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Chronic lateral elbow tendinopathy with a supervised graded exercise protocol

Arzu Razak Özdinçler, PT, PhD[a], Zahide Seda Baktır, PT, PhD[b], Ebru Kaya Mutlu, PT, PhD[c], Ahmet Koçyiğit, PT, MSc[d,*]

[a] Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Biruni University, İstanbul, Turkey
[b] Faculty of Health Sciences, Physiotherapy and Rehabilitation Department, İstanbul Aydin University, İstanbul, Turkey
[c] Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Istanbul University-Cerrahpasa, İstanbul, Turkey
[d] Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Istanbul Gelisim University, Istanbul, Turkey

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ABSTRACT

Study Design: Prospective Case Series.
Background: Variety of studies inquired the effectiveness of exercise treatment in LET (Lateral Elbow Tendinopathy). The research on the effectiveness of these approaches are still ongoing and very much needed due to the uncertainty of the subject.
Purpose: We aimed to understand how the application of exercises in a graded manner affect the treatment outcomes in terms of pain and function.
Methods: This study is completed by 28 patients with LET and it was planned as a prospective case series. Thirty participants were included to participate in the exercise group. Basic Exercises (Grade 1) were performed for four weeks. Advanced Exercises (Grade 2) were performed for another four weeks. The VAS (Visual Analog Scale), pressure algometer, the PRTEE (Patient-Rated Tennis Elbow Evaluation) and a grip strength dynamometer were used to measure outcomes. The measurements were performed at baseline, at the end of four weeks and at the end of eight weeks.
Results: Investigation of the pain scores revealed that all VAS scores ($p < 0.05$, ES = 1.35; 0.72; 0,73 activity, rest, and night respectively) and pressure algometer results were improved both during basic ($p < 0.05$, ES = 0.91) and advanced exercises ($p < 0.05$, ES = 0,41). PRTEE scores were found to be improved in patients with LET after basic and advanced exercises ($p > 0.001$, ES = 1.15; $p > 0.001$, ES = 1.56 respectively). The grip strength only changed after basic exercises ($p = 0.003$, ES = 0.56).
Conclusions: The basic exercises were beneficial for both pain and function. However, advanced exercises are required for obtaining further improvements in terms of pain, function, and grip strength.

Introduction

Lateral elbow tendinopathy is a kind of soft tissue condition that is affecting 1%-3% of population.[1] Pain around the lateral epicondyle has variety of names including epicondylalgia, epicondylitis, periostitis, and tendinosis of Extensor Carpi Radialis Brevis. The definitions referring epicondylitis and periositis are discontinued over time. These descriptions were likely indicated an inflammatory origin.[2,3] Under chronic conditions, the affected tissue generally lacked inflammatory cells (macrophages, lymphocytes, and neutrophils).[4] In chronic cases, the problem was often degeneration origined and angiofibroblastic hyperplasia was the proof of immature tissue repair. For this reason, the term lateral epicondylitis may be revised as lateral elbow tendinopathy.[5]

Range-of-motion (ROM) exercises, stretching, strengthening, and functional exercises are advised to be included in the treatment programs according to the current literature.[5] Stretching exercises cause elongation in the muscle-tendon unit. However, it is still unknown whether the stretching should be static or ballistic, also the issue of selection in isometric or isotonic strengthening exercises still persists in this area.[1,2] Viswas et al claimed that eccentric exercises were better for pain management and functionality in tendinopathies.[6] Dimitrios advocated for the heavy slow resistance program which includes both concentric and eccentric

* Corresponding author. Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Istanbul Gelisim University, Istanbul, Turkey.
E-mail address: akocyigit@gelisim.edu.tr (A. Koçyiğit).

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exercises. It is hypothesized to be more beneficial than only eccentric training in management of pain and function in LET.[7]

All the upper quadrant muscles should properly function in order to carry out the activities of daily living. Otherwise, upper extremity problems like lateral elbow tendinopathy may cause deterioration of the function and decrease in quality of life. However, there isn't any specific exercise protocol in the literature about the management of LET as it exists in shoulder and knee injuries. In the literature it was emphasized that the exercises should be modified to the tolerance and the capability of the patients.[7] Patients with LET may have difficulty in performing exercises in an appropriate manner due to pain. The pain causes alterations in movement strategies and postural deviations, affecting other joints which in turn causes functional disability in time. To avoid the pain-related inactivity during the early stages of the disease, we planned a graded exercise model. The main focus of our supervised graded exercise plan revolves around the pain tolerance and tissue healing process. This regulation enables us to re-structure our exercise program accordingly with patients' tolerance in a graded manner.[8]

In the beginning, a program including warm-up, isometric strengthening, and functionally oriented exercises are collectively named as basic protocol. The transition to the advanced program is decided with the symptomatic feedback and the change in VAS activity scores, inquired during basic exercises. Advanced exercise program consists of stretching along with both concentric and eccentric strengthening exercises. It was hypothesized that more benefit would be obtained because of the transition between two grades of exercises, which is planned accordingly with tolerance of patients with LET. The primary aim of our study; was to determine the effectiveness of basic exercise protocol on pain, functional status, grip strength and the change in Nirschl Pain Scale (NPS) (Table 2). Secondary aim was to reveal the effects of the re-structured advanced exercise protocol on these parameters after the pain intensity was reduced as a result of the basic exercise protocol.

Materials and methods

A prospective case series study was conducted on patients with LET. Patients were referred to the physiotherapy unit of the authors' institution from the Department of Orthopedics and Traumatology of a University. They received written and verbal explanations about the procedures of the study protocol to be applied. They signed informed consent forms, which were approved by the ethical committee of a Public Hospital.

Patients eligible for inclusion in this study were aged between 30 and 50 years due to this range being the most common for this diagnosis, and all had a prior LET diagnosis.[9,10] There was atleast a year before the last treatmet received for LET for all participants. In the clinic where our research was conducted, the diagnosis of lateral epicondylitis is made by anamnesis and clinical examination. Typical pain location, spread and special tests (Cozen Test and Mills Test) are applied by the orthopedist and, if necessary, ultrasound imaging is done and sent to the PT department with a confirmed diagnosis. These diagnostic procedures were conducted by a single doctor for the duration of the study. The participants were outlined in Figure 1. The patients were between the stages 4-6 of NPS (Fig. 2). All patients diagnosed with lateral epicondylitis between NPS stages 4-6 were referred to the clinic, patients with NPS stages 1 through 3 are referred for a home exercise program. Electrotherapy and injection protocol is applied to patients who are in stage 7 of NPS. The exclusion criteria were neoplasia, pregnancy, neurologic deficits, cervical radiculopathy, periferal nerve disease, rheumatoid arthritis, shoulder disease, radial tunnel syndrome, previous surgery of the affected upper extremities, congenital or acquired bone deformity in ipsilateral upper extremity, the initiation of opioid analgesia or corticosteroid or analgesic injection interventions within the previous year, any physical therapy intervention on the upper extremity in the previous year, bilateral elbow tendinopathy and secondary orthopedics problems.[11]

Intervention

Initially, all groups received basic exercise program for four weeks, three times a week. Exercises were evaluated monthly by a physiotherapist; all complaints and suggestions were recorded. Equipment required for the exercises were elastic finger band, one kilogram weight or an equivalent dumbell, hand exercise ball and a towel. The physiotherapist checked and revised their exercise programs according to the change of VAS-Activity scores. At the end of four weeks of basic treatment, three-unit decrease (Minimal Clinical Important Difference for VAS Score) was aimed for progression.[12] For home exercises, patients were provided with a logbook and were asked to log all their exercises. For clinical applications there was constant physiotherapist supervision for the entire duration, there was no specific qualifications required for the providing physiotherapist other than a minimum of five years in clinical practice, due to the exercises being under the definition of the profession. The participants who fulfilled these criteria continued their advanced exercises for another four weeks. Both the basic and two exercises were conducted for four weeks, for a total of 12 sessions. Additionally, at the beginning of an exercise program, a brief patient education was given to teach how to act during any work activity or computer use. The maintenance of the neutral wrist position, especially avoiding the palm down position, along with the proper usage of the two-handed position and a two-kilogram limit of load per hand during any carrying activities were emphasized.[13]

Basic Exercise Program: Basic exercise program consisted of a warm-up, isometric strengthening exercise and functionally-oriented exercises which adapt to the patients daily activities were applied three times daily with 10 repetitions.[14] (Appendix A). However, neither stretching nor isotonic strengthening exercises were allowed in the basic rehabilitation, so as not to disrupt the healing process.

Advanced Exercise Program: During prior clinical observations, we determined that the stretching exercises and isotonic strengthening exercises, including both concentric and eccentric, might create discomfort and/or irritating sensation during the first four weeks of the rehabilitation.[14] For this reason, it was decided that these exercises were not appropriate for the basic protocol. After basic exercises were terminated, stretching and isotonic strengthening exercises are used to retrain in the bearable limits with patients for another four weeks. Stretching for wrist extension motion was applied daily with five repetitions. For wrist extensor muscle, eccentric strengthening exercises were practiced two times a day with 10 repetitions. The concentric and eccentric strengthening exercises were started with the use of a dumbell or theraband according to the capabilities of patients. Warm-up exercises existing in basic protocol were replaced by stretching, along with concentric and eccentric strengthening exercises (Appendix A). Patients have continued their re-structured exercise program for another four weeks.

Outcome measurement

Pain was measured by VAS, Pain Pressure Threshold (PPT), the level of function determined with the PRTEE Questionnaire, and grip strength measurement. The outcome measurements were performed at baseline, after basic, and two exercise programs.

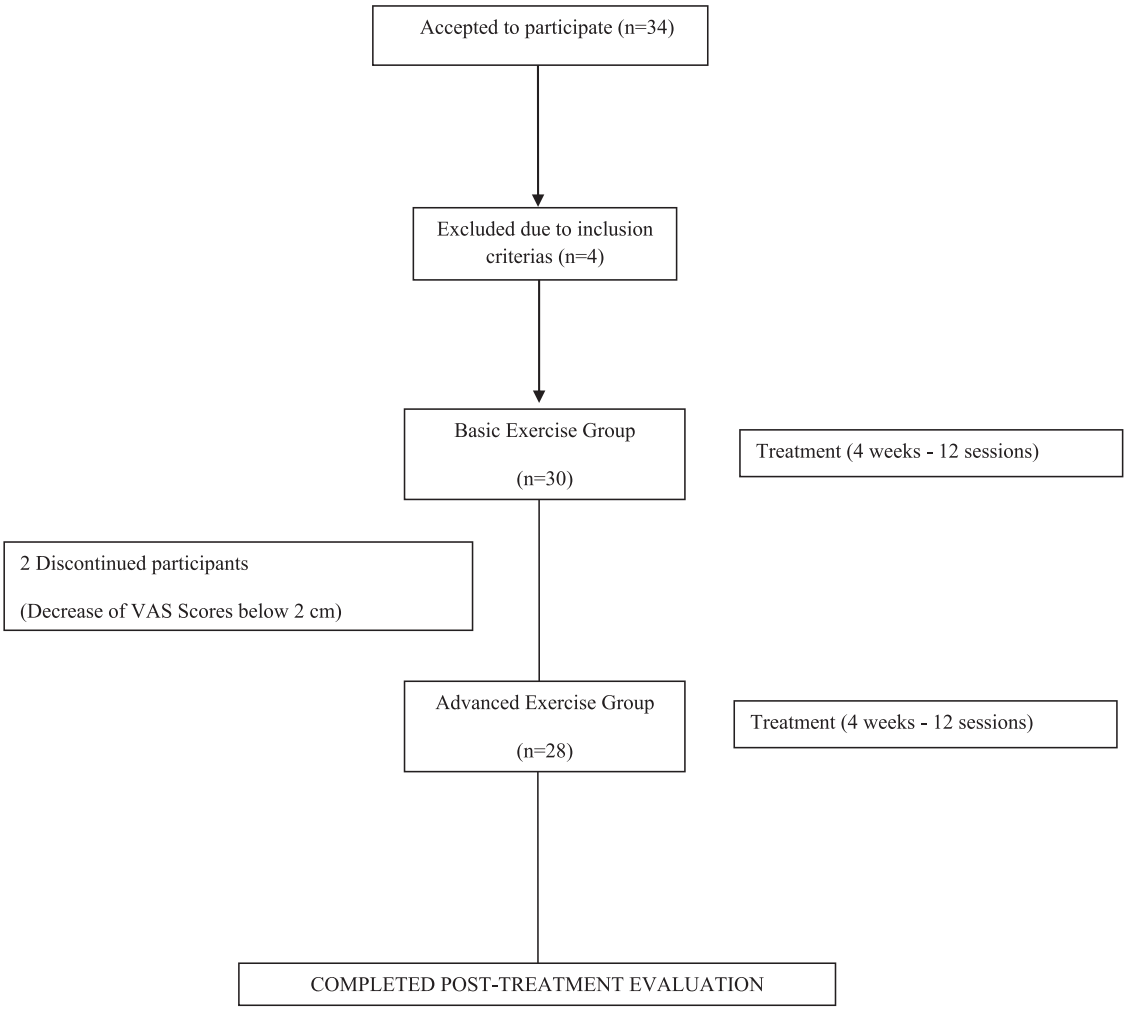

Fig. 1. Design of the study (STROBE flow diagram).

Pain

Visual Analog Scale (VAS): Pain intensity was assessed with VAS, during rest, activity and at night (0-10 visual analog scale, with zero as no pain and 10 as worst imaginable pain).[12]

Pain Pressure Threshold: The pain was measured by using a Baseline 1200-304 system (Push-Pull Force Gauge; Fabrication Enterprises, Inc). The handheld pressure algometer enables a linear response to force application between 0 and 10 kg (22lbs × 1/4 lb and 10 kgs × 100 gm). The PPT was assessed in all participants at the lateral epicondyle.[15] The patient was sitting with the shoulder at 30^0 abduction, the elbow at 90° flexion; the forearm, wrist, and hand supported on the table. Three measurements of PPT were taken as the amount of pressure required to elicit a sensation of pain, distinct from pressure sensation.[16]

Level of function

Patient Rated Tennis Elbow Evaluation (PRTEE): PRTEE is a simple, reliable, and valid form for the evaluation of pain and function that is specifically oriented for patients diagnosed with lateral epicondylosis.[17,18] The tool was developed by MacDermid and published with reliability statistics in 1999,[19] had an update in 2005,[20] and was independently evaluated by Rompe et al in 2007.[21] The Turkish version demonstrated high reliability and validity as reported by Altan et al in 2010.[22] The tool consists of two subscales. The first part includes five questions investigating the pain status and the second part involves 10 questions investigating the level of function in both daily (four items) and usual activities (six items) during the previous week. The symptoms are inquired by using a 0-10 numeric pain rating.[21] In our study, we calculated total PRTEE scores as well as subscales of PRTEE score that include PRTEE-P (pain) and PRTEE-F (function) scores.

Grip Strength Measurement: A hand-held dynamometer (Baseline Hydraulic Hand Dynamometer; Fabrication Enterprises Inc, Irvington, NY) was used for the measurement. The handle of the meter was adjusted in the position, as advised by Mathiowetz et al.[23] The diameter of the dynamometer is 1,5 inches. The American Society of Hand Therapists proposed a standardized arm position for grip strength evaluation described as the shoulder in adduction, elbow at an angle of 90° flexion, and wrist in neutral.[23,24] The mean values of three evaluations (kilograms force) were recorded and used in the analyses.[22]

Statistical analyses

All the data was evaluated using SPSS (the Statistical Package for the Social Sciences) version 20.0 for Windows. Descriptive statistics were analyzed (frequency, mean and standard deviation). NPS was given as a percentage value before treatment and after

Phase 1	Stiffness or mild soreness appear after activity. Pain resolves within 24 hours.
Phase 2	Stiffness and mild soreness occur before activity and is relieved by warm-up. Pain re-appears after activty and lasts up to 48 hours.
Phase 3	Stiffness and mild soreness occur before specific sport and occupational activity and partially relieved by warm-up. Pain minimally present during activty but no alteration occurs during the activity.
Phase 4	The symptoms are more intense than phase 3. Pain causes performance issues in the athlete and is mild during activities of daily living but does not cause major disruptions.
Phase 5	Significant pain occurs before, during and after activity and causes disruptions in pattern of activity. The pain occurs during activities of daily living but does not cause a major change.
Phase 6	Phase 5 levels of pain persist even with rest. Pain distrupts even simple activities of daily living.
Phase 7	Phase 6 levels of pain persists and also distrupts the sleep consistently. Pain is aching in nature and intensifies with activity.

Fig. 2. The classification of pain according to Nirschl Pain Phase Scale.

each grade of exercise. Before the statistical analysis, Shapiro-Wilk test was used to assess the distribution of data. Collected data was found to be normally distributed and thus a parametric test was used for the statistical analysis. Paired sample t tests were used for statistical analysis of the before- after basic and two exercises comparisons for pain level, muscle strength, and function. Effect size was separately calculated for each phase of treatment.[25] ES of 0.2 was considered small, 0.5 moderate, and 0.8 large. P values lower than 0.05 were considered statistically significant for all of the analysis results.

Results

Thirty-four patients were evaluated for possible inclusion. Thirty patients meeting with inclusion criteria of the study were included. At baseline, 13 of 30 patients belonged to the stage four, nine of 30 patients belonged to stage five and eight of 30 patients belonged to stage six according to NPS LET stages. After basic exercise distribution of patients' stages according to NPS were changed respectively to values zero (one participant), one (one participants), two (four participants), three (13 participants), four (nine participants), five (two participants). Advanced exercise progression was not planned for two people who took place, they were stage one and two according to NPS due to the lack of symptoms after basic exercises, as not to affect the distribution of results in the study (Fig. 1) [https://www.nirschl.com/elbow-tendinosis/]. Twenty-eight patients were re-assessed after basic exercise program to recruit in the advanced exercise program. After advanced exercises, distribution of patients' pain stages according to NPS was changed to respectively to values zero (three participants), one (two participants), two (11 participants), three (12 participants). The demographic data of the participants are presented in Table 1. The mean age and body mass index were similar in both groups, also all the participants were right-handed.

According to the pain in VAS and in PPT scores, after basic exercise, patients had a lower score than before treatment indicating improvement (VAS-Activity $p > 0.001$, ES = 1.35; VAS-Rest $p = 0.007$, ES = 0.72; VAS-night $p > 0.001$, ES = 0.73; PPT $p = 0.002$, ES = 0.91). Additionally, a significant decrease in VAS and PPT scores were found after advanced exercise in patients with LET (VAS-Activity $p = 0.005$, ES = 1.73; VAS-Rest $p = 0.01$, ES = 1.00; VAS-Night $p = 0.01$, ES = 1.03; PPT $p = 0.002$,

Table 1
Demographic features

Values	
Age (years) (Mean±SD)	46.17 ± 8.41
Length (cm) (Mean±SD)	165.38 ± 6.44
Weight (kg) (Mean±SD)	78.59 ± 14.80
BMI (kg/m²) (Mean±SD)	28.73 ± 5.19
Affected Side (Percentage)	65.5% Right Side
Female (Percentage)	55.2%
Male (Percentage)	44.8%
Smoking(Percentage)	27.6%
Injection (Percentage)	17.2%
Comorbidity (Percentage)	31%
Time of prior symptoms	48 ± 8 wk

ES = 1.40). Functional evaluation after basic exercise and after advanced exercise were evaluated with PRTEE and were found improvement in all patients with LET ($p > 0.001$, ES = 1.15; $p > 0.001$, ES = 1.56 respectively). The grip strength only changed after basic exercises ($p = 0.003$, ES = 0.56) (Table 3).

Discussion

In this study, both the basic and advanced exercises resulted in an improvement of pain and function. The modification and progression of the basic treatment program into a more advanced program gradually contributes to better results, especially in terms of grip strength. It was shown that the advanced exercises are a necessary part of treatment for getting more benefit in terms of pain and function. Performing basic program for four weeks enables the ease of symptoms, and after the progression into the advanced exercises, further benefits are gained in function. We've observed that in basic exercises; stretching along with concentric and eccentric exercises could not be tolerated by patients because of the pain. The graded nature of the intervention of this study was designed to test a more feasible approach for such exercises due to their proven advantages.

ROM exercises, isometric strengthening, and some function-based exercises were included in the basic program. Park et al compared the difference between early inclusion of isometric exercises at the beginning and after four weeks of medication use.[26] This study concluded that adding isometric exercises to the program in the early course of treatment was more advantageous than adding at four weeks.[26] For this reason, the isometric exercises have been started from the beginning of the basic program. The LET occasionally causes limitation in ROM because of abnormal pain processing. Painful state of the disease leads to the under-use of the involved extremity, which contributes to weakening of the tendon-bone connection, as such, Picado et al theorized the maintenance of reduced activity levels and basic functional abilities in the early term of treatment is preferable to complete rest.[27] During basic treatment, we tried to prevent immobilization and apply controlled forces on tissues without aggravating pain response. Based on Cohen et al after the immobilization period, pain reappears as soon as activities are resumed.[28] Controlled loading of tendons enables the healing process to move on more efficiently. The aim of the inclusion of functionally oriented exercises in the basic program was to provide affinity with daily activities before proceeding to a more advanced approach.

Exercise options intended for LET include static stretching exercises, strengthening; isometric, isotonic (concentric and eccentric), isokinetic, functional, and occupational exercises performed for the wrist.[29,30] Pienimaki et al[30] mentioned the success of their treatment program, which includes isometric & isotonic forearm exercises, stretching exercises and functional exercises for forearm muscles. The requisite of eight weeks to get progress in treatment was emphasized for patients that have a high level of baseline pain.[30] Olaussen et al compared the effect of the corticosteroid injections and a sham injection, which was applied as an addition to a rehabilitation program consisting of stretching, eccentric strengthening exercises, and Mill's manipulation in acute phase of LET.[31] The marked benefit of corticosteroid injection was apparent only at six weeks. After the termination of the treatment; the improvements could not be preserved while steroid injections caused worse results when compared with the control group. It was hard to discriminate the success of this treatment approach because of its multi-model design. After three months of treatment, there were no significant differences between groups on pain reduction, function, and grip strength. This study was also inefficient in terms of an exhibition of the isolated effect, concerning individual forms of exercises. Svernlöv et al compared stretching and eccentric training groups. It was shown that eccentric training is more advantageous for recovery of symptoms, including pain and grip strength in the short term.[32] However, after one year, no differences were detected between groups.

Eccentric exercises are mentioned as a cornerstone intervention in a variety of tendinopathies because it results in "lengthened" muscle-tendon complex and structural remodeling of the tendon with hypertrophy and increased tensile strength of the tendon.[33] It may also provide neuromuscular benefits through central adaptation and co-contraction of both agonist and antagonist muscles. Mafi et al mentioned that eccentric loading might cause pain response and painful overload.[34] Therefore, these exercises were postponed to advanced program in our study. Each step of our intervention was designed according to our patient populations' previously observed range and abilities. Söderberg et al found that the use of a forearm band, accompanying eccentric exercises was superior to the isolated use of the forearm band in terms of pain and function at six weeks.[35] It is asserted that eccentric strengthening exercises has a positive effect on pain, function, and grip strength. Wen et al compared the effects of eccentric exercises with iontophoresis and stretching exercises.[36] It is found that there is no significant difference between the groups in terms of pain. Despite many reports documenting favorable results with eccentric exercises for other tendinopathies, this particular study was unable

Table 2
Nirschl stages of patients before treatment, after basic exercise and after advanced exercise.

Nirschl Stages	Before treatment ($N = 30$)	After grade 1 exercise ($N = 30$)	After grade 2 exercise ($N = 28$)
0		1 (% 3.33)	3 (% 10.72)
1		1 (% 3.33)	2 (% 7.14)
2		4 (% 13.34)	11 (% 39.28)
3		13 (% 43.34)	12 (% 42.86)
4	13 (% 43.33)	9 (% 30)	
5	9 (% 30)	2 (% 6.66)	
6	8 (26.66)		
7			

Table 3
Changes of outcome measurements before treatment, after basic and advanced exercises.

	Before treatment	After basic exercises	p*	Effect size	After advanced exercises	p**	Effect size	p***	Effect size
VAS-activity (cm)	7.31 ± 2.31	4.17 ± 2.49	**>0.001**	1.35	3.31 ± 2.42	**>0.001**	1.73	**0.005**	0.34
VAS-rest (cm)	4.55 ± 2.94	2.41 ± 2.48	**0.007**	0.72	1.59 ± 2.06	**>0.001**	1.00	**0,01**	0.33
VAS-night (cm)	5.31 ± 3.69	2.58 ± 2.86	**>0.001**	0.73	1.48 ± 2.42	**>0.001**	1.03	**0.01**	0.38
Algometer (kg)	3.61 ± 1.03	4.55 ± 1.22	**0.002**	0.91	5.06 ± 1.62	**0.001**	1.40	**0.02**	0.41
PRTEE	56.23 ± 23.58	29.00 ± 19.13	**>0.001**	1.15	19.29 ± 15.46	**>0.001**	1.56	**>0.001**	0.50
Grip Strength (kg)	17.10 ± 7.11	21.09 ± 8.31	**0.003**	0.56	21.98 ± 8.77	**0.001**	0.68	0.307	0.10

* Values in bold indicate a statistically significant change between before the treatment to after basic exercises.
** Values in bold indicate a statistically significant change between before the treatment to after advanced exercises.
*** Values in bold indicate a statistically significant change between before the basic exercises to after advanced exercises.

to show any statistical advantage to eccentric exercises over conventional therapy for LET. Woodley et al emphasized that there is insufficient evidence to regarding the effect of eccentric exercises over the concentric exercise in LET.[37] Due to lack of any evidence verifying the novel strengthening method, no definitive conclusion could take place regarding the predominant type of strengthening exercises. Peterson et al compared concentric and eccentric graded exercises by modifiying the applied load. It was emphasized that eccentric graded exercises was more beneficial than concentric strengthening in terms of rapid pain reduction and increased grip strength.[38] Therefore, it was suggested that the eccentric exercises should be given at the appropriate dosage.

We also found improvements in pain pressure threshold after the advanced program. This indicates that the basic program causes increase in tolerance of pressure which could be interpreted as a decrease in the perception of pain. In the light of these findings, we can alter the pain perception by adding the stretching and eccentric strengthening exercises with the help of proper timing and dosage. In our study, several exercises including isometric strengthening, stretching along with concentric and eccentric strengthening were taking place in the protocol, like other studies in the literature. However, the hallmark effect of our exercises was achieved with appropriate combination and progression according to the patients' potential.

Our study has some limitations. Firstly, we relatively had a small sample size. Secondly, our study lacked any long-term follow up results of subjects. On the other hand, all the patients were diagnosed by the same orthopedist. Additionally, the two patients excluded from advanced program continued basic program for the rest of their treatment. This was due to their pain decrease being less then two centimeters in VAS, it was determined they would benefit more from the basic program and so they were excluded from the final assessment. This is the first study to include variety of exercises during different periods of treatment determined by the change in NPS (Fig. 2). In LET treatment the exercise plan was precautiously constituted with grading exercises according to the situation of patients that are periodically observed under supervision. Our program mainly focused on wrist exercises but the integration of scapular exercises to basic might be a new perspective for future studies.

Appendix

Chronic lateral elbow tendinopathy with a supervised graded exercise protocol appendix A.

Basic and advanced (Grade 1-2) treatment program Exercise	Details	Figure
Warm-up exercises (GRADE 1 - Basic) All of these movements are performed with 10 repetititon three times daily.		
Wrist extension	Patient sits at the table and the wrist is rest on the table in neutral position. Patient takes the wrist to the extension and hold at the end range 10 seconds.	
Wrist circumduction	Patient sits at the table and the wrist is rest on the table in neutral position. Patient makes small circles with the wrist.	

(*continued on next page*)

(*continued*)

Basic and advanced (Grade 1-2) treatment program Exercise	Details	Figure
Warm-up exercises (GRADE 1 - Basic) All of these movements are performed with 10 repetititon three times daily.		
Wrist radial and ulnar deviation	Patient sits at the table and the wrist is rest on the table in neutral position. Patient is requested to take the wrist towards the thumb and hold at the end range for 10 seconds than return to neutral. Patient is requested to take the wrist towards the little finger and hold at the end range for 10 seconds than return to neutral.	
Pronation	Patient is in sitting positon. The elbow at 90° flexion in midposition next to the trunk. Patient is requested to turn the palm to the ground and to keep the position for 10 seconds.	
Supination	Patient is in sitting positon. The elbow at 90° flexion in midposition next to the trunk. Patient is requested to turn the palm to the ceiling and to keep the position for 10 seconds.	
Isometric strengthening exercises (GRADE 1- Basic) All of these movements are performed with 10 repetititon three times daily.		
Wrist extension	Patient sits at the table. Affected shoulder is adduction and 30° flexion while resting on the table. Elbow and wrist are also supported on the table in extension and wrist is in 90^0degree extension. Patient applies resistance with the palm of other hand to the dorsum of affected hand without appearing active extension in affected wrist. Patient is requested to keep the end-range of position for 10 seconds.	
Stretching exercises (Grade 2 - Advanced) All of these movements are performed with five repetititon three times daily.		
Wrist extension	Patient is in upright position or sits at the table. Affected shoulder is taken in 90^0-degree flexion, elbow is in extension and pronation and wrist is in 90^0 degree flexion. Patient tries to increase the range of wrist flexion in affected hand by pulling it towards the body with the help of other hand. Patient is requested to keep the end-range of position for 30 seconds.	

(*continued on next page*)

(*continued*)

Basic and advanced (Grade 1-2) treatment program		
Exercise	Details	Figure
Warm-up exercises (GRADE 1 - Basic)		
All of these movements are performed with 10 repetititon three times daily.		
Eccentric-concentric strengthening exercises (Grade 2- Advanced)		
All of these movements are performed with 10 repetition two times daily.		
Wrist flexion and extension	Patient sits at the table. Affected shoulder is taken in 60^0 degree flexion, elbow is in extension and supination and supported on the table and wrist is at the end of the table in extendeded position. Patient applies a resistance by taking the wrist to end range flexion while holding one kg dumbell. Patient is requested to keep the end-range of position for 10 seconds. After this the patient takes the wrist in extenson by lowering dumbell below the level of table. Patient is requested to keep the end-range of position for 10 seconds.	
Functionally-oriented exercises (Grade 1 - Basic)		
All of these movements are performed with 10 repetititon three times daily.		
Finger extension	Patient surrounds the finger with an elastic finger band. Patient makes closer the finger tips while the finger is in extension. After that the patient tries to keep the finger in extension against the resistance of band.	
Gripping	Patient is requested to squeeze the ball which is enclosed with the palm of affected hand.	
Towel squeezing	Patient is in upright or sitting positon. The shoulder is in 60^0 degree flexion and elbow is in extension with pronation. Patient is requested to take the affected wrist in full extension towards the body and the other hand in full flexion towards the ground.	

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Quiz: # A04

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1. The study design is
   a. qualitative
   b. RCTs
   c. case series
   d. case study

2. Outcomes of _____ were evaluated
   a. function and pain
   b. pain and ROM
   c. return to work rates
   d. patient satisfaction

3. Protocols called for
   a. bilateral application of all elements during both programs
   b. ultrasound and icing in addition to exercise during the advanced program
   c. only isometric exercises for strengthening throughout both programs
   d. isotonic and stretching exercises were not included in the basic program

4. Grip strength
   a. did not improve
   b. improved after both basic and advanced exercises
   c. improved after basic exercises
   d. improved after advanced exercise

5. VAS scores improved after both basic and advanced exercises
   a. false
   b. true

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