Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 3, 2021, Pages. 342 - 354
Received 16 February 2021; Accepted 08 March 2021.

High-Power Laser Versus Phonophoresis in Subacromial Impingement Syndrome: Randomized Controlled Trial

Walid Ahmed Kamal[1*], Mahmood Saber[2], Khalid Aiad[3], Mohamed SeragEldeinMahgoub Mostafa[4], Wagdy William Younan[5], Samah Saad Zahran[6]

[1*]Physical Therapist MSC, Ministry of Interior, Egypt. E-mail: walidkamal558@gmail.com

[2]Professor, Laser Application in Surgery, National Institute of Laser Enhanced Science, Cairo University, Giza, Egypt.

[3]Professor, Orthopedic Physical Therapy, Cairo University, Giza, Egypt.

[4]Associate Professor, Basic Sciences Department, Faculty of Physical Therapy, Cairo University and Heliopolis University for Sustainable Development, Egypt.

[5]Lecturer, Physical Therapy, Department of Physical Therapy for Disturbance of Growth and Development in Pediatric and it is Surgeries, Faculty of Physical Therapy, Deraya University, Egypt.

[6]Lecturer, Physical Therapy Department for Musculoskeletal Disorders and their Surgery, Faculty of Physical Therapy, Cairo University, Egypt.

ABSTRACT

Objective wastoresearch the effect of high-energy laser therapy in shoulder impingement syndrome versus phonophoresis. Study design was A provisional, randomized, pre-post-test, controlled experiment. Setting Cleopatra Hospital - Egypt ambulatory clinic. The trial was carried out betweenJuly 2020 and January 2021. Participants; Forty diagnosed Patients with 1 - 2 stage impingement pain syndrome was divided randomly into two equal groups. Interventions; Group (A) underwenta program of Neodymium-yttrium Aluminum Garnet Laser 1064 nm Wave Length Hiro 3, high intensity pulsated laser 8 W, 12 J/cm2 dose and 10000 J of Total energy maximum was applied for 15 minutes and 150 'us' single impuls, 760 mj, two sessions a week for one and half month in addition to exercise.Group (B) In addition to an exercise phonophoresis was obtained with sodium diclofenac. Major outcomes measurement; Scale visual analog (VAS), electro goniometer, Ultrasonography. A statistically significant reduction was observed in VAS score, and improvement of mobility of shoulder in laser group compared with phonophoresis group ($p< 0.05$). In Conclusion. In impingement syndrome, high-level laser therapy contributed to an increased shoulder mobility.

KEYWORDS

Impingement Pain Syndrome**,** High Power Laser Therapy, Phonophoresis**,** Shoulder Mobility.

Introduction

In the subacromial space, shoulder impingement syndrome is characterized as asymptomatic irritation of the rotator cuff and the subacromial bursa.[1] The term covers a broad range of disorders, which leads to an alteration in the relationship between soft tissues [inflammation] and structure [rigidity], especially when the arm is arched between 60 and 120 degrees [2].Sub-acromial impingement syndrome (SIS) is characterized by intense pain spreading through the

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 3, 2021, Pages. 342 - 354
Received 16 February 2021; Accepted 08 March 2021.

biceps and deltoid of the shoulder, pain rising in the night during abduction and internalrotation [3].

One of the most common causes of shoulder pain is sub-acromial impingement syndrome, which occurs when the rotator cuff muscles are compressed in the sub-acromial space and the curacao acromial arch [4]. Many factors predispose to the development of SIS, with weak rotating cuff muscles, abnormal muscle function, articular capsule defects and long overhead bracelet movement, being the most important risk factors. [5].

SAIS induces edema, swelling, and can become chronic if appropriate treatment is not implemented, conservative and surgical treatment methods can be used to minimize discomfort, increase joint mobility, enhance muscle strength and quality of life in SAISConservative treatment strategies include analgesic and non-steroidal anti-inflammatory or corticosteroid medications, resting, adjustment of routine triggers, approaches to physical activity, range of movement and strengthening exercises, local anesthetic subacromial injections [6]Treatment with Laser is based on the assumption that laser radiation and possible monochromatic light in general can change the function of cells and tissues in a way depending on the light's properties, e.g. wavelength, coherence, etc. [7]. This absorption is obtained not with concentrated, diffuse light into all aspects 'sparing phenomena, increasing mitochondrial oxidative response, and adenosine triphosphate, RNA or DNA photochemical,' but with high intensity laser therapy, involving high intensity radiation causing minimal and slow light absorption by chromium spheres [8]'.

Ultrasound results in lower pain, higher stress tolerance for soft tissue injuries (tenosynovitis, tendinitis and epicondylitis) and the addition of fluocinonide phonophoresis does not improve ultrasound benefits alone [9].

The efficacy of dexamethasone lidocaine phonophoresis compared to ultrasound alone in perceived pain correlated with symptomatic tendinitis (triceps, biceps, shoulder and knee), and findings did not indicate any substantial variations in treatment modality [10].

A new research has shown that SIS is beneficial with ultrasound therapy and effectively reduces pain and enhances functionality[11].

The dual therapeutic effects of physiotherapy and medicine are combined in phonophoresis and iontophoresis. A drug is used as an ultrasound transmitter rather than traditional conductor gel in phonophoresis [12].

As such, this research aims to determine efficacy of high-power laser versus phonophoresis on shoulder mobility in subacromial impingement syndrome.Up to our knowledge there is no one use ultrasonography as objective method to assess this improvement and also use different type of exercises.

There is limited research studying the impact ofhigh-power laser therapy versus phonophoresis on shoulder mobility in subacromial impingement syndrome.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 3, 2021, Pages. 342 - 354
Received 16 February 2021; Accepted 08 March 2021.

Materials and Methods

The research design was planned to be a prospective, randomized controlled- pre – post – testexperiment.

The study was conducted between July 2020 to January 2021.

Participants

40 patients (20 males - 20 females), with SAIS was selected from outpatient's physical therapy department of Cleopatra hospital. Patients affirmed their agreement by signing an informed consent document to participate in the study.

This research involved patients diagnosed clinically and radiologically as subacromial impingement syndrome of 28 – 45 years of age, who were complained of phase 1-2 unilateral subacromial impingement syndrome of one month or longer and found nerve compression consistent on physical testing [13].

Patients with reduced mobility in the shoulder, radicular arm pain, inflammation of rheumatoid disorders, acromioclavicular or glenohumeral osteoarthritis, extreme cervical spondylosis, calcium deposition, thyroid, diabetes mellitus, ischemic cardiac disease and pacemaker or prior history of neurologically disease have been removed.Patients who obtained physical and rehabilitative treatment and were injected with steroids within 6 months before the study were also removed from the study, as well as those who had undergone shoulder surgery. It was screened in all patients, and nobody was removed.

Randomization

Each participant received informed agreement after having explained the nature purpose and advantages of the study, informed them at any time of their right to refuse or withdraw, and the confidentiality of any information received, the patients were randomly assigned, by an indigenous sealing researcher, to two groups " LASER group and phonophoresis group " using computer generated randomization card.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 3, 2021, Pages. 342 - 354
Received 16 February 2021; Accepted 08 March 2021.

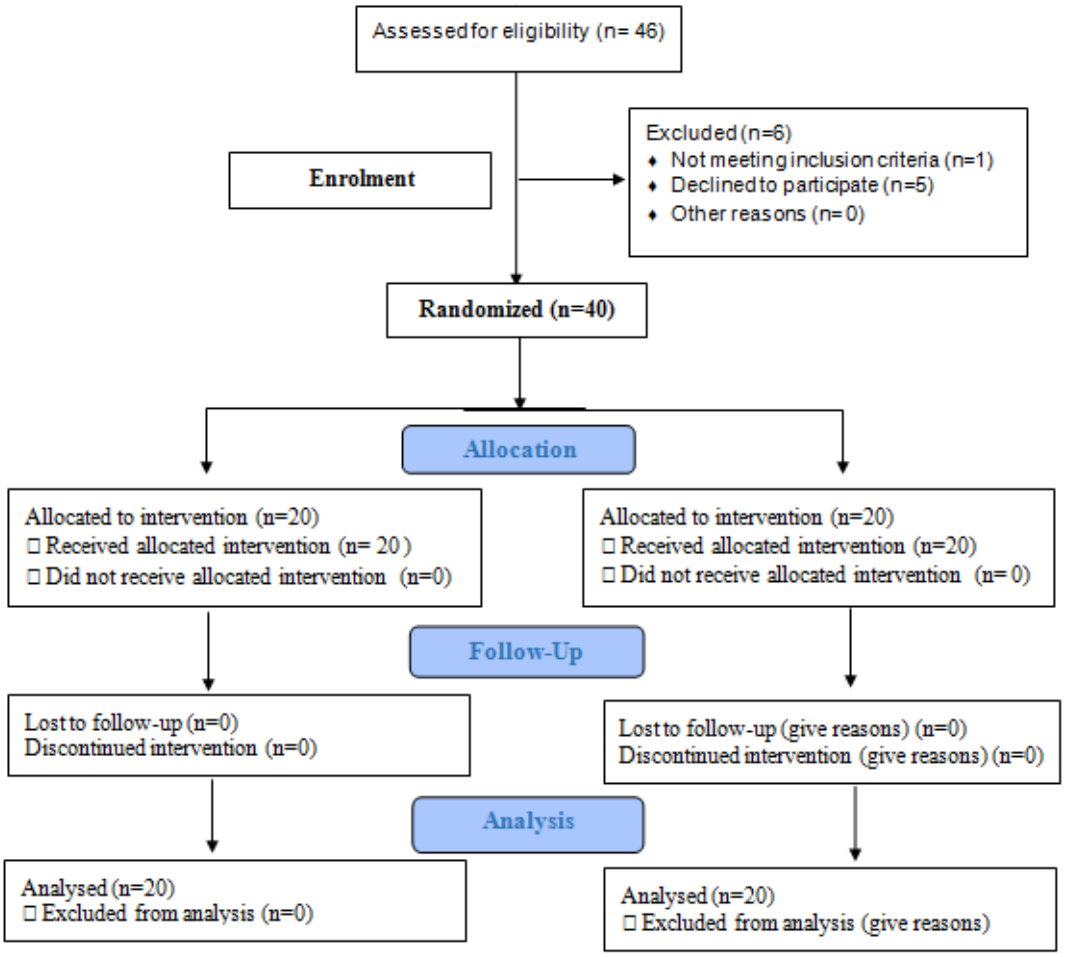

Fig. 1. Participant Flow Chart

After randomization, no subjects left the study.

Interventions

Random division of the patients into two groups:

Group (A): Composed of 20 patients who received 12 consecutive session of HILT Twice a weekly over 6 weeks in addition to therapeutic exercises.

Group (B):composed of 20 patients who receivedtopical medium phonophoresis of 50 mg sodium diclofenac gel. 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 weeksin addition to therapeutic exercises[14].

High intensity laser therapy treatment was done using (HIRO3.0 Nd: YAG pulsed laser) (Arcugnano, Via Volta, 9 Vicenza, Italy) peak power 3kW intensity 15000W/cm energy per pulse 350 mj.The procedure consisted of three stages of each session. The first step was to scan the

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 3, 2021, Pages. 342 - 354
Received 16 February 2021; Accepted 08 March 2021.

anterior shoulder joint quickly manually (100cm2/30s) by a single shot of 850 mj on a frequency of 30 Hz. Scanning was carried out in parallel with the joint line, the patient's arm being rotated internally at the rear scan and rotated externally on a front scan. the total energy dose provided during that process was 4000J.The intermediate phase was a fixed phase, with an emission of 1 shot, 350 mj, at 20-25 Hz.0. The total energy given at that phase was 4000 J. The hand was applied perpendicular vertically for5 secondeeach scan to shoulder joint involve both the front and back shoulder joint linesThe final phase included the rapid manual scanning, up to the total energy dose of 2000J, of the same areas handled in the initial phase and deltoid areas. It took about 15 minutes to apply all three stages of HILT. To keep the skin at the same distance, A set spacer standing hand piece was used.Throughout the whole process both the subject and the operator wear safety glasses to protect their eyes from laser. Patient between sessions was encouraged to exercise [15].

Each exercise started with 10 to 15 minutes of aerobic warming and ended with five minutes of icing packaging in the affected areas. The training was conducted in four stages. Each patient began with Phase 1 and moved to Phase 4, depending on his or her condition. Step 1 was designed to achieve painless passive movement range (ROM). To accomplish that, it was done 8 to 10 times daily in all directions for the isometric shoulder exercise and the passive ROM exercise. Also 15-20 ROM exercises a day were conducted in postural exercises (e.g. chin tuck and scapular retraction). If the ROM was up to 50 percent, the successful aid ROM exercise was done using a belt in both directions. Cross-bodies and neck stretches were also carried out 4 times a day during this process and each lasted 10 seconds. Once a week, Mobilization exercises were conducted. Step 2 (active ROM exercises) started if the patient had been able to perform passive and active support ROM exercises completely and painlessly. The abduction or segment of the shoulder (scapular plane elevation) was carried out by raising the arm at an angle less than 60. The external and the internal rotator cuff muscles were closely trained while the arms were positioned on the body's sides.This was a 3-set exercise each day, each of 10 repeats. Phase 1 stretching exercises have also been conducted in phase 2 but have been expanded to 15 to 20 seconds. Phase 3 was designed to reinforce the rotator cuff and scapula muscles. Scaping took place at an angle above 60. Exercises were conducted at a 90-angle shoulder abduction to strengthen the rotator cuff muscles responsible for external and internal rotations. Reverse flying, shoulder extension and curve row exercises took place in 3 sets of 10 repeats with an elastic band or 1- to 1.5-kg. Step 4 was accompanied by a medicine ball for the training of the scapular muscles. The rotator cuff and biceps muscles were strengthened in 3 sets of 15 repeats with a progressively rise of 25 to 50% in external resistance.exercises were done by 4 physical therapists from outpatient clinic of Cleopatra hospital for both groups[16].

Outcome Measures

All the assessment procedures were done before treatment and after finishing the treatment plan.

1. Visual Scale Analog (VAS): The pain is calibrated using a 10 cm line with zero indicating no pain and 10 indicating the worst of all. [17].
2. Electro goniometer: is an estimation of the mechanical state of the joining by electronic parts and is currently used in research centers in relation to radiography with high accuracy level [18].Active shoulder flexion and abduction were measured by the electrogoniometerthrough a stander proceduremeasuring [19,20].

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 3, 2021, Pages. 342 - 354
Received 16 February 2021; Accepted 08 March 2021.

3. Ultrasonagraphy: It is a noninvasive test with no side effects, it is advantageous to assess dynamically the tendons and determine their consistency during movement of the shoulder. If ultrasound is to diagnose impingement accurately, the abduction of the shoulder should be examined dynamically. The ultrasonic impingement test is conducted with the arm withdrawn in the scapular plane or a little toward it since it allows the corresponding anatomical landmarks to be visualized simultaneously through the arc of elevation. An additional four subacromial impingement signs are recorded in the ultrasound literature: (a) "SA- SD bursa lateral bunching, or fluid distension to the impingement point in the curacao- acromial arch[21] (b) "The supraspinatus tendon is bunched sideways to the impingement point of the curacao-acromial arch.; (c) curacao- acromial ligament bulge and (d) Less often, complete "blocking" of supraspinatus tendon movementSince the humeral head migrates upwards to avoid its passage under the acromion.

A single radiologist with over ten years of experience in musculoskeletal ultrasound scanning has conducted an ultrasound test. All assessed both shoulders.Ultrasound scanner with a linear array probe 8-15 MHz was used with Acuson Sequoia 512 (Siemens, Germany). This probe had an axial space resolution of 0.280 mm. Ultrasonographic scan was conducted according to the procedure of measurements of the thickness of the supraspinatus tendon recommended by "the European Society of Musculoskeletal Radiology". The coronal view of the sulcus, between greater tuberosity and articular cartilage with the modified crass location, measured the thickness of the supraspinatus tendon. The Changed Crass location implies that the subjects' arm should be rear, and the palmar side of their hand should be positioned on the upper side of the iliac wing with the elbow flexed, directed posteriorly. The probe was mounted parallel to the supraspinatus tendon on the insertion spot. The reason we chose the Updated Crass position over the Crass position is that most patients suffer from rotator cuff pathology and they can get closer than the latter to the guidance. The sensor was shifted ahead and after to observe the insertion of the supraspinatus tendon located before the biceps tendon. [22].

Statistical Analysis

Results were showed Mean ± standard deviation (SD). Two independent variables – interference and measuring interval – and four dependent variables were run in a two-way mixed design MANOVA (Ultrasonography Dimension of supraspinatus, VAS, ROM of shoulder flexion and abduction). A linear relation existed between the modified values as evaluated by scatterplot and no multi-linearity proof as evaluated by Pearson ($|r|<0.9$). No univariate outliers were found in the data, as evaluated by boxplot inspection, and no multivariate outliers were found in the data, as evaluated with Mahalanobis gap ($p>001$).Ultrasonography Typically distributed as calculated by Shapiro-Wilk's Test Dimension of supraspinatus, VAS, shoulder bending ROM and abduction ($p>-05,04$). Covariance matrix homogeneity was tested by Box's M ($p=0.009$) and variance homogeneity, were measured by Levene'shomogeneity Test of Variance ($p>.05$). For data processing, the Social Sciences Statistics Package (SPSS) computer program (windows version 23) has been used. P value $\leq 0.05$was deemed significant and < 0.01 was deemed extremely meaningful.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 3, 2021, Pages. 342 - 354
Received 16 February 2021; Accepted 08 March 2021.

Results

The course of the study included a total of 40 participants were randomized. In Group A, there are 20 participants who received 12 consecutive HILT sessions plus therapeutic exercises, twice a week over 6 weeks. In Group B there were 20 participants who received phonophoresis three sessions a week for one and half month in addition to therapeutic exercises. The experiment was performed by all randomized participants. The groups of age, height, weight, and BMI were identical at baseline ($p > 0.05$). (table 1).

The relationship between intervention form and themeasuring period was statistically significant on the combined dependent variables, F= 452,608, p=0,001, Wilks' =0,04, partial η2=0,96. The impact on the combined dependent variables, F= 279,95, p=0, was statistically significant. 001, Wilks' =.063, partial η2 = 0.947.While the key impact on the combined dependent variables was statistically important, F=1575.499, p=0.001, Wilks' Λ = 0.012, partial η2 = 0.978. Multiple pairwise comparison Post hoc tests showed a substantial decrease ($p<0,05$) in the Ultrasound Dimension and VAS in both groups, while shoulder flexion and abduction ROM showed a significant increase in both categories ($p<0,05$). The Post hoc tests showed a considerable increase in both groups.In the contrast of the two post program groups, the Ultrasonographic component of supraspinatus and VAS decreased statistically significantly and the ROM of shoulder flexion and abduction increased in favor of group A in comparison to group B ($p > 0.05$) (Table 2).

Table 1. Subjects general characteristics

	Study group(A) (n = 20)	**Control group(B) (n = 20)**	**P value**
Age (yrs.)	37.55 ±11.28	36.65 ±11.44	0.81^{NS}
Gender Male/ female	10 / 10	10 / 10	1.00^{NS}
Weight (Kg)	60.13 ±9.46	64.77 ±10.36	0.353^{NS}
Height (Cm)	158.62 ±10.75	166.89 ±11.81	0.433^{NS}
BMI (Kg/m^2)	19.83 ±4.67	21.73 ±2.91	0.576^{NS}
^{NS} P > 0.05 = non-significant, P = Probability. BMI: body mass index.			

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 3, 2021, Pages. 342 - 354
Received 16 February 2021; Accepted 08 March 2021.

Table 2. Descriptive statistics and 2x2 mixed design Multiple variance analyzes (MANOVA) for all dependent variables at various calculated times for both groups

		Group A (n = 40)	**Group B (n = 40)**	**P value***
Ultrasonography Dimension of supraspinatus (mm)	Pre-prog	6.74 ±0.66	6.54 ± 0.69	0.98 ^{NS}
	Post-prog	3.97 ± 0.38	5.35 ± 0.6	0.001 ^{HS}
	P value**	0.001 ^{HS}	0.001 ^{HS}	
VAS	Pre-prog	6.87 ±0.62	6.92 ± 0.78	0.091 ^{NS}
	Post-prog	1.71 ± 0.56	3.86 ± 0.71	0.001 ^{HS}
	P value**	0.001 ^{HS}	0.001 ^{HS}	
ROM of Shoulder Flexion	Pre-prog	106.3 ±3.22	105.76 ± 3.66	0.567 ^{NS}
	Post-prog	157.85 ± 4.56	123.17 ± 15.93	0.001 ^{HS}
	P value**	0.001 ^{HS}	0.001 ^{HS}	
ROM of Shoulder Abduction	Pre-prog	105.4 ±3.33	105.3 ± 3.46	0.99^{NS}
	Post-prog	153.47 ± 2.96	117.45 ± 3.91	0.001^{HS}
	P value**	0.001 ^{HS}	0.001 ^{HS}	

* Inter-group comparison; ** intra-group comparison of the results pre- and post-program.
^{NS} P > 0.05 = non-significant, HS P < 0.01 = highly significant, P = Probability, ROM: range of motion.

Discussion

The current research was conducted to examine the impact of high-level laser therapy versus phonophoresis in subacromial impingement syndrome on shoulder mobility. The mean value of VAS, electro goniometer, and Ultrasonography between groups prior to and after treatment was significantly different. The high intensity pulsed laser used in this study can therefore suffice to decrease subacromial and subdeltoid bursitisThis study used high intensity laser therapy in shoulderimpingementsyndrome and used of ultrasonography as an objective method for assessment of subacromial and subdeltoid bursitis.

A variety of causes are commonly thought to be contributing to rotator cuffdiseases, such as poor posture, weakness and decay of the rotating cuff and the scapular muscles, a reduced shoulder complex ROM, degenerative and inflammatory tendon and bursa, acromial dysmorphology, capsular tightness and gleno-humeral instability.[23].

The protocol used by karaka[24] and pekyvas[25]mentioned nine sessions on alternating days, three weeks, andSanta Mato et al. used 10 sessions " five sessions/week for two weeks',' while

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 3, 2021, Pages. 342 - 354
Received 16 February 2021; Accepted 08 March 2021.

our intervention protocol called for 12 laser sessions " two sessions/weeks for 6 weeks so our results arrange in accord with Santa Mato et alwho declared that high-intensity laser community hadstronger improvements than ultrasonic[26].

pakhavajs and Baltaci applied a placebo-free design and analyzed only the post-treatment outcomes, which has shown when coupled with other physiotherapy methods, high-intensity laser therapy leads to better outcomes. This study is in line with other study published in 2015by SaeHoon et al. who examined HILT's therapeutic effectiveness in patients with frozen shoulder [15]. Random division of 66 patients into two classes was: HILT (n=33) and placebo (n=33). A therapeutic dose of 4000J for 15 minutes was required for the HILT protocol. Three weeks of medication three days a week have been treated. VAS was assessed at baseline after 3, 8, and 12 weeks of care for pain, VAS for satisfaction and passive ROM. At the benchmark. The HILT group had clinically lower VAS scores for three weeks and eight weeks. No noticeable change in pain occurred within 12 weeks. The HILT group collectively had clinically lower pain values for 3 and 8 weeks. In 12 weeks after this there was no noticeable improvement in pain. The addition of high intensity Laser Therapy to regular exercise therapy has not been linked to an acceptable effect or detectable harm [15].These findings are not in line with the findings of recent research work done by Javier et al 2019 who stated that Three weeks of intervention included 15 sessions in total (five sessions/week). During each session participants were undergoing either as highly intensive laser (experimental group) or sham-laser (sham-controlled group) therapy, accompanied by a procedure for the subacromial syndrome of the exercise therapy which was intended for all subjects to stretching and strengthening exercises. They concluded that exercise plus highly intensive laser therapy is not better than exercise, which decreases discomfort and enhances the functionality of subacromial patients. [27]. Pulsed HILT long-term impact in the treatment of the post mastectomy pain syndrome was examined by Ebid and El-sodany 2015who reported that after 12 weeks of follow-up,HILT for patients with PMPS is an important form of physical therapy. Really, it is superior to a sham laser in terms of pain relief, improved shoulder ROM and enhancement in quality of life than a sham laser [28]. Kujawa J et alreported thatuses of a particular waveform with regular peaks of high amplitude levels and distances between the waveforms (in time) to reduce thermal phenomena, can rapidly cause profound tissue photochemistry that boosts blood flow, vascular permeability and cell metabolism.[29] HILT had an analgesic effect on the nerve endings, but there was no proof of reduced inflammation [30,31]. Rotator cuff injuries are common problems, but the person concerned may remain asymptomatic until there has already been significant muscle injury. The prevalence of partial or full-thickness tears rises dramatically after age 50 as rotator cuff lesions are a normal ageing correlation and often have no clinical signs. [32]. In addition, HILT is the other recently experienced physiotherapy agent in clinical use. The efficacy of HILT in Bell's palsy therapy was contrasted with that of LILT, and HILT was more effectively found. The efficacy was tested compared to ultrasound in two separate studies of back pain; one study showed successful therapy of pain and disability; however, no difference was found in the other study [33,34,35]. Furthermore,Kheshie AR et al 2014 stated in their study that, HILT was found to be more effective than LILT in the treatment of knee osteoarthritis [36].

Our results come in agreement with recent study done by Shin-Tsu Chang, et al 2020 who stated that 20 patients had one HILT session with Subacromial Impingement Syndrome (SAIS). Before and immediately after the intervention were measured Visual Scale (VAS), shoulder Range of Motion (ROM) and Constant-Murley Scale (CMS). All the results indicators were significantly improved by the HILT group [37].

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 3, 2021, Pages. 342 - 354
Received 16 February 2021; Accepted 08 March 2021.

U.S. in addition to other PT agents was successful. [38,39,40,41].Perez Merino et al. stated that in addition to Exercise and Cryotherapy, comparing three classes in which US, Phonophoresis and Iontophoresis were applied in patients diagnosed with subacromial impingement and found that US was more successful.[41]Yavuz et al., In a study with identical findings, the patients with subacromial impingement compared two groups of US and LLLT plus exercise and HP. Although US was found to be more effective, LLLT could also be used when US was contraindicated.[38]Our research showed that US phonophoresis is successful and continues to have this positive impact at the end of the study if it is applied in addition to Exercise treatment in SAIS.

The findings of this study were close to those of a study conducted by Yavuz F et al. and Perez Merino et al. who found that US care for patients with chronic shoulder pain is effective adjuvant treatment [38,41].The explanations for the best results relative to studies by Giombini et al, Ainsworth et al and Kurtais et al. may be the variations we had in the additional phonophoresis and exercises [42,43,44].

Therefore, we conclude that HILT in our study is better spreading into a wider region and deeper tissues. We also assume that the swift effect would more efficiently minimize inflammation and pain than the US phonophoresis and thus allow for a greater improvement in patients.

Limitations

In our opinion, there was a lack of placebo control and long-term follow-up findings restricted by this study.

Conclusions

The short-term effect of HILT was shown to be superior in reducing pain and enhancing mobility for stage 1 and 2 SAIS patients than in US phonophoresis, however, if therapeutic efficacy were tested and favorable results obtained, clinicians would perhaps be more likely to use HILT in further studies.

References

[1] De Witte, P.B., Nagels, J., Van Arkel, E.R., Visser, C.P., Nelissen, R.G., &De Groot, J.H. (2011). Study protocol subacromial impingement syndrome: the identification of pathophysiologic mechanisms (SISTIM). *BMC musculoskeletal disorders*, *12*, 282.

[2] Laws, M., &Forriol, F. (2012). Rotator cuff tear: etiology, examination, and treatment. *Trauma Fund MAPFRE*, *23*(1), 39-56.

[3] Santamato, A., Solfrizzi, V., &Panza, F. (2009). Randomized clinical trial people with subacromial impingement syndrome: a versus ultrasound therapy in the treatment of short-term effects of high-intensity laser therapy. *Physical Therapy, 89*, 643-652.

[4] Husni, E.M., & Donohue, J.P. (2005). Painful shoulder and reflex sympathetic dystrophy syndrome. *Kopman WJ, Moreland LW (Eds). Arthritis and Allied Conditions. 15th ed.*

Philadelphia: LWW, 2133-2151.

[5] McClure, P.W., Bialker, J., Neff, N., Williams, G., &Karduna, A. (2004). Shoulder function and 3-dimensional kinematics in people with shoulder impingement syndrome before and after a 6-week exercise program. *Physical therapy*, *84*(9), 832-848.

[6] Dorrestijn, O., Stevens, M., Winters, J.C., Van Der Meer, K., &Diercks, R.L. (2009). Conservative or surgical treatment for subacromial impingement syndrome? A systematic review. *Journal of shoulder and elbow surgery*, *18*(4), 652-660.

[7] Basford, J.R. (1995). Low intensity laser therapy: still not an established clinical tool. *Lasers in surgery and medicine*, *16*(4), 331-342.

[8] Zati, A., &Valente, A. (2006). Laser terrapin inmedicine, terraria elision remove endodermic in medicine riabiltaintre. *EdizioniMinervamesica*, 162-185.

[9] Klaiman, M.D., Shrader, J.A., Danoff, J.V., Hicks, J.E., Pesce, W.J., &Ferland, J. (1998). Phonophoresis versus ultrasound in the treatment of common musculoskeletal conditions. *Medicine and science in sports and exercise*, *30*(9), 1349-1355.

[10] Penderghest, C.E., Kimura, I.F., & Gulick, D.T. (1998). Double-blind clinical efficacy study of pulsed phonophoresis on perceived pain associated with symptomatic tendinitis. *Journal of Sport Rehabilitation*, *7*(1), 9-19.

[11] Yildirim, M.A., Ones, K., &Celik, E.C. (2013). Comparision of ultrasound therapy of various durations in the treatment of subacromial impingement syndrome. *Journal of physical therapy science*, *25*(9), 1151-1154.

[12] Dohnert, M.B., Venâncio, M., Possato, J.C., Zeferino, R.C., Dohnert, L.H., Zugno, A.I., & Luciano, T.F. (2012). Gold nanoparticles and diclofenac diethylammonium administered by iontophoresis reduce inflammatory cytokines expression in Achilles tendinitis. *International journal of nanomedicine*, *7*, 1651–1657.

[13] Neer, C.S. (1983). 2nd Impingement lesions. *Clinical Orthopaedics and Related Research*, 173, 70–77.

[14] García, I., Lobo, C., López, E., Serván, J.L., &Tenías, J.M. (2016). Comparative effectiveness of ultrasonophoresis and iontophoresis in impingement syndrome: a double-blind, randomized, placebo controlled trial. *Clinical rehabilitation*, *30*(4), 347-358.

[15] Sae, H.K., Yeon, H.K., Hwa, R.L., &Young, E.C. (2015). Shor-term effects of high-intensity laser therapy on frozen shoulder: A prospective randomized control study. *Manual therapy*, *20*(6), 751-757.

[16] Parisa, N., Armita, G., Farrokh, N., Safoora, G., & Ali, M. (2017). Treatment of Subacromial Impingement Syndrome: Platelet-Rich Plasma or Exercise Therapy? A Randomized Controlled Trial. *The Orthopedic Journal of Sports Medicine*, 2017.

[17] Price, D.D., Bush, F.M., Long, S., & Harkins, S.W. (1994). A comparison of pain measurement characteristics of mechanical visual analogue and simple numerical rating scales. *Pain*, *56*(2), 217-226.

[18] Norkin, C.C., & White, D.J. (2003). Measurement of joint motion. *A guide to goniometry*, *2*, 181-198.

[19] Goodwin, J., Clark, C., Deakes, J., Burdon, D., & Lawrence, C. (1992). Clinical methods of goniometry: a comparative study. *Disability and rehabilitation*, *14*(1), 10-15.

[20] Norkin, C., & White, D.J. (1985). Joint Measurement. *A Guide to Goniometry. Philadelphia: FA Davis*, 56-93.

[21] Farin, P.U., Jaroma, H., Harju, A., &Soimakallio, S. (1990). Shoulder impingement syndrome: sonographic evaluation. *Radiology*, *176*(3), 845-849.

[22] Kim, K., Kim, H.G., Song, D., Yoon, J.Y., & Chung, M.E. (2016). Ultrasound dimensions of the rotator cuff and other associated structures in Korean healthy adults. *Journal of Korean Medical Science*, *31*(9), 1472-1478.

[23] Calis, H.T., Berberoglu, N., &Calis, M. (2011). Are ultrasound, laser and exercise superior to each other in the treatment of subacromial impingement syndrome? A randomized clinical trial. *European Journal of Physical and Rehabilitation Medicine*, *47*(3), 375-380.

[24] Karaca, B. (2016). Effectiveness of high-intensity laser therapy in subacromial impingement syndrome. *Photomedicine and laser surgery*, *34*(6), 223-228.

[25] Pekyavas, N.O., &Baltaci, G. (2016). Short-term effects of high-intensity laser therapy, manual therapy, and Kinesio taping in patients with subacromial impingement syndrome. *Lasers in medical science*, *31*(6), 1133-1141.

[26] Santamato, A., Solfrizzi, V., Panza, F., Tondi, G., Frisardi, V., Leggin, B.G., ... & Fiore, P. (2009). Short-term effects of high-intensity laser therapy versus ultrasound therapy in the treatment of people with subacromial impingement syndrome: a randomized clinical trial. *Physical Therapy*, *89*(7), 643-652.

[27] Aceituno-Gómez, J., Avendaño-Coy, J., Gómez-Soriano, J., García-Madero, V.M., Ávila-Martín, G., Serrano-Muñoz, D., &Criado-Álvarez, J.J. (2019). Efficacy of high-intensity laser therapy in subacromial impingement syndrome: a three-month follow-up controlled clinical trial. *Clinical rehabilitation*, *33*(5), 894-903.

[28] Ebid, A.A., & El-Sodany, A.M. (2015). Long-term effect of pulsed high-intensity laser therapy in the treatment of post-mastectomy pain syndrome: a double blind, placebo-control, randomized study. *Lasers in medical science*, *30*(6), 1747-1755.

[29] Kujawa, J., Zavodnik, L., Zavodnik, I., Buko, V., Lapshyna, A., &Bryszewska, M. (2004). Effect of low-intensity (3.75-25 J/cm2) near-infrared (810 nm) laser radiation on red blood cell ATPase activities and membrane structure. *Journal of clinical laser medicine & surgery*, *22*(2), 111-117.

[30] Tsuchiya, K., Kawatani, M., Takeshige, C., & Matsumoto, I. (1994). Laser irradiation abates neuronal responses to nociceptive stimulation of rat-paw skin. *Brain research bulletin*, *34*(4), 369-374.

[31] Nicolau, R.A., Martinez, M.S., Rigau, J., & Tomas, J. (2004). Neurotransmitter release changes induced by low power 830 nm diode laser irradiation on the neuromuscular junctions of the mouse. *Lasers in surgery and medicine*, *35*(3), 236-241.

[32] Milgrom, C., Schaffler, M., Gilbert, S., & van Holsbeeck, M. (1995). Rotator-cuff changes in asymptomatic adults. The effect of age, hand dominance and gender. *The*

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 3, 2021, Pages. 342 - 354
Received 16 February 2021; Accepted 08 March 2021.

Journal of bone and joint surgery. British volume, *77*(2), 296-298.

[33] Alayat, M.S.M., Elsodany, A.M., & El Fiky, A.A.R. (2014). Efficacy of high and low level laser therapy in the treatment of Bell's palsy: a randomized double blind placebo-controlled trial. *Lasers in medical science*, *29*(1), 335-342.

[34] Fiore, P., Panza, F., Cassatella, G., Russo, A., Frisardi, V., Solfrizzi, V., &Santamato, A. (2011). Short-term effects of high-intensity laser therapy versus ultrasound therapy in the treatment of low back pain: a randomized controlled trial. *European Journal of Physical and Rehabilitation Medicine*, *47*(3), 367-373.

[35] Boyraz, I., Yildiz, A., Koc, B., &Sarman, H. (2015). Comparison of high-intensity laser therapy and ultrasound treatment in the patients with lumbar discopathy. *BioMed research international*, *2015*.

[36] Kheshie, A.R., Alayat, M.S.M., & Ali, M.M.E. (2014). High-intensity versus low-level laser therapy in the treatment of patients with knee osteoarthritis: a randomized controlled trial. *Lasers in medical science*, *29*(4), 1371-1376.

[37] Chen, Y.W., Cheng, Y.Y., Lee, Y., & Chang, S.T. (2020). The immediate effect of high-intensity laser therapy on pain relief and shoulder function in patients with subacromial impingement syndrome. *World Journal of Physical and Rehabilitation Medicine*, *4*(1), 1016.

[38] Yavuz, F., Duman, I., Taskaynatan, M.A., & Tan, A.K. (2014). Low-level laser therapy versus ultrasound therapy in the treatment of subacromial impingement syndrome: a randomized clinical trial. *Journal of back and musculoskeletal rehabilitation*, *27*(3), 315-320.

[39] Bingöl, Ü., Altan, L., &Yurtkuran, M. (2005). Low-power laser treatment for shoulder pain. *Photomedicine and Laser Therapy*, *23*(5), 459-464.

[40] Mao, C.Y., Jaw, W.C., & Cheng, H.C. (1997). Frozen shoulder: correlation between the response to physical therapy and follow-up shoulder arthrography. *Archives of physical medicine and rehabilitation*, *78*(8), 857-859.

[41] Pérez-Merino, L., Casajuana, M.C., Bernal, G., Faba, J., Astilleros, A.E., González, R., &Nogués, M.R. (2016). Evaluation of the effectiveness of three physiotherapeutic treatments for subacromial impingement syndrome: a randomised clinical trial. *Physiotherapy*, *102*(1), 57-63.

[42] Gursel, Y.K., Ulus, Y., Bilgic, A., Dincer, G., &Van Der Heijden, G.J. (2004). Adding ultrasound in the management of soft tissue disorders of the shoulder: a randomized placebo-controlled trial. *Physical therapy*, *84*(4), 336-343.

[43] Giombini, A., Di Cesare, A., Safran, M.R., Ciatti, R., &Maffulli, N. (2006). Short-term effectiveness of hyperthermia for supraspinatus tendinopathy in athletes: a short-term randomized controlled study. *The American Journal of Sports Medicine*, *34*(8), 1247-1253.

[44] Ainsworth, R., Dziedzic, K., Hiller, L., Daniels, J., Bruton, A., &Broadfield, J. (2007). A prospective double blind placebo-controlled randomized trial of ultrasound in the physiotherapy treatment of shoulder pain. *Rheumatology*, *46*(5), 815-820.