Clinical and Experimental Health Sciences

"Iontophoresis vs. Phonophoresis": Which is A Best Way to Treat Subacromial Impingement Syndrome? A Randomized Study

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ABSTRACT

Objective: Subacromial Impingement Syndrome (SIS) is an important shoulder issue characterized by multiple symptoms, mainly pain, caused by intrinsic and extrinsic factors. This paper will investigate the comparative effects of iontophoresis and phonophoresis interventions when added to conservative physiotherapy protocol on pain, mobility, impairment and functionality in SIS.

Methods: A total of 43 patients were randomly assigned to two groups: (IP vs PP). All patients were assessed two times using the Visual Analogue Scale (VAS), universal goniometer, Shoulder Disability Questionnaire (SDQ) and Quick-Disabilities of the Arm, Shoulder and Hand Questionnaire (QuickDASH). All groups received a standard conventional treatment program. Then, diclofenac sodium solution was applied to the group to which they belonged. The treatment program was completed in a total of 2 weeks, 5 days a week.

Results: The study results showed significant improvements in VAS, goniometric measurement, SDQ, and QuickDASH scores in both groups compared to their pre-treatment ($p<.001$ for all). At the same time, no difference and superiority were found between the groups ($p>.05$ for all).

Conclusions: While both IP and PP interventions caused positive gains in terms of the parameters mentioned above in SIS, these gains were not superior in favor of any method. Both treatment methods can be preferred over each other as alternative methods in reducing pain intensity, increasing range of motion in joints, and eliminating disability within clinical possibilities.

Keywords: Subacromial Impingement Syndrome, Iontophoresis, Phonophoresis, Pain,

1. INTRODUCTION

Subacromial Impingement Syndrome (SIS) is a pathology resulting from the compression and inflammation of the soft tissues between the humeral head and the coracoacromial arch due to intrinsic and extrinsic factors (1,2). It has a prevalence of above 35% and is manifested by a wide range of symptoms (2). These multiple symptoms, such as limitation in shoulder movements, sleep disorders, and fatigue, besides pain, bring consequences such as interference in daily living activities, functional loss, and disability (3–6). Due to the tendency of the disease to become chronic and the consequences of symptoms, importance of the treatment process and the using modalities increase.

The main goals of SIS treatment is to relieve pain, reduce subacromial inflammation, promote rotator cuff recovery, increase joint mobility, and improve upper extremity functionality (2, 7). Conservative treatment approaches are reportedly effective in achieving these goals in the early phases (Stage I-II) (8). Key conservative techniques include non-steroidal anti-inflammatory drugs, intra-articular injections, and physical therapy modalities (7, 9). While it is recommended to combine exercise with other physiotherapy agents (9), the diversity in physiotherapy interventions is striking (10).

Although protocols consisting of combinations of different modalities are encountered in treating SIS, electrotherapy interventions are widely used. The most commonly used therapeutic ultrasound among electrotherapy agents is also an acceptable agent in treating SIS but there is uncertainties in the literature regarding the level of evidence for its effect (9, 11). Ultrasound can be tailored to the patient's clinical needs. Phonophoresis is a technique that involves applying pharmacological agents, like corticosteroids, local

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anesthetics, and salicylates topically, along with ultrasound. This helps to enhance the penetration of subcutaneous tissues. Here, the diffusion of the topical agent under the skin becomes easier due to both the thermal and nonthermal (cavitation) properties of high-frequency sound waves (12). The therapeutic effect occurs from the use of pharmacological agents rather than the thermal or non-thermal effects of ultrasound. The activity of the cell membrane changes due to the effects of stable cavitation and micro-fluctuation, facilitating soft tissue healing (13).

Iontophoresis treatment is the injection of medical agents into the body from the skin using an electric current. This intervention is a form of the transdermal delivery system, in which a charge-carrying substance is passed through the skin with a low electric current (14). The use of ionic drugs in iontophoresis treatment has a main therapeutic effect, which varies depending on the drug's specific pharmaceutical content and mechanism of action.

Early and efficient reduction of pain and inflammation is considered a crucial factor in successful medical and non-medical treatments for SIS. With this perspective, this study aims to compare the effects of iontophoresis (IP) and phonophoresis (PP) interventions on pain, when added to a conservative physiotherapy protocol for subacromial impingement syndrome. The secondary aims are to examine the effects of identical treatment methods on mobility, impairment, and functionality.

2. METHODS

2.1. Study Design and Ethics

This single-center study was conducted in a tertiary care public hospital. Forty-seven out of 51 patients were evaluated the study in this prospective, parallel-group, randomized controlled study. The patient allocation ratio is 1:1. The framework of the study is superiority. In study design, a random allocation sequence was generated using the "randomize numbers" function of online software (www.randomizer.org) by an independent clinician who was not involved in recruitment or assessment. Based on this list, all patients who met the inclusion criteria and consented to participate were assigned as Group A (the iontophoresis group (IP) and Group B (the phonophoresis group (PP). The allocation list was kept concealed by this clinician. Patient assignments were determined by the same independent clinician who created the randomization file. The physiotherapist who performs assessments and administers treatment procedures, and patients were aware of the assigned intervention due to the nature of the treatments. All of the collected data were coded, and the statistician was provided with anonymized datasets where only group codes (Group A and Group B) were visible. So, the statistician who analyzed the results remained blinded to group allocation. This procedure ensured that the randomization process was unbiased and reproducible. The research was conducted following the guidelines of the Declaration of Helsinki, and the ethics committee of the Medipol University approved it (Protocol ID: 02.06.2015.284). The clinical trial number was given from ClinicalTrials.gov with NCT06094361 ID number). All patients gave written informed consent after being verbally informed about the study.

2.2. Participants

Patients diagnosed with Stage I-II SIS between the ages of 18 and 65 were eligible for inclusion in the study. Patients were excluded if they underwent shoulder surgery, participated in a shoulder-related treatment program within the previous six months, or failed to adhere to the treatment program by 70% or more. Patients in both groups began receiving treatment within the next week following diagnosis.

2.3. Assessments

Assessments were conducted twice, at the start and after completion of the 10-session treatment program by the same physiotherapist. All of collected data, represented by statistical codes stored in a computer.

Sociodemographic Data Form: The patient's information such as age, Body Mass Index (BMI), gender, education level, dominant extremity, affected side, and presence of trauma were questioned.

Primary Outcome

Visual Analog Scale (VAS): The VAS is a widely used scale for the assessment of pain intensity. Patients were asked to rate their pain intensity both at rest and at night on a ten-centimeter line. On this scale, 0 means the absence of pain, and 10 means the presence of unbearably severe pain (15). Pain intensity was measured at baseline (T0) and immediately at the end of the 2-week treatment program (T1).

Secondary Outcomes

Range of Motion (ROM): The angular values of flexion, extension, abduction, internal and external rotation performed actively by the patients were examined with a universal goniometer. Measurements were made in the supine position for flexion and abduction and in the prone position for extension and rotations. Kendall McCreary's rating system was used for measurement references (16). Measurements were repeated three times and averaged.

Shoulder Disability Questionnaire (SDQ): The SDQ is a sixteen-item scale that assesses disability in individuals with shoulder complaints. Answering on the scale is marked as "Yes," "No," and "Not applicable." Its scoring is between 0-100 points. A high score indicates a high degree of disability (17).

Quick-Disabilities of the Arm, Shoulder and Hand Questionnaire (QuickDASH): In the scale, the functional status of individuals with shoulder pathology is questioned during their daily activities, and it is an assessment form

filled by the patients themselves. 11 items in the first part of QuickDASH were used for this research. The score of the used section varies between 11 and 55. A high score indicates a high level of influence on functions. The Turkish validity and reliability of the scale were made (18).

All of the ROM, SDQ, and QuickDASH were measured at baseline (T0) and immediately after completion of the 2-week treatment program (T1).

2.3. Interventions

All treatment programs were delivered five days per week for two weeks. The total number of sessions was ten.

2.3.1.Common Protocol for All Groups: A hot pack, containing silicon dioxide, was used as a superficial heating agent and applied to all patients for 30 minutes. The agent was placed in direct contact with the skin and wrapped in a three-layer towel to avoid burns. The Cefar-physio4 (Cefar, Malmö Sweden) device was utilized for Transcutaneous Electrical Nerve Stimulation (TENS) therapy, which acted as a pain reliever in conventional mode. The current frequency of the considered mode was 80 Hz, and the therapy duration was 30 minutes. The current intensity was adjusted based on the patient's feedback.

A physiotherapist supervised all exercise sessions, which included Codman exercises, active-assisted normal range of motion exercises, isometric shoulder exercises, capsule stretching, and isotonic shoulder and back exercises. Exercise programs gradually progressed from 10-20 repetitions. All exercise sessions were supervised by the same physiotherapist, and the number of repetitions and resistance levels were progressively adjusted according to each patient's tolerance and clinical status. So, the exercise program was both standardized in its core content and individualized in its progression. For anticipated post-exercise pain, an ice pack was applied for 15 minutes.

2.3.2. Iontophoresis Group (IP): Iontophoresis was applied with a Chattanooga Physio (DJO Global, Herentals, Belgium) brand device. The galvanic current mode was selected for the intervention. Intervention area was cleaned to prevent irritation and active electrode pad (cathode-5 cm^2) was immersed in 75 mg diclofenac sodium solution. The current intensity of the application for 10 minutes was 0.1-0.2 mA/cm^2.

2.3.3. Phonophoresis Group (PP): Phonophoresis was performed with a Chattanooga brand ultrasound device (Chattanooga, Intelect Legend Ultrasound, TN, USA). 75 mg gel containing 1% diclofenac sodium was applied to the shoulder area. The ultrasound was conducted continuously for 6 minutes with frequency of 1 MHz and an intensity of 1.5 $watts/cm^2$.

2.4. Statistical Analysis

The statistical analysis was performed using version 21 of the Statistical Package for the Social Sciences (SPSS). To verify normal distribution, the Shapiro-Wilk test and histogram curves were utilized. Descriptive statistics for parametric variables included mean, standard deviation, and percentage. Since the data exhibited normal distribution, independent sample T-tests were used for group comparison while paired sample T-tests were used to detect changes within the group. The significance level of $p<.05$ was deemed acceptable for all analyses. For variables with nominal assessments, data were analyzed utilizing Yates Continuity Correction and Fisher's exact chi-square test.

According to our knowledge, no directly comparable study with identical methodology was available in the literature; we assumed that enrolling at least 40 participants would provide a minimum adequate sample size to ensure statistical reliability. After 43 patients' data collection, we conducted a post hoc power analysis using G*Power 3.1.9.1 software (19). The resting VAS scores was taken as reference. In this context, Cohen's effect size was calculated as 1.00. When the alpha error was accepted as 5%, and effect size was 1.00, the post hoc power was found to be 94.27%.

3. RESULTS

Forty-three patients (IP:22 and PP:21) completed the study (Figure 1). No complications or harmful effects occurred in any patient. The demographic characteristics of the groups, including gender (p=.663), education level (p=.353), dominant extremity (p=.518), affected side (p=1.000), presence of trauma (p=.664), disease stage (p=.407) and symptom duration (p=.624) results were similar. In addition, the mean age of the IP group was 49.05±12.09 years, and the mean age of the PP group was 45.48±9.42 years (p=.228). The mean BMI of the groups was also similar (p=.110). The demographic characteristics of all patients are summarized in Table 1.

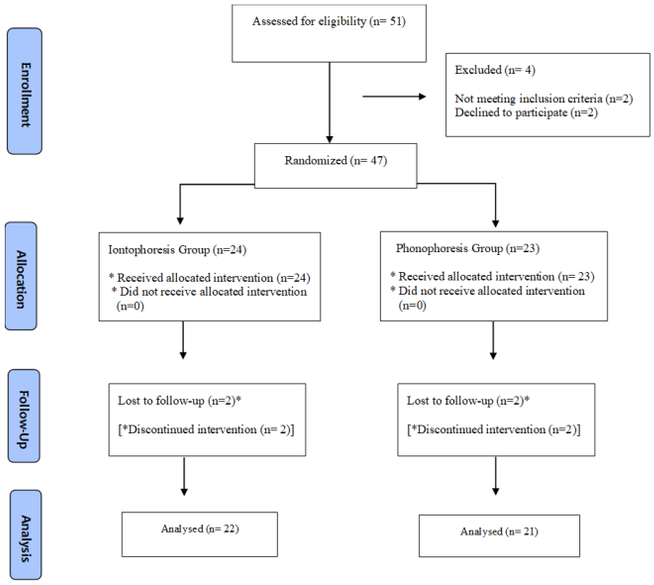


Figure 1. *CONSORT Flow diagram*

Table 1. *Characteristics of the Patients with SIS*

Variables	Groups		p
	IP	PP	
Gender, *n (%)*			
Female	14 (63.60)	12 (57.10)	.663[a]
Male	8 (36.40)	9 (42.90)	
Education Status, *n (%)*			
Primary School	3 (13.65)	1 (4.80)	.353[b]
Secondary School	3 (13.65)	0 (0.00)	
High School	5 (22.70)	8 (38.10)	
University	10 (45.50)	10 (47.60)	
Master Education	1 (4.50)	2 (9.50)	
Dominant Limb, *n (%)*			
Right	20 (90.90)	15 (71.40)	.518[b]
Left	2 (9.10)	6 (28.60)	
Affected Side, *n (%)*			
Right	12 (54.50)	12 (57.10)	1.000[a]
Left	10 (45.50)	9 (42.90)	
Absence of Trauma, *n (%)*			
Yes	5 (22.70)	7 (33.30)	.664[a]
No	17 (77.30)	14 (66.70)	
Stage, *n (%)*			
I	12 (54.50)	15 (71.40)	.407[a]
II	10 (45.50)	6 (28,60)	
	Mean (SD)	**Mean (SD)**	
Age (years)	49.05 ± 12.09	45.48 ± 9.42	.288
Body Mass Index (kg/cm^2)	28.35 ± 5.57	25.95 ± 3.87	.110
Symptom Duration (months)	9.8 ± 4.7	8.6 ± 3.1	.604

a: Yates Continuity Correction; b: Fisher's Exact Chi-Square Test; PP: Phonophoresis Group; IP: Iontophoresis Group; SD: Standard Deviation

According to the results of the VAS score used to assessed the severity of pain, the initial scores of both groups were similar at rest (p=.312) and night (p=.120). There was no statistically significant difference in VAS scores after treatment (for both, p>.05). In intragroup analyzes, significant decreases were observed in the pain intensity of both groups (for both, p<.001) (Table 2).

Initial active range of motion of flexion (p=.531), extension (p=.923), abduction (p=.459), internal rotation (p=.413), and external rotation (p=.428) in the IP and PP group were similar. After both treatments protocol, all ranges of motion increased, but no difference was detected between the groups (for both, p>.05). According to in-group analysis, significant improvements were observed in shoulder joint angles in all directions (for both, p<.05).

The initial SDQ score of the IP group was 48.00±20.75. It was 50.12±21.18 in the PP group (p=.770). After the treatment, the SDQ score of the IP group decreased to 22.36±20.41. That of the PP group dropped to 19.35±15.84 (p=.779). Accordingly, while no difference was observed between the groups, significant improvements were observed in the within-group changes (for both, p<.001) (Table 2).

The effect of shoulder pain on daily life functions was assessed with the QuickDASH. While the initial (p=.428) and post-treatment (p=.354) values were similar between the groups, significant improvements were observed in the QuickDASH scores of both groups in intragroup analyzes (for both, p<.001) (Table 2).

Table 2. *Comparison of Pain, Function and Disability Status Between Groups*

Variables	Time	Groups		p
		IP	PP	
Resting Pain	T_0	5.09 ± 2.13	4.52 ± 1.72	.312
	T_1	2.63 ± 1.59	1.42 ± 1.80	.339
	p	<.001	<.001	-
Night Pain	T_0	5.59 ± 3.01	4.47 ± 2.42	.120
	T_1	1.77 ± 1.99	2.45 ± 2.78	.546
	p	<.001	<.001	-
Flexion	T_0	149.09 ± 18.49	152.85 ± 20.58	.531
	T_1	162.27 ± 13.77	162.61 ± 14.28	.936
	p	<.001	<.001	-
Extension	T_0	45.22 ± 8.79	45.47 ± 7.89	.923
	T_1	52.50 ± 5.72	51.90 ± 6.22	.745
	p	<.001	<.001	-
Abduction	T_0	140.90 ± 19.49	135.00 ± 31.22	.459
	T_1	157.95 ± 18.36	157.61 ± 17.14	.951
	p	<.001	<.001	-
Internal Rotation	T_0	61.81 ± 10.97	65.00 ± 14.14	.413
	T_1	68.18 ± 8.52	70.23 ± 11.77	.514
	p	<.001	<.001	-
External Rotation	T_0	72.95 ± 11.81	69.52 ± 16.03	.428
	T_1	78.18 ± 9.45	77.38 ± 10.56	.794
	p	<.001	<,001	-
SDQ	T_0	48.00 ± 20.75	50.12 ± 21.18	.770
	T_1	22.6 ± 20.41	19.35 ± 15.84	.779
	p	<.001	<.001	-
QuickDASH	T_0	38.90 ± 14.74	41.57 ± 9.53	.428
	T_1	19.63 ± 9.37	22.64 ± 10.37	.354
	p	<.001	<.001	-

PP: Phonophoresis Group; IP: Iontophoresis Group; SDQ: Shoulder Disability Questionnaire; T_0: Baseline Assessment, T_1: Second Assessment; QuickDASH: Quick-Disabilities of the Arm, Shoulder and Hand Questionnaire

4. DISCUSSION

The study aimed to investigate the efficacy of iontophoresis and phonophoresis in reducing pain severity and to make a comparison of the results. The primary finding indicate that both methods effectively reduced pain severity in SIS

patients, but neither proved to be superior to the other. When examining the secondary results, it was found that both groups showed improvement in the joint range of motion of the shoulder in five different directions, disability score, and functionality. However, no superiority was observed between the two groups.

Many studies indicate that electro-physical agents are part of the standard treatment plan for SIS patients (20, 21). Research has shown the advantages of TENS and hot-pack interventions for patients with various stages of SIS (21, 22). Hot-pack therapy promotes vasodilation in soft tissue, increases cell permeability, and removes metabolic waste. In addition, there is a decrease in muscle spasms and an increase in tissue elasticity. Furthermore, it is well established that hot applications also increase endorphin hormone levels (23). TENS demonstrates therapeutic effects through gate-control theory and opioid release, depending on the application protocol (24, 25). In our study, a standard protocol was applied, utilizing superficial heat and TENS in both groups to optimize effects. In addition, one group received iontophoresis while the other received phonophoresis. Following the applications, both groups demonstrated reductions in pain intensity and disability levels, as well as improvements in joint mobility and functionality.

Conservative treatment approaches, especially including exercise programs, have an important place in the treatment of shoulder impingement syndrome (8). Exercises are a key factor in eliminating the power imbalance between the muscles and correcting the biomechanical factors in patients with SIS. This allows the muscles to operate in normal patterns and contributes to the joint range of motion and functionality (26, 27). A systematic review reported that the positive effects of exercise combined with other treatment approaches are greater (8). In addition, it is emphasized in the literature that performing the exercises by a specialist health professional effectively reduces the severity of pain and disability (28). In addition to conservative electrophysiological agents, this study applied a personalized supervised exercise program for the shoulder region. This program was progressively adjusted according to each patient's tolerance and clinical status by the same physiotherapist. In this way, it was aimed for the patients to perform their exercise programs most accurately and to standardize the rehabilitation process. Increase in joint movements and functionality levels of both groups; The decrease in disability levels can be interpreted as the contribution of exercises to the treatment program.

Studies indicate that the positive effects of ultrasound, as a therapeutic modality for treating SIS, such as increased blood flow, vascular permeability, and local metabolism, lack sufficient evidence. Therefore, these effects remain at the level of assumption in individuals with rotator cuff disease in the United States (29, 30). Besides the direct ultrasound application, phonophoresis and iontophoresis interventions are also performed. In each of these methods, drugs with different contents are used. In this study, diclofenac sodium, a non-steroidal anti-inflammatory (NSAI) drug, was administered to patients with ultrasound and low-frequency direct current.

Transdermal delivery of NSAIDs is a therapeutic approach to prevent hepatic first-pass metabolism and gastrointestinal side effects (31). In this method, the frequency of skin reaction in patients is also high (32). In our study, none of the patients experienced any skin reactions to iontophoresis administered for ten minutes at the recommended safe dose range. Furthermore, post-treatment results indicated that neither the iontophoresis group nor the phonophoresis group exhibited superiority over the other in reducing pain intensity, improving range of motion, functionality, or minimizing disability. Nevertheless, there were improvements in all these parameters compared to the pre-treatment period. Studies utilizing various methodologies for iontophoresis and phonophoresis applications can be found in the literature. For instance, in patients with SIS who received dexketoprofen through iontophoresis and phonophoresis, pain and shoulder function were investigated, while the control group received therapeutic ultrasound. This study discovered that although there were greater enhancements in pain and function scores in the therapeutic ultrasound group, there were no variations between groups in the repeated measures during the follow-up period (33). At the end of an eighteen-session study, iontophoresis was found to be more effective than pseudo iontophoresis in improving pain and functional scores in patients with stage II-III SIS (34). Patients with stage II rotator cuff pathology have been treated with piroxicam phonophoresis in addition to exercise, and improvements in the intensity of pain and level of function have been reported (35). In a study of phonophoresis in patients with SIS, the NSAID ketoprofen was used in combination with lidocaine-prilocaine. Improvements in pain and function were observed over a three-month follow-up period (36). Acetic acid iontophoresis has been reported to reduce disability more than pseudo iontophoresis in patients with calcific tendinitis (37). Both the iontophoresis and phonophoresis groups had decreased pain intensity and increased range of motion in our study. This decrease in the range of motion did not show superiority in favor of any group. Under normal conditions, decreasing pain intensity and increasing range of motion after conventional methods may improve patients' shoulder function. This study is one of the limited studies directly comparing the effects of iontophoresis and phonophoresis applied with the same pharmacological agent (diclofenac sodium) in patients with Stage I-II Subacromial Impingement Syndrome (SIS) (38, 39). Thus, bias that may arise from drug differences was prevented. The reliability of the results was supported by high post hoc power. However, the lack of a patient group who only underwent iontophoresis or phonophoresis was one of the limitations of this study and prevented us from making an isolated evaluation. Therefore whether the effect was due to conventional methods or iontophoresis and phonophoresis applications was not clear in this study.

According to our results, iontophoresis and phonophoresis interventions, added to conventional methods such as

superficial heat, TENS, and exercise in patients with a diagnosis of SIS, are clinically preferable methods for reducing pain severity, increasing joint range of motion, reducing disability, and improving functionality. However, it is worth noting that these interventions necessitate clinical experience. Moreover, all patients received the same standard treatment, in addition to a standardized, supervised exercise program. This is supported by previous studies, emphasizing the role of supervised exercise in improving outcomes in SIS (9, 23).

One of limitation of the study is that an a priori sample size calculation was not conducted. Although the post hoc power analysis confirmed that the achieved sample size was adequate, future studies should perform a priori power calculations to strengthen methodological robustness.

The lack of a placebo/sham group (e.g., pseudo-iontophoresis or pseudo-phonophoresis) in the study limited our ability to distinguish the true physiological effect of these methods from placebo or nonspecific effects and is one of the most important limitations of our study. Additionally, due to the use of a single pharmacological agent (diclofenac sodium), the results cannot be generalized to other drugs commonly used in iontophoresis or phonophoresis, such as corticosteroids or salicylates, which have shown varying degrees of efficacy in previous studies. Furthermore, the short follow-up period, limited to only stage I and II SIS cases, and the fact that it was conducted at a single center may be considered limitations related to our research question. Therefore, we cannot provide information on the long-term effectiveness or sustainability of iontophoresis and phonophoresis with different pharmacological agents and clinical settings; these points should be addressed in future multicentric studies. It is also vital to further the study by incorporating pseudo-iontophoresis and phonophoresis applications to reveal their true effects.

5. CONCLUSION

According to the results of our research, iontophoresis and phonophoresis applications with diclofenac sodium, in addition to physiotherapy agents, provide positive and significant gains in pain, inflammation, range of motion, disability, and functionality in treating patients with subacromial impingement syndrome. On the other hand, neither treatment is superior to the other in terms of beneficial therapeutic effects. Although we did not investigate cost-effectiveness in our study, iontophoresis can be considered a cheaper treatment in terms of equipment. This point is important in terms of preferability and should be investigated. In addition, the long-term effects and whether the gains obtained within the scope of combined treatments can be obtained after isolated iontophoresis and phonophoresis treatments should be examined in future studies.

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Design of the study: EK, AYO
Acquisition of data for the study: EK
Analysis of data for the study: EŞ
Interpretation of data for the study: EŞ, AYO
Drafting the manuscript: EK, EŞ, AYO
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REFERENCES

[1] Bıglıanı LU, Levıne WN. Current Concepts Review – Subacromial impingement syndrome. JBJS. 1997;79(12):1854–68. https://doi.org/10.2106/00004.623.199712000-00012

[2] Gutiérrez-Espinoza H, Araya-Quintanilla F, Cereceda-Muriel C, Álvarez-Bueno C, Martínez-Vizcaíno V, Cavero-Redondo I. Effect of supervised physiotherapy versus home exercise program in patients with subacromial impingement syndrome: A systematic review and meta-analysis. Phys Ther Sport. 2020;41:34-42. https://doi.org/10.1016/j.ptsp.2019.11.003

[3] Michener LA, McClure PW, Karduna AR. Anatomical and biomechanical mechanisms of subacromial impingement syndrome. Clin Biomech. 2003;18(5):369-379. https://doi.org/10.1016/S0268-0033(03)00047-0

[4] Kalter J, Apeldoorn AT, Ostelo RW, Henschke N, Knol DL, Van Tulder MW. Taping patients with clinical signs of subacromial impingement syndrome: The design of a randomized controlled trial. BMC Musculoskelet Disord. 2011;12(1):188. https://doi.org/10.1186/1471-2474-12-188

[5] Aceituno-Gómez J, Avendaño-Coy J, Gómez-Soriano J, García-Madero VM, Ávila-Martín G, Serrano-Muñoz D, González-González J, Criado-Álvarez JJ. Efficacy of high-intensity laser therapy in subacromial impingement syndrome: a three-month follow-up controlled clinical trial. Clin Rehabil. 2019;33(5):894–903. https://doi.org/10.1177/026.921.5518824691

[6] Çelik MS, Sönmezer E, Acar M. Effectiveness of proprioceptive neuromuscular facilitation and myofascial release techniques in patients with subacromial impingement syndrome. Somatosensory & Motor Research 2022;39(2-4):97-105. https://doi.org/10.1080/08990.220.2021.2018293

[7] Şen U, Karagülle M, Erkorkmaz Ü. The Efficacy of balneotherapy in the patients with subacromial impingement syndrome. Turkiye Klin J Med Sci. 2010;30(3):906–913. https://doi.org/10.5336/medsci.2008-8589

[8] Dong W, Goost H, Lin XB, Burger C, Paul C, Wang ZL, Kabir K. Treatments for shoulder impingement syndrome a prisma systematic review and network meta-analysis. Medicine 2015;94(10):e510. https://doi.org/10.1097/MD.000.000.0000000510

[9] Steuri R, Sattelmayer M, Elsig S, Kolly C, Tal A, Taeymans J, Hilfiker R. Effectiveness of conservative interventions including exercise, manual therapy and medical management in adults with shoulder impingement: A systematic review and

meta-analysis of RCTs. BJSM. 2017;51:1340-1347. https://dx.doi.org/10.1136/bjsports-2016-096515

[10] Büyüktepe Y, Şenocak E, Yildiz Özer A. The effect of kinesiological taping on pain, function, and disability in subacromial impingement syndrome – A randomized controlled study. IJDSHS. 2022;5(2):113-121. https://doi.org/10.33438/ijdshs.1178195

[11] Sürücü GD, Gedik DE. Comparison of the efficacy of high intensity laser and ultrasound therapies in shoulder impingement syndrome: A randomized clinical trial. In: Evereklioğlu C, editor. Research & Reviews in Health Sciences First Edit. Ankara: Yaşar Hız; 2021. p. 19–30.

[12] Klaiman MD, Shrader JA, Danoff J V., Hicks JE, Pesce WJ, Ferland J. Phonophoresis versus ultrasound in the treatment of common musculoskeletal conditions. Med Sci Sports Exerc. 1998;30(9):1349–1355. https://doi.org/10.1097/00005.768.199809000-00002

[13] Gholap AD, Rajurkar VG, Dighe SB. Phonophoresis : Ultrasound-enhanced transdermal drug delivery. Inven Rapid. 2012;4(1):1–3. https://doi.org/10.4103/0973-2585.105994

[14] Nagar R, Sengar SS. A simple user-made iontophoresis device for palmoplantar hyperhidrosis. J Cutan Aesthet Surg. 2016;9(1):32–33. https://doi.org/10.4103/0974-2077.178542

[15] Ozer AY, Kapsigay B, Şenocak E, Karaca S, Tanhan A, Elma H, Ergen Ö, Polat MG. Effectiveness of different exercise programs in individuals with non-specific neck pain: telerehabilitation, given with synchronous exercises versus homebased exercise. Medicina Sportiva: Journal of Romanian Sports Medicine Society 2021;17(2):3327–3335.

[16] Eraslan L, Yar O, Ergen B, Huri G, Düzgün İ. Investigation of the relationship between soft tissue flexibility and acromiohumeral distance in subacromial pain syndrome. JETR. 2021;8(3):270–278. https://doi.org/10.15437/jetr.803570

[17] Ozsahin M, Akgun K, Aktas I, Kurtais Y. Adaptation of the shoulder disability questionnaire to the Turkish population, its reliability and validity. Int J Rehabil Res. 2008;31(3):241–245. https://doi.org/10.1097/MRR.0b013e3282fb7615

[18] Düger T, Yakut E, Öksüz Ç, Yörükan S, Bilgütay BS, Ayhan Ç, Yakut Y. Reliability and validity of the Turkish Version of the Disabilities of the Arm, Shoulder and Hand (DASH) Questionnaire. Fiz Rehabil. 2006;17(3):99–107. (Turkish)

[19] Faul F, Erdfelder E, Lang A-G, Buchner A. G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. Behav Res Methods. 2007;39(2):175–191. https://doi.org/10.3758/BF03193146

[20] Botanlioğlu H, Kesmezacar H, Erginer R, Babacan M. Conservative treatment of the shoulder impingement syndrome. Gulhane Med J. 2006;48(4):208–214. (Turkish)

[21] Hakgüder A, Taştekin N, Birtane M, Uzunca K, Zateri C, Süt N. Comparison of the short-term efficacy of physical therapy in subacromial impingement syndrome patients with stage I and II magnetic resonance imaging findings. Turkish J Rheumatol. 2011;26(2):127–134. https://doi.org/10.5606/tjr.2011.019

[22] Başkurt Z, Başkurt F, Özcan A, Yilmaz Ö. The immediate effects of heat and TENS on pressure pain threshold and pain intensity in patients with stage I shoulder impingement syndrome. Pain Clin. 2006;18(1):81–85. https://doi.org/10.1163/156.856.906775249839

[23] Özveren H. Non-pharmacological methods at pain management. Sağlık Bilimleri Fakültesi Hemşirelik Dergisi 2011;18(1):83–92. (Turkish)

[24] Herrera-Lasso I, Mobarak L, Fernández-Dominguez L, Cardiel MH, Alarcón-Segovia D. Comparative effectiveness of packages of treatment including ultrasound or transcutaneous electrical nerve stimulation in painful shoulder syndrome. Physiotherapy 1993;79(4):251–253. https://doi.org/10.1016/S0031-9406(10)60708-0

[25] Ay S, Doğan ŞK. Comparison of efficacy of different analgesic currents in patients with shoulder pain. Med J SDU. 2009;16(3):1-5. (Turkish)

[26] Kelly SM, Wrightson PA, Meads CA. Clinical outcomes of exercise in the management of subacromial impingement syndrome: a systematic review. Clin Rehabil. 2010;24(2):99–109. https://doi.org/10.1177/026.921.5509342336

[27] Camargo PR, Alburquerque-Sendín F, Avila MA, Haik MN, Vieira A, Salvini TF. Effects of stretching and strengthening exercises, with and without manual therapy, on scapular kinematics, function, and pain in individuals with shoulder impingement: A randomized controlled trial. J Orthop Sports Phys Ther. 2015;45(12):984–997. https://www.jospt.org/doi/10.2519/jospt.2015.5939

[28] Abdulla SY, Southerst D, Côté P, Shearer HM, Sutton D, Randhawa K, Varatharajan S, Wong JJ, Yu H, Marchand AA, Chrobak K, Woitzik E, Shergill Y, Ferguson B, Stupar M, Nordin M, Jacobs C, Mior S, Carroll LJ, van der Velde G, Taylor-Vaisey A. Is exercise effective for the management of subacromial impingement syndrome and other soft tissue injuries of the shoulder? A systematic review by the Ontario Protocol for Traffic Injury Management (OPTIMa) Collaboration. Man Ther. 2015;20(5):646-656. https://doi.org/10.1016/j.math.2015.03.013

[29] Analan PD, Leblebici B, Adam M. Effects of therapeutic ultrasound and exercise on pain, function, and isokinetic shoulder rotator strength of patients with rotator cuff disease. J Phys Ther Sci. 2015;27(10):3113–3117. https://doi.org/10.1589/jpts.27.3113

[30] Celik D, Atalar AC, Sahinkaya S, Demirhan M. The value of intermittent ultrasound treatment in subacromial impingement syndrome. Acta Orthop Traumatol Turc. 2009;43(3):243–247. https://doi.org/10.3944/AOTT.2009.243

[31] Crevenna R, Burian A, Oesterreicher Z, Lackner E, Jäger W, Rezcicek G, Keilani M, Zeitlinger M. Iontophoresis driven concentrations of topically administered diclofenac in skeletal muscle and blood of healthy subjects. Eur J Clin Pharmacol. 2015;71(11):1359-1364. https://doi.org/10.1007/s00228.015.1909-9

[32] Riecke BF, Bartels EM, Torp-Pedersen S, Ribel-Madsen S, Bliddal H, Danneskiold-Samsøe B, Arendt-Nielsen LA. A microdialysis study of topically applied diclofenac to healthy humans: passive versus iontophoretic delivery. Results Pharma Sci. 2011;1(1):76–79. https://doi.org/10.1016/j.rinphs.2011.11.001

[33] Pérez-Merino L, Casajuana MC, Bernal G, Faba J, Astilleros AE, González R, Giralt M, Romeu M, Nogués MR. Evaluation of the effectiveness of three physiotherapeutic treatments for subacromial impingement syndrome: A randomised clinical trial. Physiotherapy. 2016;102(1):57-63. https://doi.org/10.1016/j.physio.2015.01.010

[34] Özmen A, Ataoğlu S. Comparing of the efficacy and effectiveness of isokinetic exercise, laser, pseudoiontophoresis and iontophoresis treatments according to the stage in treatments of subacromial impingement syndrome. Türkiye

Klinikleri J Med Sci 2015;35(3):166–178. https://doi.org/10.5336/medsci.2015-45220

[35] Genc A, Ozcan A, Gelecek N. The effectiveness of piroxicam phonophoresis for treatment of stage II rotator cuff injuries. Jt Dis Relat Surg. 2002;13(1):23–26. (Turkish)

[36] Guler H, Turhanoglu AD, Inanoglu K, Inanoglu D, Ozer C. Comparison of ketoprofen phonophoresis with ketoprofen and lidocaine-prilocaine phonophoresis in patients with subacromial impingement syndrome. Turkish J Rheumatol. 2009;24(2):88–93.

[37] Leduc BE, Caya J, Tremblay S, Bureau NJ, Dumont M. Treatment of calcifying tendinitis of the shoulder by acetic acid iontophoresis: A double-blind randomized controlled trial. Arch Phys Med Rehabil. 2003;84(10):1523–1527. https://doi.org/10.1016/S0003-9993(03)00284-3

[38] García I, Lobo C, López E, Serván JL, Tenías JM. Comparative effectiveness of ultrasonophoresis and iontophoresis in impingement syndrome: A double-blind, randomized, placebo-controlled trial. Clin Rehabil. 2016;30(4):347-358. https://doi.org/10.1177/026.921.5515578293

[39] Chhetri RS, Khatri KP, Khanal J, Milan KC. Outcome of needle fenestration, subacromial steroid and diclofenac phonophoresis in acute calcific tendinitis of shoulder. JNMA J Nepal Med Assoc. 2017;56(207):357-361. https://doi.org/10.31729/jnma.3280