ORIGINAL ARTICLE

Eastern Journal of Medicine

East J Med 27(2): 307-316, 2022
DOI: 10.5505/ejm.2022.81904

The Effects of Cold Application To Trapezius Muscle On The Fibromyalgia

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ABSTRACT

This study aimed to assess the effect of cold application on trapezius muscles on fibromyalgia (FM).

This randomised, controlled study was conducted at the Physical Medicine and Rehabilitation outpatient clinic of a university hospital, in 42 people who had been diagnosed with FM. The participants were randomly divided into intervention (n=22) and control (n=20) groups. Cold application was applied to the trapezius muscles of the participants in the intervention group for 10 minutes. The pain levels of the participants in both the intervention and the control groups were evaluated every day for a period of 1 week. A questionnaire, the visual analogue scale and Revised Fibromyalgia Impact Questionnaire (FIQR) were used to collect data.

The mean pain scores of the participants in the intervention group were measured before cold application, 30 minutes after application, and on Days 1, 2, 3, 4, 5, 6 and 7, and these scores differed significantly ($p<0.001$). Function, impact, symptoms and total FIQR scores decreased significantly after cold application in the intervention group ($p<0.001$).

The pain levels of the people with FM, which were measured 30 minutes after they received cold application on the trapezius muscle and on Days 1, 2, 3, 4, 5, 6 and 7 post-application, decreased significantly. Their symptoms also decreased significantly and their functions, impact and general health status improved compared to the control group.

Keywords: Fibromyalgia, Cold Application, Trapezius Muscles, Pain

Introduction

Fibromyalgia is a medical condition that is characterised by chronic widespread musculoskeletal pain, and its cause is unknown (1). Other common symptoms of FM include fatigue, sleep disorders, anxiety and depression (2). It also leads to serious limitations in the daily activities and in the professional, family and social lives of people with the condition (3), and negatively influences their quality of life (3,4). Furthermore, the high costs of medicines, short-term disability and decrease in productivity that are associated with FM have negative impacts on both the people with the condition and the healthcare services (3). The prevalence of FM ranges between 0.2% and 6.6% in the general population, and between 0.6% and 15% in special population groups (5). Its prevalence is estimated at 8.8% in Turkey (6).

The chronic widespread pain in FM results from the musculoskeletal system (7). A majority of people with FM report pain and stiffness in their neck-shoulder muscles, and develop the condition from localised muscular pain conditions, such as trapezius myalgia (8). Mitochondrial, microcircular and/or metabolic disorders in the trapezius muscles of people with FM sensitise muscle nociceptors; muscle perfusion anomalies decrease pH and activate muscle nociceptors (9). Muscle anomalies, including changes in mitochondrial or muscle metabolism, sensitise muscle nociceptors and lead to pain, fatigue and weakness. This may result in peripheral sensitisation of the afferent pain pathways, which provide tonic impulse input to the central pathways, resulting in central sensitisation (10,11).

Stress and inflammation proteins that produce enzymes in metabolic pathways, and are associated with myopathies and muscle damage and recovery, are found in the trapezius muscles of people with FM. It is known that these proteins influence the process of inflammation or the nociceptors in a direct or indirect manner (12). People with FM have higher concentrations of algesic and metabolic substances, such as lactate, pyruvate and glutamate, in their trapezius muscles. It has also been noted that central alterations in people with FM are consequences of peripheral tissue changes (13,14).

Interactions between peripheral and central factors constitute an important part of the

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Received: 27.01.2021, **Accepted:** 25.01.2022

pathopsychology of FM. Widespread pain in the musculoskeletal system is related to multiple active myofascial trigger points (MTrPs), which are the main sources of peripheral pain in FM. Central sensitivity in FM is triggered by the MTrPs, which constitute tonic peripheral nociceptive impulses (15,16). The FM pain pattern is reproduced by mechanical stimulation of the MTrPs, which are localised in the trapezius muscle, and is primarily caused by muscle pain and spasm. MTrPs are the sources of the peripheral nociceptive inputs that trigger central sensitisation in FM, so they should be targeted for pain management (17).

Given that the primary source of FM is not known, there is no definite cure for this disease. From an interdisciplinary perspective, pharmacological and non-pharmacological methods may be simultaneously used in its treatment, and it has been suggested that non-pharmacological methods are used as the first option (18). Cold application is a non-pharmacological treatment and reduces blood flow, metabolic rate, inflammation, muscle spasms, oxygen use and pain (19-22).

As a result of a literature review, we found only one previous study that had examined local cold application to the trapezius muscle in people with FM. This study, which measured pain levels of the patients at 10 minutes, 1.5 hours and 1 day after the cold application, but which did not include a control group, found that local cold application to the trapezius muscle decreased pain levels (23). The present study aimed to evaluate the effects of the application of cold to the trapezius muscles in FM. Significant differences in total FIQR and domains scores, and pain level were hypothesized between the intervention and control groups

Materials and Methods

This randomised-controlled study was conducted between September and December 2016 at the Physical Medicine and Rehabilitation outpatient clinic of a University hospital, in 42 people who had been diagnosed with FM according to the diagnostic criteria of the American College of Rheumatology (24). One of the 44 eligible individuals refused to take part in the study, and another was excluded, due to a change in the medicines that they were taking. Consequently, the study was conducted in 42 participants, who were randomly divided into intervention (n=22) and control (n=20) groups (Figure 1). In dividing the patients, we used closed envelopes, in which the names of each group (A= Intervention; B= Control) were written, and asked the participants to select an envelope.

We conducted a power analysis in order to evaluate the sample size. The analysis revealed that the study had a 0.05 significance level, a 95% confidence interval, a 3.145 effect size and 0.99 power scores, indicating the adequacy of the sample.

Ethical permission was obtained from the research ethics committee of a University Faculty of Health Sciences (10.10.2013) and the administrative board of the hospital in which the study was conducted. The participants were informed of the aim and scope of the study, and their consent was obtained.

Inclusion criteria: Only people with FM who met the following criteria were included:

- Agreed to participate
- Aged over 18 years
- Had no cold allergy
- Had no scare and injuries to the trapezius muscles
- Had pain scores five or more
- Were not pregnant, and had no sense disorders or circulatory disorder in the peripheral artery
- Had been taking their medicines for at least a month
- Had no communication problems and mental illness, such as severe depression and schizophrenia

Data collection: We used a questionnaire, the visual analogue scale (VAS), the Revised Fibromyalgia Impact Questionnaire (FIQR) and a pain evaluation form to collect the data.

The questionnaire was prepared by the researcher in line with the literature (23). The questionnaire had 7 questions that measured the participants' characteristics, such as gender, age, profession, body-mass index, marital status and period of disease.

The VAS was used for the participants' self-evaluation of pain. Participants are asked to score their pain levels using this 10-cm-long scale, which ranges from 0–10, with higher scores indicating greater pain (25). The pain evaluation form was constructed by the study author, and includes the VAS, as well as information on the date and time that the participants' pain levels were measured. The form was delivered to the participants in both groups, and they were asked to evaluate their pain levels every day for 1 week.

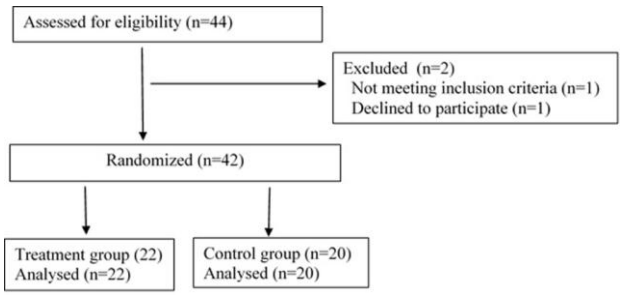

Fig 1. Consolidated Standards of Reporting Trials (CONSORT) Fowchart

The FIQR was developed to evaluate the health statistics of the people with FM for 1 week. It comprises 21 questions and three domains (function, overall impact and symptom). The total score ranges between 0 and 100, and the maximum score that can be obtained from the function (nine questions), overall impact (two questions) and the symptom (10 questions) domains are 30, 20 and 50, respectively. Higher scores indicate worse health status (26,27). The reliability and validity of the scale in Turkish was tested by Ediz et al (27).

Cold gel pack: The cold gel packs that were used had a size of 26 x 37 cm, and contained gel that maintained coldness inside the pack. The pack was placed inside a thin white towel in order to protect the skin from direct contact with the cold. The cold gel packages were left in a deep freezer (minus eighteen degrees) for at least 4 hours before application (23), and two packs were used for the right and left trapezius muscles of each participant. The temperature of the cold gel packs was 1-2 ^{0}C.

Interventions: Following examination, each participant was informed of the research and those who met the inclusion criteria were determined. The participants in both groups were taken to an empty room of the Physical Medicine and Rehabilitation unit and were asked to complete the questionnaire and the FIQR (before application). The participants' pain levels were evaluated using the VAS (before application).

The cold application was applied to the patients in the intervention group by a nurse (she had no knowledge of the study) working at the Physical Medicine and Rehabilitation unit. The patients were asked to remove all their clothes from their upper body and to lie down in a prone position. The cold gel packs were removed from the deep freezer, placed inside a thin white towel and applied to the right and left trapezius muscles of each participant for 10 minutes. Following the application, the participants were given 30 minutes to rest. Their pain scores were then evaluated via administration of the VAS (30 minutes later). Finally, the participants were given the pain evaluation forms and were asked to complete these forms at the same time every day for 1 week.

The patients in the control group did not receive a cold application. They were given the pain evaluation forms and were asked to complete them at the same time every day for 1 week.

The participants in both groups were asked to use their medicines without delay. The researcher also telephoned them every day in order to check whether they had completed the pain evaluation form. On Day 8, the participants were called to the Physical Medicine and Rehabilitation unit, and the FIQR scale (after application) was administered. In addition, the pain evaluation form was received from the participants.

Statistical Analysis: The data obtained were analysed using Statistical Package for the Social Sciences software, version 18. We used Fisher's exact test to compare the genders of the participants in both groups, Pearson's chi-square test to compare the participants' marital and professional status, education levels, an independent-sample t test to compare their body mass index (BMI) and a Mann-Whitney U test to compare their ages with the duration of their disease (Table 1).

A Mann-Whitney U test was used to determine the difference in the pain scores of the control and intervention groups, measured at different times. A Friedman test was used to determine intra-group differences in the pain scores of both groups. For meaningful differences in the intervention group, a Wilcoxon test was used to determine intra-group differences (Table 2). Independent-sample t and Mann-Whitney U tests were used to compare the scores of the FIQR and its three domains obtained from the intervention and control groups. A paired-sample T-test and a Wilcoxon test were used to compare the intra-group scores of the FIQR and its three domains obtained from the intervention and control groups, before and after cold application (Table 3).

Results

The age of the participants ranged between 22 and 60 years, with a mean of 36.36. The mean BMI and duration of disease values were 25.31 and 8.21, respectively. No significant difference

Table 1. Comparison of the Participant Characteristics in the Intervention and Control Groups

Characteristics	Intervention(n=22)	Control (n=20)	Test value	P-value
Gender	n (%)	n (%)		
Female	20 (90.9)	19 (95.0)	*	1.000
Male	2 (9.1)	1 (5.0)		
Marital Status				
Married	16 (72.7)	13 (65.0)	$\chi2$=0.293	0.588
Single	6 (27.3)	7 (35.0)		
Education				
Elementary school	9 (40.9)	9 (45.0)		
Secondary school	3 (13.6)	2 (10.0)	$\chi2$ =0.582	0.900
High school	7 (31.9)	5 (25.0)		
University	3 (13.6)	4 (20.0)		
Professional Status				
Employed	7 (31.8)	6 (30.0)	$\chi2$ =0.016	0.899
Unemployed	15 (68.2)	14 (70.0)		
	Mean ± SD	Mean ± SD		
Age, years	36.59 ± 10.39	36.10 ± 11.23	U=208.500	0.772
Disease Duration, years	8.68 ± 5.47	7.70 ± 5.04	U=203.000	0.667
Body Mass Index (kg/m2)	25.25 ± 3.99	25.38 ± 2.82	t=0.117	0.908

*:Fisher's exact test, $\chi2$: Pearson chi-square, U: Mann-Whitney U test, t: Independent sample t test, SD: Standard deviation

between the intervention and control groups was found ($p>0.05$), as shown in Table 1.

The mean pain scores of the participants in the intervention group were measured before cold application (7.14±1.28), 30 minutes after cold application (0.50±0.80), then after 24 hours (0.50±0.80), 2 days (0.73±0.94), 3 days (1.45±1.63), 4 days (3.32±2.38), 5 days (4.55±2.26), 6 days (5.32±1.96) and 7 days (5.59±1.76), and they differed significantly ($p<0.001$), as shown in Table 2. Further analysis showed that the mean before-application pain score of the intervention group was significantly higher than the mean pain scores that were measured on the eight occasions after cold application ($p<0.001$). Mean pain scores for this group decreased significantly 30 minutes and 24 hours after cold application, but then subsequently increased. The mean pain scores measured 30 minutes and 24 hours after cold application were lower than the scores obtained on Days 3, 4, 5, 6 and 7, and the mean pain score measured on Day 2 after cold application was lower than the pain scores obtained on Days 3, 4, 5, 6 and 7. The mean pain score measured on Day 3 after the cold application was lower than the mean scores measured on Days 4, 5, 6 and 7. The mean pain score measured on Day 4 after the cold application was lower than the mean scores obtained on Days 5, 6 and 7. Similarly, the mean pain score measured on Day 5 after the cold application was lower than the mean scores obtained on Days 6 and 7.

With regard to the control group, we did not find any significant differences in the mean pain scores measured before cold application (7.05±1.39), after 24 hours (7.00±1.45), 2 days (6.85±1.39), 3 days (6.95±1.39), 4 days (7.10±1.48), 5 days (7.00±1.49), 6 days (6.90±1.52) and 7 days (6.95±1.50) ($p>0.05$), as shown in Table 2.

The mean intervention group pain scores that were measured 30 minutes later, on Days 1, 2, 3, 4, 5, 6, and 7 after cold application were significantly lower than those of the control group ($p<0.05$). There was no significant difference between the groups with regard to the mean pain scores that were measured before the application in both groups ($p>0.05$), as shown in Table 2.

In the intervention group, the mean function scores decreased significantly from before (18.86±4.92) to after cold application (11.50±3.04). Similarly, the mean impact scores decreased from before (10.68±3.78) to after (5.55±2.58) cold application. Furthermore, the mean symptom scores decreased significantly from before (32.09±8.26) to after (16.14±4.21) cold application. Overall, the mean total FIQR scores decreased significantly from before

Table 2. Comparison of the Pain Scores for the Intervention and the Control Groups

Groups	Before Application Pain (Mean±SD)	After Application Pain (Mean± SD)								
		30 minutes later	24 hours later	2 days later	3 days later	4 days later	5 days later	6 days later	7 days later	Test value P- value
Intervention (n=22)	7.14±1.28	0.50±0.80	0.50±0.80	0.73±0.94	1.45±1.63	3.32±2.38	4.55±2.26	5.32±1.96	5.59±1.76	F=147.418 < 0.001
Control (n=20)	7.05±1.39	-	7.00±1.45	6.85±1.39	6.95±1.39	7.10±1.48	7.00±1.49	6.90±1.52	6.95±1.50	F=4.638 0.704
Test value	U=214.500	-	U=0.000	U=0.000	U=10.000	U=48.500	U=89.500	U=119.000	U=121.500	
P- value	0.887	-	< 0.001	< 0.001	< 0.001	< 0.001	0.001	0.010	0.011	

U: Mann-Whitney U test, F: Friedman test, VAS: Visual analogue scale, SD: Standard deviation

Table 3. Comparison of the FIQR Scores of the Intervention and Control Groups

FIQR and Domains	Intervention (n=22)	Control (n=20)	Test value	P value
Function	Mean±SD	Mean±SD		
Before application	18.86±4.92	20.20±3.66	t = -0.990	0.328
After application	11.50±3.04	19.95±5.16	t = -6.545	< 0.001
Test value	t* = 7.769	t* = 0.340		
P value	< 0.001	0.738		
Impact				
Before application	10.68±3.78	10.35±2.70	t = 0.324	0.748
After application	5.55±2.58	10.40±2.98	t = -5.660	< 0.001
Test value	t* = 8.215	t* = -0.152		
P value	< 0.001	0.881		
Symptoms				
Before application	32.09±8.26	31.15±8.42	t = 0.365	0.717
After Application	16.14±4.21	32.95±8.03	U = 9.500	< 0.001
Test value	Z = -4.110	Z = -1.394		
P value	< 0.001	0.163		
Total FIQR				
Before application	61.64±14.87	62.00±12.33	t = -0.086	0.932
After application	33.18±7.30	63.30±11.44	t = -10.268	< 0.001
Test value	t* = 10.086	t* = -0.596		
P value	< 0.001	0.558		

FIQR: Revised Fibromyalgia Impact Questionnaire, t: Independent sample test, U: Mann-Whitney U test, t*: Paired-sample T-test, Z: Wilcoxon test, SD: Standard deviation

(61.64±14.87) to after (33.18±7.30) cold application. Therefore, the function, impact, symptom and total FIQR scores were significantly higher before the cold application than afterwards ($p<0.001$), as shown in Table 3. Following cold application, the function, impact, symptom and total FIQR scores of the intervention group decreased significantly compared to those of the control group ($p<0.001$), as shown in Table 3. In addition, no significant difference was found between the mean function, impact, symptom and total FIQR scores measured in the control group after cold application ($p>0.05$) (Table 3).

Discussion

Two main conclusions can be drawn from the present study, which was conducted to determine the effects of the application of cold to the trapezius muscles in FM. Firstly, we found that such an application for 10 minutes decreased pain levels after 30 minutes and on Days 1, 2, 3, 4, 5, 6 and 7, compared to a control group. Secondly, and in association, a 10-minute cold application to the trapezius muscles decreased the symptoms of FM, and increased the well-being of the participants in terms of function, impact and general health status.

Mitochondrial, microcircular and/or metabolic disorders of the trapezius muscles of people with FM sensitise muscle nociceptors (9). Muscle anomalies are important for inducing central sensitisation as they sensitise muscle nociceptor impulses (11). Pain patterns in FM syndrome stem from the MTrPs, which are localised to various muscles, including those of the trapezius (17). Active MTrPs, which are found in the upper trapezius muscles, serve as one of the sources of noxious input, which leads to the sensitisation of spinal and supraspinal pain pathways (28). Stress and inflammation proteins that produce enzymes in metabolic pathways, and which are associated with myopathies and muscle damage and recovery, increase pain levels in FM (12). It has been found that people with FM have higher concentrations of algesic and metabolic substances, such as lactate, pyruvate and glutamate, in their trapezius muscles, which, in turn, increase pain levels. Furthermore, central alterations are consequences of peripheral tissue changes (13,14).

Topical cold application decreases the temperature of the skin and the underlying tissues to a depth

of 2–4 cm (21). It induces a local anaesthetic effect, referred to as cold-induced neurapraxia, by decreasing the activation threshold of tissue nociceptors and the conduction velocity of nerve signals conveying pain (19-22). Cold application reduces muscular spasm by inhibiting the spinal cord reflex loop and cooling intramuscular fibres (20,22). The cold inhibits gamma motor neuron activity, inactivates nerves that innervate muscles and reduces metabolic waste, which, in turn, decreases muscular spasm and pain (19,22). Furthermore, it reduces neuromuscular flow (22) and damage caused by hypoxia, by slowing metabolism and reducing oxygen consumption (20,21).

The only previous study that has been conducted on the impact of local cold application on the trapezius muscles found that pain levels, which were measured 10 minutes, 1.5 hours and 1 day after the cold application, decreased significantly. This study explained the decrease in pain levels with reference to the cold application-induced inhibition of nociceptors in the trapezius muscles (23). In the present study, in which cold was applied to both trapezius muscles, we found that pain levels decreased with the inhibition of nociceptors in the trapezius muscles, which have been sensitised due to peripheral factors.

Cold application may have prevented nociceptor sensitisation by reducing the potential activities of algesic and metabolic substances found in the trapezius muscles. It may also have reduced nociceptor sensitisation by preventing the activities of MTrPs. Almost all of the participants described complaints, such as stiffness and tension in the trapezius muscles; the majority of those in the intervention group stated that it was not only the pain, but that all their FM complaints were related to problems in the trapezius muscles.

The present study found that the mean pain scores of the participants who received a cold application, continued to decrease from 30 minutes to Day 7 after the application. The mean pain score of the intervention group, which was 7.14 before cold application, decreased to 0.50 at 30 minutes after the application and remained at the same level 24 hours later. Two days later, the mean pain score of the intervention group increased to 0.73, and this trend of increase continued until Day 6. We found a slight increase on Day 7 (5.59), which was statistically insignificant. The previous study, which assessed the impact of local cold application on only one of the trapezius muscle, found that the mean pain score before cold application (6.45) decreased to 2.75 at 10 minutes after the application, and 2.45 at 1.5 hours after the application, but increased to 3.36 in 24 hours (23). Cold application leads to a decrease in FM pain levels within minutes. While the previous study found that the pain levels increased 1 day after application, in the present study, which used cold application on both trapezius muscles, the pain levels did not begin to increase until the second day after application. During the telephone conversations, the participants in the intervention group primarily stated that their pain increased after housework, sleep loss, visiting relatives and shopping. Previous studies have noted that repeated physical activities, stress, sleep loss (28), overloading muscles and psychophysical trauma may activate MTrPs and increase pain levels (17). We believe that the increase in pain is related to activation of the nociceptors in the trapezius muscles.

Interestingly, we found that cold application to both trapezius muscles decreased not only pain, but also the common symptoms of FM. Furthermore, we observed improvements in the function, impact, and general health status of the participants who received the cold application compared to the control group. Central pain in FM occurs in conjunction with other centrally mediated symptoms, including fatigue, insomnia, memory problems and mood disturbances (29). Disruption to neurotransmitters that facilitate pain transmission may result in fatigue, memory problems and sleep and mood disturbances, since the same neurotransmitters may also control sleep, mood, memory and alertness (30). We believe that further studies on the impact of cold application on the trapezius muscles of people with FM, in terms of symptoms, function and general health status, may be of value.

This study was limited to a total of only 42 people with FM, of whom 22 were in the intervention and 20 were in the control group.

The present study, which analysed the effects of cold application on FM, found that the pain levels of the participants who received this application, decreased 30 minutes, 1, 2 3, 4, 5, 6 and 7 days after the application. Symptoms also decreased after the application, and improvements in function, impact and general health status were observed.

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