Evidence for the effectiveness of electrophysical modalities for treatment of medial and lateral epicondylitis: a systematic review

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ABSTRACT

Background Several treatments are available to treat epicondylitis. Among these are instrumental electrophysical modalities, ranging from ultrasound, extracorporeal shock wave therapy (ESWT), transcutaneous electrical nerve stimulation (TENS) to laser therapy, commonly used to treat epicondylitis.
Objectives To present an evidence-based overview of the effectiveness of electrophysical modality treatments for both medial and lateral epicondylitis (LE).
Methods Searches in PubMed, EMBASE, CINAHL and Pedro were performed to identify relevant randomised clinical trials (RCTs) and systematic reviews. Two reviewers independently extracted data and assessed the methodological quality. A best-evidence synthesis was used to summarise the results.
Results A total of 2 reviews and 20 RCTs were included, all of which concerned LE. Different electrophysical regimes were evaluated: ultrasound, laser, electrotherapy, ESWT, TENS and pulsed electromagnetic field therapy. Moderate evidence was found for the effectiveness of ultrasound versus placebo on mid-term follow-up. Ultrasound plus friction massage showed moderate evidence of effectiveness versus laser therapy on short-term follow-up. On the contrary, moderate evidence was found in favour of laser therapy over plyometric exercises on short-term follow-up. For all other modalities only limited/conflicting evidence for effectiveness or evidence of no difference in effect was found.
Conclusions Potential effectiveness of ultrasound and laser for the management of LE was found. To draw more definite conclusions high-quality RCTs examining different intensities are needed as well as studies focusing on long-term follow-up results.

INTRODUCTION

Lateral epicondylitis (LE) is a frequently occurring condition associated with chronic elbow dysfunction and pain.[1] The incidence is 3–11/1000 patients/year.[1 2] Due to the various symptoms (including pain and loss of function) patients may withdraw from important daily activities such as work and sport. In most cases symptoms last for 6 months to 2 years but finally are self-limiting.[3] Costs and time away from job (and/or reduced daily activities) are substantial because of the long period of recovery.[4] Although the actual cause of the clinical condition of LE is unknown, correlations with specific repetitive movements 2 h/day, handling tools >1 kg, handling loads >20 kg at least 10 times/day, low job control and low social support at work have been identified.[5] Diagnostic criteria for LE are a history of pain and/or tenderness at or close to the lateral ligament of the elbow region.[2] The term 'epicondylitis' is somewhat misleading because it wrongly suggests that inflammation is the cause of the clinical condition. In this review we chose to maintain this terminology because most clinicians and most literature still functionally use it as such.

Medial epicondylitis (ME) affects the musculotendinous origin of the common flexor compartment of the lower arm region where it attaches to the medial epicondyl. The clinical conditions are very similar to those in patients with LE. The important difference is the pain that occurs by activation of the flexor compartment, instead of the extensor compartment, in LE.[6] Several treatments are available for LE including mobilisation techniques, various injections and surgery. The use of instrumental electrophysical modalities, ranging from ultrasound, extracorporeal shock wave therapy (ESWT), transcutaneous electrical nerve stimulation (TENS) to laser therapy, might have value in the treatment of LE and/or ME. Ultrasound is a commonly used method and causes increased protein synthesis at low-intensity use.[7 8] ESWT is a relatively new treatment and its function lies in the pressure-focused pulses which may cause tissue regeneration at the specific site.[9] TENS stimulates the nerve system by using electric pulses to reduce pain.[10] Laser therapy uses low-level laser pulses to induce cellular function.[11]

The present study provides an overview of the evidence for the effectiveness of electrophysical modalities for the treatment of patients with LE and ME.

METHODS

Search strategy

The Cochrane Library, PubMed, EMBASE, CINAHL and Pedro were searched to identify relevant studies on interventions for LE and ME: systematic reviews up to February 2010 and randomised clinical trials (RCTs) up to August 2012. Keywords related to epicondylitis such as 'epicondylitis', 'tennis elbow' and 'interventions' were included. The complete search strategy is available on request.

Inclusion criteria

Systematic reviews and/or RCTs were considered eligible for inclusion if they fulfilled all the following criteria: (1) patients with ME or LE were included, (2) epicondylitis was not caused by an acute trauma or any systemic disease as described in the definition of 'Complaints of the Arm, Neck and/or Shoulder' (CANS)[12 13], (3) interventions for treating epicondylitis were evaluated, (4) results on pain, function or recovery were reported and (5) the article was written in English, French, German or Dutch.

After the full-text articles were included, the included studies were divided into different treatment approaches which are presented in separate reviews. The present review concerns electrophysical modalities, which are described in this paper.

Study selection

Two reviewers (BiH, RD/MR/SG) independently screened titles, abstract and finally full-text papers. A consensus method was used to solve any disagreements concerning the inclusion of studies, and a third reviewer (BK) was consulted if disagreement persisted.

Categorisation of the relevant literature

Relevant articles are categorised under three headers: *Systematic reviews* includes all reviews on this treatment method; *Recent RCTs* contains all RCTs published after the search date of the systematic review on the same intervention; *Additional RCTs* describes all RCTs concerning an intervention that has not yet been described in a systematic review.

Data extraction

Two reviewers (BMH, RD/MR/SG) independently extracted the data. Information was collected on study population, interventions used, outcome measures and outcome. A consensus procedure was used to solve any disagreement between the authors. The follow-up period was categorised as short term (≤3 months), mid-term (4–6 months) and long term (>6 months).

Methodological quality assessment

Two reviewers (BMH, RD/MR/SG) independently assessed the methodological quality of each RCT. The 12 quality criteria were adapted from Furlan *et al*[14] (table 1). Each item was scored as 'yes', 'no' or 'don't know'. High quality was defined as a 'yes' score of ≥50%. A consensus procedure was used to solve any disagreement between the reviewers.

Table 1 Methodological quality assessment

	Sources of risk of bias **Item**
A	1. Was the method of randomisation adequate?
B	2. Was the treatment allocation concealed?
C	Was knowledge of the allocated interventions adequately prevented during the study? 3. Was the patient blinded to the intervention? 4. Was the care provider blinded to the intervention? 5. Was the outcome assessor blinded to the intervention
D	Were incomplete outcome data adequately addressed? 6. Was the drop-out rate described and acceptable? 7. Were all randomised participants analysed in the group to which they were allocated?
E	8. Are reports of the study free of suggestion of selective outcome reporting?
F	Other sources of potential bias: 9. Were the groups similar at baseline regarding the most important prognostic indicators? 10. Were co-interventions avoided or similar? 11. Was the compliance acceptable in all groups? 12. Was the timing of the outcome assessment similar in all groups?

Box 1 Levels of evidence

- *Strong evidence*: consistent (ie, when ≥75% of the trials report the same findings) positive (significant) findings within multiple higher quality RCTs.
- *Moderate evidence*: consistent positive (significant) findings within multiple lower-quality RCTs and/or one high-quality RCT.
- *Limited evidence* for effectiveness: positive (significant) findings within one low-quality RCT.
- *Conflicting evidence*: provided by conflicting (significant) findings in the RCTs (<75% of the studies reported consistent findings)
- *Evidence of no effect*: RCT(s) available, but no (significant) differences between the intervention and control groups were reported

For the included reviews we described the methodological quality scale or criteria used in the review, and used their ratings as high/low quality for the included RCTs.

Data synthesis

A quantitative analysis of the studies was somewhat limited due to heterogeneity of the interventions and outcome measures. Therefore, we summarised the results using a best-evidence synthesis.[15] The article was included in the best-evidence synthesis only if a comparison was made between the groups and the level of significance was reported. The results of the study were labelled 'significant' if one of the three outcome measures (pain, function and improvement) showed significant results. The levels of evidence for effectiveness were ranked as shown in box 1.

RESULTS

Characteristics of the included studies

The initial literature search resulted in 12 potentially relevant reviews and 227 RCTs. Finally, 2 reviews[16 17] and 20 RCTs on electrophysical modalities were included (figure 1).

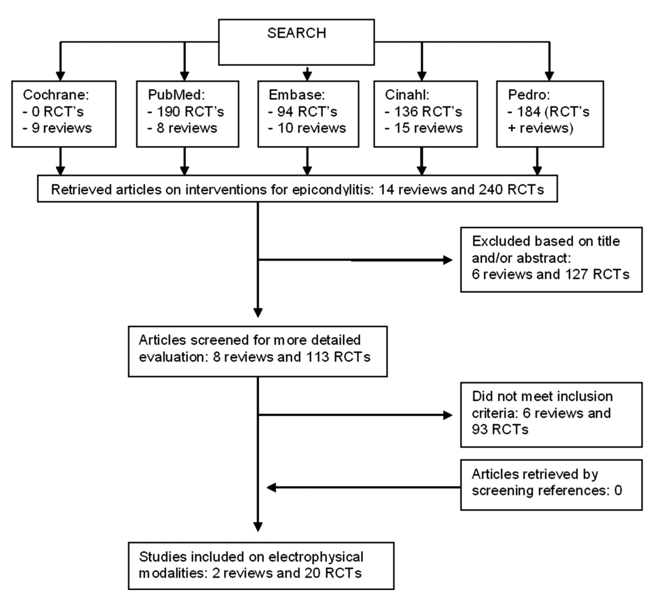

Figure 1 Flowchart of the literature search.

The characteristics of the included studies are listed in online supplementary appendix 1.

Methodological quality of the included studies

Table 2 presents the results of the methodological quality assessment: 14 of the 20 (70%) included RCTs were of high quality.

The review of Smidt *et al*[16] used the Amsterdam-Maastricht consensus list with a score >50% defined as high quality: 70% (16 of 23) were of high quality.

The review of Buchbinder *et al*[17] used six criteria to assess methodological quality (appropriate randomisation, allocation concealment, blinding (patient and/or caregiver), number lost to follow-up and intention-to-treat analysis) but high/low quality was not indicated. Therefore, we indicated a methodological quality score of ≥50% to be high quality.

The most prevalent methodological shortcomings were co-interventions not avoided or similar (67%), incomplete data outcome/ITT analyses (62%) and allocation concealment (55%).

Effectiveness of interventions for epicondylitis medialis

No reviews or RCTs were found for ME.

Effectiveness of interventions for epicondylitis lateralis

Two systematic reviews were found reporting on physiotherapy[16] and ESWT,[17] and 20 RCTs evaluating ultrasound, laser, electrotherapy, TENS, ESWT and pulsed electromagnetic field. Evidence for the effectiveness of the various interventions for LE is reported in table 3.

ULTRASOUND

Ultrasound versus placebo or no treatment

Systematic review

In the review of Smidt *et al*[16] three high-quality studies[8 19 21] studied the effects of ultrasound versus placebo. In two of the studies, no significant benefit for ultrasound was reported on general improvement both at 5 weeks follow-up.[8 19] On the contrary, Binder *et al*[8 19 21] found a significant difference on general improvement in favour of the ultrasound group (standard mean difference (SMD) 0.52 (95% CI 0.33 to 0.82)) at 8 weeks follow-up. Binder *et al*[21] reported on pain at 4 and 8 weeks follow-up and Lundeberg *et al*[19] at 13 weeks follow-up. In both latter studies, data were pooled and showed a significant improvement on pain (SMD −0.98 (95% CI −1.64 to −0.33) in favour of the ultrasound group.

Furthermore, in the study of Lundeberg *et al*[19] significant results in favour of ultrasound versus no treatment were reported on pain at 13 weeks (SMD −1.70 (95% CI −2.26 to −1.13)) and global improvement at both 5 weeks (relative risk (RR) 0.63 (95% CI 0.41 to 0.96)) and 13 weeks (RR 0.44 (95% CI 0.26 to 0.74)).

Recent RCT

D'Vaz *et al*[20] (n=30, high-quality) studied the effects of ultrasound versus placebo. Outcome measurements were ≥50% improvement on pain, function and grip strength at 12 weeks of follow-up. Improvement in favour of ultrasound was seen but the difference was not significant compared with placebo.

Conflicting evidence was found for the effectiveness of ultrasound versus placebo on the short term, and moderate evidence for effectiveness on the mid-term.

Friction massage as add on therapy to ultrasound

Systematic review

In the review of Smidt *et al*,[16] the study of Stratford *et al*[22] (n=9, high quality) compared ultrasound to ultrasound plus friction massage and reported no significant results at 5 weeks of follow-up.

There is evidence of no difference in effect between friction massage as add on therapy to ultrasound versus ultrasound on the short term.

Ultrasound versus exercises

Recent RCT

Pienimaki *et al*[25] (n=30, low quality) included patients who were treated with a progressive strengthening plus stretching arm exercise programme versus local pulsed ultrasound therapy. Significant differences were found in favour of exercise therapy on pain (MD −0.4 (95% CI −2.1 to −0.4)) at 36 months follow-up.

There is limited evidence for the effectiveness in favour of exercises versus ultrasound on the long term.

Ultrasound plus exercises versus a brace plus exercises versus laser therapy plus exercises:

Recent RCT

The high-quality study of Öken *et al*[11] (n=59) studied three different types of interventions: (1) brace during the daytime for 2 weeks, (2) continuous ultrasound 5 days/week for 2 weeks and (3) low-level laser therapy 5 days/week for 2 weeks. All participants received exercise therapy as addition to their treatment. No significant differences were found between the groups on pain, grip strength and improvement at 6 weeks of follow-up.

There is evidence of no difference in effect of ultrasound plus exercises versus a brace plus exercises versus laser therapy plus exercises on the short term.

Ultrasound versus chiropractic therapy

Recent RCT

Langen-Pieters *et al*[24] (n=14, low quality) found significant results in favour of continuous ultrasound therapy versus chiropractic therapy. At 6 weeks of follow-up significant differences on pain and pain-free function were found (no p-values given) although no significant differences were found on pain-free grip strength.

There is limited evidence for the effectiveness of ultrasound versus chiropractic therapy on the short term.

Ultrasound versus acupuncture therapy

Recent RCT

Davidson *et al*[23] (n=16, high quality) found no significant differences between ultrasound therapy and acupuncture therapy on pain, pain-free grip strength, or the disabilities of the arm, shoulder and hand (DASH) questionnaire at 4 weeks of follow-up.

We found evidence of no difference in effect of ultrasound versus acupuncture on the short term.

LASER

Laser versus placebo

Systematic review

In the review of Smidt *et al*[16], six studies[18 26 28 29 30 32 33] reported on the effectiveness of laser versus placebo. The two high-quality studies[26 32] reported on pain. Vasseljen *et al*[26] found no significant differences at 3 and 7 weeks of follow-up.

Table 2 Methodological quality scores of the included studies

	Adequate randomisation?	Allocation concealment?	Blinding? Patients?	Blinding? Caregiver?	Blinding? Outcome assessors?	Incomplete outcome data addressed? Drop-outs?	Incomplete outcome data? ITT analysis?	Free of Suggestions of selective outcome reporting?	Similarity of baseline characteristics?	Co-interventions avoided or similar?	Compliance acceptable in all groups?	Timing of the outcome assessment similar?	Score maximum	Score study	Per cent
Ultrasound															
Haker and Lundeberg[18]*	–	+	+	+	+	+	–	+	+	+	+	+	12	10	83
Lundeberg *et al*[19]*	–	+	+	+	+	+	+	–	–	+	+	+	12	9	75
D'Vaz *et al*[20]	+	+	+	–	+	+	–	+	?	+	+	+	12	9	75
Oken *et al*[11]	+	?	–	–	+	+	+	+	+	?	?	+	12	7	58
Binder *et al*[21]*	–	+	+	+	–	+	–	–	–	–	+	+	12	7	58
Stratford *et al*[22]*	+	+	–	–	+	+	+	–	–	–	+	+	12	7	58
Davidson *et al*[23]	+	?	–	–	+	+	–	+	?	+	+	–	12	6	50
Langen-Pieters and Brantingham[24]	+	?	–	–	–	+	+	+	–	?	+	–	12	5	42
Pienimaki *et al*[25]	?	?	–	–	?	+	?	+	+	?	?	–	12	3	25
Laser															
Vasseljen *et al*[26]*	+	+	+	+	+	+	–	+	+	+	+	+	12	11	92
Stergioulas[27]	+	+	+	–	+	+	+	+	+	+	+	+	12	11	92
Haker and Lundeberg[28]*	–	+	+	+	+	+	+	+	–	+	+	+	12	10	83
Haker and Lundeberg[18]*	–	+	+	+	+	+	–	+	+	+	+	+	12	10	83
Vasseljen *et al*[26]*	+	+	–	–	–	+	–	+	+	+	+	+	12	8	67
Krasheninnikoff *et al*[29]*	–	+	+	+	+	–	–	–	+	–	+	+	12	7	58
Lam and Cheing[30]	+	?	+	–	?	+	+	+	+	?	?	+	12	7	58
Basford *et al*[31]	+	?	+	–	+	+	–	+	+	–	+	–	12	7	58
Lundeberg *et al*[32]*	–	+	+	+	+	–	–	–	–	–	–	+	12	5	42
Gudmundsen[33]*	–	–	–	–	+	–	–	–	–	–	–	–	12	1	8
Electrotherapy															
Coff and Caragianis[34]	?	–	–	–	?	+	+	+	+	?	+	+	12	6	50
NourbakhshReza[35]	?	–	+	–	+	?	?	+	?	?	?	+	12	4	33
Pulsed electromagnetic field															
Uzunca *et al*[36]	–	+	–	–	+	+	+	+	+	?	?	+	12	7	58
Devereaux *et al*[37]	?	?	+	–	+	+	+	?	+	?	?	+	12	6	50
Chard and Hazleman[38]*	–	–	+	+	+	–	–	–	–	–	–	+	12	4	33
TENS															
Weng *et al*[39]	?	?	?	?	?	?	?	+	?	?	?	?	12	1	8
ESWT															
Rompe *et al*[40]†	+	+	+	n.a.	+	+	+	n.a.	n.a.	n.a.	n.a.	n.a.	6	6	100
Gunduz*et al*[41]	+	+	+	?	+	+	+	+	+	+	+	+	11	11	100
Chung and Wiley[42]†	+	+	+	n.a.	+	–	+	n.a.	n.a.	n.a.	n.a.	n.a.	6	5	83

Continued

Table 2 Continued

	Adequate randomisation?	Allocation concealment?	Blinding? Patients?	Blinding? Caregiver?	Blinding? Outcome assessors?	Incomplete outcome data addressed? Drop-outs?	Incomplete outcome data? ITT analysis?	Free of Suggestions of selective outcome reporting?	Similarity of baseline characteristics?	Co-interventions avoided or similar?	Compliance acceptable in all groups?	Timing of the outcome assessment similar?	Score maximum	Score study	Per cent
Haake *et al*[43]†	–	+	+	n.a.	+	+	+	n.a.	n.a.	n.a.	n.a.	n.a.	6	5	83
Pettrone and McCall[44]†	?	+	+	n.a.	+	+	+	n.a.	n.a.	n.a.	n.a.	n.a.	6	5	83
Mehra *et al*[45]†	+	–	+	n.a.	–	+	+	n.a.	n.a.	n.a.	n.a.	n.a.	6	4	67
Speed *et al*[46]†	?	?	+	n.a.	+	+	+	n.a.	n.a.	n.a.	n.a.	n.a.	6	4	67
Staples *et al*[47]	+	?	+	–	+	+	–	+	+	+	?	+	12	8	67
Spacca *et al*[48]	+	?	+	–	?	+	+	+	+	?	+	+	12	8	67
Collins and Jafarnia[49]	?	–	+	–	+	+	+	–	+	–	+	+	11	7	64
Pettrone and McCall[44]	+	+	+	–	+	–	–	+	+	?	?	+	12	7	58
Melikyan *et al*[50]†	?	?	+	n.a.	+	+	–	n.a.	n.a.	n.a.	n.a.	n.a.	6	3	50
Rompe *et al*[40]†	?	?	+	n.a.	+	+	–	n.a.	n.a.	n.a.	n.a.	n.a.	6	3	50
Levitt[51]†	?	?	+	n.a.	+	+	–	n.a.	n.a.	n.a.	n.a.	n.a.	6	3	50
Radwan *et al*[9]	+	?	–	–	–	+	–	+	+	?	n.a.	+	11	5	45
Chung *et al*[52]	?	?	+	–	?	+	–	+	?	?	+	–	12	4	33
Crowther *et al*[53]	+	?	–	n.a.	?	–	+	n.a.	n.a.	n.a.	n.a.	n.a.	6	2	33
Total positive scores per item	19	19	29	11	28	32	17	25	17	11	18	26			

*Articles included in the review of Smidt *et al*[16] in which the Amsterdam-Maastricht consensus list was used to score the methodological quality.
†Articles included in the review of Buchbinder *et al*[17] in which six specific criteria were used to score the methodological quality.
+, yes; –, no; ?, unclear/unsure; n.a. not applicable because these items were not used as quality criteria.

Table 3 Evidence for effectiveness of electrophysical modalities for epicondylitis†

Ultrasound (US)	Laser	Electrotherapy	Pulsed electromagnetic field therapy (PEMF)	Transcutaneous electrical nerve stimulation (TENS)	Extracorporeal shock wave therapy (ESWT)
US* vs placebo or no treatment Short term ± Mid-term ++	Laser* vs placebo Short term ± Mid-term ENE Long term ENE	Noxious level electrical stimulation over the platelet tender points* vs placebo Short term +	PEMF compared to placebo Short term ENE	Low-frequency vs high-frequency TENS on acupuncture points Short term ENE	ESWT vs placebo Short term ± Mid term ENE Long term ENE
US vs US plus friction massage Short term (<3 months) ENE	Laser vs placebo and plyometric exercises Short term ++	InterX and soft tissue massage, stretching, US and exercise vs soft tissue massage, stretching, US and exercise. Short term ENE Long term ENE		Low-frequency TENS on acupuncture points* vs placebo Short term +	ESWT vs percutaneous tenotomy Short term ENE Long term ENE
US vs exercises* Long term +	Laser vs US plus friction massage* Short term ++			High-frequency TENS on acupuncture points* vs placebo Short term +	ESWT vs corticosteroid injection* Short term + Long term ENE
US plus exercises vs a brace plus exercises vs laser therapy plus exercises Short term ENE					ESWT vs physical therapy Short term ENE Mid-term ENE Long term ENE
US* vs chiropractic therapy Short term +					
US vs acupuncture therapy Short term ENE					

†For medial epicondylitis no RCTs on electrophysical modalities were found.
+, Limited evidence found; ++, moderate evidence found; +++, strong evidence found; ±, conflicting evidence for effectiveness; *, in favour of; ENE, evidence of no effect of the treatment; interX, new electric modality; RCTs available, but no differences between intervention and control groups were found.

However, Lundeberg *et al*[32] found a significant difference in favour of the laser group (SMD −2 (95% CI −2.77 to −1.22)) at 13 weeks of follow-up. Four high-quality studies[18 26 28 29] reported no significant differences on global improvement at all follow-up times.

One low-quality study[33] (n=52) and one high-quality study[32] (n=23) found significantly better results in favour of laser therapy after 4 weeks (RR 0.72 (95% CI 0.60 to 0.87)) and 26 weeks (RR 0.46 (95% CI 0.23 to 0.93)), respectively.

Recent RCTs

Two high-quality recent RCTs were found: the study of Lam *et al*[30] (n=39) reported significantly better results on pain (laser: from 5.14 (1.88) (mean (SD)) at baseline to 1.48 (1.36) versus placebo: from 5.61 (2.03) at baseline to 4.28 (2.11), p=0.000), maximum strength (laser: from 20.38 (8.21) at baseline to 29.57 (8.96) versus placebo: from 18.28 (9.41) to 21.61 (9.70), p=0.011) and the DASH questionnaire (laser: from 34.75 (13.77) at baseline to 15.79 (11.59) versus placebo: 38.92 (18.92) at baseline to 31.58 (17.98), p=0.002) all measured at 3 weeks of follow-up. In contrast, the study of Basford *et al*[31] (n=47) found no significant benefits of laser versus placebo on pain and grip strength at 2 months of follow-up.

For laser versus placebo there is conflicting evidence for effectiveness on short-term follow-up and evidence of no difference in effect on mid-term and long-term follow-up.

Laser versus placebo and plyometric exercises

Recent RCT

In the high-quality study of Stergioulas *et al*,[27] a significant benefit was found in favour of the laser treatment group on short term. Pain at rest p<0.005 (from 6.95 (9.81) (mean (SD)) to 3.41 (6.26) versus control group from 6.10 (8.43) to 4.75 (7.63)) and grip strength p<0.05 (from 26.17 (8.78) to 33.37 (9.45) versus control group: from 23.68 (8.03) to 25.52 (8.37)) both in favour of laser group directly after eight treatment sessions. At 8 weeks of follow-up pain at rest p<0.05 (from 6.95 (9.81) to 1.61 (3.30) versus control group from 6.10 (8.43) to 2.93 (3.11)) and grip strength p<0.01 (from 26.17 (8.78) to 40.22 (10.45) versus control group: from 23.68 (8.03) to 29.31 (8.98)) again showed significant results in favour of the laser treatment group.

For laser versus placebo and plyometric exercises moderate evidence for effectiveness on short-term follow-up was found.

Ultrasound plus friction massage versus laser

Systematic review

In the review of Smidt *et al*,[16] at 7 weeks follow-up Vasseljen *et al*[26] (n=15, high quality) found a significant benefit in favour of ultrasound plus friction massage versus laser therapy on pain (SMD −0.84 (95% CI −1.58 to −0.09)); no significant results were found on global improvement.

There is moderate evidence for the effectiveness on pain reduction of ultrasound plus friction massage versus laser on the short term.

ELECTROTHERAPY

Noxious level electrical stimulation over the platelet tender points versus placebo

Recent RCT

Nourbakhsh *et al*[35] (n=16, low quality) reported on the effectiveness of low-frequency electrical stimulation over the palpated tender points for 2–3 weeks versus placebo (n=18). After 3 weeks of treatment, pain intensity, pain-limited activity, grip strength and functional level showed significant improvement (p=0.01, 0.003, 0.04 and 0.013, respectively) in favour of the treatment group.

There is limited evidence for the effectiveness of noxious level electrical stimulation over the platelet tender points versus placebo on the short term.

InterX as add-on therapy to soft tissue massage, stretching, ultrasound and exercise

Recent RCT

Coff *et al*[34] (n=26, high quality) studied the effectiveness of a new electrical modality (InterX) as add-on therapy to soft tissue massage, stretching, ultrasound and exercises. For all measured parameters (pain at best, pain at worst, grip strength and functional difficulty) no significant differences were found between the groups at 3 and 9 months of follow-up.

There is evidence of no difference in effect of InterX treatment as add-on therapy to soft tissue massage, stretching, ultrasound and exercise on the short and long term.

PULSED ELECTROMAGNETIC FIELD THERAPY

Systematic review

In the systematic review of Smidt *et al*[16] for one study[38] (n=17, low quality) reporting on the effectiveness of pulsed electromagnetic field therapy (PEMF) an effect size was calculated. This study compared PEMF to placebo and found no significant results on pain at 8 weeks of follow-up.

Recent RCTs

Uzunca *et al*[36] (n=40, high quality) compared PEMF to placebo. At 3 months of follow-up significant differences on rest pain and activity pain were found within all groups, but no comparisons between the groups were made.

Devereaux *et al*[37] (n=30, high quality) reported on the effectiveness of PEMF versus placebo and found no significant differences at 6 weeks of follow-up.

There is evidence of no difference in effect of PEMF versus placebo in patients with LE on the short term.

TENS

TENS versus placebo

Recent RCT

Weng *et al*[39] (n=40, low quality) compared the efficacy of low-frequency TENS, high-frequency TENS and sham TENS, all focused on acupuncture points. Significant differences were found at 2 weeks follow-up on a change in pain scores between low-frequency TENS versus sham TENS and between high-frequency TENS and sham TENS (low-frequency TENS: −18.5 (18.1) (mean (SD)) versus high-frequency TENS: −16.32 (16.56) versus sham TENS). No significant difference was found on pain between high-frequency and low-frequency TENS.

On the very short term (2 weeks), limited evidence was found for the effectiveness of low-frequency or high-frequency TENS on acupuncture points versus sham TENS, whereas evidence of no difference in effect was found between the low-frequency and high-frequency TENS groups.

ESWT

ESWT versus placebo

Systematic review

In the review of Buchbinder *et al*[17] (10 RCTs, n=1099) nine high-quality RCTs reported on ESWT versus placebo. One RCT [53] (n=93, low quality) studied ESWT versus injections and found a significant difference in favour of injections at 3 months follow-up by pain reduction of 50% from baseline as the criterion of success (21/25 (84%) versus 29/48 (60%), $p<0.05$); however, the results did not remain significant at 6 months of follow-up. The high-quality studies of Mehra *et al*[45] (n=24) and Melikyan *et al*[50] (n=74) found no significant differences for ESWT treatment of epicondylitis lateralis versus placebo at 1, 3, 6 and 12 months of follow-up.

Pooled analyses of the three high-quality studies of Haake *et al*[43] (n=272), Rompe *et al*[40] (n=115) and Speed *et al*[46] (n=75) showed no significant differences regarding pain at rest at 4–6 weeks follow-up.

Pooled analyses of three high-quality studies (Haake *et al*,[43] Rompe *et al*[54] and Pettrone *et al*[44] (n-total=455)) also showed no significant difference on pain and grip strength at 12 weeks follow-up. However, a significant difference in favour of ESWT was found in the pooled analyses of two studies[35 45] at 12 weeks of follow-up on 50% improved pain (RR 2.20 (95% CI 1.55 to 3.12)). However, these results were not supported by the findings in four other individual RCTs (Speed *et al*[46], Haake *et al*[43], Chung *et al*[42] (n=60) and Levitt *et al*[51] (n=183)) with a follow-up period of 4–12 weeks that were unable to be pooled.

Recent RCTs

Five recent RCTs were found. Four high-quality [44 47 48 49] and one low-quality study (Chung *et al*[52] (n=60)) compared ESWT to placebo or control treatment.

Two of these RCTs[48 52] found no significant differences at 4 and 6 weeks, and at 12–48 weeks of follow-up, between ESWT treatment and placebo. Spacca *et al*[48] found significant differences in favour of ESWT versus placebo on pain (ESWT group from 4.5 (2–7) (mean) at baseline to 0.5 (0–2) versus control group from 4.5 (2 to 8) at baseline to 6.5 (3–9)) and grip strength (ESWT group from 38 (32–41) (mean) at baseline to 46 (34–56) versus control group 37 (32–41) at baseline to 36 (32–44)) at 12 weeks of follow-up. Pettrone *et al*[44] found significant differences on pain (active ESWT from 74 (15.8) (mean (SD) at baseline to 37.6 (28.7) versus placebo ESWT from 75.6[16] at baseline to 51.3 (29.7)) and overall impression (active ESWT from 70.3 (16.0) at baseline to 32.8 (27.7) versus placebo ESWT from 46.2 (28.11) at baseline to 46.2 (28.11)) both measurements at 12 weeks follow-up. Collins et al[49] found significant difference on pain during activity in favour of ESWT group (ESWT group: from 7.73 (mean) to 3.35 vs placebo group: from 7.81 to 5.50 at 8 weeks follow-up).

There is conflicting evidence for the effectiveness of ESWT versus placebo on the short term and evidence of no difference in effect on the mid-term and long term.

ESWT versus percutaneous tenotomy

Recent RCT

Radwan *et al*[9] (n=56, low quality) compared ESWT to percutaneous tenotomy. No significant differences between the groups were found at 52 weeks follow-up on pain score, grip strength or recovery.

There is evidence of no difference in the effect of ESWT versus percutaneous tenotomy.

ESWT versus physical therapy

Recent RCT

Gunduz *et al*[41] compared ESWT to physical therapy (combination of hot pack, US and friction massage) and no significances between the groups were found on pain score and grip strength.

There is evidence of no difference in effect of ESWT versus physical therapy.

DISCUSSION

LE and ME are painful, chronic and common clinical conditions for which a variety of treatments are available, but without a gold standard treatment.[2] This overview aims to present evidence for the effectiveness of electrophysical modalities for epicondylitis. No studies for ME were found. For LE we found studies reporting on ultrasound, laser therapy, electrotherapy, TENS, ESWT and PEMF. Surprisingly, most studies reported results on short-term outcomes and only 30% reported results on mid-term and long-term follow-up.

Electrical devices

The usage of electrical devices in the treatment of epicondylitis plays has increased in recent years.[55] However, in this review evidence of no difference in the effect of electrotherapy versus placebo was found.

Of importance may be the limited evidence found in studies of both Nourbakhsh *et al*[35] and Weng *et al*[39] who treated their patients with specific localisation (noxious level electrical stimulation over the platelet tender points and TENS on acupuncture points, respectively). It may be useful to establish the precise localisation used in electrophysical modalities.

Extracorporeal shock wave therapy

We found conflicting evidence for the effectiveness of ESWT versus placebo, percutaneous tenotomy and physical therapy on short-term, mid-term and long-term follow-up. The review of Bisset *et al*[56] that was written after our search date also studied ESWT compared to placebo and corticosteroid injection plus local anaesthetic injection. In these studies, short-term-limited evidence was found in favour of corticosteroid injection versus ESWT and evidence of no difference in effect was found of ESWT compared to placebo.

In a review[57] focusing on the effectiveness of ESWT for rotator cuff tendinosis, different intensities of ESWT were evaluated and promising results in favour of high-intensity ESWT (>0.28 mJ/mm^2) versus placebo, low-intensity and medium-intensity ESWT were found to treat calcific rotator cuff tendinosis. From this point of view, it may possible that, high-intensity ESWT may play a role in the treatment of LE.

Ultrasound and laser therapy

Ultrasound showed moderate evidence for effectiveness versus placebo on the mid-term. In a recent review of Bisset *et al*[56] it was concluded that ‘they don’t know whether US is more effective than placebo’. Though, in this review, no differentiation between short-term, mid-term and long-term follow-up times was made. Therefore our conclusions differ and are more specific.

Ultrasound plus friction massage was more effective (moderate evidence) than laser therapy. For laser therapy versus placebo conflicting evidence or evidence of no difference in effect was found, but on the contrary moderate evidence was found in favour of laser therapy over plyometric exercises on short-term follow-up. These findings were similar as those found in the recent reviews of Bisset *et al*[56] and Bjordal *et al*,[58] who both reported on Low Level Laser Therapy (LLLT) versus placebo in the treatment of LE, and found that there is conflicting evidence for effectiveness of LLLT on similar outcome measurements on short-term follow-up.

Many physiotherapists used or still use ultrasound in combination with friction massage for epicondylitis, which was thought to be caused by inflammation. Nowadays, the aetiology is thought to be structural overuse of the extensor carpi radialis brevis muscle (ECRB) which leads to micro trauma and finally primary tendinosis of the ECRB, with or without involvement of the extensor digitorum communis instead of inflammation.[59] Current ultrasound and laser-treatment methods focus mainly on reducing pain, increasing strength and (above all) improving the quality of life of patients rather than directly treating inflammation[59].

Study limitations

In this review we used the Furlan-list to assess the methodological quality of the RCTs.[14] Also, we used the arbitrary limit of 50% to decide whether or not the evaluated study is of high quality; accordingly, 14 of the 20 (70%) RCTs were of high quality. However, more high-quality studies are needed to draw more valid conclusions.

Another limitation is that, of the RCTs included in our review, only 32% included over 50 patients. We recommend larger trials to give more power to outcomes regarding the treatment of LE.

CONCLUSION

No studies were found studying the effectiveness of treatments for ME. The results of this review for LE show the potential effectiveness of some of the electrophysical modalities to treat LE. There is some evidence that ultrasound is more effective than placebo on mid-term follow-up. Also, ultrasound plus friction massage showed moderate evidence versus laser therapy on the short term. On the contrary, moderate evidence was found in favour of laser therapy over plyometric exercises on short-term follow-up. For all other modalities only limited, conflicting or evidence of no difference in effect was found.

To draw more valid conclusions regarding electrophysical modalities, we recommend conducting high-quality RCTs studying different intensities. Studies should also include longer follow-up periods in order to investigate the long-term effects of electrophysical modalities for the treatment of epicondylitis.

What are the new findings?

- This study gives an overview of the evidence for effectiveness of electrophysical modalities for lateral and medial epicondylitis including ultrasound, laser, electrotherapy, extracorporeal shock wave therapy, transcutaneous electrical nerve stimulation and pulsed electromagnetic field therapy.
- There is moderate evidence for the effectiveness of ultrasound compared to placebo on mid-term and in favour of ultrasound plus friction massage compared to laser therapy for the short term for treating lateral epicondylitis.
- Moderate evidence was found in favour of laser therapy over plyometric exercises on short-term follow-up to treat lateral epicondylitis.
- Only limited, conflicting evidence for effectiveness or evidence of no difference in effect was found for the other electrophysical modalities.
- Future RCTs should preferably be aimed at different intensities of the modalities and focus on the long-term effects.

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