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Systematic review

Effectiveness of corticosteroid injections compared with physiotherapeutic interventions for lateral epicondylitis: A systematic review

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Abstract

Objectives To compare the effectiveness of corticosteroid injections with physiotherapeutic interventions for the treatment of lateral epicondylitis (tennis elbow).

Data sources The electronic databases AMED, Cinahl, Medline and Embase were searched up to Week 12 2009. In addition, the Cochrane Central Register of Controlled Clinical Trials, the Metaregister of Controlled Clinical Trials and the Physiotherapy Evidence Database (PEDro) were searched up to March 2009.

Review methods All English-language randomised controlled trials (RCTs) that included participants with a clinical diagnosis of lateral epicondylitis, comparing corticosteroid injections with physiotherapeutic interventions, and used at least one clinically relevant outcome measure were included. The review authors extracted and analysed the data independently, using the PEDro scale to assess the methodological quality of each eligible study.

Results Five RCTs were identified and included in the review. Four of the studies included the measurement of pain-free grip strength. Standardised mean differences (effect sizes) were calculated for this outcome measure and assessor's rating of severity at 3, 6, 12, 26 and 52 weeks for two of the RCTs. Large effect sizes were demonstrated in favour of corticosteroid injections at short-term follow-up. At intermediate- and long-term follow-up, medium-to-large effect sizes were demonstrated in favour of physiotherapeutic interventions compared with corticosteroid injections. However, at long-term follow-up, the research suggests that there is a small benefit of physiotherapeutic interventions compared with a 'wait and see' policy.

Conclusion Overall, the findings indicated that corticosteroid injections are effective at short-term follow-up, and physiotherapeutic interventions are effective at intermediate- and long-term follow-up. However, due to the limited number of high-quality RCTs and differences in the interventions and outcomes utilised within each of the included studies, any conclusions drawn must be interpreted with caution.

Keywords: Tennis elbow; Physical therapy; Rehabilitation; Triamcinolone acetonide

Background

Lateral epicondylitis (tennis elbow) is a painful musculoskeletal condition which is considered to be due to over-use, over-stress or over-exertion of the wrist extensors of the forearm [1]. It is often associated with individuals who have repetitive occupations and/or hobbies [2], affects the dominant hand [1] and primarily occurs between the ages of 35 and 64 years [3].

Clinical presentation is characterised by lateral elbow pain, which may radiate into the forearm, with reproduction of pain on resisted wrist extension and localised palpation around the common extensor origin [4]. Most individuals will classically report pain as the main feature of their condition, associated with marked deficits in activities involving gripping and wrist extension [5]. Many individuals are referred to physiotherapy departments for optimal management of this condition. The primary aims of treatment are pain relief and restoration of muscle condition [5].

Although there is widespread acceptance that the common extensor origin, particularly the origin of extensor carpi radialis brevis [1], is the affected structure, several the-

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ories have developed regarding the underlying aetiology. Historically, an acute inflammatory response is thought to be responsible for the associated disability [4], suggesting that treatments should focus on the resolution of inflammation. However, more recent histopathological examinations suggest that a non-inflammatory process is present and that treatments should be aimed at normal vascularisation and collagen production in the affected tendon [2,6]. There is a dearth of literature identifying numerous treatment interventions, suggesting that this musculoskeletal condition is complex to manage. Such controversy regarding the rationale behind many advocated treatment interventions [7] introduces further uncertainty into optimal management.

The Cochrane Library has published several reviews in an attempt to determine the optimal management of tennis elbow. The reviews cover a widespread range of treatments including: acupuncture [8], oral non-steroidal anti-inflammatory drugs (NSAIDs) [9], orthotic devices [10], shock wave therapy [11] and surgery [12]. The evaluation of acupuncture as a treatment modality is the only review of particular relevance to current physiotherapy practice; however, the inclusion criteria were poorly defined and not sufficiently specific to only include individuals with a diagnosis of lateral epicondylitis.

Four systematic reviews [13–16] have studied the effectiveness of physiotherapeutic interventions and rehabilitation in the management of lateral epicondylitis, incorporating many different interventions, e.g. ultrasound, exercise and mobilisations. One review [13] attempted to perform a quantitative meta-analysis of various treatments. However, due to poor methodological quality and contradictory results, the authors concluded that there was insufficient evidence to support a single type of intervention. Another review [14] included interventions which are rarely used within current physiotherapy practice (e.g. ionisation, Reebox). However, this review did find good-quality evidence to support positive effects with regards to acupuncture, exercise therapy, manipulations/mobilisations and ultrasound. The only interventions that were refuted definitively were laser therapy and pulsed electromagnetic field therapy (PEMT).

Smidt *et al.* [15] performed a comprehensive review with well-defined selection criteria and stringent quality assessment. Fourteen of 23 studies were found to have an acceptable validity score, although the authors found that none of the included studies had an adequate sample size or sufficient power. The main finding was weak evidence to support the effectiveness of ultrasound compared with placebo.

Bisset *et al.* [16] carried out a well-designed review and identified 28 studies that had acceptable levels of quality for inclusion. Although some evidence was found to support the short-term benefit of ultrasound, ionisation and acupuncture, no evidence was found to suggest a benefit over placebo in the long term.

As several treatment modalities used regularly in physiotherapy practice have been shown to lack scientific rationale, many clinicians appear to base their management of this complex condition on subjective data and clinical experience [17].

The most consistent benefit identified in the literature appears to be short-term pain relief following corticosteroid injections [3,18]. Two systematic reviews have studied the effectiveness of corticosteroid injections for lateral epicondylitis, and both concluded that corticosteroid injections are effective in the short term but not at longer-term follow-up. Conclusions were drawn with reference to an alternative treatment, e.g. NSAIDs, wrist brace and phonophoresis.

In 1995, the scope of physiotherapy was extended to include corticosteroid injections within the management of musculoskeletal conditions [19], and physiotherapists can now choose to include this as a treatment option in the management of tennis elbow. Thus, in an attempt to provide clinically effective treatments supported by scientific evidence as well as clinical expertise [20], it was felt that a new review was justified. The particular aim of this review is to compare the effectiveness of corticosteroid injections with physiotherapeutic interventions regularly used in clinical practice. No previous systematic reviews that make this direct comparison have been identified, and all recent and updated primary research will be included in this review.

Objective

The aim of this review is to compare the effectiveness of corticosteroid injections with physiotherapeutic interventions for the treatment of lateral epicondylitis.

Method

Search strategy

The authors searched the databases Medline (1966 to Week 12 2009), Cinahl (1982 to Week 12, 2009), Amed (1985 to Week 12, 2009) and SPORTDiscus (1985 to Week 12 2009) via the EBSCOhost searching interface. The search terms were adapted for the Embase (1980 to Week 12 2009) database, which was searched via OVID. Subject headings and keywords based around population and interventions were used to identify potentially relevant citations. Truncation symbols were used within the headings and keywords. An example of the Embase search strategy is detailed in Box 1 . In addition, the Physiotherapy Evidence Database (PEDro) was searched up to Week 12 2009 using the keywords ‘forearm or elbow’, ‘musculoskeletal’ and ‘clinical trial’. The Cochrane Central Register of Controlled Clinical Trials was searched up to March 2009 using the keywords ‘tennis elbow’, ‘lateral epicondylitis’ and ‘elbow pain’. Additional searching included the metaregister of controlled clinical trials, subject headings and keywords were used to identify

Box 1Example of Embase search via OVID: to Week 12 2009

1 tennis elbow.mp. or Tennis Elbow/
2 lateral epicondylitis.mp. or Tennis Elbow/
3 elbow joint.mp. or exp Elbow/
4 tendin$.mp.
5 tendon$.mp. or Tendon Injury/or Tendon Lesion/
6 tendonitis.mp. or Tendinitis/
7 3 and 4
8 3 and 5
9 3 and 6
10 1 or 2 or 6 or 7 or 8 or 9
11 physical therapy.mp. or Physiotherapy/
12 physio$.mp.
13 physical$.mp.
14 Rehabilitation/or rehab$.mp.
15 Exercise/or exercise$.mp.
16 (home adj3 exercise$).mp.
17 mobilis$.mp.
18 manip$.mp.
19 friction$.mp.
20 Acupuncture Analgesia/or Acupuncture/or acupuncture$.mp.
21 acupressure.mp. or Acupressure/
22 trigger point therapy.mp. or Massage/
23 electro$.mp.
24 ultrasonic therapy.mp. or Ultrasound Therapy/
25 Ultrasound/or ultrasound.mp.
26 ultrasonics.mp. or Ultrasound/
27 ultra$.mp.
28 tens.mp.
29 Transcutaneous Nerve Stimulation/or transcutaneous electrical nerve stimulation.mp.
30 Laser/or laser$.mp.
31 laser therapy.mp.
32 taping$.mp.
33 bracing$.mp.
34 stretching$.mp.
35 strengthening$.mp.
36 or/11-35
37 Triamcinolone/or Corticosteroid/or Steroid/or steroid injection.mp. or Triamcinolone Acetonide/
38 steroid.mp. or Steroid/
39 injection therapy.mp.
40 38 or 39 or 37
41 10 and 36 and 40

potentially relevant citations, and were based around population and both physiotherapeutic and injection interventions.

All searches were limited to studies published in the English language, and the references of all primary studies and publications identified were screened for further relevant studies.

Study selection

Studies were eligible for inclusion in the review if they met the following criteria.

Study design

Randomised controlled trials (RCTs) were considered for inclusion if they demonstrated evidence of random allocation of subjects to either an injection group or a physiotherapeutic intervention group. Only trials published in the English language were considered.

Participants

Male or female participants aged at least 18 years with a clinical diagnosis of lateral epicondylitis, characterised by lateral elbow pain reproduced on resisted wrist extension/dorsiflexion, were included [4].

Interventions

Studies which compared a corticosteroid injection group with a physiotherapeutic intervention group were included. The latter comprised any interventions regularly used within physiotherapy practice in the management of lateral epicondylitis. These included (but were not limited to): ultrasound, electrotherapy, frictions, taping, acupuncture, mobilisations, manipulations, exercises, home exercise programmes and mills manipulation. The review authors were required to be familiar with the intervention and agree on its inclusion.

Studies were excluded if there was failure to define and describe the physiotherapeutic intervention and/or the corticosteroid injections used within the study.

Outcomes

All studies had to include at least one clinically relevant and validated outcome measure which has been shown to be sensitive to change [21]. These could include (but were not limited to) measures of the severity of pain, grip strength (pain free or maximum), elbow disability and global improvement, with follow-up of at least 6 weeks.

Study quality assessment

The 11-item PEDro scale was used to assess the quality of the studies eligible for inclusion in the review. This was included as it is a scale specifically designed to assess RCTs on PEDro [22]. It is based on the Delphi list described by Verhagen *et al.* [23], and includes assessment of criteria which are thought to be central to bias minimisation and high internal validity; namely randomisation, concealed allocation, and blinding of subjects, therapists and assessors [24–26].

Eligible studies identified in the search were assessed independently by the review authors. Each study was openly assessed and documented. Any disagreements involving quality assessment of the pilot or selected studies were

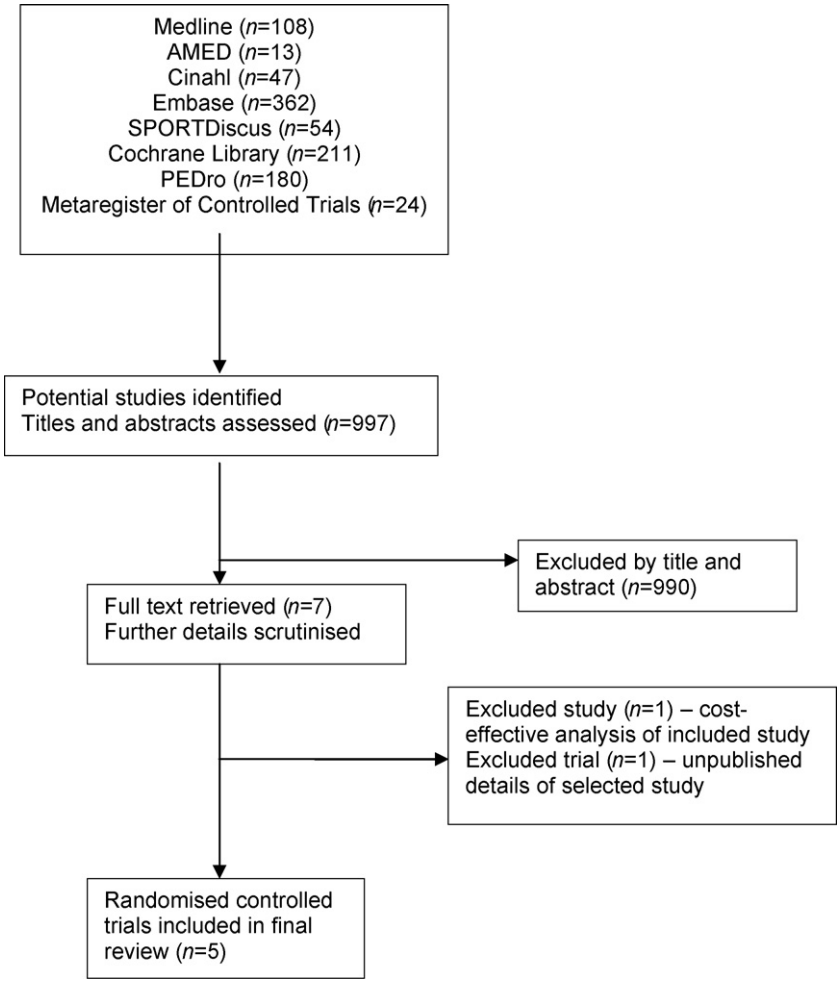

Fig. 1. Flow diagram of study selection.

resolved in a consensus meeting and documented to demonstrate the level of disagreement [25].

Data extraction

A comprehensive data extraction form was developed which was independently pilot tested prior to use in the review. Data extracted included participant eligibility criteria, the type and duration of interventions, outcome measures used within each study, follow-up periods, methods of data analysis and research findings. Data extraction forms were compared at consensus meetings.

Data analysis

Data from the injection, physiotherapeutic intervention and 'wait and see' study groups were analysed. Where possible, effect sizes (standardised mean differences) were calculated at short- (3 to 6 weeks), intermediate- (between 6 and 26 weeks) and long-term (52 weeks) follow-up periods in studies which included outcome measures that were directly comparable. The effect size was calculated as described by Coe [27].

Data analysis was undertaken using MedCalc® Version 10.4 (MedCalc Software: Mariarkerke, Belgium). Standardised mean differences and 95% confidence intervals were calculated using a random effects model. Descriptive analysis was undertaken on studies with heterogenous outcomes.

As effect sizes are calculated using an experimental and control group, for the purpose of the review, data from the injection groups were substituted as the experimental group, and data from the control/'wait and see' and physiotherapeutic intervention groups were substituted as the control group. Analysis was made with reference to the injection group [27], i.e. positive effect sizes indicated a beneficial effect in favour of the injection group, and negative effect sizes indicated a beneficial effect in favour of the physiotherapeutic intervention or control/'wait and see' group. For comparison between the physiotherapeutic intervention group and the control group, intervention data were substituted as the experimental group.

Table 1
Summary of the characteristics of the included studies.

Study	Design	Population	Duration of disorder	Injection intervention	Physiotherapeutic intervention	Control	Outcome measures	Follow-up	Summary of findings
Smidt *et al.* 2002 [30]	RCT	$n = {}^{*}185$ Female $n = 93$ Mean age 47 years Pain at lateral side of elbow increased with pressure on lateral epicondyle and resisted dorsi-flexion. Injection group $n = 62$ Physiotherapy group $n = 64$ Wait and see group $n = 59$	At least 6/52 (median 11/52)	10 mg triamcinolone acetonide and 1 ml lidocaine 2%. Tender points identified and injected until patient pain free with resisted dorsiflexion. Max three injections in 6/52	Pulsed U/S, deep friction massage, exercise programme and home exercise programme	Wait and see advice, paracetamol or NSAIDs	Overall severity of complaints, pain during day, pain-free grip strength, max grip strength, modified pain-free questionnaire, global improvement, pain pressure threshold, inconvenience, patient satisfaction	3,6,12,26 and 52 weeks	At 6/52, corticosteroid injection group showed significant improvement across all outcomes compared with physiotherapy group. At 12, 26 and 52 weeks, physiotherapy group showed significant improvement across all outcomes compared with corticosteroid injection group. Short-term significant findings in favour of physiotherapy group compared with wait and see group. At 52 weeks, no significant difference in outcomes between physiotherapy group and wait and see group 37% recurrence in injection group

Table 1 (*Continued*)

Study	Design	Population	Duration of disorder	Injection intervention	Physiotherapeutic intervention	Control	Outcome measures	Follow-up	Summary of findings
Bisset *et al.* 2006 [31]	RCT	$n = {}^{*}198$ Female $n = 70$ Mean age 47.6 years Pain over lateral elbow increased with palpation of lateral epicondyle, gripping, resisted wrist or 2nd, 3rd finger extension. Injection group $n = 65$ Physiotherapy group $n = 66$ Wait and see group $n = 67$	At least 6/52 (median 22/52)	1 mg lidocaine 1% with 10 mg triamcinolone acetonide delivered to painful elbow points. 2nd injection after 2/52 if required. Advice to continue normal activities	Elbow manipulation and exercise and home exercise programme. Eight 30-minute treatments over 6/52	Wait and see advice on activity modification, use of analgaesia, heat, cold and brace if needed	Severity of elbow complaints, severity of pain in previous 1/52, pain-free grip strength, pain-free function questionnaire, global/general improvement	3,6,12,26 and 52 weeks	At 6/52, corticosteroid injection showed significant improvement across all outcomes compared with physiotherapy group and wait and see group. At 6/52, physiotherapy group showed significant improvement compared with wait and see group for all outcomes. At 12, 26 and 52 weeks, physiotherapy group showed significant improvement compared with corticosteroid injection group. At 52 weeks, no significant difference in outcomes between physiotherapy group and wait and see group. 72% recurrence in injection group

Table 1 (*Continued*)

Study	Design	Population	Duration of disorder	Injection intervention	Physiotherapeutic intervention	Control	Outcome measures	Follow-up	Summary of findings
Verhaar *et al.* 1996 [32]	RCT	$n = ^{*}106$ Female $n = 47$ Mean age 43 years Pain at lateral side elbow, tenderness over extensor origin, pain on resisted dorsi-flexion. Injection group $n = 53$ Physiotherapy group $n = 53$	Mean 33/52	1 ml triamcinolone acetate suspension 1%, diluted with 1 ml lidocaine into origins of extensor digitorum and extensor carpi radialis brevis. Max three injections in 4/52. Advice to avoid pain provoking activity	Deep transverse frictions and mills manipulations. 12 treatments over 4/52	N/A	Occurrence of pain, severity of pain, mean grip strength, subjective loss of grip strength, resumption of labour, resisted dorsi-flexion and resisted dorsi-flexion of middle finger, local tenderness	6 and 52 weeks	At 6/52, corticosteroid injection group showed significant improvement across all outcomes. At 52 weeks, no difference in outcomes between the two groups. 34% recurrence rate in injection group
Uzunca *et al.* 2007 [33]	RCT	$n = ^{*}60$ Female $n = 45$ Mean age 48.6 years Tenderness over extensor carpi radialis brevis origin. Pain on resisted wrist extension and supination. Injection group $n = 20$ Physiotherapy group $n = 20$ Sham physiotherapy group $n = 20$	Mean 3.4/12	Single injection of 1 cc methyl-prednisolone (40 mg) 1 cc prilocaine most painful area around lateral epicondyle	PEMF x 5 sessions per week over 3/52. Dose = 6 MT Frequency = 25 Hz and 4.6 Hz consecutively	Sham PEMF Same audio and visual sense but no exposure to magnetic field	VAS: pain levels during rest, night time and resisted wrist extension and supination. Algometric pain thresholds	3 and 12 weeks	All pain parameters improved after 3/52 in all groups. VAS levels during activity and on resisted wrist extension were significantly lower in the injection group compared with the PEMF group. Only pain levels on resisted wrist extension and supination were significantly lower in the PEMF group compared with the sham group. At 12/52, the PEMF group had lower pain during rest, activity and night-time compared with the injection group

Table 1 (*Continued*)

Study	Design	Population	Duration of disorder	Injection intervention	Physiotherapeutic intervention	Control	Outcome measures	Follow-up	Summary of findings
Tonks *et al.* 2007 [34]	RCT	$n = {}^{*}48$ Gender or mean age not stated Pain on palpation of extensor origin and resisted wrist extension. Injection group $n = 12$ Physiotherapy group $n = 12$ Injection and physiotherapy group $n = 12$ No treatment group $n = 12$	Not stated	Single injection of 10 mg triamcinolone and 2% lignocaine hydrochloride over tender part of extensor origin	Exercise programme: progressive slow repetitive wrist stretching and muscle conditioning intensified over four stages. Duration and frequency not stated	No treatment	Pain-free grip strength, PRFEQ, extensor weight strength	7/52	Significant improvement in all outcomes for injection group only compared with physiotherapy and injection group, physiotherapy alone group and no treatment group

RCT, randomised controlled trial; NSAIDs, non-steroidal anti-inflammatory drugs; U/S, ultrasound; PEMF, pulsed electromagnetic field therapy; VAS, visual analogue scale; PRFEQ, patient related forearm evaluation questionnaire.

[*] Sample size at commencement of study.

The effect sizes were interpreted as described by Cohen [28]. An effect size of 0.2 was considered to represent a small beneficial effect, 0.5 a medium effect and >0.8 a large effect.

Results

Search results

The review authors independently assessed the title and abstract of each article. In total, 997 studies were initially identified from the search. From these, 990 were excluded and seven were deemed to be eligible for closer scrutiny. One study was excluded after retrieval of the full text [29]. This study proved to be a cost-effective analysis of another RCT [30]. One unpublished trial required additional details to be scrutinised. Further investigation found that the trial had recently been published and was one of the selected RCTs. The results of the search are detailed in Fig. 1.

Subsequently, five studies were deemed to be eligible for inclusion in the final review [30–34]. All five studies were RCTs that included comparison between an injection group and a physiotherapeutic intervention group. The studies by Bisset *et al.* [31], Smidt *et al.* [30] and Tonks *et al.* [34] also included a control/'wait and see' group. The study by Verhaar *et al.* [33] only included a comparison between a physiotherapeutic intervention group and a corticosteroid injection group. The study by Tonks *et al.* [34] had an additional group which received physiotherapeutic interventions in combination with corticosteroid injections. The control group in the study by Uzunca [33] received sham PEMT.

Characteristics of included studies

Populations

The characteristics of each study are summarised in Table 1. All studies identified clear inclusion and exclusion criteria. The mean age and gender of participants in each study were comparable, although the average duration of tennis elbow varied. Bisset *et al.* [31] and Smidt *et al.* [30] reported calculations to determine that a sample size of 60 participants per group was necessary to detect a clinically important difference of 25% in success rate between groups. In both studies, at least 60 participants per group started and completed the trial. In the study by Verhaar *et al.* [32], the maximum number of participants per group at any stage was 53. In comparison, the sample populations in each group in the studies by Uzunca *et al.* [33] and Tonks *et al.* [34] were lower at 20 and 12, respectively.

Interventions

The type, frequency and duration of the physiotherapeutic interventions varied significantly across the included studies. The interventions included different types of electrotherapy (ultrasound and PEMT), manual therapy and exercise programmes. The interventions for each study are summarised in Table 1. The injection drugs were comparable between four of the studies, although one study [33] used methylprednisolone instead of triamcinolone. There were differences across all studies in the strength of the local anaesthetic, injection site and number of injections administered.

Outcome assessment

Each study included more than one outcome measure, and variations of pain and grip strength were reported in all five RCTs. However, a wide variety of outcome measurements were included, using a variety of assessment tools. Four studies [30–33] incorporated pain-free grip strength as a measure. Only the studies by Bisset *et al.* [31] and Smidt *et al.* [30] reported comparable measures between groups at baseline, which permitted meta-analysis for both pain-free grip strength and assessor's rating of severity.

Three studies [30–32] reported measurements at baseline, 6 weeks and 1 year. Uzunca *et al.* [33] had follow-up periods of 3 and 12 weeks, and Tonks *et al.* [34] had a single follow-up at 7 weeks. Two studies [30,31] included more frequent follow-up measurements throughout the assessment period.

Quality assessment

The quality assessment for each individual study is detailed in Table 2. There were variations in the method-

Table 2
Quality assessment of included studies using the Physiotherapy Evidence Database scale.

	Bisset *et al.* 2002 [30]	Smidt *et al.* 2006 [31]	Verhaar *et al.* 1996 [32]	Uzunca *et al.* 2007 [33]	Tonks *et al.* 2007 [34]
Random allocation	1	1	1	1	1
Concealed allocation	1	1	1	1	1
Baseline comparability	1	1	1	1	0
Blind subject	0	0	0	0	0
Blind clinician	0	0	0	0	0
Blind assessor	1	1	0	1	0
Adequate follow-up	1	1	1	1	0
Intention-to-treat analysis	1	1	1	0	0
Between-group analysis	1	1	1	1	1
Point estimates and variability	1	1	1	1	1
Total score	**8**	**8**	**7**	**7**	**4**

Table 3
Effect sizes: corticosteroid injections compared with physiotherapeutic interventions for pain-free grip strength and assessor's rating of severity.

Study	Follow-up (weeks)	Sample size injection	Sample size physiotherapeutic interventions	Pain-free grip strength	Rating of severity
Bisset *et al.* 2002 [30]	3	63	64	1.25	1.26
	6	65	63	0.55	0.65
	12	65	58	−0.67	−0.7
	26	64	59	−1.06	−1.38
	52	65	63	−0.61	−0.89
Smidt *et al.* 2006 [31]	3	62	64	1.29	1.13
	6	62	64	1.08	1.05
	12	61	64	−0.37	−0.32
	26	60	64	−0.57	−0.5
	52	60	64	−0.72	−0.48

Positive effect sizes favour corticosteroid injections. Negative effect sizes favour physiotherapeutic interventions.

ological assessment scores of each of the included studies. All of the included studies allocated participants at random to the corticosteroid injection group or the physiotherapeutic intervention group. With the exception of the study by Tonks *et al.* [34], the groups were comparable at baseline. Unsurprisingly due to the nature of the interventions, none of the participants or clinicians were blind to the interventions. Three studies [30–32] included intention-to-treat analyses. Follow-up was adequate in all studies with the exception of Tonks *et al.* [34], who only compared the short-term benefit of physiotherapeutic interventions and corticosteroid injections.

Results of data analysis

Table 1 shows the summary of results for each of the RCTs. The results of meta-analysis comparing corticosteroid injections and physiotherapeutic interventions on the outcomes of pain-free grip strength and assessor's rating of severity in the studies by Bisset *et al.* [30] and Smidt *et al.* [31] are outlined in Table 3. Forest plots (Figs. 2–5) demonstrate the effect sizes comparing the corticosteroid injection, physiotherapeutic intervention and control/'wait and see' groups at various follow-up points for the outcome of pain-free grip strength. The main conclusion from both studies [30,31] for both outcome measures is that corticosteroid injections are effective at short-term follow-up, and physiotherapeutic interventions are effective at intermediate- and long-term follow-up. Physiotherapeutic interventions demonstrated a large effect compared with the 'wait and see' group at short-term follow-up, but only a small benefit at long-term follow-up. Both studies also reported sufficient sample sizes for the detection of a clinically important difference.

All of the included studies found that corticosteroid injections were significantly more effective than physiotherapeutic interventions for outcome measurements at short-term follow-up, i.e. between 3 weeks [30,31,33] and 7 weeks [32,34]. Tonks *et al.* [34] found that, at short-term follow-up, there was no significant difference between the group receiving physiotherapeutic interventions and injections compared with injections alone. However, this study did have significantly smaller study groups and had large loss to follow-up at 7 weeks. Where measurements were undertaken in the intermediate term, three of the studies found that physiother-

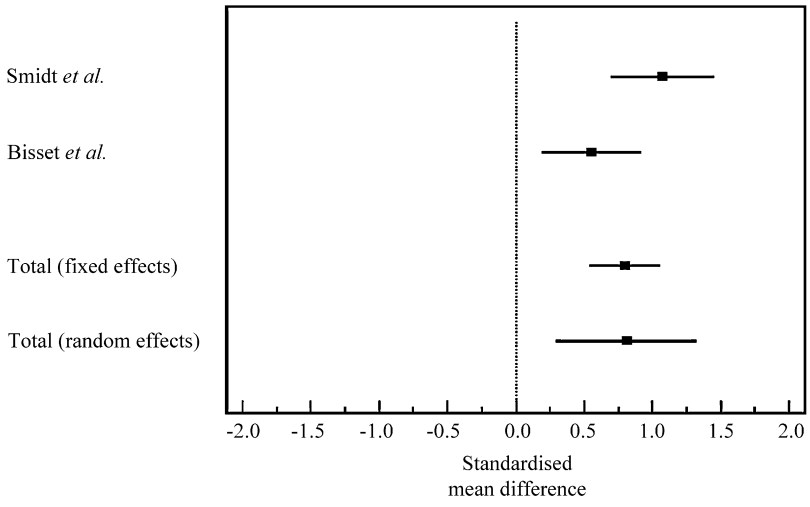

Fig. 2. Comparison: corticosteroid injections compared with physiotherapeutic interventions at 6 week follow-up. Outcome: pain-free grip strength.

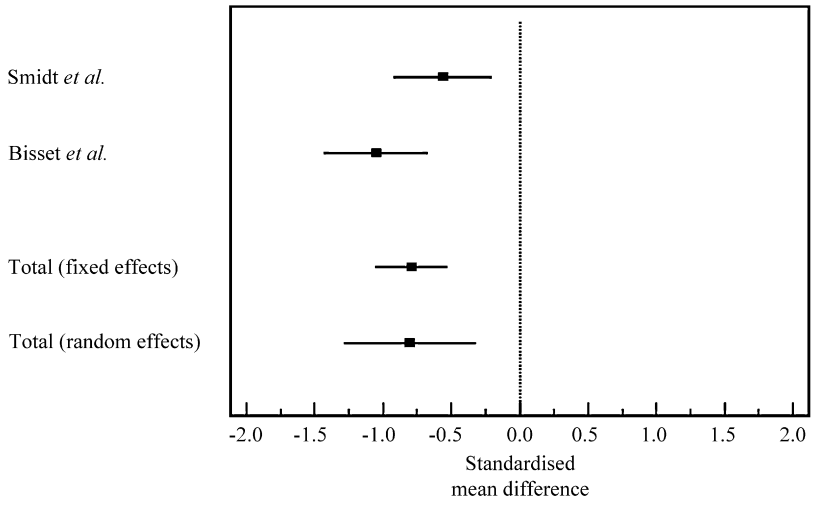

Fig. 3. Comparison: corticosteroid injections compared with physiotherapeutic interventions at 26 week follow-up. Outcome: pain-free grip strength.

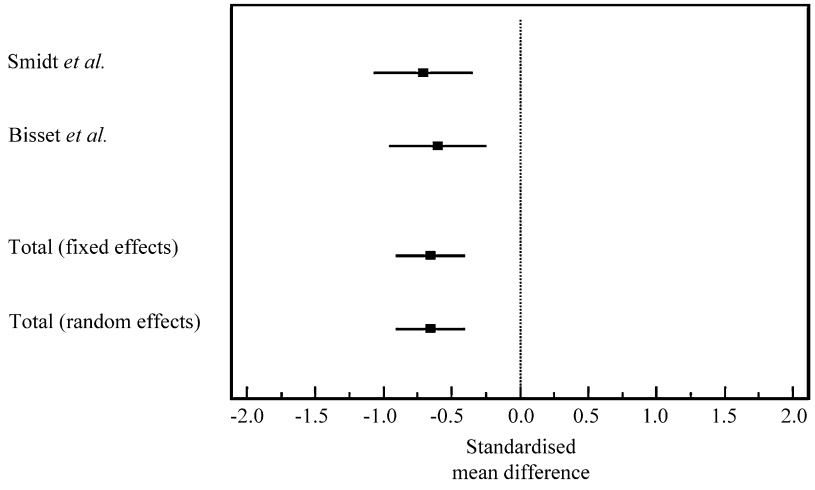

Fig. 4. Comparison: corticosteroid injections compared with physiotherapeutic interventions at 52 week follow-up. Outcome: pain-free grip strength.

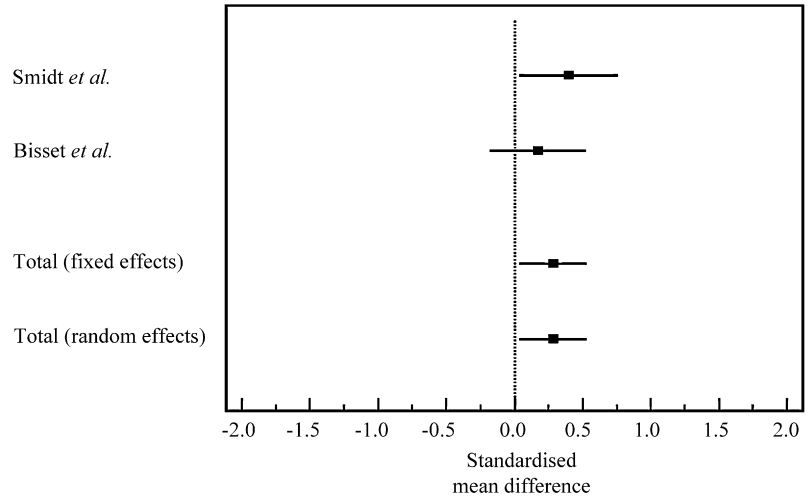

Fig. 5. Comparison: physiotherapeutic interventions compared with ‘wait and see’ approach at 52 weeks follow-up. Outcome: pain-free grip strength.

apeutic interventions were significantly more effective than corticosteroid injections [30,31,33].

Despite corticosteroid injections being found to be more effective in the short term compared with physiotherapeutic interventions, reported recurrence rates varied from 34% to 74% in three of the included studies [30–32].

Discussion

Although the research does indicate that corticosteroid injections are more effective than physiotherapeutic interventions in the short term, and that physiotherapeutic interventions are more effective than corticosteroid injections in the intermediate to longer term, the findings must be interpreted with some caution. The results of this review can only suggest that corticosteroid injections or physiotherapeutic interventions are more effective at different stages of intervention. Conclusions cannot be drawn on the basis of this review about the effectiveness of physiotherapeutic interventions alone in the short term, or corticosteroid injections alone in the intermediate to longer term. However, physiotherapeutic interventions did have a significant effect in the short term compared with the 'wait and see' approach. The smaller benefit demonstrated in the longer term perhaps adds further weight to the self-limiting nature of this condition.

No previous systematic reviews have been undertaken which have directly compared the effectiveness of corticosteroid injections with physiotherapeutic interventions. However, the findings from this review, that corticosteroid injections demonstrate beneficial treatment effects for short-term outcomes, are consistent with previous findings [3,17]. The outcome measures used in this review are comparable with those included in the review by Smidt *et al.* [17]. Neither of these reviews have refuted the effectiveness of corticosteroid injections at intermediate- and long-term follow-up, but suggested that firm conclusions could not be drawn due to a lack of high-quality evidence and methodological flaws in studies. Similarly, conclusions from reviews that have evaluated the effectiveness of physiotherapeutic interventions have suggested that poor-quality primary studies have included limited intermediate- and long-term follow-up [14–16].

There were differences across all five of the included studies, particularly in relation to the type, frequency and duration of the physiotherapeutic interventions and corticosteroid injections, the outcome measures used to determine effectiveness and methodological quality; these also need to be taken into consideration when interpreting the findings of this review.

The duration of lateral epicondylitis varied from 11 weeks [30] to 33 weeks [32]. The study by Bisset *et al.* [31] had a median duration that was twice that of the comparable study by Smidt *et al.* [30]. Although chronic cases are thought to be more difficult to treat [35], this did not appear to influence the outcome of either intervention in either study.

Although four of the studies [30–32,34] included triamcinolone acetonide as the corticosteroid of choice, there were differences in the dose, frequency and sites of injection. Smidt *et al.* [30] included a stronger local anaesthetic mixed with the corticosteroid, and participants were allowed three injections. Only 12% of participants received a second injection in the study by Bisset *et al.* [31], compared with 27% in the comparable study [30], where 15% also received a third injection.

Such differences in the injection intervention may account for the larger effect size reported in favour of injections at 6 week follow-up for both outcome measures [30]. However, no literature has been identified which advocates an ideal number of injections, and one previous study found little evidence to justify the selection and dosage of corticosteroid and local anaesthetic [36].

The purpose of this review was to compare the effectiveness of physiotherapeutic interventions compared with corticosteroid injections. However, it does need to be clearly reiterated that there were substantial differences with regard to the types, duration and frequency of physiotherapeutic interventions. Smidt *et al.* [30] included a combination of pulsed ultrasound alongside deep friction massage and an exercise programme as the physiotherapeutic interventions. A previous systematic review [15] concluded that treatment effects of two studies showed statistically significant and clinically relevant differences in favour of ultrasound when compared with placebo. However, insufficient evidence was found which demonstrated benefit or lack of effect to support the addition of deep friction massage or exercise. An additional review [37] aimed to evaluate the effectiveness of deep transverse friction massage in the treatment of tendonitis, and concluded that deep transverse friction massage did not demonstrate a consistent clinically important benefit when compared with a control or combined with other physiotherapeutic modalities.

Bisset *et al.* [31] included elbow manipulation (mobilisation with movement) and therapeutic exercise within their physiotherapeutic interventions. A recent systematic review [16] identified preliminary evidence in support of such treatment modalities; however, no longer-term effects were reported.

The study by Uzunca *et al.* [33] investigated the effectiveness of PEMT in comparison with sham PEMT and corticosteroid injections. They found significant improvements in all pain outcomes at 3 weeks for all three groups, although these were significantly lower for the injection group. Only pain on resisted wrist extension and supination were significantly different between the PEMT and sham PEMT groups. This would seem to confirm the limited benefit of PEMT reported in a previous review [14].

A major methodological flaw in three of the studies with long-term follow-up [30–32] was the inclusion of additional treatment following the 6-week intervention period.

Such inclusion potentially contaminates the data collected at intermediate- and long-term follow-up, and thus influences the validity of the conclusions drawn from the analysis of this data.

Co-interventions administered to injection participants are fairly comparable between studies (49% compared with 63%). However, 21% of physiotherapy participants in one study [31] received additional treatment compared with 81% in the comparable study [30]. The differences in the number of participants who required additional treatment introduces further error when attempting to compare the intermediate- and long-term effectiveness of each intervention between the studies.

A wide variety of outcome measures with varying degrees of validity and reliability were included within the five studies. Although four of the studies measured grip strength as an outcome, it was only possible to compare the data from Smidt *et al.* [30] and Bisset *et al.* [31]. The study by Verhaar *et al.* [32] did not specify whether pain-free or maximum grip strength was measured, or follow the standardised procedure advocated to obtain a valid and reliable measurement. The study by Tonks *et al.* [34] only had one follow-up period, and the method of calculation of pain-free grip strength was not comparable with Smidt *et al.* [30] and Bisset *et al.* [31].

Two studies [30,31] also included an assessor's rating of severity, but used different scales to express this score. Although Smidt *et al.* [30] provided a little detail about how this score was established, no reference was given to the validity of the 11-point scale used as a measure. As validated scales are important to ensure that they measure what they claim to measure [38], data collected from these scales may not have been as valid a measure as intended. However, as an additional study by Smidt *et al.* [38] found that an identical scale was reliable between trained assessors, it was deemed sufficiently consistent to determine an effect size and base comparisons. The authors had already transformed data into 100-point scales which standardised data for comparison and analysis. Bisset *et al.* [30] expressed their score on a 100-mm visual analogue scale, which has been shown to be valid, reliable and sensitive to change [21].

Although Verhaar *et al.* [32] measured a rating of severity, this was expressed on an ordinal four-point scale. Data were dichotomised to make comparisons, and thus it was not possible to calculate an effect size. Additionally, the severity was a rating of pain rather than a multi-dimensional rating, and no reference was made about who scored this rating. As with pain-free grip strength, it was decided that this measure was not sufficiently consistent to make a comparative analysis.

Implications of findings for practice

A number of implications for practice can be drawn from this review. The populations included in each of the studies are comparable with the characteristics of patients referred to physiotherapy departments. The corticosteroid dosage and strength used in the studies is also comparable, although hospital guidelines govern the type of corticosteroid administered. Professional guidelines for physiotherapists [39] advocate the use of 2% lidocaine, consistent with that used in the study by Smidt *et al.* [26].

The injection technique used in the two studies where data were synthesised [30,31] delivers the injection into painful and tender elbow points. Although this technique appeared to be effective in the short term, direct comparison cannot be made with that used in physiotherapy practice which dispenses the injection into the teno-osseous origin of the common extensor tendon [40]. This is more consistent with the injection technique used in the studies by Verhaar *et al.* [32] and Tonks *et al.* [34].

The physiotherapeutic treatment modalities included within both primary studies are comparable with those used within clinical practice. The exact choice of intervention often depends on the clinical experience of each individual physiotherapist. However, the frequency and number of treatments included in the intervention period for each of the studies may be slightly higher compared with clinical practice.

With the inclusion of corticosteroid injections in physiotherapy practice, physiotherapists are ideally placed to combine the short-term benefits of early symptomatic relief gained from corticosteroid injections and the longer-term benefits of physiotherapeutic interventions such as the prevention of recurrence and addressing the cause of the problem. Within clinical practice, professional guidelines advocate the inclusion of rehabilitation following injection to maximise the potential benefits, and view injections as an adjunct rather than an alternative to rehabilitation [38,40,41]. Few studies have investigated the benefits of combining injections with physiotherapeutic interventions.

One of the studies included in this review [34] had a combination group; however, the sample size was small and the follow-up was limited to 7 weeks. In addition, the methodological quality of this study was low. A further study [42] also evaluated the effectiveness of corticosteroid injections, although there was little difference between the two groups at 4 week and 6 month follow-up. Further good-quality clinical trials are needed to evaluate the effectiveness of injections alongside physiotherapeutic interventions.

This review has highlighted several limitations in the methodological quality of the studies included within the review. More methodologically sound RCTs are still needed to improve the level of evidence supporting, in particular, the effectiveness of physiotherapeutic interventions in the short, intermediate and longer term.

Conclusions

The findings of this review suggest that corticosteroid injections are favourable to physiotherapeutic interventions at short-term follow-up; however, the recurrence rates have been shown to vary from 34% to 72% [30–32]. Physiothera-

peutic interventions have been shown to be favourable in the intermediate to longer term. With the inclusion of the administration of corticosteroid injections within clinical practice, physiotherapists are well placed to maximise the benefits of both corticosteroid injections and physiotherapeutic interventions. The results must be interpreted with caution due to differences in the study interventions, outcome measures, follow-up and methodological quality. Further high-quality research is required, with greater emphasis on the efficacy of corticosteroid injections in combination with physiotherapeutic interventions.

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