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Application of Exercise with Low Level Laser Therapy and Ultrasound Therapy brings better result among Rotator Cuff Injury Subjects

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ABSTRACT

Rotator cuff injury [1] is the 3rd most common pain in the back and knee pain. 1% of the population consult the physician for their shoulder pain, Rotator cuff injury is very common for overhead activity athletes. Rotator cuff injury brings compromise the shoulder movement and decrease in the shoulder movement. Neer [2] describe the rotator cuff injury is due to impingement and the subjects with above the age of 40 years are affected most. Xiaobin chen [3] said that due to bone mineral density decrease as the age advances and the chance of the ligament and tendon tear increase in the rotator cuff. **Methodology** 15 subjects in each group, Total 30 number of subjects were included in the study. Ultrasound therapy group A and laser therapy group B. Subjects were treated for 4 weeks with ultrasound and laser therapy 5 days week and data were taken on the 0 days 30 day and 90 days. **The result** shows greater improvement in laser therapy group with exercise than the Ultrasound therapy group. **Conclusion** laser therapy shows much better improvement than the ultrasound group for the management of the Rotator cuff injury grade 1 and 2.

Keyword; Rotator Cuff Injury, ROM, Goniometer, VAS, SPADI pain, Disability.

1. INTRODUCTION

Shoulder pain is the 3rd most common pain after back and knee in human body. About 1% [1] of population report to physician and 99% doesn't visit to physician for pain in shoulder. Initially it's very difficult to differentiate is that injury is of Rotator cuff or some things else? Injury to the shoulder causes pain, tenderness, decrease in functional activity of the shoulder movements, Rotator cuff injury also brings handicappers in the upper extremity movements patients unable to do day to day activity just like wearing of shirts and nodding of the buttons of the shirts, tying of tie node it's all due to pain and weakness of the shoulder joint muscles, tendon and ligaments of the Rotator cuff. According to C.S. Neer the Rotator cuff injury is three type or its due internal changes in the bone of the Humorous head bone of the shoulder joint which impinges the rotator cuff muscle which causes pain. C.S Neer [2] 1983 has categorized the Rotator cuff in three stages, the types of tear, edema and hemorrhage as grade 1 may be due to overuse and overhead activity in sports. This is observed in younger age group of below 25 years. Grade 2 Stages found in age above 25 years to 40 years due to overhead activity, due to repeated overhead activity and there is mechanical inflammation the bursa becomes thickened and fibrotic, this occurs in throwing and found in above 40 years of age.

A new study by Xiaobin Chen [3] 2015 Bone mineral density (BMD) decrease as ages advance and the chance of tear increase in ligament and tendon of Rotator cuff. Failure of Rotator cuff injury is more commonly due to wear and tear of the cuff is more clinical problem of the shoulder joint. According to Frederick A Matsen [4] 2008 around 4.5 million people visits every year to physician in U.S regarding pain in shoulder joint. Rotator cuff injury is due to age related advancement [5]. Rotator cuff injury is very common in overhead activity sports activity in which there is repeated activity of shoulder movement that leads to micro trauma which converts to injury to Rotator cuff muscles, tendon and ligaments [6] 1997. Female are more prone to get rotator cuff tear than male a research report by Francesco Oliva in case of thyroid hormone imbalance and non-traumatic rotator cuff tear [7] 2014 .

2. METHODOLOGY

30 male subjects are taken for the study, with 15 subjects in each group, Group A is ultrasound group and group B is laser group were recruited and diagnosed by the Orthopedic surgeon, The study is taken place at the Goodwill hospital and Research center, Noida, UP, India. The study was approved by the research committee of the Monad University, Hapur, UP, India for Ph.D. curriculum course. Before the participation of the study each subjects were explained about the prospective study of the disease and consent were taken before the participation and explained they can be allotted to any group by lottery method 30 chit is prepared with same size and same color of paper with mark A and B and mix thoroughly put in the box and participants were asked to withdraw the paper from the box, whatever written in the paper for the allotment, the subjects were then allotted to group. The subjects were treated according to the inclusion and exclusion criteria of the study.

2.1 Inclusion Criteria: subjects with rotator cuff injury grade 1 and 2 only, diagnosed by Orthopedics surgeon and recruited from OPD, pain and tenderness, limitation of movements, ROM is decreased in Abduction, Flexion Internal, and external rotation. Age group 20-55 years, only male subjects were taken for the study, 3 weeks to 4 weeks of injury to rotator cuff injury. All the subjects were diagnosed with rotator cuff injury using clinical as well as radiological examination by an expert.

2.2 Exclusion Criteria: subjects with Diabetics mellitus, Brachial plexus injury subjects with recent surgery to shoulder and neck, neurological symptom like paresthesia, cervical spondylitis, subjects with loss of sensation to shoulder and radiculopathy of upper arm, evidence of calcification of shoulder tendon and frozen shoulder, complete Rotator cuff tear, secondary to hypothyroid, history of cardio-vascular accident (CVA), neurological illness, Parkinson disease.

2.3 Procedure: This study is a randomized controlled study with a total number of 30 diagnosed subject of Rotator cuff injury with grade 1 and 2 were selected for the study. 15 subjects were selected in each group A and Group B. Group A is ultrasound therapy and Group B is Laser therapy group. The subjects were supplied a Horizontal marked line with 0 to 10 on paper for Visual Analog Scale test, 0 as a minimum scale for pain and 10 marks scale as for maximum pain, and another sheet of written Questioner document for SPADI Pain and SPADI Disability is given to the subjects for the analysis how they fell after the treatment session. The data were taken on the base line, 0 days, on the 30th day and on the 90th day i.e. follow up day. The goniometer is used to measure the Range of motion of the shoulder joint i.e. Abduction, Flexion, Internal Rotation and External Rotation on the 0 days, 30th day and 90th day respectively. The range of shoulder motion is measured by the full circle Goniometer scale adopting the standard method as described in the various study of shoulder movements in published articles. After receiving the written consent from the participant for the study, Demographic data is evaluated for Age, Gender, Weight, Height, BMI and onset of a symptom of the disease of the two group were recorded at the base day. All the dependable variable data of VAS, ROM Flexion Abduction, Internal and External Rotation, SPADI pain, SPADI disability were recorded on the base line day. All the variable is recorded by the same blind tester who perform the test and retest on the same place and on the same environment on the base line day 0 day, on the 30th day and on the follow up on the 90th day.

After group allocation, the treatment intervention is started according to the group allocation to the subjects. According to the protocol of the concern group. Treatment intervention was given by the same blind tester for 5 days a week for 4 weeks total 20 sessions in both the group.

Duration of a Treatment session is about 45-50 minutes per session. Subjects were advised not to take any other treatment during this period and don't change the exercise protocol which is advised to the subjects for the study. Subjects were asked to report if one felt discomfort during this period of the study.

2.4 Variable: Dependent variable was VAS, range of motion (Abduction, Flexion, Internal and External rotation) score, SPADI Pain and SPADI Disability score respectively.

2.5 Ultrasound Therapy Group A: For Ultrasound therapy coupling medium gel [8] is used for the smooth movement of the transducer head of the ultrasound over the shoulder joint in a circular manner. The gel is used to get to receive the maximum ultrasonic wave to the tissue of the injured muscles. The purpose of the gel is to exclude the air between the skin and the transducer head of the ultrasound. The ultrasound machine is with following parameters 1Mhz frequency, duty cycle ± 5 , 20% to 50% and 1Mhz in continuous mode with ultrasound head 5 cm for 8 minutes for 5 days a week for 4 weeks and total 20 session, followed by Hot moist pack for 20 minutes, and after hot moist pack exercised program. The exercise includes pendulum [9] exercise on 15 repetitions in a clock wise and 15 repetitions in an anticlockwise direction and after this 15 repetition of resistance exercise is given in Abduction and Flexion direction. Subjects were lying on the couch with thin pillow under the neck to get the subjects in full comfortable position and then the therapist will hold the hand of the subjects and the therapist will abduct the arm gently to maximum range of abduction and subjects were asked to apply resistance against force applied by the therapist in drawing the in Adduction position by the therapist, this exercise will increase the tone and power of the muscles of the shoulder joint ,and the same exercise protocol is followed in the flexion of the arm resistance exercise, This exercise will help in improving the strengthening of flexors muscles and translation of the movement will be easily done at the glen humeral joint. Both this resistance exercise improves the functional movements and dynamics of the shoulder joint.

2.6 Laser Therapy Group B: subjects and the Therapist will wear the goggles because the laser is hazardous to eye it causes cataract [11] if the laser beam rays enter the eye cornea so proper protection is required for both the subjects and the therapist before the start of the laser therapy. Dosimetry of the Laser is irradiated with infrared diode laser with 905 wave length, with power wattage of 25 watts, with 5000Hz pulse frequency, with 1.5 joule /cm² of total energy density for 10 minutes at 4 marked point on the shoulder joint anteriorly 2 point marks on the supraspinatus muscle, 2 point marked posteriorly on the shoulder joint for 5 days a week and for 4 weeks total 20 sessions followed by Hot moist pack for 20 minutes and same exercise protocol followed in the ultrasound group. The total duration of treatment is for 45-50 minutes, and home exercise program is prescribed for both the group after 20 sessions. The home exercise includes 15-20 repetition of wall crawling exercise in the abduction and flexion direction of the shoulder joint.15 repetition of theraband [10] resistance exercise by holding with both hand and subjects were asked to expand theraband in opposite direction of each other arm in supine as well as in standing position whichever is in comfortable for the subjects,15 repetition of dumbbell exercise with 2.5 pound weight initially and gradually can be increased as accordingly to the development of the subject of the endurance and strength of the muscles for another 12 weeks .all the exercise will be twice daily i.e. on the one session in the morning and another session of exercise in the evening hours and then data were taken on the follow up on the 90th day.

3. RESULT

Table 1. Base line comparisson of the demographic variables of the subjects who participated in the study Demographic value at the base line day. Demographic valuation of the age of ultrasound group A, The mean age of ultrasound group is 41.40 ± 8.61 , the mean age of laser group B is 39.66 ± 6.94 . The mean weight of ultrasound group A is 64.26 ± 2.76 , the mean weight of the laser group B is 62.60 ± 1.91 . The Mean height of the ultrasound group A is 165.40 ± 2.41 , The Mean height of the Laser group A is 165.06 ± 1.70 . The Mean BMI of U.S group is $23.48 \pm .82$ Stan. Deviation and the mean BMI of the LASER Group B are $22.98 \pm .60$. The mean onset of disease of ultrasound group is $3.26 \pm .45$ and the Mean onset of disease of LASER Group B is $3.40 \pm .50$.

Table 1; Demographic Variables of the Participants

Demographic Variables	Ultrasound Group A (N= 15)	LASER Group B (N= 15)	Mean Difference	Level of significance (P value)
AGE (years)	41.40± 8.61	39.66 ± 6.94	-1.734	.274
WEIGHT (kg)	64.26 ± 2.76	62..60 ± 1..91	-1.66	.653
HEIGHT(cm)	165.40 ± 2.41	165.06 ± 1.70	-0.34	.332
BMI	23.48 ± .825	22.98 ± .60	-0.5	.050
Onset of Symptom (week)	3.26 ± .45	3.40 ± .50	0.14	.228

The mean difference of the age is 1.734, Weight 1.66, Height 0.34, BMI 0.5 and on the set of symptom is 0.14 respectively.

Using t test for two independent mean value SPSS 16 .The significant level of age group is $P > .274$ which is not-significant, the p Value for weight is $P > .653$ which is Non-significant. The P value Height is $P > .332$ is non-significant. The P value for BMI is $P > .050$ is also not-significant, The P Value for onset of disease is $P > .228$ is also not-significant at base demographic data.

Table 2: Base line comparisons of the variables VAS, ROM Flexion, Abduction, Internal Rotation, External Rotation, SPADI Pain, and SPADI Disability subject participated at the base day 0 day

Variables	VAS U.S 0 DAY N=15	VAS LASER 0 DAY N=15	Mean Difference	Level of Significance P value
VAS 0 day	7.60±.50	7.40±.73	-0.2	0.176
ROM Flex 0 day	52.40± 7.82	56.20 ± 6.17	3.8	0.075
ROM Abd 0 day	51.66 ± 8.56	54.26 ± 5.00	2.6	0.159
ROM Int. Rot 0 DAY	28.40 ± 2.32	29.33 ± 2.12	0.93	0.130
ROM Ext. Rot 0 day	29.20 ± 2.26	30.06 ± 2.01	0.86	0.159
SPADI PAIN 0 day	37.20 ± 1.22	37.20 ± 1.74	0	0.169

The mean difference at the base line for the VAS is -0.2 , ROM Flexion is 3.8 ,ROM Abduction is 2.6,ROM Int.Rot is 0.93,ROM Ext.Rot is 0.86 , SPADI Pain is 0,and for the SPADI Disability is -1.74 respectively .The P value for the Vas at base day 0 day is $P > 0.176$, for ROM Flexion is $p > 0.075$, for ROM Abduction is $P > 0.159$, ROM Int.Rot is $P > 0.130$, ROM Ext.Rot $P > 0.159$, SPADI Pain P value at base day 0 day is $P > 0.169$ and for the SPADI Disability P value at base day 0 day is $P > 0.070$ respectively .All the variables p value is non-significant at the base line day.

SPADI Disability 0 day	59.00 $\pm$ 3.07	57.26 $\pm$ 3.19	-1.74	0.070
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TABLE 3: One way ANOVA Comparison within the Group among the Variables Score with Time

Variables		0 Day	30 Day	90 Day	Level of Difference P value
Pain severity (VAS)	Ultrasound group	7.6 $\pm$ 0.50	4.4 $\pm$ 0.73	2.4 $\pm$ 0.73	0.001*
	Laser group	7.4 $\pm$ 0.73	3.06 $\pm$ 0.70	0.53 $\pm$ 0.51	0.001*
ROM Shoulder Flexion	Ultrasound group	52.4 $\pm$ 7.82	83.8 $\pm$ 6.04	124.66 $\pm$ 4.38	0.001*
	Laser group	56.2 $\pm$ 6.17	93.26 $\pm$ 3.30	131.66 $\pm$ 3.24	0.001*
ROM Shoulder Abduction	Ultrasound group	51.66 $\pm$ 8.56	84.6 $\pm$ 3.94	123.8 $\pm$ 4.29	0.001*
	Laser group Group	54.26 $\pm$ 5.00	94.33 $\pm$ 3.15	131.93 $\pm$ 2.25	0.001*

ROM INTERNAL ROTATION	Ultrasound group	28.4 $\pm$ 2.32	49.46 $\pm$ 1.92	59.06 $\pm$ 1.22	0.001*
	Laser Group	29.33 $\pm$ 2.12	55.46 $\pm$ 4.67	63 $\pm$ 1.19	0.001*
ROM EXTERNAL ROTATION	Ultrasound group	29.2 $\pm$ 2.62	51.4 $\pm$ 2.69	63.4 $\pm$ 1.88	0.001*
	Laser	30.06 $\pm$ 2.01	61.8 $\pm$ 2.80	71.2 $\pm$ 2.62	0.001*

	Group				
SPADI PAIN	Ultrasound	37.73 $\pm$ 1.22	18.8 $\pm$ 1.65	8.8 $\pm$ 1.32	0.001*
	Group				
	Laser	37.2 $\pm$ 1.74	14 $\pm$ 2.23	7.2 $\pm$ 1.37	0.001*
	Group				
SPADI DISABILITY	Ultrasound	59 $\pm$ 3.07	28.33 $\pm$ 1.54	12.46 $\pm$ 1.55	0.001
	Group				
	Laser	57.26 $\pm$ 3.19	19.73 $\pm$ 3.89	9.4 $\pm$ 2.02	0.001*
	Group				

The table 3 ANOVA comparison within the group shows there is a significant improvement in both Ultrasound and Laser therapy group while comparing from 0 days to 30 days and from 90 days to 30 and day and 0 days, The VAS, ROM, SPADI Pain and Disability improved significantly in both the group. Laser therapy produces much better improvement than the Ultrasound therapy.

Table 4 shows the mean difference of the variable 0 days to 30 days, 30 days to 90 days and 0 days to 90 days of both the group Ultrasound and Laser group respectively with passage of times (no of days)

TABLE 4: Mean Difference of Variable VAS, ROM, SPADI Pain, and SPADI Disability

Variables		ULTRASOUND therapy Group Mean difference group A	P value	Laser therapy group mean difference group B	P Value
Pain-severity (vas)	0 day to 30 day	3.2	0.001*	3.06	0.001*
	30 day to 90 day	2	0.001*	-2.533	0.001*
	0 day to 90 day	-5.2	0.001*	-6.86	0.001*
ROM. Flex	0 day to 30 day	31.4	0.001*	37.06	0.001*
	30 day to 90 DAY	40.56	0.001*	38.4	0.001*
	0 day to 90 day	72.26	0.001*	75.46	0.001*

ROM.	0 day to	32.6	0.001*	40.07	0.001*
Abd	30 day				
	30 day to 90 day	39.2	0.001*	37.6	0.001*
	0 day to 90 day	72.14	0.001	77.67	0.001*

ROM	0 day to	21.06	0.001*	26.13	0.001*
.Int.Rot	30 day				
	30 day to 90 day	9.6	0.001	7.54	0.001*
	0 day to 90 day	30.66	0.001*	33.67	0.001*
ROM	0 day to	22.2	0.001*	31.74	0.001*
Ext.Rot	30 day				
	30 day to 90 day	12	0.001*	9.4	0.001*
	0 day to 90 day	34.2	0.001*	41.14	0.001
SPADI	0 day to	18.8	0.001*	23.2	0.001*
Pain	30 day				
	30 day to 90 day	-10	0.001*	-6.8	0.001*
	0 day to 90 day	-28.93	0.001*	-30	0.001*
SPADI	0 day to	30.67	0.001*	37.53	0.001*
Disability	30 day				
	30 day to 90 day	-15.87	0.001*	-10.33	0.001*
	0 day to 90 day	-46.54	0.001*	-47.86	0.001*

There is a significant improvement in both the group i.e. Ultrasound and Laser therapy group, but when comparing with each other from base day to 90 days. The Laser therapy group with exercise has Edge over the Ultrasound therapy group and there is a higher improvement in vas, Rom, SPADI Pain and Disability in laser therapy group than Ultrasound therapy group.

The pain (VAS) decrease by 1.319 time in laser in comparison to the ultrasound on the 90th day follow up day. The Rom Flexion in the laser therapy group increase by 1.044 time higher than the ultrasound therapy group, The Rom Abd increase by 1.033 times higher in laser therapy group than the ultrasound therapy group. The Internal Rotation increases by 1.098 time higher in laser than ultrasound therapy group, The External Rotation increases

by 1.202 times higher in laser than ultrasound therapy group. The SPADI pain decreases by 1.036 in laser therapy group than the ultrasound therapy group. The SPADI Disability decrease by 1.028 times in laser therapy group than the ultrasound therapy group.

4. DISCUSSION

The discussion part include that exercise played important role in improving the strengthening the rotator cuff muscle after the injury of the rotator cuff muscle with the intervention of the laser therapy and ultrasonic therapy in Rotator cuff injury with grade 1 and 2. According to the various research published article H.B.Shiv kumar [9] et.al 2014 pendulum exercise (Codman exercise) used pendulum exercise and helps in improving the coordination of the shoulder at the glenohumeral joint. Frank A Treiber [10] et al 1998 used theraband tube and lightweight dumbbell to increase the strength and torque of the rotator cuff muscles, use of theraband resistance exercise increase the abduction, internal as well as internal muscles force and increase the strength of rotator cuff muscles as in our study also theraband also helps in increasing the strength of the shoulder muscles. Similarly another study by the Gerold R.E.Benbichler[12] et.al.on the calcified tendinitis on the supraspinatus and infraspinatus muscle which cause pain and disability to the shoulder joint movement by using Ultrasound therapy. Ultrasound therapy with dosimetry of 0.89 MHz and an intensity of 2.5 W/cm² for 15 minutes per session to the area over the calcified area. The first 15 of the 24 treatments were given daily (five times per week) for three weeks, and the remaining 9 were given three times a week for three weeks. The pulsed mode was 1:4, the transducer was 5 cm (Sonodyn, Siemens), and an aquasonic gel was used as the couplant to avoid cavitation. At the end those who receive ultrasound therapy has got better result than who received sham ultrasound therapy. At the end of the study after 9 months, clinical improvement was significantly more common in the ultrasound-treatment group than in the sham-treatment group (29 [91 percent] vs. 15 [52 percent], P=0.002 by two tailed Fisher's exact test). The pain, disability and quality of life improved in those subjects who receive ultrasound therapy. Similarly another study by the Osvander Lechi[13] et al 2000 on the partial or complete tear of the Rotator cuff tear using ultrasound therapy to the trigger points, continuous ultrasound with frequency of 1.0 Mhz and dose of 1.5 w/cm² for 5 minutes to the subacromial region (model AVATAR US 873- KLD Biosistemas Equip. Elet. Ltda.), and stretching exercises external rotation in shoulder plan and horizontal abduction at 30 degrees of flexion, strengthening exercises with isometrics, elastic bands and dumbbell weights for shoulder external and internal rotators, muscles of the scapular waist (trapezius and anterior serratus) and deltoid. No patient received infiltration with corticoid or other therapy. The estimated time of treatment was 6 months, with a follow up evaluation 6 months after the end of treatment has got better improvement in muscles function of the Rotator cuff muscles. Similarly another study by Katsuyuki Morishita [14] et al 2014 that ultrasound irradiation is help full in increasing the range of motion of muscles due to its properties of increasing temperature in the muscles fibers which helps in increasing the blood supply and helps in vasodilatation of the tissue, which improves the elastic nature of the muscles fibers and helps in improving the range of motion of muscles hence it is seen in the Katsuyuki Morishita et al research when ultrasound therapy 3 MHz with intensity of 1.0w/cm² and 100% duty cycle for 10 minutes in continuous mode is used over subjects on trapezius muscle in three different group, ultrasound therapy group, placebo group, and controlled group, the researcher found better result in ROM active and passive ROM and VAS decreased in ultrasound therapy group, when compared to placebo and controlled group from base day to end of the treatment. similarly another study by Hoon Chung, Tianhong Dia et al[15] said that irradiation of laser on the human body produces biomodulation in cells and low level laser acts on the mitochondria to increase ATP (Adenosine Tri Phosphate) production and LLLT may cause photodissociation of NO from cytochrome C oxidase (CCO), cellular respiration is down regulated by the production of NO by mitochondrial NO synthesis (mt NOS isoform specific to mitochondria) that binds to CCO and inhibit it. A research has demonstrated that how Light increased NO bioavailability CCO Can acts as a nitrate reductase enzyme (a one electron reduction of nitric gives NO) particularly when oxygen partial pressure is low. LLLT promotes metabolism of oxygen LLLT also increase the reactive oxygen species (ROS), in turn ROS activate transcription factor which leads to the up gradation of the of various stimulation and protective genes. These genes are most likely to cellular proliferation, migration, and production of cytochrome and growth factor. LLLT produces vasodilation by triggering the relaxation of smooth muscles associated with endothelium which is highly relevant to the treatment of joint inflammation, the vasodilation increases the availability of the oxygen to the treated cell and also allow for greater trafficking of the immune cells into the tissue. These two effects contribute to accelerate the healing. NO is a potent vasodilator. LLLT may produce photodissociation of NO not only from CCO, but from intracellular stores such as nitrosylated

form of both and myoglobin, leading to vasodilation. Another study by G.D Baxter et.al[16]1994 said the laser therapy is help full in wound healing , reducing edema and swelling in various etiology however Baxter et.al (1991) demonstrated that low level laser with intensity 9.6 j/cm^2 with out put power 830 Nm for 30s,over palm at four equidistance points were treated with laser, at two point proximal and two point distal flexor retinaculum at wrist and four point approximately at equal distance on the forearm reduces the pain, and there is rise of temperature by 0.5°C after 2 minutes of irradiation of laser to the median nerve at the elbow and wrist joint ,there is increase in median nerve latency when compared from base line ($7.00 \pm 0.13 \text{ ms}$ and after at 60 minutes $7.48 \pm 0.15 \text{ ms}$.This clearly indicates that low-level laser therapy is helpful in increasing the conductivity of nerve when compared from the base line day pre treatment to post treatment of laser treatment. As in our study laser with exercise helps in improving the ROM, abduction, flexion internal and external rotation, Decreases the pain severity and disability

5. CONCLUSION

The current study conclude that laser and ultrasound therapy with exercise produces improvement in rotator cuff injury with grade 1 and 2 but Laser with exercise produce much better effects in rotator cuff injury in grade 1 and 2. Laser therapy is effective mode of treatment for Rotator cuff injury.

Ethical clearance Ethical clearance is taken from the ethical committee of the Monad University, Hapur, UP, India.

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