

An exercise programme for the management of lateral elbow tendinopathy

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Background: Home exercise programmes and exercise programmes carried out in a clinical setting are commonly advocated for the treatment of lateral elbow tendinopathy (LET), a very common lesion of the arm with a well-defined clinical presentation. The aim of this study is to describe the use and effects of strengthening and stretching exercise programmes in the treatment of LET.

Eccentric exercises: Slow progressive eccentric exercises for LET should be performed with the elbow in extension, forearm in pronation, and wrist in extended position (as high as possible). However, it is unclear how the injured tendon, which is loaded eccentrically, returns to the starting position without experiencing concentric loading and how the "slowness" of eccentric exercises should be defined. Nor has the treatment regimen of the eccentric exercises of a supervised exercise programme been defined.

Stretching exercises: Static stretching is defined as passively stretching a given muscle-tendon unit by slowly placing and maintaining it in a maximal position of stretch. We recommend the position should be held for 30–45 s, three times before and three times after eccentric exercises during each treatment session with a 30 s rest interval between each procedure. The treatment region of static stretching exercises when a supervised exercise programme is performed is unknown.

Discussion: A well designed trial is needed to study the effectiveness of a supervised exercise programme for LET consisting of eccentric and static stretching exercises. The issues relating to the supervised exercise programme should be defined so that therapists can replicate the programme.

Lateral elbow tendinopathy (LET), commonly referred to as lateral epicondylitis and/or tennis elbow, is one of the most common lesions of the arm. LET is a degenerative or failed healing tendon response characterised by the increased presence of fibroblasts, vascular hyperplasia, and disorganised collagen in the origin of the extensor carpi radialis brevis (ECRB), the most commonly affected structure.¹ It is generally a work related or sport related pain disorder usually caused by excessive quick, monotonous, repetitive eccentric contractions and gripping activities of the wrist.² The dominant arm is commonly affected, with a prevalence of 1–3% in the general population.³ Although LET occurs at all ages, the peak prevalence of LET is between 30 and 60 years of age.^{4,5} The proportion of those afflicted by LET is not influenced by the sex of the patient, but the disorder appears to be of longer duration and severity in females.^{4–6}

LET is usually defined as a syndrome of pain in the area of the lateral epicondyle,^{4,7,8} the main complaints being pain and decreased function, both of which may affect activities of daily living. Diagnosis is simple and can be confirmed by tests that reproduce the pain, such as palpation over the facet of the lateral epicondyle, resisted wrist extension, and resisted middle finger extension.⁷

Although the signs and symptoms of LET are clear and its diagnosis is easy, to date no ideal treatment has emerged. Many clinicians advocate a conservative approach as the treatment of choice for LET.^{9–12} Physiotherapy is a conservative treatment that is usually recommended for LET patients.^{10,13,14} A wide array of physiotherapy treatments have been recommended for the management of LET.^{10,15–17} These treatments have different theoretical mechanisms of action, but all have the same aim, to reduce pain and improve function. Such a variety of treatment options suggests that the optimal treatment strategy is not known, and more research is needed to discover the most effective treatment in patients with LET.

One of the most common physiotherapy treatments for LET is the exercise programme.^{11–13} There are two types of exercise programme: home exercise programmes and exercise programmes carried out in a clinical setting. A home exercise programme is commonly advocated for LET patients because it can be performed any time during the day without requiring supervision by a physiotherapist. Our clinical experience, however, has shown that home exercise programmes are rarely effective because patients fail to comply with the regimen.¹⁸ Only exercise programmes performed in a clinical setting under the supervision of a physiotherapist appear to be at all effective. For the purposes of this report, "supervised exercise programme" will refer to such programmes. Exercise programme advocates claim that this is the most effective treatment for LET^{19–21} and our clinical experience supports this assumption. Further research is needed to confirm this but is beyond the scope of the present article. The aim of this study is to describe the use and the effects of exercise programmes in the treatment of LET (as we have already done for Cyriax physiotherapy²²).

EXERCISE PROGRAMMES

The literature on this subject suggests that strengthening and stretching exercises are the main components of exercise programmes because tendons must not only be strong but also flexible.^{9,13,20,23}

The treatment regimen of home exercise programmes for other tendinopathies similar to LET is usually once or twice daily for at least 3 months.^{29–34} The treatment regimen of supervised exercise programmes is not known with certainty, but our experience suggests that such programmes should be administered at least three times per week for 4 weeks.¹⁸ The most likely explanations for this difference in the treatment

Abbreviations: ECRB, extensor carpi radialis brevis; LET, lateral elbow tendinopathy; RCT, randomised controlled trial

regimen of exercise programmes may be the compliance of patients and/or the clinical route/routine.

STRENGTHENING EXERCISES

There are essentially three forms of musculotendinous contractions that strengthen soft tissue structures such as tendons: (i) isometric, (ii) concentric, and (iii) eccentric.²⁴⁻²⁶ Most therapists agree that eccentric contractions appear to have the most beneficial effects for the treatment of LET.^{1 13 19-21 23 24 27} Moreover, therapists advocate eccentric exercises only for the injured tendon and not for all tendons in the relevant anatomical region. In the case of LET, eccentric training should be performed for the extensor tendons of the wrist, including the ECRB tendon which LET most commonly affects.^{19-21 24 26 27}

Eccentric exercises

The three principles of eccentric exercises are: (i) load (resistance); (ii) speed (velocity); and (iii) frequency of contractions.

Load (resistance)

One of the main principles of eccentric exercises is increasing the load (resistance) on the tendon. Increasing the load clearly subjects the tendon to greater stress and forms the basis for the progression of the programme. Indeed, this principle of progressive overloading forms the basis of all physical training programmes. Therapists believe that the load of eccentric exercises should be increased according to the patient's symptoms, otherwise the possibility of re-injury is high.^{1 9 13 19-21 23 24 28} The rate of increase of the load cannot be standardised among patients during the treatment period although anecdotal evidence in the form of discussion with therapists suggested that they did not have a protocol to account for how the injured tendon, which is loaded eccentrically, returns to a starting position without experiencing concentric loading. Therapists claim that this concentric loading has no or little effect on the management of the injured tendon, but, in order to demonstrate the real effects of eccentric exercise, clinicians would need ways to avoid concentric loading of the tendon.

Speed (velocity)

Another basic principle of successful eccentric exercises is the speed (velocity) of contractions. Stanish *et al*,²⁴ Fyfe and Stanish,²⁶ and Stanish *et al*²¹ state that the speed of eccentric training should be increased in every treatment session, thus increasing the load on the tendon to better simulate the mechanism of injury, which usually occurs at relatively high velocities. However, other therapists claim that eccentric contractions should be performed at a slow velocity to avoid the possibility of re-injury.^{1 13 19 20 23} We concur with this latter opinion because, in contrast to traumatic events which produce rapid eccentric forces, low velocity eccentric loading presumably does not exceed the elastic limit of the tendon and generates less injurious heat within the tendon.¹ Therapists do not define the "slowness" of eccentric exercises. The most likely explanation for this lack of definition is the therapists' claim that in order to avoid pain, patients perform the eccentric exercises slowly anyway. Nevertheless, when an exercise programme treatment protocol is developed, the slowness of eccentric exercises should be defined. Failure to do so will make it difficult for therapists to replicate the exercise programme and put it into practice.

Frequency of contractions

The third principle of eccentric exercises is the frequency of contractions. Sets and repetitions can vary in the literature, but therapists claim that three sets of ten repetitions, with

the elbow in full extension, forearm in pronation and with the arm supported, can normally be performed without overloading the injured tendon, as determined by the patient's tolerance.^{1 13 21 23 24 26 28}

If the affected arm is not supported, our experience has shown that patients complain of pain in other anatomical areas distant from elbow joint, such as the shoulder, neck, and scapula. Furthermore, therapists claim that the elbow has to be in full extension and the forearm in pronation because, in this position, the best strengthening effect for the extensor tendons of the wrist is achieved.^{12 23}

Recommendations for the application of eccentric exercises for the treatment of LET

Based on the above evaluation, eccentric exercises for LET should be performed on a bed with the elbow supported on the bed in full extension, forearm in pronation, wrist in extended position (as high as possible), and the hand hanging over the edge of the bed. In this position, patients should flex their wrist slowly until full flexion is achieved, and then return to the starting position. Patients are instructed to continue with the exercise even if they experience mild pain. However, they are instructed to stop the exercise if the pain becomes disabling. They should perform three sets of 10 repetitions at each treatment session, with at least a 1 min rest interval between each set. When patients are able to perform the eccentric exercises without experiencing any minor pain or discomfort, the load is increased using free weights or therabands.

However, no literature was retrieved that explained the following three issues: (i) how the injured tendon, which is loaded eccentrically, returns to the starting position without experiencing concentric loading; (ii) the treatment regimen of the eccentric exercises; and (iii) how the slowness of eccentric exercises should be defined. All these issues should be answered so a complete treatment protocol for exercise programmes can be established. The starting and final positions of eccentric exercises, the increase in the load, and the degree of mild or disabling pain cannot properly be standardised because all these are individualised by patients' descriptions of pain experienced during the procedure.

STRETCHING EXERCISES

Even though a variety of stretching techniques, such as ballistic, static, and proprioceptive neuromuscular facilitation movements, have been proposed to increase flexibility, there is a concern as to which stretching techniques and/or procedures should be used for optimal gains in flexibility. Flexibility has been defined as the range of motion possible about a single joint or through a series of articulations.^{35 36} Therapists claim that static stretching, an extremely effective and simple stretching procedure, is the most widely used stretching technique.^{9 13 21 24 26 37}

Static stretching exercises

Static stretching is defined as passively stretching a given muscle-tendon unit by slowly placing it in a maximal position of stretch and sustaining it there for an extended period of time.^{13 38} This maximal stretching position is determined by the moderate discomfort and/or pain that the patient experiences.^{21 36 37} Static stretching exercises are individualised by patient feedback as to the discomfort and/or pain experienced during the procedure.

Therapists advocate static stretching exercises only for the injured tendon and not for all tendons in the anatomical region. In the case of LET, static stretching should be performed for the ECRB tendon, the site most commonly affected by LET.^{20 21 24} The best stretching position result for the ECRB tendon is achieved with the elbow in extension,

forearm in pronation, and wrist in flexion and with ulnar deviation, according to the patient's tolerance.²³ Recommendations for the optimal time for holding this stretching position vary, ranging from as little as 3 s to as much as 60 s.^{39–43} Therapists believe that a stretch for 30–45 s is most effective for increasing tendon flexibility.^{13 21 23 24 26 37 42}

A static stretch should be repeated several times per treatment session, although the first stretch repetition results in the greatest increase in muscle-tendon unit length.^{13 23 35–38} Taylor *et al*³⁸ report that more than 80% of a muscle-tendon unit length can be obtained after the fourth repetition of a static stretch. Stanish *et al*,²⁴ Fyfe and Stanish,²⁶ and Stanish *et al*²¹ claim that six repetitions of static stretching exercises should be performed in each treatment session, divided into an equal number of repetitions, with three before and three after eccentric training. Clinicians suggest a 15–45 s rest interval between each repetition.^{13 37} However, there is no information concerning the treatment regimen for static stretching exercises. As was described in the eccentric exercises section, this information is available for home exercise programmes based on other tendinopathies similar to LET and for a supervised exercise programme based on the authors' experience.

Logically, it would seem that increasing tissue temperature before stretching would increase the flexibility of the muscle-tendon unit; however, many therapists believe that stretching with or without a warm up yields the same results.^{37 41}

Recommendations for the application of static stretching exercises for the treatment of LET

Based on the previously reported evaluation, static stretching exercises for LET should be applied slowly with the elbow in extension, forearm in pronation, wrist in flexion and with ulnar deviation according to the patient's tolerance, in order to achieve the best stretching position result for the ECRB tendon, which is the injured tendon in LET. This position should be held for 30–45 s, three times before and three times after the eccentric exercises during each treatment session with a 30 s rest interval between each procedure. No literature was found to establish the treatment regimen of static stretching exercises for exercise programmes. The static stretching exercises will be individualised by the patient's description of the discomfort and pain experienced during the procedure.

HOW EXERCISE PROGRAMMES WORK

How an exercise programme relieves pain remains uncertain. It is claimed that eccentric training results in tendon strengthening by stimulating mechano-receptors in tenocytes to produce collagen, which is probably the key cellular mechanism that determines recovery from tendon injuries.^{19 20 32} In addition, eccentric training may induce a response that normalises the high concentrations of glycosaminoglycans. It may also improve collagen alignment of the tendon and stimulate collagen cross-linkage formation, both of which improve tensile strength^{19 20 28 32} as supported by experimental studies on animals.⁴⁴

It has also been proposed that the positive effects of exercise programmes for tendon injuries may be attributable to either the effect of stretching, with a lengthening of the muscle-tendon unit and consequently less strain experienced during joint motion, or the effects of loading within the muscle-tendon unit, with hypertrophy and increased tensile strength in the tendon.²⁹ Ohberg *et al*⁴⁵ believe that, during eccentric training, the blood flow is stopped in the area of damage and this leads to neovascularisation, the formation of new blood vessels, which improves blood flow and healing in the long term.

Exercise programmes appear to reduce pain and improve function, reversing the pathology of LET although there is a lack of good quality evidence to confirm that physiological effects translate into clinically meaningful outcomes.

STUDIES IN WHICH EXERCISE PROGRAMMES FOR LET HAVE BEEN USED

An electronic search for clinical studies was carried out in six databases: Medline (from 1966 to February 2005), EMBASE (from 1988 to February 2005), Cinahl (from 1982 to February 2005), Index to Chiropractic Literature (from 1992 to February 2005), SportDiscus (from 1990 to February 2005), and CHIROLARS (from 1994 to February 2005). The following key words were used individually or in various combinations: "tennis elbow", "lateral epicondylitis", "lateral epicondylalgia", "rehabilitation", "treatment", "management", "exercise programme", "exercise therapy", "clinical studies", and "randomized controlled clinical studies".

Only English language publications were considered. An attempt was made to identify other references from existing reviews, books, and other papers cited in the publications searched. Additional reports were sought from the reference sections of papers that were retrieved, following contact with experts in the field, from the Cochrane Collaboration clinical trial register (last search February 2005) and from internet sites. Unpublished reports and abstracts were included in the review.

Although no previously published trials have examined the effectiveness of supervised exercise programmes for LET, a home exercise programme has been used in some previously published clinical trials on LET^{46–52} and was the sole treatment in one previously published randomised controlled trial (RCT).⁴⁶ A home exercise programme was only part of the treatment approach in other studies^{47–52} and, therefore, it was not possible to establish with certainty the degree to which the home exercise programmes contributed to the overall results.

In the only previously published RCT,⁴⁶ the effectiveness of a home exercise programme was compared with ultrasound. Pienimäki *et al*⁴⁶ found that the home exercise programme was a more effective treatment than ultrasound at the end of the treatment. However, their treatment protocol (type of exercises, intensity, frequency, duration of treatment) was totally different to that employed in the present report and research should continue to investigate the long term effects of their treatment methods.

Therefore, there is clearly a need for a well designed trial to study the effectiveness of an exercise programme for LET consisting of eccentric and static stretching exercises. Previously published randomised and non-randomised trials found that such a home exercise programme reduced the pain in patellar³³ and Achilles tendinopathy,^{29–32 34} respectively. However, home exercise programmes were performed once or twice a day for approximately 3 months in all previously published studies. In contrast, Stasinopoulos and Stasinopoulos⁵³ administered a supervised exercise programme three times per week for 4 weeks for the management of patellar tendinopathy with resulting pain reduction. Thus, it seems that a supervised exercise programme may give good clinical results in a shorter period of time than a home exercise programme. The most likely explanation for this difference is that a supervised exercise programme achieves a higher degree of patient compliance. Therefore, it is preferable to study the effectiveness of a supervised exercise programme for the management of LET in a future trial. Unanswered issues relating to exercise programmes need to be examined in a study where: (i) the non-injured extremity is used to return the injured extremity to the

What is already known on this topic

Exercise programme consisting of eccentric and static stretching exercises are claimed to be an effective treatment for the management of LET.

What this study adds

Future well designed trials are needed to establish the relative and absolute effectiveness of eccentric and static stretching exercises for LET.

starting position; (ii) the subjects perform the eccentric contractions from full flexion to full extension counting to 30; and (iii) the treatment regimen is carried out three times a week for 4 weeks. Such a trial will be completed in the near future.

CONCLUSIONS

Although exercise programmes are commonly used in the treatment of LET, more research is needed to assess, firstly, their effectiveness and, secondly, the mechanism of action of both their components.

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