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Strengthening the Flexors Muscles in Lateral Elbow Tendinopathy Management - A Pilot Study

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Abstract

Background: *The most effective physical therapy approach for Lateral Elbow Tendinopathy (LET) is an exercise program. The present pilot trial aims to compare the effectiveness of an exercise program with wrist extensors' loading and an exercise program with wrist flexors' loading in the treatment of LET.*

Patients and Methods: *A randomized clinical pilot trial was carried out with 24 patients who had LET in a research center. They were randomly allocated to two groups. Group A (n=12) was treated with extensors wrist loading. Flexors' wrist loading was given to group B (n=12). All patients received five treatments per week for four weeks. The pain was evaluated using a visual analog scale, and the function was assessed using a visual analog scale, as well as pain-free grip strength at the end of the four-week course of treatment (week 4) and one month (week 8) after the end of treatment.*

Results: *No differences were found between the groups at the end of treatment (P>0.05) and the follow-up (P>0.05).*

Conclusion: *A progressive exercise program consisting of eccentric-concentric training combined with isometric contractions of wrist extensors and / or flexors and stretching exercises of wrist extensors decreases pain and increases function in LET patients with the forearm in supination or pronation.*

Keywords: *Lateral elbow tendinopathy, exercise, training.*

1. Introduction

Lateral elbow tendinopathy (LET) is the most common tendinopathy in the elbow area. Although the diagnosis of LET is simple and quick, no ideal treatment has emerged[1]. A conservative treatment is usually advocated by the majority of physicians. Therefore, physiotherapy is provided. A lot of physical therapy approaches have been provided for the management of LET such as manual therapy, soft tissue manipulation, external support, physical agents, and heavy-slow resistance exercise[1]. Such a plethora of approaches suggests that the gold standard treatment strategy is unknown, and further research is needed to find the most effective treatment approach in LET patients.

The most effective physical therapy approach for LET is an exercise program, supervised or in clinical placement[2,3]. A progressive exercise program consisting of eccentric-concentric training combined with isometric contractions and stretching exercises of wrist extensors decreases pain and increases function in LET patients with the forearm in supination or pronation[4-8]. However, there is a possibility patients cannot load the wrist extensors due to pain. In this situation, the wrist extensors can be loaded indirectly and gently, loading the wrist flexors. To our knowledge, there have been no studies to assess the effectiveness of wrist flexors loading for LET management. Therefore, the present article compares the effects of an exercise program with extensors wrist loading and an exercise program with flexors wrist loading on pain and function in patients experiencing LET.

2. Methods

A randomized controlled, monocentre pilot trial was conducted in a research centreover 24 months to assess the effectiveness of an exercise program with extensors wrist loading and an exercise program with flexors wrist loading on pain and function in patients experiencing LET. A parallel group design was used because crossover designs are limited in situations where patients are cured by the intervention and do not have the opportunity to receive the other treatments after crossover[9]. Three investigators were involved in the study: (1) a physiotherapist, the primary investigator, (DS) who evaluated the patients to confirm the LET diagnosis and allocated patients to groups, (2) a physiotherapist who performed all baseline and follow-up assessments, and gained informed consent and (3) a physiotherapist, who administered the treatments. All assessments were conducted by a physio who was blind to the patient's therapy group. The same physio interviewed each patient to ascertain baseline demographic and clinical characteristics, including patient name, sex, age, duration of symptoms, previous treatment, occupation, the affected arm, and the dominant arm.

Patients over 18 years old who were experiencing lateral elbow pain were examined and evaluated in the research centre in Athens between November 2021 and September 2022. All patients lived in Athens, Greece were native speakers of Greek, and were either self-referred or referred by their physician or physiotherapist.

Patients were included in the study if, at the time of presentation, they had been evaluated as having clinically diagnosed LET for at least 3 months. Patients were included in the trial if they reported (a) pain on the facet of the lateral epicondyle when palpated, (b) less pain during resistance supination with the elbow in 90∘ of flexion rather than in full extension, and (c) pain in at least two of the following four tests [9]:

1. Tomsen test (resisted wrist extension)
2. Resisted middle finger test
3. Mill's test (full passive flexion of the wrist)
4. Handgrip dynamometer test.

Patients were excluded from the study if they had one or more of the following conditions: (a) dysfunction in the shoulder, neck (radiculopathy), and/or thoracic region; (b) local or generalized arthritis; (c) neurological deficit; (d) radial nerve entrapment; (e) limitations in arm functions; (f) the affected elbow had been operated on and (g) had received any conservative treatment for the management of LET in the 4 weeks before entering the study[10-12].

All patients received a written explanation of the trial before entry into the study. All patients gave signed informed consent to participate in the study. The topical ethical committee approved the study.

The patients were randomly allocated to two groups by drawing lots. Patients in Group A were treated with an exercise program with extensors wrist loading (for the trial this group will be called wrist extension) and patients in Group B were treated with an exercise program with flexors wrist loading (for the trial this group will be called wrist flexion).

All patients were instructed to use their arms during the study but to avoid activities that irritated the elbow such as grasping, lifting, knitting, handwriting, driving a car, and using a screwdriver. They were also told to refrain from taking anti-inflammatory drugs throughout the study. Patient compliance with this request was monitored using a treatment diary.

Communication and interaction (verbal and non-verbal) between the therapist and patient were kept to a minimum, and behaviors sometimes used by therapists to facilitate positive treatment outcomes were purposefully avoided. For example, patients were given no indication of the potentially beneficial effects of the treatments or any feedback on their performance in not indicating the pre-application and post-application measurements[12].

The patients in the wrist extension group followed a supervised exercise program as reported in a previously published trial[4]. The elbow was on the bed extended, the forearm pronated, the wrist in extension (and the hand hanging at the edge of the table. From this position, subjects flexed their wrists and then returned to the extension (starting position). In the starting position, subjects carried out an isometric contraction of wrist extensors. When the isometric contraction finished the subjects carried out the eccentric-concentric contraction and so on. The exercise involved isolated wrist extension and flexion paced to an external audio/visual cue on the patients' smartphone (PR Metronome; http://eumlab.com/pro-metronome/). Subjects were to track the movement and listen to the sound of the metronome with their eyes. Each beat was ten seconds apart so that the pace of the metronome was settled to 6 beats per minute. This allowed a ten-second eccentric, concentric, and isometric phase.

In the wrist flexion group the elbow was on the bed extended, the forearm supinated, and the wrist in extension. From this position, subjects flexed their wrists and then returned to the extension (starting position). In the full flexion final position, subjects carried out an isometric contraction of wrist flexors. When the isometric contraction finished the subjects carried out the eccentric-concentric contraction and so on. The exercise involved isolated wrist extension and flexion paced to an external audio/visual cue on the patients' smartphone (PR Metronome; http://eumlab.com/pro-metronome/). Subjects were to track the movement and listen to the sound of the metronome with their eyes. Each beat was ten seconds apart so that the pace of the metronome was settled to 6 beats per minute. This allowed a ten-second eccentric, concentric, and isometric phase.

Both groups performed three sets of 15 repetitions of slow progressive exercises of the wrist extensors / flexors (according to the group) at each treatment, with a 1-minute rest interval between each set. Subjects were informed to continue with the exercise even if they complained of mild pain. However, subjects were informed to stop the exercise if the pain became disabling. The disabling and mild pain were monitored asking the subjects to rate the pain on VAS before and after the treatment period. The definition of mild pain was below 4 on VAS whereas the definition of disabling pain was above 8 on VAS[10,13]. When subjects were able to carry out the exercise program without experiencing any discomfort or pain, free weights were used to increase the load.

The treatment groups performed static stretching exercises of the wrist extensors[4,7,10,12]. Three times before and three times after the exercises, six times in total were repeated the static stretching exercises at each treatment session, with a 30-second rest interval between each repetition. The other hand helped to perform the static stretching exercises of the wrist extensors. The patient's elbow was placed in an extended position, the forearm in a pronated position, and the wrist in ulnar deviation and flexion according to the patient's tolerance. 30 - 45 seconds was holding this position each time and then releasing.

The above-reported exercise program was followed 5 times per week for 4 weeks and was individualized based on the patient's description of pain experienced during the process[4].

Pain, function, and drop-out rate were measured in the present study. Each patient was evaluated at the baseline (week 0), at the end of treatment (week 4), and at 1 month (week 8) after the end of treatment.

The pain was measured on a visual analog scale (VAS), where 0 (cm) was "least pain imaginable" and 10 (cm) was "worst pain imaginable". The pain VAS was used to measure the patient's worst level of pain over the previous 24 hours before each evaluation, and this approach is valid and sensitive to the VAS[14].

The function was measured using a VAS, in which 0 (cm) was taken as "no function" and 10 (cm) as "full function". Patients were instructed to report their overall level of elbow function over the previous 24 hours before each evaluation, and this approach is valid and sensitive to the VAS[14].

In addition, the function was measured by pain-free grip strength. Pain-free grip strength is defined as the amount of force each patient can generate with an isometric gripping action before eliciting pain[12]. Force was measured in pounds with a Jamar hand dynamometer that had adjustable handles to accommodate different hand sizes. The arm was placed in a standardized position of elbow extension, forearm pronation, and internal rotation of the upper limb such that the palmar aspect of the hand faced posteriorly with the upper limb placed by the patient's side. Patients were then instructed to squeeze the dynamometer handles until they first experienced pain and then to release their grip[12]. The attained grip force was subsequently recorded, and the reading was not visible to the patient. Three measures of pain-free grip strength were recorded with a 30-second rest interval between each measurement, and the mean value of these repetitions was calculated.

A drop-out rate was also used as an indicator of treatment outcome. Reasons for patient dropout were categorized as follows: (1) a withdrawal without reason; (2) not returned for follow-up and (3) request for an alternative treatment.

The change from baseline was calculated for each follow-up. Differences between groups were determined using the independent t-test. The difference within groups between baseline and end of treatment was analyzed with a paired t-test. A 5% level of probability was adopted as the level for statistical significance. SPSS version 20 statistical software was used for the statistical analysis.

3. Results

Twenty eight patients who were eligible for inclusion visited the research center within the trial period. Two were unwilling to participate in the study and two did not meet the inclusion criteria described above. The other 24 patients were allocated into one of the two possible groups: (1) wrist extension group (n=12; 4 male, 8 female; mean age = 44.8 years +-SD=4.7 years), (2) wrist flexion group (n=12; 5 male, 7 female; mean age=44.6 years +_SD=4.8 years) Patient flow through the trial is summarized in a CONSORT flow chart (Figure 1).

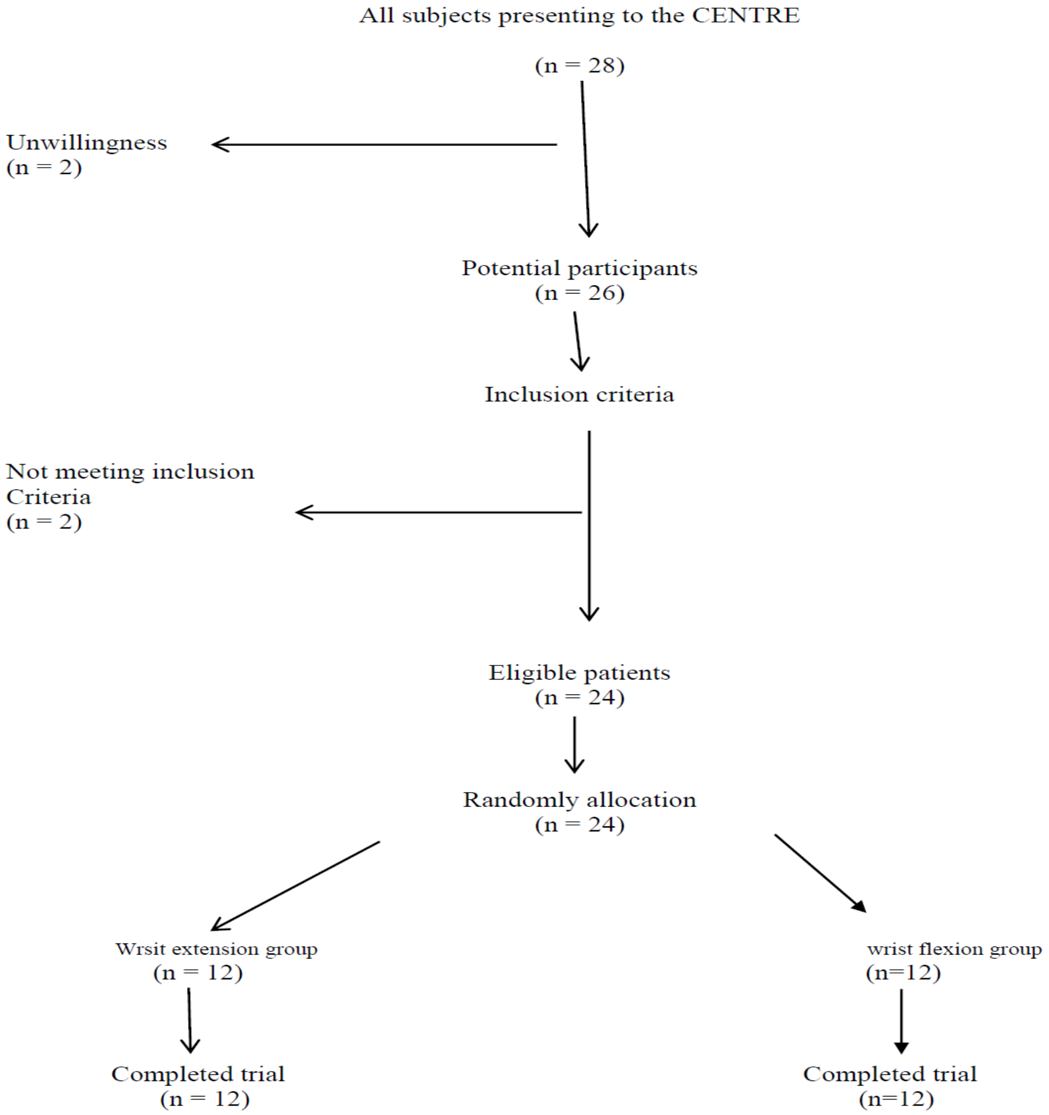

Figure 1. *Flow chart of the study.*

At baseline, there were more females in the groups (6 in total). The mean age of patients was approximately 45 years and the duration of LET was approximately nine months. LET was in the dominant arm in 95% of patients. There were no significant differences in mean age (p.0.0005, independent t-test) or the mean duration of complaints (p.0.0005, independent t-test) between the groups. Drug therapy has been tried by all patients. All patients were manual workers.

Baseline pain on VAS was 8.8 (95% CI 8.43 to 9.2) for the whole sample (n = 24; Table 1). There were no significant differences between the groups for baseline pain (p>0.05 independent t-test; Table 1). At week 4, there was a decline in VAS of about 7 units in the wrist extension group and 7 units in the wrist flexion group compared with the baseline (p<0.0005, paired t-test; table 2). There were no significant differences in the magnitude of reduction between the groups at weeks 4 and 8 (p<0.0005 independent t-test; Table 2).

The baseline function on VAS was 3.5 (95% CI 3.22 to 4.58) for the whole sample (n = 24; Table 1). There were no significant differences between the groups for baseline function (p>0.05 independent t-test; Table 1). At week 4, there was a rise in VAS of approximately 5 units in the wrist extension group and 5 units in the wrist extension group compared with the baseline (p<0.0005, paired t-test; table 2). There were no significant differences in the magnitude of improvement between the groups at weeks 4 and 8 (p< 0.0005 independent t-test; Table 2)

The baseline pain-free grip strength was 25.32 lb (95% CI 24.12 to 26.56) for the whole sample (n = 24; Table 1). There were no significant differences between the groups for baseline pain-free grip strength (p>0.05 independent t-test; Table 1). At week 4, there was a rise in pain-free grip strength of approximately 37 units in the wrist extension group and 36 units in the wrist flexion group compared with the baseline (p<0.0005, paired t-test; Table 2). There were no significant differences in the magnitude of improvement between the groups at weeks 4 and 8 (p0.0005 independent t-test; table 2).

There were no drop-outs and all patients completed the study.

Table 1. *Pain, function, and pain-free grip strength over the 24 h before each evaluation*

	Wk 0	Wk 4	Wk 8
Pain			
WRIST EXTENSION GROUP	8.79 (8.28 to 9.13)	1.77 (1.33 to 2.25)	1.34 (1.06 to 1.81)
WRIST FLEXION GROUP	8.81 (8.24 to 9.16)	1.79 (1.37 to 2.28)	1.35 (1.08 to 1.83)
Function			
WRIST EXTENSION GROUP	3.51 (3.25 to 4.02)	8.48 (7.62 to 8.89)	8.58 (7.81 to 8.92)
WRIST FLEXION GROUP	3.53 (3.23to 4.07)	8.46 (7.64 to 8.93)	8.55 (7.79 to 8.86)
Pain-free strength (lb)			
WRIST EXTENSION GROUP	25.35 (24.79 to 25.92)	61.8 (61.02 to 62.24)	62.05 (62.32 to 62.25)
WRIST FLEXION GROUP	25.31 (24.72 to 25.81)	60.6 (59.84 to 60.96)	61.16 (60.77 to 61.71)

Table 2. *Change in pain, function, and pain-free grip strength over the 24 h before each evaluation from baseline*

	Pain (cm)		Function (cm)		Pain-free grip strength (lb)		
	EXT	FLEX	EXT	FLEX	EXT	FLEX	p Value
Week 4	−7.02	−7.02	4.97	4.93	36.45	35.29	>0.0005
Week 8	−7.45	−7.46	5.07	4.02	36.7	35.85	>0.0005

4. Discussion

The results obtained from this randomized clinical trial are novel, as to date there have been no data comparing the effects of an exercise program with extensors wrist loading and an exercise program with flexors wrist loading in LET patients. No differences were found between the groups at the end of treatment and the follow-up. A supervised exercise program was followed in the present study because it was found that exercise programs under supervision present better results faster[15-17]. An exercise program with flexors wrist loading can be recommended when the patients cannot load the wrist extensors for some reason, such as pain. It is thought that the wrist extensors can be loaded indirectly and gently, loading the wrist flexors.

Progressive eccentric training of wrist extensors has shown good clinical results in LET patients[18-20]. Such exercise training is used as the first treatment option for LET patients[16]. However, many patients with LET do not respond to eccentric exercises for wrist extensors alone[2,21,22]. Thus, eccentric exercises of wrist extensors are combined with static stretching exercises for extensor carpi radialis brevis (ECRB) with positive results[4,10,11,13]. Stretching may make the tendon more resistant to strain or strengthen it increasing the range of motion of the relevant joint[23,24]. Moreover, stretching contributes to the orientation of the new collagen fibers with a “lengthening” of the muscle-tendon unit[25]. For these reasons stretching exercises of ECRB were used for the wrist flexion group in the present study.

The management of LET is changing, and in our days eccentric training of wrist extensors is not the only exercise option[2]. Few studies on progressive eccentric training of wrist extensors have been published in the last decade[21]. Physicians should consider concentric-eccentric training of wrist extensors alongside or instead of eccentric training for the rehabilitation of LET with the forearm in pronation or supination[26]. For the same reason, the present trial used concentric-eccentric training of wrist flexors loading gently and indirectly the wrist extensors, as mentioned above.

Martinez-Silvestrini et al.[27] stated that LET patients require isometric contraction because

LET is often related to forceful grip activities. More research is needed to conclude the effectiveness of isometric training in tendinopathy since conflicting results have been found in terms of immediate and short-term pain relief [28-30]. Isometric exercise can be used as part of a supervised progressive loading exercise program[4]. Bateman et al. (2022) tried to develop an optimized physiotherapy treatment protocol for the treatment of people with LET[31]. They recommended that isometric exercises, as part of the exercise program, should be performed for up to 60 s with maximal resistance and repeated five times, once daily[31]. It was determined that the exercise should provoke pain to a level that the individual patient deemed acceptable to them[31]. It was hypothesized that static stretching exercises and the simultaneous use of isometric and isotonic contractions will decrease pain and improve function in LET patients. Therefore, isometric contractions for wrist flexors were used in this trial.

The exercise training in LET should include progressive strengthening exercises not only for wrist flexors/ extensors but also for supinator, rotator cuff, and scapular muscles[32,33]. Using supinator, rotator cuff, and scapular muscles progressive strengthening loading, LET patients will carry out painless activities such as gripping, increasing the function of the arm.

Moreover, reduced proprioception has also been noticed in LET patients[34]. The reduced proprioception is usually ignored by clinicians in the treatment of LET; thus, the symptoms may persist for a long time, and recurrence is common. If physiotherapists use approaches to improve reduced proprioception, the results will be effective earlier[35].

The sounds of a metronome did the exercise. This affects neuroplasticity [23,24,36,37] the relationship between pain and changes in motor control. Tendon neuroplastic training; TNT, affects the central sensitization that occurs in chronic pain [38].

Finally, motor and sensory system deficits are common in the non-injured extremity of patients with unilateral LET[39]. This suggests that specific training of the contralateral extremity may also provide additional benefits to the affected extremity through cross-education[40]. Unfortunately, a pilot study did not support the previous[41].

The load of exercises was increased according to the patient's symptoms otherwise the results were poor[42]. Furthermore, eccentric exercises were performed at a low speed in every treatment session because this allows tissue healing[43]. Ice was recommended at the end of the treatment but research has shown that ice as a supplement to an eccentric exercise program offers no benefit to patients with tendinopathy[13]. Finally, the avoidance of painful activities is crucial for tendon healing, because training during the treatment period increases patients' symptoms and delays tendon healing[44].

The mechanism of action of wrist extensors' loading in LET has been examined and discussed in the literature[1]. On the other hand, the way that wrist flexors' loading achieves the goals remains uncertain, as there is a lack of good quality evidence to confirm that physiological effects translate into clinically meaningful outcomes and vice versa. The clinical improvement of the HSR group was accompanied by increased collagen turnover. It is unknown if the isometric contractions can reverse the pathology of the tendinopathy and in this case the pathology of LET or reduce only the pain.

However, this trial does have some shortcomings. First, a power analysis was not performed. Second, no placebo (sham) or no treatment group was included in the present trial. The placebo (sham)/no treatment group is important when the absolute effectiveness of a treatment is determined. However, the absolute effectiveness of technique-based interventions is difficult to investigate because a good and trustworthy placebo (sham)/no treatment control for exercise programs appears to be difficult or impossible to devise, due in part to difficulties in defining the active element of these treatments. Absolute effectiveness also does not provide the therapists with information as to which is the most appropriate treatment for the management of a condition, in this case, LET. Third, other activities and treatments patients might be getting when not in the centre were not monitored. Patients' diaries suggested that patients were compliant with the study instructions, although patients may have given incorrect details to please the investigators. For example, it was possible that patients followed the treatment but took analgesic medications at the same time, and the improvement of symptoms may be due to those medications. Therefore, ways should be found to measure how other treatments such as analgesic medications contribute to the improvement of symptoms. Finally, the blinding of patients and therapists would be problematic in that case, if not impossible, because patients know if they are receiving the exercise program treatment and therapists need to be aware of the treatment to administer it appropriately. In addition to the previously reported weaknesses, structural changes in the tendons related to the treatment intervention were not shown, and the intermediate and long-term effects (6 months or more after the end of treatment) of treatments were not investigated. Further research is needed to establish the possible mechanism of action of this treatment approach, and the cost-effectiveness of such treatment, because the reduced cost is an important issue for the recommendation of any given treatment.

In conclusion, a progressive exercise program consisting of eccentric-concentric training combined with isometric contractions of wrist extensors and / or flexors and stretching exercises of wrist extensors decreases pain and increases function in LET patients with the forearm in supination or pronation. Using the recommended exercise training of the present trial adding a progressive loading of the whole upper limb, would be the ideal exercise program in the management of LET. The rest recommended physical therapy modalities such as manual therapy, soft tissue manipulation, external support, physical agents (mentioned in the first paragraph of introduction) should not be substitute but instead added to an exercise program. More research is required to discover which treatment approach, if exists a treatment approach, combined with progressive exercise loading will provide the best results in LET patients.

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