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Effect of Hydrocortisone Phonophoresis Versus Iontophoresis in Patients with Subacromial Impingement Syndrome

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Abstract

Background: Subacromial impingement syndrome (SAIS) is one of the most frequently entities involved in the shoulder complex characterized by pain and functional restrictions. This condition is caused by the impingement of the tendons of the rotator cuff, particularly the supraspinatus tendon, head of the biceps brachii, and subacromial bursa between the head of the humerus and coracoacromial arch. The main goals of SAIS treatment are to control pain and increase the range of motion (ROM) in order to enable healing of the compromised rotator cuff. Many programs including electrotherapy, manual therapy, passive, active and active assistive ROM exercises, and stretching and strengthening exercises to the rotator cuff and thoracoscapular muscles are frequently used for the conservative treatment of this complex process. The aim of this comparative study is to investigate the most efficient method for improving pain and quality of life and increasing shoulder range of motion in patients with Subacromial Impingement Syndrome.

Objective: this study compared the effects of hydrocortisone phonophoresis to hydrocortisone iontophoresis on patients with stage 2 subacromial impingement syndrome (SIS).

Subjects and methods: Between April 2023 to October 2023, randomized-controlled trial was carried on sixty patients with SIS from the outpatient clinic of Physiotherapy Horus University, Damietta. The age of patients ranged from 25 – 40 years old. Patients were randomly assigned into 3 equivalent groups, 20 patients for each group. Group A: Conventional group received therapeutic exercise program, Group B: Phonophoresis group received therapeutic exercise program plus hydrocortisone phonophoresis, and Group C: Iontophoresis group received therapeutic exercise program plus hydrocortisone Iontophoresis.

Results: The results showed that Group B who received the exercise program in addition to hydrocortisone phonophoresis gave the best active flexion, abduction, internal rotation range of motion, and Shoulder Pain and Disability Index value (SPADI) followed by Group C which received the exercise program in addition to hydrocortisone iontophoresis and then those in Group A who received therapeutic exercise program.

Conclusion: Hydrocortisone Phonophoresis improves active shoulder flexion, abduction, internal rotation range of motion, SPADI value more than Hydrocortisone Iontophoresis.

Keywords: Hydrocortisone phonophoresis, Iontophoresis, Subacromial impingement syndrome, Shoulder Pain and Disability Index, Digital Goniometer.

1. Introduction

Patients of all ages experience shoulder impingement syndrome (SIS) on a daily basis in clinical practice. It ranks 3rd among musculoskeletal conditions, behind cervical and back problems and it causes impairment of shoulder joint function and serious reduction in quality of life **(Kachanathu et al., 2019)**.

In general, Subacromial impingement is recurrent and chronic in nature, it is commonly associated with a number of pathogenic factors, such as acromial morphology, muscle imbalance, capsular laxity or tightness, rotator cuff muscle weakness, tendon or bursa degeneration and inflammation, and abnormal glenohumeral and scapulothoracic kinematics **(Cheng et al., 2020).**

Phonophoresis (PH) is an effective method for treating a range of musculoskeletal conditions, including osteoarthritis of the knee, bursitis, adhesions, as well as de Quervain's tenosynovitis. The main use of this method is to improve circumstances for the local penetration of the medications, perhaps as a result of the thermal impacts of ultrasound. Some of the benefits of administering the agents topically include protecting the drugs from degradation in the gastrointestinal tract, regulating the rate of pharmacologic effects, decreasing the possibility of side effects associated with the treatment, and avoiding injection-related complications **(Maghroori, Taheri, & Heidari, 2021).**

As a form of electrotherapy known as iontophoresis, a local electrical current is used to introduce a medication into tissues. The idea behind it is that in a specific electrical field, the positively charged drug ions, will be added to the anode which will be the active electrode. The negatively charged drug ions will be added to the cathode which will be the active electrode. Both direct and alternating currents are utilized in iontophoresis. Typically, it is administered to the skin using a low-voltage direct current with the goal of delivering ions that have physiological effects. Iontophoresis has many benefits, such as not causing any harm to the patient, being painless and sterile, and ensuring even absorption without systemic side effects including gastrointestinal distress (**da Luz, de Borba, Ravanello, Daitx, & Döhnert, 2019**)

Hydrocortisone, a corticosteroid known for its anti-inflammatory properties, has been applied topically to alleviate a range of inflammatory diseases affecting the musculoskeletal system **(Maghroori, Fakhari, & Taheri, 2021)**.

This study was carried-out for the purpose of comparing the effects of Phonophoresis with hydrocortisone or Iontophoresis on active shoulder flexion, abduction, internal rotation range of motion, SPADI value in patients with SIS. Up to my knowledge there is no comparative study between hydrocortisone phonophoresis and hydrocortisone iontophoresis

Hypothesis:

Ho1: There will be no statistically significant difference between adding hydrocortisone phonophoresis or iontophoresis in decreasing pain in treatment of subacromial impingement syndrome.

Ho2: There will be no statistically significant difference between adding hydrocortisone phonophoresis or iontophoresis on function in treatment of subacromial impingement syndrome.

Ho3: There will be no statistically significant difference between adding hydrocortisone phonophoresis or iontophoresis on range of motion in patient with subacromial impingement syndrome.

2. Subjects and Methods

This was a single-blinded, randomized-controlled trial carried-out on sixty patients with SIS outpatient-clinic based-random selection from the outpatient clinic of Physiotherapy Horus University, Damietta from April 2023 to October 2023. Patients were randomized into 3 equivalent groups, 20 patients for each group. Group A: Conventional group, 20 patients underwent therapeutic exercise program for SIS, including strengthening exercises for rotator cuff muscles, scapular stabilizers, and shoulder mobilization, along with home exercises, 3 times weekly for 6 weeks. Group B: Phonophoresis group 20 patients underwent same therapeutic exercise program for SIS, 3 times weekly for 6 weeks, along with hydrocortisone 10% phonophoresis, and Group C: Iontophoresis group, 20 patients received a conventional physical therapy program for SIS, along with hydrocortisone 10% iontophoresis, administered through a direct current electrical stimulation unit.

- **Inclusion criteria:** subjects were included in the study if they have been diagnosed with subacromial impingement syndrome and have had the all of the following criteria:
  1. All of the patients had a diagnosis of unilateral SIS in stage II Neer classification greater than 3 months, a positive impingement sign (Hawkins-Kennedy test or Neer's test), a painful arc throughout active arm abduction, pain or weakness with resisted abduction in the scapular plane using the humeral medial rotation (empty can test**),(Subasi Yesilyaprak, Seitz, Timmons, & Walsworth, 2015)**.
  2. The patients were informed about the study procedure and signed the informed consent before the participation in this study.
  3. The right to withdraw from the study at any time was explained to every patient**.**
  4. Aged from 25 to 40 years from both sexes.
  5. Shoulder pain failed to react to conservative NSAIDs.
  6. Scores greater than 5 on a numeric rate scale for pain ranging from 0 to 10, **(Alian, S.M., Zaghlol, R.S. & Khalil, S.S. 2020).**
- **Exclusion criteria:** Subjects were excluded from the study if they have had any problem that may interfere with the results of the study.
  1. Any patient with Adhesive capsulitis.
  2. Patients who are unable to give informed consent.
  3. Past history of shoulder dislocation.
  4. Shoulder arthritis.
  5. Patients with pacemakers or pregnancy.
  6. Past shoulder operations, Rheumatoid arthritis, malignancy, prior corticosteroid injection, internal metallic fixation, tears in the rotator cuffs either full or partial thickness, within the previous three months, shoulder physiotherapy treatment as well as cervical radiculopathy was excluded from the study.

Participants Characteristics: The age ranged from 25 to 40 from both genders from Damietta Governate, and all of them were right-handed. They agree to participate in the study without any benefit. Equal baseline characteristics.

Confounding Factors: The factors that may affect the level of pain and range of motion of the shoulder joint such as adhesive capsulitis, shoulder arthritis, past shoulder operations, rheumatoid arthritis and previous physiotherapy were excluded to control any confounding factors.

- **Randomization and allocation**

A blinded researcher used a computer list to construct the random allocation sequence, which was then sealed in opaque envelopes to guarantee that the allocation was concealed.

- **Ethical considerations**

This trial could not begin patient recruitment until it had received approval from the faculty of physical therapy at Cairo University's ethical research council**.** All patients who agreed to take part in the study had their questions answered and signed an informed consent document explaining the study's methods. Each participant was informed of their right to discontinue participation in the study at any moment.

Methods

Procedures of the Study: The procedures of the present study were classified into the following procedures:

Procedures of evaluation

Shoulder ROM:

The Active ROM of patients was measured using a digital goniometer calibrated at three angles (180˚, 90˚, and zero degree). Patients were evaluated for **Active** shoulder flexion, abduction, and internal rotation before and after 6 weeks, ensuring accuracy in measurements, **Shoulder flexion ROM:** The patient's shoulder flexion ROM was measured using an electronic goniometer, with the patient in a supine lying position. The goniometer's axis was fixed at the humeral head, and the readings were recorded three times. The mean of three readings was used for data analysis (MM & AMF, 2014). **Shoulder abduction ROM:** The patient's shoulder abduction ROM was measured using an electronic goniometer, with the patient's limb resting at the side of the body and the goniometer axis placed inferior to the lateral coracoid process. The readings were repeated three times, and the mean was utilized for data analysis (MM & AMF, 2014). **Shoulder medial rotation ROM:** The patient's shoulder medial rotation ROM was measured using an electronic goniometer. The patient was supine with a 90-degree abducted shoulder, elbow flexion, and pronated forearm. The goniometer's axis was placed at the ulna's olecranon process, and the readings were repeated three times (MM & AMF, 2014). **Shoulder pain and Disability Index:** Patients were given an Arabic version of SPADI before treatment and at 6 weeks. They completed a questionnaire, marking each item on the VAS. The scores were summed and analyzed. The total pain and disability scores were calculated, with a score range of 0-100%. Greater scores showed greater impairment or disability, while lower scores indicated lower impairment or disability (P. T & A, 2020).

Primary outcome measures:

The SPADI is the most commonly used instrument in research around the shoulder joint to assess the proportion of disability. It is easy to administer, responsive, agreeable, and interpretable with objectivity with good construct validity and a minimum ceiling and flooring effects which have been tested in many clinical settings. It is self-administered and assesses

both shoulder pain and disability during the important functional tasks of daily living **(Pahade, A. J., et al 2021)**.
The SPADI was designed to evaluate the degree of shoulder pain and discomfort in performing activities of daily living by the patients themselves, without clinician components. SPADI has been shown to have excellent internal reliability/consistency (Cronbach's alpha=0.86–0.96) and test-retest reliability (intra-class correlation coefficient=0.84–0.95). SPADI total score correlated well with the American Shoulder and Elbow Surgeons (ASES) Society Standardized Shoulder Assessment form **(Kim D. H. (2023).**

Secondary outcome measures: Digital Goniometer
Digital Goniometer ROM of was measured with by the digital goniometer that was calibrated on a well-known angle in three different angles which are (180˚, 90˚ and zero degree) both angles of 180˚ and 0˚ were calibrated on a straight line, while the 90˚ angle was calibrated on a right-angle plastic tri angle. This method of calibration was repeated each time the device was used to allow accuracy of the measurement.

Procedures of treatment
Therapeutic exercise program
All patients in the three groups were given the same therapeutic exercise program (3 times weekly for 6 consecutive weeks) which consist of:
Scapular muscles exercise: The participants in the study were asked to complete three sets of ten repetitions while taking a 60-second rest in among each one with a weight ranging from 1 to 1.5 kilograms. The exercises included prone horizontal abduction, side-lying external rotation (A towel was placed between the trunk and the zero-abducted arm to avoid compensatory movements), prone horizontal extension, and forward shoulder flexion from side-lying position. **(Cools et al., 2007). Rotator cuff muscles strengthening exercises:** The study involved shoulder scaption, shoulder flexion, and horizontal extension exercises, which involved elevating the arm in the scapular plane using an elastic band, with a 60-second rest period between each set (Ahmed Kamal, Saber, Aiad, Mahgoub, & Mostafa, 2020) .The shoulder prone rowing exercise was conducted to enhance the strength of the scapular retractor and shoulder extensor muscles, completing three sets of ten repetitions with a sixty-second rest in between (Escamilla, R. F., Hooks, T. R., & Wilk, K. E. (2014).**) Shoulder mobilization exercise:** Physical therapist applied Dorsal and Caudal glide techniques to patients in supine position, repeating 10-15 repetitions per session for caudal and posterior mobilization (**Pekgöz et al. 2020).**

Hydrocortisone Phonophoresis: In addition to the previous therapeutic program this procedure was applied only for group B every session, the shoulder region was cleaned and dehydrated. Each patient was placed in a comfortable relaxed supine position. **Hydrocortisone gel (10%) was locally prepared using 2 vials of hydrocortisone 100 mg.**
In this study, the effective area of radiation (ERA) in the mode continuous (100 percent) is 5 cm2, in 1 MHz and 0.7 W/cm2, with four ERA treated areas. Therapy lasted five minutes (three minutes in the insertion of the supraspinatus and two minutes in the infraspinatus insertion) three times weekly over 6 weeks in addition to therapeutic exercises **(Kamal et al, 2020).**

Hydrocortisone iontophoresis

In addition to the conventional previous program group C every session underwent a procedure involving cleaning and dehydrating the shoulder region, then administering 2 vials of hydrocortisone 100 mg via direct current. The drug was poured onto the active rubber electrode with sponge (5×7 cm2) and transmitted to the skin from the negative electrode. The current amplitude was 4Milliampere for 10 minutes. The active electrode was positioned at the anterolateral aspect of the shoulder, and a passive (positive) electrode was positioned elsewhere, at a distance appropriate to the passive electrode's size.

Intervention provider: Corresponding Author (xxxxxxxxxxxxxxx).

Modes of Delivery: each patient received his sessions individually at the Outpatient Clinic, Faculty of Physical Therapy Horus University, New Damietta, Egypt.

Modifications: No modifications occurred to any intervention or assessment.

Rationale for selecting hydrocortisone:

Hydrocortisone passes through the cell membrane, combines with cytoplasmic receptors, and stimulates the production of different proteins for specific enzymes. It also plays a role in treating symptomatic inflammation by increasing the surface blood circulation. Although phonophoresis with a corticosteroid is a very common treatment for musculoskeletal inflammations, there is little scientific evidence to support the effectiveness of using phonophoresis to deliver the medicine to the muscle **(Roostayia et al., 2019).**

Statistical analysis:

Sample size calculation was done using G Power and Sample Size Calculations software, version 3.0.11 for MS Windows (William D. Dupont and Walton D., Vanderbilt University, Nashville, Tennessee, USA). Sample size calculation was done using the comparison of ROM of shoulder flexion between subjects with subacromial impingement syndrome treated with high power laser and those treated with phonophoresis. As reported in previous publications, the mean ± SD of shoulder flexion ROM in study group was 34 approximately 153.47 ± 2.96, while in control group it was approximately 123.17±15.93 (Walid et al., 2021). Accordingly, we calculated that the minimum proper sample size was 16 subjects in each group to be able to reject the null hypothesis and we added 4 participants as s reserve for any drop out with 80% power at $\alpha = 0.05$ level and effect size = 1.12 using Student's t test for independent samples.

Data were screened, for normality assumption test and homogeneity of variance. Normality test of data using Shapiro-Wilk test was used, that reflect the data was normally distributed ($P>0.05$) after removal outliers that detected by box and whiskers plots. Additionally, Levene's test for testing the homogeneity of variance revealed that there was no significant difference ($P>0.05$). All these findings allowed to conducted parametric and non-parametric analysis. The data is normally distributed and parametric analysis is done.

The statistical analysis was conducted by using statistical SPSS Package program version 25 for Windows (SPSS, Inc., Chicago, IL). Quantitative data are expressed as mean and standard deviation for patient's age, flexion, abduction, internal rotation, shoulder pain and disability index, and isometric flexion external rotation variables. Qualitative data are expressed as frequency (percentage) for gender variable. One -way analysis of variance (ANOVA) test used to compare among Group A, Group B, and Group C for patient's age. Chi-square test used to compare among Group A, Group B, and Group C for patient's gender

variable. Multivariate analysis (3 x 2) of variance (MANOVA) used to compare the tested major variables of interest (flexion, abduction, internal rotation, shoulder pain and disability index, and isometric flexion external rotation variables) at different tested groups (Group A, Group B, and Group C) and measuring periods (pre- and post-treatment). Bonferroni correction test (Post hoc-tests) used to compare between pairwise within and between groups of the tested variables which P-value was significant from MANOVA test. All statistical analyses were significant at 0.05 level of probability ($P \leq 0.05$).

Results

In the current study, a total of 60 patients with subacromial impingement syndrome from both gender (32 males and 28 females) participated in this study and assigned randomly into 3 groups (20 patients / group). No significant differences ($P<0.05$) in clinical general characteristics of subacromial impingement syndrome patients (Table 1) among groups A, B, and C for patients age (P=0.292) and gender (P=0.594).

Table 1. Clinical general characteristics of subacromial impingement syndrome patients

Items	**Groups**			***P*-value**
	Group A (n=20)	**Group B (n=20)**	**Group C (n=20)**	
Age (year)	32.89 ±4.71	33.32 ±5.32	30.88 ±4.42	0.292
Gender (males: females)	9 (45%): 11 (55%)	12 (60 %): 8 (40 %)	11 (55 %): 9 (45 %)	0.626

Group A: received therapeutic exercise program; Group B: received exercise program in addition to hydrocortisone phonophoresis; Group C: received exercise program in addition to hydrocortisone iontophoresis.

Quantitative data (age) are expressed as mean ±standard deviation and compared by ANOVA test.

Qualitative data (gender) are expressed as frequency (percentage) and compared by Chi-square test.

P-value: probability value

Statistical analysis for range of motion variables within each group is presented in Table (2). There were significantly ($P<0.05$) increased in flexion, abduction, and internal rotation compared to pre-treatment within Group A (P=0.017, P=0.017, and P=0.0001, respectively), Group B (P=0.0001, P=0.0001, and P=0.0001, respectively), and Group C (P=0.001, P=0.001, and P=0.0001, respectively). Moreover, there was significantly ($P<0.05$) decreased in Shoulder pain and disability index at post-treatment compared to pre-treatment within Group A (P=0.012), Group B (P=0.0001), and Group C (P=0.0001). There was a significant ($P<0.05$) increased in external rotation isometric force at post-treatment compared to pre-treatment in group B (P=0.0001), but there were insignificantly ($P>0.05$) increased in external rotation isometric force at post-treatment compared to pre-treatment within Group A (P=0.323) and Group C (P=0.098). The patients with subacromial impingement syndrome in Group B received exercise program in addition to hydrocortisone phonophoresis program more improved range of motion variables for flexion (25.77%), abduction (26.33%), internal rotation (50.96%), shoulder pain and disability index (55.53%), and external rotation isometric force (55.91%) followed by patients in Group C (17.20, 19.47, 32.19, 47.92, and 16.90%, respectively) received exercise program in addition to hydrocortisone iontophoresis program, and then those in Group A (10.90, 12.65, 26.24, 29.61,

and 9.83%, respectively) who received therapeutic exercise program; Group B: received exercise program in addition to hydrocortisone phonophoresis.

Statistical analysis for range of motion variables among groups A, B, and C are shown in Table (2). No significant differences (P>0.05) at pre-treatment among groups A, B, and C in for flexion (P=0.618), abduction (P=0.513), internal rotation (P=0.906), shoulder pain and disability index (P=0.541), and external rotation isometric force (P=0.955). But there were significant differences (P<0.05) at post-treatment among groups A, B, and C in flexion (P=0.005), abduction (P=0.025), internal rotation (P=0.0001), shoulder pain and disability index (P=0.015), and external rotation isometric force (P=0.0001). So, these significant differences in mean values of flexion, abduction, internal rotation, shoulder pain and disability index, and external rotation isometric force at post-treatment, are favorable of patients with subacromial impingement syndrome in Group B, followed by Group C, and then Group A

Post-hoc test between each pairwise group comparisons at post-treatment for main variable outcomes are illustrated in Table (3). There were significant differences (P<0.05) between pairwise of Group A versus Group B in flexion (MD=18.59; P=0.009), abduction (MD=10.01; P=0.001), internal rotation (MD=12.74; P=0.0001), shoulder pain and disability index (MD=9.19; P=0.012), and external rotation isometric force (MD=2.83; P=0.0001).

Moreover, there were significant differences (P<0.05) between pairwise of Group B versus Group C in flexion (MD=16.90; P=0.024), abduction (MD=9.72; P=0.001), internal rotation (MD=8.11; P=0.019), and external rotation isometric force (MD=2.22; P=0.002), while no significant difference (P>0.05) in shoulder pain and disability index (MD=4.41; P=1.000).

However, no significant differences (P>0.05) between pairwise of Group A versus Group C in flexion (MD=1.69; P=1.000), abduction (MD=0.29; P=1.000), internal rotation (MD=4.63; P=0.356), shoulder pain and disability index (MD=4.78; P=0.966), and external rotation isometric force (MD=0.61; P=1.000).

The post-hoc test and mean differences between groups showed that the exercise program in addition to hydrocortisone phonophoresis program (Group B) followed by exercise program in addition to hydrocortisone iontophoresis program (Group C) gave the best values of range of motion which including flexion, abduction, internal rotation, shoulder pain and disability index, and external rotation isometric force.

Table 2. Within and between group comparisons for range of motion variables

Variables	Items	Groups (Mean ±SD)			*P*-value[2]
		Group A (n=20)	Group B (n=20)	Group C (n=20)	
Flexion	Pre-treatment	138.67 ±23.44	137.05 ±23.40	132.65 ±17.61	0.618
	Post-treatment	153.78 ±20.93	172.37 ±6.51	155.47 ±14.14	0.005*
	MD (Change)	15.11	35.32	22.82	
	95% CI	2.76 – 27.46	23.29 – 47.33	10.11 – 35.53	
	Improvement %	10.90%	25.77%	17.20%	
	P-value[1]	0.017*	0.0001*	0.001*	
Abduction	Pre-treatment	133.00 ±25.84	126.53 ±25.56	125.65 ±19.43	0.513
	Post-treatment	149.83 ±22.55	159.84 ±10.06	150.12 ±15.96	0.025*
	MD (Change)	16.83	33.31	24.47	
	95% CI	3.13 – 30.53	19.98 – 46.65	10.37 – 38.56	
	Improvement %	12.65%	26.33%	19.47%	
	P-value[1]	0.017*	0.0001*	0.001*	
Internal rotation	Pre-treatment	48.94 ±8.96	49.37 ±9.52	50.24 ±7.15	0.906
	Post-treatment	61.78 ±11.90	74.53 ±5.61	66.41 ±7.67	0.0001*
	MD (Change)	12.84	25.16	16.17	
	95% CI	7.07 – 18.59	19.55 – 30.76	10.25 – 22.10	
	Improvement %	26.24%	50.96%	32.19%	
	P-value[1]	0.0001*	0.0001*	0.0001*	
Shoulder pain and disability index	Pre-treatment	41.10 ±15.81	44.39 ±14.52	46.37 ±14.20	0.541
	Post-treatment	28.93 ±18.41	19.74 ±8.64	24.15 ±10.69	0.015*
	MD (Change)	12.17	24.65	22.22	
	95% CI	2.78 – 21.55	15.51 – 33.78	12.55 – 31.87	
	Improvement %	29.61%	55.53%	47.92%	
	P-value[1]	0.012*	0.0001*	0.0001*	
External rotation isometric force	Pre-treatment	6.31 ±1.96	6.26 ±1.66	6.45 ±1.73	0.955
	Post-treatment	6.93 ±2.13	9.76 ±1.98	7.54 ±1.85	0.0001*
	MD (Change)	0.62	3.50	1.09	
	95% CI	-0.62 – 1.88	2.27 – 4.71	-0.20 – 2.38	
	Improvement %	9.83%	55.91%	16.90%	
	P-value[1]	0.323	0.0001*	0.098	

Group A: received therapeutic exercise program; Group B: received exercise program in addition to hydrocortisone phonophoresis; Group C: received exercise program in addition to hydrocortisone iontophoresis.

Data are expressed as mean ±standard deviation and compared statistically by MANOVA test

MD: Mean difference CI: confidence interval P-value: probability value * Significant (P<0.05)

P-value[1]: Probability value within each group; P-value[2]: Probability value within among groups

Table 3. Pairwise comparison (post-hoc test) between groups for range of motion variables at post-treatment

Variables	Items	Post-hoc test (post-treatment)		
		Group A *vs.* Group B	**Group A *vs.* Group C**	**Group B *vs.* Group C**
Flexion	MD	18.59	1.69	16.90
	P-value	0.009*	1.000	0.024*
Abduction	MD	10.01	0.29	9.72
	P-value	0.001*	1.000	0.001*
Internal rotation	MD	12.74	4.63	8.11
	P-value	0.0001*	0.356	0.019*
Shoulder pain and disability index	MD	9.19	4.78	4.41
	P-value	0.012*	0.966	1.000
External rotation isometric force	MD	2.83	0.61	2.22
	P-value	0.0001*	1.000	0.002*

Group A: received therapeutic exercise program; Group B: received exercise program in addition to hydrocortisone phonophoresis; Group C: received exercise program in addition to hydrocortisone iontophoresis.

Data are expressed as mean difference and compared statistically by Bonferroni correction test.

P-value[3]: probability value between pairwise groups (post-hoc test) MD: Mean difference

* Significant (P<0.05)

Discussion

The purpose of this study was to compare Hydrocortisone Phonophoresis versus Iontophoresis in patients with stage 2 Subacromial Impingement Syndrome. The parameters that were investigated in this study were assessed by SPADI questionnaire, digital Electrogoniometer and Manual Digital Dynamometer. The results of this study provide supporting evidence that hydrocortisone phonophoresis improves active shoulder flexion, abduction, internal rotation range of motion, SPADI value and shoulder external rotation isometric force more than hydrocortisone iontophoresis.

So, these significant differences in mean values of flexion, abduction, internal rotation, shoulder pain and disability index, and external rotation isometric force at post-treatment, are favorable of patients with subacromial impingement syndrome in Group B, followed by Group C, and then Group A

In this study, the results from groups (A) Therapeutic exercise program, (B) phonophoresis and (C) iontophoresis were compared before the treatment and after the last session. The results indicated that there were significant improved differences in all measures within each group.

The results showed that Group B who received the exercise program in addition to hydrocortisone phonophoresis improved higher flexion, abduction and internal rotation range, improved higher SPADI followed by Group C which received the exercise program in addition to hydrocortisone iontophoresis, and then those in Group A who received therapeutic exercise program.

The results of this study came in accordance with **(Pekgöz, F., et al 2020)** who stated that exercise therapy is associated with successful outcomes comparable to surgery. In a recent systematic review and meta-analysis of randomized-controlled trials regarding the effectiveness of conservative measures with shoulder impingement, manual therapy plus exercise was found to be superior to exercise alone. Several studies have demonstrated the beneficial effects of exercise in patients with SAIS, particularly in terms of pain and function.

The results of this study are in agreement with **Cameron, M. H. (2021)** who demonstrated that ultrasound is intended to enhance delivery of the drug through the skin, thereby delivering the drug for local or systemic effects. Ultrasound increases transdermal drug penetration by increasing the permeability of the stratum corneum through cavitation. This theory is supported by the observation that ultrasound can enhance drug penetration even when ultrasound is applied before the drug is put on the skin. Ultrasound may change the permeability of stratum corneum through both thermal and nonthermal mechanisms. It has been proposed that ultrasound alters the skin's porous pathways by enlarging the pores' effective radii, by creating more pores, or by making the pores less tortuous. When the permeability of the stratum corneum is increased, a drug will diffuse across it because of the difference in concentration on either side of the skin. Iontophoresis, similar to phonophoresis, may also promote transdermal drug penetration by increasing the permeability of the outermost layer of the skin, the stratum corneum, the main barrier to transdermal drug uptake

Also, the results of this study agree with **Asheghan, et al 2020** who stated that instead of an injection, PPT provides a safe and painless route of administrating anti-inflammatory medications by using ultrasound. Of anti-inflammatory medicines corticosteroid and non-steroidal anti-inflammatory drugs have been used in PPT**.**

In agreement with the results of the current study **Kelle et al. (2023)** who concluded that that ibuprofen phonophoresis with both pulsed and continuous modes combined with exercise is more effective than phonophoresis with sham US combined with exercise in reducing pain and improving shoulder functions.

The result of this study came in accordance with **Iordan, D. A., et al (2023)** who investigated the Effect of hydrocortisone ultrasonic phonophoresis in the treatment of knee osteoarthritis. The results demonstrated that hydrocortisone therapy combined with PT had a beneficial effect on pain and functional mobility in patients with KOA.

The result of this study was confirmed the observations of **OA Mowafy, et al (2023)** who evaluate and compare efficacy of hydrocortisone phonophoresis on xerosis cutis in chronic haemodialysis patients. The results showed that phonophoresis increased the effect of hydrocortisone on xerosis cutis compared to topical hydrocortisone.

The results of this study supported by **Akhalkatsi, V., et al (2022)** who evaluate effect of the combined utilization of static progressive stretching and phonophoresis with hydrocortisone in rehabilitation of knee contractures caused by arthrofibrosis. The results demonstrate that static progressive stretching in the rehabilitation process of knee contractures caused by

arthrofibrosis is greatly improved after the utilization of ultraphonophoresis with highly concentrated hydrocortisone alongside standard home exercise programs and this effect is especially apparent in the cases of patients with type III arthrofibrosis and knee flexion contractures.

The results of this study were supported by **Wahba, E. S. (2018)** who stated that effectively, medicines contained within or under the ultrasound gel are pushed by the sound waves of the ultrasound and driven far beneath the skin. Phonophoretically administered medications can penetrate the body to a much deeper level than those massaged by hand over the surface of the skin. Phonophoresis offers the potential advantage of delivering a pharmacologic agent in a relatively safe, painless, and easy manner to structures that lie somewhat deep within the body. So phonophoresis is a type of combination therapy that implicates both the therapeutic effects of ultrasound and enhancement the drug therapy efficacy in the treatment simultaneously, making this combination more successful than every treatment alone.

Also, the results of this study agree with **Taskaynatan, M. A., et al (2007)** who approved that Application of Steroid Iontophoresis to the conventional physical therapy for patients with biceps tendonitis seems to provide a better and more prolonged clinical and functional improvement.

The results of this study came in accordance with **Yigiter, K., and Kerem, M. (2002)** who showed that iontophoresis plus SWD produced results that were better than with SWD alone in the treatment of adhesive capsulitis.

In agreement with the results of the current study the results of **Tyagi, V., et al (2021)** who demonstrated that short-duration constant current iontophoresis was able to achieve pharmacologically relevant concentrations of DEX-P (anionic dexamethasone phosphate) and BUF (cationic buflomedil hydrochloride) in the mucosa in only 5 min. Iontophoresis afforded greater transport and superior delivery efficiencies compared to simple passive transport.

Also in agreement with the results of this study the results of **Dasht Bozorg, B., Et al (2021)** who stated that Application of anodal iontophoresis resulted in greater distribution of hydrocortisone into deeper layers of skin and the receptor chamber, in comparison to passive permeation.

Murphy, R. J., and Carr, A. J. (2010) concluded that physiotherapy may improve pain and function in people with mixed shoulder disorders compared with placebo and this came in accordance with the results of the current study.

The results of this study disagree with **Baktir, S., et al (2019)** who found that iontophoresis was superior to phonophoresis regarding all outcomes: pain, function, and grip strength.

The results of **Park, S. W., et al 2020** suggest that surgical (e.g. sub-acromial decompression) and non-surgical (e.g. manual therapy, taping, stretching and strengthening) management of subacromial pain syndrome should not focus solely on addressing a potential decrease in subacromial space, but also on the importance of other biopsychosocial factors.

The results of **Burger, M., et al** suggesting that besides a significant improvement in shoulder function in favour of Corticosteroid Injection at 6-7 weeks follow-up ($p < 0.0001$), no evidence was found for the superiority of CSIs compared with physiotherapy for pain, ROM and shoulder function in the short- (1-3 months), mid- (6 months) and long term (12 months) .

The results of **Gutiérrez-Espinoza, H., et al** showed that supervised physical therapy and home-based progressive shoulder strengthening and stretching exercises for the rotator cuff

and scapular muscles are equally effective in patients with subacromial impingement syndrome treated conservatively.

The results of **Dong, W., et al** demonstrated that regarding nonoperative treatments, with respect to the pain score, combined treatments composed of exercise and other therapies tended to yield better effects than single-intervention therapies. Localized drug injections that were combined with exercise showed better treatment effects than any other treatments, whereas worse effects were observed when such injections were used alone. Regarding the Constant-Murley Score, most combined treatments based on exercise also demonstrated better effects than exercise alone. Notwithstanding, the choice of surgery should be made cautiously because similar outcomes may also be achieved by the implementation of exercise therapy **(Dong et al., 2015)**.

The results of **Ortega-Castillo, M., and Medina-Porqueres, I.** showed that Eccentric exercise may reduce pain and improve strength in upper limb tendinopathies, but whether its effectiveness is much better than other forms of treatment remain questionable.

In agreement with the results of the current study the results of **Tyagi, V., et al (2021)** who demonstrated that short-duration constant current iontophoresis was able to achieve pharmacologically relevant concentrations of DEX-P (anionic dexamethasone phosphate) and BUF (cationic buflomedil hydrochloride) in the mucosa in only 5 min. Iontophoresis afforded greater transport and superior delivery efficiencies compared to simple passive transport.

Singh, H., et al concluded Kinesiology tape use demonstrated a statistically significant reduction in pain-free range of motion. MPTR myofascial trigger point release improved in all pain scores and the disability scores index. SSE scapular stabilization exercises also reduced pain; however, mixed results were seen for range of motion. Finally, resistance training not only reduced pain but improved proprioception and joint position sense. Even though all techniques showed some promise in treating SIS, further large-scale studies exploring related outcomes are needed **(Singh, Thind, & Mohamed, 2022).**

Karanasios, S., et al 2023 demonstrated that although exercise and manual therapy (EMT) and corticosteroid injections provide first-line treatment options, evidence for the best management of Subacromial Pain Syndrome remains inconclusive. He also stated that the addition of corticosteroid injections to Exercise manual therapy provided no better results in shoulder disability compared with Exercise manual therapy or corticosteroid injections alone in the mid-term. Based on very low to moderate certainty of evidence, EMT has similar effects to corticosteroid injections on improving all outcomes in patients with SAPS at all follow-up periods**.**

Pieters, L., et al (2020) concluded that There is a growing body of evidence to support exercise therapy as an intervention for subacromial shoulder pain.

The strength of this study: there is no published research work that provides comparing hydrocortisone phonophoresis to iontophoresis in patients with subacromial impingement. Therefore, this is the preliminary study in this field.

Implications of Physiotherapy Practice

Comparing the efficacy of hydrocortisone phonophoresis and iontophoresis offers valuable insights into optimizing treatment protocols for individuals with subacromial impingement syndrome. Understanding which modality yields better outcomes can guide physical therapists

in tailoring interventions to improve patient recovery and reduce pain associated with this common shoulder condition. Such research can enhance the effectiveness and precision of physical therapy interventions, ultimately leading to better patients' outcomes and quality of life.

Conclusion

Phonophoresis and iontophoresis enhance hydrocortisone transport through the skin through thermal mechanisms and mechanical effects. Phonophoresis increases skin temperature, cell membrane permeability, and ion conductance, while iontophoresis enhances drug transport through electro migration. Both methods improve treatment of subacromial impingement and regain work speed**.** Hydrocortisone Phonophoresis improves active shoulder flexion, abduction, internal rotation range of motion, SPADI value more than Hydrocortisone Iontophoresis.

Limitations

Limitations of the study include lack of similar studies on this topic. Future studies are recommended to include patients with different ages, using phonophoresis with different parameters, using iontophoresis with different ions, a similar study may be done to evaluate the whole power of the shoulder muscles measuring the adverse effects of both modalities and studying time effect on treatment and follow up evaluations. Further studies are recommended with larger sample and blind assessors.

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