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Original Research Article

COMPARISON OF LASER AND ULTRASOUND THERAPY FOR THE MANAGEMENT OF SHOULDER ROTATOR CUFF MUSCLES INJURY

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ABSTRACT

Background: Rotator cuff injury is a common problem for Indian population and the management plays a crucial role in healing and preventing the aggravation of the problem.

Purpose of Study: To compare Ultrasound Therapy and LASER for the management of shoulder rotator cuff muscles injury.

Methodology: 20 male patients (10 in each group) were randomly recruited for the study. Group A were given Ultrasound therapy whereas group B were given LASER therapy for 5 days in a weak for four weeks. The data were taken on baseline, on 21 days and 30 days.

Result: The result shows that the SPADI pain and disability index score, VAS score and ROM of shoulder are improved significantly higher in LASER group compared to as ultrasound therapy group.

Conclusion: Thus the study concludes that ultrasound therapy as well as LASER therapy is helpful modalities for management of rotator cuff injuries but LASER causes higher improvement. Therefore LASER is much better than the Ultrasound therapy for the management of grade 1 and 2 rotator cuff injury.

KEY WORDS: Ultrasound, rotator cuff injury, Shoulder joint, SPADI, LASER.

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INTRODUCTION

Rotator cuff injuries are common problems even though the affected individual may remain grossly asymptomatic until large injury to muscles have already occurred. The incidence of partial- or full-thickness tears increases markedly after 50 years of age as rotator-cuff lesions are a natural correlate of ageing, and are often present with no clinical symptoms [1]. Unlike most soft tissues that require 7-10 days to heal, the primary healing of tendons is believed to take at least six weeks to get healed. In case of incomplete management of the tendon injuries the defect may progress predisposing the need of surgery. Consequently the cost of treatment increases simultaneously and functional gains are reduced. Pain is the most common symptom of patients with rotator cuff injury. Patients with well-preserved function of the supraspinatus and infraspinatus are the best candidates for conservative treatment. Patients with less functional rotator cuff muscles are prone to get

increase in muscle tears and may necessitate the need of a surgical treatment [2]. Rotator cuff injury may arise pain and spasm which limit the range of motion of the shoulder the muscles do not makes the small adjustment within the joint to allow the humeral head to move smoothly.

Alone exercises may not be able to resolve the inflammation and associated damage to the muscle and tendons. Hence some modalities may be applied to enhance the healing process of the soft tissues injury. For promotin the healing of soft tissue injury, the most commonly used physiotherapy modalities are ultrasound therapy and LASER (light amplification by stimulated emission of radiations) therapy. The aim of this current study was to compare the efficacy of the ultrasound therapy and the LASER therapy for managing the shoulder roator cuff muscle injury.

METHODOLOGY

Study Design: 20 male patients with 10 in each group A and group B, with diagnosis of shoulder rotator cuff injury were recruited for the study from the out-patient (OPD) department of the Goodwill hospital & Research Centre Noida U.P., India. Before participation the prospective individuals were explained about the objective of the study along with the duration and nature of the study. They were also explained that upon participation in the study they can be allotted to any of the treatment group as per their random allocation.

Inclusion and Exclusion Criteria for the study: Subjects diagnosed with unilateral rotator cuff injury (stage 1 and 2); resisted isometric contraction of the muscle painful suggestive of its inflammation/tendinitis; age group of between 20 -55 years (this excludes mostly age related degenerated tears; and adolescence related bone/muscles disorders; pain associated with shoulder movements for at least 3 Week to 1 months; limitations in the shoulder range of motion in direction of abduction and flexion. All subjects must have diagnosis of rotator cuff injury established using clinical and radiological examination by experts.

Patients with type-I diabetes mellitus; past history of surgery on the affected extremity or neck; history of neck/head injury; neurological symptoms such as paraesthesia or loss of sensation; radiological evidence of tendon calcification in the rotator cuff muscle(s); evidence of complete muscle tear; rotator cuff injury secondary to hyperthyroidism; history of cardio-vascular accident, brachial plexus injury, neurological illness, parkinsonism.

Procedure: The design of the study is randomized – controlled trial, subjects were randomly allocated equally in to any one of the two intervention groups by lottery method. For this, 20 folded papers chits of same shape, colour and size were marked either with symbol “A” for the Ultrasound group or symbol “B” for LASER Group were kept in a box and mixed thoroughly before and after withdrawing a paper chit from the box. Each participant of the study was asked to withdraw any one slip of own choice from the box. After the slip was withdrawn, the symbol marked on this slip indicated which treatment group he/she has to be allotted.

After receiving the written consent form from the participants, the demographic variables including age, weight, gender, sex and height of the two groups were recorded at baseline. Baseline scores of the dependent variables of the study were recorded including pain score; SPADI (Shoulder pain and disability index) disability index score; SPADI pain index score; shoulder ROM (range of motion) for flexion and abduction.

All variables were recorded done by same blinded tester at baseline (0 day), after 21 days, and after 30 days of interventions. All interventions were done by same physiotherapist supervising the test and intervention procedures. Test and retest of the two groups was conducted in the same place and environment and at same time of the day. After group allocations, respective subjects for either group were given interventions as per the protocol of their concerned group. Treatment interventions were done by same physiotherapist for the 5 days in week for 4weeks (hence total 20 sessions). The duration of each individual treatment session was about 45 to 50 minutes per session. Subjects we required not to take any other treatment or change their exercise schedule. They were requested to report any discomfort or issues if experienced by them during the study tenure.

Variables: Dependent Variables of the study were perceived level of pain intensity, range of motion (flexion, abduction), SPADI pain score, SPADI disability scores. The independent variables of the study included ultrasound treatment and LASER treatment.

Pain: Pain score was scored as the participants were asked to mark the currently experienced level of pain on a 10 cm horizontal linecalled as VAS (Visual analogue scale). Two extremes of this line were labeled as "0" indicating no pain at all; and the "10" indicating maximum intensity of pain as subjectively perceivable by the specific participant. The distance of the point marked by the participant from the "0" point indicates the level of pain as perceived.

SPADI: Participants were also requested to complete the shoulder pain and disability index (SPADI) Questionnaire.Shoulder Pain and Disability Index (SPADI) is a tool to measure the self-reportedcurrent level of shoulder pain and disability in an outpatient setting for the patients suffering from shoulder problems. The SPADI contains 13 items that assess two domains; a 5-item subscale that measures pain and an 8-item subscale that measures disability [3]. In both domains of SPADI the each item is scored on a visual analogue scale (VAS). The scale is a valid tool to document the pain and disability for the shoulder pathologies including rotator cuff disease [4] and adhesive capsulitis [5].

The patient was instructed to mark a point on the line (similar to VAS) for each item that best represented their experience of their shoulder problem over the last week. Each subscale score is summed and transformed to a score out of 100. A mean is taken of the two subscales to give a total sc ore out of 100, higher score indicating greater impairment or disability. With a reliability coefficients of ICC (intra-class correlation coefficient) $\geq$ 0.89 the SPADI has good internal consistency is high with Cronbach á typically exceeding 0.90 [6], and a good construct validity, correlating well with other region-specific shoulder questionnaires [5]. SPADI effectively reflects the change in responses over time and effectively is able to discriminate adequately between patients with improving and deteriorating conditions [7]. For the current study the SPADI pain and the SPADI disability scored were interpreted separately.

Shoulder ROM: Range of motion for the shoulder joint was measured using full circle goniometer adopting the standard methodology as described in many previous published literatures.

LASER treatment group: Following are the parameters of the LASER therapy used in the LASER intervention group: Infra-red diode LASER; wavelength 905nm; maximum power 25 watt; peak power value 25 watt; pulse frequency 5000Hz; total energy density 1.5Joule/cm2; scanning method; treatment duration 10 minutes per session.

Patient was positioned in the supine lying posture on high couch; with body parts well supported in the position of maximum comfort. The affected shoulder was exposed and marks were made on skin on the anterior aspect of the greater tubercle of humerus bone shoulder at the maximum tender point. Therapist stood on the affected side of affected shoulder. The remaining part of the patient's body was covered except the part to be treated.

For the LASER treatment both therapist as well as patient wore the protective goggles. Therapist manually scanned the treatment probe over the targeted area in rhythmic manner to cause uniform exposure of the LASER beam to the target area of shoulder.

ULTRASOUND treatment group: For ultrasound treatment the coupling medium was applied over the target marked area and then ultrasound transducer head was moved in uniform circular motion to cover the entire area and to make the uniform exposure over the region. The purpose of the coupling medium is to exclude air from the region between the patient and the transducer so that ultrasound can get to the area to be treated.

Group A patients administrated with ultrasound with Frequency 1 MHz .+/-5%; duty cycle 10%,20%,50% continuous; ultrasound head size 5cm; peak power 20 Watts at 1MHz; intensity amplitude used 0 to2.5W/cm2 in continuous mode; treatment time 8 Minutes per session for 5 day week for 4 weeks.

In both groups the therapist brought the patie nt's shoulder into flexion passively (sometime

therapist can add a little adduction by asking the patient to fully relax the shoulder, this increases the tension in the capsule). At the end of range therapist asked the patient to try and bring the arm back to neutral (in the direction of extension) and by resisting further movement by therapist for about 5-10sec. The therapist increased the stretch gently and repeated 2-3 times applying this muscle energy technique to any of the direction in which the patient restricted.

Data analysis: The design of this study is randomized – controlled trial with the post-intervention follow up to three months. The subjects of this study were equally and randomly allocated in to either of the two groups namely "ultrasound treatment group" or the "LASER treatment group" using paper chit method. Each of the both groups consisted of 10 patients each participants. The demographic characteristics Age, Weight, sex, Height and duration of symptoms of the both groups were assessed at baseline for comparing the baseline homogeneity comparison using unrelated t-test. Outcome variables of the study such as VAS (pain), SPADI disability index, SPADI pain score, goniometry ROM of shoulder joint for shoulderflexion, abduction were collected by same physiotherapist for the test procedure at base line as well as at end of third week as well as after 30 days.

A priori alpha level of significance was chosen as 0.05 was used for all analyses. Data obtained was summarized using descriptive statistics of mean and standard deviation. All statistical analysis was performed using SPSS 16.0.

Scores of the dependent variables VAS (pain), SPADI disability index, ROM of shoulder joint for flexion and abduction were compared for the three instances in each group at baseline, 21 days and 30 days using repeated measures ANOVA and the comparisons were evaluated using Tukey's post-hoc analysis. These comparisons were performed to evaluate the differences in the performance of the variables for between-group as well as with-in group comparisons.

RESULTS

Table 1 depicting the Independent t-test for between group comparison of the baseline data shows that there was no significant difference between the baseline scores of the Age (p = 0.142); weight (p = 0.289); height (p = 0.534) and symptoms duration (p=1.000). It shows that both the groups were homogenous at baseline and there was very little possibility that the any improvement/deterioration in the scores with time could be due to group characteristics.

Table 1: Baseline comparison of the demographic variables of participants.

Demographic variables	Ultrasound therapy group (n=10)	LASER therapy group (n=10)	Mean difference	Level of significance (P value)
Age (years)	35.0 ± 4.1	32.1 ± 4.3	2.9	0.142
Weight (kg)	65.7 ± 3.6	63.6 ± 4.9	2.1	0.289
Height (cm)	166.3 ± 3.3	167.1 ± 2.3	0.8	0.534
Duration of symptoms (weeks)	3.5 ± 0.6	3.6 ± 0.5	0.01	1

Table 2: ANOVA comparison among the variable scores with time show that, the performance of the ultrasound therapy group and LASER therapy group shows that for all variables the scores improved significantly with time.

Table 2: ANOVA comparison among the variable scores with time.

		0 day	21 day	30 day	Level of difference P value
Pain severity (VAS)	Ultrasound group	7.60 ± 0.84	6.93 ± 0.48	6.06 ± 0.99	0.001*
	LASER group	7.50 ± 0.53	5.20 ± 0.63	3.20 ± 0.63	0.000*
ROM shoulder flexion	Ultrasound group	53.60 ± 8.54	60.70 ± 5.76	66.90 ± 5.69	0.001*
	LASER group	51.30 ± 6.55	69.40 ± 5.89	90.40 ± 5.89	0.000*
ROM shoulder abduction	Ultrasound group	54.10 ±7.03	57.40 ± 4.50	61.50 ± 4.90	0.02*
	LASER group	53.50 ± 6.26	70.20 ± 4.59	93.80 ± 3.70	0.000*
SPADI pain	Ultrasound group	36.80 ± 2.04	33.20 ± 4.69	22.90 ± 4.46	0.00*
	LASER group	33.10 ± 3.66	30.10 ± 4.75	22.60 ± 7.02	0.00*
SPADI disability score	Ultrasound group	56.70 ± 3.37	49.90 ± 5.82	46.80 ± 9.87	0.01*
	LASER group	52.00 ± 5.678	36.10 ± 3.18	20.50 ± 2.88	0.000*

Table 3 shows that the variable scores of the LASER group improved significantly higher while compared to the Ultrasound therapy group. While making the week wise comparison it was found that in "0 versus 21 days" comparison none of the variable significantly improved in the ultrasound therapy group while all variables improved significantly in the LASER therapy group.

For "21 day versus 30th day comparison" there was no significant improvement in the Rom shoulder flexion; ROM abduction and the SPADI disability score.All remaining variables improved significantly in the ultrasound therapy group; and

all the variables improved significantly in the LASER therapy group.

While exploring "0 day versus 30th day" comparison, it was found that all variables improved significantly in the ultrasound therapy as well as LASER therapy group. However the improvement in the LASER therapy group was much higher than that in the ultrasound therapy group. The improvement in the laser therapy (as compared to the improvement in ultrasound therapy group) group was 2.79 times higher for the pain severity; 2.94 times higher for ROM shoulder flexion; 5.45 times higher for ROM shoulder abduction; 0.76 times higher for SPADI pain score; and 3.18 times higher SPADI disability scores.

Table 3: Shows that the variable scores of the LASER group compared to the Ultrasound therapy group.

		Ultrasound therapy group mean difference	P value	LASER therapy group mean difference	P value
Pain severity (VAS)	0 versus 21 days	0.67	0.169	2.3	0.000**
	21 -30 day	0.87	0.057	2	0.000**
	0 versus 30 days	1.54	0.001	4.3	0.000**
ROM shoulder flexion	0 versus 21 days	7.1	0.067	18.1	0.000**
	21 -30 day	6.2	0.122	21	0.000**
	0 versus 30 days	13.3	0	39.1	0.000**
ROM shoulder abduction	0 versus 21 days	3.3	0.397	16.7	0.000**
	21 -30 day	4.1	0.247	23.6	0.000**
	0 versus 30 days	7.4	0.017	40.3	0.000**
SPADI pain score	0 versus 21 days	3.6	0.118	3	0.431
	21 -30 day	10.3	0	7.5	0.011*
	0 versus 30 days	13.9	0	10.5	0.000**
SPADI disability score	0 versus 21 days	6.8	0.088	15.9	0.000**
	21 -30 day	3.1	0.58	15.6	0.000**
	0 versus 30 days	9.9	0.009	31.5	0.000**

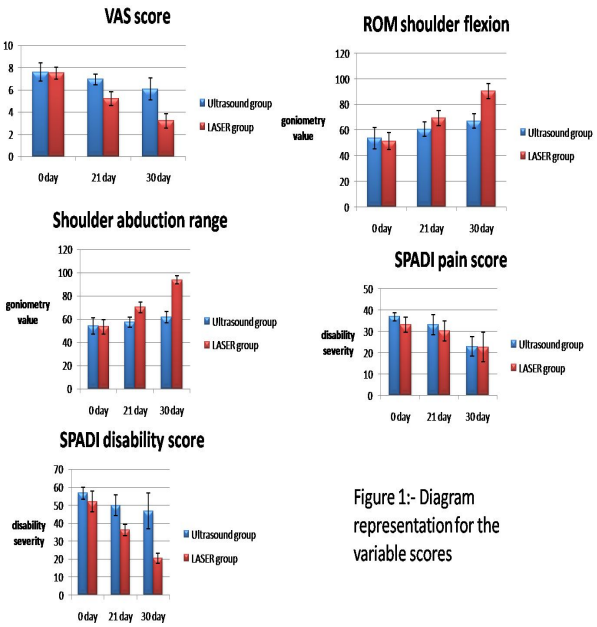

Figure 1:- Diagram representation for the variable scores

DISCUSSION

Aim of the preset study was to compare the effectiveness of ultrasound therapy and the LASER therapy for the management of grade 1 & grade 2 rotator cuff injuries.

The comparison of the pre-intervention scores (day 0) with that at the end of 4 weeks treatment (measured on 30 days) in using paired t-test in each group revealed that there was statistically significant improvement in both the groups for the shoulder ROM and the SPADI disability scores. The pain score on VAS scale and the SPADI pain scale improved significantly only in the LASER treatment group while these had no significant improvement in the Ultrasound therapy group. It shows that both the treatments brought significant improvements in the ranges and the associated disability scores. Furthermore only the LASER treatment was effective in reducing the pain scores.

Furthermore the mean difference comparison shows that the mean improvement the ROM of shoulder movements for the flexion, abduction and external rotation was higher in the patients treated with the LASER treatment. The mean improvement in the shoulder ROM was lesser in the group treated with the ultrasound therapy.

These finding are similar to the study done by Santamato et al (2009)[8] who observed a significantly greater reduction pain in the LASER treated group compared to the Ultrasound treated group having patients suffering from Sub-acromial impingement syndrome after the treatment for 10 treatment sessions over period of two consecutive weeks.

In another study [9]among 30 patients with shoulder tendonitis, the low power infrared LASER therapy of 904nm was found to be effective in getting a statistically significant improvement various parameters such as maximum active extension, flexion, abduction of shoulder; subjective pain; subjective stiffness with movement; and the functions. The improvement was seen in 6 sessions over a period of 2 weeks. In same study the other two groups were given dummy LASER therapy and the analgesic medicine (naproxen sodium). There was no improvement in the dummy LASER group while in the analgesic medicine group only movement and functions

had shown improvement. This study supported the effectiveness of LASER therapy over dummy LASER and analgesic medicine in tendonitis of shoulder

The exact mechanism, by which LASER helps to repair the soft tissue injury, is still under exploration in researches worldwide. Large numbers of researchers have presented the possible mechanisms for the therapeutic effects of LASER therapy.

Fillipin et al, (2005) [10] during their study on the traumatized tendo-achilis tendon of the Male Wistar rats using low level gallium-arsenide laser of 904nm wavelength, 45mW average power, 5J/cm2 dosage for 35 seconds found that the administration of low level laser therapy (LLLT) for 14 or 21 days markedly reduces the histological abnormalities; reduces collagen concentration and prevented oxidative stress, reduction of the abnormal collagen fibrosis helps to balance the oxidant-antioxidant balance.

Demir et al (2004) [11] studied the individual as well as combined effects of laser therapy and ultrasound therapy found that although US, L, and combined US + L treatments increases tendon healing biochemically and biomechanically more than the control groups yet no statistically significant difference was found between them. Ultrasound therapy as well as laser therapy had significant improvement in the tendon healing [12]. Combining both treatments together does not causes any additional more cumulative positive effects.

Gum et al (1997) [13] also reported that the beneficial effects of ultrasound and laser photo stimulation on tendon healing may counteract one another when applied simultaneously.

Renno et al (2011) [14] using histo-pathological analysis and immune-histochemistry for cyclo-oxygenase-2 (COX-2) found that both LLLT and US therapies have positive effects on muscle metabolism after minor injury in rats, but LLLT seems to produce a better response.

Ultrasound therapy in this current study found the significant improvement in the ROM of shoulder and significant reduction in the SPADI disability score. However in this group the pain reduction and the SPADI pain score reduction was not statistically significant.

In therapeutic applications of US, non-ionizing radiation is delivered to the desired tissues in the mechanical waves form. This delivering caused to creation heats the tissue. Different researches indicated beneficial effects of low frequency US on wound healing which are dependent on the exposure levels. In this frequency, high intensities lead to cell death, whereas at low intensities useful effects are emerged. Laakso et al (2002) [15] revealed that the spatial average temporal average dosage with the range of 0.5 W/ cm2 to 3 W/cm2 caused to minimize side effects. Similarly, applying US with the dosage of 1 W/ cm2 to 1.5 W/cm2 had considerable therapeutic effects [16].

There is strong evidence that ultrasound has positive effects on tendon healing [11].

During 'Proliferative' stage of soft tissue healing, there occurs the migration of cells to the injury area, forming the granulation tissue and also formation of fibroblasts. In this regard, US can repair fibroblasts and epithelium, hence increases collagen synthesis [17].

Rotator cuff injuries are common problems even though the affected individual may remain grossly asymptomatic until large injury to muscles have already occurred. The incidence of partial- or full-thickness tears increases markedly after 50 years of age as rotator-cuff lesions are a natural correlate of ageing, and are often present with no clinical symptoms (Milgrom et al, 1995).

The therapeutic purpose of this is to heat the tendons, muscle and other tissue to improve blood flow and accelerate healing.

Limitations of the study: In this study only male participants were involved. The radiological and ultrasonography thickness measurement of the affected rotator cuff muscles was not used as a variable in this study.

CONCLUSION

Current study concludes that both ultrasound therapy as well as laser therapy is helpful modalities for improving the ranges of shoulder flexion, abduction and rotation; and for reducing the SPADI disability scores among the patients with grade 1&2 rotator cuff injuries. LASER causes higher improvement in these parameters while compared to ultrasound therapy.

Though both of these modalities can be used for the management of the rotator cuff injuries, yet LASER is much better than ultrasound therapy for the management of grade 1 & 2 rotator cuff injury.

ABBREVIATIONS

LASER- Light Amplification by Stimulated Emission of Radiations
LLLT- Low Level Laser Therapy
ROM- Range of Motion
SPADI- Shoulder Pain and Disability Index
UST- Ultrasound Therapy
VAS- Visual Analogue Scale

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Conflicts of interest: None

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