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Effect of scapular muscle strength training on pain, function and grip strength in patients with lateral epicondylitis: A randomized control trial

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Abstract
Objective: The objective of this study was to see the effect of scapular muscle strength training on pain, function and grip strength in patients with lateral epicondylitis at the end of 6 weeks.
Subject and Methods: 40 subjects diagnosed with lateral epicondylitis for more than three months were divided into two equal groups using random allocation. The study included both males and females in the age group of 30-50 years. Group A was given scapular muscle strengthening exercises along with conventional exercises. Group B was given only conventional exercises. Both the groups received treatment for duration of 6 weeks (4 sessions/week). Outcome measures for pain, function and grip strength were Numerical pain rating scale (NPRS), Patient Rated Tennis Elbow Evaluation Scale (PRTEE) and Hand held dynamometer respectively which were taken pre intervention and after the study duration.
Result: In Group A, NPRS score reduced from 3.5±1.14 to 2.89±1.02 and the PRTEE score reduced from 50±18.67 to 30.16±12.02.
In Group B, NPRS score reduced from 3.83±1.2 to 2.89±1.023 and the PRTEE score reduced from 50.11±18.961 to 43.94±18.05.
In Group A, grip strength improved from 16.556±5.125 to 17.556±4.829.
In Group B, grip strength improved from 18±4.058 to 19±4.298.
Conclusion: Adding scapular muscle strengthening along with conventional exercise had significant effects in improving function and reducing pain but no significant effects in improving grip strength in patients with Lateral epicondylitis.

Keywords: lateral epicondylitis, scapular muscle strength training, conventional exercise, pain, function, grip strength

1. Introduction

Lateral Epicondylitis is also described as tendinopathy at the common extensor origin at the lateral epicondyle of the humerus. It is the most common injury that affects both working and non-working population. It mainly occurs when activities, in which repeated wrist extension is required, are performed. The repeated wrist extension movement causes stress over musculotendinous junction, which further leads to fibrosis and micro tears in the tissue involved. This causes irritation and leads to inflammation of periosteum and causes pain which is also the main symptom of lateral epicondylitis [1]. Pain usually occurs during activities that involve wrist extension and also during gripping activities. As a result, there is decrease in functional ability in activities involving use of elbow and wrist. Due to pain, the movement is restricted and hence it leads to weakness of wrist extensor musculature further leading to decreased grip strength which is important component in proper execution of daily activities.

Most frequently used approach among physicians is conservative management [2].

To date, there is no consensus on the optimal treatment approach for lateral epicondylalgia, which is in large part due to its unclear underlying etiology. Most of the physicians tend to focus on interventions addressing the elbow region. Accordingly, proposed interventions include manual therapy, iontophoresis, strengthening and stretching of the wrist extensor and forearm supinator musculature, non-steroidal anti-inflammatory drugs, eccentric training, splinting and bracing, cortisone injections.[3] Prolonged and repetitive use of cortisone injection leads to weakening of musculotendinous junction, post injection pain, subcutaneous atrophy, and skin depigmentation.

There is good evidence supporting the short term efficacy, up to 3 months in pain relief, for physical rehabilitation as a treatment strategy. Modalities such as ultrasound, iontophoresis, and acupuncture also have shown to be effective in the short term (0-3 months) [4].

Though we have a good evidence of short term management, the question of long term management of lateral epicondylitis still remains. There are high recurrence rates of lateral epicondylitis due of lack of long term efficacy in conservative management. Recurrence is also seen as there is breaking of immobile scar and adhesions due to movement, before complete healing has taken place. A recent study reported a recurrence rate between 29% to 38% within one year of receiving conservative treatment [5]. Finally, a study which did a follow-up after two years of physiotherapy intervention, half the patients reported pain and functional loss secondary to intervention.[6]This suggests that the rehabilitation component is missing in long term management.

Majority of treatment approaches have focused on regional treatment that is over elbow region.

Recently, researchers have started exploring not only impairments of elbow region but also the impairments that occur at cervical and shoulder region in patients with lateral epicondylitis. Also according to kinetic chain theory the dynamic upper extremity tasks occur as a result of integration of multiple segments, sequential joint motion and muscle activation system. Therefore the energy development and output follows a proximal to distal sequencing. In upper extremity functions or movement are executed by proximal stability and distal functional movements [7].

This suggests that proximal upper quarter must be included in rehabilitation in patients with lateral epicondylitis. It was established in a study done by Alizadehkhaiyat *et al.* [4] that there was weakness in rotator cuff musculature in patients with lateral epicondylitis compared to those from the control group. This study did not address scapular muscle strength [8].

A study also done by Joseph M Day on scapular muscle assessment in patients with Lateral epicondylitis indicates that scapular muscle strength is impaired in patients with lateral epicondylitis. Hence this study aims at finding the effectiveness of scapular muscle strength training on pain, function, and grip strength in patients with lateral epicondylitis.

2. Materials and Methods

2.1 Selection of Subjects

40 subjects diagnosed with lateral epicondylitis for more than three months were included in the study. Both males and females were included in the study within the age group of 30-50 years. Subjects with scapular muscle strength less than grade 4 were included. Subjects with unilateral lateral epicondylitis were included. Patients with Upper neurological disorder, fibromyalgia, previous surgery to elbow region, cervical radiculopathy. Recent burns, infections and trauma to upper extremity, surgery on upper quadrant within six months were excluded from the study.

The selected subjects were divided into two equal groups (Group A and B) of 20 subjects each using random allocation (chit method). Scapular muscle strengthening along with conventional exercises was given to Group A and only conventional exercises were given to Group B.

2.2 Outcome measures

i) Numerical Pain Rating Scale(NPRS)-assessment of pain Reliability-0.95-0.96.Validity-0.86-0.95

The NPRS is a segmented numeric version of the visual analog scale (VAS) in which a respondent selects a whole number (0-10 integers) that best reflects the intensity of their pain, intensity of pain. The common format is a horizontal bar or line. The NPRS is anchored by terms describing pain severity extremes. The pain NPRS is a single 11- point numerical scale. An 11-point numeric scale (NRS 11) with 0 (no pain) and 11 (worst imaginable pain).

Patient Rated Tennis Elbow Evaluation Scale

Reliability- pain = 0.92, Function:- Special activities= 0.87, usual activities- 0.77 Validity- pain = 0.92, Function:- Special activities= 0.90, usual activities- 0.70

The Patient Rated Forearm Evaluation Questionnaire is a 15-item self reported questionnaire to measure perceived pain and disability in people with tennis elbow. It has three subscales: pain, usual activities and specific activities. The pain subscale has five items about the intensity of pain during various activities. The specific activities subscale has six items tapping into the difficulty experienced while performing specific activities, like lifting a coffee cup. The four items in the usual activities subscale capture the difficulty experienced in performing usual daily roles like work and recreation.

Each of the items of the PRTEE is scored on a 0–10 scale, where 0 is 'no pain' or 'no difficulty' and 10 is 'worst ever' or 'unable to do'. People are asked to rate the pain and difficulty that they have experienced in the past week because of tennis elbow by circling the appropriate response that reflects their current state. The total score ranges from 0 to 100, where high scores indicate greater pain and disability. Pain and function are equally represented in the total score. To calculate the total score, the raw pain score is taken as a total of 50, and the usual activities subscale and the specific activities subscale scores are added together and divided by two to get a function score out of 50. Therefore: PRTEE total score = [Pain score (max 50) + Function score (max 100/2 = 50)]

ii) Grip Strength

Reliability- 0.95 Validity-0.94

Measurement tool - A hydraulic hand held dynamometer

The dynamometer is placed in hand with subjects seated with shoulder in adduction, neutral rotation; elbow in 90˚ flexion; forearm in mid prone and wrist in 0-30˚ extension and 0-15˚of ulnar deviation.

The dynamometer handle position is set at level II [9].

Testing Motion: squeeze the handle for 3-5 seconds with a rest of 15-20 seconds and three trials are taken [10].

2.3 Procedure

Group A

Scapular muscle strengthening exercises[11] along with conventional exercises

1) Upper Trapezius

Patient Position: Standing

Shrug the shoulders

Instructions: Raise shoulders towards ears.

2) Middle Trapezius

Patient Position: Prone lying with shoulder at the edge of table.

Shoulder: Abducted to 90 degrees

Elbow: Flexed to right angle

Head turned to either side for comfort.

Instructions: Lift your elbow toward the ceiling.

3) Lower Trapezius

Patient Position: Prone lying

Shoulder: At 90 degree of abduction

Elbow: 90 degree flexion

Instructions - Lift the arm backwards

4) Serratus Anterior

Patient position: Standing

Instructions: Lift arm upwards over your head in the plane of scapula.

No. of repetitions: 10 repetitions, 3sets

No. of sessions per week: 4 per week for 6 weeks

Intensity – based on repetition maximum.

Patient uses dumbbell as a resistance.

Group B
Only conventional exercises [12]
Conventional exercises
Conventional exercises were given to both groups as follows-
Exercises were followed after static stretching-
Static stretching-
Patient position – Seated, elbow extended, forearm pronated and wrist flexed with ulnar deviation.
Hold time: 30-45 secs ‘
Rest interval: n30 second between each bout of stretching.
No of times- 3 times before and 3 times after exercise.

Eccentric exercises: Patient is in sitting position with full elbow extension, forearm pronation and maximum wrist extension. From this position patient slowly lowers
wrist into flexion for the count of 30.
No. of repetitions: 10 repetitions, 3 sets
No. of sessions per week: 4 per week for 6 weeks
Intensity – based on repetition maximum.
Patient uses dumbbell as a resistance.
Ultrasound post treatment was applied over lateral epicondyle at a dosage of 3MHZ,1.5w/cm^2 pulsed mode ratio 1:4 for 8 minutes to both the groups.[13]

3. Statistical analysis
Statistical analysis within the group (Intragroup analysis) was done using paired t-test for PRTEE and grip strength. Intragroup analysis for NPRS was done using Wilcoxon rank test.
Statistical analysis was done using: Intergroup analysis for PRTEE and grip strength was done using unpaired t-test to compare effectiveness between two groups.
Intergroup analysis for NPRS was done using Mann Whitney U Test.

4. Findings
Intragroup numerical pain rating scale (group A)

Table 1

NRS	PRE	POST
Mean	3.5	2.89
SD	1.14	1.02
P Value	p<0.0001 (considered extremely significant)	

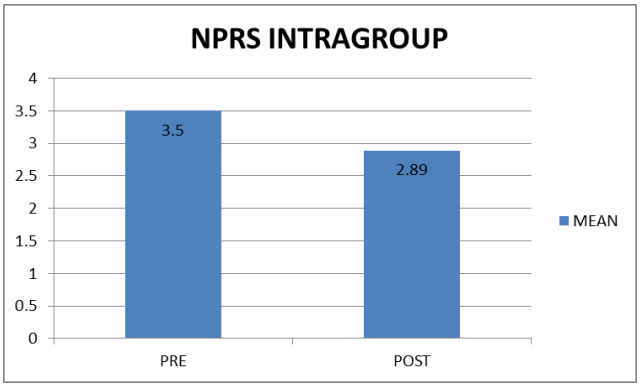

Fig 1

Intragroup patient rated tennis elbow evaluation scale (Group a)

Table 2

PRTEE	PRE	POST
Mean	50	30.167
SD	18.667	12.016
p value	p<0.0001(considered extremely significant)	
t value	t=8.749 with 17 degrees of freedom	

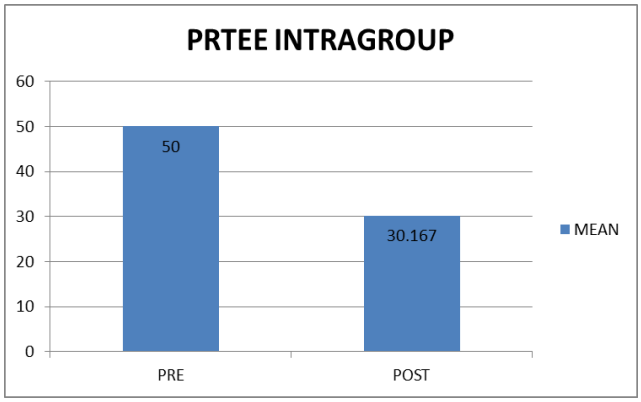

Fig 2

Intragroup grip strength: (group A)

Table 3

Prtee	PRE	POST
Mean	16.556	17.556
SD	5.125	4.829
p value	p<0.0001(considered extremely significant)	
t value	t= 3.431 with 17 degrees of freedom	

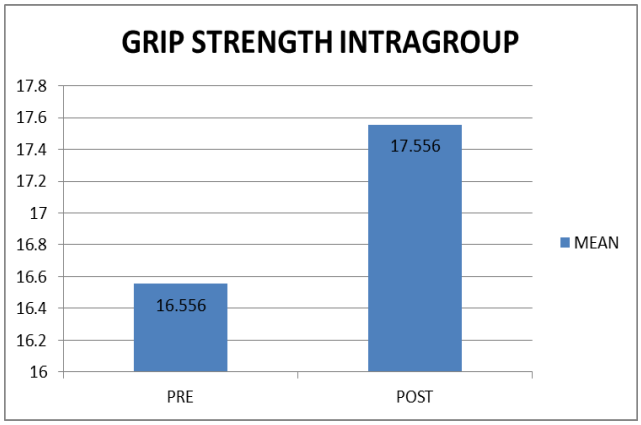

Fig 3

Intragroup numerical pain rating scale (Group b)

Table 4

NPRS	PRE	POST
MEAN	3.833	2.889
SD	1.2	1.023
p value	p<0.0001 (considered extremely significant)	

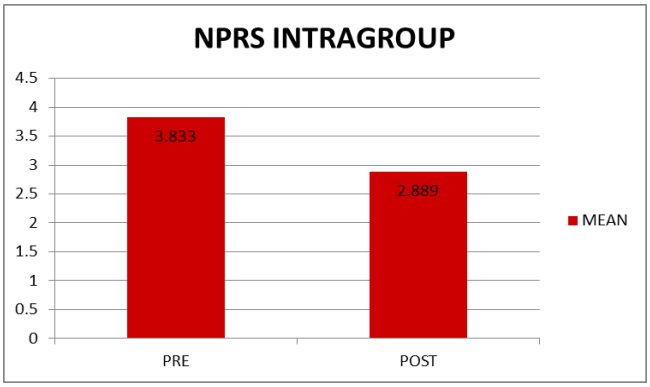

Fig 4

Intragroup patient rated tennis elbow evaluation scale: (group b)

Table 5

PRTEE	PRE	POST
Mean	50.111	43.944
SD	18.961	18.047
p value	p<0.0001(considered extremely significant)	
t value	t= 12.175 with 17 degrees of freedom	

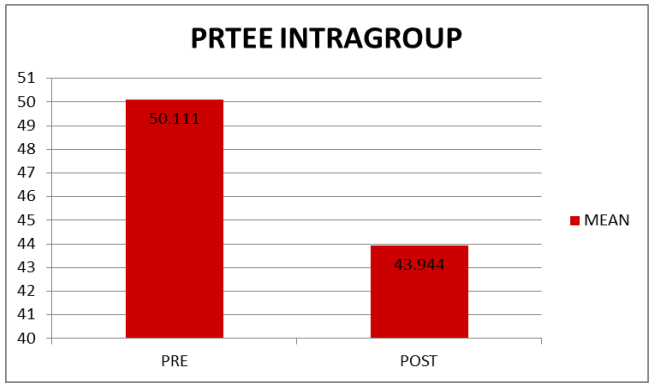

Fig 5

Intragroup grip strength: (group B)

Table 6

PRTEE	Pre	Post
Mean	18	19
SD	4.058	4.298
p value	p<0.0001(considered extremely significant)	
t value	t= 4.123 with 17 degrees of freedom	

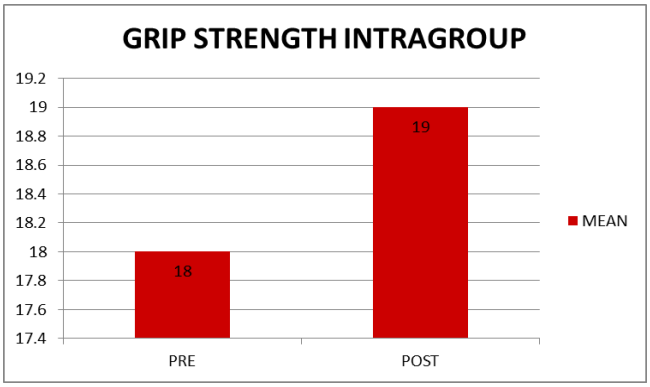

Fig 6

Inter group numerical pain rating scale (group a vs group b)

Table 7

NPRS	PRE	POST
MEAN	2	2.889
SD	0.686	1.023
p value	p<0.0001 (considered extremely significant)	

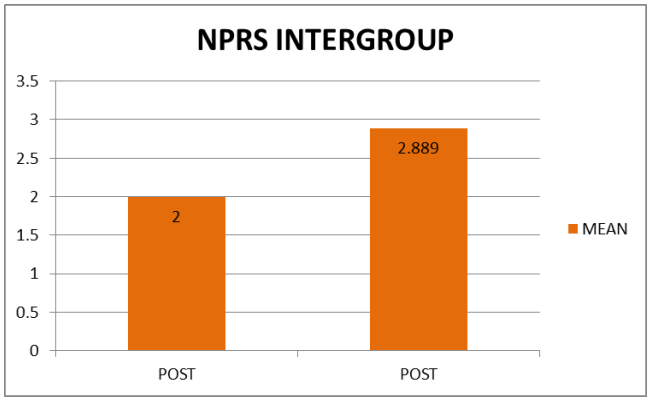

Fig 7

Intergroup patient rated tennis elbow evaluation scale: (group a VS group b)

Table 8

Prtee	Pre	Post
Mean	30.167	43.944
SD	12.016	18.047
p value	p<0.0001 (considered extremely significant)	
t value	t= 2.696 with 29 degrees of freedom	

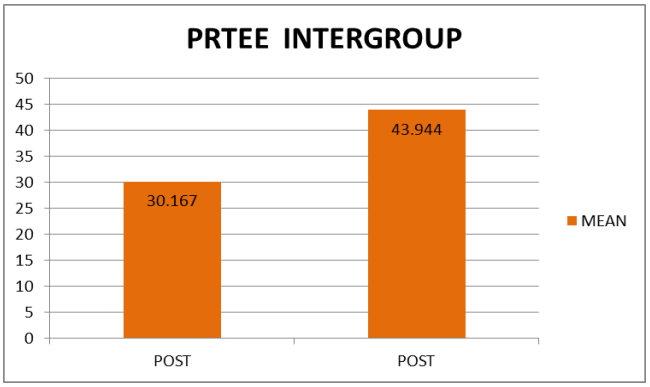

Fig 8

Intergroup grip strength: (group a VS group B)

Table 9

PRTEE	PRE	POST
Mean	17.556	19
SD	4.829	4.298
p value	p>0.0001(considered not significant)	
t value	t= 0.9480 with 33 degrees of freedom	

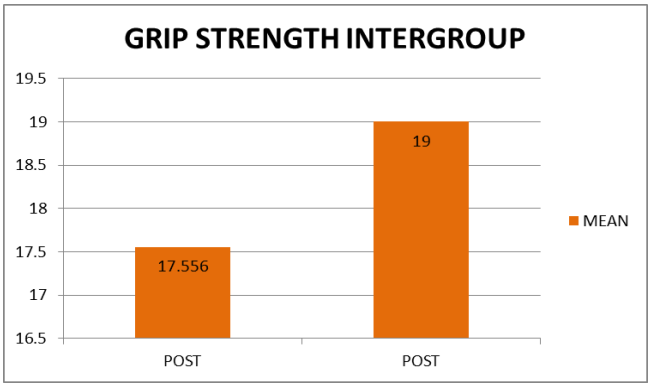

Fig 9

5. Result

- After statistical analysis was done, it was found that there was decrease in NPRS score when both groups were compared post treatment (Mean±SD: 2±0.89 – Group A and 2.889±1.02 – Group B). p value=0.0096 – considered very significant.
- The decrease in PRTEE score in Group A (Mean±SD:30.1±18.6) was statistically more significant than Group B(Mean±SD:43.9±12.01) post treatment. P value <0.0001 considered extremely significant.
- Decrease in grip strength showed no statistical difference when both groups were compared post treatment. (Mean±SD: 17.55±4.82-Group A and 19±4.29-Group B).p value >0.0001 which is not considered significant.

6. Discussion

Lateral epicondylitis also described as tendinopathy at common extensor origin at the lateral epicondyle of humerus. Due to stress over musculotendinous junction that leads to tears and fibrosis of tissue and hence leads to pain during wrist extension and gripping activities. It also affects the function and grip strength of patient. Scapular muscle weakness leads to diminished proximal control and this leads to increased demand on wrist and elbow and further causing injury to elbow.

Present study was done to see the effectiveness of scapular muscle strength training on pain, function and grip strength in patients with lateral epicondylitis. Study included 40 subjects in the age group of 30-60 years. Mean age group was 43±7. Patients with dominant side affected were more than non dominant side affected. Also female patients were more than male patients. Groups were divided into half by random allocation of groups. Group A was scapular muscle strengthening exercises along with conventional exercises and Group B was given only conventional exercises. Both groups were given ultrasound post treatment. The duration of study was six weeks and exercises were given 4days/week. There were four drop outs during the treatment. Two of them had upper limb injury and other two out of them one person met with accident and the other person simply discontinued. When pre and post analysis was done for group A for which scapular muscle strengthening along with conventional exercises was given, data was analyzed using paired t- testing within the group for PRTEE scales and grip strength and wilcoxn for NPRS showed statistical difference in all three outcome measures that is pain, function and grip strength. During any gripping activity or activities in which wrist flexion, extension is involved the musculoskeletal components of scapula, shoulder, elbow and wrist that are links of kinetic chain help in the distal control and mobility and equal distribution of energies all over the upper limb. Strengthening scapular musculature provides proximal stability and helps to reduce stress over musculotendinous junction hence preventing stimulation of nociceptors by decreasing the neural transmitter in affected tissue and helps to reduce pain [14]. As the pain is reduced it also helps in enhancing function and decreasing disability. Due to equal distribution of kinetic energy in kinetic chain it also helps to perform with more ease. Due to tensile loading over the muscle by eccentric exercises this might have helped to improve grip strength [15].

When pre and post analysis was done for Group B for which only conventional exercises was given, data was analyzed using paired t-testing within the group for PRTEE scale and grip strength and Wilcoxon for NPRS showed statistical difference in all three outcome measure that is pain, function and grip strength. Strengthening eccentrically has helped to reduce pain due to neovascularisation as exercises halt the growth of blood vessels in tendons as seen in the study by Pufe T, Peterson *et al*. on the mechanical factors that influence the expression of endostatin [14]. It also promotes collagen production and helps to promote healing of tendon. Reduction in pain and improvement in tensile strength might have helped in improving function and grip strength that was seen from statistical analysis. Studies have shown the evidence of short term efficacy in pain relief and functional improvement in patients with lateral epicondylitis.

Intergroup analysis was unpaired t-test for grip strength and PRTEE scale and Mann-Whiteney for NPRS. When pre and post treatment values were compared showed significant difference in values of NPRS and PRTEE scale. There was not considerable effect seen on grip strength after comparing the groups which were given scapular muscle strengthening along with conventional exercises to the group which were only given conventional exercises. Adding scapular muscle exercises have helped in gaining the proximal stability and improved the distal control of joint. Pain might have significantly reduced due to decreased neural transmission as the repetitive stress over tendons of elbow joint has reduced as well due to increase of tensile strength of elbow extensors as well as the modality that is Ultrasound might have reduced pain. Improvement in kinetic chain link has helped to improve function and decrease functional disability. However there were no significant effects of increase in grip strength were seen as it might it due to the variation in the duration of condition (5-12 months) as patients with symptoms more than three months were taken. In long standing cases there might wasting of affected muscles and grip strength might have become weak [17]. Present study involved strengthening of only four scapular muscles in patients with lateral epicondylitis where as in study done by Devika Bhide *et al*. has shown increase in grip strength by strengthening six scapular muscles.in young adults in which tendons were not injured. Therefore strengthening scapular muscle however will not cause any significant difference in improving grip strength in patients with lateral epicondylitis.

7. Conclusion

This study concludes that adding scapular muscle strengthening exercises along with conventional exercises

has significant effects in improving function and decreasing pain in patients with lateral epicondylitis. There have been no significant effects on grip strength after adding scapular muscle exercises along with conventional exercises in patients with lateral epicondylitis.

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