Comparison of effects of a home exercise programme and a supervised exercise programme for the management of lateral elbow tendinopathy

D Stasinopoulos,[1,2,3] I Stasinopoulos,[1] M Pantelis,[4] K Stasinopoulou[1]

[1]Rheumatology and Rehabilitation Centre, Athens, Greece
[2]School of Health and Human Sciences, Leeds Metropolitan University, Leeds, UK
[3]Department of Physiotherapy, TEI Lamias, Lamia, Greece
[4]Private Clinic, Ithaki, Greece

Correspondence to
Dr Dimitrios Stasinopoulos, Rheumatology and Rehabilitation Centre, 20 Xinda Street, Athens 11141, Greece; d_stasinopoulos@yahoo.gr

Accepted 28 August 2008
Published Online First 3 November 2009

ABSTRACT

Background Home and supervised exercise programmes consisting of stretching and eccentric exercises have been recommended for the management of lateral elbow tendinopathy (LET). No studies have examined their comparative efficacy effectiveness.

Objective In this study, whether a home exercise programme is more successful than a supervised exercise programme in treating patients with LET was investigated.

Methods Patients with unilateral LET for at least 4 weeks were included in this trial. They were sequentially allocated to receive either a home exercise programme or a supervised exercise programme five times a week for 12 weeks. The exercise programme consisted of slow progressive eccentric exercises of wrist extensors and static stretching of the extensor carpi radialis brevis tendon. Outcome measures were pain, using a visual analogue scale, and function, using a visual analogue scale and the pain-free grip strength. Patients were evaluated at baseline, at the end of treatment (week 12), and 3 months (week 24) after the end of treatment.

Results 70 patients met the inclusion criteria. At the end of treatment, there was a decline in pain and a rise in function in both groups compared with baseline ($p<0.0005$, paired t test). There were significant differences in the reduction of pain and the improvement of function between the groups at the end of treatment and at the 3-month follow up; the supervised exercise programme produced the largest effect ($p<0.0005$, independent t test).

Conclusions Supervised exercise programme is superior to home exercise programme to reduce pain and improve function in patients with LET at the end of the treatment and at the follow-up. Further research is needed to confirm our results.

Lateral elbow tendinopathy (LET), commonly referred to as lateral epicondylitis, lateral epicondylalgia, lateral epicondylosis and/or tennis elbow is one of the most common lesions of the arm. However, LET is the most appropriate term to use in clinical practise because all the other terms make reference to inappropriate aetiological, anatomical and pathophysiological terms.[1] The condition is usually defined as a syndrome of pain in the area of the lateral epicondyle[2–4] that may be degenerative or failed healing tendon response rather than inflammatory.[5] Hence, the increased presence of fibroblasts, vascular hyperplasia, proteoglycans and glycosaminoglycans together with disorganised and immature collagen may all take place in the absence of inflammatory cells.[5] The origin of the extensor carpi radialis brevis (ECRB) is the most commonly affected structure.[5] It is generally a work-related or sport-related pain disorder. The dominant arm is commonly affected, the peak prevalence of LET is between 30 and 60 years of age,[2 6] and the disorder appears to be of longer duration and severity in women.[2 6 7]

The main complaints of patients with LET are pain and decreased function[2 8–12] both of which may affect daily activities. Diagnosis is simple, and a therapist should be able to reproduce this pain in at least one of three ways: (1) digital palpation on the facet of the lateral epicondyle, (2) resisted wrist extension and/or resisted middle-finger extension with the elbow in extension, and (3) by getting the patient to grip an object.[1 8–10]

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.[2 8 11] Physiotherapy is a conservative treatment that is usually recommended for LET patients.[11 13 14] A wide array of physiotherapy treatments have been recommended for the management of LET.[11 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.[11 18–20]

One of the most common physiotherapy treatments for LET is an exercise programme.[8 13 21] One consisting of eccentric and static stretching exercises has shown good clinical results in LET[22 23] as well as in conditions similar to LET in clinical behaviour and histopathological appearance, such as patellar[24–28] and Achilles tendinopathy.[29–34] Such an exercise programme is used as the first treatment option for our patients with LET.[35]

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 patients with tendinopathies such as LET because it can be performed any time during the day without requiring supervision from a physiotherapist, and the patient visits the therapist once or twice per week for further instructions; whereas in the exercise programme carried out in the clinic, the patient visits the clinic every day to carry out the exercise programme under the supervision of the therapist. Therefore, the exercise programmes carried out in a clinical setting are called supervised exercise programmes.[23 35] Previous trials have found that a home exercise programme reduced the pain in patellar[24–28] and Achilles[29–34] tendinopathy. In contrast, Stasinopoulos and his colleagues used a supervised exercise programme in the management of LET.[22 23 25]

To our knowledge, there have been no studies to compare the effectiveness of these two exercise programmes for the management of LET. Therefore, the aim of the present article was to make a comparison of the effects of a home exercise programme and a supervised exercise programme for the treatment of LET.

METHODS

A controlled, monocentre trial was conducted in a clinical setting over 27 months to assess the effectiveness of a home exercise programme and a supervised exercise programme. 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.[36] Three investigators were involved in the study: (1) the primary investigator who administered the treatments (DS); (2) a medical doctor (KS) and a specialised rheumatologist (IS) who evaluated the patients to confirm the LET diagnosis, and (3) a physiotherapist (PM) who performed all baseline and follow-up assessments, and gained informed consent. All assessments were conducted by PM who was blind to the patients' therapy group. PM interviewed each patient to ascertain baseline demographic and clinical characteristics, including patient name, sex, age, duration of symptoms, previous treatment, occupation, affected arm and dominant arm.

Patients over 18 years old who were experiencing lateral elbow pain were examined and evaluated in the rheumatology and rehabilitation centre located in Athens between January 2005 and January 2007. 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 4 weeks. 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:[1]

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 and/or thoracic region; (b) local or generalised 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.[2 37 38]

All patients received a written explanation of the trial prior to entry into the study. All patients gave signed informed consent to participate in the study. The study was approved by the Topical Research Ethics Committee and access to patients was authorised by the manager of the rheumatology and rehabilitation centre (IS).

The patients were allocated to two groups by sequential allocation. For example, the first patient with LET was assigned to the home exercise programme group, the second patient with LET to the supervised exercise programme group, and so on.

All patients were instructed to use their arm during the course of 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 course of 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 was kept to a minimum, and behaviours 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 the pre-application and post-application measurements.[39]

The exercise programme was the same for both groups, consisting of slow progressive eccentric exercises of the wrist extensors and static stretching exercises of the ECRB tendon. Three sets of 12 repetitions of slow progressive eccentric exercises of the wrist extensors at each treatment session were performed, with 1-min rest interval between each set. Static stretching exercises of the ECRB tendon were repeated six times at each treatment session, three times before and three times after the eccentric exercises, with a 30-s rest interval between each repetition. Eccentric exercises of the wrist extensors were performed with the elbow on the bed in full extension, the forearm in pronation, the wrist in an extended position (as high as possible), and the hand hanging over the edge of the bed. From this position, patients flexed their wrist slowly while counting to 30, then returned to the starting position with the help of the other hand. Patients were told to continue with the exercise even if they experienced mild pain. However, they were told to stop the exercise if the pain became disabling. When patients were able to perform the eccentric exercises without experiencing any minor pain or discomfort, the load was increased using free weights. Static stretching exercises of the ECRB tendon were performed with the help of the other hand. The patient's elbow was placed in full extension, the forearm in full pronation, and the wrist in flexion and ulnar deviation according to the patient's tolerance. This position was held for 30–45 s each time and then released. The exercise programme was given five times a week for 12 weeks and was individualised on the basis of the patient's description of pain experienced during the procedure. The difference between both groups was that the supervision programme was given under the supervision of the physical therapist, whereas in the home exercise programme, the patients visited the physical therapist once per week for further instructions

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 12) and at 3 months (week 24) after the end of treatment.

Pain was measured on a visual analogue 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 h before each evaluation, and this approach has been shown to be valid and sensitive of the VAS.[40]

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 h before each evaluation, and this approach has been shown to be valid and sensitive of the VAS.[40]

In addition, function was measured by pain-free grip strength. Pain-free grip strength is defined as the amount of force each patient is able to generate with an isometric gripping action before eliciting pain.[39] 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 standardised 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.[39] 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-s 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 drop out were categorised as follows: (1) a withdraw 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 analysed with a paired t test. A 5% level of probability was adopted as the level for statistical significance. SPSS V.11.5 statistical software was used for the statistical analysis.

RESULTS

One hundred sixteen patients eligible for inclusion visited the clinic within the trial period. Twenty-seven were unwilling to participate in the study, and 19 did not meet the inclusion criteria described above. The other 70 patients were sequentially allocated to one of the two possible groups: (a) home exercise programme (n = 35; 16 men, 19 women; mean (SD) age 44.38 (5.39) years); (b) supervised exercise programme (n = 35; 17 men, 18 women; mean (SD) age 45.72 (6.21) years). Patient flow through the trial is summarised in a CONSORT flow chart (fig 1).

At baseline, there were more women in the groups (four more in total). The mean age of the patients was about 45 years, and the duration of LET was about 5 months. LET was in the dominant arm in 90% of patients. There were no significant differences in mean age (p>0.0005, independent t test) or the mean duration of symptoms (p>0.0005, independent t test) between the groups. Patients had received a wide range of previous treatments (table 1). Drug therapy had been tried by 70%. All patients were manual workers.

Baseline pain on VAS was 8.70 (95% CI 8.33 to 8.87) for the whole sample (n = 70; table 2). There were no significant differences between the groups for baseline pain (p>0.05 independent t test; table 2). At week 12, there was a decline in VAS of about 8 units in the supervised exercise programme and 5.50 units in the home exercise programme compared with the baseline (p<0.0005, paired t test; table 3). There were significant differences in the magnitude of reduction between the groups at weeks 12 and 24 (p>0.0005 independent t test; table 3).

Baseline function on VAS was 3.60 (95% CI 3.27 to 4.57) for the whole sample (n = 70; table 2). There were no significant differences between the groups for baseline function (p>0.05 independent t test; table 2). At week 12, there was a rise in VAS of approximately 4.50 units in the supervised exercise programme group and 2 units in the home exercise programme group compared with the baseline (p<0.0005, paired t test; table 3). There were significant differences in the magnitude of improvement between the groups at weeks 12 and 24 (p> 0.0005 independent t test; table 3).

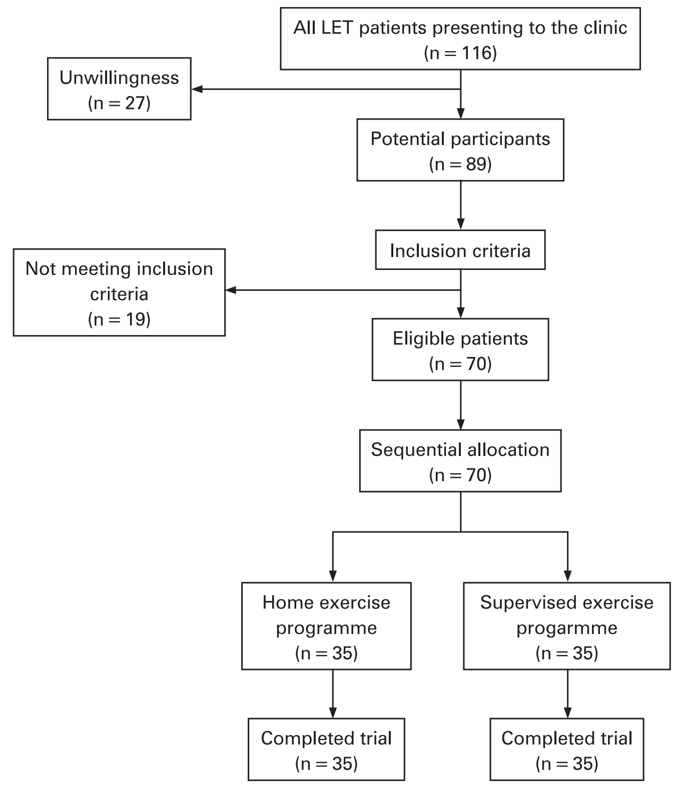

Figure 1 Flow chart of the study.

Baseline pain-free grip strength was 25.2 lb (95% CI 24.03 to 26.8) for the whole sample (n = 70; table 2). There were no significant differences between the groups for baseline pain-free grip strength (p>0.05 independent t test; table 2). At week 12, there was a rise in pain-free grip strength of approximately 35 units in the supervised exercise programme group and 18 units in the home exercise programme group compared with the baseline (p<0.0005, paired t test; table 3). There were significant differences in the magnitude of improvement between the groups at weeks 12 and 24 (p>0.0005 independent t test; table 3).

There were no drop outs, no adverse effects were referred and all patients successfully completed the study.

DISCUSSION

The results obtained from this controlled clinical trial are novel; as to date, there have been no data comparing the effectiveness of a home exercise programme and a supervised exercise

Table 1 Previous treatments of participants

	Home exercise programme (%)	Supervised exercise programme (%)
Drugs	24 (69)	25 (71)
Physiotherapy	6 (17)	4 (12)
Injection	5 (14)	6 (17)

Values are number (%).

Table 2 Pain, function and pain-free grip strength over the 24 h before each evaluation

	Pain (cm)		Function (cm)		Pain-free grip strength (lb)	
	HEP	SEP	HEP	SEP	HEP	SEP
Week 0	8.75 (8.30 to 8.93)	8.70 (8.31 to 8.87)	3.55 (3.24 to 4.01)	3.65 (3.47 to 4.12)	25.18 (24.70 to 25.77)	25.23 (24.65 to 25.79)
Week 12	3.27 (2.89 to 3.78)	1.68 (1.10 to 2.35)	5.58 (5.11 to 5.97)	8.23 (7.56 to 8.61)	43.65 (42.72 to 44.02)	60.75 (60.05 to 61.06)
Week 24	3.19 (2.87 to 3.75)	1.38 (1.02 to 1.85)	5.67 (5.14 to 6.19)	8.58 (7.67 to 8.88)	44.07 (43.68 to 44.55)	61.20 (60.67 to 61.71)

HEP, home exercise programme; SEP, supervised exercise programme.

programme for the reduction of pain and improvement of function in LET. The supervised exercise programme produced the largest effect at the end of the treatment and 3 months after the end of the treatment.

Standard eccentric exercises offer adequate rehabilitation for tendon disorders, but many patients with tendinopathies do not respond to this prescription alone.[41] The load of eccentric exercises was increased according to the patients' symptoms because the opposite has shown poor results.[42] Eccentric exercises were performed at a low speed in every treatment session because this allows tissue healing.[5 29]

Exercise programmes appear to reduce the pain and improve function, reversing the pathology of LET,[43–46] as supported by experimental studies on animals.[47] The way that an exercise programme 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.

Although a home exercise programme can be performed any time during the day without requiring supervision from a physiotherapist, our clinical experience has shown that patients fail to comply with the regimen of home exercise programmes.[35] Although many ways can be recommended to improve the compliance of patients with the home exercise programme such as phone calls, exercise monitors and better self-management education, it is believed that this problem can be really solved by the supervised exercise programmes performed in a clinical setting under the supervision of a physiotherapist. It is believed because our experience has shown that many patients stopped the home exercise programme without giving explanations, whereas patients completed the supervised programme. One possible reason why they continue the supervised exercise programme could be the cost. In the supervised exercise programme, the patients visit the therapist more times than the home exercise programme, and this is more expensive.

An exercise programme has been used in previous clinical trials on LET.[22 23 38 48–54] However, it was the sole treatment in only three previous trials.[22 23 38] A home exercise programme was the sole treatment in one of these three,[38] and was administered in a totally different manner from the exercise programmes used in the present controlled clinical trial and the studies conducted by our team[22 23] (type of exercises, intensity, frequency, duration of treatment). There is clearly a need for a clinical trial that would compare the effects of our exercise programme treatment protocol, with the home exercise programme treatment protocol used by Pienimaki *et al*.[38]

Previous trials have found that a home exercise programme reduced the pain in patellar[24–28] and Achilles[29–34] tendinopathy. However, it was performed for about 3 months, twice daily, in all previous studies. In contrast, in the present controlled clinical trial, the home exercise programme was conducted once per day but the supervised exercise programme was a more effective treatment than the home exercise programme. This difference can be explained by many observations such as the patients in the supervised exercise programme achieved a higher degree of compliance, the progression of the supervised programme was well conducted by the therapist, or the patients reported improvement to please the investigators. In addition, in the studies conducted by Stasinopoulos and his colleagues,[22 23 25] a supervised exercise programme was administered for a month, and it may give good long-term clinical results in a shorter period of time than the home exercise programme. The patient compliance can explain this difference.

However, this trial does have some shortcomings. First, a power analysis was not performed. Second, although this study was not a randomised controlled trial because a genuine randomisation procedure was not followed, the use of sequential allocation to allocate patients to treatment groups allowed a true cause and effect relation to be demonstrated. Third, 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 programmes 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. 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 programme treatment and therapists need to be aware of the treatment to administer it appropriately.

Table 3 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)		
	HEP	SEP	HEP	SEP	HEP	SEP	p Value
Week 12	−5.48	−7.02	2.03	4.58	18.47	35.52	<0.0005
Week 24	−5.56	−7.32	2.12	4.93	18.89	35.97	<0.0005

HEP, home exercise programme; SEP, supervised exercise programme.
Values are mean visual analogue scores where 0 = least pain, function imaginable and 10 = worst pain, function imaginable. p Values for independent t test on change in VAS from baseline are shown.

CONCLUSION

The exercise programme, consisting of eccentric and static stretching exercises, had reduced the pain and improved the function in patients with LET at the end of the treatment and at follow-up. Supervised exercise programme was superior to home exercise programme. Further well-designed trials are needed to confirm our results.

Competing interests None.

What is already known on this topic

Exercise programme, consisted of eccentric and stretching exercises, is an effective treatment approach for patients with tendinopathy, such as lateral elbow tendinopathy. There are two types of exercise programmes, the supervised exercise programme and the home exercise programme.

What this study adds

Supervised exercise programme carried out in the clinic under the supervision of the physiotherapist is a more effective treatment than the home exercise programme in the management of lateral elbow tendinopathy.

REFERENCES

1. **Haker E.** Lateral epicondylalgia: diagnosis, treatment and evaluation. *Crit Rev Phys Rehabil Med* 1993;**5**:129–54.
2. **Vicenzino B,** Wright A. Lateral epicondylalgia. I. Epidemiology, pathophysiology, aetiology and natural history. *Phys Ther Rev* 1996;**1**:23–34.
3. **Stasinopoulos D,** Johnson IM. Lateral elbow tendinopathy is the most appropriate diagnostic term for the condition commonly referred to as lateral epicondylitis. *Med Hypotheses* 2006;**67**:1399–401.
4. **Assendelft W,** Green S, Buchbinder R, *et al*. Tennis elbow. *BMJ* 2003;**7410**:327.
5. **Kraushaar BS,** Nirschl R. Current concepts review—tendinosis of the elbow (tennis elbow). Clinical features and findings of histological immunohistochemical and electron microscopy studies. *J Bone Joint Surg Am* 1999;**81**:259–85.
6. **Verhaar J.** Tennis elbow: anatomical, epidemiological and therapeutic aspects. *Int Orthop* 1994;**18**:263–7.
7. **Waugh E,** Jaglal S, Davis A, *et al*. Factors associated with prognosis of lateral epicondylitis after 8 weeks of physical therapy. *Arch Phys Med Rehabil* 2004;**85**:308–18.
8. **Noteboom T,** Cruver S, Keller A, *et al*. Tennis elbow: a review. *J Orthop Sports Phys Ther* 1994;**19**:357–66.
9. **Plancher K,** Halbrect J, Lourie G. Medial and lateral epicondylitis in the athlete. *Clin Sports Med* 1996;**15**:282–303.
10. **Peters T,** Baker C. Lateral epicondylitis. *Clin Sports Med* 2001;**20**:549–63.
11. **Trudel D,** Duley J, Zastrow I, *et al*. Rehabilitations for patients with lateral epicondylitis a systematic review. *J Hand Ther* 2004;**17**:243–66.
12. **Hong QN,** Durand MJ, Loisel P. Treatment of lateral epicondylitis where is the evidence. *Joint Bone Spine* 2004;**71**:369–73.
13. **Selvier T,** Wilson J. Methods utilized in treating lateral epicondylitis. *Phys Ther Rev* 2000;5:117–24.
14. **Stasinopoulos D,** Johnson MI. Physiotherapy and tennis elbow/lateral epicondylitis. BMJ. 2004 Sept 6. http://bmj.com/cgi/eletters/327/7410/329#73306 (Accessed 1 Jun 2009)
15. **Smidt N,** Assendelft W, Arola H, *et al*. Effectiveness of physiotherapy for lateral epicondylitis: a systematic review. *Ann Med* 2003;**35**:51–62.
16. **Trinh KV,** Phillips SD, Ho E, *et al*. Acupuncture for the alleviation of lateral epicondyle pain: a systematic review. *Rheumatology* 2004;**43**:1085–90.
17. **Stasinopoulos D,** Johnson MI. Effectiveness of extracorporeal shock wave therapy for tennis elbow: a review. *Br J Sports Med* 2005;**39**:132–6.
18. **Labelle H,** Guibert R, Joncas J, *et al*. Lack of scientific evidence for the treatment of lateral epicondylitis of the elbow: an attempted meta-analysis. *J Bone Joint Surg* 1992;**74**:646–51.
19. **Smidt N,** Assendelft W, Arola H, *et al*. Effectiveness of physiotherapy for lateral epicondylitis: a systematic review. *Ann Med* 2003;**35**:51–62.
20. **Bisset L,** Paungmali A, Vicenzino B, *et al*. A systematic review and meta-analysis of clinical trials on physical interventions for lateral epicondylalgia. *Br J Sports Med* 2005;**39**:411–22.
21. **Wright A,** Vicenzino B. Lateral epicondylalgia. II. Therapeutic management. *Phys Ther Rev* 1997;**2**:39–48.
22. **Manias P,** Stasinopoulos D. A controlled clinical pilot trial to study the effectiveness of ice as a supplement to the exercise programme for the management of lateral elbow tendinopathy. *Br J Sports Med* 2006;**4**0:81–5.
23. **Stasinopoulos D,** Stasinopoulos I. Comparison of effects of Cyriax physiotherapy, a supervised exercise programme and polarized polychromatic non-coherent light (Bioptron light) for the treatment of lateral epicondylitis. **Clin Rehabil** 2006;**20**:12–23.
24. **Purdam CR,** Johnsson P, Alfredson H, *et al*. A pilot study of the eccentric decline squat in the management of painful chronic patellar tendinopathy. *Br J Sports Med* 2004;**38**:395–7.
25. **Stasinopoulos D**, Stasinopoulos I. Comparison of effects of exercise programme, pulsed ultrasound and transverse friction in the treatment of chronic patellar tendinopathy. *Clin Rehabil* 2004;**18**:347–52.
26. **Jonsson P,** Alfredson H. Superior results with eccentric compared to concentric quadriceps training in patients with jumper's knee: a prospective randomised study. *Br J Sports Med* 2005;**39**:847–50.
27. **Young MA,** Cook JL, Purdam CR, *et al*. Eccentric decline squat protocol offers superior results at 12 months compared with traditional eccentric protocol for patellar tendinopathy in volleyball players. *Br J Sports Med* 2005;**39**:102–5.
28. **Bahr R,** Fossan B, Loken S, *et al*. Surgical treatment compared with eccentric training for patellar tendinopathy (jumper's knee). A randomized, controlled trial. *J Bone Joint Surg Am* 2006;**88**:1689–98.
29. **H,** Pietila T, Johnson P, *et al*. Heavy-load eccentric calf muscle training for the treatment of chronic Achilles tendinosis. *Am J Sports Med* 1998;**26**:360–6.
30. **Mafi N,** Lorentzon R, Alfredson H. Superior short-term results with eccentric calf muscle training compared to concentric training in a randomized prospective multicenter study on patients with chronic Achilles tendinosis. *Knee Surg Sports Traumatol Arthrosc* 2001;**9**:42–7.
31. **Niesen-Vertommen SL,** Taunton JE, Clement DB, *et al*. The effect of eccentric versus concentric exercise in the management of Achilles tendonitis. *Clin J Sports Med* 1992;2:109–13.
32. **Ohberg L,** Lorentzon R, Alfredson H. Eccentric training in patients with Achilles tendinosis: normalized tendon structure and decreased thickness at follow up. *Br J Sports Med* 2004;38:8–11.
33. **Roos EM,** Engstrom M, Lagerquist A, *et al*. Clinical improvement after 6 weeks of eccentric exercises in patients with mid-portion Achilles tendinopathy: a randomised trial with 1-year follow-up. *Scand J Med Sci Sports* 2004;**14**:286–95.
34. **Silbernager KG,** Thomee R, Thomee P, *et al*. Eccentric overload training with chronic Achilles tendon pain: a randomized controlled study with reliability testing of the evaluation methods. *Scand J Med Sci Sports* 2001;**11**:197–206.
35. **Stasinopoulos D,** Johnson MI. Treatment/management for tendinopathy. Rapid response to Khan *et al* (2002) article Time to abandon the 'tendinitis' myth. *BMJ* 2004 Sep 22.
36. **Johannsen F,** Gam A, Hauschild B, *et al*. Rebox: an adjunct in physical medicine? Arch Phys Med Rehabil 1993;74:438–40.
37. **Vasseljen O.** Low-level laser versus traditional physiotherapy in the treatment of tennis elbow. *Physiotherapy* 1992;**78**:329–34.
38. **Pienimaki T,** Tarvainen T, Siira P, *et al*. Progressive strengthening and stretching exercises and ultrasound for chronic lateral epicondylitis. *Physiotherapy* 1996;**82**:522–30.
39. **Vicenzino B,** Collins, Wright A. The initials effects of a cervical spine manipulative physiotherapy treatment on the pain and dysfunction of lateral epicondylalgia. *Pain* 1996;**68**:69–74.
40. **Stratford P,** Levy D, Gauldie S, *et al*. Extensor carpi radialis tendonitis: a validation of selected outcome measures. *Physiother Can* 1987;**39**:250–5.
41. **Cannell L,** Taunton J, Clement D, *et al*. A randomized clinical trial of the efficacy of drop squats or leg extension/leg curls to treat clinically diagnosed jumper's knee in athletes: a pilot study. *Br J Sports Med* 2001;**35**:60–4.
42. **Jensen K,** Di Fabio R. Evaluation of eccentric exercise in treatment of patellar tendinitis. *Phys Ther* 1989;**69**:211–6.
43. **Hawary R,** Stanish W, Curwin S. Rehabilitation of tendon injuries in sport. *Sports Med* 1997;**24**:347–58.
44. **Khan KM,** Cook JL, Kannus P, *et al*. Time to abandon the ''tendonitis'' myth. *BMJ* 2002;**324**:626–7.
45. **Khan K,** Cook J, Taunton J, *et al*. Overuse tendinosis, not tendinitis: a new paradigm for a difficult clinical problem. *Phys Sportsmed* 2000;**28**:38–48.
46. **Ohberg L,** Lorentzon R, Alfredson H. Neovascularisation in Achilles tendons with painful tendinosis but not in normal tendons: an ultrasonographic investigation. *Knee Surg Sports Traumatol Arthrosc* 2001;**9**:233–8.
47. **Vilarta R,** Vidal BDC. Anisotropic and biomechanical properties of tendons modified by exercise and denervation: aggregation and macromolecular order in collagen bundles. *Matrix* 1989;**9**:55–61.
48. **Drechsler W,** Knarr J, Mackler L. A comparison of two treatment regimens for lateral epicondylitis: a randomised trial of clinical interventions. *J Sport Rehabil* 1997;**6**:226–34.
49. **Kochar M,** Dogra A. Effectiveness of a specific physiotherapy regimen on patients with tennis elbow. *Physiotherapy* 2002;**88**:333–41.
50. **Smidt N,** Windt D, Assendelft W, *et al*. Corticosteroids injections, physiotherapy, or a wait and see policy for lateral epicondylitis: a randomised controlled trial. *Lancet* 2002;**359**:657–62.
51. **Struijs PAA,** Kerkhoffs GMMJ, Assendelft WJJ, *et al*. Conservative treatment of lateral epicondylitis: brace versus physical therapy or a combination of both: a randomized clinical study. *Am J Sports Med* 2004;32:462–9.
52. **Struijs PAA,** Damen PJ, Bakker EWP, *et al*. Manipulation of the wrist for the management of lateral epicondylitis: a randomised pilot study. *Phys Ther* 2003;**83**:608–16.
53. **Svernlov B**, Adolfsson L. Non-operative treatment regime including eccentric training for lateral humeral epicondylalgia. *Scand J Med Sci Sports* 2001;**11**:328–34.
54. **Nilsson P,** Thom E, Baigi A, *et al*. A prospective pilot study of a multidisciplinary home training programme for lateral epicondylitis. *Musculoskeletal Care* 2007;**50**:35–50.