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Original Article

Comparison of the effectiveness of dry needling and balneotherapy on pain, mood, anxiety, kinesiophobia, disability, and quality of life of patients with myofascial pain syndrome: A prospective, single-blind, randomized study

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ABSTRACT

Objectives: This study aims to compare the efficacy of dry needling and balneotherapy in the treatment of trapezius muscle myofascial pain syndrome (MPS).

Patients and methods: This prospective study was conducted between February 2020 and May 2020. One hundred twenty patients (23 males, 97 females; mean age: 42.3±6.8 years; range, 18 to 50 years) were divided into three groups: dry needling (Group 1), balneotherapy (Group 2), and dry needling + balneotherapy combination (Group 3). Pain was assessed using a Visual Analog Scale (VAS) and the pressure pain threshold (PPT), cervical joint range of motion (ROM) using goniometry, mood using the Beck Depression Scale (BDS), anxiety levels using the Beck Anxiety Scale (BAS), fear of movement using the Tampa Kinesiophobia Scale (TKS), disability using the Neck Disability Index (NDI), and quality of life using the 36-item Short-Form Health Survey (SF-36). The measurements were repeated before the treatment and at the first week and third month after the treatment.

Results: There were significant improvements in all parameters after the treatment in all three groups ($p<0.05$). It was found that Group 1 was superior to Group 2 in terms of VAS ($p=0.010$), BDS ($p<0.001$), BAS ($p=0.007$), and NDI ($p<0.001$) values. There was no difference between Group 1 and Group 2 in PPT evaluations ($p=0.070$). There was no difference between the groups in ROM measurements ($p>0.05$). The highest level of well-being was detected in Group 3 ($p<0.001$) in the TKS values. Considering SF-36 scores, statistically more significant score increases occurred in dry needling groups (Group 1 and Group 3) than in the group that received only balneotherapy treatment (Group 2; $p<0.005$).

Conclusion: Both dry needling and balneotherapy were effective in improving pain, cervical ROM, depressive mood, anxiety, kinesiophobia, functionality, and quality of life scores in MPS. Combination of these two methods increased the success of the treatment.

Keywords: Balneotherapy, dry needling, myofascial pain syndrome.

Myofascial pain syndrome (MPS) is a clinical syndrome with pain originating from trigger points (TPs) in taut bands of muscles or fascia and is characterized by muscle spasms, tenderness, stiffness, fatigue, and restricted joint range of motion (ROM) accompanied by pain.[1] Myofascial pain syndrome is one of the common causes of chronic musculoskeletal pain.[2,3] When MPS is not treated in the acute period, it can become chronic and cause loss of function, mood disorder, and decreased quality of life.[3,4] Dry needling is one of these interventional applications that has been used for years and is effective in many randomized controlled studies.[2-5,6] However, physicians need to be able to offer other methods of treatment to their patients, as it is an interventional application, has the possibility of causing some complications, and some patients avoid choosing it due to pain.[7]

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Hydrotherapy can be defined as the use of water to protect health and treat diseases. Balneotherapy is a warning-adaptation treatment performed at a certain time interval and in a cure style with repeated use in series at regular intervals, in the form of thermal or mineral waters, peloids and baths, packages, drinks, and inhalation applications of whichever dose is specified.[8] Underground water with a temperature above 20°C, total mineral content exceeding 1 g/L, and containing certain substances above a threshold value is called "thermomineral water."[9] Balneotherapy is also used in the treatment of chronic neck pain,[10-12] cervical osteoarthritis, and cervical discopathy.[13,14] However, as far as we know, there are no studies investigating the effectiveness of balneotherapy applied using thermomineral water in the treatment of MPS. Moreover, there is no study in which the efficiencies of dry needling and balneotherapy are compared in the treatment of MPS. This study aimed to compare the efficiencies of dry needling and balneotherapy in the treatment of cervical MPS and to investigate the effects on pain in the trapezius muscle according to cervical MPS, cervical ROM, mood, anxiety, disability, kinesiophobia, and quality of life by applying these treatments separately or in combination.

PATIENTS AND METHODS

In this single-blind prospective study, a total of 198 patients with MPS in the trapezius muscle were assessed at the outpatient clinic of the Kırşehir Training Research Hospital, Department of Physical Therapy and Rehabilitation, between February 2020 and May 2020. Among these patient, 120 (23 males, 97 females; mean age: 42.3±6.8 years; range, 18 to 50 years) who met the inclusion criteria were included in the study (Figure 1). The patients were informed about the study's purpose, duration, and the treatment to be administered, and both oral and written consent were obtained. The study commenced after receiving approval from the Kırşehir Training Research Hospital Clinical Research Ethics Committee (Date: 12.12.2019, No: 2019-22/217). This study was conducted in line with the principles outlined in the Declaration of Helsinki.

Patients who were aged 18-50 years and had a clinical diagnosis of MPS for more than three months were included in the study. The clinical diagnosis of MPS was established according to the criteria outlined by Travell and Simons,[15] requiring the presence of five major criteria and at least one minor criterion for confirmation. Patients who had cervical disc herniation or radiculopathy; myelopathy; fibromyalgia; tumor, infectious, psychiatric; systemic disease and bleeding diathesis; kyphoscoliosis; pregnancy; who had Stage 3 or 4 osteodegeneration; who had undergone previous brain, neck, or shoulder surgery; whose onset of symptoms was less than three months ago, and who used analgesics for any reason were not included in the study. Throughout the study period, patients did not receive any additional medical treatments or engage in specific exercise programs apart from the allocated interventions. The patients were randomly divided to three groups of 40 individuals each using the closed envelope method: Group 1 (dry needling group), Group 2 (balneotherapy group), and Group 3 (dry needling + balneotherapy group).

For dry needling, after cleaning the trapezius muscle with an appropriate antiseptic, the TP determined in the examination was pricked using 0.25×0.25-mm sterile acupuncture needles until the TP in the muscle band was found. After that, the needles in the TPs were pricked three times with an interval of 2 min by using the salt-pepper method (the same point was needled eight to 10 times with rapid needle movements in and out), and then the needle was withdrawn 20 min later. This treatment was repeated once a week for three weeks. All TPs were evaluated and treated, but the values of the most painful point were recorded.

Balneotherapy was administered using thermomineral water at a temperature of 40 to 42°C in the spa within our department for three weeks, five days per week, 20 min per day, totaling 15 sessions. The balneotherapy water contained the following mineral concentrations: 556 mg/L of bicarbonate, 34.5 mg/L of magnesium, 98.3 mg/L of sulfate, 186.7 mg/L of sodium, 232 mg/L of chloride, 226 mg/L of calcium, 58.43 mg/L of silicate acid, and 2.6 mg/L of fluoride. Balneotherapy was performed on the patients as a whole-body bath at 9:00 AM for 20 min.

Both methods applied to the first two groups were applied to Group 3. Balneotherapy was given first to prevent infection, and then dry needling was performed.

The patients' demographic and clinical data, including age, sex, height, weight, body mass index, marital status, educational background, occupation, smoking and alcohol use, presence of chronic

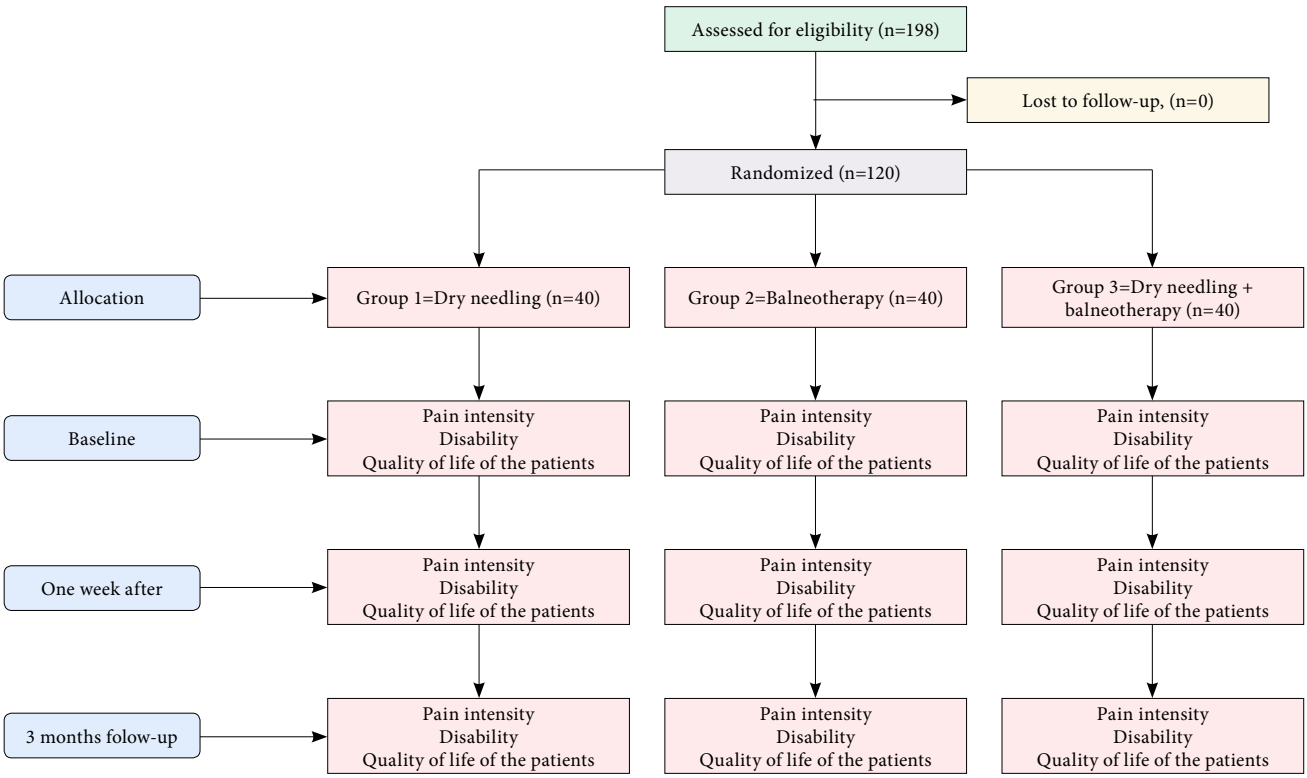

Figure 1. Flowchart of participant inclusion in the study.

diseases, current medications, dominant hand, pain duration, and pain location, were recorded.

Pain was measured using the Visual Analog Scale (VAS). The meanings of the numbers ranging from 0 to 10 on a 10-cm line were explained to the patients. A score of 0 indicated no pain, while 10 represented the most severe pain. Following these instructions, patients were instructed to indicate their pain levels at rest and during movement on the 10-cm line.[16]

An algometry device was used for the pressure pain threshold (PPT) evaluation. The algometer consisted of a metal piston, the pressure of which was measurable in kilograms (Baseline [10 kg] Push-Pull Force Gauge; Fabrication Enterprises Inc., Elmsford, NY, USA). The tip of the pressure algometer was applied at a 90° angle to the TP, with pressure increased by 1 kg/cm² every 3 sec until the patient verbally indicated discomfort. The pressure value at which pain was felt was recorded as the pain threshold. This procedure was repeated three times with 20-sec intervals, and the average was recorded in kg/cm². The measurements were made on all TPs, but the most painful TP was recorded.[17]

Cervical ROM during active flexion, extension, right and left rotation, and right and left lateral flexion was measured using a goniometer and recorded in degrees.

The Beck Depression Scale (BDS) was designed to assess the severity of depression by evaluating the physical, emotional, cognitive, and motivational symptoms associated with the condition.[18] In the scale, which consists of 21 questions, patients are requested to choose an expression describing how they felt in the last week. Each item consists of four sentences. These sentences are ranked from the steady state (0 points) to the most severe (3 points). The highest possible score is 63; 0 to 13 points are evaluated as no depression, 14 to 24 points as moderate depression, and above 25 points as severe depression.

The Beck Anxiety Scale (BAS) was used to assess the frequency of anxiety symptoms experienced by individuals. It provides a Likert-type measurement with each symptom category (n=21) offering four options. Each item is scored from 0 to 3, and higher scores indicate more severe anxiety experienced by the individual.[19]

The fear of moving, called kinesiophobia, was assessed using the Tampa Kinesiophobia Scale (TKS). The TKS is a 17-item scale.[20] The scale utilizes a 4-point Likert system (1 = strongly disagree, 4 = fully agree). After reversing the scores for items 4, 8, 12, and 16, a total score is calculated. This score ranges from 17 to 68, with higher scores reflecting greater levels of kinesiophobia.

The Neck Disability Index (NDI) consists of 10 questions covering topics such as pain, personal care, concentration, work, driving, and sleeping.[21] The questions assess the relationship between neck pain severity and its impact on professional life, social and functional aspects of life, recreational activities, and emotional well-being. Each question is scored on a scale from 0 to 5 points. The questionnaire is scored out of a maximum of 50 points, where 0 indicates no restrictions and 50 indicates complete disability.

The 36-item Short-Form Health Survey (SF-36) is commonly used in scales that evaluate quality of life.[22] It contains 36 questions consisting of eight subtitles. It includes physical function (10 items), physical role restriction (4 items), pain (2 items), social function (2 items), mental health (5 items), emotional role restriction (3 items), energy-vitality (4 items), and general health perception (6 items) evaluations. In the SF-36, all items assess both positive and negative health states. Each dimension's scores are coded and converted to a scale from 0 (indicating the worst health) to 100 (indicating the best health).

All scales used had validity and reliability studies conducted in the native language of the patients included in the study.[23-27] All evaluations were performed by a researcher blinded to treatment groups before the treatment, 7±2 days after the treatment, and three months after the treatment for a total of three times. The study was designed as single-blind (practitioner), as it was not possible for patients to be blinded due to the nature of the treatments.

Statistical analysis

The data were analyzed using the IBM SPSS version 21.0 software (IBM Corp., Armonk, NY, USA). The normality of the variables was assessed through the Kolmogorov-Smirnov and Shapiro-Wilk tests. Descriptive statistics were presented as mean ± standard deviation (SD), median (min-max), and frequency and percentage (n, %). For univariate analyses of qualitative variables, Pearson chi-square test and Fisher exact test were applied. In cases where the normality assumption was not met, the Kruskal-Wallis and Friedman tests were used for univariate analyses. To determine statistical differences among therapy groups, the Kruskal-Wallis test was employed for each outcome measure. For post hoc comparisons of groups with significant differences were made using the Mann-Whitney U test and Wilcoxon's signed-rank test. Bonferroni correction was applied to control for multiple tests. A p-value <0.05 was interpreted as statistically significant.

Priori power analysis was conducted at the beginning of the study to calculate the sample size based on the tests to be used using G*Power version 3.1.9.7 (Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany). For the analysis of variance, with an effect size of 0.40, alpha of 0.005, power of 0.95, and three groups, the minimum sample size required for the study was calculated as 107. When calculating the sample size for the chi-square test, with an effect size of 0.40, alpha of 0.005, power of 0.95), and degree of freedom of 4, the minimum sample size required was found to be 117. Due to the presence of three groups in the study, it was conducted with a total of 120 participants, with 40 individuals in each group.

RESULTS

The demographic characteristics of the study groups and the distribution of the descriptive analyses between the groups are presented in Table 1. The pain duration and pain locations of the patients are compared in Table 1. The distribution of TP locations among the study groups was classified as upper right, middle right, lower right, upper left, middle left, and lower left in the trapezius muscle. It was determined that the majority of the TPs were located in the upper trapezius muscle fibers, and there was no statistically significant difference between the groups (p>0.05).

Pain score changes measured using VAS at rest, VAS during movement, and PPT within and between groups are compared in Table 2. There was no statistically significant difference between the groups in the pretreatment evaluations (p>0.05). When compared within groups, there was a decrease in pain scores after treatment in all groups (p<0.001). However, in comparisons between groups, statistically significant differences were observed in

TABLE 1
Demographic and clinical characteristics of the patients

	Group 1 (n=40)					Group 2 (n=40)					Group 3 (n=40)					
	n	%	Mean±SD	Median	Min-Max	n	%	Mean±SD	Median	Min-Max	n	%	Mean±SD	Median	Min-Max	*p*
Age (year)			40.9±6.9	43.5	18-50			42.0±6.8	42.5	20-50			42.2±6.65	45.5	20-50	0.109[1]
Sex																0.062[2]
Male	7	17.5				8	20				8	20				
Female	33	82.5				32	80				32	80				
Educational status																0.462[3]
Illiterate	2	5				2	5				2	5				
Literate	1	2.5				0	0.0				0	0.0				
Primary school	8	20				17	42.5				11	27.5				
Middle school	5	12.5				7	17.5				6	15				
High school	7	17.5				3	7.5				8	20				
College	17	42.5				11	27.5				13	32.5				
Job																0.431[3]
Housewife	21	52.5				26	65				23	57.5				
Civil servant	9	22.5				7	17.5				4	10				
Heavy physical worker	8	20				5	12.5				12	30				
Unemployed	2	5				2	5				1	2.5				
BMI (kg/m^2)			26.3±4.6	25.65	17.8-41.5			28.4±4.7	27.9	20.2-38.7			27.3±5.0	26.5	19.5-41.8	0.096[1]
Chronic disease	10	25.0				15	37.5				16	40.0				0.317[2]
Chronic diseases																
Hypertension	3	7.5				6	15.0				4	10.0				0.668[3]
Diabetes mellitus	1	2.5				6	15.0				4	10.				0.179[3]
Hypothyroidism	2	5.0				2	5.0				5	12.5				0.497[3]
Migraine	3	7.5				1	2.5				2	5.0				0.869[3]
Other[+]	3	7.5				2	5.0				2	5.0				1.000[3]
Drug use status	9	22.5				14	35.0				14	35.0				0.376[2]
Smoking status	11	27.5				10	25.0				8	20.0				0.727[2]
Pain duration (year)			4.6±4.9	2.5	0.2-20			6.5±5.8	4.5	0.5-20			5.3±4.5	3.5	0.5-20	0.126[1]
Pain location																0.892[2]
Right	5	12.5				8	20.0				7	17.5				
Left	9	22.5				8	20.0				10	25.0				
Bilateral	26	65.0				24	60.0				23	57.5				
Dominant hand side																0.9253
Right	35	87.5				37	92.5				36	90				
Left	5	12.5				3	7.5				4	10				

SD: Standard deviation; BMI: Body mass index; [1]Kruskal-Wallis test; [2] Chi-square test; [3] Fisher Exact test; [+]A patient has more than one additional disease, the percentage is calculated on the number of patients. Asthma, gastritis, FMF, UC, hepatitis B.

TABLE 2
Pain scores and p-values of comparisons in repeated measures and between groups

	Group 1 (n=40)		Group 2 (n=40)		Group 3 (n=40)			Group 1 *vs.* Group 2	Group 1 *vs.* Group 3	Group 2 *vs.* Group 3
	Mean±SD	Min-Max	Mean±SD	Min-Max	Mean±SD	Min-Max	p^1	p^3	p^3	p^3
VAS at rest										
Pre-treatment	6.6±2.1	2-10	6.7±2.2	2-10	6.3±1.9	2-10	0.624	-	-	-
1st week	2.5±1.5	0-6	3.4±1.7	0-7	1.8±1.4	0-5	**<0.001**	**0.010**	0.074	**<0.001**
3rd month	2.7±1.7	0-6	4.0±1.7	1-7	2.3±1.7	0-6	**<0.001**	**0.001**	0.335	**<0.001**
p^2	**<0.001**		**<0.001**		**<0.001**					
p (Pre-treatment *vs.* 1st week)[4]	**<0.001**		**<0.001**		**<0.001**					
p (Pre-treatment *vs.* 3rd month)[4]	**<0.001**		**<0.001**		**<0.001**					
p (1st week-3rd month)[4]	**0.183**		**<0.001**		**0.019**					
VAS during movement										
Pre-treatment	8.4±1.4	5-10	8.4±1.7	3-10	8.1±1.3	5-10	0.182	-	-	-
1st week	3.6±1.6	0-7	4.6±1.8	0-9	2.8±1.5	0-6	**<0.001**	**0.013**	**0.014**	**<0.001**
3rd month	3.7±1.6	1-7	5.1±1.7	1-9	3.4±1.8	1-7	**<0.001**	**<0.001**	**0.294**	**<0.001**
p^2	**<0.001**		**<0.001**		**<0.001**					
p (Pre-treatment *vs.* 1st week)[4]	**<0.001**		**<0.001**		**<0.001**					
p (Pre-treatment *vs.* 3rd month)[4]	**<0.001**		**<0.001**		**<0.001**					
p (1st week-3rd month)[4]	0.787		**0.029**		**0.013**					
PPT										
Pre-treatment	2.2±0.4	1.3-3.2	2.1±0.6	1.3-3.7	2.1±0.5	1.1-2.9	0.985	-	-	-
1st week	3.8±0.8	2.4-5.9	3.5±1.0	2.1-6.0	4.3±0.8	2.6-6.0	**<0.001**	0.070	**<0.001**	**<0.001**
3rd month	3.6±0.8	2.3-5.8	3.3±1.1	1.7-6.0	4.2±1.0	2.3-6.0	**<0.001**	0.069	**0.003**	**<0.001**
p^2	**<0.001**		**<0.001**		**<0.001**					
p (Pre-treatment *vs.* 1st week)[4]	**<0.001**		**<0.001**		**<0.001**					
p (Pre-treatment *vs.* 3rd month)[4]	**<0.001**		**<0.001**		**<0.001**					
p (1st week-3rd month)[4]	**0.001**		**0.001**		0.086					

SD: Standard deviation; VAS: Visual Analog Scale; PPT: Pressure pain threshold; [1] Kruskal Wallis test; [2] Friedman test; [3] Mann-Whitney U test; [4] Wilcoxon Signed-Rank test. Post-hoc test results were Bonferroni adjusted.

TABLE 3
Cervical joint ROM degrees and p-values of comparisons in repeated measures and between groups

	Group 1 (n=40)		Group 2 (n=40)		Group 3 (n=40)			Group 1 *vs.* Group 2	Group 1 *vs.* Group 3	Group 2 *vs.* Group 3
Cervical ROM	Mean±SD	Min-Max	Mean±SD	Min-Max	Mean±SD	Min-Max	p^1	p^3	p^3	p^3
Flexion										
Pre-treatment	42.6±9.1	20-50	40.9±10	20-50	42.1±8.9	20-50	0.838	-	-	-
1st week	49.4±1.5	45-50	49.6±1.2	45-50	49.7±1.2	44-50	0.371	-	-	-
3rd month	49.4±1.3	45-50	48.4±2.6	40-50	49.1±3.4	35-59	0.147	-	-	-
p^2	**<0.001**		**<0.001**		**<0.001**					
p (Pre-treatment *vs.* 1st week)[4]	**<0.001**		**<0.001**		**<0.001**					
p (Pre-treatment *vs.* 3rd month)[4]	**<0.001**		**<0.001**		**<0.001**					
p (1st week-3rd month)[4]	0.856		**<0.001**		0.080					
Extension										
Pre-treatment	49.6±11.1	20-60	49.3±10.2	26-60	51.9±8.6	30-60	0.683	-	-	-
1st week	59.1±2.7	46-60	59.2±2.1	50-60	59.4±2.6	45-60	0.442	-	-	-
3rd month	59.2±1.6	54-60	57.8±3.2	46-60	58.4±3.3	45-60	0.124	-	-	-
p^2	**<0.001**		**<0.001**		**<0.001**					
p (Pre-treatment *vs.* 1st week)[4]	**<0.001**		**<0.001**		**<0.001**					
p (Pre-treatment *vs.* 3rd month)[4]	**<0.001**		**<0.001**		**<0.001**					
p (1st week-3rd month)[4]	0.857		**0.002**		0.053					
Right rotation										
Pre-treatment	69.1±14.9	20-80	71±11.4	43-80	67.3±13.6	30-80	0.347	-	-	-
1st week	78.5±4.5	60-80	79.8±0.8	76-80	79.7±1.3	72-80	0.229	-	-	-
3rd month	78.6±2.7	68-80	78.1±3.8	60-80	78.1±5.5	47-80	0.740	-	-	-
p^2	**<0.001**		**<0.001**		**<0.001**					
p (Pre-treatment *vs.* 1st week)[4]	**<0.001**		**<0.001**		**<0.001**					
p (Pre-treatment *vs.* 3rd month)[4]	**<0.001**		**<0.001**		**<0.001**					
p (1st week-3rd month)[4]	**0.797**		**<0.001**		**0.005**					
Left rotation										
Pre-treatment	68.4±18.3	20-80	71.4±10.4	42-80	68.0±12.8	20-80	0.112	-	-	-
1st week	78.5±4.2	60-80	79.5±1.8	70-80	79.0±3.7	60-80	0.760	-	-	-
3rd month	77.9±4.3	60-80	78.3±3.1	67-80	78.1±6.0	43-80	0.746	-	-	-
p^2	**<0.001**		**<0.001**		**<0.001**					
p (Pre-treatment *vs.* 1st week)[4]	**<0.001**		**<0.001**		**<0.001**					
p (Pre-treatment *vs.* 3rd month)[4]	**<0.001**		**<0.001**		**<0.001**					
p (1st week-3rd month)[4]	0.599		**0.002**		0.283					

TABLE 3
Continued

Cervical ROM	Group 1 (n=40) Mean±SD	Group 1 (n=40) Min-Max	Group 2 (n=40) Mean±SD	Group 2 (n=40) Min-Max	Group 3 (n=40) Mean±SD	Group 3 (n=40) Min-Max	p^1	Group 1 *vs.* Group 2 p^3	Group 1 *vs.* Group 3 p^3	Group 2 *vs.* Group 3 p^3
Right lateral flexion										
Pre-treatment	39.7±8.3	10-45	37.3±3.1	14-45	36.1±6.0	13-45	-	0.323	0.096	0.512
1st week	44.4±1.9	35-45	44.5±1.2	15-45	44.6±1.9	15-45	-	0.154	0.180	0.958
3rd month	44.4±1.4	40-45	44.9±0.5	43-45	44.8±0.9	40-45	-	0.263	0.794	**0.173**
p^2	**<0.001**		**<0.001**		**<0.001**					
p (Pre-treatment *vs.* 1st week)[4]	**<0.001**		**<0.001**		**<0.001**					
p (Pre-treatment *vs.* 3rd month)[4]	**<0.001**		**<0.001**		**<0.001**					
p (1st week-3rd month)[4]	0.797		0.000		0.005					
Left lateral flexion										
Pre-treatment	37.6±10.0	10-45	37.5±7.6	15-45	35.8±8.6	15-45	0.256	-	-	-
1st week	44.2±2.0	36-45	44.6±1.8	34-45	44.8±1.2	38-45	0.234		-	-
3rd month	44.2±1.4	40-45	44.3±1.1	41-45	43.6±2.6	34-45	0.323	-	-	-
p^2	**<0.001**		**<0.001**		**<0.001**					
p (Pre-treatment *vs.* 1st week)[4]	**<0.001**		**<0.001**		**<0.001**					
p (Pre-treatment *vs.* 3rd month)[4]	**<0.001**		**<0.001**		**<0.001**					
p (1st week-3rd month)[4]	0.952		**<0.001**		0.230					

SD: Standard deviation; ROM: Range of motion; [1] Kruskal Wallis test; [2] Friedman test; [3] Mann-Whitney U test; [4] Wilcoxon Signed-Rank test. Post-hoc test results were Bonferroni adjusted.

TABLE 4
Depression, anxiety, kinesiophobia, and disability scores and p-values of comparisons in repeated measures and between groups

	Group 1 (n=40)		Group 2 (n=40)		Group 3 (n=40)			Group 1 *vs.* Group 2	Group 1 *vs.* Group 3	Group 2 *vs.* Group 3
	Mean±SD	Min-Max	Mean±SD	Min-Max	Mean±SD	Min-Max	p^1	p^3	p^3	p^3
BDS										
Pre-treatment	12.0±7.8	0-33	16.5±7.7	0-32	15.5±13.0	0-77	0.032	0.008	0.258	0.168
1st week	6.4±6.4	0-30	11.8±6.8	0-25	8.1±7.0	0-29	**<0.001**	**<0.001**	0.287	**0.013**
3rd month	6.4±6.9	0-28	13.6±7.4	0-28	7.4±6.9	0-30	**<0.001**	**<0.001**	0.431	**<0.001**
p^2	**<0.001**		**<0.001**		**<0.001**					
p (Pre-treatment *vs.* 1st week)[4]	**<0.001**		**<0.001**		**<0.001**					
p (Pre-treatment *vs.* 3rd month)[4]	**<0.001**		**<0.001**		**<0.001**					
p (1st week-3rd month)[4]	0.700		**<0.001**		**0.033**					
BAS										
Pre-treatment	12.1±10.7	0-54	15.4±11.1	1-44	11.0±8.0	0-39	0.217	-	-	-
1st week	5.8±7.4	0-41	10.3±8.7	0-30	5.5±6.5	0-28	**0.005**	**0.007**	0.782	**0.004**
3rd month	5.8±6.8	0-36	10.8±8.7	0-32	5.5±6.1	0-24	**0.003**	**0.003**	0.877	**0.003**
p^2	**<0.001**		**<0.001**		**<0.001**					
p (Pre-treatment *vs.* 1st week)[4]	**<0.001**		**<0.001**		**<0.001**					
p (Pre-treatment *vs.* 3rd month)[4]	**<0.001**		**<0.001**		**<0.001**					
p (1st week-3rd month)[4]	0.853		0.299		**0.825**					
TKS										
Pre-treatment	35.4±7.4	23-54	37.6±8.4	26-60	34.6±7.7	17-53	0.402	-	-	-
1st week	30.1±7.3	18-48	31.6±9.2	20-55	27.1±8.2	17-53	0.060	-	-	-
3rd month	30.3±8.2	16-49	31.6±9.1	17-53	26.7±8.0	17-54	**0.031**	0.736	0.051	**0.011**
p^2	**<0.001**		**<0.001**		**<0.001**					
p (Pre-treatment *vs.* 1st week)[4]	**<0.001**		**<0.001**		**<0.001**					
p (Pre-treatment *vs.* 3rd month)[4]	**<0.001**		**<0.001**		**<0.001**					
p (1st week-3rd month)[4]	0.728		0.875		0.501					
NDI										
Pre-treatment	16.1±7.5	1-30	18.4±7.5	5-37	16.0±5.6	4-26	0.374	-	-	-
1st week	6.8±4.8	0-18	11.8±6.0	0-22	7.3±4.2	0-16	**<0.001**	**<0.001**	0.505	**<0.001**
3rd month	7.4±4.8	0-19	12.8±6.3	0-23	8.0±5.0	0-201	**<0.001**	**<0.001**	0.549	**<0.001**
p^2	**<0.001**		**<0.001**		**<0.001**					
p (Pre-treatment *vs.* 1st week)[4]	**<0.001**		**<0.001**		**<0.001**					
p (Pre-treatment *vs.* 3rd month)[4]	**<0.001**		**<0.001**		**<0.001**					
p (1st week-3rd month)[4]	0.551		**0.003**		0.105					

SD: Standard deviation; BAS: Beck Anxiety Scale; BDS: Beck Depression Scale; TKS: Tampa Kinesiophobia Scale; NDI: Neck Disability Index; [1] Kruskal Wallis test; [2] Friedman test; [3] Mann-Whitney U test; [4] Wilcoxon Signed-Rank test; * p<0.05; ** p<0.01 Post-hoc test results were Bonferroni adjusted.

TABLE 5
Quality of life scores and p-values of comparisons in repeated measures and between groups

SF-36	Group 1 (n=40) Mean±SD	Group 1 (n=40) Min-Max	Group 2 (n=40) Mean±SD	Group 2 (n=40) Min-Max	Group 3 (n=40) Mean±SD	Group 3 (n=40) Min-Max	p^1	Group 1 *vs.* Group 2 p^3	Group 1 *vs.* Group 3 p^3	Group 2 *vs.* Group 3 p^3
Physical function										
Pre-treatment	75.2±17.3	38.8-100	70.6±18.4	33.3-100	73.1±18.3	27.7-100	0.496	-	-	-
1st week	91.4±10.0	61.1-100	83.8±12.1	55.5-100	90.8±9.8	61.1-100	**0.004**	**0.003**	0.730	**0.005**
3rd month	89.4±10.4	55.5-100	79.6±14.6	44.4-100	86.6±11.9	55.5-100	**0.004**	**0.002**	0.318	**0.018**
p^2	**<0.001**		**<0.001**		**<0.001**					
p (Pre-treatment *vs.* 1st week)[4]	**<0.001**		**<0.001**		**<0.001**					
p (Pre-treatment *vs.* 3rd month)[4]	**<0.001**		**<0.001**		**<0.001**					
p (1st week-3rd month)[4]	0.018		**<0.001**		**<0.001**					
Physical role restriction										
Pre-treatment	15.6±36.1	0-100	18.1±38.4	0-100	19.4±37.8	0-100	0.887	-	-	-
1st week	91.2±17.5	50-100	74.4±24.3	25-100	86.2±19.6	50-100)	**0.002**	**<0.001**	0.174	**0.024**
3rd month	82.6±20.6	25-100	66.2±22.3	25-100	75.6±22.3	25-100	**0.003**	**<0.001**	0.118	0.051
p^2	**<0.001**		**<0.001**		**<0.001**					
p (Pre-treatment *vs.* 1st week)[4]	**<0.001**		**<0.001**		**<0.001**					
p (Pre-treatment *vs.* 3rd month)[4]	**<0.001**		**<0.001**		**<0.001**					
p (1st week-3rd month)[4]	**0.002**		**0.005**		**<0.001**					
Pain										
Pre-treatment	39.4±13.9	10-67.5	37.5±16.4	10-80	44.9±18.1	10-80	0.182	-	-	-
1st week	70.2±13.1	45-100	65.4±14.4	35-90	73.9±14.1	35-100	**0.019**	0.116	0.157	**0.007**
3rd month	66.2±12.2	32.5-87.5	58.8±16.2	22.5-90	70.6±13.9	32.5-90	**0.003**	**0.031**	0.122	**0.001**
p^2	**<0.001**		**<0.001**		**<0.001**					
p (Pre-treatment *vs.* 1st week)[4]	**<0.001**		**<0.001**		**<0.001**					
p (Pre-treatment *vs.* 3rd month)[4]	**<0.001**		**<0.001**		**<0.001**					
p (1st week-3rd month)[4]	**0.003**		**<0.001**		**<0.001**					
Social function										
Pre-treatment	64.1±18.4	12.5-100	58.4±19.9	25-100	67.5±17.6	12.5-100	0.077	-	-	-
1st week	80.3±12.6	50-100	73.8±12.5	50-100	80.4±12.1	50-100	**0.022**	**0.021**	0.938	**0.015**
3rd month	77.3±12.4	50-100	70.5±13.6	50-100	77.7±12.5	50-100	**0.029**	**0.026**	0.881	**0.019**
p^2	**<0.001**		**<0.001**		**<0.001**					
p (Pre-treatment *vs.* 1st week)[4]	**<0.001**		**<0.001**		**<0.001**					
p (Pre-treatment *vs.* 3rd month)[4]	**<0.001**		**<0.001**		**<0.001**					
p (1st week-3rd month)[4]	**0.016**		**0.007**		**0.016**					

TABLE 5
Continued

SF-36	Group 1 (n=40) Mean±SD	Group 1 (n=40) Min-Max	Group 2 (n=40) Mean±SD	Group 2 (n=40) Min-Max	Group 3 (n=40) Mean±SD	Group 3 (n=40) Min-Max	p^1	Group 1 *vs.* Group 2 p^3	Group 1 *vs.* Group 3 p^3	Group 2 *vs.* Group 3 p^3
Mental health										
Pre-treatment	59.7±14.2	32-92	53.9±18.8	20-92	58.7±16.7	20-88	0.322	-	-	-
1st week	68.9±12.0	36-92	64.2±15.5	36-96	68.0±15.7	32-96	0.298	-	-	-
3rd month	68.6±10.4	40-88	63.6±15.5	32-96	67.8±14.9	32-92	0.287	-	-	-
p^2	**<0.001**		**<0.001**		**<0.001**					
p (Pre-treatment *vs.* 1st week)[4]	**<0.001**		**<0.001**		**<0.001**					
p (Pre-treatment *vs.* 3rd month)[4]	**<0.001**		**<0.001**		**<0.001**					
p (1st week-3rd month)[4]	0.820		0.411		0.431					
Emotional role restriction										
Pre-treatment	22.5±42.3	0-100	20.0±40.5	0-100	25.8±43.0	0-100	0.792			
1st week	90.0±15.5	66.6-100	76.6±22.9	33.3-100	89.2±19.1	33.3-100	**0.006**	**0.006**	0.922	**0.007**
3rd month	82.5±21.4	33.3-100	65.8±24.5	33.3-100	81.6±23.8	33.3-100	**0.003**	**0.002**	0.939	**0.005**
p^2	**<0.001**		**<0.001**		**<0.001**					
p (Pre-treatment *vs.* 1st week)[4]	**<0.001**		**<0.001**		**<0.001**					
p (Pre-treatment *vs.* 3rd month)[4]	**<0.001**		**<0.001**		**<0.001**					
p (1st week-3rd month)[4]	**0.018**		**<0.001**		**0.022**					
Energy - vitality										
Pre-treatment	47.8±16.4	10-80	41.4±21.4	0-100	45.1±18.0	15-90	0.298	-	-	-
1st week	60.8±13.2	20-85	54.9±16.5	20-100	63.4±14.7	35-100	**0.029**	0.034	0.618	**0.016**
3rd month	59.9±12.2	25-80	53.2±17.7	15-100	61.5±13.0	35-90	**0.048**	**0.042**	0.771	**0.027**
p^2	**<0.001**		**<0.001**		**<0.001**					
p (Pre-treatment *vs.* 1st week)[4]	**<0.001**		**<0.001**		**<0.001**					
p (Pre-treatment *vs.* 3rd month)[4]	**<0.001**		**<0.001**		**<0.001**					
p (1st week-3rd month)[4]	0.315		0.201		0.065					
General health perception										
Pre-treatment	40.0±16.5	10-80	43.9±21.0	5-95	44.4±18.6	15-90	0.500	-	-	-
1st week	54.5±15.8	20-80	54.2±16.7	25-95	59.0±16.8	25-95	0.365	-	-	-
3rd month	53.4±14.4	20-80	53.0±18.5	20-95	56.8±17.2	25-90	0.487	-	-	-
p^2	**<0.001**		**<0.001**		**<0.001**					
p (Pre-treatment *vs.* 1st week)[4]	**<0.001**		**<0.001**		**<0.001**					
p (Pre-treatment *vs.* 3rd month)[4]	**<0.001**		**<0.001**		**<0.001**					
p (1st week-3rd month)[4]	0.229		0.184		0.019					

SD: Standard deviation; SF-36: Short Form-36 Quality of Life Scale; [1] Kruskal Wallis test; [2] Friedman test; [3] Mann-Whitney U test; [4] Wilcoxon Signed-Rank test. Post-hoc test results were Bonferroni adjusted.

the control measurements of VAS at rest, VAS during movement, and PPT scores (Table 2).

The changes in the cervical ROM within and between the groups are compared in Table 3. A statistically significant increase was found in the first week and third month evaluations after the treatment compared to pretreatment in all groups. In the evaluations between the groups, a statistically significant difference was found only between Group 1 and Group 2 in the comparison of cervical extension at the third month after the treatment ($p=0.048$; Table 3). No side effects were reported in any of the groups during the study period, indicating that both dry needling and balneotherapy were safe treatment modalities for MPS.

The depressive mood changes measured using the BDS within and between the groups, changes in the anxiety status evaluated using the BAS, kinesiophobia values measured using the TKS, and disability values measured using the NDI are compared in Table 4. In the comparisons between the groups, a statistically significant decrease was found in the first week and third month evaluations after the treatment compared to the pretreatment values in all three groups ($p<0.001$). A decrease in depressive mood, anxiety situation, kinesiophobia, and disability was observed in all groups after the treatment (Table 4).

The quality of life scores measured using the SF-36 within and between the groups are compared in Table 5. In the pretreatment evaluations, there was a statistically significant difference between Groups 2 and 3 only in the social function subgroup ($p=0.029$). In the intragroup evaluations, statistically significant increases were found in all subgroups of the SF-36 in the first week and third month evaluations after the treatment compared to pretreatment. In the comparisons made between the groups, it was determined that there were statistically more significant score increases in the SF-36 subgroup scores in dry needling groups (Group 1 and Group 3), except for the mental health and general health subgroups, compared to the group that only received balneotherapy (Group 2; Table 5).

DISCUSSION

This study revealed that dry needling, balneotherapy, and the combination of these two in the treatment of MPS lead to a decrease in patients' pain, depressive mood, anxiety, kinesiophobia levels, and an increase in ROM, functionality, and quality of life. In all three methods, it was shown that the state of well-being continued in the evaluations made both immediately after the treatment and three months later. However, in the comparisons made between the groups, better well-being was observed in some parameters in the groups in which dry needling was used (Group 1 and Group 3).

Dry needling is a treatment method that has been frequently used in clinics. However, different results on the effectiveness of dry needling were reported in systematic reviews. In a systematic review and meta-analysis published in 2015, it was stated that dry needling in the treatment of MPS was effective in the short and medium term compared to control or sham application groups, but not in the long term.[4] In comparing dry needling with other treatment groups (e.g., lidocaine injection, physiotherapy, and laser), it was reported that there was no difference between the groups in the short and long term, but other treatment methods were superior to dry needling in the medium term.[4] In their study comparing dry needling and kinesiotaping therapies in MPS, Yılmaz et al.[28] utilized a 0.25×25-mm acupuncture needle for dry needling, administering three sessions with a five-day interval over a total of 15 days. In a systematic review published in 2016, the authors concluded that dry needling was less successful in reducing pain compared to other treatments.[2] In a more recent meta-analysis published in 2020, it was reported with a moderate-low level of evidence that dry needling was effective in pain severity and pain-related disability in the short term compared to the control group, but this was not observed in the long term. Not effect on the PPT and neck ROM was demonstrated.[5] However, in all these meta-analyses, all authors stated that the evaluated studies were heterogeneous, and this was a major limitation in the interpretation of the results. In the present study, the well-being of the patients who received dry needling was statistically significantly improved compared to the pretreatment period in all parameters examined. In the comparisons made between the groups, when the evaluations made immediately after the treatment were reviewed, it was observed that the group that received dry needling only had more well-being in the VAS at rest, depression, anxiety, and neck disability scores than the group that received balneotherapy only, and in the evaluations made three months after the treatment, the VAS during movement scores were added to these. Given that pain is a subjective sensation, PPT measurements with algometry were

added to this study, as it can give more objective values compared to VAS. In the PPT scores, there was no statistical difference between dry needling and balneotherapy groups in the evaluations made immediately after the treatment and three months later.

Korkmaz et al.[29] found that both oxygen-ozone and lidocaine injections effectively improved pain and functional status in the treatment of MPS.

In our study, we also found that dry needling was an effective treatment method for MPS.

In a recent systematic review, because balneotherapy was an anti-inflammatory, antioxidant, chondroprotective, and immunomodulatory treatment method, it was stated that it was an alternative that could be preferred for use in diseases related to the musculoskeletal system.[30] In a systematic review of applications performed with water in the treatment of neck pain; hydrotherapy, aquatherapy (exercise in water), peloidotherapy, and balneotherapy methods were examined.[31] According to the results of the review, a reduction in neck pain, and an increase in functional capacity and quality of life were reported with balneotherapy. Consistent with the clinical findings from this review, the present study demonstrated significant improvements in all parameters evaluated in the group receiving balneotherapy alone for the treatment of MAS, both immediately after treatment and three months after treatment, compared to pretreatment values. Although the mechanism of action has not yet been clarified, balneotherapy can be preferred as an effective treatment method in patients who do not want interventional treatment methods. In a study by Gáti et al.[32] examining the effects of calcium-magnesium-bicarbonate content in thermal mineral water on chronic low back pain, the total mineral content was reported as 1000 mg/mL (1080 mg/mL). The water was found to be rich in calcium, magnesium, sodium, and bicarbonate, with a high hardness level (total hardness 259 CaO mg/L, 25.9 nkf). Our thermal water also contained similarly high levels of minerals with similar properties. The differential effectiveness observed between balneotherapy and dry needling in certain parameters may be attributed to the distinct mechanisms of action of these treatments. Dry needling directly targets myofascial TPs, providing immediate relief by disrupting taut muscle bands and promoting local twitch responses, which can lead to significant reductions in pain and improvements in muscle function.[1] This localized intervention can more effectively address specific areas of muscle tightness and pain compared to balneotherapy.

In contrast, balneotherapy exerts its effects through a combination of thermal, mechanical, and chemical mechanisms that provide systemic benefits. While these effects can lead to overall improvements in musculoskeletal health and general well-being, the impact may be less pronounced in specific pain and function parameters when compared to the targeted approach of dry needling.[8,9] Additionally, the relaxing and anti-inflammatory properties of balneotherapy contribute to gradual improvements, which might not achieve the same level of immediate symptom relief as dry needling.[30]

Furthermore, patient perception and psychological factors may also play a role. The invasive nature of dry needling might induce a stronger placebo effect or psychological response compared to the more passive balneotherapy, leading to greater reported improvements.[7] Overall, while both treatments are beneficial, their differing mechanisms and application methods contribute to the variations in effectiveness observed in this study.

One of the limitations of this study was that the patients were not blinded due to the nature of the study. Another limitation was that dry needling was not performed using a guide (ultrasonography). However, this treatment was used by experienced physicians who had years of experience in the field. The third limitation of the study was that the last follow-up was performed in the third month, and longer-term results were not evaluated. Despite all these limitations, the greatest strength of the present study was it being the first study in the literature to evaluate the effectiveness of balneotherapy in treating MPS and compare it to dry needling. In addition, the effect of dry needling on pain, depressive mood, functional status, and quality of life was investigated many times in the literature, but kinesiophobia was evaluated in a pilot study conducted with only a small number of patients.[33] With this study, the kinesiophobia levels and improvements after both dry needling and balneotherapy treatments were also reported in patients who developed neck pain due to the MPS.

In conclusion, dry needling, balneotherapy, and the combination of both can be used in the treatment of neck pain in patients with MPS due to TPs in the trapezius muscle. Effectiveness of these methods

continued three months after treatment. With these treatment methods, besides the reduction in neck pain, joint mobility limitation, depressive mood, anxiety, and kinesiophobia levels, the functionality and quality of life increased.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions: Idea/concept: Z.K.G., F.A.K., E.E.K.; Design: Z.K.G., F.A.K., S.Ş.; Control/supervision: Z.K.G., F.A.K., F.T., H.R.E.; Data collection and/or processing: Z.K.G.; Analysis and/or interpretation, materials: Z.K.G., F.A.K.; Literature review: Z.K.G., E.G.; Writing the article: Z.K.G., F.A.K., E.G.; Critical review: Z.K.G., F.A.K., S.Ş., E.E.K.; References and fundings: Z.K.G.

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