

BMJ Open Treating lateral epicondylitis with corticosteroid injections or non-electrotherapeutical physiotherapy: a systematic review

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ABSTRACT

Objectives: To evaluate the current evidence for the efficacy of corticosteroid injection and non-electrotherapeutic physiotherapy compared with control for treating lateral epicondylitis.

Design: Systematic review.

Participants: We searched five databases in September 2012 for randomised controlled studies with a minimum quality rating. Of the 640 studies retrieved, 11 were included, representing 1161 patients of both sexes and all ages.

Interventions: Corticosteroid injection and non-electrotherapeutic physiotherapy.

Outcome measures: Relative risk (RR) or standardised mean difference (SMD) for overall improvement, pain and grip strength at 4–12, 26 and 52 weeks of follow-up.

Results: Corticosteroid injection gave a short-term reduction in pain versus no intervention or non-steroidal anti-inflammatory drugs (SMD -1.43 , 95% CI -1.64 to -1.23). At intermediate follow-up, we found an increase in pain (SMD 0.32 , 95% CI 0.13 to 0.51), reduction in grip strength (SMD -0.48 , 95% CI -0.73 to -0.24) and negative effect on the overall improvement effect (RR 0.66 (0.53 to 0.81)). For corticosteroid injection versus lidocaine injection, the evidence was conflicting. At long-term follow-up, there was no difference on overall improvement and grip strength, with conflicting evidence for pain.

Manipulation and exercise versus no intervention showed beneficial effect at short-term follow-up (overall improvement RR 2.75 , 95% CI 1.30 to 5.82), but no significant difference at intermediate or long-term follow-up. We found moderate evidence for short-term and long-term effects of eccentric exercise and stretching versus no intervention. For exercise versus no intervention and eccentric or concentric exercise and stretching versus stretching alone, we found moderate evidence of no short-term effect.

Conclusions: Corticosteroid injections have a short-term beneficial effect on lateral epicondylitis, but a negative effect in the intermediate term. Evidence on the long-term effect is conflicting. Manipulation and exercise and exercise and stretching have a short-term effect, with the latter also having a long-term effect.

ARTICLE SUMMARY

Strengths and limitations of this study

- We found few good quality studies on non-electrotherapeutic physiotherapy. A meta-analysis was possible for one of the investigated treatments.
- The conclusions on the efficacy of corticosteroid injections are based on eight studies, and are strongest for short-term and intermediate-term results.
- Owing to large heterogeneity between studies, only some outcomes on corticosteroid injections were possible to pool.
- We included only studies with a control-group with no treatment and used an established quality rating scale, which strengthens the review.

INTRODUCTION

Lateral epicondylitis of the elbow is a frequently encountered complaint in general practice with an incidence of 4–7/1000/year.^{1–3} It is characterised by pain and tenderness over the lateral humeral epicondyle and pain on resisted dorsiflexion and radial deviation of the wrist. It is usually a self-limiting condition, often resolving in 6–12 months regardless of treatment, but complaints may last up to 2 years or longer.⁴ Owing to considerable pain and discomfort, many patients need time off from work.

Most authors attribute the condition to a lesion in the short radial extensor muscle.^{1–5} A recent study has found evidence of reduced hyperaemia measured with spectral and colour Doppler in lateral epicondylitis treated with corticosteroid injection, suggesting the evidence of an inflammatory component.⁶ Others, finding little evidence of inflammation, have proposed the term ‘lateral epicondylalgia’ for the condition.⁷

Most patients with lateral epicondylitis are treated in general practice, and although a

large number of treatments are in use, there is no consensus on which treatments are most effective. The Cochrane Library has reviewed several treatments. For topical non-steroidal anti-inflammatory drugs (NSAIDs) and NSAIDs taken orally, the conclusion is that both may have a short-term effect.⁸ For extracorporeal shockwave therapy, a review of nine studies including 1000 patients found this treatment to have no effect.⁹ For acupuncture,¹⁰ deep friction massage,¹¹ orthosis¹² and surgery,¹³ the reviews were inconclusive due to few published studies.

Four review articles have been published on the effect of corticosteroid injections.^{14–17} They found a short-term effect of corticosteroid injection, but no proven long-term effect, and one review found evidence of a negative long-term effect.¹⁵ However, some of the reviews included non-controlled studies¹⁴ and non-randomised studies.¹⁶ In one review,¹⁵ 4 of the 12 included studies had no control group and one was a small pilot study with a short follow-up. Based on this, we find evidence in published reviews on the long-term effect of corticosteroid injections to be conflicting.

Five reviews of physiotherapeutic interventions show that there are few published studies on the effect of non-electrotherapeutic treatment, and many have methodological weaknesses.¹⁶ Bisset *et al*¹⁸ found evidence that manipulation and exercise had a short-term effect. Four other reviews¹⁶ found short-term effects of mobilisation, manipulation and exercise. Three of these reviews included non-randomised or non-controlled studies.¹⁶ Most previous systematic reviews have included electrotherapeutic physiotherapy such as ultrasound and extracorporeal shockwave.¹⁴

Since there is no established, well-documented treatment to which new treatments can be compared, the use of a control group is important. The natural course of the condition, where most patients eventually recover regardless of the intervention, makes this even more necessary. In a comparison of two different treatments, any effect found may only reflect this natural course of recovery unless the treatments prove better than a control group with no treatment.

It has been shown that systematic reviews which include studies with low scores on internal validity may overestimate effect sizes, thus introducing a potential bias to the review.²² There may also be a problem using rating scales with heterogeneous criteria, including that is, criteria related to external validity, interpretation or ethical issues.²²

To address these issues, a new systematic review on non-electrotherapeutic physiotherapy and corticosteroid injection seemed warranted. We wanted to include only randomised studies with a control group with no treatment or studies in which the groups only differed in regard to the investigated treatment. An established quality rating scale would be used. We also wanted to review the most current evidence on the efficacy of corticosteroid injections, since previous reviews have differing conclusions on the long-term effect.

Objective

The aim of this review was to assess the current evidence for the efficacy of corticosteroid injections and non-electrotherapeutic physiotherapy compared with control in patients with tennis elbow.

METHODS

We followed the recommendations of the Cochrane Collaboration²⁴ and the PRISMA Group²⁵ in the search and report of this systematic review.

Study selection

We used the following inclusion criteria.

Study type

Randomised controlled trials assessing treatments for lateral epicondylitis or tennis elbow were eligible for inclusion. The studies had to have at least one treatment group and one control group. We defined a control group as a group receiving no treatment (a wait-and-see approach), common treatments with expected or known moderate effect (advice, rest, NSAIDs, painkillers) or the same treatment as the experimental group with the exception of the investigated treatment.

Participants

All age groups with a clinical diagnosis of lateral epicondylitis were included without restriction on the gender.

Treatments

We searched for studies investigating or comparing the efficacy of one of the following treatments: corticosteroid injection, non-electrotherapeutic physiotherapy including stretching, mobilisation, manipulation, massage, exercise or home training. Studies on the splinting, ultrasound, shock wave and other electrotherapeutic modalities were excluded.

Outcome measures and follow-up

At least one validated, patient-centred outcome was necessary. This could include outcomes important to the patient, such as pain, range of movement, grip strength, work status and relevant functional questionnaires. We included only studies carried out in a clinical setting with at least a 4-week follow-up of the treatment effect.

Study quality assessment

We used the 11-item Physiotherapy Evidence Database (PEDro) scale to assess the quality of the studies included in the review. This rating system closely resembles the Cochrane Collaboration Scoring system²⁴ and is based on the Delphi list, developed for quality assessment of randomised controlled trials (RCTs) by Verhagen *et al*²⁶ It has been used in several previously published reviews.¹⁵ The PEDro scale assesses the internal and external validity of a study by addressing

the issues of eligibility criteria, randomisation, allocation, blinding, statistics and data reporting. The reliability of this scale has been confirmed by Maher *et al.*²⁷. The maximum score is 10, since item number 1 on the scale (specified eligibility criteria) is not counted.

A minimum score of 5t of 10 points (50%) was chosen to be necessary for inclusion in the review, as inclusion of lower quality studies in a systematic review may overestimate the treatment effect of interventions.²⁸ Ten studies were independently assessed by two researchers (MO and ØH)^{29–38} and three studies were rated by both researchers together.^{39–41} The final decision on the PEDro score was reached by consensus.

Search methods for identification of studies

Electronic searches

From October 2009 to January 2010, we searched the following databases for publications: MEDLINE (Ovid and PubMed), EVSCO/CINAHL, EMBASE, Allied and Complimentary Medicine, PEDro and the Cochrane RCT register. The searches within each database were carried out without restrictions on dates or languages. We used free text, not MESH terms, in these searches, and the key terms used were ‘tennis elbow’, ‘lateral epicondylitis’, epicondylalgia, elbow, randomised, injection, corticosteroid and physiotherapy. The Boolean operator AND was used to link diagnostic terms and treatment where applicable. An additional search was carried out in September 2012 to identify any recently published studies.

Searching other resources

Further search was carried out in the reference list of articles initially considered for review.

Selection of studies

The searches resulted in a number of studies potentially eligible for inclusion. Titles and abstracts were then read by two researchers independently (MO and ØH) and potential studies were selected based on the inclusion criteria. The final decision on inclusion was made by consensus from a reading of the full-text documents.

Data extraction and statistical analysis

The included studies were read in full text and assessed by two independent researchers (MO and ØH). One article, published in Italian, was translated by a professional bureau.⁴¹ A standardised set of data was extracted from each selected study and recorded using standardised forms. We calculated statistics using the statistical computing language R (<http://www.r-project.org>, The R Foundation for Statistical Computing, Vienna, Austria). We reported the results of the outcome measures for three different timings of follow-up, defined as short term (4–12 weeks after randomisation), intermediate term (6 months after randomisation) and long term (more than 6 months after randomisation). For dichotomous data, we calculated relative risk (RR) and 95% CI

with the R-project library ‘epi.R’, for continuous data, the standardised mean difference (SMD) and 95% CI with the R-project library ‘compute.es’. We pooled estimates when we found sufficient clinical and statistical homogeneity between trials using the I^2 statistic, defined as I^2 less than 65%.⁴²

Some studies did not report the mean, SD or number of samples, which were necessary to calculate SMD. Additional calculations were then required. For Coombes,³⁸ the median and the IQR were given. We set the median as the mean value and the SD was given by IQR/1.35 under the assumption of normal distribution. For Newcomer,³³ SD was calculated by the t-statistics obtained by the p value and degrees of freedom. For Price *et al.*,³⁴ the t-statistics were obtained by the degrees of freedom and 95% probability. SD was estimated by the t-statistics, the mean value and the upper/lower CIs.

For overall improvement, an RR larger than 1 favoured treatment and was statistically significant if the CI excluded 1. We defined the effect as large for values larger than 2 or less than 0.5, medium between 0.5 and 0.8 and between 1.25 and 2 and small for values between 0.8 and 1.0 and between 1.0 and 1.25.

For continuous data, a positive or negative SMD favoured treatment depending on the outcome measures, that is, for pain, a negative SMD favoured treatment and for grip strength a positive SMD favoured treatment. SMD was statistically significant if the CI excluded 0. We defined the effect as large for SMD more than 0.8, medium between 0.5 and 0.8 and small for values less than 0.5. For outcomes that could not be pooled, we graded the strength of the scientific evidence as strong (consistent findings in several high quality randomised controlled studies), moderate (one high quality randomised controlled study), conflicting (inconsistent finding between many studies) or no evidence.⁴³

Inter-rater reliability

The inter-rater reliability for the individual PEDro scores was assessed by calculating the intraclass correlation coefficient.⁴⁴ The R-project library ‘psych’ was used for this calculation. A substantial inter-rater reliability was found (intraclass correlation coefficient 0.69 (0.15–0.91), $p < 0.01$).

RESULTS

The search retrieved an initial 839 hits, representing 640 individual articles. The further selection process is outlined in [figure 1](#). Six hundred and twenty-three articles were excluded based on the title and abstract in a preliminary review. Seventeen articles^{29–37 39 41 45–50} were then assessed using the full-text documents. Three were found not to be RCTs,^{45–47} two had a PEDro quality rating below 50% ([table 2](#))^{37 39} and three had a follow-up shorter than 4 weeks.^{48–50} The additional search carried out in September 2012 retrieved two possible studies,^{40 51} one of which was excluded for not

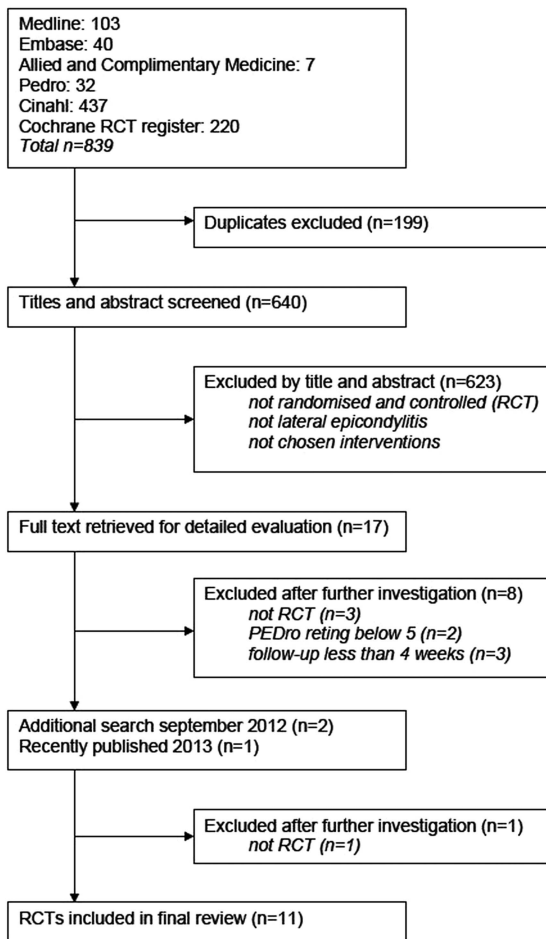


Figure 1 Outline of the selection process.

having a control group.⁵¹ A recently published study was also assessed³⁸ and a total of 11 studies were included in the final review.^{29–36 38 40 41}

Included studies

The characteristics and details of each study are given in table 1. The included studies represented a total population of 1161 patients. Several studies had more than one treatment group, so the 11 included studies investigated 15 treatment groups relevant for this review. For the statistical analysis, one study, which used two different corticosteroids, was treated as two studies.³⁴

The mean age of patients varied from 41 to 51 years and the female percentages varied from 35 to 63. There were large differences in the duration of complaints at baseline between studies. Most had a duration of several weeks to months and only one stated a short duration.³³ Eight studies had control groups with no active treatment,^{29–31 34–36 38 40} for example, a wait-and-see group or NSAIDs. Two of these used lidocaine as a placebo injection.^{31 34} In the three other studies, the control and treatment groups both received similar active treatments, with the intervention group additionally receiving the treatment to be investigated.^{32 33 41}

Eight studies investigated corticosteroid injections, representing 925 patients.^{29–31 33–36 38} Five different corticosteroids were used, with different dosages and injection techniques. The control groups received no active treatment in seven of the eight studies, whereas in one study the control and the treatment groups received additional exercise treatment.³³ Seven of the studies had a long-time follow-up of 24 weeks or more.^{29–31 33–35 38}

There were few studies covering non-electrotherapeutic physiotherapy. We found five studies which could be included, representing 600 patients.^{29 32 38 40 41} The treatment modalities investigated were manipulation and exercise,^{29 38} concentric or eccentric exercises,³² and exercise⁴⁰ and eccentric exercises with stretching.⁴¹ Three studies had a control group with no active treatment,^{29 38 40} whereas the other two had control groups that received stretching and orthosis, respectively. Three studies^{29 38 41} had a follow-up of 24 weeks or more.

The most frequently used outcome measures were assessment of pain and grip strength. Six studies measured pain-free grip strength with hand-held dynamometers.^{29–33 35} Eight studies used a number of different questionnaires covering pain, function and disability.^{29–33 35 38 40} Nine studies assessed pain on a visual analogue scale or Likert scale,^{29–34 36 38 40} and six studies rated the patient's assessment of improvement on graded scales.^{29 30 35 36 38 41}

Risk of bias in included studies

We addressed the issues of the quality of the included studies and completeness of reported data by rating them with the PEDro scale (table 2). Most studies used a computerised randomisation schedule, and 7 of the 11 studies used concealed allocation.^{29–31 35 38 40 41} Baseline comparison was carried out in all studies, the dropout rate was below 15% in 10 studies^{29 30 32–36 38 40 41} and intention-to-treat analysis was stated in all studies. There was between-group analysis of at least one outcome measure in all the studies, and both point measures and variations of outcome measures were reported in all studies.

The use of blinding was more diverse among the studies. Blinding the patient for treatment is difficult for physiotherapeutic treatments, but the use of blinded assessors reduces the risk of bias. None of the studies on physiotherapy in our review had blinded patients or therapists, but two used blinded assessors.^{29 38} This might give biased results in the studies covering physiotherapeutic treatments.

For the eight studies on corticosteroid injection, the number using blinding was larger. There was blinding of patients in four studies,^{31 33 34 38} of the treating doctor in two studies^{31 33} and of assessors in six studies.^{29–31 34 35 38}

In several studies, the control group received some form of treatment (similar to the treatment group).^{32–34 36 41} In these studies, synergistic effects between the treatments cannot be ruled out. This makes the results more difficult

Table 1 Demographics, treatments and outcome measures in the eleven included studies

Study and year setting and sample size	Women (percentages)	Age (mean if not otherwise stated)	Duration of discomforts (weeks)	Treatment groups	Control group	Outcome measures (excerpts)	Follow-up (weeks)
Bisset <i>et al</i> 2006 <i>Outpatient clinic</i> n=198	35	47.6 (SD 7.8)	22 (median) (IQR 12–42)	(1) 10 mg Triamcinolone and 1 mL lidocaine against the most painful point repeated after 2 weeks (2) Elbow manipulation (manipulation with movement) and exercise 8 sessions of 30 min duration during a 6 week period and home exercise	Information, wait-and-see	Improvement on 6-point Likert-scale PFGS assessed severity on VAS Pain on VAS Pain-free function questionnaire	52
Coombes <i>et al</i> 2013 <i>Community setting</i> n=165	38	49.7 (SD 8.1)	16 (median) (IQR 10–26)	(1) One injection of 1 mL triamcinolone 10 mL/mL and 1 mL lignocaine 1% against site of greatest palpable tenderness at the common extensor origin (2) Elbow manipulation (manipulation with movement) and exercise 8 sessions of 30 min duration during a 8 week period and home exercise (3) <i>One injection of triamcinolone followed by 8 sessions of elbow manipulation and exercise, home exercise for 8 weeks (not considered in this review)</i>	Placebo injection 0.5 mL 0.9% isotonic saline	Improvement on 6-point Likert-scale 1 year recurrence Pain on VAS PRTEE questionnaire EuroQol-EQ-5D quality-of-life score	52
Hay <i>et al</i> 1999 <i>General practice</i> n=164	Group 1:41 (Group 2:53) Control:48	Age ≥45: (percentages) Group 1:70 (Group 2:68) Control:38	9 (mean) Percentage with pain >3 months: Group 1:36 (Group 2:25) Control:31	(1) One injection of methylprednisolone 20 mg and 0.5 mL 1% lignocaine towards tender spot (2) <i>Naproxen orally 500 mg twice daily for 2 weeks (not considered in this review)</i>	Placebo tablets	Improvement on 5-point Likert-scale Pain on 10-point Likert-scale Function on 10-point Likert-scale Main discomfort on 10-point Likert-scale Disability questionnaire PFGS	52

Continued

Table 1 Continued

Study and year setting and sample size	Women (percentages)	Age (mean if not otherwise stated)	Duration of discomforts (weeks)	Treatment groups	Control group	Outcome measures (excerpts)	Follow-up (weeks)
Price <i>et al</i> 1991 <i>Outpatient clinic</i> n=88	Group 1:48 Group 2:43 Control:38	Group 1:47 Group 2:47 Control:46 (Median)	Group 1:20 (6–150) Group 2:36 (6–154) Control:16 (6–150) (Median and range)	(1) Hydrocortisone 25 mg and 1% lidocaine against tender point (2 mL fluid) (55% received 2 injections) (2) Triamcinolone 10 mg and 1% lidocaine (30% received two injections)	2 mL 1% lidocaine against tender point	Pain on VAS Tenderness score Pain-weighted grip strength	24
Smidt <i>et al</i> 2002 <i>General practice</i> n=185	Group 1:55 (Group 2:44) Control: 53	Group 1: 47 (Group 2:48) Control: 46 (Median)	Group 1:11 (8–16) (Group 2:11 (8–21)) Control:11 (8–21) (Median and IQR)	(1) 10 mg triamcinolone and 1 mL lidocaine against all tender points up to three injections (2) <i>One group received physiotherapy with ultrasound (not considered in this review)</i>	Wait-and-see (some were prescribed naproxen orally 1000 mg daily)	Improvement on 6-point Likert scale Severity of discomfort on scale Questionnaires PFGS Maximum grip strength (MGS) Pressure-pain measurements Satisfaction with treatment	52
Toker <i>et al</i> 2008 <i>Outpatient clinic</i> n=21	43	45 (range 19–72)	Not stated	One injection of 1 mL methylprednisolone and 1 mL prilocain with oral diklofenac three tablets (dose not stated) and etofenamate topically	Oral diklofenac three tablets (dose not stated) and etofenamate topically	Perceived absence of pain Absence of pain on palpation over lateral epicondyle and on isometric dorsiflexion of wrist pain score DASH questionnaire* Pain on VAS Grip strength	4
Lindenhovius <i>et al</i> 2008 <i>Outpatient clinic</i> n=64	Treatment: 63 Control: 60	Treatment: 50±8 Control: 51±10	Treatment: 12±4 (2–20) Control: 8±4 (1–20)	4 mg dexamethasone and 10 mg lidocaine (2 mL fluid) against the most tender spot, fanning of the needle. One injection—but 6 of 64 got 2 injections	10 mg lidocaine, 2 mL fluid total	DASH questionnaire* Pain on VAS Grip strength	26
Newcomer <i>et al</i> 2001 <i>Outpatient clinic</i> n=39	51	Treatment: 46.0±7.0 Control: 44.6±7.6	Treatment: 3.2 (mean) SD 0.8 Control: 3.4 (mean) SD 0.9	One injection of 5 mL 4:1 0.25% bupivacaine and 6 mg/ mL β-methasone against tender point. Home exercises consisting of ice massage, wrist stretching and progressive	Placeboinjection of 5 mL bupivacaine Home exercises consisting of ice massage, wrist stretching and progressive eccentric	Pain on VAS Functional pain questionnaire (PFGS at 4 and 8 weeks)	26

Continued

Table 1 Continued

Study and year setting and sample size	Women (percentages)	Age (mean if not otherwise stated)	Duration of discomforts (weeks)	Treatment groups	Control group	Outcome measures (excerpts)	Follow-up (weeks)
M-Silvestrini <i>et al</i> 2005 <i>Outpatient clinic</i> n=94	47	45.5±7.7	More than 12	eccentric and concentric exercises (1) Concentric strengthening 3×10 repetitions once daily and wrist stretching twice daily for 6 weeks (2) Eccentric strengthening 3×10 repetitions once daily and wrist stretching twice daily for 6 weeks	and concentric exercises Wrist stretching twice daily for 6 weeks	PFGS Pain on VAS PRFEQ questionnaire Patient's log of training DASH questionnaire*	6
Peterson <i>et al</i> 2011 <i>General practice</i> n=81	42	48	Treatment: 107 Control: 96	Three-month daily exercise regime performed at home with progressively increasing load on the extensor muscles	Information, wait-and-see	Pain on VAS during contraction and during elongation of forearm muscles Muscle strength with hand-held dynamometer DASH questionnaire	12
Selvanetti <i>et al</i> 2003 <i>Setting not stated</i> n=62	Treatment: 45 Control: 48	Treatment: 41.3 Control: 40.5	Treatment: 28 (8–40) Control: 29 (12–44)	4 weeks home-exercise after instruction from physiotherapist consisting of stretching and eccentric exercise Counseling and use of elbow support	Sham ultrasound 20 sessions Counseling and use of elbow support	Ko scoring system (includes clench test, Thomsen test and pain) Verhaar scoring system on global improvement Subjective improvement VAS scale (0–100)	44 (24–56)

*DASH questionnaire is an upper extremity specific health status measure.

DASH, Disability of the Arm, Shoulder and Hand; PFGS, Pain-Free Grip Strength; PRFEQ, Patient-rated Forearm Evaluation Questionnaire; PRTEE questionnaire, Patient-Rated Tennis Elbow Score, VAS, Visual Analogue Scale.

Table 2 Quality rating of studies by assessing internal and external validity with the PEDro scale

Study	PEDro criterion	Bisset	Coombes	Hay	Price	Smidt	Toker	Lindenhovius	Newcomer	M-Silvestrini	Peterson	Selvanetti	Kochar	Tonks
1	Eligibility criteria were specified	1	1	1	1	1	1	1	1	1	1	1	1	1
2	Participants were randomly allocated to groups	1	1	1	1	1	1	1	1	1	1	1	1	1
3	Allocation was concealed	1	1	1	0	1	0	1	0	0	1	1	0	1
4	The groups were similar at baseline regarding the most important prognostic indicators	1	1	1	1	1	1	1	1	1	1	1	1	0
5	There was blinding of all participants	0	0	0	1	0	0	1	1	0	0	0	0	0
6	There was blinding of all therapists who administered the therapy	0	0	0	0	0	0	1	1	0	0	0	0	0
7	There was blinding of all assessors who measured at least one key outcome	1	1	1	1	1	0	1	0	0	0	0	0	0
8	Measures of at least one key outcome were obtained from more than 85% of the participants initially allocated to groups	1	1	1	1	1	1	0	1	1	1	1	0	0
9	All participants for whom outcome measures were available, received the treatment or control condition as allocated or, where this was not the case, data for at least one key outcome was analysed by 'intention to treat'	1	1	1	1	1	1	1	1	1	1	1	0	0

Continued

Table 2 Continued

Study	Bisset	Coombes	Hay	Price	Smidt	Toker	Lindenhovius	Newcomer	M-Silvestrini	Peterson	Selvanetti	Kochar	Tonks
10 The results of between-group statistical comparisons are reported for at least one key outcome	1	1	1	1	1	1	1	1	1	1	1	1	1
11 The study provides point measures as well as measures of variability for at least one key outcome	1	1	1	1	1	1	1	1	1	1	1	1	1
Total PEDro score (Sum criteria 2–11, maximum score is 10)	8	8	8	8	8	6	9	8	6	7	7	4	4
												EXCLUDED	EXCLUDED

to interpret. Two studies had a short follow-up of 4 and 6 weeks,^{32 36} which for a condition usually lasting several months reduces the clinical implication of the results. The difference in duration of complaints at baseline also complicates comparison between studies.

Effects of interventions

Corticosteroid injection

The efficacy of corticosteroid injections for treating lateral epicondylitis was investigated in eight studies (table 3 and figure 2⁵²). For short-term follow-up, the heterogeneity between studies made pooling of outcomes possible only for pain. For corticosteroid injection versus no intervention or NSAIDs, we found strong evidence for a beneficial effect on overall improvement and a large positive effect on pain.^{29 30 35 36 38} For grip strength, we found moderate evidence for a negative effect.³⁵ For corticosteroid injection versus lidocaine injection, evidence was conflicting for effect on pain, with two studies showing a large positive effect (Price *et al*³⁴ using hydrocortisone and triamcinolone) and one showing no significant difference.³¹ For maximum grip strength, the evidence was also conflicting, with one study showing a large positive effect of treatment (Price *et al*³⁴ using triamcinolone), and two studies showing no statistical difference (Lindenhovius *et al*³¹, Price *et al*³⁴ using hydrocortisone). For corticosteroid injection, exercise and stretching versus exercise and stretching alone, we found moderate evidence for no significant difference on pain and grip strength.³³

At intermediate follow-up, we found sufficient homogeneity to pool estimates for overall improvement^{29 30 38} and pain^{29 30 35 38} for corticosteroid injection versus no intervention or NSAIDs. For overall improvement, this showed a medium negative effect and for pain, a small negative effect. For maximum grip strength, pooling of corticosteroid injection versus no intervention, NSAIDs and lidocaine showed a small negative effect.^{31 34 35} For corticosteroid injection versus lidocaine injection, pooling of estimates was not possible due to heterogeneity. For pain, two studies showed a large negative effect (Price *et al*³⁴ using hydrocortisone and triamcinolone), and one study showed no significant difference;³¹ thus, the evidence was conflicting. For grip strength, the evidence was also conflicting, with the same two studies showing a large negative effect³⁴ and one showing no significant difference.³¹ For corticosteroid injection, exercise and stretching versus exercise and stretching alone, we found moderate evidence of no significant effect on pain.³³

At long-term follow-up, pooled estimates of overall improvement showed no difference in the effect of corticosteroid injection versus no intervention or NSAIDs.^{29 30 35 38} For pain, heterogeneity prevented pooling and we found the evidence conflicting with one study showing a large negative effect,³⁰ and three others showing no significant difference in effect.^{29 35 38} For

Table 3 Effect size of improvement rate, reduction in pain and increase in grip strength for corticosteroid injection

	Short term 4–12 weeks	Intermediate term 26 weeks	Long term 52 weeks
<i>Overall improvement RR (95% CI) RR>1 favours treatment</i>			
CSI vs no intervention or NSAIDs			
Bisset	2.94 (1.90 to 4.45)*	0.55 (0.41 to 0.73)*	0.75 (0.62 to 0.90)*
Coombes	7.32 (2.83 to 18.94)*	0.68 (0.50 to 0.92)*	0.91 (0.77 to 1.06)
Hay	1.60 (1.18 to 2.17)*	0.77 (0.60 to 0.98)*	1.07 (0.88 to 1.30)
Smidt	2.86 (1.96 to 4.16)*	–	0.84 (0.68 to 1.02)
Token	2.27 (1.04 to 4.97)*	–	–
Pooled	–	0.66 (0.53 to 0.81)*	0.87 (0.73 to 1.04)
Heterogeneity	>65%	p=0.21, I ² =35%	p=0.07, I ² =58%
<i>Pain (negative value favours treatment) SMD (95% CI)</i>			
CSI vs no intervention or NSAIDs			
Bisset	–1.43 (–1.83 to –1.04)*	0.40 (0.04 to 0.76)*	0.27 (–0.08 to 0.62)
Coombes	–2.14 (–2.68 to –1.60)*	0.16 (–0.28 to 0.59)	0.08 (–0.35 to 0.52)
Hay	–1.05 (–1.45 to –0.66)*	0.42 (0.04 to 0.80)*	1.35 (0.94 to 1.76)*
Smidt	–1.49 (1.89 to –1.08)*	0.27 (–0.09 to 0.63)	0.15 (–0.20 to 0.51)
Token	–1.14 (–2.07 to –0.22)*	–	–
Pooled	–1.43 (–1.64 to –1.23)*	0.32 (0.13 to 0.51)*	–
Heterogeneity	p=0.032, I ² =62%	p=0.79, I ² =0%	>65%
CSI vs lidocaine injection			
Lindhovius	–0.25 (–0.74 to 0.24)	0.27 (–0.30 to 0.84)	–
Price 1	–1.06 (–1.63 to –0.49)*	3.13 (2.31 to 3.95)*	–
Price 2	–3.37 (–4.20 to –2.54)*	1.55 (0.93 to 2.17)*	–
Pooled	–	–	–
Heterogeneity	>65%	>65%	–
<i>All above pooled</i>			
Heterogeneity	>65%	>65%	–
CSI, exercise and stretching vs exercise and stretching			
Newcomer†	0.16 (–0.49 to 0.81)	–0.37 (–1.04 to 0.30)	–
<i>Maximum grip strength (positive value favours treatment) SMD (95% CI)</i>			
CSI vs no intervention or NSAIDs			
Smidt	–1.42 (–1.82 to –1.03)*	–0.38 (–0.74 to –0.02)*	–0.36 (–0.72 to 0.002)
No pooling	–	–	–
CSI vs lidocaine injection			
Lindhovius	–0.19 (–0.68 to 0.30)	0.07 (–0.50 to 0.64)	–
Price 1	–0.06 (–0.59 to 0.48)	–0.98 (–1.58 to –0.38)*	–
Price 2	2.31 (1.62 to 3.00)*	–0.86 (–1.44 to –0.29)*	–
Pooled	–	–	–
Heterogeneity	>65%	>65%	–
<i>All above pooled</i>			
Heterogeneity	>65%	p=0.04, I ² =64%	–
CSI, exercise and stretching vs exercise and stretching			
Newcomer†	–0.17 (–0.61 to 0.27)	–	–

*Statistically significant (p<0.05); Price 1: hydrocortisone versus lidocaine and change in pain-free grip strength and Price 2: triamcinolone versus lidocaine.

†The values for Newcomer are given as change in pain.

CSI, corticosteroid injection; NSAIDs, non-steroidal anti-inflammatory drugs; RR, relative risk; SMD, standard mean difference.

grip strength, we found moderate evidence of no significant difference.³⁵ For corticosteroid injection versus lidocaine injection and corticosteroid injection, and exercise and stretching versus exercise and stretching alone, we found no data on the long-term effect.

Physiotherapy

We included five studies (n=600) investigating non-electrotherapeutical physiotherapy, representing five different treatment modalities (table 4 and figure 3⁵²).

Two studies investigated the efficacy of manipulation and exercise versus no intervention.^{29 38} In the short term, the pooled estimates showed a large positive effect on overall improvement. For pain, pooling was not possible due to heterogeneity. We found strong evidence for a beneficial effect, whereas for pain-free grip strength we found moderate evidence for a beneficial effect. In the intermediate term, the pooled estimates showed no difference between treatment and control for either pain or overall improvement. There

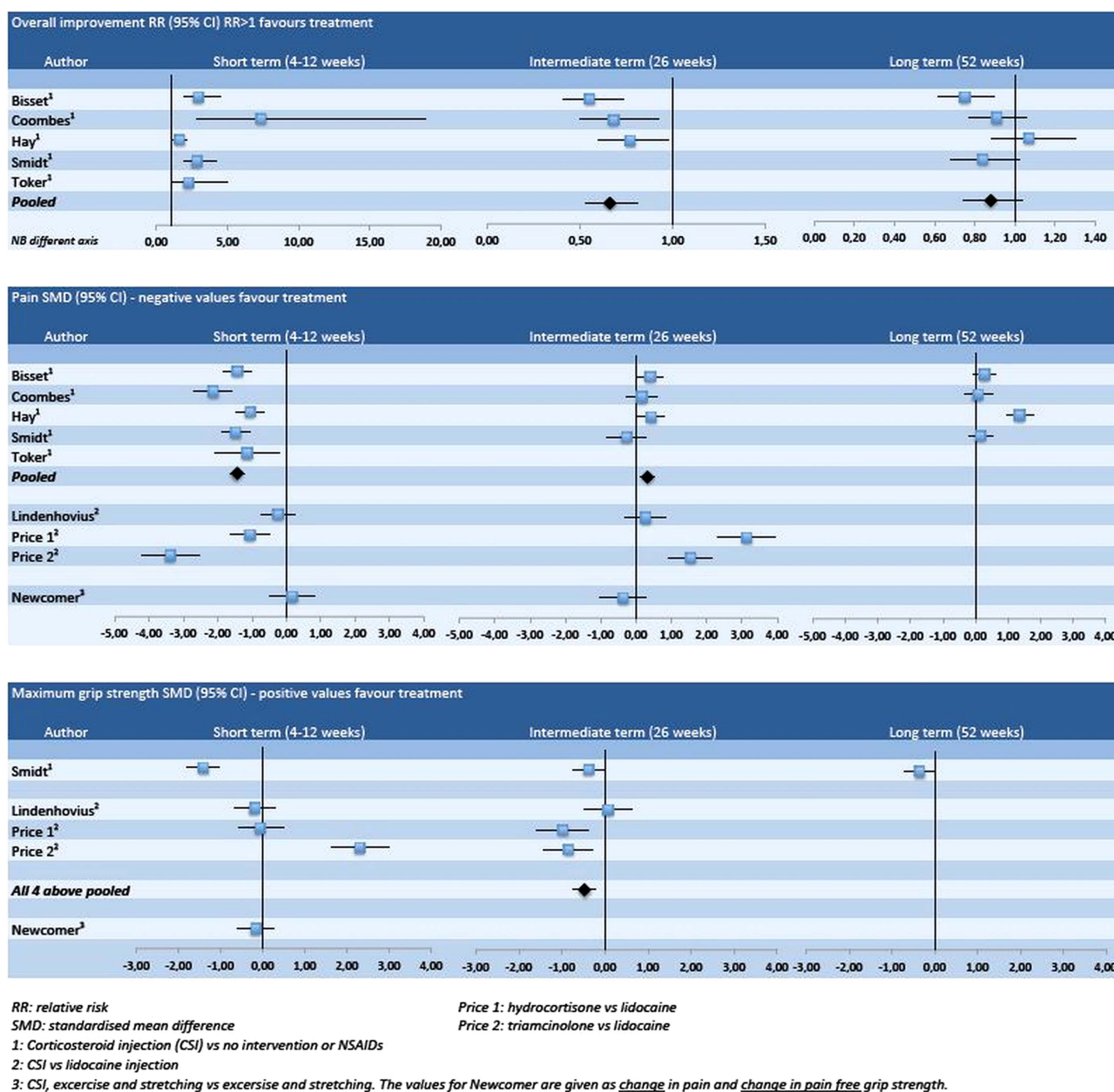


Figure 2 Forest plot of effect sizes for corticosteroid injection.

was moderate evidence for no difference in pain-free grip strength. In the long term, the pooled estimates again showed no difference between treatment and control for either pain or improvement and we found moderate evidence for no difference in pain-free grip strength.

The efficacy of exercise versus no intervention was investigated in one study.⁴⁰ We found moderate evidence for no short-term difference in effect for outcomes on pain and Disability of the Arm, Shoulder and Hand (DASH) score. There were no data on the intermediate-term or long-term effect.

For eccentric exercise and stretching versus stretching, investigated in one study,³² we found moderate evidence for no short-term treatment effect for outcomes on pain,

pain-free grip strength and DASH score. There were no data on the intermediate-term or long-term effect.

The same study also investigated the efficacy of concentric exercise and stretching versus stretching. We found moderate evidence for no short-term treatment effect for outcomes on pain, pain-free grip strength and DASH score. There were no data on the intermediate-term or long-term effect.

Eccentric exercise with stretching versus no intervention was investigated in one study.⁴¹ We found moderate evidence for a positive effect on pain and grip strength at short-term follow-up. There were no data on efficacy at intermediate follow-up, but in the long term we found moderate evidence of a positive effect on overall improvement, pain and grip strength.

Table 4 Effect sizes of treatment effects for non-electrotherapeutic physiotherapy

	Short term 4–12 weeks	Intermediate term 26 weeks	Long term 52 weeks
<i>Manipulation and exercise vs no intervention</i>			
Overall improvement RR (relative risk) (95% CI)—RR>1 favours treatment			
Bisset	2.44 (1.54 to 3.85)*	0.94 (0.78 to 1.12)	1.04 (0.93 to 1.15)
Coombes	4.00 (1.46 to 10.94)*	1.06 (0.89 to 1.28)	1.08 (0.99 to 1.18)
Pooled	2.75 (2.09 to 3.62)*	0.99 (0.75 to 1.30)	1.05 (0.75 to 1.49)
Heterogeneity	$p=0.37$, $I^2=0\%$	$p=0.33$ $I^2=0\%$	$p=0.57$ $I^2=0\%$
Pain SMD (standardised mean difference; 95% CI)—negative value favours treatment			
Bisset	-0.63 (-0.99 to -0.27)*	-0.25 (-0.62 to 0.11)	-0.38 (-0.74 to -0.03)*
Coombes	-1.27 (-1.74 to -0.79)*	0.00 (-0.44 to 0.44)	0.00 (-0.44 to 0.44)
Pooled	—	-0.15 (-0.43 to 0.13)	-0.23 (-0.51 to 0.04)
Heterogeneity	>65%	$p=0.39$ $I^2=0\%$	$p=0.18$ $I^2=45\%$
Pain-free grip strength ratio affected/ unaffected arm SMD (95%)			
Bisset	0.76 (0.39 to 1.13)*	0.20 (-0.47 to 0.56)	0.17 (-0.18 to 0.52)
<i>Exercise vs no intervention</i>			
DASH score (0–100, 100 most discomforts, negative value favours treatment) SMD (95% CI)			
Peterson	-0.03 (-0.47 to 0.40)	—	
Pain on maximum voluntary contraction SMD (95% CI)—negative value favours treatment			
Peterson	-0.30 (-0.74 to 0.14)	—	
Pain on maximum muscular elongation SMD (95% CI)—negative value favours treatment			
Peterson	-0.24 (-0.68 to 0.19)	—	
<i>Eccentric exercise and stretching vs stretching</i>			
DASH score (0–100, 100 most discomforts, negative value favours treatment) SMD (95% CI)			
M-Silvestrini	-0.07 (-0.46 to 0.60)	—	
Pain SMD (95% CI)—negative value favours treatment			
M-Silvestrini	-0.04 (-0.57 to 0.49)	—	
Pain-free grip strength affected arm SMD (95%)			
M-Silvestrini	-0.26 (-0.79 to 0.27)	—	
<i>Concentric exercise and stretching vs stretching</i>			
DASH score (0–100, 100 most complaints, negative value favours treatment) SMD (95% CI)			
M-Silvestrini	0.14 (-0.39 to 0.68)	—	
Pain SMD (95% CI)—negative value favours treatment			
M-Silvestrini	0.41 (-0.13 to 0.95)	—	
Pain-free grip strength affected arm SMD (95% CI)			
M-Silvestrini	-0.34 (-0.88 to 0.20)		
<i>Eccentric exercise and stretching vs no intervention (sham ultrasound, elbow support) overall improvement RR (95% CI)—RR>1 favours treatment</i>			
Selvanetti	—	—	23.39 (3.38 to 161.70)*
Pain on Ko scale (larger value means less pain) SMD (95% CI)			
Selvanetti	4.45 (3.51 to 5.40)*		-4.65 (3.68 to 5.63) *
Grip strength on Ko scale (larger value means greater strength) SMD (95% CI)			
Selvanetti	3.16 (2.40 to 3.92)*		-3.65 (2.82 to 4.47) *

*Statistically significant ($p<0.05$).

DISCUSSION

Summary of main results

This review found overall evidence for a short-term beneficial effect of corticosteroid injection. At intermediate follow-up, the evidence showed an overall negative effect. For corticosteroid injection versus lidocaine injection, we found the evidence to be conflicting. At long-term follow-up, the evidence suggests no difference in effect on overall improvement and grip strength, but the evidence was conflicting for pain. For manipulation and exercise versus no intervention, we found an overall beneficial effect in the short term, but there was no significant difference at intermediate-term or long-term follow-up. The evidence on exercise versus no

intervention showed no differences at short-term follow-up. For eccentric exercise and stretching versus stretching alone, the evidence showed no short-term difference in effect. The same was found for concentric exercise and stretching versus stretching. The evidence on eccentric exercise and stretching versus no intervention showed a beneficial effect in the short term and long term, while there were no data on intermediate follow-up.

For treating lateral epicondylitis, this review showed evidence for a short-term benefit of corticosteroid injection and manipulation with exercise. Eccentric exercise and stretching showed beneficial effect both at short-term and long-term follow-up.

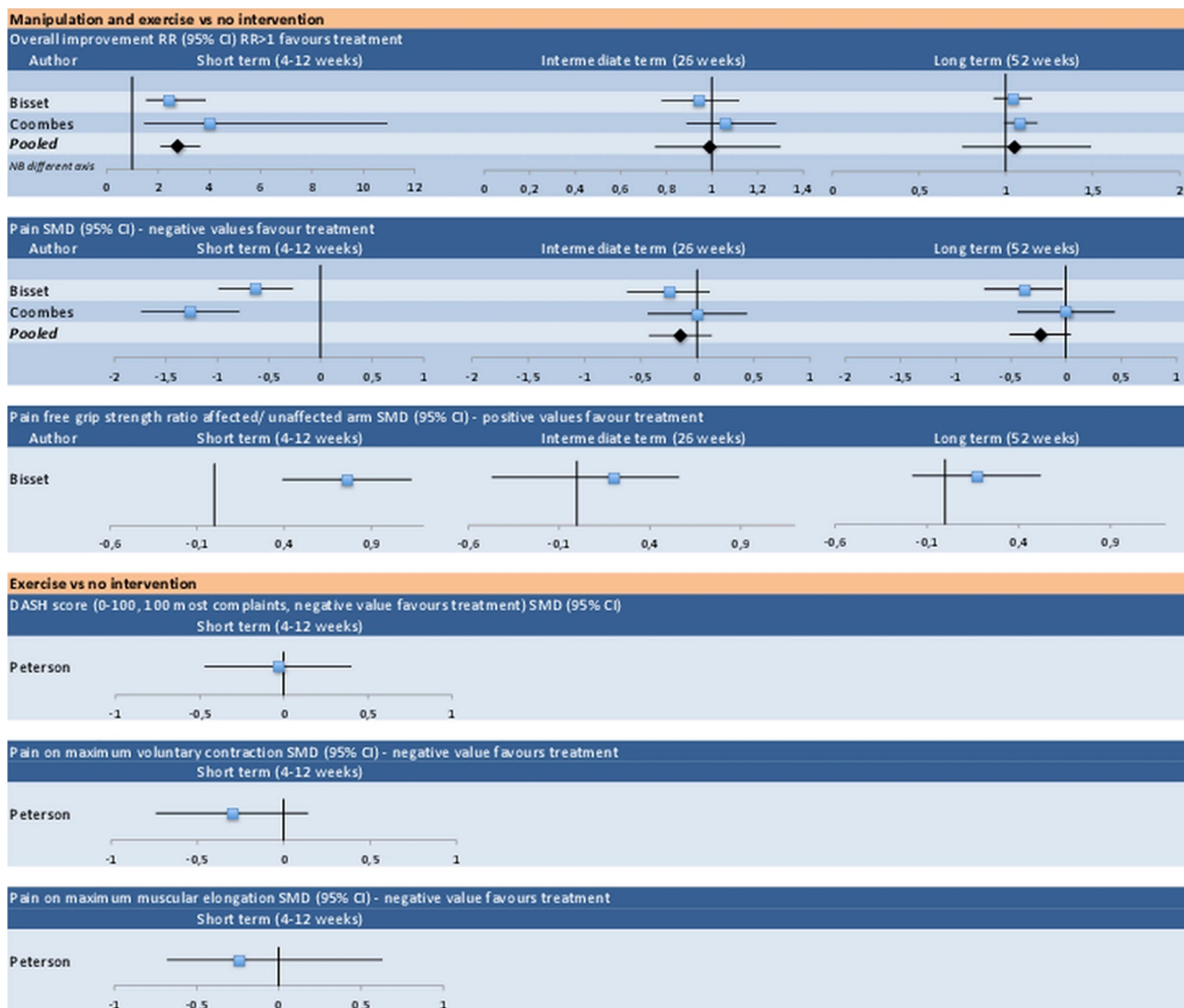


Figure 3 Forest plot of effect sizes for non-electrotherapeutic physiotherapy.

Overall completeness and quality of the evidence

There is a paucity of well-designed studies for determining the effect of non-electrotherapeutic physiotherapy. The conclusions on the effect of these treatments are therefore limited. It was possible to do a comparison and review of several individual studies for only one treatment modality, manipulation and exercise versus no intervention (table 4).

We included eight studies treating a total of 925 patients with corticosteroid injections in our review. The conclusions for this treatment are more solid due to the larger number of studies, seven of which had long-term follow-up. Owing to differences in the type of corticosteroids used, treatment regimes and outcome measures in the included studies, pooling of outcome measures was difficult. We found statistical heterogeneity for most outcomes, and pooling was possible only for a few of the outcomes and follow-ups. The long-term effect of corticosteroid injection showed conflicting results in the

included studies. The large differences across studies in the duration of complaints at baseline, corticosteroids used in different dosages and control group treatments may explain this.

The difference in the duration of complaints at baseline complicates the interpretation and comparison of the results, since there might be different effects of the treatments on an epicondylitis of recent onset compared with one that has lasted several months. This is also reflected by Cook and Purdam⁵³ who considered tendinopathy as a continuum with three stages and different characteristics and presumably treatments for each stage. Haahr and Andersen⁵⁴ found that high physical strain at work, work with manual tasks, high perceived stress at baseline and a high level of pain and dysfunction seem to predict an unfavourable outcome after 1 year. Thus, any differences in baseline characteristics for these parameters might possibly influence between-group differences of outcome.

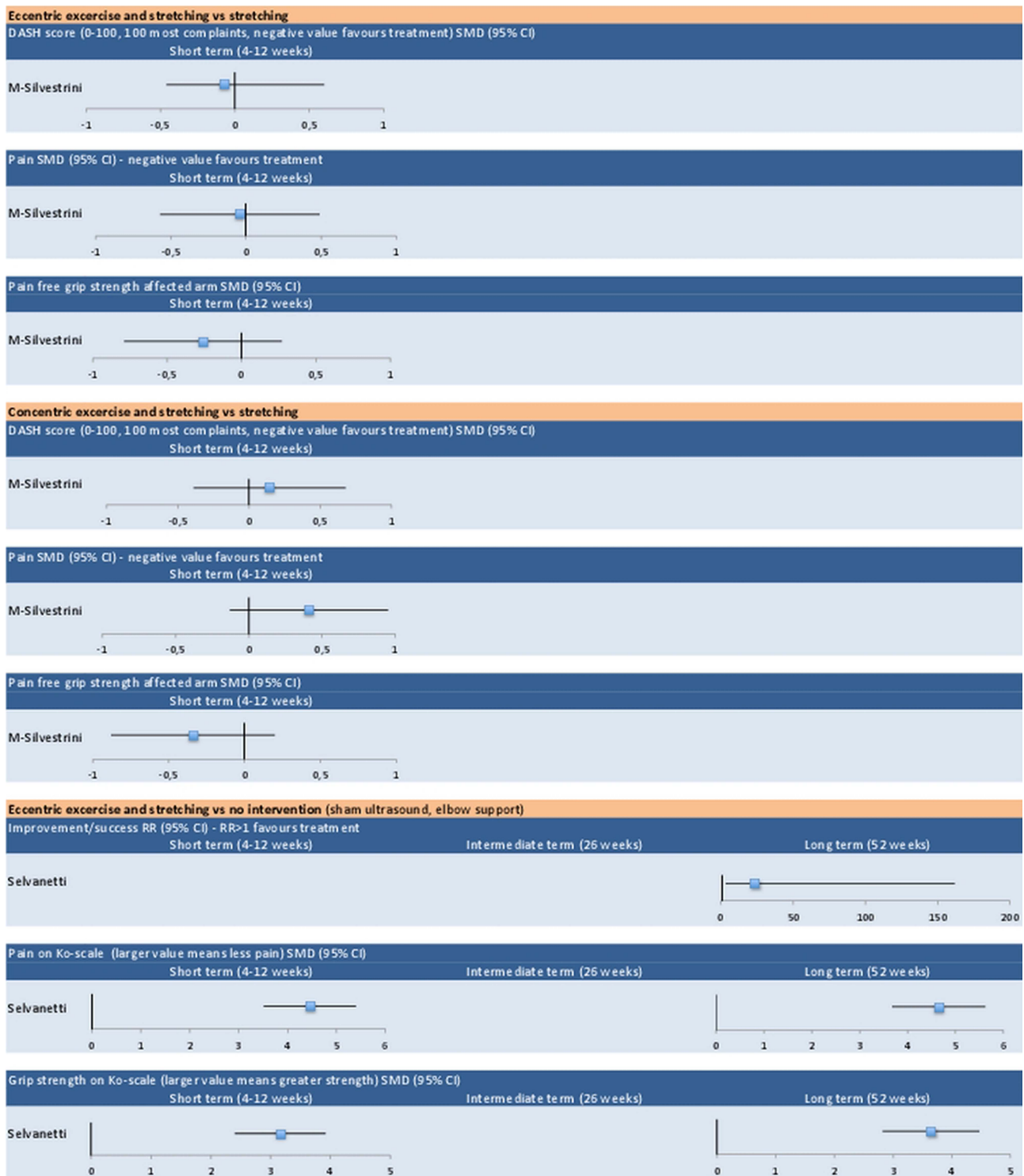


Figure 3 (Continued)

Potential biases in the review process

The search process, selection of search terms and possible errors in reading and assessing the large number of articles represent a possible bias. Although we have searched several databases with a number of search terms, we may have missed some published studies. To reduce the risk of bias in the inclusion process, we

used two reviewers who independently screened the articles.

Our choice of inclusion criteria, especially the type of control or comparison treatment and the use of a cut-off quality score (PEDro), has important implications for the conclusions that can be drawn from this review. The efficacy of the treatments are here compared only with a

control (no treatment) or to an underlying treatment that is common to both intervention groups, so no conclusion can be drawn as to which of the two different treatments is better.

To address the issue of publication bias, we searched two clinical trial registries: ClinicalTrials.gov (US National Institutes of Health) and Current Clinical Trials. We found no completed, unpublished studies on corticosteroid injection. Two completed studies on non-electrotherapeutic physiotherapy were found, one from the UK completed in 2008 on manipulation with movement and one from Sweden completed in 2009 on eccentric training. We have found no published articles from these studies. Unpublished studies are not indexed in PubMed or other databases, and older studies may have been conducted without registration in a clinical trial registry, making it difficult to make an overall assessment of publication bias.

Agreements and disagreements with other reviews

Our findings agree with earlier reviews.^{14 16 17 55} We found consistent evidence of a beneficial short-term effect of corticosteroid injections, but evidence on the long-term effect is still conflicting. Coombes *et al*¹⁵ found in their review that corticosteroid injections have a worse outcome in the long term than most conservative interventions for tendinopathies of different locations. The included studies in our review did not allow for a similar strong conclusion on the long-term effect of corticosteroid injections. For non-electrotherapeutic physiotherapy, we agree with earlier reviews^{14 16 18 19 21} that there is moderate evidence of a short-term effect of manipulation and exercise. Our review strengthens this conclusion with the inclusion of a recently published study.⁴⁰ In addition, we found moderate evidence of the short-term and long-term beneficial effects of eccentric exercise and stretching.

AUTHORS' CONCLUSIONS

Implications for practice

We found that corticosteroid injection and manipulation with exercise gave a short-term benefit compared with control for treating lateral epicondylitis. In the intermediate term, treatment with corticosteroid injection came out worse, while manipulation with exercise was not different from control. In the long term, both treatments showed no benefit over control. For patients wanting treatment, it seems reasonable to recommend manipulation and exercise. For patients with mild symptoms, a wait-and-see approach would be appropriate. Though showing a large short-term benefit, the negative intermediate-term effect and uncertain long-term effect of corticosteroid injection make this treatment difficult to recommend. Eccentric exercise with stretching showed efficacy both at short-term and long-term follow-up, but only in one study.

Implications for research

We found few studies and some conflicting results on the long-term efficacy of corticosteroid injection. More trials or a meta-analysis with individual patient data from earlier studies might give better answers to the question on the long-term effect.

For non-electrotherapeutic physiotherapy, more studies with a randomised controlled design are needed. Blinding, for example by using a blinded assessor, should be applied wherever possible. The promising results of manipulation with exercise and eccentric exercise with stretching need further investigation.

Future studies should differentiate between acute and chronic complaints. Baseline levels of perceived pain, stress levels, handedness and presence of physical stress at work should be recorded. Standardisation in the usage of outcome measures will enable data pooling and meta-analyses in future reviews. Studies investigating the combined effect of physiotherapy and corticosteroid injection treatments would also be useful. Most patients with acute lateral epicondylitis are treated in a general practice setting, and future research should be performed in such a setting.

Contributors MO and OH designed the study, performed the searches, read the articles, decided which articles to include, performed the data extractions, interpreted the findings and wrote the main manuscript. ML designed the study, decided which articles to include, interpreted the findings and revised the manuscript. SB decided which articles to include, interpreted the findings and revised the manuscript. HS did the statistical calculations and analysis, interpreted the findings and revised the manuscript.

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