ClinicalEvidence

Tennis elbow

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ABSTRACT

INTRODUCTION: Lateral pain in the elbow affects up to 3% of the population, and is considered an overload injury of the extensor tendons of the forearm where they attach at the lateral epicondyle. Although usually self-limiting, symptoms may persist for over 1 year in up to 20% of people. METHODS AND OUTCOMES: We conducted a systematic review and aimed to answer the following clinical question: What are the effects of treatments for tennis elbow? We searched: Medline, Embase, The Cochrane Library, and other important databases up to November 2009 (Clinical Evidence reviews are updated periodically, please check our website for the most up-to-date version of this review). We included harms alerts from relevant organisations such as the US Food and Drug Administration (FDA) and the UK Medicines and Healthcare products Regulatory Agency (MHRA). RESULTS: We found 80 systematic reviews, RCTs, or observational studies that met our inclusion criteria. We performed a GRADE evaluation of the quality of evidence for interventions. CONCLUSIONS: In this systematic review we present information relating to the effectiveness and safety of the following interventions: acupuncture, autologous whole blood injections, corticosteroid injections, combination physical therapies, exercise, extracorporeal shock wave therapy, iontophoresis, low-level laser therapy, manipulation, non-steroidal anti-inflammatory drugs (oral and topical), orthoses (bracing), platelet-rich plasma injections, pulsed electromagnetic field treatment, surgery, and ultrasound.

QUESTIONS

INTERVENTIONS

Key points

- Lateral pain in the elbow affects up to 3% of the population, and is usually an overload injury that often follows minor trauma to extensor forearm muscles.

  Although usually self-limiting, symptoms may persist for over 1 year in up to 20% of people.

- Corticosteroid injections improve pain, function, and global improvement from tennis elbow in the short term compared with placebo, local anaesthetic, orthoses, physiotherapy, and oral NSAIDs.

  We don't know which corticosteroid regimen leads to greatest pain relief.

  In the long term, physiotherapy or oral NSAIDs may be more effective than corticosteroid injections at reducing pain.

Corticosteroid injections may increase the recurrence rate compared with physiotherapy and "wait and see".

Repeated corticosteroid injections may lead to lower reduction in pain and greater need for surgery than single corticosteroid injection.

Topical NSAIDs lead to short-term pain relief and better global improvement compared with placebo, but long-term effects are unknown.

- Extracorporeal shock wave therapy is unlikely to be more effective than placebo at improving pain, and may be less effective than injected corticosteroids.

We don't know whether acupuncture or exercise and mobilisation reduce symptoms of tennis elbow as we found few trials, and they gave conflicting results.

We don't know whether orthoses (braces) reduce symptoms compared with no treatment or other treatments, as we found few trials.

We don't know whether manipulation improves pain and function, as we found few trials and they were of low quality.

We also don't know whether open or percutaneous surgical techniques, exercise, combination physical therapies, ultrasound, iontophoresis, or pulsed electromagnetic field treatment improve pain and function, as we found insufficient good-quality evidence.

Low-level laser therapy may be beneficial at improving pain in the short term when compared with placebo.

DEFINITION

Tennis elbow has many analogous terms, including lateral elbow pain, lateral epicondylitis, lateral epicondylalgia, tendonitis of the common extensor origin, and peritendinitis of the elbow. Tennis elbow is characterised by pain and tenderness over the lateral epicondyle of the humerus, and pain on resisted dorsiflexion of the wrist, middle finger, or both. For the purposes of this review, tennis elbow is restricted to lateral elbow pain or lateral epicondylitis or lateral epicondylalgia.

INCIDENCE/ PREVALENCE

Lateral elbow pain is common (population prevalence 1–3%), [1] with peak incidence occurring at 40 to 50 years of age. In women aged 42 to 46 years, incidence increases to 10%. [2] [3] In the UK, the Netherlands, and Scandinavia, the incidence of lateral elbow pain in general practice is 4–7/1000 people a year. [3] [4] [5]

AETIOLOGY/ RISK FACTORS

Tennis elbow is considered an overload injury, typically after minor and often unrecognised trauma of the extensor muscles of the forearm. Despite the title tennis elbow, tennis is a direct cause in only 5% of people with lateral epicondylitis. [6]

PROGNOSIS

Although lateral elbow pain is generally self-limiting, in a minority of people symptoms persist for 18 months to 2 years, and in some cases for much longer. [7] The cost, therefore, both in terms of lost productivity and healthcare use, is high. In a general practice trial of an expectant waiting policy, 80% of people with elbow pain of already >4 weeks' duration had recovered after 1 year. [8]

AIMS OF INTERVENTION

To reduce lateral elbow pain and improve function, with minimal adverse effects.

OUTCOMES

Pain relief: includes pain at rest, with activities and resisted movements (visual analogue scale or Likert scale), Roles–Maudsley subjective pain score; **functional improvement**: includes grip strength (dynamometer), function (validated disability questionnaire, includes 30-point Disabilities of the Arm, Shoulder, and Hand [DASH] questionnaire, or visual analogue scale or Likert scale); **quality of life** (validated questionnaire); **global improvement**: includes return to work, normal activities, or both; overall participant-reported improvement; **recurrence**; **adverse effects** (participant or researcher report).

METHODS

Clinical Evidence search and appraisal November 2009. The following databases were used to identify studies for this systematic review: Medline 1966 to November 2009, Embase 1980 to November 2009, and The Cochrane Database of Systematic Reviews 2009, Issue 4 (1966 to date of issue). When editing this review we used The Cochrane Database of Systematic Reviews 2009, Issue 4. An additional search within The Cochrane Library was carried out for the Database of Abstracts of Reviews of Effects (DARE) and Health Technology Assessment (HTA). We also searched for retractions of studies included in the review. Abstracts of the studies retrieved from the initial search were assessed by an information specialist. Selected studies were then sent to the contributor for additional assessment, using predetermined criteria to identify relevant studies. Study design criteria for inclusion in this review were: published systematic reviews of RCTs and RCTs in any language, at least single blinded, and containing >20 individuals of whom >80% were followed up. There was no minimum length of follow-up required to include studies. We excluded all studies described as "open", "open label", or not blinded unless blinding was impossible. We included systematic reviews of RCTs and RCTs where harms of an included intervention were studied applying the same study design criteria for inclusion as we did for benefits. In addition we use a regular surveillance protocol to capture harms alerts from organisations such as the FDA and the MHRA, which are added to the reviews as required. To aid readability of the numerical data in our reviews, we round many percentages to the nearest whole number. Readers should be aware of this when relating percentages to summary statistics such as relative risks (RRs) and odds ratios (ORs). We have performed a GRADE evaluation of the quality of evidence for interventions included in this review (see table, p 30). The categorisation of the quality of the evidence (into high, moderate, low, or very low) reflects the quality of evidence available for our chosen outcomes in our defined populations of interest. These categorisations are not necessarily a reflection of the overall methodological quality of any individual study, because the *Clinical Evidence* population and outcome of choice may represent only a small subset of the total outcomes reported, and population included, in any individual trial. For further details of how we perform the GRADE evaluation and the scoring system we use, please see our website (www.clinicalevidence.com).

QUESTION **What are the effects of oral drug treatment for tennis elbow?**

OPTION **NSAIDS (ORAL)**

Pain relief

Compared with placebo Oral NSAIDs may be more effective at improving pain in the short term, but we don't know whether they are more effective at improving pain at 6 months or 1 year (very low-quality evidence).

Compared with corticosteroid injection We don't know how oral NSAIDs and corticosteroid injections compare for improving pain at 4 weeks, but oral NSAIDs may be more effective at improving pain at 26 weeks (very low-quality evidence).

Global improvement

Compared with corticosteroid injection Oral NSAIDs may be less effective at increasing self-reported perception of benefit at 4 weeks (very low-quality evidence).

Functional improvement

Compared with placebo Oral NSAIDs may be no more effective at improving functional impairment (very low-quality evidence).

For GRADE evaluation of interventions for tennis elbow, see table, p 30 .

Benefits: We found one systematic review (search date 2001) [9] and no subsequent RCTs. None of the RCTs in the review evaluated the effect of NSAIDs on return to work or quality of life.

Oral NSAIDs versus placebo:

The review included two RCTs. [9] The RCTs were not pooled, because one reported means and standard deviations, and the other reported medians and ranges. One RCT (129 people) found limited evidence that oral NSAIDs (diclofenac) significantly improved pain in the short term compared with placebo, but did not assess long-term results (pain at 28 days: WMD –13.9, 95% CI –23.2 to –4.6 on 100-point scale). [9] The second RCT (164 people) found no significant difference between oral NSAIDs (naproxen) and vitamin C placebo in pain over 4 weeks, 6 months, or 1 year, or in functional impairment at 6 months or 1 year (median pain measured from 0 = lowest to 9 = highest [baseline], at 4 weeks: 4 with NSAIDs *v* 3.5 with placebo; 6 months: 1 with NSAIDs *v* 1 with placebo; 12 months: 0 with NSAIDs *v* 0 with placebo; median functional impairment measured from 0 = lowest to 9 = highest [baseline = 4 for both groups]: at 4 weeks: 3 with NSAIDs *v* 2 with placebo; at 6 months: 0 with NSAIDs *v* 0.5 with placebo; at 12 months: 0 with NSAIDs *v* 0 with placebo; significance not reported). [9]

Oral NSAIDs versus corticosteroid injection:

The review included three RCTs. [9] Because of incomplete reporting of results, only two RCTs were included in the meta-analysis. The first of these RCTs compared naproxen 500 mg versus methylprednisolone 20 mg plus lidocaine (lignocaine); and the second RCT compared naproxen 500 mg (initial high dose, then 250 mg) versus betamethasone 6 mg plus pilocaine plus placebo tablets. Meta-analysis of self-reported perception of benefit found a significant difference at 4 weeks in favour of corticosteroid injection (2 RCTs; subjective assessment of improvement at 4 weeks: RR 3.06, 95% CI 1.55 to 6.06). [9] The third RCT, which was not included in the meta-analysis because of skewed data, found lower pain and functional impairment at 4 weeks in the corticosteroid-injection group than in the oral NSAIDs group (median pain measured from 0 = lowest to 9 = highest [baseline]: 1 with corticosteroids *v* 4 with oral NSAIDs; significance not reported; median functional impairment measured from 0 = lowest to 9 = highest [baseline]: 0 with corticosteroids *v*

3 with NSAIDs; significance not reported). [9] The greater benefit of corticosteroid injection compared with NSAID (naproxen) was only found in the short term (up to 4 weeks).

Long-term results of the largest RCT included in the review [9] were reported in an earlier review [10] (search date 1999) (53 people in smallest group; see comments). The review found significantly greater improvement in pain with an oral NSAID (RR 1.71, 95% CI 1.17 to 2.51), but no significant difference in grip strength (RR 0.98, 95% CI 0.78 to 1.22) at 26 weeks. Results were not reported for global improvement.

Harms:

Oral NSAIDs versus placebo:
The review identified one trial of oral NSAIDs, which found an increased risk of abdominal pain and diarrhoea with oral NSAIDs compared with placebo (abdominal pain: 19/64 [30%] with oral NSAIDs *v* 6/64 [9%] with placebo; RR 3.17, 95% CI 1.35 to 7.41; diarrhoea: 25/64 [39%] with oral NSAIDs *v* 13/64 [20%] with placebo; RR 1.92, 95% CI 1.08 to 3.14). [9] One systematic review (search date 1994, 12 RCTs of NSAIDs in a variety of disorders) [11] found that the overall relative risk of complications from oral NSAIDs was 3.0 to 5.0. Adverse effects were predominantly gastrointestinal. See important differences between available NSAIDs in our review on NSAIDs.

Oral NSAIDs versus corticosteroid injection:
The review gave no information about the adverse effects of oral NSAIDs compared with corticosteroid injection. [9]

Comment:

The systematic review reported the number of people in the smallest group for each trial rather than the total number of people in the trial. [10]

See comment on topical NSAIDs, p 4 .

QUESTION	What are the effects of topical drug treatment for tennis elbow?

OPTION	NSAIDS (TOPICAL)

Pain relief
Compared with placebo Topical NSAIDs seem more effective at improving pain at 4 weeks (moderate-quality evidence).

Global improvement
Compared with placebo Topical NSAIDs may be more effective at reducing the proportion of people who report a "poor/no overall" effect of treatment (low-quality evidence).

Functional improvement
Compared with placebo Topical NSAIDs may be no more effective at improving grip strength or range of motion (low-quality evidence).

For GRADE evaluation of interventions for tennis elbow, see table, p 30 .

Benefits:

We found one systematic review (search date 2001) [9] and no subsequent RCTs. None of the RCTs in the review evaluated the effect of NSAIDs on return to work or quality of life.

Topical NSAIDs versus placebo:
The review found that topical NSAIDs significantly improved pain at up to 4 weeks compared with placebo (3 RCTs, 130 people; pain [scale 0–10; 0 = no pain; 10 = maximum pain]: 1.73–2.10 with topical NSAIDs *v* 3.00–3.83 with placebo; WMD –1.88, 95% CI –2.54 to –1.21) and significantly reduced subjective reports of "poor/no overall" effect (2 RCTs, 119 people; proportion of people reporting "poor/no overall" effect: 12.5–27% with topical NSAIDs *v* 51–78% with placebo; RR 0.39, 95% CI 0.23 to 0.66). [9] Inclusion of unblinded trials did not significantly change the results. The review found no significant differences between topical NSAIDs and placebo in grip strength (further data not reported; reported as non-significant) or range of motion (1 RCT, 40 people; proportion of people reporting no improvement in range of motion: 15/17 [88%] with topical NSAIDs *v* 20/23 [87%] with placebo; RR for limitation of movement 1.01, 95% CI 0.80 to 1.28). It found that NSAIDs significantly improved pain, tenderness, or swelling compared with placebo (3 RCTs, 157 people; proportion of people reporting no improvement in pain, tenderness, or swelling: 54/77 [70%] with topical NSAIDs *v* 66/80 [83%] with placebo; RR 0.83, 95% CI 0.70 to 0.99) and decreased doctor's opinion of ineffectiveness (1 RCT, 85 people; doctor's opinion of poor/no effect: 15/44 [34%] with topical NSAIDs *v* 23/41 [56%] with placebo; RR 0.61, 95% CI 0.37 to 0.99). The topical NSAIDs used were diclofenac (2 RCTs) and benzydamine (1 RCT).

Topical NSAIDs versus orthoses:
See orthoses, p 16 .

Harms:

Topical NSAIDs versus placebo:
Pooled results from two RCTs included in the review [9] found that topical NSAIDs significantly increased adverse events compared with placebo (RR 2.26, 95% CI 1.04 to 4.94). Adverse effects were mild (foul breath and minor skin irritation). In one of the RCTs, [12] 9 people were withdrawn from the study after premature discontinuation of treatment, including 8 people in the treatment group with burns, blisters, rashes, and skin thickening.

Topical NSAIDs versus orthoses:
See orthoses, p 16 .

Comment:

Further placebo-controlled and comparative trials of topical compared with oral NSAIDs would help to clarify the effects of NSAIDs in the treatment of tennis elbow. Few trials used intention-to-treat analysis, and the sample size of most was small (populations range from 18–128 people for trials included in the meta-analysis). [9]

Clinical guide:
Both topical and oral NSAIDs may provide short-term relief of pain in tennis elbow, although topical NSAIDs may be associated with fewer adverse effects.

QUESTION What are the effects of local injections for tennis elbow?

OPTION CORTICOSTEROID INJECTIONS

Pain relief
Compared with no intervention or placebo We don't know whether corticosteroid injections are more effective at reducing pain in people with tennis elbow (low-quality evidence).

Compared with NSAIDs Corticosteroid injections may be more effective at reducing pain at 6 weeks, but are no more effective at 1 year (low-quality evidence).

Compared with local anaesthetic We don't know whether corticosteroid injections are more effective at reducing pain in people with tennis elbow (very low-quality evidence).

Compared with local anaesthetic We don't know whether corticosteroid injections plus local anaesthetic is more effective at reducing pain in people with tennis elbow (low-quality evidence).

Compared with combination physical therapies Corticosteroid injections may be more effective at reducing pain at 6 weeks, but not at 1 year in people with tennis elbow (low-quality evidence).

Different types of corticosteroid injections compared with each other We don't know which corticosteroid injection is more effective at reducing pain in people with tennis elbow (moderate-quality evidence).

Corticosteroid injection plus NSAIDs compared with NSAIDs alone Corticosteroid injection plus NSAIDs may be more effective at improving pain and function at 1 month in people with tennis elbow (very low-quality evidence).

Corticosteroid injection plus local anaesthetic injection compared with extracorporeal shock wave therapy A single corticosteroid injection plus local anaesthetic injection may be more effective at improving pain at 6 weeks and 3 months (low-quality evidence).

Single versus multiple corticosteroid plus local anaesthetic injections We don't know whether single injections of betamethasone plus pilocarpine are more effective than repeated injections at improving pain in the short term, but multiple injections may be less effective at reducing pain in the long term compared with single injections (very low-quality evidence).

Global improvement
Compared with no intervention or placebo Corticosteroid injections seem more effective at increasing the rate of global improvement at 6 weeks, but not at 1 year in people with tennis elbow (moderate-quality evidence).

Compared with NSAIDs Corticosteroid injections may be more effective at improving global improvement at 6 weeks, but may be as effective at 1 year (low-quality evidence).

Compared with local anaesthetic We don't know whether corticosteroid injections are more effective at increasing the rate of global improvement in people with tennis elbow (very low-quality evidence).

Compared with local anaesthetic We don't know whether corticosteroid injections plus local anaesthetic is more effective at improving global improvement in people with tennis elbow (low-quality evidence).

Compared with combination physical therapy Corticosteroid injections seem more effective at increasing the rate of global improvement in the short term (3–6 weeks), but are less effective in the longer term (12–52 weeks) in people with tennis elbow (moderate-quality evidence).

Functional improvement
Compared with saline injections We don't know whether corticosteroid injections are more effective at increasing the rate of functional improvement in people with tennis elbow (low-quality evidence).

Compared with NSAIDs Corticosteroid injections may be more effective at improving grip strength at 6 weeks, but may be as effective at 1 year (low-quality evidence).

Compared with local anaesthetic We don't know whether corticosteroid injections are more effective at improving grip strength in people with tennis elbow (very low-quality evidence).

Compared with local anaesthetic We don't know whether corticosteroid injections plus local anaesthetic is more effective at improving grip strength in people with tennis elbow (low-quality evidence).

Compared with combination physical therapies Corticosteroid injections may be more effective at increasing grip strength and the proportion of people who returned to work at 6 weeks, but not at 1 year in people with tennis elbow (low-quality evidence).

Different types of corticosteroid injections compared with each other We don't know which corticosteroid injection is more effective at increasing grip strength in people with tennis elbow (low-quality evidence).

Recurrence
Compared with no intervention or placebo Corticosteroid injections seem to produce greater recurrence rates after 6 weeks in people with tennis elbow (moderate-quality evidence).

Compared with combination physical therapies Corticosteroid injections seem to produce greater recurrence rates after 6 weeks in people with tennis elbow (moderate-quality evidence).

For GRADE evaluation of interventions for tennis elbow, see table, p 30 .

Benefits: We found 4 systematic reviews (search dates 1999, [10] 2003, [13] 2004, [14] and 2003 [15]), which between them identified 13 RCTs comparing corticosteroid injection versus placebo or other conservative treatments. Three reviews [10] [13] [15] included only RCTs whereas the other review also included controlled clinical trials. [14] Methodological quality of included trials was assessed by two reviews; [13] [14] however, only one review [14] excluded trials that failed to meet 50% quality ratings. One systematic review [10] performed some meta-analyses, while all other reviews provided a qualitative assessment of included studies. We also found two additional RCTs [16] [17] and three subsequent RCTs. [18] [19] [20]

Corticosteroid injections versus no intervention or placebo:
One review [10] identified two RCTs comparing corticosteroid injection (1 mL methylprednisolone acetate) versus injection of saline solution. The larger of the two RCTs [21] (29 people in smallest group; see comment below) found that corticosteroid injection significantly increased short-term global improvement compared with placebo (timescale not further specified; absolute numbers not reported; RR 0.11, 95% CI 0.04 to 0.33 [RR <1 favours corticosteroid injections]). [10] The RCT did not measure pain or grip strength. The second RCT [22] (10 people in smallest group) found no significant difference between groups in short-term pain (SMD +0.04, 95% CI –0.82 to +0.90), global improvement (RR 1.21, 95% CI 0.65 to 2.26), or grip strength (SMD +0.19, 95% CI –0.67 to +1.05). In this study, NSAIDs were prescribed in combination with saline injection. [10]

Two reviews [10] [14] included one RCT comparing corticosteroid injections versus placebo. [23] The RCT (164 people aged 18–70 years, symptom duration >3 months) compared three interventions: corticosteroid injections, oral NSAIDs, or placebo (vitamin C tablets) for up to 1 year of follow-up. Only the corticosteroid injection versus placebo comparison is reported here. The RCT found that corticosteroid injections significantly increased the rate of global improvement compared with placebo at 4 weeks (92% with corticosteroid injections *v* 50% with placebo; reported as significant; P value and absolute data not reported). However, the RCT found no significant difference in global improvement between groups at 1 year (further data not reported).

One subsequent three-armed RCT (198 people aged 18–65 years with a clinical diagnosis of tennis elbow of a minimum 6 weeks' duration) compared corticosteroid injections versus no intervention "wait and see" (defined as an advice booklet) or physiotherapy for 52 weeks of follow-up. [18] Only the corticosteroid versus "wait and see" results are reported here. The RCT found that corticosteroid injections significantly increased the rate of treatment success (including global improvement, pain, function, and pain-free grip) at 6 weeks compared with "wait and see" (51/65 [78%] with corticosteroid injections *v* 16/60 [27%] with "wait and see"; RRR 0.7, 99% CI 0.4 to 0.9; NNT 2). However, the RCT found that corticosteroid injections significantly reduced the rate of treatment success at 52 weeks compared with "wait and see" (44/65 [68%] with corticosteroid injections *v* 56/62 [90%] with "wait and see"; RRR 0.3, 99% CI 0.04 to 0.4; NNT 4). [18] The RCT also reported that corticosteroid injections significantly increased the risk of recurrence after 6 weeks compared with "wait and see" (47/65 [72%] with corticosteroid injections *v* 6/67 [9%] with "wait and see"; RRR 0.9, 99% CI 0.6 to 1.1). [18]

Corticosteroid injections versus local anaesthetic:
One review [10] identified three RCTs [24] [25] [21] (containing 18, 29, and 35 people in the smallest groups; see comment below) comparing corticosteroid injections versus local anaesthetic. All three RCTs found significant results in favour of corticosteroid injections on one or more outcome measures individually. The pooled analysis reported in the review also found that corticosteroids significantly increased the rate of global improvement compared with local anaesthetic (3 RCTs; RR 0.18, 95% CI 0.08 to 0.39; P value not reported). Only one of the three RCTs included in the review measured pain and grip strength. [25] It found that corticosteroids significantly reduced pain scores (hydrocortisone *v* lidocaine [lignocaine]: SMD –0.62, 95% CI –1.15 to –0.10; triamcinolone *v* lidocaine: SMD –1.04, 95% CI –1.59 to –0.50), but found no significant difference between groups in grip strength (hydrocortisone *v* lidocaine: SMD –0.37, 95% CI –0.89 to +0.15; triamcinolone *v* lidocaine: SMD –0.43, 95% CI –0.95 to +0.09). [25]

One review [14] included one RCT [26] (39 people with lateral epicondylitis with symptoms for <4 weeks) comparing corticosteroid injection versus local anaesthetic injection (marcaine). Both groups also received rehabilitation. The review reported no significant difference between groups in pain or grip strength at 4 weeks (reported as not significant, no P value or absolute data reported), but that corticosteroid injection significantly improved mean visual analogue scale (VAS) pain scores at 8 weeks to 6 months compared with sham injection (P = 0.04; absolute data not reported).

Corticosteroid injections plus local anaesthetic versus local anaesthetic:
One subsequent RCT (64 people with lateral elbow pain) compared dexamethasone plus lidocaine versus lidocaine alone at 1 and 6 months' follow-up. [19] The RCT found no significant difference between groups at either 1 or 6 months for average Disabilities of the Arm, Shoulder, and Hand (DASH) scores (1 month: 19 with dexamethasone *v* 27 with lidocaine; 95% CI –10.0 to +14.3; P = 0.72; 6 months: 18 with dexamethasone *v* 13 with lidocaine; 95% CI –16.6 to +5.9; P = 0.34), average VAS pain scores (1 month: 3.7 with dexamethasone *v* 4.3 with lidocaine; 95% CI –0.8 to +2.1; P = 0.42; 6 months: 2.4 with dexamethasone *v* 1.7 with lidocaine; 95% CI –2.3 to +0.8; P = 0.39), or average percentage grip strength (1 month: 83% with dexamethasone *v* 87% with lidocaine; 95% CI –8.5% to +15.2%; P = 0.57; 6 months: 98% with dexamethasone *v* 97% with lidocaine; 95% CI –10.8% to +9.1%; P = 0.86). [19] However, follow-up of only 80% of people at 1 month and 75% of people at 6 months may have compromised the sensitivity of this study.

Corticosteroid injections versus orthoses:
See benefits of orthoses, p 16 .

Corticosteroid injections versus combination physical therapies:
The review [14] included two RCTs [27] [28] comparing corticosteroid injections versus physiotherapy.

The first RCT (106 people with tennis elbow) [27] included in the review [14] compared local corticosteroid injections versus physiotherapy (defined as deep friction massage plus manipulation technique). [27] It found that corticosteroid injections significantly improved pain, return to work, and grip strength at 6 weeks compared with physiotherapy (reported as significant P values and absolute data not reported). The RCT found no significant differences in these outcomes between groups at 1 year (reported as not significant; P values and absolute data not reported). [14]

The second three-armed RCT (185 people with lateral epicondylitis of at least 6 weeks' duration) [28] included in the review [14] compared corticosteroid injections versus either physiotherapy (defined as exercise, ultrasound, and deep friction massage) or "wait and see". Only the corticosteroid injection versus physiotherapy results are reported here. The RCT found that corticosteroid injections significantly increased treatment success rate (defined as general improvement, elbow pain-free function, grip strength, self assessment of treatment success) compared with physiotherapy at 6 weeks (92% with corticosteroid injection *v* 47% with physiotherapy; reported as significant; P value and absolute data not reported). However, this benefit was not maintained in the long term; the RCT found that compared with physiotherapy, corticosteroid injections significantly decreased success rate at 1 year (69% with corticosteroid injection *v* 91% with physiotherapy; reported as significant; P value and absolute data not reported). The review also reported that the RCT found high recurrence rate with corticosteroid injections at 6 weeks (further data not reported). [14]

We found one three-armed subsequent RCT (198 people aged 18–55 years with a clinical diagnosis of tennis elbow for a minimum 6 months' duration) [18] comparing corticosteroid injections with either physiotherapy (defined as manual therapy and exercise) or "wait and see" for 52 weeks of follow-up. [18] Only the corticosteroid injection versus physiotherapy results are reported here. The RCT found that corticosteroid injection significantly increased the rate of treatment success (including global improvement, pain, function, and pain-free grip) at 3 weeks compared with physiotherapy (47/63 [75%] with injection *v* 15/64 [23%] with physiotherapy; RRR 0.7, 99% CI 0.4 to 0.9; NNT 2), but found no significant difference between groups at 6 weeks (51/65 [78%] with injections *v* 41/63 [65%] with physiotherapy; RRR +0.4, 99% CI –0.2 to +0.9; NNT 7). [18] The RCT found that compared with physiotherapy, corticosteroid injections significantly reduced the rate of treatment success at 12 weeks (29/65 [45%] with injections *v* 45/58 [78%] with physiotherapy; RRR 0.4, 99% CI 0.1 to 0.7; NNT 3) and 52 weeks (44/65 [68%] with injections *v* 59/63 [94%] with physiotherapy; RRR 0.3, 99% CI 0.1 to 0.5; NNT 4). The RCT also found that corticosteroid injections significantly increased the risk of recurrences after 6 weeks compared with physiotherapy (47/65 [72%] with injections *v* 5/66 [8%] with physiotherapy; RRR 0.9, 99% CI 0.6 to 1.1). [18]

Corticosteroid injections versus NSAIDs:
See oral NSAIDs versus corticosteroid injections, p 3 .

Three reviews [14] [13] [15] included one three-armed RCT [28] (185 people aged 18–70 years, symptom duration >6 weeks) comparing corticosteroid injections versus "wait and see" (defined as ergonomic advice plus NSAIDs) or physiotherapy at 6 and 52 weeks' follow-up. Only the corticosteroid injection versus "wait and see" comparison is reported here. The RCT found that corticosteroid injections significantly increased treatment success rate (defined as general improvement, elbow pain-free function, grip strength, self assessment of treatment success) compared with "wait and see" at 6 weeks (92% with corticosteroid injections *v* 32% with "wait and see"; reported as significant; P value and absolute data not reported). However, this benefit was not maintained in the long term, the RCT found no significant difference in treatment success rate between corticosteroid injections and "wait and see" at 52 weeks (69% with corticosteroid injections *v* 83% with "wait and see"; reported as not significant; P value and absolute data not reported). The RCT also found that there was a high recurrence rate with corticosteroid injections after 6 weeks, but no further data was given by the review. [14]

Corticosteroid injections plus NSAIDS versus NSAIDS alone:
We found one RCT (21 people with tennis elbow) comparing corticosteroid injections plus NSAIDs versus NSAIDs alone. [20] The RCT found that combination treatment significantly increased the proportion of people with complete or near complete pain relief and unlimited function at 1 month compared with NSAIDs alone (10/11 [90%] with combination treatment *v* 4/10 [40%] with NSAIDs alone; P value not reported). Long-term outcomes were not assessed. [20]

Different corticosteroid injection regimens versus each other:
The review [14] identified one RCT [25] comparing different corticosteroid preparations. The three-armed RCT included in the review (88 people with tennis elbow) compared anaesthetic injection with hydrocortisone 25 mg or triamcinolone 10 mg. The RCT found no significant difference between hydrocortisone and triamcinolone in pain or grip strength at 8 weeks' or 6 months' follow-up (further data not reported). [14]

One additional RCT (246 people, published in German) compared dexamethasone 21-palmitate lipid microsphere (dex pal) versus conventional dexamethasone 21-acetate crystal (dex ace) suspension. [16] The RCT reported that both treatments improved pain outcomes, and found no significant difference between groups in the proportion of people reporting "strong" or "very strong" pain with pressure, pain after exercise, or resting pain at 2, 7, or 21 days (P values 0.266 or over for all comparisons). [16]

Corticosteroid injections versus extracorporeal shock wave therapy:
The review [13] identified one RCT (93 people), [29] which compared a single corticosteroid plus local anaesthetic injection (triamcinolone 20 mg made up to 1.5 mL with 1% lidocaine [lignocaine]) versus three sessions weekly of extracorporeal shock wave therapy (ESWT) (2000 shock waves). [29] Self-reported pain was measured at 6 weeks and 3 months, and treatment success was defined as >50% reduction in pain from baseline. It found that corticosteroid plus local anaesthetic injections were significantly more effective at reducing pain at 6 weeks and 3 months compared with ESWT (treatment success rate: 21/25 [84%] with corticosteroid plus local anaesthetic injection *v* 29/48 [60%] with ESWT; P <0.05). [29]

Single versus multiple corticosteroid plus local anaesthetic injections:
One additional RCT (52 people, published in Turkish) compared single versus repeated injections (on average 4.2 times over 12 weeks) of 0.5 mL betamethasone diluted with 0.5 mL pilocaine. [17] It reported that both treatments significantly improved pain intensity and patient satisfaction at 6 and 12 weeks (P <0.01), but found no significant difference between treatments. Repeated injections significantly increased pain and patient dissatisfaction at 18 months. [17]

Corticosteroid injections versus ultrasound:
See ultrasound versus corticosteroid injections., p 21

Corticosteroid injections versus pulsed electromagnetic field treatment:
See pulsed electromagnetic field treatments versus corticosteroid injections, p 24 .

Harms:

Corticosteroid injections versus no intervention or placebo:
The second RCT [22] included in the review [10] reported post-injection pain and local skin atrophy (further data not reported). The RCT comparing corticosteroid injections versus placebo [23] included in the review [14] reported that three people in the placebo group experienced local elbow atrophy. The subsequent RCT found that 13 people in the injection group reported adverse effects, pain after treatment being the most common (12 people in the corticosteroid injection group). Two people in the corticosteroid injection group reported loss of skin pigment, and one person also reported atrophy of the subcutaneous tissue after corticosteroid injections. [18] The RCT gave no information about adverse effects in the placebo group. [18]

Corticosteroid injections versus NSAIDs:
The RCT reported no difference between groups in skin irritation (5% with corticosteroid injections *v* 5% with "wait and see"), but found that corticosteroid injections increased the proportion of people with skin colour change (11% with corticosteroid injections *v* 5% with "wait and see"). [28]

Corticosteroid injections versus local anaesthetic:
Two RCTs [24] [25] identified by the review [10] reported on adverse effects, including facial flushes, post-injection pain, and skin atrophy (further data not reported). [10] The RCT [26] identified by the review [14] comparing corticosteroid injection versus sham injection reported 4 withdrawals due to pain (1 with corticosteroid injection *v* 3 with control; P value not reported). [14]

Corticosteroid injections plus local anaesthetic versus local anaesthetic:
The subsequent RCT gave no information on adverse effects. [19]

Corticosteroid injections versus orthoses:
See harms of orthoses, p 16 .

Corticosteroid injections versus combination physical therapies:
The first RCT [27] included in the review [14] reported that no skin infection or hypopigmentation was seen in the corticosteroid group (further data not reported). The second RCT [28] included in the review [14] gave no information on adverse effects for physiotherapy. For adverse effects on the injection arm, please see corticosteroid injections versus no intervention or placebo.

The subsequent RCT reported a higher proportion of mild adverse effects (mainly increased pain after treatment) with corticosteroid injections compared with physiotherapy (13/63 [21%] with corticosteroid injections *v* 7/64 [11%] with physiotherapy; P value not reported). [18]

Corticosteroid injections versus oral NSAIDs:
See harms of oral NSAIDs, p 3 .

Corticosteroid injections plus NSAIDs versus NSAIDs alone:
The RCT gave no information on adverse effects. [20]

Different corticosteroid injection regimens versus each other:
The RCT [25] identified by the review [14] reported that a greater proportion of people had atrophy with triamcinolone compared with hydrocortisone (12/30 [40%] with triamcinolone injection *v* 6/29 [21%] with hydrocortisone injection); however, this difference was not significant (reported as not significant; P value not reported). [14]

The additional RCT reported that a similar proportion of people in each group experienced adverse effects (2/123 [2%] with dex pal *v* 6/123 [5%] with dex ace; P value not reported). [16]

Corticosteroid injections versus extracorporeal shockwave therapy:
The RCT [29] included in the review [13] gave no information about adverse effects, although it reported that 17/42 (40%) people in the corticosteroid-injection group refused treatment after randomisation (reasons not stated).

Single versus multiple corticosteroid plus local anaesthetic injections:
The RCT reported no local or systemic adverse effects for either single or multiple corticosteroid injections. [17] However, the RCT found that a greater proportion of people underwent surgery with multiple injections compared with single injections (8/30 [27%] with multiple injections *v* 0/22 [0%] with single injections). [17]

Corticosteroid injections versus ultrasound:
See ultrasound versus corticosteroid injections, p 21

Corticosteroid injections versus pulsed electromagnetic field treatment:
See pulsed electromagnetic field treatments versus corticosteroid injections, p 24 .

Comment: The systematic review reported the number of people in the smallest group for each trial rather than the total number of people in the trial. [10] The review found that, in the longer term, there was a high rate of improvement in all groups, including in the placebo group. It found that, in general, the quality of the methodology of the RCTs was poor to modest. The corticosteroid suspensions used in these trials were methylprednisolone (2 RCTs), triamcinolone (4 RCTs), betamethasone (2 RCTs), hydrocortisone (5 RCTs), and dexamethasone (1 RCT). In one RCT, two different substances were used.

OPTION AUTOLOGOUS WHOLE BLOOD INJECTIONS New

We found no direct information from RCTs about the effects of autologous whole blood injections in the treatment of people with tennis elbow.

For GRADE evaluation of interventions for tennis elbow, see **table, p 30 .**

Benefits: We found one systematic review (search date 2008), [30] which identified three case series investigating whole blood injection for lateral epicondylalgia, but no RCTs.

Harms: We found no RCTs.

Comment: The systematic review identified four prospective case series investigating autologous whole blood, reporting significant (P <0.05) improvement in each study compared with baseline. [30]

OPTION PLATELET-RICH PLASMA INJECTIONS New

We found no direct information from RCTs about the effects of platelet-rich plasma injections in the treatment of people with tennis elbow.

For GRADE evaluation of interventions for tennis elbow, see **table, p 30 .**

Benefits: We found one systematic review (search date 2008), which identified no RCTs (see comment below). [30]

Harms: We found no RCTs.

Comment: The systematic review identified one non-randomised controlled trial of platelet-rich plasma compared with control injections. [30] They reported that people receiving platelet-rich plasma improved by a mean of 81% by 27 weeks and 93% at 25.6 months compared with baseline. Controls reported 17% improvement at 4 weeks, but 3/5 (60%) of people receiving control withdrew before the 8 week follow-up and the remaining two people were not followed further.

QUESTION What are the effects of non-drug treatment for tennis elbow?

OPTION ACUPUNCTURE

Pain relief
Compared with sham acupuncture Needle acupuncture may be more effective at increasing pain relief duration after one treatment, or at improving pain after 10 acupuncture sessions at 2 weeks, but may be no more effective at improving pain at 3 or 12 months (low-quality evidence).

Compared with ultrasound Acupuncture may be more effective at reducing pain at 6 months in people with tennis elbow (low-quality evidence).

Different types of acupuncture compared with each other Floating acupuncture may be more effective than electroacupuncture in the short term (undefined) at reducing pain in people with tennis elbow (very low-quality evidence).

Global improvement
Compared with sham acupuncture We don't know whether needle or laser acupuncture is more effective at increasing the proportion of people who report "good" or "excellent" results or "cure" at 3 to 12 months, or whether it is more effective at decreasing the proportion of people who report "no improvement" or "worse" outcome at 3 to 12 months (very low-quality evidence).

Different types of acupuncture compared with each other Traditional deep acupuncture may be more effective than superficial acupuncture in the short term (undefined) at improving self-assessed treatment benefit in people with tennis elbow, but not at 3 and 12 months (low-quality evidence).

Functional improvement
Compared with sham acupuncture Needle acupuncture may be more effective at improving functional impairment at 2 weeks (low-quality evidence).

Compared with ultrasound Acupuncture may be more effective at increasing functional recovery at 6 months in people with tennis elbow (low-quality evidence).

Different types of acupuncture compared with each other Traditional deep acupuncture may be more effective than superficial acupuncture in the short term (undefined) at improving pain-free grip strength, and reducing pain while lifting in people with tennis elbow, but not at 3 and 12 months (low-quality evidence).

For GRADE evaluation of interventions for tennis elbow, see table, p 30 .

Benefits: We found three systematic reviews (search dates 2003 [13] [31] and 2004 [32]) assessing the effects of acupuncture on tennis elbow. The systematic reviews did not pool results of the RCTs because of considerable heterogeneity among trials. We have reported results for RCTs included in at least one of these reviews. We found no RCTs assessing the effects of acupuncture on quality of life, strength, or return to work.

Acupuncture versus sham acupuncture:
We found 5 RCTs (1 RCT reported in 2 publications [33] [34]) comparing acupuncture versus sham acupuncture. [33] [34] [35] [36] [37] [38]

The first RCT (45 people) published in two studies [33] [34] found that 10 acupuncture treatments significantly improved pain (measured on a 30-mm visual analogue scale [VAS]: –8.43 with acupuncture *v* –4.89 with sham treatment; P <0.05) and functional outcomes (measured on the Disabilities of the Arm, Shoulder, and Hand [DASH] scale from 1 to 100: –23.70 with acupuncture *v* –8.54 with sham treatment; P <0.05) at 2 weeks compared with sham treatment. [33] [34]

The second RCT (48 people) found that needle acupuncture significantly increased the duration of pain relief (WMD 18.8 hours, 95% CI 10.1 hours to 27.5 hours) and the proportion of people with at least 50% reduction in pain (19/24 [79%] with acupuncture *v* 6/24 [25%] with placebo; RR 3.2, 95% CI 1.5 to 6.5) after one treatment compared with sham acupuncture where needles were not inserted (see comment below). [35]

The third RCT (82 people) found that, compared with sham treatment, needle acupuncture significantly increased the proportion of self-reported "good" or "excellent" results (22/44 [50%] with acupuncture *v* 8/38 [21%] with sham treatment; P <0.01) and the pain threshold on gripping (32 with acupuncture *v* 10 with sham treatment; P <0.05) after 10 treatments, but found no significant difference at 3 months (good or excellent results: data reported graphically; reported as not significant; pain threshold on gripping: 47 with acupuncture *v* 37 with sham treatment; reported as not significant) or 12 months (good or excellent results: data reported graphically; reported as not significant: pain threshold on gripping: 62 with acupuncture *v* 55 with sham treatment; reported as not significant). [36]

The fourth RCT (49 people) found no significant difference in the proportion of people reporting either no improvement or a worsening of symptoms, after 10 sessions (6/23 [26%] with laser *v* 5/26 [19%] with sham treatment; reported as not significant), and at 3 months (2/22 [9%] with laser *v* 6/25 [24%] with sham treatment; reported as not significant) or 12 months (1/18 [6%] with laser *v* 0/21 [0%] with sham treatment; reported as not significant), between laser acupuncture and sham treatment. It found a smaller proportion of "excellent" or "good" results in the laser acupuncture group compared with the sham treatment group after 10 treatments (5/23 [22%] with laser *v* 12/26 [46%] with sham treatment; reported as not significant), but not at 3 months (12/22 [55%] with laser *v* 13/25 [52%] with sham treatment; reported as not significant) and 10 months (14/18 [78%] with laser *v* 14/21 [67%] with sham treatment; reported as not significant). [37]

The fifth RCT found no significant difference in cure rate (definition of cure not reported) between vitamin B12 injection plus acupuncture and vitamin B12 injection alone (RR 0.44, 95% CI 0.15 to 1.29). [38]

Acupuncture versus ultrasound:
One RCT (40 people) of moderate methodological quality compared acupuncture versus pulsed ultrasound. [39] It found that acupuncture significantly improved pain and functional recovery immediately after treatment (mean pain [visual analogue scale] score: 2.85 with acupuncture *v* 4.49 with ultrasound; P value not reported; mean functional score: 5.8 with acupuncture *v* 9.8 with ultrasound; P value not reported) and at 6 months' follow-up (mean pain [visual analogue scale] score: 2.05 with acupuncture *v* 4.90 with ultrasound; P value not reported; mean functional score: 5.2 with acupuncture *v* 10.0 with ultrasound; P value not reported) compared with ultrasound. [39] A second RCT was identified; however, the sample size of the RCT (17 people) was too small to meet our inclusion criteria for this review. [40]

Different types of acupuncture versus each other:
We found one small RCT (20 people) comparing manual acupuncture versus electroacupuncture, which assessed pain immediately after a course of 6 treatments over 2 weeks. [41] It found that electroacupuncture significantly reduced pain compared with manual acupuncture (pain scored on 10-cm visual analogue scale; pain reduction: 50% with electroacupuncture *v* 32% with manual acupuncture; P <0.001). [41]

One RCT (93 people) [42] included in the review [31] compared floating acupuncture where the needle remained *in situ* for 1 to 2 days versus 7 sessions of routine electroacupuncture. It found that floating acupuncture significantly improved pain relief during the first treatment (P <0.01; further data not reported). [31] A second RCT (82 people) [36] included in the review [32] compared traditional deep acupuncture with superficial acupuncture. It found that traditional acupuncture significantly increased the proportion of people who reported good or excellent results on a self-reported scale of treatment benefit (22/44 [50%] with traditional deep acupuncture *v* 8/38 [21%] with superficial acupuncture; P <0.01). A similar short-term benefit was found for measures of pain-free grip strength (P <0.05; absolute data not reported) and pain while lifting 3 kg (P <0.05; absolute data not reported), but there was no significant difference between groups for any outcome measure at 3 and 12 months of follow-up (further data not reported). [32]

Harms:

Acupuncture versus sham acupuncture:
Long-term follow-up of one RCT [34] found that one person (1/45 [2%]) withdrew because of pain from acupuncture. [33] It found no other adverse events. The other RCTs gave no information about adverse effects. [35] [36] [37] [38]

Acupuncture versus ultrasound:
The RCT found that no adverse effects were reported. [39]

Different types of acupuncture versus each other:
The RCTs gave no information on adverse effects. [41] [42] [36]

Comment:

There is conflicting evidence about the value of acupuncture for tennis elbow, although some trials have demonstrated a small short-term benefit. There may be differences in efficacy between different forms of acupuncture, such as manual acupuncture and electroacupuncture.

OPTION EXERCISE

Pain relief
Exercise plus stretching compared with stretching Exercise plus stretching may be no more effective at increasing pain relief at 6 weeks in people with tennis elbow (low-quality evidence).

Compared with concentric exercise Eccentric exercise may be no more effective at increasing pain relief at 6 weeks in people with tennis elbow (low-quality evidence).

Exercise plus stretching compared with ultrasound plus massage Exercise plus stretching may be more effective at reducing pain at rest and under strain in people with chronic tennis elbow at 6 to 8 weeks (low-quality evidence).

Global improvement

Compared with stretching Exercise may be no more effective at increasing the proportion of people with tennis elbow who return to activity at 3 to 12 months (low-quality evidence).

Exercise plus stretching compared with stretching Exercise plus stretching may be no more effective at increasing global improvement at 6 weeks in people with tennis elbow (low-quality evidence).

Compared with concentric exercise Eccentric exercise may be no more effective at increasing global improvement at 6 weeks in people with tennis elbow (low-quality evidence).

Exercise plus stretching compared with ultrasound Exercise plus stretching may be more effective at increasing the proportion of people with tennis elbow who return to activity at 6 months (low-quality evidence).

Functional improvement
Compared with stretching Exercise may be no more effective at improving grip strength at 6 to 9 weeks, but may be more effective at improving grip strength at 6 months in people with tennis elbow (low-quality evidence).

Exercise plus stretching compared with stretching Exercise plus stretching may be no more effective at improving grip strength at 6 weeks in people with tennis elbow (low-quality evidence)

Compared with concentric exercise Eccentric exercise may be no more effective at improving grip strength at 6 weeks in people with tennis elbow (low-quality evidence).

Exercise plus stretching compared with ultrasound Exercise plus stretching may be more effective at improving function at 1 to 11 months in people with tennis elbow (low-quality evidence).

Exercise plus stretching compared with ultrasound plus massage Exercise plus stretching may be no more effective at improving maximal grip strength in people with chronic tennis elbow at 6 to 8 weeks (low-quality evidence).

For GRADE evaluation of interventions for tennis elbow, see table, p 30 .

Benefits: We found two systematic reviews (search dates 2003), [43] [13] which identified three RCTs [44] [45] [46] investigating eccentric exercise, and a fourth RCT investigating isometric and isotonic exercises. [47]

Exercise versus stretching:
One RCT (30 people) [46] included in the review [43] compared a home programme of eccentric exercise versus contract-relax stretching for 12 weeks. [46] Both groups additionally received an elbow support and night wrist splint. The RCT found no significant difference in self-assessed patient satisfaction/return to activity between groups at 3, 6, or 12 months post treatment (reported as not significant; P value not reported). The RCT found no significant difference in grip strength between groups at 3 months, although both groups improved compared with pre-treatment (P = 0.01). However, the RCT found that eccentric exercise significantly improved grip strength at 6 months compared with stretching (P = 0.05). [46]

Exercise plus stretching versus stretching alone:
One three-armed RCT (94 people, lateral elbow pain of >3 months) [44] included in the review [43] compared eccentric exercise plus stretching versus concentric exercise plus stretching versus stretching alone for 6 weeks. We only report the data for eccentric exercise plus stretching compared with stretching alone here. The review found no significant difference in pain levels between eccentric exercise and stretching at 6 weeks (WMD –1.00, 95% CI –16.46 to +14.46; P = 0.9). The review also found no significant difference between eccentric exercise and concentric exercise in function using the Disabilities of the Arm, Shoulder, and Hand (DASH) for eccentric exercise compared with stretching at 6 weeks (WMD –3.00, 95% CI –12.71 to +6.71; P = 0.54). Similarly, the review found no significant difference between groups in grip strength at 6 weeks (WMD –4.0, 95% CI –12.50 to +4.50; P = 0.36).

Eccentric exercise versus concentric exercise:
One three-armed RCT (94 people, lateral elbow pain of >3 months) [44] included in the review [43] compared eccentric exercise plus stretching versus concentric exercise plus stretching versus stretching alone for 6 weeks. We only report the data for eccentric exercise compared with concentric exercise here. The review found no significant difference in pain levels between concentric and eccentric programmes at 6 weeks (WMD +8.00, 95% CI –8.02, to +24.02; P = 0.33). The review also found no significant difference between eccentric exercise and concentric exercise in function using the Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire at 6 weeks (WMD 0, 95% CI –9.76 to +9.76; P = 1.00). Similarly, the review found no significant difference between groups in grip strength at 6 weeks (WMD –3.00, 95% CI –13.1 to +7.1; P = 0.56).

Exercise plus stretching versus ultrasound:
One RCT (60 people) [45] included in the review [43] compared eccentric exercise plus contract-relax stretching (20–30 sessions) versus sham ultrasound (20 sessions). The review found that eccentric exercise plus stretching significantly increased patient satisfaction/return to activity compared with ultrasound at 6 months (RR 21.97, 95% CI 3.17 to 152.20; P = 0.002; absolute data not reported). The review also found that combination treatment significantly improved function (assessed by a previously used but unvalidated measure) at 4 weeks (WMD 38.70, 95% CI 29.75 to 47.65; P = 0.00001) and at 11 months (WMD 39.20, 95% CI 30.32 to 48.08; P = 0.00001) compared with sham ultrasound. [43]

Exercise plus stretching versus ultrasound plus massage:
One RCT (36 people) [47] included in the review [13] compared exercises (isometric and isotonic) plus stretching versus ultrasound plus friction massage for chronic tennis elbow with high baseline pain (7.6 on a 10-cm visual analogue scale) for 6 to 8 weeks. [13] The review found that exercise significantly improved pain at rest (SMD 0.97, 95% CI 0.30 to 1.63) and under strain (SMD 0.66, 95% CI 0.01 to 1.31) compared with ultrasound. However, there was no significant difference between groups in maximal grip strength (SMD 0.52, 95% CI –0.12 to 1.16).

Harms: The first review reported that no adverse effects were found in any RCT of eccentric exercise programmes. [43] The second review gave no information about adverse effects. [13]

Comment: None.

OPTION MANIPULATION — New

Pain relief
Manipulation plus ultrasound compared with ultrasound alone Mulligan-type manipulation plus ultrasound may reduce pain at 3 to 12 weeks in people with tennis elbow (low-quality evidence).

Global improvement
Compared with ultrasound alone Mulligan-type manipulation plus ultrasound may be more effective at improving global assessment of recovery at 12 weeks in people with tennis elbow (low-quality evidence).

Functional improvement
Compared with sham manipulation Elbow manipulation may be more effective at improving pain-free grip in people with tennis elbow (low-quality evidence).

Manipulation plus ultrasound compared with ultrasound alone Mulligan-type manipulation plus ultrasound may be more effective at improving grip strength at 12 weeks in people with tennis elbow (low-quality evidence).

For GRADE evaluation of interventions for tennis elbow, see table, p 30 .

Benefits: We found two systematic reviews (search dates 2003), [13] [15] which identified two RCTs [48] [49] investigating the immediate effects of cervical or elbow manipulation and one RCT [50] investigating the short-term effects of elbow manipulation.

Manipulation versus sham manipulation:
The review [13] pooled data from two studies evaluating elbow manipulation. [48] [49] The review found that manipulation significantly improved pain-free grip strength compared with sham manipulation immediately after treatment (2 RCTs, 48 people; SMD 1.28, 95% CI 0.84 to 1.73).

Manipulation plus ultrasound versus ultrasound alone:
One RCT (46 people) [50] included in the review [15] compared 10 sessions of Mulligan-type manipulation plus ultrasound versus ultrasound alone over 3 weeks. Following this, both groups performed a 9-week programme of strengthening/stretching exercises. The RCT found that Mulligan-type manipulation significantly improved pain on a 10-cm visual analogue scale at 3 weeks (5.9 cm with manipulation plus ultrasound *v* 1.67 cm with ultrasound alone; P <0.01) and at 12 weeks (P <0.05). The RCT also found that manipulation plus ultrasound significantly improved both global assessment (P <0.05) and grip strength (P <0.05) compared with ultrasound alone at 12 weeks. [15]

Harms: The systematic reviews gave no information on adverse effects. [13] [15]

Comment: None.

OPTION COMBINATION PHYSICAL THERAPIES — New

Pain relief

Compared with brace Exercise plus massage may be no more effective at reducing pain at 6 weeks (low-quality evidence).

Compared with wrist manipulation Exercise plus massage plus ultrasound seems no more effective at reducing pain at 3 weeks, but seems less effective at reducing pain at 6 weeks (moderate-quality evidence).

Compared with brace Exercise plus massage plus ultrasound may be more effective at reducing severity of complaint at 6 weeks (low-quality evidence).

Compared with exercise plus massage plus ultrasound plus brace Exercise plus massage plus ultrasound may be no more effective at reducing severity of complaint at 6 weeks to 12 months (low-quality evidence).

Global improvement
Compared with brace Exercise plus massage may be no more effective at increasing global improvement at 6 weeks (low-quality evidence).

Compared with wrist manipulation Exercise plus massage plus ultrasound seems less effective at increasing global improvement at 3 weeks, but seems as effective at 6 weeks (moderate-quality evidence).

Compared with brace Exercise plus massage plus ultrasound may be as effective at improving success rates at 6 weeks to 1 year (low-quality evidence).

Compared with exercise plus massage plus ultrasound plus brace Exercise plus massage plus ultrasound may be no more effective at increasing global improvement at 6 weeks to 1 year (low-quality evidence).

Compared with "wait and see" We don't know whether physiotherapy increases treatment success rates at 6 weeks to 1 year (low-quality evidence).

Functional improvement
Compared with wrist manipulation Exercise plus massage plus ultrasound seems no more effective at improving pain-free grip or maximum strength grip at 3 to 6 weeks (moderate-quality evidence).

Compared with brace Exercise plus massage plus ultrasound may be more effective at reducing disability scores at 6 weeks (low-quality evidence).

Compared with exercise plus massage plus ultrasound plus brace Exercise plus massage plus ultrasound may be no more effective at reducing disability scores at 6 weeks to 12 months (low-quality evidence).

Recurrence
Compared with "wait and see" Physiotherapy is no more effective at reducing recurrence rates after 6 weeks (low-quality evidence).

For GRADE evaluation of interventions for tennis elbow, see table, p 30 .

Benefits: We found 5 systematic reviews (search dates 1999, [51] 2003, [31] [15] [14] and 2006 [52]), which identified 6 RCTs between them, investigating a combination of exercise and other modalities, such as friction massage and ultrasound. Meta-analysis was not performed in any reviews because of insufficient numbers of studies. Reference is made to individual RCTs where reviews provided insufficient information.

Combination physical therapies versus "wait and see":
Two RCTs [28] [18] comparing physiotherapy with "wait and see" were identified by two systematic reviews. [14] [52]

The first three-armed RCT (185 people with lateral epicondylitis of at least 6 weeks' duration) [28] included in the review [14] compared physiotherapy (defined as exercise, ultrasound, and deep friction massage) with either corticosteroid injections or "wait and see". Only the physiotherapy versus "wait and see" data are reported here. The review found no significant difference between groups in success rate (including disability, pain-free grip strength) at 6 weeks (47% with physiotherapy *v* 32% with "wait and see"; P value not reported) and 1 year (91% with physiotherapy *v* 83% with "wait and see"; P value not reported). [14]

The second three-armed RCT (198 people aged 18–55 years with a clinical diagnosis of tennis elbow for a minimum of 6 months) [18] included in the review [52] compared physiotherapy (defined as manual therapy and exercise) with either corticosteroid injections or "wait and see" for 52 weeks of follow-up. [18] Only the physiotherapy versus "wait and see" data are reported here. The RCT found that physiotherapy significantly improved treatment success rate (including pain, disability, and pain-free grip) compared with "wait and see" at 6 weeks (41/63 [65%] with physiotherapy *v*

16/60 [27%] with "wait and see"; RRR 0.5, 99% CI 0.2 to 0.8; NNT 3); however, this benefit was not maintained at 52 weeks (59/63 [94%] with physiotherapy *v* 56/62 [90%] with "wait and see"; RRR +0.04, 99% CI –0.1 to +0.2; NNT 30). [18] The RCT also found no significant difference between groups in recurrence after 6 weeks and beyond (5/66 [8%] with physiotherapy *v* 6/67 [9%] with "wait and see"; RRR +0.2, 99% CI –1.4 to +1.7). [18]

Combination physical therapies (exercise plus massage) versus brace:
One RCT (60 people with tennis elbow) [53] included in the review [51] compared exercise plus friction massage versus elbow support. The review found no significant difference between groups in pain (SMD –0.17, 95% CI –0.6 to +0.27) or global improvement (RR 0.97, 95% CI 0.61 to 1.56; absolute data not reported) at 6 weeks. [51]

Combination physical therapies (exercise plus massage plus ultrasound) versus wrist manipulation:
One RCT (28 people with lateral epicondylitis for a minimum of 6 weeks) [54] included in the review [14] compared a combination of friction massage, ultrasound, and exercise versus wrist manipulation for 6 weeks. The RCT found that combination treatment significantly reduced the proportion of people who reported increased global improvement on a 6-point scale (1 = complete recovery to 6 = much worse) compared with wrist manipulation at 3 weeks (3/15 [20%] with combination treatment *v* 8/13 [62%] with manipulation; RR 3.1, 95% CI 1 to 9.2; P = 0.05), but found no significant difference between groups at 6 weeks (10/15 [67%] with combination treatment *v* 11/13 [85%] with manipulation; P = 0.4). The RCT found no significant difference between groups for mean decrease in pain (measured on an 11-point numeric scale) during the day at 3 weeks (mean decrease: 1.7 with combination treatment *v* 2.6 with manipulation; P = 0.18), but combination therapy significantly reduced pain relief compared with wrist manipulation at 6 weeks (mean decrease: 5.2 with combination treatment *v* 3.2 with manipulation; P = 0.03). It also found no significant difference between groups for measures of pain-free grip (3 weeks: P = 0.11; 6 weeks: P = 0.11) or maximum grip strength (3 weeks: P = 0.13; 6 weeks: P = 0.15). [54]

Combination physical therapies (exercise plus massage plus ultrasound) versus brace:
One three-armed RCT (180 people) [55] included in the review [15] compared physical therapy (including ultrasound, friction massage, strengthening and stretching exercises) versus brace or a combination of both interventions for 6 weeks with a 1-year follow-up. Only the physical therapy programme versus brace comparison is reported here. The RCT found no significant difference between groups in success rate (self-assessed global improvement score of completely recovered or much improved) at 6 weeks (28/56 [50%] with physical therapy *v* 27/68 [40%] with brace; RR 1.22, 95% CI 0.9 to 1.7). However, the RCT found that physical therapy significantly improved severity of complaints (mean difference: 13/100; 95% CI 3 to 21) and disability as measured by the modified Pain-Free Function Questionnaire (PFFQ) (mean difference: 7/100; 95% CI 1 to 12), compared with brace alone at 6 weeks. No significant differences were found between groups at 6 and 12 months (reported as not significant; P values not reported). [55]

Combination physical therapies versus each other (exercise plus massage plus ultrasound versus exercise plus massage plus ultrasound plus brace):
One three-armed RCT (180 people) [55] included in the review [15] compared physical therapy (including ultrasound, friction massage, strengthening and stretching exercises) versus brace or a combination of both interventions for 6 weeks with a 1-year follow-up. Only the physical therapy programme compared with combination therapy is reported here. The RCT found no significant difference between groups in success rate (self-assessed global improvement score of completely recovered or much improved) at 6 weeks (28/56 [50%] with physical therapy *v* 25/56 [45%] with combination therapy; RR 0.90, 95% CI 0.6 to 1.3). The RCT found no significant differences between groups in success rate, severity of complaint, or disability at 6 or 12 months' follow-up (reported as not significant; P values not reported). [55]

Combined physical therapies versus corticosteroid injections:
See benefits of corticosteroid injections, p 5 .

Harms: The systematic reviews gave no information on adverse effects. [51] [31] [15] [14] [52]

Comment: None.

OPTION **ORTHOSES (BRACING)**

Pain relief
Compared with combination physical therapies Orthoses may be less effective at 6 weeks at improving pain in people who have pain as their main complaint (very low-quality evidence).

Global improvement
Compared with corticosteroid injection Orthoses (splint or elbow band) may be less effective at increasing the proportion of people who rate their global improvement as "good" or "excellent" at 2 weeks, but not at 6 or 12 months (low-quality evidence).

Compared with physiotherapy Orthoses may be less effective at improving patient satisfaction scores at 6 weeks (low-quality evidence).

Functional improvement
Compared with physiotherapy Orthoses may be more effective at improving the ability to perform daily activities at 6 weeks (low-quality evidence).

Note
We found no direct information from RCTs about whether orthoses are better than no active treatment.

For GRADE evaluation of interventions for tennis elbow, see table, p 30 .

Benefits: We found one systematic review (search date 1999) [56] and one additional RCT. [55]

Orthoses versus sham orthoses or no treatment:
The review identified no RCTs. [56]

Orthoses versus corticosteroid injections:
The review [56] identified two RCTs comparing orthoses versus corticosteroid injections. [57] [58] Results of the systematic review were not pooled, because of considerable heterogeneity among trials. The review reported that validity scores for the included RCTs ranged from low to medium. [56] The first RCT (16 people) compared an orthotic device versus corticosteroid injections. [57] However, the trial was very small and people were not blinded to treatment, so it was therefore excluded from this review. The second RCT (70 people, 4 treatment groups) found that corticosteroid injection significantly increased the proportion of people rating global improvement as "good" or "excellent" at 2 weeks, but found no significant difference at 6 or 12 months compared with orthoses (global improvement rated as "good" or "excellent", at 2 weeks: 3/37 [8%] pooled results for splint and elbow band *v* 13/19 [68%] with corticosteroid injection; RR 2.9, 95% CI 1.8 to 5.7; 6 months: 19/37 [51%] pooled results for splint and elbow band *v* 14/19 [74%] with corticosteroid injection; RR 0.70, 95% CI 0.46 to 1.05; 12 months: 22/37 [59%] pooled results for splint and elbow band *v* 13/19 [68%] with corticosteroid injection; RR 0.90, 95% CI 0.60 to 1.03). [58]

Orthoses versus combination physical therapies:
We found one additional RCT (180 people), a three-arm trial comparing orthoses versus physiotherapy (ultrasound plus friction massage plus exercise) versus a combination of orthoses plus physiotherapy. [55] It found that, over the short term, orthosis was less effective at reducing pain among people with pain as their main complaint (34–45% of the study population at 6 weeks) compared with physiotherapy (mean pain score on a scale of 0 = no complaint to 100 = severe complaints among people with pain as main complaint at 6 weeks; mean difference in improvement: 18 with orthosis *v* 31 with physiotherapy; mean difference 13, 95% CI 3 to 21), improving Pain-Free Function Questionnaire [59] scores (mean improvement [scale of 0–100; baseline range: 48–51]; mean difference in improvement: 10 with orthoses *v* 17 with physiotherapy; mean difference 7, 95% CI 1 to 12), and improving patient satisfaction scores (mean improvement [scale of 0–100; baseline range not reported]; mean difference in improvement: 66 with orthoses *v* 75 with physiotherapy; mean difference 9, 95% CI 1 to 18). However, it found that orthoses were more effective than physiotherapy at improving ability to perform daily activities (mean improvement [scale of 0–100; baseline range: 59–64]; mean difference in improvement: 26 with orthoses *v* 15 with physiotherapy; mean difference 11, 95% CI 1 to 21). It found no significant difference between orthoses and physiotherapy at 6 and 12 months. [55]

Orthoses versus topical NSAIDs:
The review identified one small RCT (17 people) comparing an NSAID cream (details of cream not provided in review) with an elbow strap. [56] However, this trial failed to meet our inclusion criteria because of its small size.

Harms: The systematic review [56] and the additional RCT [55] gave no information about adverse effects.

Comment: The review identified three RCTs comparing adding an orthotic device to corticosteroid injections or ultrasound. All three RCTs reported only short-term results, and data were insufficient, or the power of the study too low, to indicate the effect of orthoses. The additional RCT [55] was a high-quality trial, with conflicting results for short-term follow-up, and no significant differences in outcomes for intermediate- (6 months) and long-term (12 months) follow-up.

Orthoses versus sham orthoses or no treatment:
We found one crossover design RCT (63 people with elbow pain for over 6 weeks), which compared brace treatment versus no treatment. [60] The researcher was not blinded to the interventions received by the people enrolled in the trial. After 12 weeks' treatment, the groups were switched for an additional 12 weeks. After the first 12 weeks, there was a significant improvement in pain (visual analogue scale), pain-free grip strength, and functionality in the brace group compared with no treatment (data presented graphically; P <0.042 [change with time for all outcomes]). The RCT reported low levels of withdrawals, none of which was directly related to adverse effects of treatment. [60]

Orthoses versus combination physical therapies:
The review identified one poor-quality RCT (84 people) comparing an elbow support with an unspecified physical therapy. [56] It found limited evidence of no difference in short-term levels of self-reported satisfaction. This study had insufficient information to assess pain improvement, had a withdrawal rate of 30%, and did not report standard deviations or confidence intervals for results.

Orthoses versus topical NSAIDs:
We found no RCTs.

OPTION	SURGERY

Pain relief
Compared with open release surgery alone Nirschl's technique plus drilling may be less effective at improving pain in people with chronic tennis elbow (low-quality evidence).

Compared with decompression of posterior interosseous nerve (PIN) We don't know whether tendon lengthening of extensor carpi radialis brevis (ECRB) is more effective at improving pain relief in people with chronic tennis elbow (very low-quality evidence).

Functional improvement
Open compared with percutaneous release surgery Percutaneous release surgery may be more effective at improving function at 1 year, and at reducing the median time to return to work, in people who had not improved with 12 months of conservative treatment (very low-quality evidence).

Compared with decompression of posterior interosseous nerve (PIN) We don't know whether lengthening of extensor carpi radialis brevis (ECRB) is more effective at improving grip strength or time taken to return to work in people with chronic tennis elbow (very low-quality evidence).

Note
We found no direct information from RCTs about whether surgery is better than no active treatment.

For GRADE evaluation of interventions for tennis elbow, see table, p 30 .

Benefits: We found one systematic review (search date 2006, 45 published studies, of which 3 were RCTs) [61] assessing the effects of surgical outcomes for tennis elbow. However, the review was qualitative; therefore, we have reported results for the included RCTs individually. [62] [63] [64]

Surgery versus no treatment:
We found no RCTs.

Surgery versus other treatments:
We found no RCTs comparing outcomes for surgery with those for other treatments.

Open versus percutaneous release surgery:
The first RCT (not blinded, 47 people who had failed 12 months of conservative treatment) compared open release surgery (removal of the damaged portion of the common extensor origin) versus percutaneous release surgery (tenotomy). [62] The RCT measured function and pain using the Disabilities of the Arm, Shoulder, and Hand (DASH) scale. It found that percutaneous release significantly improved DASH scores at 1 year compared with open release (improvement in median DASH score: 20 with percutaneous release *v* 17 with open release; P = 0.001). [62] The clinical importance of this 3-point difference has been questioned, because the minimum clinically important difference has been reported to be 10 to 15 points. [65] The RCT also found that percutaneous release significantly reduced median time to return to work compared with open release (2 weeks with percutaneous release *v* 5 weeks with open release; P = 0.0001) and significantly improved measures of subjective satisfaction (P = 0.012). [62]

Open release surgery plus drilling versus open release surgery alone:
The second double-blind RCT (18 people [23 elbows] who had limited or no relief following physiotherapy or corticosteroid injections) compared open release surgery with Nirschl's technique with or without decortication (making drill holes through the cortex of the lateral humeral condyle). [63] The RCT found that compared with open release surgery with Nirschl's technique alone, Nirschl's technique release plus drilling did not improve average pain scores (measured by 10-cm visual analogue scale) at 3 and 6 months combined (average pain improvement: 4.6 cm with Nirschl's plus drilling *v* 6.8 cm with Nirschl's alone). However, the RCT did not report P values. [63]

Decompression of posterior interosseous nerve (PIN) versus lengthening of distal tendon of extensor carpi radialis brevis (ECRB):
The third RCT (not blinded, 28 people with tennis elbow of average duration 23 months who had failed conservative treatment) compared decompression of the posterior interosseous nerve (PIN) versus lengthening of the tendon of the extensor carpi radialis brevis (ECRB). [64] The RCT found no significant differences between groups in subjective pain relief (reported as not significant; P value not reported), grip strength (reported as not significant; P value not reported), or return to work (average: 2 months with PIN *v* 2.5 months with ECRB; P value not reported). [64] The authors of the RCT concluded that while of similar value, neither surgical technique was considered a very effective treatment of chronic tennis elbow. [64]

Harms:

Open versus percutaneous release surgery:
The RCT gave no information about adverse effects. [62]

Open release surgery plus drilling versus open release surgery alone:
The RCT [63] reported that compared with release surgery, additional drilling resulted in adverse effects, including greater and longer-lasting postoperative pain (occasionally necessitating overnight admission), less postoperative elbow movement, and more wound bleeding (further data not reported). [63]

Decompression of posterior interosseous nerve (PIN) versus lengthening of distal tendon of extensor carpi radialis brevis (ECRB):
The RCT reported no significant postoperative complications. [64]

Comment:

Various surgical techniques, including open, percutaneous, and endoscopic approaches, have been described for treating lateral elbow pain based on the surgeon's concept of the pathological entity. The review concluded that there is insufficient evidence to support the use of one operative procedure for tennis elbow over another. It reported gross methodological deficiencies between studies and questioned findings of reported high success rates coupled with relatively low complication/failure rates following virtually all types of surgical procedures. [61]

OPTION — EXTRACORPOREAL SHOCK WAVE THERAPY

Pain relief
Compared with sham treatment Extracorporeal shock wave therapy (ESWT) may be no more effective at improving pain at 4 to 6 weeks, or at improving pain from resisted wrist extension at 12 weeks (low-quality evidence).

Compared with corticosteroid injection plus local anaesthetic injection ESWT may be less effective at improving pain at 6 weeks and 3 months compared with a single corticosteroid injection plus local anaesthetic injection (low-quality evidence).

Global improvement
Compared with placebo We don't know whether ESWT is more effective at improving "treatment success" (very low-quality evidence).

Functional improvement
Compared with placebo ESWT seems no more effective at improving measures of function or pain-free grip at 6 weeks to 6 months in people with chronic tennis elbow (moderate-quality evidence).

For GRADE evaluation of interventions for tennis elbow, see table, p 30 .

Benefits:

We found two systematic reviews (search dates 2005 [66] and 2006 [67]) and one subsequent RCT [68] comparing the effects of extracorporeal shock wave therapy (ESWT) versus sham treatment or a physical intervention for tennis elbow. One systematic review [66] pooled data, but the other review did not attempt to pool results, citing methodological and clinical heterogeneity as the reason. [67]

Extracorporeal shock wave therapy (ESWT) with or without local anaesthetic versus sham treatment:
We found two systematic reviews (search date 2005, 9 RCTs, 1006 people [66] and search date 2006, 8 RCTs, 834 people [67]) and one subsequent RCT [68] comparing different regimens of ESWT versus sham treatment.

In the first review, people in three of the RCTs also received local anaesthetic. [66] The RCTs were of variable quality and some were poorly reported, although 5 were considered to be of moderate to high quality. Pooled results for 6 RCTs, in people with chronic unresponsive tennis elbow, found no significant difference between ESWT and sham treatment in 11/13 pooled analyses. Pooled analyses found no significant difference in pain improvement between groups at 4 to 6 weeks (3 RCTs, 446 people; improvement in pain measured on a scale from 0–100: WMD –9.42, 95% CI –20.70 to +1.86). They also found no significant difference between groups in improvement in pain from resisted wrist extension at 12 weeks (3 RCTs, 455 people; improvement in pain using the Thomsen test: WMD –9.04, 95% CI –19.37 to +1.28). [66]

Three RCTs could not be pooled because two did not provide measures of variance, [69] [70] and one included people with short-term symptoms with no previous treatment. [71] However, their inclusion within the pooled analyses in people with chronic tennis elbow would not have altered the overall findings of the review. [66]

The first RCT (24 people) excluded from pooled analysis found that ESWT improved pain at 6 months compared with sham treatment (mean pain score at 6 months [baseline]: 3.0 [6.6] with ESWT *v* 6.2 [6.6] with placebo; improvement of 3 or greater in pain score at 6 months, measured on a 10-point visual analogue scale: 10/13 [77%] with ESWT *v* 1/11 [9%] with sham treatment; P values not reported; reported as significant). [69] However, these results should be interpreted with caution, as treatment allocation concealment was inadequate. [69]

The second excluded RCT (86 people) found no significant difference between the two treatment groups for any measured outcome at any time point, and no significant difference in the proportion of people who eventually required surgery (17/37 [46%] with ESWT *v* 16/37 [43%] with placebo; RR 1.06, 95% CI 0.64 to 1.77). [70]

The third excluded RCT (60 people with previously untreated tennis elbow) found no significant difference between ESWT in treatment success at 5 weeks compared with sham treatment (12/31 [39%] with ESWT *v* 9/29 [31%] with placebo; RR 1.65, 95% CI 0.62 to 2.51). [71] The review found a significantly higher level of treatment success (defined as at least 50% improvement in pain with resisted wrist extension) at 12 weeks with ESWT compared with sham treatment (2 RCTs, 192 people; RR 2.20, 95% CI 1.55 to 3.12), although this finding was not supported by 4 RCTs that could be pooled, and which found no significant difference in treatment success between groups at 4 to 12 weeks. [66]

The second systematic review (8 RCTs, 834 people), [67] included 7 RCTs from the first systematic review, plus one additional placebo-controlled trial. Two RCTs included in the review [72] [73] used a subtherapeutic application as sham treatment. The review assessed trial quality, but meta-analyses were not performed because the authors considered the individual RCTs too heterogeneous to justify pooling of data. Three RCTs were excluded from the review for the following reasons: small sample size, [70] the intervention involved a single application of ESWT, [74] and only the long-term follow-up results from a previous study were reported. [75]

Four of 8 RCTs included in the second review [67] reported positive findings for pain reduction in people with mainly chronic tennis elbow, but no significance assessments were reported. However, one RCT included in the review (62 people with chronic tennis elbow) compared radial shock wave therapy versus sham treatment once a week for 4 weeks. [73] It suggested that shock wave therapy was more effective than sham treatment at reducing pain, both after treatment and at 6 months. However, it is difficult to draw reliable conclusions from these results, because outcome assessment was not blinded, and because, for some parameters, such as pain at rest, pain with resisted movements, and tenderness, the control group was observed to worsen over time — an outcome inconsistent with both the self-limited nature of the condition and the usual expected placebo response (see comment below).

The subsequent double-blind RCT (68 people with chronic tennis elbow) compared 2000 pulses of low-energy ESWT given at weekly intervals without local anaesthetic (ESWT) versus sham treatment (3 treatments of a subtherapeutic dose of 100 pulses of low-energy ESWT) once a week for 4 weeks. [68] The RCT found no significant differences between the groups (intention-to-treat analysis) in measures of pain (pain: mean difference in visual analogue scale [VAS] +1.7, 95% CI –18.8 to +15.3), function (mean difference in function VAS –2.9, 95% CI –17.2 to +11.9; mean difference in 8-item pain-free function index +0.1, 95% CI –1.2 to +1.3; mean difference in Disability of the Arm, Shoulder, and Hand [DASH] scale function +6.3, 95% CI –2.5 to +15.1; mean difference in the Problem Elicitation Technique [PET] –0.6, 95% CI –37.8 to +36.7), or pain-free grip strength (mean difference –0.05, 95% CI –0.22 to +0.12) at 6 weeks' follow up. [68] The RCT also found no significant difference between groups for any outcome at 6 months' follow-up (pain: mean difference VAS; scale –9.0, 95% CI –26.6 to +8.6; function: mean difference in function VAS –9.8, 95% CI –25.2 to +5.7; mean difference in 8-item pain-free function index –0.8, 95% CI –2.2 to +0.6; mean difference in DASH function –0.3, 95% CI –10.3 to +9.8; mean difference in pain-free grip strength –0.05, 95% CI –0.15 to +0.26; mean difference in the PET –8.0, 95% CI –50.0 to +33.9). [68] See comment below for details on trial methods.

Different ESWT regimens versus each other:
We found no RCTs comparing the effectiveness of early versus delayed ESWT, or comparing different modes of delivery with each other.

ESWT versus corticosteroid injections:
See benefits of corticosteroid injections, p 5 .

Harms:

ESWT (with or without local anaesthetic) versus placebo:
The reviews gave no information on adverse effects. [66] [67] The subsequent RCT reported similar low rates of adverse effects in both groups; these included isolated cases of increased pain, bruising or lumps after treatment, and burning sensations. However, no significance assessments were performed between groups. [68]

Different ESWT regimens versus each other:
We found no RCTs comparing the effectiveness of early versus delayed ESWT, or comparing different modes of delivery with each other.

ESWT versus corticosteroid injections:
See harms of corticosteroid injections, p 5 .

Comment:

The inconsistencies in findings between RCTs in this review were, in part, considered a result of trial quality and differences in the treatment application. This systematic review supported a therapeutic benefit of ESWT for managing people with chronic tennis elbow under restricted conditions of repetitive application of 2000 pulses of low-energy ESWT at weekly intervals for 3 to 6 weeks, clinical focusing of the beam, no use of local anaesthesia, and a follow-up of at least 3 months after treatment. [67]

It is important to note that this RCT [68] used the ESWT under conditions recommended by the second systematic review — i.e., patients with chronic tennis elbow, application of 2000 low-energy ESWT at weekly intervals for 3 to 6 weeks, clinical focusing of the beam, no use of local anaesthesia, and a follow-up of at least 3 months after treatment. [66]

Clinical guide:
The available data provide some evidence that shock wave therapy is no better than placebo at improving outcomes.

OPTION	ULTRASOUND	New

Pain relief
Compared with sham ultrasound We don't know whether ultrasound is more effective at reducing pain in people with tennis elbow (very low-quality evidence).

Compared with phonophoresis We don't know whether ultrasound is more effective at reducing pain at 1 to 5 weeks in people with tennis elbow (very low-quality evidence).

Compared with corticosteroid injections We don't know whether ultrasound is more effective at reducing pain in people with tennis elbow (very low-quality evidence).

Global improvement
Compared with placebo/control We don't know whether ultrasound is more effective at increasing global improvement in people with tennis elbow (low-quality evidence).

Compared with phonophoresis Ultrasound may be more effective at increasing global improvement at 5 weeks in people with tennis elbow (low-quality evidence).

Functional improvement

Compared with placebo/control We don't know whether ultrasound is more effective at improving function or maximal grip strength in people with tennis elbow (very low-quality evidence).

Compared with phonophoresis We don't know whether ultrasound is more effective at improving pain-free grip strength at 5 weeks in people with tennis elbow (low-quality evidence).

For GRADE evaluation of interventions for tennis elbow, see **table, p 30** **.**

Benefits: We found three systematic reviews (search dates 2003 [13] [15] [31]) and one subsequent RCT [76] comparing the effects of ultrasound versus placebo or various physical interventions for tennis elbow.

All but one review [15] assessed methodological quality of included studies, and only one review [13] excluded trials that failed to meet 50% quality ratings. One systematic review [13] was able to pool results from two RCTs, but the other reviews were either not able to pool results because of heterogeneity among trials, or only performed a qualitative assessment of included studies. Additionally, we found no RCTs assessing the effects of ultrasound on quality of life or return to work.

Ultrasound versus sham ultrasound:
We found three systematic reviews (search dates 2003), [13] [15] [31] which between them identified three RCTs comparing ultrasound versus sham ultrasound. [77] [78] [79] We also found one subsequent RCT. [76]

The first review [13] identified two RCTs [77] [79] comparing ultrasound with sham ultrasound. The first RCT (99 people) included in the review found that compared with sham ultrasound, ultrasound significantly improved pain (SMD visual analogue scale 1.68, 95% CI 1.11 to 2.24) and maximal grip strength (SMD 0.78, 95% CI 0.28 to 1.28) at 12 weeks' follow-up. However, the RCT found no significant difference between groups in global improvement at 12 weeks' follow-up (RR 1.5, 95% CI 0.71 to 3.19). The review pooled data from the two RCTs, and also found no significant difference between groups in global improvement at 3 months (2 RCTs, 142 people; RR 1.01, 95% CI 0.62 to 1.65). [13]

The second review [15] included two RCTs (220 people), one of which was included in the first review. [77] The second RCT included in the review (76 people) [78] found that compared with sham ultrasound, ultrasound significantly increased the proportion of people who had a satisfactory outcome (defined as full functional recovery with no more than minor ache/slight tenderness) on objective examination at 8 weeks (24/38 [63%] with ultrasound *v* 11/28 [39%] with placebo; P <0.01). However, the RCT did not specify eligibility criteria, there was no concealment of allocation, no intention-to-treat analyses, and outcome measures were not validated.

One subsequent double-blind RCT (48 people with chronic lateral epicondylitis who had failed in at least one first-line treatment including NSAIDs and corticosteroid injections) compared self-application of pulsed low-intensity ultrasound (LIUS) applied daily versus sham ultrasound for 12 weeks. [76] The RCT found no significant difference between groups at 12 weeks in treatment success defined as >50% reduction in pain from baseline (16/25 [64%] with LIUS *v* 13/23 [57%] with sham ultrasound; mean difference +7%, 95% CI –20% to +35%; P = 0.60), pain and function as measured using the Patient-Related Forearm Evaluation Questionnaire (>50% improvement in pain score: 12/25 [48.0%] with LIUS *v* 11/23 [47.8%] with sham ultrasound; P = 0.99; function: 15/25 [60%] with LIUS *v* 11/23 [48%] with placebo; P = 0.40), grip strength (median reduction: 73% with LIUS *v* 62% with sham ultrasound; P = 0.45), and a summary status of local injury questionnaire (data not presented). [76]

Ultrasound versus phonophoresis:
We found two systematic reviews (search dates 2003), [13] [31] which identified two RCTs comparing ultrasound versus phonophoresis (ultrasound with a corticosteroid coupling agent). The first RCT included in the reviews (40 people) [80] used a 2 × 2 factorial design comparing phonophoresis (no drug *v* hydrocortisone coupling gel) as one factor and transverse friction massage (no frictions *v* frictions) as the other. The RCT found no significant difference between groups in global improvement (RR 2.7, 95% CI 0.34 to 21.53), pain (SMD +0.25, 95% CI –0.66 to +1.15), and pain-free grip strength (SMD +0.32, 95% CI –0.59 to +1.23) at 5 weeks' follow-up. [13]

The second RCT (24 people) [81] included in the second review [31] compared ultrasound plus a home programme (wearing an elbow brace, avoiding strenuous activity, and ice massage) versus phonophoresis plus the same home programme. The RCT found no significant difference between groups in pain at 5 days' follow-up (reported as not significant; P value not reported). [31]

Ultrasound versus corticosteroid injections:
We found one systematic review (search date 2003), [31] which identified one RCT (24 people) [81] of low quality (no allocation concealment, insufficient data to establish similarity of groups at baseline, numbers lost to follow-up not reported, no intention-to-treat analyses, follow-up data for individual groups not reported), and with a short follow-up time of 5 days. The RCT found no significant difference in pain scores between groups (reported as not significant; P value not reported). [31]

Ultrasound versus exercise:
See benefits of exercise, p 12 .

Ultrasound versus acupuncture:
See benefits of acupuncture, p 10 .

Harms: The systematic reviews [13] [15] [31] and subsequent RCT [76] gave no information on adverse effects.

Comment: None.

OPTION IONTOPHORESIS New

Pain relief
Compared with iontophoresis with placebo Iontophoresis with an active drug may be more effective at reducing pain at 2 days to 2 weeks, but not at 1 month in people with tennis elbow (very low-quality evidence).

Compared with phonophoresis We don't know whether iontophoresis is more effective at reducing pain at 4.5 months in people with tennis elbow (very low-quality evidence).

Different regimens of iontophoresis compared with each other Iontophoresis with sodium diclofenac may be more effective at reducing pain on resisting wrist extension compared with iontophoresis with sodium salicylate (very low-quality evidence).

Global improvement
Compared with iontophoresis with placebo We don't know whether iontophoresis with an active drug is more effective at increasing self-assessed global improvement at 1 to 3 months in people with tennis elbow (very low-quality evidence).

Functional improvement
Compared with phonophoresis We don't know whether iontophoresis is more effective at increasing functional improvement at 4.5 months in people with tennis elbow (very low-quality evidence).

For GRADE evaluation of interventions for tennis elbow, see table, p 30 .

Benefits: We found 4 systematic reviews (search dates 2003, [13] [31] 2004, [82] and 2006 [52]) comparing the effects of iontophoresis with placebo or a physical intervention for tennis elbow. Only one review [13] pooled results from two RCTs, and the other reviews did not attempt to pool results.

Iontophoresis with active drug versus iontophoresis with placebo:
The first review [13] identified three RCTs assessing the efficacy of iontophoresis versus placebo in people with tennis elbow.

The first RCT included in the review (199 people) [83] compared dexamethasone iontophoresis (6 treatments) versus placebo (saline) iontophoresis over 15 days. Outcomes were measured 2 days and 1 month after the end of treatment. The RCT found that compared with placebo, dexamethasone significantly reduced pain scores (visual analogue scale, mean improvement: 23 mm with dexamethasone *v* 14 mm with placebo; P = 0.012) and significantly increased the proportion of people who rated as moderately improved or better on the blinded investigator's assessment of symptomatic improvement (52% with dexamethasone *v* 33% with placebo; P = 0.013) at 2 days' follow-up. [83] The review found no significant difference between groups in self-assessed global improvement at 2 days (RR 1.18, 95% CI 0.87 to 1.61; P = 0.477) or at 1 month (RR 1.11, 95% CI 0.84 to 1.48). The review also found no significant difference between groups in pain at 1 month of follow-up (SMD +0.12, 95% CI –0.18 to +0.41). [13]

The second RCT [84] included in the review (41 people) compared dexamethasone iontophoresis versus placebo (saline) over 4 treatment sessions. The review found no significant difference between groups at 1 week (RR 0.84, 95% CI 0.37 to 1.90), 3 months (RR 0.93, 95% CI 0.67 to 1.29), and 6 months (RR 0.93, 95% CI 0.71 to 1.24) in self-assessed global improvement. [13]

The first review pooled data from two RCTs [83] [84] and found no significant difference between dexamethasone iontophoresis compared with placebo in self-assessed global improvement at 1 to 3 months' follow-up (2 RCTs, 240 people; RR 1.03, 95% CI 0.83 to 1.28). [13]

The third RCT [85] included in the review (97 people) compared two-dose levels of NSAID iontophoresis (pirprofen) versus sham iontophoresis. The review found that both high- and low-dose iontophoresis significantly reduced pain severity (high dose: SMD 1.63, 95% CI 0.87 to 2.38; low dose: SMD 1.76, 95% CI 0.97 to 2.54) and self-assessed global improvement (high and low dose RR 1.55, 95% CI 1.09 to 2.20) compared with sham at 2 weeks. [13]

The second review [31] identified one RCT (24 people) [86] comparing at least 20 sessions of iontophoresis with diclofenac (150 mg) versus placebo iontophoresis (saline 150 mg). The review found that iontophoresis with diclofenac significantly improved reduction in pain (reported as significant; P value not reported). [31]

Iontophoresis versus phonophoresis:
One systematic review (search date 2004) [82] identified one RCT (61 people) [87] comparing naproxen (10%) administered via galvanic current (iontophoresis) versus naproxen (10%) administered via ultrasound (phonophoresis). Both groups also received a standard physiotherapy programme of education regarding the condition, advice to rest and modify activities, cold compress, stretches, and strengthening exercises. The average length of follow-up was 4.5 months. The review found no significant difference between groups in pain severity (visual analogue scale) and grip strength (reported as not significant; P values not reported). [82] The results of this RCT should be interpreted with caution as there may be some confounding because of the inclusion of additional physiotherapy interventions in both groups, a lack of blinding of the outcome assessor, and variability in the timing of follow-up outcome measures. [82]

Different iontophoresis regimens:
One systematic review (search date 2006) [52] identified one RCT (40 people) [88] comparing iontophoresis with sodium diclofenac versus iontophoresis with sodium salicylate. Both groups received infrared treatment. The review found that iontophoresis with sodium diclofenac significantly reduced pain on resisting wrist extension compared with iontophoresis with sodium salicylate ($P < 0.01$; further data not reported). [52]

Harms: One systematic review [13] noted that one RCT reported adverse effects with iontophoresis. [83] The RCT included in the review reported similar rates of mild adverse effects in both groups on the area of skin over which the active electrode was placed (75% with dexamethasone *v* 60% with placebo; P value not reported); these included skin vesicles, blisters, atopic dermatitis, erythema, burning sensation, local skin reaction, hypersensitivity, and pruritus in both dexamethasone and placebo groups. [83]

Comment: None.

OPTION PULSED ELECTROMAGNETIC FIELD TREATMENT — New

Pain relief
Compared with sham pulsed electromagnetic field (PEMF) We don't know whether PEMF treatment is more effective at reducing pain in people with tennis elbow (very low-quality evidence).

Compared with corticosteroid injections PEMF treatment may be less effective at reducing pain after treatment, but may be more effective at reducing pain at 3 months in people with tennis elbow (low-quality evidence).

Functional improvement
Compared with placebo We don't know whether PEMF treatment is more effective at increasing function at 8 weeks in people with tennis elbow (low-quality evidence).

For GRADE evaluation of interventions for tennis elbow, see table, p 30 .

Benefits: **Pulsed electromagnetic field treatment versus sham PEMF:**
We found two systematic reviews (search dates 2003), [13] [31] which identified one RCT (30 people) comparing pulsed electromagnetic field (PEMF) treatment versus placebo in patients with tennis elbow.

The RCT included in the reviews (30 people) found no significant difference in pain reduction or grip strength between groups, with 8 people in each group (53%) reporting full recovery after 8 weeks of treatment (reported as not significant; P value not reported). [13] [31]

We identified one subsequent three-armed quasi-randomised trial (60 people with epicondylitis) comparing PEMF treatment (15 sessions) versus a sham PEMF (unknown number of sessions) or corticosteroid injections. [89] Only the PEMF treatment versus sham PEMF data are reported here. Both groups also received advice regarding rest, modification of daily activities, and a static wrist splint. The RCT found that PEMF treatment significantly reduced mean pain on resisted wrist dorsiflexion (visual analogue scale [VAS] mean: 2.67 with PEMF treatment *v* 4.16 with sham PEMF; reported as significant; P value not reported) and pain on forearm supination (VAS mean: 1.00 with PEMF treatment *v* 2.39 with sham PEMF; reported as significant; P value not reported) after treatment. At 3 months' follow up, the RCT found that PEMF treatment significantly reduced pain at rest (VAS mean: 0.09 with PEMF treatment *v* 1.79 with sham PEMF; P value not reported), during activity (VAS mean: 0.62 with PEMF treatment *v* 3.37 with sham PEMF), during resisted wrist dorsiflexion (VAS mean: 0.86 with PEMF treatment *v* 3.42 with sham PEMF), and during resisted forearm supination (VAS mean: 0.24 with PEMF treatment *v* 1.53 with sham PEMF) compared with sham PEMF. [89]

Pulsed electromagnetic field treatment versus corticosteroid injection:
We identified one subsequent three-armed quasi-randomised trial (60 people with epicondylitis) comparing PEMF treatment (15 sessions) versus a sham PEMF (unknown number of sessions) or corticosteroid injection (1 cc methylprednisolone acetate [40 mg] and 1 cc prilocaine hydrochloride [20 mg]). [89] We only report the PEMF treatment versus corticosteroid injection data here. Both groups also received advice regarding rest, modification of daily activities, and a static wrist splint. The RCT found that compared with corticosteroid injection, PEMF treatment significantly increased pain during activity (VAS mean: 3.88 with PEMF treatment *v* 1.75 with corticosteroid injection; P value not reported) and pain during resisted wrist dorsiflexion (VAS mean: 2.67 with PEMF treatment *v* 1.57 with corticosteroid injection; P value not reported) at the end of treatment. However, the RCT found that at 3 months' follow-up, PEMF treatment significantly reduced pain during rest (VAS mean: 0.09 with PEMF treatment *v* 1.40 with corticosteroid injection; P value not reported), activity (VAS mean: 0.62 with PEMF treatment *v* 2.75 with corticosteroid injection), and night pain (VAS mean: 0 with PEMF treatment *v* 0.65 with corticosteroid injection; P value not reported) compared with corticosteroid injection. [89]

Harms: The two reviews [13] [31] and subsequent RCT [89] gave no information on adverse effects.

Comment: None.

OPTION	LOW-LEVEL LASER THERAPY	New

Pain relief
Compared with sham treatment/other non-laser interventions Low-level laser therapy (LLLT) seems more effective at reducing pain after treatment at up to 2 months, but seems no more effective at reducing pain at 3 months in people with tennis elbow (moderate-quality evidence).

Global improvement
Compared with sham treatment/other non-laser interventions LLLT seems more effective at increasing global improvement after treatment at up to 2 months, but seems no more effective at increasing global improvement at 3 to 12 months in people with tennis elbow (moderate-quality evidence).

Functional improvement
Compared with sham treatment/other non-laser interventions LLLT seems more effective at improving pain-free grip strength after treatment up to 2 months, but seems no more effective at improving pain-free grip strength at 3 to 12 months in people with tennis elbow (moderate-quality evidence).

For GRADE evaluation of interventions for tennis elbow, see table, p 30 .

Benefits: We found two systematic reviews (search date unknown, 13 RCTs, 730 people, [90] and 2003, 6 RCTs, 277 people [13]) comparing different low-level laser therapy (LLLT) regimens versus placebo (defined as sham treatment or other non-laser interventions, no additional information reported).

Low-level laser therapy (LLLT) versus sham treatment/other non-laser interventions:
Of the 12 RCTs included in the first review, [90] 6 reported consistent positive results in favour of LLLT for more than one outcome, two RCTs reported positive findings in favour of LLLT for one outcome measure, 4 RCTs reported non-significant findings, and one RCT reported findings significantly in favour of the sham treatment or other non-laser interventions.

The first review found that LLLT significantly reduced pain scores at the end of treatment (10 RCTs, 481 people; WMD 10.24, 95% CI 3.04 to 17.46; P = 0.005) and at 3 to 8 weeks of follow-up (6 RCTs, 243 people; WMD 11.80, 95% CI 7.64 to 16.07; P <0.0001) compared with placebo. The review also found that LLLT significantly increased global improvement at the end of treatment (7 RCTs; 152/221 [69%] with LLLT *v* 109/216 [50%] with placebo; RR 1.36, 95% CI 1.16 to 1.60; P = 0.0002) and at 3 to 8 weeks' follow-up (3 RCTs; 71/85 [84%] with LLLT *v* 43/86 [50%] with placebo; RR 1.68, 95% CI 1.32 to 2.13; P <0.0001) compared with placebo. The review also found that LLLT significantly improved pain-free grip at the end of treatment compared with placebo (8 RCTs, 323 people; SMD 0.66, 95% CI 0.42 to 0.90; P <0.00001). [90] See comment below for discussion of heterogeneity.

The second review [13] included 5 RCTs included in the first review, plus one RCT that was excluded from the first review because the application technique was considered invalid. [91] The review found contradictory results between RCTs for short-term to 3-month follow-up for measures of pain, grip strength, and global improvement. The review pooled data from included RCTs and found no significant difference between LLLT compared with placebo at 3 months' follow-up, for measures of pain (visual analogue scale: SMD +0.33, 95% CI –0.21 to +0.86), pain-free grip strength (SMD +0.17, 95% CI –0.41 to +0.75), and global improvement (RR 1.09, 95% CI 0.77 to 1.53). The review also found no significant difference in effect between LLLT compared with placebo with pooled data of global improvement (RR 1.52, 95% CI 0.97 to 2.38) and pain-free grip strength (SMD –0.05, 95% CI –0.55 to +0.45) on long-term follow-up of 6 to 12 months. However, the number of RCTs included in the meta-analysis was not specified. [13] See comment below for discussion of heterogeneity.

Harms: The first review [90] reported no adverse effects within the included RCTs, while the second review gave no information on adverse effects. [13]

Comment: Considerable heterogeneity in the treatment procedures for LLLT was reported in the first review, including different wave lengths, number of treatment sessions, intervention time periods, and application techniques (acupoints [2 trials], tendon application [11 trials]). Seven RCTs enrolled people with poor prognosis (based on the demographic data presented), and in two RCTs people received an exercise regimen concurrently with laser or placebo, which the authors suggest may have deflated the effect size of the laser therapy. [90]

The second review concluded that while there was some contradiction in the short-term effects of LLLT, the pooled data suggested evidence of no effect over that of placebo in both the short and long term. It should be noted that the RCTs assessed in this review were heterogeneous in the wavelengths of laser applied and the method of application (directly over the tendon versus acupuncture points); therefore, pooling of data may be invalid. However, given that 5 of the 6 trials that investigated the effects of LLLT in this review reported non-significant results, the pooled results were consistent with the findings of the majority of the individual trials. [13]

Clinical guide:
Overall, conflicting data and heterogeneity between RCTs suggests that caution should be taken in drawing conclusions regarding the effects of LLLT. However, it seems that LLLT using a 904-nm wavelength applied directly over the tendon area may be effective in reducing pain and improving functional outcomes in the short term in people with tennis elbow.

GLOSSARY

Disabilities of the Arm, Shoulder, and Hand (DASH) This functional index is a 30-item questionnaire designed to assess function in people with musculoskeletal disorders of the upper limb. Each item is scored from 1–5, and the total score is converted to a 1–100 scale.

Extracorporeal shock waves These may be generated by electrohydraulic, electromagnetic, or piezoelectric systems that have an electroacoustic conversion mechanism and a device to focus the shock waves to the centre of the target zone.

Iontophoresis Also known as ionisation, iontophoresis is a technique whereby a drug such as corticosteroid is introduced through the skin using an electrical charge.

Low-quality evidence Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.

Moderate-quality evidence Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.

Pain-Free Function Questionnaire A questionnaire assessing 10 activities that are frequently affected in patients with tennis elbow. Patients rate each activity on a scale from 0–4 (4 indicating severe discomfort) to give a total score ranging from 0–40. This score is then converted to a 0–100 scale for ease of comparison with other outcome measures.

Radial shock waves Extracorporeal shock waves that are produced pneumatically through the acceleration of a projectile inside a handpiece and are transmitted radially from its tip to the target zone.

Roles–Maudsley score A subjective pain score where 1 = excellent, no pain, full movement, full activity; 2 = good, occasional discomfort, full movement, and full activity; 3 = fair, some discomfort after prolonged activity; and 4 = poor, pain limiting activities.

Shock waves Single pulsed acoustic or sound waves that disperse mechanical energy at the interface of two substances with different acoustic impedance.

Very low-quality evidence Any estimate of effect is very uncertain.

SUBSTANTIVE CHANGES

Autologous whole blood injections New option added. Categorised as Unknown effectiveness, as we found no RCT evidence to assess the effects of this intervention.

Platelet-rich plasma injections New option added. Categorised as Unknown effectiveness, as we found no RCT evidence to assess the effects of this intervention.

Manipulation New option added with two systematic reviews. [13] [15] Categorised as Unknown effectiveness, as there remains insufficient good-quality evidence to assess the effects of manipulation on tennis elbow.

Combination physical therapies New option added with 5 systematic reviews. [14] [15] [31] [51] [52] Categorised as Unknown effectiveness, as there remains insufficient good-quality evidence to assess the effects of combination physical therapies on tennis elbow.

Ultrasound New option added with three systematic reviews [13] [15] [31] and one subsequent RCT. [76] Categorised as Unknown effectiveness, as there remains insufficient good-quality evidence to assess the effects of ultrasound on tennis elbow.

Iontophoresis New option added with 4 systematic reviews. [13] [31] [52] [82] Categorised as Unknown effectiveness, as there is insufficient good-quality evidence to assess the effects of iontophoresis on tennis elbow.

Pulsed electromagnetic field treatment New option added with two systematic reviews [13] [31] and one subsequent RCT. [89] Categorised as Unknown effectiveness, as there is insufficient good-quality evidence to assess the effects of pulsed electromagnetic field treatment on tennis elbow.

Low-level laser therapy New option added with two systematic reviews. [13] [90] Categorised as Likely to be beneficial in the short term.

Acupuncture New evidence added. [31] [39] Categorisation unchanged (Unknown effectiveness), as there remains insufficient good-quality evidence to assess the effects of acupuncture on tennis elbow.

Corticosteroid injections New evidence added. [14] [15] [18] [19] [20] Categorisation unchanged (Likely to be beneficial in the short term).

Exercise New systematic review added, [43] which identified one new RCT. [46] Categorisation unchanged (Unknown effectiveness), as there remains insufficient good-quality evidence to assess the effects of exercise on tennis elbow.

Extracorporeal shock wave therapy New evidence added. [66] [67] [68] Categorisation unchanged (Unlikely to be beneficial).

Surgery New evidence added. [63] [64] Categorisation unchanged (Unknown effectiveness), as there remains insufficient good-quality evidence to assess the effects of surgery on tennis elbow.

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TABLE GRADE evaluation of interventions for tennis elbow

Important outcomes: Pain relief, global improvement, functional improvement, quality of life, adverse effects

Number of studies (participants)	Outcome	Comparison	Type of evidence	Quality	Consistency	Directness	Effect size	GRADE	Comment
What are the effects of oral drug treatments for tennis elbow?									
2 (293) [9]	Pain relief	Oral NSAIDs *v* placebo	4	–3	–1	0	0	Very low	Quality points deducted for incomplete reporting of results, short follow-up, and use of vitamin C as placebo. Consistency point deducted for conflicting results
1 (164) [9]	Functional improvement	Oral NSAIDs *v* placebo	4	–3	0	0	0	Very low	Quality points deducted for sparse data, incomplete reporting of results, and use of vitamin C as placebo
2 (at least 53) [9]	Pain relief	Oral NSAIDs *v* corticosteroid injection	4	–3	–1	0	0	Very low	Quality points deducted for sparse data, unclear definition of outcome, and incomplete reporting of results. Consistency point deducted for conflicting results
2 (not stated) [9]	Global improvement	Oral NSAIDs *v* corticosteroid injection	4	–3	0	0	0	Very low	Quality points deducted for sparse data, incomplete reporting of results, and subjective assessment of outcome
What are the effects of topical drug treatments for tennis elbow?									
3 (130) [9]	Pain relief	Topical NSAIDs *v* placebo	4	–1	0	0	0	Moderate	Quality point deducted for sparse data
2 (119) [9]	Global improvement	Topical NSAIDs *v* placebo	4	–2	0	0	0	Low	Quality points deducted for sparse data and subjective assessment of outcomes
2 (at least 40) [9]	Functional improvement	Topical NSAIDs *v* placebo	4	–2	0	0	0	Low	Quality points deducted for sparse data and incomplete reporting of results
What are the effects of local injections for tennis elbow?									
3 (at least 372) [10] [14] [18]	Pain relief	Corticosteroid injection *v* no intervention or placebo	4	–1	0	0	0	Moderate	Quality point deducted for incomplete reporting of results
4 (at least 401) [10] [14] [18]	Global improvement	Corticosteroid injection *v* no intervention or placebo	4	–1	0	0	0	Moderate	Quality point deducted for incomplete reporting of results
2 (at least 208) [10] [18]	Functional improvement	Corticosteroid injection *v* no intervention or placebo	4	–1	0	0	0	Moderate	Quality point deducted for incomplete reporting of results
1 (185) [14] [15] [18]	Pain relief	Corticosteroid injection *v* NSAIDs	4	–1	–1	0	0	Low	Quality point deducted for sparse data. Consistency point deducted for conflicting results
1 (185) [14] [15] [18]	Global improvement	Corticosteroid injection *v* NSAIDs	4	–1	–1	0	0	Low	Quality point deducted for sparse data. Consistency point deducted for conflicting results
1 (185) [14] [15] [18]	Functional improvement	Corticosteroid injection *v* NSAIDs	4	–1	–1	0	0	Low	Quality point deducted for sparse data. Consistency point deducted for conflicting results
2 (68) [10] [14]	Pain relief	Corticosteroid injection *v* local anaesthetic	4	–1	–1	0	0	Low	Quality point deducted for sparse data. Consistency point deducted for conflicting results
3 (85) [10]	Global improvement	Corticosteroid injection *v* local anaesthetic	4	–2	–1	–1	0	Very low	Quality points deducted for sparse data and incomplete reporting of results. Consistency point deducted for conflicting results. Directness point deducted for concurrent treatment with rehab in 1 RCT

Important outcomes	Pain relief, global improvement, functional improvement, quality of life, adverse effects								
Number of studies (participants)	**Outcome**	**Comparison**	**Type of evidence**	**Quality**	**Consistency**	**Directness**	**Effect size**	**GRADE**	**Comment**
2 (68) [10] [14]	Functional improvement	Corticosteroid injection *v* local anaesthetic	4	–2	–1	–1	0	Very low	Quality points deducted for sparse data and incomplete reporting of results. Consistency point deducted for conflicting results. Directness point deducted for concurrent treatment with rehab in 1 RCT
1 (64) [19]	Pain relief	Corticosteroid injection plus local anaesthetic *v* local anaesthetic alone	4	–1	0	0	0	Moderate	Quality point deducted for sparse data
1 (64) [19]	Global improvement	Corticosteroid injection plus local anaesthetic *v* local anaesthetic alone	4	–1	0	0	0	Moderate	Quality point deducted for sparse data
1 (64) [19]	Functional improvement	Corticosteroid injection plus local anaesthetic *v* local anaesthetic alone	4	–1	0	0	0	Moderate	Quality point deducted for sparse data
1 (106) [14]	Pain relief	Corticosteroid injection *v* physiotherapy	4	–2	0	0	0	Low	Quality points deducted for sparse data and incomplete reporting of results
2 (383) [14] [18]	Global improvement	Corticosteroid injection *v* physiotherapy	4	–1	0	0	0	Moderate	Quality point deducted for sparse data
1 (106) [14]	Functional improvement	Corticosteroid injection *v* physiotherapy	4	–2	0	0	0	Low	Quality points deducted for sparse data and incomplete reporting of results
2 (383) [14] [18]	Recurrence	Corticosteroid injection *v* physiotherapy	4	–1	0	0	0	Moderate	Quality point deducted for sparse data
2 (334) [14] [16]	Pain relief	Different types of corticosteroid injection *v* each other	4	–1	0	0	0	Moderate	Quality point deducted for incomplete reporting of results
1 (88) [14]	Functional improvement	Different types of corticosteroid injection *v* each other	4	–2	0	0	0	Low	Quality points deducted for sparse data and incomplete reporting of results
1 (21) [20]	Pain relief	Corticosteroid injections plus NSAIDs *v* NSAIDs alone	4	–2	0	–1	0	Very low	Quality points deducted for sparse data and incomplete reporting of results. Directness point deducted for the use of a combined outcome
1 (93) [29]	Pain relief	Corticosteroid injection *v* ESWT	4	–2	0	0	0	Low	Quality points deducted for sparse data and no intention-to-treat analysis
1 (52) [17]	Pain relief	Single *v* multiple injections	4	–2	0	–1	0	Very low	Quality points deducted for sparse data and incomplete reporting of results. Directness point deducted for unclear outcome measurement
What are the effects of non-drug treatments for tennis elbow?									
3 (175) [34] [35] [36]	Pain relief	Acupuncture *v* sham acupuncture	4	–2	0	0	0	Low	Quality points deducted for sparse data and incomplete reporting of results
1 (161) [36] [37] [38]	Global improvement	Acupuncture *v* sham acupuncture	4	–2	0	–1	0	Very low	Quality points deducted for sparse data and incomplete reporting of results. Directness point deducted for unclear measurement of outcomes
1 (45) [34]	Functional improvement	Acupuncture *v* sham acupuncture	4	–1	0	–1	0	Low	Quality point deducted for sparse data. Directness point deducted for short follow-up
1 (40) [39]	Pain relief	Acupuncture *v* ultrasound	4	–2	0	0	0	Low	Quality points deducted for sparse data and incomplete reporting of results

Important outcomes	Pain relief, global improvement, functional improvement, quality of life, adverse effects								
Number of studies (participants)	**Outcome**	**Comparison**	**Type of evidence**	**Quality**	**Consistency**	**Directness**	**Effect size**	**GRADE**	**Comment**
1 (40) [39]	Functional improvement	Acupuncture *v* ultrasound	4	–2	0	0	0	Low	Quality points deducted for sparse data and incomplete reporting of results
2 (113) [31] [41]	Pain relief	Different types of acupuncture *v* each other	4	–2	0	–1	0	Very low	Quality points deducted for sparse data and incomplete reporting of results. Directness point deducted for short follow-up
1 (88) [32]	Global improvement	Different types of acupuncture *v* each other	4	–2	0	0	0	Low	Quality points deducted for sparse data and incomplete reporting of results
1 (88) [32]	Functional improvement	Different types of acupuncture *v* each other	4	–2	0	0	0	Low	Quality points deducted for sparse data and incomplete reporting of results
2 (30) [43]	Functional improvement	Exercise *v* stretching	4	–2	0	0	0	Low	Quality points deducted for sparse data and incomplete reporting of results
1 (30) [43]	Global improvement	Exercise *v* stretching	4	–2	0	0	0	Low	Quality points deducted for sparse data and incomplete reporting of results
1 (94) [43]	Pain relief	Exercise plus stretching *v* stretching alone	4	–2	0	0	0	Low	Quality points deducted for sparse data and incomplete reporting of results
1 (94) [43]	Global improvement	Exercise plus stretching *v* stretching alone	4	–2	0	0	0	Low	Quality points deducted for sparse data and incomplete reporting of results
1 (94) [43]	Functional improvement	Exercise plus stretching *v* stretching alone	4	–2	0	0	0	Low	Quality points deducted for sparse data and incomplete reporting of results
1 (94) [43]	Pain relief	Eccentric *v* concentric exercise	4	–2	0	0	0	Low	Quality points deducted for sparse data and incomplete reporting of results
1 (94) [43]	Global improvement	Eccentric *v* concentric exercise	4	–2	0	0	0	Low	Quality points deducted for sparse data and incomplete reporting of results
1 (94) [43]	Functional improvement	Eccentric *v* concentric exercise	4	–2	0	0	0	Low	Quality points deducted for sparse data and incomplete reporting of results
1 (60) [43]	Global improvement	Exercise plus stretching *v* ultrasound	4	–2	0	0	0	Low	Quality points deducted for sparse data and incomplete reporting of results
1 (60) [43]	Functional improvement	Exercise plus stretching *v* ultrasound	4	–2	0	0	0	Low	Quality points deducted for sparse data and incomplete reporting of results
1 (36) [13]	Pain	Exercise plus stretching *v* ultrasound plus massage	4	–2	0	0	0	Low	Quality points deducted for sparse data and incomplete reporting of results
1 (36) [13]	Functional improvement	Exercise plus stretching *v* ultrasound plus massage	4	–2	0	0	0	Low	Quality points deducted for sparse data and incomplete reporting of results
1 (46) [15]	Functional improvement	Manipulation *v* sham manipulation	4	–2	0	0	0	Low	Quality points deducted for sparse data and incomplete reporting of results
1 (46) [15]	Global improvement	Manipulation plus ultrasound *v* ultrasound alone	4	–2	0	0	0	Low	Quality points deducted for sparse data and incomplete reporting of results

Important outcomes	Pain relief, global improvement, functional improvement, quality of life, adverse effects								
Number of studies (participants)	**Outcome**	**Comparison**	**Type of evidence**	**Quality**	**Consistency**	**Directness**	**Effect size**	**GRADE**	**Comment**
3 (94) [13] [15]	Functional improvement	Manipulation plus ultrasound *v* ultrasound alone	4	–2	0	0	0	Low	Quality points deducted for sparse data and incomplete reporting of results
1 (60) [51]	Pain relief	Exercise plus massage *v* brace	4	–2	0	0	0	Low	Quality points deducted for sparse data and incomplete reporting of results
1 (60) [51]	Global improvement	Exercise plus massage *v* brace	4	–2	0	0	0	Low	Quality points deducted for sparse data and incomplete reporting of results
1 (28) [14]	Pain relief	Exercise plus massage plus ultrasound *v* wrist manipulation	4	–1	0	0	0	Moderate	Quality point deducted for sparse data
1 (28) [14]	Global improvement	Exercise plus massage plus ultrasound *v* wrist manipulation	4	–1	0	0	0	Moderate	Quality point deducted for sparse data
1 (28) [14]	Functional improvement	Exercise plus massage plus ultrasound *v* wrist manipulation	4	–1	0	0	0	Moderate	Quality point deducted for sparse data
1 (80) [15]	Pain relief	Exercise plus massage plus ultrasound *v* brace	4	–2	0	0	0	Low	Quality points deducted for sparse data and incomplete reporting of results
1 (80) [15]	Global improvement	Exercise plus massage plus ultrasound *v* brace	4	–2	0	0	0	Low	Quality points deducted for sparse data and incomplete reporting of results
1 (80) [15]	Functional improvement	Exercise plus massage plus ultrasound *v* brace	4	–2	0	0	0	Low	Quality points deducted for sparse data and incomplete reporting of results
1 (80) [15]	Pain relief	Exercise plus massage plus ultrasound *v* exercise plus massage plus ultrasound plus brace	4	–2	0	0	0	Low	Quality points deducted for sparse data and incomplete reporting of results
1 (80) [15]	Global improvement	Exercise plus massage plus ultrasound *v* exercise plus massage plus ultrasound plus brace	4	–2	0	0	0	Low	Quality points deducted for sparse data and incomplete reporting of results
1 (80) [15]	Functional improvement	Exercise plus massage plus ultrasound *v* exercise plus massage plus ultrasound plus brace	4	–2	0	0	0	Low	Quality points deducted for sparse data and incomplete reporting of results
2 (383) [14] [52]	Global improvement	Combination physical therapies *v* "wait and see"	4	–1	–1	0	0	Low	Quality point deducted for sparse data. Consistency point deducted for conflicting results
1 (198) [52]	Recurrence	Combination physical therapies *v* "wait and see"	4	–2	0	0	0	Low	Quality points deducted for sparse data and incomplete reporting of results
1 (180) [55]	Pain relief	Orthoses *v* combination physical therapies	4	–1	0	–2	0	Very low	Quality point deducted for sparse data. Directness points deducted for inclusion of different comparators and subgroup analysis
1 (180) [55]	Global improvement	Orthoses *v* combination physical therapies	4	–1	0	–1	0	Low	Quality point deducted for sparse data. Directness point deducted for inclusion of different comparators
1 (180) [55]	Functional improvement	Orthoses *v* combination physical therapies	4	–1	0	–1	0	Low	Quality point deducted for sparse data. Directness point deducted for inclusion of different comparators

Important outcomes	Pain relief, global improvement, functional improvement, quality of life, adverse effects								
Number of studies (participants)	**Outcome**	**Comparison**	**Type of evidence**	**Quality**	**Consistency**	**Directness**	**Effect size**	**GRADE**	**Comment**
1 (70) [58]	Global improvement	Orthoses *v* corticosteroid injections	4	–1	0	–1	0	Low	Quality point deducted for sparse data. Directness point deducted for inclusion of different comparators
1 (18) [63]	Pain relief	Open release surgery plus drilling *v* open release surgery alone	4	–2	0	0	0	Low	Quality points deducted for sparse data and incomplete reporting of results
1 (28) [64]	Pain relief	Decompression of posterior interosseous nerve *v* lengthening of distal tendon of extensor carpi radialis brevis	4	–3	0	0	0	Very low	Quality points deducted for sparse data, incomplete reporting of results, and lack of blinding
1 (28) [64]	Functional improvement	Decompression of posterior interosseous nerve *v* lengthening of distal tendon of extensor carpi radialis brevis	4	–3	0	0	0	Very low	Quality points deducted for sparse data, incomplete reporting of results, and lack of blinding
1 (47) [62]	Functional improvement	Open *v* percutaneous release surgery	4	–3	0	0	0	Very low	Quality points deducted for sparse data, lack of blinding, and uncertainty about clinical relevance of improvement
6 (618) [66] [68]	Pain relief	ESWT *v* sham treatment	4	0	–1	–1	0	Low	Consistency point deducted for conflicting results. Directness point deducted for inclusion of other intervention
7 (at least 252) [66]	Global improvement	ESWT *v* sham treatment	4	–2	–1	–1	0	Very low	Quality points deducted for incomplete reporting of results and poor methodologies. Consistency point deducted for conflicting results. Directness point deducted for inclusion of other interventions
1 (68) [68]	Functional improvement	ESWT *v* sham treatment	4	–1	0	0	0	Moderate	Quality point deducted for sparse data
2 (147) [13] [76]	Pain relief	Ultrasound *v* sham ultrasound	4	–3	–1	0	0	Very low	Quality points deducted for sparse data, incomplete reporting of results, and methodological weaknesses. Consistency point deducted for conflicting results
2 (142) [13]	Global improvement	Ultrasound *v* sham ultrasound	4	–2	0	0	0	Low	Quality points deducted for sparse data and incomplete reporting of results
3 (223) [13] [15] [76]	Functional improvement	Ultrasound *v* sham ultrasound	4	–2	–1	0	0	Very low	Quality points deducted for incomplete reporting of results and methodological weaknesses. Consistency point deducted for conflicting results
2 (64) [13] [31]	Pain relief	Ultrasound *v* phonophoresis	4	–3	0	0	0	Very low	Quality points deducted for sparse data, incomplete reporting of results, and methodological weaknesses
1 (40) [13]	Global improvement	Ultrasound *v* phonophoresis	4	–2	0	0	0	Low	Quality points deducted for sparse data and incomplete reporting of results
1 (40) [13]	Functional improvement	Ultrasound *v* phonophoresis	4	–2	0	0	0	Low	Quality points deducted for sparse data and incomplete reporting of results
1 (24) [31]	Pain relief	Ultrasound *v* corticosteroid injection	4	–3	0	0	0	Very low	Quality points deducted for sparse data, incomplete reporting of results, and methodological weaknesses

Important outcomes	Pain relief, global improvement, functional improvement, quality of life, adverse effects								
Number of studies (participants)	**Outcome**	**Comparison**	**Type of evidence**	**Quality**	**Consistency**	**Directness**	**Effect size**	**GRADE**	**Comment**
3 (320) [13] [31]	Pain relief	Iontophoresis with an active drug *v* iontophoresis with placebo	4	–1	–1	–2	0	Very low	Quality point deducted for incomplete reporting of results. Consistency point deducted for conflicting results. Directness points deducted for the use of different active drugs and different numbers of treatment in the trials
3 (180) [13]	Global improvement	Iontophoresis with an active drug *v* iontophoresis with placebo	4	–1	–1	–2	0	Very low	Quality point deducted for incomplete reporting of results. Consistency point deducted for conflicting results. Directness points deducted for the use of different active drugs and different numbers of treatment in the trials
1 (61) [82]	Pain relief	Iontophoresis *v* phonophoresis	4	–3	0	–1	0	Very low	Quality points deducted for sparse data, incomplete reporting of results, and methodological weaknesses. Directness point deducted for the inclusion of other treatment
1 (61) [82]	Functional improvement	Iontophoresis *v* phonophoresis	4	–3	0	–1	0	Very low	Quality points deducted for sparse data, incomplete reporting of results, and methodological weaknesses. Directness point deducted for the inclusion of other treatment
1 (40) [52]	Pain relief	Different regimens of iontophoresis *v* each other	4	–2	0	–1	0	Very low	Quality points deducted for sparse data and incomplete reporting of results. Directness point deducted for the inclusion of other treatment
2 (90) [13] [31] [89]	Pain relief	PEMF treatment *v* sham PEMF	4	–2	–1	0	0	Very low	Quality points deducted for sparse data and incomplete reporting of results. Consistency point deducted for conflicting results
1 (30) [13] [31]	Functional improvement	PEMF treatment *v* sham PEMF	4	–2	0	0	0	Low	Quality points deducted for sparse data and incomplete reporting of results
1 (60) [89]	Pain relief	PEMF treatment *v* corticosteroid injections	4	–2	0	0	0	Low	Quality points deducted for sparse data and incomplete reporting of results
11 (481) [90] [13]	Pain relief	LLLT *v* sham treatment or other non-laser interventions	4	–1	0	0	0	Moderate	Quality point deducted for incomplete reporting of results
8 (437) [13] [90]	Global improvement	LLLT *v* sham treatment or other non-laser interventions	4	–1	0	0	0	Moderate	Quality point deducted for incomplete reporting of results
9 (323) [13] [90]	Functional improvement	LLLT *v* sham treatment or other non-laser interventions	4	–1	0	0	0	Moderate	Quality point deducted for incomplete reporting of results

Type of evidence: 4 = RCT; 2 = Observational; 1 = Non-analytical/expert opinion. ESWT, extracorporeal shock wave therapy. LLLT, low-level laser therapy. PEMF, pulsed electromagnetic field.
Consistency: similarity of results across studies.
Directness: generalisability of population or outcomes.
Effect size: based on relative risk or odds ratio.