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Original investigation

The Effects of Muscle Strength and Muscle Endurance on Upper Extremity Functions of Lateral Epicondylitis Patients

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ABSTRACT

Purpose: Lateral epicondylitis can cause limitations in upper extremity functions of patients due to the decrease in upper extremity muscle strength and endurance in patients. The aim of this study is to determine the effect of muscle strength and endurance on upper extremity functions in patients with lateral epicondylitis.

Methods: Forty-five patients (mean age: 47.60±3.22, 30 females, 15 male) diagnosed with chronic lateral epicondylitis were included in the study. Upper extremity muscle endurance of the patients was evaluated with unsupported arm exercise test (in 1st and 2nd diagonal pattern), upper extremity muscle strength of the patients was evaluated with Hand Held Dynamometer (HHD), and upper extremity functions of the patients were evaluated with Lateral Epicondylitis Function Scale (LEFS) scores.

Results: There was a moderate negative correlation between the unsupported arm exercise test endurance on the affected side and the LEFS scores of the patients with lateral epicondylitis ($p<0.05$), and a moderate negative correlation was found between shoulder extensor, elbow flexor, elbow supinator, and wrist extensor muscle strength and LEFS scores ($p<0.05$).

Conclusion: Decreasing muscular endurance and strength in patients with chronic lateral epicondylitis cause a decrease in the upper extremity functions. We consider that muscular endurance and strengthening exercises should be included in the physiotherapy programmes in order to increase the upper extremity functions in patients with chronic lateral epicondylitis.

Keywords: Lateral epicondylitis, strength, endurance, function

INTRODUCTION

Lateral epicondylitis (tennis elbow) is one of the common lesions of the arm that starts with pain and sensitivity on the lateral epicondyle of the elbow and micro tears at the origin of the extensor carpi radialis brevis muscle. Lateral epicondylitis are common disorders of the upper extremity (1). In lateral epicondylitis, a significant impairment occurs in upper extremity activities in daily life with the occurrence of pain and decrease in grip strength. Due to these effects, the gripping, pronation-supination movement causes limitations in activities such as writing, gripping the door handle, and lifting weight (2).

The decrease in the upper extremity and handgrip strength caused by pain during the chronic period is one of the most important symptoms in patients with lateral epicondylitis (3). Decreasing muscle strength causes limitations in the endurance of the wrist muscles and functional movements of the upper extremity along with impairment of gripping functions in the long term (4). Muscle endurance is defined as the ability of a muscle group to repeat similar movements or tensions, or the ability or capacity of a muscle group to statically preserve a percentage of a maximum voluntary contraction throughout a specified period (5). Maintaining the endurance abilities of the elbow-wrist muscles in patients with lateral epicondylitis without eliciting pain or fatigue symptoms is important for the continuation of functional activities (6).

Long term writing, eating, repetitive arm movements in lateral epicondylitis are important parameters evaluating the functional level of the patients (7). Limitations occurring in these activities cause significant deterioration in the independence level and quality of life of the patients. Although there are many scoring and survey systems evaluating functional levels of patients with lateral epicondylitis regarding this subject (7, 8), there are no studies

examining the relationship between decreasing muscle strength and endurance caused by lateral epicondylitis and the level of upper extremity functions. The aim of this study is to determine the effect of strength and endurance of shoulder, elbow and hand-wrist muscles on upper extremity functions in patients with chronic lateral epicondylitis.

METHODS

Patients

Forty-five patients (30 female, 15 male, mean age 47.6±3.22) who were admitted to the Physiotherapy and Rehabilitation and Orthopaedics and Traumatology outpatient clinics between March 2017 and May 2017 with the complaints of pain on the lateral epicondylitis region and functional limitations, and who had a positive result in at least one of the Mill's test, resisted wrist extension test (Cozen's test), resisted third digit extension test (Maudsley's test) and who were subsequently diagnosed with chronic lateral epicondylitis were included in the study. In the exclusion criteria; patients who (a) received physiotherapy in the last 3 months, (b) received corticosteroid injection in the lateral epicondylitis region in the last 3 months, (c) were receiving regular anti-inflammatory medications on a regular basis, (d) had neurologic and orthopaedic problems which cause pain in the cervical region, arm, shoulder, elbow, and hands, (e) had a history of rheumatic disease, and (f) had cooperation difficulties due to cognitive disorders were excluded from the study. The study was carried out according to the principles of the Declaration of Helsinki. All patients were informed about the study and informed consent forms were signed prior to the inclusion to the study. (Ethics committee approval was obtained with the decision of European University of Lefke, numbered ÜEK/02/04/1617/3).

Lateral Epicondylitis Function Scale (LEFS) was used in the evaluation of the level of upper extremity functions of the patients. The validity and reliability of the Turkish version of LEF scale was carried out by Altan et al. (7) pain and functional activity level on the affected arm is determined in this scale. LEF scale evaluates pain in the affected arm (50 points) and function-daily activities of the affected arm (50 points) over a total of 100 points (Best score=0, Worst score=100).

Shoulder, elbow, and wrist isometric muscle strength evaluation was carried out with the Hand Held Dynamometer (HHD) (model 01 163, Lafayette Instrument Company, Lafayette, Ind., USA) (9). The test was performed with the patients in prone and sitting positions using the positions necessary for fine muscles testing method described by Lovett without eliciting compensatory movements. The values occurring with isometric contraction on the HDD were recorded in kilograms. Muscle strength measurements were evaluated for 5 seconds with 3 repetitions. The average of three repeated measurements was recorded.

The unsupported arm exercise test was used to evaluate the upper extremity (shoulder, elbow, hand-wrist) muscle endurances of the patients. This test is used among the proprioceptive neuromuscular facilitation techniques and includes simultaneous and consecutive diagonal movements (in the 1st and 2nd diagonal pattern) of many muscle groups in the upper extremity (10). In the 1st diagonal pattern, flexion, adduction, and external rotation movements of the shoulder (Figure 1), and in the 2nd diagonal pattern, flexion, abduction, and external rotation movements of the shoulder (Figure 2) were carried out by the patients in an alternate manner. When the patients were in the standing position (Figure 1 and 2), the test was started with 0.25 kg weight on the wrist and the weights were increased by 0.25 kg every 2 minutes. The number of repeated movements performed by the patient on the 1st and 2nd diagonal pattern, test duration, and weight amounts (in terms of kg) were recorded. Test was terminated for the patients who had disrupted movement patterns due to fatigue and compensatory movements in the muscles.

Figure 1. First diagonal pattern (flexion, adduction, and external rotation)

Figure 2. Second diagonal pattern (flexion, abduction, and external rotation)

Statistical Analysis

Statistical Package for Social Sciences (SPSS) 20.0 data analysis package program was used in the statistical analysis of the data acquired from the study. Whether the data had normal distribution was determined with the use of Shapiro-Wilk test. As the "p" values acquired from the Shapiro-Wilk test were smaller than 0.05, it was determined that there was no normal distribution. Thus, non-parametric hypothesis tests were used in the study. Descriptive statistics for the discrete and continuous variables in the study were shown as percentage, mean, standard deviation, minimum and maximum values. The Wilcoxon test was performed for the comparison of the values in the affected side and unaffected side of the patients. Spearman correlation analysis was carried out to determine the correlations between LEFS score, endurance test, and muscle and grip strength of patients participating in the study. A p value <0.05 was considered statistically significant.

RESULTS

Demographic and clinical characteristics of patients with chronic lateral epicondylitis included in our study are presented in Table 1.

Table 1. Demographic and clinical characteristics of patients with chronic lateral epicondylitis

	Lateral epicondylitis patients (n=45)
Age (year)	47.60±3.22
Height (cm)	167.42±8.48
Weight (kg)	74.06±16.52
Body mass index (kg/m^2)	26.28±4.99
Female/Male	30/15
Dominant arm (right/left)	42/3
Involved arm (right/left)	34/11

In the muscle strength measurements of the patients with chronic lateral epicondylitis carried out with HHD, it was found that there was a moderate negative correlation between the shoulder extensor, elbow flexor, elbow supinator, and wrist extensor muscle strengths and LEFS scores ($p<0.05$, Table 2).

In the evaluation of muscle endurance, there was a moderate negative correlation between the weight amounts and number of repetitions and the LEFS scores in the 1st diagonal pattern of the unsupported arm exercise test on the affected side ($p<0.05$), and there was a moderate negative correlation between the number of repetitions and LEFS scores in the 2nd diagonal pattern ($p<0.05$, Table 3).

DISCUSSION

Decrease in the muscle strength and endurance levels due to pain causes limitations in hand and upper extremity functions in patients with lateral epicondylitis (4, 11). The main purpose of the treatment in chronic lateral epicondylitis is to provide pain relief and allow return of the patients to their daily functional activities by decreasing the load on the arm due to the repetitive activities (12). There are many surveys in the literature evaluating the functional activities of patients with upper extremity problems (13). These surveys usually consist of sections that evaluate daily life activities and function. LEF scoring system that is used commonly in the literature in recent years is a survey developed especially for tennis elbow and its Turkish version was found to have high validity and reliability (7, 14). Therefore, we used this scale in our study.

Muscle strength loss is the most commonly observed symptom in patients with lateral epicondylitis. In particular, the decrease in the muscle strength due to pain causes a decrease in the functional activities of the patients (15). Resistive muscle strength evaluation

Table 2. The relationship between upper extremity muscle strengths in the affected side and lateral epicondylitis function scores of the patients with chronic lateral epicondylitis

		LEFS score-Pain	LEFS score-Function	LEFS-Total
Shoulder flexion	r	-0.222	-0.228	-0.211
	p	0.143	0.132	0.163
Shoulder extension	r	-0.318*	-0.298*	-0.303*
	p	0.033	0.047	0.043
Shoulder abduction	r	-0.211	-0.260	-0.220
	p	0.164	0.084	0.147
Shoulder adduction	r	-0.093	-0.119	-0.085
	p	0.542	0.436	0.577
Shoulder internal rotation	r	-0.255	-0.242	-0.237
	p	0.092	0.109	0.117
Shoulder external rotation	r	-0.213	-0.242	-0.212
	p	0.160	0.109	0.162
Elbow flexion	r	-0.314*	-0.300*	-0.298*
	p	0.035	0.045	0.047
Elbow extension	r	-0.201	-0.296*	-0.241
	p	0.186	0.048	0.110
Pronation	r	-0.217	-0.229	-0.205
	p	0.153	0.130	0.176
Supination	r	-0.364*	-0.385**	-0.366*
	p	0.014	0.009	0.013
Wrist flexion	r	-0.233	-0.270	-0.247
	p	0.123	0.073	0.102
Wrist extension	r	-0.479**	-0.418**	-0.459**
	p	0.001	0.004	0.002

LEFS, lateral epicondylitis function scale
*p<0.05

Table 3. The relationship between the muscle endurance of the affected side in unsupported arm exercise test (in 1st and 2nd diagonal patterns) and Lateral Epicondylitis Function scores

		LEFS score-Pain	LEFS score-Function	LEFS score- Total
1st diagonal patterns				
Weight amounts	r	-0.385*	-0.383*	-0.389*
	p	0.009	0.009	0.008
Number of repeated movements	r	-0.466*	-0.498*	-0.483*
	p	0.001	0.001	0.001
Test duration	r	-0.256	-0.243	-0.237
	p	0.090	0.107	0.117
2nd diagonal patterns				
Weight amounts	r	-0.244	-0.255	-0.255
	p	0.106	0.090	0.090
Number of repeated movements	r	-0.405**	-0.416*	-0.421*
	p	0.006	0.004	0.004
Test duration	r	-0.100	-0.094	-0.103
	p	0.515	0.539	0.501

LEFS, lateral epicondylitis function scale.
*p<0.05

methods in the upper extremities are important in terms of showing the effects on the muscle and tendons generating the movement. The evaluation carried out with maximum isometric contraction against the resistance is an important indicator of muscle strength (4). Hand held dynamometer (HHD), is commonly used in clinic due to its simplicity and objectivity in measuring the muscle strength compared to the manual muscle test and the isometric dynamometer measuring isometric muscle strength (16). The studies in the literature focuses on the wrist extensors and grip strength of the hand muscles while evaluating the muscle strength in patients with lateral epicondylitis that are more related to the physiopathology of the disease (17), there have been no studies investigating the effects on functional activities of other upper extremity muscles. Considering the fact that shoulder and elbow joints provide a large movement area for functional hand movements besides the positioning and movement of the upper extremity in space, we think that shoulder and elbow joint muscle strength apart from flexor and extensor muscles of the hand can affect functional activities in patients with lateral epicondylitis. Langford et al. (18) reported that the muscular imbalance in the shoulder region can be a factor in the development of lateral epicondylitis and thus the compensatory movements of weak shoulder muscles can cause injuries in the elbow region due to excessive loads. However, the relationship between the strength of these muscles and functional activities has not been analysed. In this study, where we evaluated the shoulder, elbow, and wrist muscle strengths using HHD and examined their relationship with functional activities, it was determined that there is a negative but significant relationship between the shoulder extension, elbow flexion and supination, and wrist extension muscle strengths and total LEFS score. Considering the linear relationship between functional activities and the muscle strength of elbow flexor and supinator muscles which work synergistic to elbow movements (flexion/supination) along with shoulder extension, this situation was parallel to our study results. Thus, upper extremity muscle strength affects the upper extremity functional movements of patients with lateral epicondylitis.

Loss of muscular endurance is generally defined as the disability of a muscle or a muscle group in maintaining the required strength. A decrease in endurance causes more rapid development of fatigue and thus causes limitations in functional activities. The majority of daily life activities require dynamic muscular endurance with which we stay active or actively use upper extremity muscles (19). In our study, unsupported arm exercise test was used in the evaluation of the dynamic muscle endurance of upper extremities. Although there are many studies in the literature evaluating the muscle strength of patients with lateral epicondylitis (3, 4, 15) there are no studies evaluating the Proprioceptive Neuromuscular Facilitation (PNF) patterns and muscular endurance in this patient group. In the literature, it is stated that the PNF method is a valid method to be used for the assessment of the upper extremity muscle endurance not only in patients with lateral epicondylitis but also in COPD patients (19). The diagonal patterns used in PNF methods are movement combinations, which include natural upper extremity movements of humans (19). In our study, the relationship between the amount of loading, movement durations, number of repetitions and LEFS scores of the patients was analysed using PNF techniques in the 1st diagonal pattern (flexion, adduction, and external rotation movement of the shoulder) and 2nd diagonal pattern (flexion, abduction, and external rotation movement of the shoulder). It was found that the LEFS scores of patients with lateral epicondylitis are related to the amount of weight and number of repetitions in the 1st diagonal pattern and the number of repetitions in the 2nd diagonal pattern. One of the most prominent symptoms in the daily activities of the patients with lateral epicondylitis is the decrease in the number of repetitions of the activities (2). Thus, besides the decrease in the muscle strength, decreases in the endurance parameters also result in limitations in functional activities. Therefore, it can cause decrease in the number of repetitions in many activities such as writing and carrying a weight. There are no studies in the literature evaluating the muscular endurance of patients with lateral epicondylitis. In this study where the muscular endurance is evaluated with the PNF patterns for the first time, we determined that there was a decrease in LEFS score with the decrease in the number of repetitions, and thus limitation has occurred in functional activities.

As for the limitation of our study, there was no control group and the number of the participants was low. We think that more objective results can be obtained by including a control (healthy) group and more patients with lateral epicondylitis.

CONCLUSION

In conclusion, musculoskeletal problems occurring in patients with lateral epicondylitis cause significant decreases in the muscle strength and especially in muscular endurance. The decreases in muscular endurance lead to a decrease in the number of repetitions and the duration of activities. Thus, we consider that muscular endurance and strengthening exercises should be included in the physiotherapy programmes in order to increase the upper extremity functions that are decreased in patients with chronic lateral epicondylitis.

Informed Consent: Written informed consent was obtained from patient who participated in this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept - GM, GE, SB ; Design - GM, GE, SB; Supervision - GM, GE, SB; Resources - GM, GE, SB; Materials-GM, GE, SB ; Data Collection and/or Processing-GM, GE, SB ; Analysis and/or Interpretation - GM, GE, SB ; Literature Search - GM, GE, SB; Writing Manuscript - GM, GE, SB; Critical Review - GM, GE, SB

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REFERENCES

1. Ertem K, Ergen E, Yoloğlu S. Functional outcomes of arthroscopic treatment of lateral epicondylitis. Acta Orthop Traumatol Turc 2015;49:471–477. [CrossRef]
2. Viswas R, Ramachandran R, Korde Anantkumar P. Comparison of effectiveness of supervised exercise program and Cyriax physiotherapy in patients with tennis elbow (lateral epicondylitis): a randomized clinical trial. ScientificWorldJournal 2012;2012:939645. [CrossRef]
3. Lucado AM, Kolber MJ, Cheng MS, Echternach JL. Upper extremity strength characteristics in female recreational tennis players with and without lateral epicondylalgia. J Orthop Sports Phys Ther 2012;42:1025–1031. [CrossRef]
4. Fedorczyk JM. Tennis elbow: blending basic science with clinical practice. J Hand Ther 2006;19:146–153. [CrossRef] https://doi.org/10.1197/j.jht.2006.02.016
5. Ergun N, Baltacı G. Spor Yaralanmalarında Fizyoterapi ve Rehabilitasyon Prensipleri. Ankara: Pelin Ofset Yayıncılık; 2006. pp.36–112.
6. Yürük ZO, Kırdı N, Şimşek N. Effects of Radial Extracorporeal Shock Wave Therapy on Pain, Grip Strength, and Functionality in Patients with Lateral Epicondylitis: A Randomized Controlled Study [Lateral Epikondilitli Olgularda Radyal Ekstrakorporeal Şok Dalga Tedavisi Ağrı, Kavrama Kuvveti ve Fonksiyonellik Üzerine Etkisi: Randomize Kontrollü Çalışma]. Clin Exp Health Sci 2016;6:107–115. [CrossRef]
7. Altan L, Ercan I, Konur S. Reliability and validity of Turkish version of the patient rated tennis elbow evaluation. Rheumatol Int 2010;30:1049–1054. [CrossRef]
8. Hudak PL, Amadio PC, Bombardier C, et al. Development of an upper extremity outcome measure: the DASH (disabilities of the arm, shoulder and hand). The Upper Extremity Collaborative Group (UECG). Am J Ind Med 1996;29:602–608. [CrossRef]
9. Schrama PP, Stenneberg MS, Lucas, van Trijffel E. Intraexaminer reliability of hand-held dynamometry in the upper extremity: a systematic review. Arch Phys Med Rehabil 2014;95:2444–2469. [CrossRef]
10. de Souza GF, Castro AA, Velloso M, Silva CR, Jardim JR. Lactic acid levels in patients with chronic obstructive pulmonary disease accomplishing unsupported arm exercises. Chron Respir Dis 2010;7:75–82. [CrossRef]
11. Pienimäki TT, Siira PT, Vanharanta H. Chronic medial and lateral epicondylitis: a comparison of pain, disability, and function. Arch Phys Med Rehabil 2002;83:317–321. [CrossRef]
12. O'Driscoll SW. Physiotherapy or a wait-and-see policy were best long-term treatment options for lateral epicondylitis. J Bone Joint Surg Am 2002;84-A:1487.
13. Kaux JF, Delvaux F, Schaus J, et al. Cross-cultural adaptation and validation of the Patient-Rated Tennis Elbow Evaluation Questionnaire on lateral elbow tendinopathy for French-speaking patients. J Hand Ther 2016;29:496–504. [CrossRef]
14. Rompe JD, Overend TJ, MacDermid JC. Validation of the Patient-rated Tennis Elbow Evaluation Questionnaire. J Hand Ther 2007;20:3–11. [CrossRef]
15. Vaquero-Picado A, Barco R, Antuña SA. Lateral epicondylitis of the elbow. EFORT Open Rev 2017;1:391–397. [CrossRef]
16. Wang CY, Olson SL, Protas EJ. Test-retest strength reliability: hand-held dynamometry in community-dwelling elderly fallers. Arch Phys Med Rehabil 2002;83:811–815. [CrossRef]
17. Dorf ER, Chhabra AB, Golish SR, McGinty JL, Pannunzio ME. Effect of elbow position on grip strength in the evaluation of lateral epicondylitis. J Hand Surg Am 2007;32:882–886. [CrossRef]
18. Langford ML. Poor posture subjects a worker's body to muscle imbalance, nerve compression. Occup Health Saf 1994;63:38–40, 42.
19. Iridiastadi H, Nussbaum MA. Muscle fatigue and endurance during repetitive intermittent static efforts: development of prediction models. Ergonomics 2006;49:344–360. [CrossRef]