. Another limitation of our study is the lack of isokinetic evaluation on the unaffected side of the patients and the inability to evaluate the difference between painful shoulder and muscle strength.

Conclusions

In conclusion, in our study, we showed that PEMF was superior to sham PEMF in terms of pain, ROM, functionality, and quality of life at 3-month follow-up in SIS treatment. However, high-quality, large-scale randomized controlled studies with long-term follow-up are needed to confirm the effects of PEMF administration on patients with SIS.

Suppliers

a. G*POWER 3.1.9.4.; Heinrich-Heine Universitat Duesseldorf.
b. Electromagnetic field device; ASA Pmt Quatro, 2012 Italia.
c. Isokinetic dynamometer; IsoMed 2000.
d. SPSS version 22; SPSS, Inc.

Keywords

Magnetic field therapy; Pain; Randomized controlled trial; Rehabilitation; Shoulder impingement syndrome; Shoulder pain

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