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Influence of Proximal Motor Control in treating Lateral Epicondylitis

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Abstract

Purpose: The goal of this study is to demonstrate the effect of proximal motor control including scapular muscles strength added to conventional physical therapy on pain, hand grip strength and arm function in patients with LE.

Methods: Fifty-two patients with chronic LE were classified into 2 equal groups, group A received scapular muscles (lower trapezius, middle trapezius and serratus anterior) strength added to traditional physical therapy (pulsed ultrasound, static stretching of extensor carpi radialis brevis (ECRB) muscle and eccentric exercises of wrist extensors) while group B received conventional physical therapy only.

Results: The results revealed that there was a significant difference between groups in pain (effect size = 2.46), function (effect size = 2.69) and hand grip strength (effect size = 0.96) (p-value = 0.001) and there was a significant difference within groups post trearment compared with that pre treatment (p-value = 0.001).

Conclusion: Adding proximal motor control including scapular muscles strength to conventional physical therapy program decreased pain, increased hand grip strength and improved function significantly in patients with LE.

Keywords: Lateral Epicondylitis, Scapular muscles strength, Kinetic chain theory, Proximal motor control.

1 . Introduction

Lateral epicondylitis (LE) is one of the most prevalent arm disorders that may be work or sport-related (1), and it may be degenerative or poor healing tendon response (2). The superior arm is widely impacted. Between the ages of 30 and 60, lateral epicondylitis is most prevalent (1).

There are two categories for LE Patients, younger group that have sport-related injuries and older group that experience work-related injuries (3). The older group is considered the initial condition which involves anyone perform tasks which include forearm rotation and wrist flexion or extension such as carpenters, bricklayers, housewives, computer operators, surgeons, dentists, violinists and squash players (4). The primary focus of conventional treatment for LE has been pain management with anti-inflammatory drugs, ultrasound, electrical stimulation, and splints. Exercises like wrist extensors strengthening and stretching should be added to conventional physical therapy for treating LE (5). In order to treat LE, it is advised to perform static stretching of extensor carpi radialis brevis (ECRB) muscle and eccentric strengthening exercises for wrist extensors (6). Recently, researchers (7 , 8) found that patients with LE had weakness of shoulder girdle. Therefore, it is reasonable to anticipate that proximal motor control involving scapular muscles strength will be incorporated as a part of the comprehensive LE therapeutic program. The kinetic chain theory is one justification for scapular muscles strengthening in this population (9).Voluntary movements of upper extremity are regulated with motor programs. These motor programs use group of muscles and joint movements in a proximal to distal sequence to simplify and create functional movements. In standing, normal motor patterns for upper extremity movements include trunk and lower extremity muscle activation before the arm motion. Based on the kinetic chain theoretically, during functional arm motions, kinetic energy is transmitted from the proximal to the more distal portions of the arm giving an efficient and effective pattern for terminal function. Because of this, proximal insufficiency raises the stress on the distal portion which overloads it (10). The distal tissues at the elbow and wrist are vulnerable to an increased strain when the proximal motor control including scapular muscles is deficient (11). Therefore, it may be crucial for rehabilitation of LE patients to focus on scapular muscle strengthening (9). This study was conducted to reveal the impact of proximal motor control including scapular muscles strengthening on pain, pain free hand grip strength and function added to conventional physical therapy in patients with Lateral Epicondylitis.

2. Patients and Methods

The study was conducted between July 2021 and July 2022. Ethical approval was granted from Faculty of Physical Therapy's institutional review board, Cairo University before starting the study [No: P.T.REC/ 012/003304] and recorded at the Clinical Trials Registry (Registry ID: NCT 05447468).

Subjects:

Fifty-two patients (24 males and 28 females) were chosen among individuals who had been recommended by an orthopedist for physical therapy diagnosed as LE at outpatient private clinic in 10th of Ramadan city, Egypt.

Sample size calculation is performed based on the finding of the previous research of Bhatt et al., (2013) (12), using G power statistical software (version 3.1). A two-sided t test was carried out with α error probability of 5% , power of 80% and effect size = 0.8.

Inclusion criteria:

Patients were included in current study if (1) Their ages range from 30-50 years old. (2) They had symptoms of LE for at least the last two months. (3) They had pain at a minimum two of the following four tests; Cozen's test, Maudsley test, Mill's test and tennis elbow test.

Exclusion criteria:

Patients were ignored from the study if they had (1) Peripheral neuropathy. (2) Lesions of upper limb nerves. (3) Cervical radiculopathy. (4) Surgical history in the affected elbow 6 months ago.

Study Design:

This study was pretest- posttest controlled trial. Participants were classified into two equal groups. Group A received scapular muscles (lower trapezius, middle trapezius and serratus anterior) strengthening added to conventional physical therapy (pulsed ultrasound, static stretching of ECRB muscle and eccentric exercises of wrist extensors) for 6 consequtive weeks while group B received the same conventional physiotherapy only for 6 consequtive weeks.

Methods:

A) Evaluation procedures:

1- Weight, height and BMI measurements:

Weight and height were measured by weight-height scale. First, the scale was calibrated then patient stood on the scale with light clothes and bare feet and the weight was recorded. Second, the patient stood with his back against the wall and heels, back, shoulders and head touched the wall. The patient was asked to tuck in his chin and looked straight ahead then, the adjustable headboard was lowered until it rested comfortably on the top of patient's head and the height was recorded. BMI was calculated according to the following equation:

BMI= Weight (in kilograms) ÷ Height² (in meters).

2- Assessment of pain:

Using visual analogue scale (VAS), a continuous 10 cm line ranges from no pain to very severe pain which is valid and reliable tool. The patient makes a mark on the point which represents their pain intenisty (13).

3- Assessment of pain free hand grip strength:

Patient sits on chair with the elbow in 90° flexion and the shoulder and radioulnar joints in fair rotation. Patient is asked to gradually press the jamar hydraulic hand dynamometer (Model J00105, China) and to stop the instant discomfort is first felt. It is performed three times with a 20-second pause in between. Average of three trials is recorded. The measurement is valid and reliable (14).

4- Assessment of function:

Using Patient-Rated Tennis Elbow Evaluation Questionaire (PRTEEQ) . It is a 15-item self-reported questionnaire to assess how much pain and how disabled patients with LE feel. It consists of three items: pain, regular tasks and particular tasks. Each of the questionnaire′s items is graded on a scale from 0 to 10, with 0 expressing no pain or difficulty and 10 representing the worst ever or being unable to perform (15). Patient is asked to mark the level of pain and difficulty they have felt over the past week by selecting the option that best describes their current condition. The overall score is between 0 and 100, where high scores correspond to more pain and disability (16).

B) Intervention:

1- **Strength of lower trapezius:** Patient was in prone position with head and feet supported on the plinth, her arm was above the head with upper extremity in line with lower trapezius muscle fibers and the shoulder joint was at 135 degree abduction (Fig. 1) (17).
2- **Strength of middle trapezius:** Patient was in prone position with head and feet supported on the plinth, shoulder joint was externally rotated and abducted 90_o and elbow joint was flexed 90_o and the patient was asked to retract the scapulae (Fig. 2) (12).
3- **Strength of serratus anterior:** Patient was in standing position with the trunk in neutral position and patient was asked to raise the arm in sliding manner against the wall in the plane of scapula end with scapular protraction (Fig. 3) (18). The patient held positions 6 seconds and perform 3 sets of 10 repetitions and 3times per week for 6 weeks.
4- **Pulsed ultrasound:** Both groups received pulsed ultrasound (CWM-302, digisonic, Korea) for 5 minutes with a 20% duty cycle, intensity of 2 w/cm² and frequency of 1 MHz 3 times per week for 6 weeks (19).
   Patient was in sitting position and the arm supported on the plinth with flexed elbow joint. Therapist stood beside the affected elbow and applied head of ultrasound on the common extensor tendon (Fig. 4).
5- **Stretching of ECRB muscle:** Therapist sat beside the affected elbow and put the elbow in extension, forearm in pronation and wrist in full flexion with ulnar deviation passively and held position for 30s (Fig. 5) and performed 3 repetitions with 30s break in between (20). Three times a week for 6 weeks.
6- **Eccentric exercises of wrist extensors:** Patient sat on a chair and their arm was rested on the hand of the chair and the patient was asked to extend elbow, pronate forearm, fully extend wrist and then flex the wrist slowly until full flexion is achieved (Fig. 6) (20). Patients applied 3 sets of 10 repetitions 3 times a week for 6 weeks. The exercise was progressed, when the patient could handle the resistance.

Statistical analysis

To compare subject characteristics between groups, an unpaired t-test was performed. To compare distribution of sex between groups, Chi squared test was used. To check whether the data had a normal distribution, Shapiro-Wilk test was run. To check the homogeneity between groups, the homogeneity of variances test by Levene was utilised. Mixed MANOVA was used to compare the impact of time and treatment, as well as the interaction of time and treatment on VAS, PRTEEQ and hand grip strength. In order to perform further multiple comparisons, Post-hoc tests utilizing the Bonferroni correction were conducted. All statistical tests have a p-value cutoff of 0.05 to indicate significance. Every statistical analysis was carried out using (SPSS) program version 25 for social studies (IBM SPSS, Chicago, IL, USA).

4. Results

- Subject characteristics:

Table (1) revealed the participant characteristics of the group A and B. There was no significant difference between groups in age, weight, height and BMI ($p > 0.05$).

Fig. 1: Strength of lower trapezius.

Fig. 2: Strength of middle trapezius.

Fig. 3: Strength of serratus anterior.

Fig. 4: Application of pulsed ultrasound.

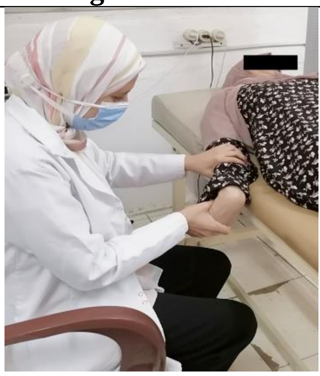

Fig. 5: Stretch of ECRB muscle.

Fig. 6: Eccentric exercise of wrist extensors.

Table 1. Comparison of subject characteristics between group A and B:

	Group A	Group B	P-value
	Mean ± SD	Mean ± SD	
Age (years)	39.81 ± 6.17	39.96 ± 5.59	0.92
Weight (kg)	80.27 ± 8.66	79.53 ± 9.71	0.77
Height (cm)	169.34 ± 6.5	167.77 ± 7.15	0.41
BMI (kg/m²)	27.96 ± 2.91	28.32 ± 3.61	0.69
Sex, n (%)			
Females	12 (46%)	15 (58%)	0.41

Males	14 (54%)	11 (42%)	

SD, Standard deviation; p value, Probability value

Effect of treatment on VAS, PRTEEQ and hand grip strength:

To examine the impact of treatment on VAS, PRTEEQ and hand grip strength, mixed MANOVA was used. There was a significant interaction effect of treatment and time (F = 8.14, p = 0.001, partial eta squared = 0.33). There was a significant main effect of treatment (F = 3.73, p = 0.01, partial eta squared = 0.19). There was a significant main effect time (F = 827.39, p = 0.001, partial eta squared = 0.98).

Within group comparison:

There was a significant improvement in VAS and PRTEEQ in group A and B post treatment compared with that pre treatment ($p < 0.001$). The percent of change of VAS and PRTEEQ in group A was 87.56 and 81.88% respectively; and that in group B was 73.29 and 71.93%. respectively.
There was a significant increase in hand grip in group A and B post treatment compared with that pre treatment ($p < 0.001$). The percent of change of hand grip in group A and B was 75.38 and 50.85% respectively. (Table 2).

Groups comparison:

Between groups, there was no significant change pre-treatment ($p > 0.05$). Comparison between groups post treatment showed a significant improvement in VAS, PRTEEQ and hand grip of group A compared with that of the group B ($p < 0.001$). (Table 2).

Table 2. Mean VAS, PRTEEQ and hand grip strength pre and post treatment of group A and B:

	Pre	Post		
	Mean ± SD	**Mean ± SD**	**% of change**	**p value**
VAS				
Group A	**9 ± 1.26**	**1.12 ± 0.51**	**87.56**	**0.001**
Group B	**8.76 ± 1.39**	**2.34 ± 0.48**	**73.29**	**0.001**
MD	**0.24**	**-1.22**		
	p = 0.53	**p = 0.001**		
PRTEEQ				
Group A	**73.03 ± 8.86**	**13.23 ± 2.74**	**81.88**	**0.0001**
Group B	**72.46 ± 10.34**	**20.34 ± 2.53**	**71.93**	**0.001**
MD	**0.57**	**-7.11**		
	p = 0.83	**p = 0.001**		
Hand grip (kg)				
Group A	**17.91 ± 4.99**	**31.41 ± 7.04**	**75.38**	**0.001**
Group B	**16.56 ± 3.95**	**24.98 ± 6.26**	**50.85**	**0.001**
MD	**1.35**	**6.43**		
	p = 0.28	**p = 0.001**		

SD, Standard deviation; MD, Mean difference; p value, Probability value

5. Discussion

This study was created to demonstrate the impact of proximal motor control including scapular muscles strengthening on pain, pain-free hand grip strength and arm function added to conventional physical therapy in patients with LE.
Our results showed that adding proximal motor control including scapular muscles (lower trapezius, middle trapezius and serratus anterior) strengthening to conventional physical therapy significantly reduced pain, increased pain-free hand grip strength and improved function compared to conventional physical therapy alone in patients with LE.

Findings of this study partially agreed with that of Bhatt et al . (2013) (12) who discovered that proximal motor control including strengthening of middle and lower trapezius muscles over a period of 10 weeks in a patient with lateral elbow tendinopathy decreased pain in daily activities and increased hand grip strength.
Furthermore, present study agrees with the findings of Sethi and Noohu, (2018) (21) who reported that adding proximal motor control including scapular muscles strength to

conventional physical therapy improved pain, pain free hand grip strength and function significantly more than conventional physical therapy alone in 26 patients with LE but, current study was applied on 52 patients.

Current study partially supports the work of Raithatha et al. (2018) (22) who found that proximal motor control including scapular muscle strength exercises added to conventional treatment significantly decreased pain and increased hand grip strength more than conventional treatment only in patients with lateral epicondylalgia, but did not improve function significantly. This might be due to decreased period of scapular strengthening which was 3 week.

And, this study (Raithatha et al., 2018) applied scapular strengthening exercises with weight in patients already had hand grip weakness which might affect the disability score of PRTEEQ. On the other hand, strengthening period in current study was 6 weeks and scapular strengthening exercises were without weight.

In addition to that, current study supports the work of Srinivas and Babu, (2022) (3) who found that proximal motor control including scapular strength with conventional physical therapy significantly improved pain and hand grip strength compared to conventional physical therapy alone in 30 athletes with LE.

Results of current study regarding pain and function on the same line with Dimitrios, (2017) (23) and Mostafaee et al. (2022) (24) who reported that conventional physical therapy added to scapula and shoulder exercises improved pain and function greater than conventional physiotherapy alone in patients with LE but, there was a non-significant difference in hand grip strength.

On the other hand, our results regarding pain and function in contrary with Sharma et al. (2015) (25) who showed that there was a non- significant difference in pain and function when adding rotator cuff strength to therapeutic ultrasound and eccentric exercise for the wrist in patient with LE but, there was a significant difference in hand grip strength.

This non-significant difference might be due to decrease of rotator cuff strengthening period which was 3 weeks and Reinold et al. (2009) (26) reported that ideal period of rotator cuff strength is at least 6 weeks to obtain positive outcomes. Also, only rotator cuff strength might be not enough to correct kinetic chain links (Sharma et al., 2015) (25). As opposed to that, current study applied scapular muscles strength for 6 weeks without rotator cuff strength.

In addition to that, current study did not support the findings of Day et al. (2021) (27) who found that both local treatment and local treatment with proximal motor control including scapular muscles strengthening equally effective in improving pain, this may be due to using small sample size and wide range of age which was 32 patients with age varied from 18 to 65 years but current study was applied on 52 patients with age ranged from 30 to 50 years.

This study has some limitations that should be taken into account in subsequent research. First, resistance of scapular strengthening exercises was applied with the lever arm of upper limbs not with external force. Second, there was no follow up for this study.

It is recommended for the future studies to follow up the symptoms, address adding core training to the rehabilitation of LE and apply another physical therapy modalities such as deep friction massage and laser.

6. Conclusion

This study proved that adding proximal motor control including scapular muscles strengthening to the conventional physical therapy program improved outcomes in patients with LE.

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