The Cochrane Library

Electromagnetic therapy for treating venous leg ulcers

Zoriah Aziz , Nicky Cullum

First published:
2 July 2015

Editorial Group:
Cochrane Wounds Group

DOI:
10.1002/14651858.CD002933.pub6 View/save citation

Cited by (CrossRef):
0 articles Check for updates

Abstract

Background

Leg ulceration is a common, chronic, recurring condition. The estimated prevalence of leg ulcers in the UK population is 1.5 to 3 per 1000. Venous ulcers (also called stasis or varicose ulcers) comprise 80% to 85% of all leg ulcers. Electromagnetic therapy (EMT) is sometimes used as a treatment to assist the healing of chronic wounds such as venous leg ulcers.

Objectives

To assess the effects of EMT on the healing of venous leg ulcers.

Search methods

For this fourth update, we searched The Cochrane Wounds Group Specialised Register (searched 30 January 2015); The Cochrane Central Register of Controlled Trials (CENTRAL) (*The Cochrane Library* 2014, Issue 12).

Selection criteria

Randomised controlled trials comparing EMT with sham-EMT or other treatments.

Data collection and analysis

Standard Cochrane Collaboration methods were employed. At least two review authors independently scrutinised search results and obtained full reports of potentially eligible studies for further assessment. We extracted and summarised details of eligible studies using a data extraction sheet, and made attempts to obtain missing data by contacting study authors. A second review author checked data extraction, and we resolved disagreements after discussion between review authors.

Main results

Three randomised controlled trials (RCTs) of low or unclear risk of bias, involving 94 people, were included in the original review; subsequent updates have identified no new trials. All the trials compared the use of EMT with sham-EMT. Meta-analysis of these trials was not possible due to heterogeneity. In the two trials that reported healing rates; one small trial (44 participants) reported that significantly more ulcers healed in the EMT group than the sham-EMT group however this result was not robust to different assumptions about the outcomes of participants who were lost to follow up. The second trial that reported numbers of ulcers healed found no significant difference in healing. The third trial was also small (31 participants) and reported significantly greater reductions in ulcer size in the EMT group however this result may have been influenced by differences in the prognostic profiles of the treatment groups.

Authors' conclusions

It is not clear whether electromagnetic therapy influences the rate of healing of venous leg ulcers. Further research would be needed to answer this question.

Plain language summary

English

Electromagnetic therapy (EMT) for treating venous leg ulcers

Venous leg ulcers (which appear as open sores) can be caused by a blockage or breakdown in the veins of the legs. Compression of the leg, using bandages or hosiery (stockings), can help heal most of these ulcers. Electromagnetic therapy is also sometimes offered. Electromagnetic therapy is not a form of radiation or heat, but uses an electromagnetic field to try to promote healing. This review of clinical trials concluded that

there is no high quality evidence about whether electromagnetic therapy speeds the healing of venous leg ulcers and its effect is unclear.

Background

Description of the condition

A leg ulcer is a common, chronic, recurring condition defined as the "loss of skin below the knee on the leg or foot, which takes more than six weeks to heal" (NHS CRD 1997). The estimated prevalence of leg ulcers within the UK population is 1.5 to 3 per 1000; however, prevalence increases with age, mounting to 20 per 1000 in people over 80 years old (NHS CRD 1997), and is higher amongst women (Callam 1986). Callam 1986 reported that 45% of people with leg ulcers in a Scottish study experienced episodes of ulceration for more than 10 years. Leg ulcers constitute a considerable cost to both the patient (Charles 1995) and the health service (Bosanquet 1992). Indeed, the economic cost of leg ulcers to the National Health Service (NHS) in the UK has been estimated at £400 million a year (Simon 2004). Venous ulcers (also known as stasis or varicose ulcers) constitute 80% to 85% of all leg ulcers (Simon 2004). These are caused by venous insufficiency which has been shown to be associated with increased hydrostatic pressure in the veins of the leg. The application of external compression reverses this and generally leads to the healing of the ulcers (O'Meara 2012). However, a significant proportion of ulcers do not heal with compression therapy and additional treatments are used for this group of people.

Description of the intervention

Recently, there has been an increasing interest in the therapeutic use of electromagnetic fields for various medical conditions, including venous leg ulcers (Markov 2007). Electromagnetic therapy (EMT), also known as electromagnetism, bioelectricity, magneto biology, magnetic healing and magnetic field therapy, uses electromagnetic energy applied to the body to treat various medical conditions, from bone and cartilage repair (Haddad 2007; Ryaby 1998) to pain relief (Shupak 2006; Thomas 2007), wound healing (Kenkre 1996; Stiller 1992), and relatively new applications such as chronic musculoskeletal pain (Thomas 2007). EMT does not use direct electrical effects or radiation, unlike other forms of electrotherapy, but induces a field effect (Stiller 1992). A number of devices have been constructed to deliver either a continuous or a pulsed electromagnetic field (PEMF). PEMFs are produced with an 'on-off' effect of pulsing current to produce field effects, which, it has been suggested, may influence tissue generation and cell proliferation, and thus may be useful for wound healing. The main advantage of PEMF compared with continuous fields is that the short duration of the pulses protects the tissues against potential damage from heat generated by continuous fields (Athanasiou 2007).

How the intervention might work

There are several theories that explain how the PEMF may exert its effect on tissue generation and cell proliferation in wound healing. Lee 1993 suggested that PEMF might facilitate the migration of electrically-charged cells involved in repairing the wound area,

thereby restoring the metabolic conditions of the healing cells. It has also been proposed that PEMF induces a tiny electrical signal on the injured cell membrane, which initiates a series of physiological effects that include an increase in the number of macrophages and fibroblasts present in the wound, a reduction of the inflammation, and an increased deposition of collagen and fibrin, all of which contribute to the healing process (Markoll 2003). Other theories suggest that PEMF is associated with the production of free radicals within cells, which mediate intracellular communication (Gordon 2007). PEMF may exert several biological processes involved in wound healing but the exact mechanism is not clear.

Why it is important to do this review

The lack of response to standard therapies for chronic leg ulcers gives impetus to this review. There are also several anecdotal reports of the beneficial effects of EMT for chronic skin wounds, despite the lack of standardisation of the PEMF devices in terms of type, duration, frequency, intensity and length of exposure. A systematic review to assess the available evidence for EMT on venous leg ulcers is therefore merited.

Objectives

To assess the evidence for the effects of EMT on the healing of venous leg ulcers.

Methods

Criteria for considering studies for this review

Types of studies

Randomised controlled trials (RCTs). There was no restriction on the basis of language, date of trial publication or publication status.

Types of participants

Studies that involved people of any age, and in any care setting, described as having a venous leg ulcer were eligible for inclusion. As the method of diagnosis of venous ulceration differed between the trials, and was not always described, it was not possible to apply a standard definition for diagnosis of venous ulcers.

Types of interventions

Any form of electromagnetic therapy (EMT) for healing of venous ulcers compared with sham-EMT, no EMT or other treatments.

Types of outcome measures

Primary outcomes

- Proportion of ulcers healed within trial period

- Rate of change in ulcer area
- Time to complete healing

Secondary outcomes

- Costs
- Quality of life
- Pain
- Acceptability of treatment
- Adverse effects

Search methods for identification of studies

Electronic searches

The search methods section for the third update of this review can be found in Appendix 1. For this fourth update, we searched the following electronic databases:

- The Cochrane Wounds Group Specialised Register (searched 30 January 2015);
- The Cochrane Central Register of Controlled Trials (CENTRAL) (*The Cochrane Library* 2014, Issue 12);

We used the following search strategy in the Cochrane Central Register of Controlled Trials (CENTRAL):

#1 MeSH descriptor Electromagnetic Phenomena explode all trees
#2 MeSH descriptor Electric Stimulation Therapy explode all trees
#3 (electromagnetic* or electrotherap*):ti,ab,kw
#4 (electric* NEXT current):ti,ab,kw
#5 ((direct or pulsed or alternating) NEXT current):ti,ab,kw
#6 (low NEXT intensity) or (low NEXT frequency):ti,ab,kw
#7 (high NEXT voltage):ti,ab,kw
#8 ("TENS" or "NMES"):ti,ab,kw
#9 (interferential NEXT therap*):ti,ab,kw
#10 (monophasic or galvanic):ti,ab,kw
#11 MeSH descriptor Diathermy explode all trees
#12 MeSH descriptor Microwaves explode all trees
#13 (diatherm* or microwave*):ti,ab,kw
#14 (#1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10 OR #11 OR #12 OR #13)
#15 MeSH descriptor Leg Ulcer explode all trees
#16 (varicose NEXT ulcer*) or (venous NEXT ulcer*) or (leg NEXT ulcer*) or (foot NEXT ulcer*) or (stasis NEXT ulcer*) or ((lower NEXT extremit*) NEAR/2 ulcer*) or (crural NEXT ulcer*) or

"ulcus cruris":ti,ab,kw
#17 (#15 OR #16)
#18 (#14 AND #17)

The search strategies for Ovid MEDLINE, Ovid EMBASE and EBSCO CINAHL can be found in Appendix 2, Appendix 3 and Appendix 4, respectively. We combined the Ovid MEDLINE search with the Cochrane Highly Sensitive Search Strategy for identifying randomised trials in MEDLINE: sensitivity- and precision-maximising version (2008 revision) (**Lefebvre 2011**). We combined the Ovid EMBASE and EBSCO CINAHL searches with the trial filters developed by the Scottish Intercollegiate Guidelines Network (**SIGN 2009**). There were no restrictions on the basis of date or language of publication.

Searching other resources

For this update we did not search any other resources.

Data collection and analysis

Selection of studies

At least two review authors independently scrutinised the search results. We obtained full reports of articles if, from the initial assessment, they appeared to satisfy the inclusion criteria. We resolved disagreements by discussion between review authors.

Data extraction and management

We included data from studies published in duplicate only once. We extracted and summarised details of eligible studies using a data extraction sheet and made attempts to obtain missing data by contacting authors. A second review author checked data extraction. We extracted the following data:

- design of study;
- inclusion and exclusion criteria;
- baseline characteristics (by treatment group);
- intervention details;
- outcome measures used;
- results (by treatment group);
- withdrawals (by treatment group); and
- adverse effects.

Assessment of risk of bias in included studies

For this review two review authors independently assessed each included study using the Cochrane Collaboration tool for assessing risk of bias (**Higgins 2011**). This tool addresses six specific domains, namely sequence generation, allocation concealment, blinding, incomplete

outcome data, selective outcome reporting and other issues (e.g. extreme baseline imbalance) (see Appendix 5 for details of the criteria on which the judgement was based). We assessed blinding and completeness of outcome data for each outcome separately. We completed a 'Risk of bias' table for each eligible study and discussed any disagreement amongst all review authors to achieve a consensus.

We explicitly judged each of these criteria using the following system: 'Yes' (i.e. low risk of bias); 'No' (i.e. high risk of bias); and 'Unclear' (i.e. either lack of information or uncertainty over the potential for bias). We presented an assessment of risk of bias using a 'Risk of bias' summary figure, which shows all the judgements in a cross-tabulation of study by entry (Figure 1; Figure 2).

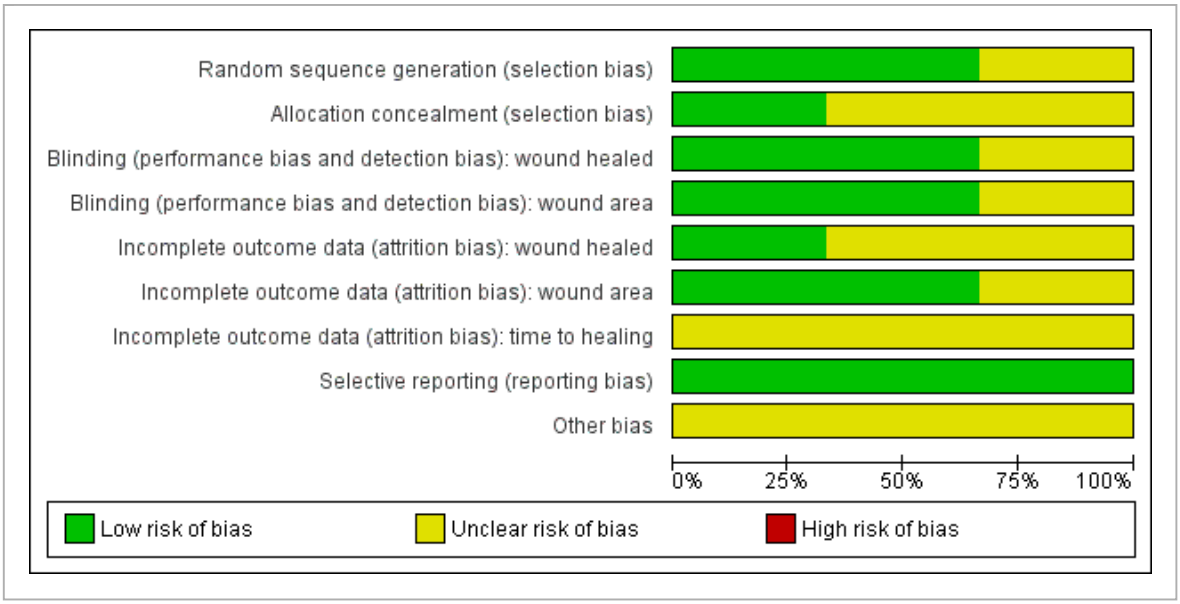

Figure 1.

Open in figure viewer

Methodological quality graph: review authors' judgements about each methodological quality item presented as percentages across all included studies.

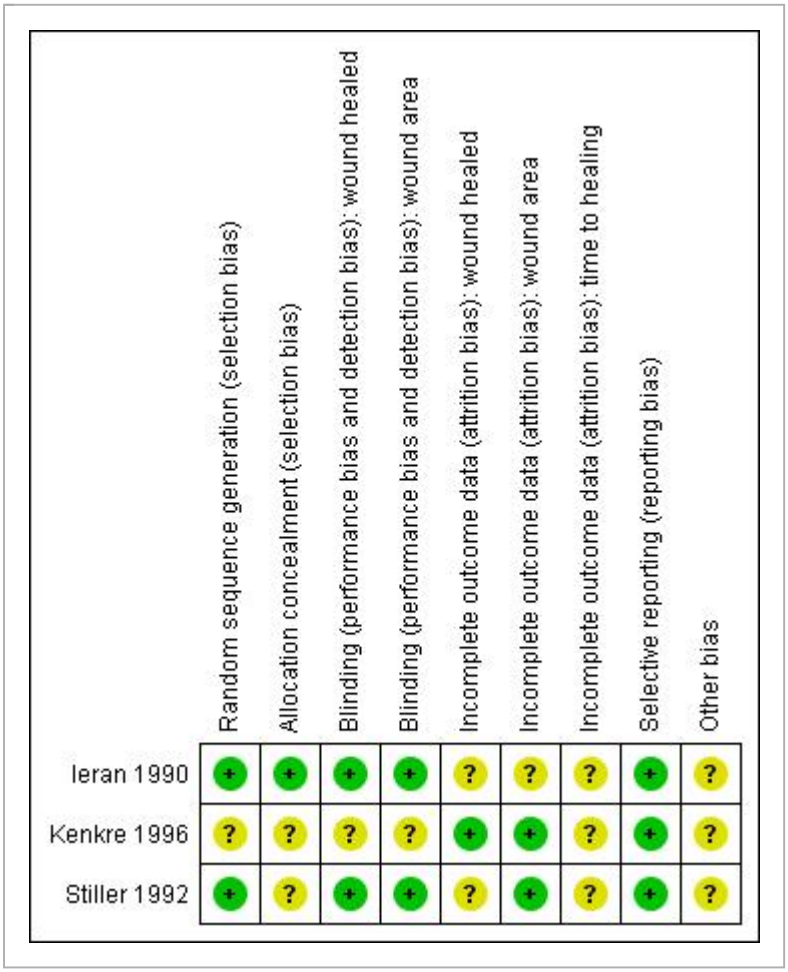

Figure 2.

Open in figure viewer

Methodological quality summary: review authors' judgements about each methodological quality item for each included study.

Data synthesis

We presented all results quantitatively where possible, and in a narrative summary where there were insufficient data. For each trial with dichotomous outcomes (e.g. were ulcers healed? (yes or no)), we calculated a risk ratio (RR) of healing with 95% confidence intervals. Where outcomes for continuous variables were presented without confidence intervals, standard deviations, or some measure of the precision of the result, we entered the data into the Characteristics of included studies and did not use them in data pooling.

Results

Description of studies

For the fourth update of the review we identified no new studies that met the inclusion criteria.

Included studies

We included three studies of EMT in the review (Ieran 1990; Kenkre 1996; Stiller 1992). All studies compared the use of EMT with sham-EMT. They were small, with sample sizes ranging from 19 to 44. All participants were considered to have venous leg ulcers, although none of the studies reported how assessments were conducted.

Ieran 1990 recruited 44 people with venous leg ulcers to a double-blind RCT conducted in Italy. Participants were randomised to receive either EMT (75 Hz, 2.7 mT, with an impulse width 1.3 ms; n = 22) for four hours per day or sham stimulation for the same period of time (n = 22). Patients carried out the stimulation at home. No compression therapy was administered. Oral and local antibiotic therapy was given concomitantly to both groups. The study ran for a three-month period. The outcome measured was the percentage of ulcers healed and the size of wound area at three months.

Kenkre 1996 examined the treatment of venous leg ulcers with EMT in a randomised, controlled, double-blind trial based in a leg ulcer clinic in an urban general practice in Birmingham, UK. Nineteen people were randomly allocated into three arms: the first treatment group received 600 Hz electric field, and 25 mT magnetic field, delivered by an Elmedistraal device (which generates perpendicular electric and magnetic fields). The second group received 600 Hz on days one to five, and 800 Hz on days six to 30 from a 25 mT magnetic field, delivered by an Elmedistraal device, for 30 minutes, five days a week for a total of 30 days followed by four weeks' observation. The control group received sham therapy. All participants had ulcer dressings changed by community staff, although there was no standardisation of dressings. All patients were reported to be receiving compression therapy; the authors reported that only two people received "adequate" compression. The primary outcome was the percentage of ulcers healed and changes in the ulcer area at day 50. Healing was based on clinical assessment scores which assessed changes in wound area.

Stiller 1992 randomised 31 people into a multi-centre, double-blind, sham-controlled trial in the USA. Eighteen people randomised to the active treatment group received the following: pulsed EMT (0.06 mV/cm, with a signal which was a three-part pulse [+, -, +] of 3.5 ms total width and a duty cycle of 25%), delivered by a Pulsed Electromagnetic Limb Ulcer Therapy (PELUT) device for three hours a day, plus standard treatment (ancillary topical treatment). Thirteen people were randomised to receive sham-EMT and standard treatment. The groups were treated over an eight-week period, or until the ulcer healed, whichever came first. Treatment continued for 12 weeks for patients who showed a favourable response at eight weeks. Standard treatment consisted of compression bandaging, leg elevation and the use of one of five named dressings. The outcomes measured were percentage change in wound area, mean decrease in wound depth, percentage change in area of granulation tissue, and percentage of ulcers healed or markedly improved at week eight. Wound healing was based on the investigators' clinical global assessment of the healing status which considered wound area, ulcer depth, appearance of granulation and pain. The percentage of ulcers either healed or showing marked improvement was combined and not presented separately in the study report.

Excluded studies

We excluded two studies, both CCTs, see Excluded studies (Jeran 1987; Todd 1991).

Risk of bias in included studies

Risk of bias in the included studies is summarised in Figure 1 and Figure 2.

Allocation

For sequence generation, two trials clearly reported adequate randomisation (**Ieran 1990**; **Stiller 1992**), in that participants were randomly distributed to the control or experimental group according to a computer-generated code. While we judged risk of bias due to allocation concealment to be low for **Ieran 1990**, it was not clear whether allocation was concealed for **Stiller 1992**. **Kenkre 1996** described their study as randomised, however, the methods of sequence generation, as well as allocation concealment, were unclear.

Blinding

All trials were reported as "double-blind." **Ieran 1990** and **Stiller 1992** described in detail how the active and dummy devices were indistinguishable to patients and investigators; in **Kenkre 1996** there was insufficient information on how the participants and outcome assessors were blinded.

Incomplete outcome data

In judging the risk of bias for incomplete outcome reporting, we considered all primary outcome measures; namely, the proportion of wounds healed, and the reduction in wound size and time to complete healing. We also considered whether an intention-to-treat (ITT) analysis was reported for the primary outcomes and whether missing data were imputed appropriately.

We considered risk of bias due to incomplete outcome data low in **Kenkre 1996** and **Stiller 1992**. No participants were excluded or lost to follow up in **Kenkre 1996**, while **Stiller 1992** imputed missing data based on the last observed values carried forward and made an estimation by linear extrapolation for the wound size outcome; the imputation results based on these two methods were reported to be in agreement with one another. **Ieran 1990** did not conduct an ITT analysis and missing outcome data were slightly more in the EMT group (4/22; 18%) compared to the sham-EMT group (3/22; 14%); risk of bias due to this slight imbalance was thus unclear.

Selective reporting

In judging the risk of bias for selective reporting, we were unable to assess the trial protocols and therefore assessed the studies based on the pre-specified outcome measures reported in the methods section of the trial report. The risk of bias due to selective reporting was considered low for all three trials as all of the pre-specified outcomes were reported.

Other potential sources of bias

Two trials were partly sponsored by the manufacturer of the device (**Kenkre 1996**; **Stiller 1992**). There is evidence that industry-sponsored trials may overestimate the treatment effect (see **Bhandari 2004**).

Effects of interventions

Electromagnetic therapy (EMT) compared with sham therapy

Primary outcomes

Number of wounds healed

We did not pool data from Ieran 1990 and Kenkre 1996 because these trials had different treatment durations. Stiller 1992 did not assess this outcome.

Number of wounds healed at 90 days

Ieran 1990 reported that three people in the sham-EMT group (3/22, 14%) and four in the EMT group (4/22, 18%) were lost to follow up. Therefore, 19 people in the sham group and 18 in the EMT group were included in the complete case analysis. Assessment at 90 days found that 12/18 (67%) ulcers had healed in the EMT group compared with 6/19 (32%) in the sham group (RR 2.11; 95% CI 1.01 to 4.42) (Analysis 1.1). The difference between the groups was marginally statistically significant in favour of EMT (P = 0.05), however, this is a small study which did not conduct an intention-to-treat (ITT) analysis and had missing data in each arm. This study was at low to moderate risk of bias overall as aspects of bias, namely sequence generation, allocation concealment and blinding, were adequately achieved.

To assess the potential impact of loss to follow up on effect estimates in Ieran 1990, we considered two assumptions; the worst-case scenario and the best-case scenario. In the worst-case scenario all the people lost to follow up were regarded as treatment failures (wounds not healed), and in the best-case scenario all the losses to follow up were considered as treatment successes (wounds healed). The significance of the results changed with the two assumptions made. In the worst-case scenario, the difference between the groups was found to be not statistically significant (RR 2.00; 95% CI 0.92 to 4.37) (Analysis 2.1) while in the best-case scenario assumption the difference between the groups was shown to be statistically significant (RR 1.78; 95% CI 1.01 to 3.12) (Analysis 3.1).

Number of wounds healed at 50 days

In Kenkre 1996 there was no loss to follow up. We grouped the two EMT treatment arms together. At day 50, 2/10 (20%) venous ulcers were healed in the EMT group compared with 2/9 (22%) in the sham-EMT group (RR 0.90; 95% CI 0.16 to 5.13). The difference between the groups was not statistically significant (Analysis 4.1). This study was at unclear risk of bias as aspects of bias, namely sequence generation, allocation concealment and blinding, were not clear.

Stiller 1992 reported that at eight weeks, 1/18 (6%) in the EMT group and 3/13 people in the sham-EMT group (23%) were lost to follow up (overall 13%). No ulcers healed in the sham group, while 50% of ulcers either healed or showed marked improvement in the EMT group. This outcome was assessed subjectively and 'marked improvement' was not a pre-specified outcome, therefore these data are not included in the analysis. This study was at unclear risk of bias overall.

Reduction in wound size

The results from the three studies for the continuous outcome (reduction in wound size) could not be pooled. No trials reported any evaluation of the precision of the reduction in wound size (change from baseline). It was also not possible to derive missing data from the statistics provided.

Based on complete case analysis in Stiller 1992, the ulcers in the EMT group were reported to decrease in size by 47% at eight weeks, whilst in the sham-EMT group the ulcers increased in size by 49% over the same time period (P value < 0.0002). For the ITT analysis, the wound area at eight weeks of people who discontinued the study was determined by two methods: either by estimation by linear extrapolation to day 56, or by the use of the last observed wound area in place of the eight-week value. The results based on the last observed values were reported to be similar to those based on the extrapolated eight-week values. The EMT group averaged a 48% decrease in wound surface area compared with a 42% increase seen in the sham-EMT group (P value < 0.0002). The ulcers appeared evenly matched for baseline size though ulcers in the sham group were of longer duration (a prognostic factor for time to heal).

Time to complete healing

Ieran 1990 reported the mean healing time but did not express the intervention effect as a hazard ratio which is the most appropriate way of summarizing time-to-event data. Kenkre 1996 and Stiller 1992 did not report on this outcome.

Secondary outcomes

Cost

Assessment of cost was not undertaken in any of the studies.

Quality of life

Quality of life using a validated scale was not measured in any of the studies. Kenkre 1996, however, assessed the mobility of participants and reported that all groups showed increased mobility at trial end.

Pain

All the studies reported pain as a secondary outcome; however, the results of the studies could not be pooled owing to the different scales used to assess pain. Kenkre 1996 used analogue scales (in mm) and reported that at the end of the study, significant reduction in pain scores was only observed for the EMT groups. The analogue scale used to measure pain in Ieran 1990 was not described. At the end of the study, pain was reported to be lower in both the EMT and sham-EMT groups but the difference between the groups was not significant. Stiller 1992 reported pain intensity on a four-point scale where 0 equated to no pain; 1 to mild pain; 2 to moderate pain; and 3 to severe pain. The reduction in pain score was reported to be significantly more for the EMT group.

Acceptability of treatment

Assessment of acceptability of treatment was not undertaken in any of the studies.

Adverse effects

Adverse effects were not reported in Ieran 1990 or Stiller 1992. Kenkre 1996 reported that 13/19 (68%) participants experienced adverse events. Two participants in the EMT group suffered moderate to severe headaches. Sensations of heat, tingling, and pins and needles in the limb were experienced by people in both groups.

Discussion

Three small trials involving a total of 94 patients were included in this review. Whilst one small trial reported significantly more ulcers healing with electromagnetic therapy (EMT) compared with sham-EM, this result was not robust to different assumptions regarding the outcomes of patients lost to follow up. One other trial did not show an effect in favour of EMT while the third trial did not assess the proportions of ulcers healed.

The extent to which the studies were at risk of bias was variable. Two of the three studies lacked clarity about the method of allocation concealment; there is evidence that inadequate allocation concealment leads to an overestimation of the treatment effect (Schulz 2000). The studies by Kenkre 1996 and Stiller 1992 were at unclear risk of bias overall with the small study by Ieran 1990 at low to moderate risk of bias.

It is important for trials to use more objective measures of treatment success, such as time to complete healing, when assessing interventions in wound trials (Grey 2009). Since the assessment of healing was based on a clinical global assessment in two of the trials, the blinding of the outcome assessor is critical to ensure detection bias has not been introduced. One study was inadequately blinded for investigator-assessed outcomes, even though indistinguishable EMT and sham devices were used (Kenkre 1996).

The methods for handling missing data in the trials varied. Kenkre 1996 did not have any drop-outs. Stiller 1992 imputed missing data using last observation carried forward analysis and estimation by linear extrapolation for wound area, while Ieran 1990 did not carry out ITT analysis. We examined whether the results changed and checked the robustness of the observed findings in Ieran 1990 by performing a worst-case scenario ITT analysis (all the people who dropped out considered as having wounds not healed) and a best-case scenario analysis (all the people who dropped out as having healed ulcers). The results changed with the two assumptions made with the assumption (all loss to follow up as having ulcers healed) showing a significant difference favouring EMT. However, the worst-case scenario assumption is an extreme and in most cases unrealistic assumption (Akl 2009). Nevertheless, our analysis was valuable in demonstrating that the effect estimate in Ieran 1990 did not remain statistically significant under the assumption of a worst-case scenario.

Another concern was that two of the studies were sponsored by the manufacturer of the electromagnetic devices (Kenkre 1996; Stiller 1992), and whilst there is evidence that industry-sponsored trials may overestimate the treatment effect (Bhandari 2004), we were unable to draw any firm conclusions as to whether this has affected the results of these trials.

Authors' conclusions

Implications for practice

At present, there is no high quality evidence that electromagnetic therapy (EMT) speeds the healing of venous leg ulcers.

Implications for research

Methodologically sound and robust RCTs are needed in order to investigate further any effect of using EMT to improve venous leg ulcer healing. When reporting these trials, authors should follow the CONSORT statement for reporting controlled trials (CONSORT 2010) so that the trials can be accurately assessed by readers and reviewers. In addition, the procedures for diagnosing venous leg ulcers and the stage of the wound(s) should be described.

Future studies should explore the effects of EMT as an adjunct to optimum treatment with compression, and also as an option for people who cannot tolerate compression or for whom compression is contraindicated.

Acknowledgements

Hamid Ravaghi and Alireza Olyaee Manesh undertook the first update of this review but were unable to undertake further updates. Kate Flemming contributed to the original review and early updates but is no longer involved with the review.
The authors would also like to thank Sally Bell-Syer and Wendy Milborrow from the Cochrane Wounds Group for their support and assistance during the updating process. In addition the authors would like to acknowledge the contribution of Elizabeth Royle who copy edited the first update of the review and Jenny Bellorini who copy edited the second update.

Data and analyses

Download statistical data

Comparison 1. Electromagnetic therapy versus sham therapy

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Ulcers healed at 90 days (complete case analysis)	1	37	Risk Ratio (M-H, Fixed, 95% CI)	2.11 [1.01, 4.42]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size

Comparison 2. Electromagnetic therapy versus sham therapy

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Ulcers healed at 90 days (per ITT analysis: withdrawals considered as ulcers not healed)	1	44	Risk Ratio (M-H, Fixed, 95% CI)	2.0 [0.92, 4.37]

Comparison 3. Electromagnetic therapy versus sham therapy

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Ulcers healed at 90 days (per ITT analysis: withdrawal considered as ulcers healed)	1	44	Risk Ratio (M-H, Fixed, 95% CI)	1.78 [1.01, 3.12]

Comparison 4. Electromagnetic therapy versus sham therapy

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Ulcers healed at 50 days (ITT analysis)	1	19	Risk Ratio (M-H, Fixed, 95% CI)	0.9 [0.16, 5.13]

Appendices

Appendix 1. Search methods for third update - 2013

Electronic searches

For this third update, we searched the following electronic databases:

The Cochrane Wounds Group Specialised Register (searched 12 November 2012);
The Cochrane Central Register of Controlled Trials (CENTRAL) (*The Cochrane Library* 2012, Issue 10);
Ovid MEDLINE (2011 to November Week 1 2012);
Ovid MEDLINE (In-Process & Other Non-Indexed Citations, November 12, 2012);
Ovid EMBASE (2011 to 2012 Week 45);
EBSCO CINAHL (2011 to 9 November 2012).

We used the following search strategy in the Cochrane Central Register of Controlled Trials (CENTRAL):

#1 MeSH descriptor Electromagnetic Phenomena explode all trees
#2 MeSH descriptor Electric Stimulation Therapy explode all trees
#3 (electromagnetic* or electrotherap*):ti,ab,kw
#4 (electric* NEXT current):ti,ab,kw
#5 ((direct or pulsed or alternating) NEXT current):ti,ab,kw
#6 (low NEXT intensity) or (low NEXT frequency):ti,ab,kw
#7 (high NEXT voltage):ti,ab,kw
#8 ("TENS" or "NMES"):ti,ab,kw
#9 (interferential NEXT therap*):ti,ab,kw
#10 (monophasic or galvanic):ti,ab,kw
#11 MeSH descriptor Diathermy explode all trees
#12 MeSH descriptor Microwaves explode all trees
#13 (diatherm* or microwave*):ti,ab,kw
#14 (#1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10 OR #11 OR #12 OR #13)
#15 MeSH descriptor Leg Ulcer explode all trees
#16 (varicose NEXT ulcer*) or (venous NEXT ulcer*) or (leg NEXT ulcer*) or (foot NEXT ulcer*) or (stasis NEXT ulcer*) or ((lower NEXT extremit*) NEAR/2 ulcer*) or (crural NEXT ulcer*) or "ulcus cruris":ti,ab,kw
#17 (#15 OR #16)
#18 (#14 AND #17)

The search strategies for Ovid MEDLINE, Ovid EMBASE and EBSCO CINAHL can be found in Appendix 2, Appendix 3 and Appendix 4, respectively. We combined the Ovid MEDLINE search with the Cochrane Highly Sensitive Search Strategy for identifying randomised trials in MEDLINE: sensitivity- and precision-maximising version (2008 revision) (**Lefebvre 2011**). We combined the Ovid EMBASE and EBSCO CINAHL searches with the trial filters developed by the Scottish Intercollegiate Guidelines Network (**SIGN 2009**). There were no restrictions on the basis of date or language of publication.

Searching other resources

For the second update, we checked the bibliography of the systematic review by **McGaughey 2009**.

Appendix 2. Ovid MEDLINE search strategy

1 exp Electromagnetic Phenomena/
2 exp Electric Stimulation Therapy/
3 (electromagnetic* or electrotherap*).ti,ab.
4 (electric* adj stimulation).ti,ab.
5 (electric* adj current).ti,ab.
6 ((direct or pulsed or alternating) adj current).ti,ab.
7 (low intensity or low frequency).ti,ab.
8 high voltage.ti,ab.

9 (TENS or NMES).ti,ab.
10 interferential therap*.ti,ab.
11 (monophasic or galvanic).ti,ab.
12 exp Diathermy/
13 exp Microwaves/
14 (diatherm* or microwave*).ti,ab.
15 or/1-14
16 exp Leg Ulcer/
17 (varicose ulcer* or venous ulcer* or leg ulcer* or foot ulcer* or (feet adj ulcer*) or stasis ulcer* or (lower extremit* adj ulcer*) or crural ulcer* or ulcus cruris).ti,ab.
18 or/16-17
19 15 and 18

Appendix 3. Ovid EMBASE search strategy

1 exp Electromagnetic Field/
2 exp Electrostimulation Therapy/
3 (electromagnetic$ or electrotherap$).ti,ab.
4 (electric$ adj stimulation).ti,ab.
5 (electric$ adj current).ti,ab. (1408)
6 ((direct or pulsed or alternating) adj current).ti,ab.
7 (low intensity or low frequency).ti,ab.
8 high voltage.ti,ab.
9 (TENS or NMES).ti,ab.
10 interferential therap$.ti,ab.
11 (monophasic or galvanic).ti,ab.
12 exp Diathermy/
13 exp Microwaves/
14 (diathermy or microwave$).ti,ab.
15 or/1-14
16 exp Leg Ulcer/
17 (varicose ulcer* or venous ulcer* or leg ulcer* or foot ulcer* or (feet adj ulcer*) or stasis ulcer* or (lower extremit* adj ulcer*) or crural ulcer* or ulcus cruris).ti,ab.
18 or/16-17
19 15 and 18

Appendix 4. EBSCO CINAHL Search strategy

S20 S15 and S19
S19 S16 or S17 or S18
S18 lower extremity N3 ulcer* or AB lower extremity N3 ulcer*
S17 TI (varicose ulcer* or venous ulcer* or leg ulcer* or foot ulcer* or (feet N1 ulcer*) or stasis ulcer* or crural ulcer*) or AB (varicose ulcer* or venous ulcer* or leg ulcer* or foot ulcer* or (feet N1 ulcer*) or stasis ulcer* or crural ulcer*)
S16 (MH "Leg Ulcer+")
S15 S1 or S2 or S3 or S4 or S5 or S6 or S7 or S8 or S9 or S10 or S11 or S12 or S13 or S14
S14 TI (diatherm* or microwave*) or AB (diatherm* or microwave*)

S13 (MH "Microwaves")
S12 (MH "Diathermy+")
S11 TI (monophasic or galvanic) or AB (monophasic or galvanic)
S10 TI interferential therap* or AB interferential therap*
S9 TI (TENS or NMES) or AB (TENS or NMES)
S8 TI high voltage or AB high voltage
S7 TI (low intensity or low frequency) or AB (low intensity or low frequency)
S6 TI (direct current or pulsed current or alternating current) or AB (direct current or pulsed current or alternating current)
S5 TI electric* current or AB electric* current
S4 TI electric* stimulation or AB electric* stimulation
S3 TI (electromagnetic* or electrotherap*) or AB (electromagnetic* or electrotherap*)
S2 (MH "Electric Stimulation+")
S1 (MH "Electromagnetics+")

Appendix 5. Risk of bias criteria

1. Was the allocation sequence randomly generated?

Low risk of bias

The investigators describe a random component in the sequence generation process such as: referring to a random number table; using a computer random number generator; coin tossing; shuffling cards or envelopes; throwing dice; drawing of lots.

High risk of bias

The investigators describe a non-random component in the sequence generation process. Usually, the description would involve some systematic, non-random approach, for example: sequence generated by odd or even date of birth; sequence generated by some rule based on date (or day) of admission; sequence generated by some rule based on hospital or clinic record number.

Unclear

Insufficient information about the sequence generation process to permit judgement of low or high risk of bias.

2. Was the treatment allocation adequately concealed?

Low risk of bias

Participants and investigators enrolling participants could not foresee assignment because one of the following, or an equivalent method, was used to conceal allocation: central allocation (including telephone, web-based and pharmacy-controlled randomisation); sequentially-numbered drug containers of identical appearance; sequentially-numbered, opaque, sealed envelopes.

High risk of bias

Participants or investigators enrolling participants could possibly foresee assignments and thus introduce selection bias, such as allocation based on: using an open random allocation schedule (e.g. a list of random numbers); assignment envelopes were used without appropriate safeguards (e.g. if envelopes were unsealed or non opaque or not sequentially numbered); alternation or rotation; date of birth; case record number; any other explicitly unconcealed procedure.

Unclear

Insufficient information to permit judgement of low or high risk of bias. This is usually the case if the method of concealment is not described or not described in sufficient detail to allow a definite judgement, for example if the use of assignment envelopes is described, but it remains unclear whether envelopes were sequentially numbered, opaque and sealed.

3. Blinding - was knowledge of the allocated interventions adequately prevented during the study?

Low risk of bias

Any one of the following.

- No blinding, but the review authors judge that the outcome and the outcome measurement are not likely to be influenced by lack of blinding.
- Blinding of participants and key study personnel ensured, and unlikely that the blinding could have been broken.
- Either participants or some key study personnel were not blinded, but outcome assessment was blinded and the non-blinding of others unlikely to introduce bias.

High risk of bias

Any one of the following.

- No blinding or incomplete blinding, and the outcome or outcome measurement is likely to be influenced by lack of blinding.
- Blinding of key study participants and personnel attempted, but likely that the blinding could have been broken.
- Either participants or some key study personnel were not blinded, and the non-blinding of others likely to introduce bias.

Unclear

Any one of the following.

- Insufficient information to permit judgement of low or high risk of bias.
- The study did not address this outcome.

4. Were incomplete outcome data adequately addressed?

Low risk of bias

Any one of the following.

- No missing outcome data.
- Reasons for missing outcome data unlikely to be related to true outcome (for survival data, censoring unlikely to be introducing bias).
- Missing outcome data balanced in numbers across intervention groups, with similar reasons for missing data across groups.
- For dichotomous outcome data, the proportion of missing outcomes compared with observed event risk not enough to have a clinically relevant impact on the intervention effect estimate.
- For continuous outcome data, plausible effect size (difference in means or standardised difference in means) among missing outcomes not enough to have a clinically relevant impact on observed effect size.
- Missing data have been imputed using appropriate methods.

High risk of bias

Any one of the following.

- Reason for missing outcome data likely to be related to true outcome, with either imbalance in numbers or reasons for missing data across intervention groups.
- For dichotomous outcome data, the proportion of missing outcomes compared with observed event risk enough to induce clinically relevant bias in intervention effect estimate.
- For continuous outcome data, plausible effect size (difference in means or standardised difference in means) among missing outcomes enough to induce clinically relevant bias in observed effect size.
- 'As-treated' analysis done with substantial departure of the intervention received from that assigned at randomisation.
- Potentially inappropriate application of simple imputation.

Unclear

Any one of the following.

- Insufficient reporting of attrition/exclusions to permit judgement of low or high risk of bias (e.g. number randomised not stated, no reasons for missing data provided).
- The study did not address this outcome.

5. Are reports of the study free of suggestion of selective outcome reporting?

Low risk of bias

Any of the following.

- The study protocol is available and all of the study's pre-specified (primary and secondary) outcomes that are of interest in the review have been reported in the pre-specified way.
- The study protocol is not available but it is clear that the published reports include all expected outcomes, including those that were pre-specified (convincing text of this nature may be uncommon)

High risk of bias

Any one of the following.

- Not all of the study's pre-specified primary outcomes have been reported.
- One or more primary outcomes is reported using measurements, analysis methods or subsets of the data (e.g. subscales) that were not pre-specified.
- One or more reported primary outcomes were not pre-specified (unless clear justification for their reporting is provided, such as an unexpected adverse effect).
- One or more outcomes of interest in the review are reported incompletely so that they cannot be entered in a meta-analysis.
- The study report fails to include results for a key outcome that would be expected to have been reported for such a study.

Unclear

Insufficient information to permit judgement of low or high risk of bias. It is likely that the majority of studies will fall into this category.

6. Other sources of potential bias

Low risk of bias

The study appears to be free of other sources of bias.

High risk of bias

There is at least one important risk of bias. For example, the study:

- had a potential source of bias related to the specific study design used; or
- has been claimed to have been fraudulent; or
- had some other problem.

Unclear

There may be a risk of bias, but there is either:

- insufficient information to assess whether an important risk of bias exists; or
- insufficient rationale or evidence that an identified problem will introduce bias.

What's new

Date	Event	Description
30 January 2015	New citation required but conclusions have not changed	New search, no new trials identified
30 January 2015	New search has been performed	Fourth update

History

Protocol first published: Issue 4, 1998
Review first published: Issue 1, 2001

Date	Event	Description
3 January 2013	New search has been performed	Third update, new search, references updated.
3 January 2013	New citation required but conclusions have not changed	No new trials identified.
16 February 2011	New citation required but conclusions have not changed	Authorship of the review changed.
16 February 2011	New search has been performed	Second update: new search, one trial (Jeran 1987) added to table of Characteristics of excluded studies. Risk of bias assessment of included trials completed and the conclusions of the review remain unchanged.
7 August 2009	Amended	Contact details updated.
5 September 2008	Amended	Converted to new review format.

Date	Event	Description
1 January 2006	New citation required but conclusions have not changed	Substantive amendment. For this first update, new searches were carried out in October 2005. No new studies were included. One study was excluded (Todd 1991). The reviewers' conclusions remain unchanged.

Contributions of authors

Nicky Cullum conducted the original review and commented on the final draft of the updates.
Zoriah Aziz undertook the second, third and fourth updates, sifted the search results, undertook the risk of bias assessment and revised the text.

Contributions of editorial base:

Sally Bell-Syer: co-ordinated the editorial process, advised on methodology, interpretation and content, and edited the updated review.
Ruth Foxlee: designed the search strategy for the updated review, ran the searches, and edited the search methods section for the update.
Rocio Lopez: undertook the search for the most recent update.

Declarations of interest

None.

Sources of support

Internal sources

- Department of Health Sciences, University of York, UK.
- School of Nursing, Midwifery and Social Work, University of Manchester, UK.

External sources

- NHS Health Technology Assessment Programme, UK.
- General Nursing Council of England and Wales Trust, UK.
- This project was supported by the National Institute for Health Research, via Cochrane Infrastructure to Cochrane Wounds. The views and opinions expressed therein are those of the authors and do not necessarily reflect those of the Systematic Reviews Programme, NIHR, NHS or the Department of Health), UK.

Differences between protocol and review

For the review update, we added an additional outcome, adverse effects, to Characteristics of included studies. The review authors judged that collecting data on adverse effects was an acceptable post hoc decision.

Characteristics of studies

Characteristics of included studies [ordered by study ID]

Ieran 1990

Methods	RCT, computer-generated schedule in blocks of 4, double-blind
Participants	44 patients with venous ulcers of at least 3 months' duration Baseline data: Mean duration of ulcer: EMT group: 30 months (range 3 to 360 months) Sham-EMT group: 23 months (3 to 240 months) Ulcers > 15 cm^2 (n, mean, SD): EMT group: 4 (34.2 ± 15.5) Sham-EMT group: 7 (39.9 ± 23.9) Ulcers < 15 cm^2 (n, mean, SD): EMT group: 14 (4.8 ± 2.9) Sham-EMT group: 12 (5.0 ± 3.3)
Interventions	EMT group: (n = 22) stimulation of ulcer with single-pulse electric current generating a magnetic field of 2.8 mT, frequency 75 Hz, impulse width 1.3 ms for 3 to 4 h daily for maximum of 90 days, or until ulcer healed Sham-EMT group: (n = 22) sham-EMT with the same duration of treatment as the EMT group above. Patients did not receive compression therapy during the study
Outcomes	Pre-specified outcomes: proportion of complete healing, change in wound area PRIMARY OUTCOMES A. Proportion healed at 90 days (excluding loss to follow up): EMT group: 12/18 (67%) Sham-EMT group: 6/19 (32%) P value < 0.02 B. Reduction in wound size at 90 days (excluding loss to follow up): EMT group: 47% decreased Sham-EMT group: 30% decreased C. Time to healing (mean): EMT group: 76 days Sham-EMT group: 71 days SECONDARY OUTCOMES Pain: reported to be significant at trial end for both groups. However, the

	difference between the 2 groups was not significant. Adverse effects: not reported	
Notes	Stopped use of stimulator by 3 weeks: EMT group: 1 Sham-EMT group: 2 Patient used stimulation discontinuously: EMT group: 1 Sham-EMT group: 1 Allergic reaction to drugs: EMT group: 1 Sham-EMT group: 0 Developed rheumatoid arthritis: EMT group: 1 Sham-EMT group: 0	
Risk of bias		
Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Quote: "patients were randomly distributed to a control group or experimental group according to a computer generated schedule prepared by a biostatistician".
Allocation concealment (selection bias)	Low risk	Quote: "the computer generated a list that assigned equal number of active and control stimulators in blocks of four, two active and two dummy units" “Nobody involved in the study was aware of the experimental condition; codes used to include patients in the control and active groups were opened at the end, when all evaluation had been completed”
Blinding (performance bias and detection bias) wound healed	Low risk	Quote: “Nobody involved in the study was aware of the experimental conditions; codes used to include patients in the control or active group were opened at the end, when all evaluation had been completed.” “Active and dummy stimulators were absolutely indistinguishable from the outside both for their shape and for their weight."
Blinding (performance bias and detection bias) wound area	Low risk	Quote: “Nobody involved in the study was aware of the experimental conditions; codes used to include patients in the control or active group were opened at the end, when all evaluation had been completed.” “Active and dummy stimulators were absolutely indistinguishable from the outside both for their shape and for their weight” "The pictures taken on each visit were shown to 3 different physicians unaware of the experimental conditions"
	Unclear risk	Randomisation: EMT (22); sham-EMT (22) At Day 90: EMT (18); sham-EMT (19)

Incomplete outcome data (attrition bias) wound healed		Comment: missing outcome data slightly more in the EMT group (4/22; 18%) compared to sham-EMT (3/22; 14%) with similar reasons for missing data. Bias due to this slight imbalance was unclear.
Incomplete outcome data (attrition bias) wound area	Unclear risk	Comment: missing outcome data slightly more in the EMT group (4/22; 18%) compared to sham-EMT (3/22; 14%) with similar reasons for missing data. Bias due to this slight imbalance was unclear.
Incomplete outcome data (attrition bias) time to healing	Unclear risk	Comment: missing outcome data slightly more in the EMT group (4/22; 18%) compared to sham-EMT (3/22; 14%) with similar reasons for missing data. Bias due to this slight imbalances was unclear.
Selective reporting (reporting bias)	Low risk	Comment: Pre-specified outcomes were reported

Kenkre 1996

Methods	RCT, allocation by pre-determined codes. Pilot study.
Participants	19 patients with venous leg ulcer, with unsatisfactory healing in last 4 weeks Baseline data: Mean duration of ulcer: EMT group A: 230.4 weeks (range 36 to 728 weeks) EMT group B: 418 weeks (36 to 1368 weeks) Sham-EMT group: 962.6 weeks (160 to 2548 weeks) Mean length of ulcer: EMT group A: 26.6 mm (range 11 to 75 mm) EMT group B: 49 mm (35 to 74 mm) Sham-EMT group: 49.1 mm (26 to 115 mm) Mean ulcer area (measured by weight of sterile acetate sheets covering the wound sites): EMT group A: 63 mg (range 6 to 269 mg) EMT group B: 81 mg (46 to 197 mg) Sham-EMT group: 119 mg (35 to 526 mg) Patients with repeated ulceration: EMT group A: 4 EMT group B: 3 Sham-EMT group: 8
Interventions	EMT group A: (n = 5) 600 Hz electric field, 25 mT magnetic field, delivered by Elmedistraal EMT group B: (n = 5) 600 Hz on days 1 to 5, 800 Hz on days 6 to 30, 25 mT magnetic field, delivered by Elmedistraal, 30-min treatment, 5 days a week for 30 days followed by 4 weeks' observation Sham-EMT group: (n = 9) sham therapy All patients had ulcer dressings changed by community staff. No standardisation of dressings. All patients reported to be receiving

	compression therapy - authors reported that only 2 patients received "adequate" compression.
Outcomes	Pre-specified outcomes: ulcer area, photograph of the leg, appearance of the ulcer and surrounding skin, pain intensity and clinical global assessment PRIMARY OUTCOMES A. No. of ulcers healed at day 50: EMT group A: 1/5 EMT group B: 1/5 Sham-EMT group: 2/9 B. Mean ulcer size (range) at day 50: (measured by weight of sterile acetate sheets covering the wound sites): EMT group A: 103 mg (0 to 394 mg) EMT group B: 30 mg (0 to 100 mg) Sham-EMT group: 78 mg (0 to 373 mg) C. Time to healing (mean): This outcome was not assessed SECONDARY OUTCOMES Pain [reduction of scores from analogue scales in mm (%)]: EMT group A: 43 (72%) EMT group B: 26 (42%) Sham-EMT group: 6 (not significant) Adverse effects: EMT group A: 4 EMT group B: 5 Sham-EMT group: 4
Notes	All patients had ulcer dressings changed by community staff. No standardisation of dressings. All patients reported to be receiving compression therapy - authors reported only 2 patients received "adequate" compression.

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Comment: process of randomisation was not described
Allocation concealment (selection bias)	Unclear risk	Comment: method of concealment was not described
Blinding (performance bias and detection bias) wound healed	Unclear risk	Quote: "...were randomised to treatment by either an active or an indistinguishable placebo machine" Comment: method of blinding the outcome assessor was not described, even though an indistinguishable device was used

Blinding (performance bias and detection bias) wound area	Unclear risk	Comment: method of blinding the outcome assessor was not described, even though an indistinguishable device was used
Incomplete outcome data (attrition bias) wound healed	Low risk	Comment: from the result presented, it was noted that there were no drop-outs
Incomplete outcome data (attrition bias) wound area	Low risk	Comment: from the result presented, it was noted that there were no drop-outs
Incomplete outcome data (attrition bias) time to healing	Unclear risk	Comment: from the result presented, it was noted that there were no drop-outs
Selective reporting (reporting bias)	Low risk	Comment: Pre-specified outcomes were reported
Other bias	Unclear risk	Comments: proportion of healed ulcer was based on clinical global assessment which was not a validated assessment. There was probably a risk of bias in the assessment. Insufficient information to permit judgement for the role played by the sponsor

Stiller 1992

Methods	RCT, computer-generated randomisation based on order of admittance to study
Participants	31 patients with venous leg ulcer. Venous leg ulcer < 7.0 cm diameter; no response to non-surgical treatment in 4 weeks prior to study; ulcer stability (not more than 15% change in diameter, and not more than 15% change in percentage of granulation tissue, in 2 weeks prior to study) Baseline data: Mean ulcer duration [weeks (SD)]: EMT group: 38.9 (5.2) Sham-EMT group: 46.8 (11.3) Mean ulcer area [cm^2 (SD)]: EMT group: 7.25 (1.02) Sham-EMT group: 7.66 (1.62) Mean ulcer depth in cm (SD): EMT group: 0.24 (0.04) Sham-EMT group: 0.26 (0.01)
Interventions	EMT group: (n = 18) pulsed electromagnetic limb ulcer therapy (PELUT) signal - 3 part pulse 3.5 ms total width, duty cycle of 25%, 0.06 mV/cm, polarity (+, -, +), 3 h daily for 8 weeks or until the ulcer healed, plus ancillary topical treatment as described below

	Sham-EMT group: (n = 13) placebo device same duration as above plus ancillary topical treatment All patients received ancillary topical treatment: compression bandage (20 mmHg at ankle level) + leg elevation + dressing
Outcomes	Pre-specified outcomes: wound surface area, wound depth, granulation tissue, clinical global assessment, pain intensity PRIMARY OUTCOMES A. Number of ulcers healed at 8 weeks: This outcome was not assessed B. (i) Percentage change in ulcer size at 8 weeks (complete case analysis): EMT group: 47% decrease Sham-EMT group: 49% increase P value < 0.0002 B (ii) Percentage change in ulcer size at 8 weeks (ITT analysis) EMT group: 48% decrease Sham-EMT group: 42% increase P value < 0.0002 C. Time to healing: This outcome was not assessed SECONDARY OUTCOMES Pain (reduction in intensity at the wound site on a 4-point scale): EMT group: 0.61 Sham-EMT group: 0.15 (P < 0.04) Adverse effects: none reported during the study.
Notes	Withdrawals: EMT group: 1 Sham-EMT group: 3 One could not be contacted; 3 others cited personal reasons not related to adverse events or lack of improvement

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Quote: “Protocol-eligible patients were randomized according to a computer-generated code based on their order of admittance to the study”.
Allocation concealment (selection bias)	Unclear risk	Comment: method of concealment was not described, but each patient was assigned either an active or an indistinguishable placebo device according to the code devised by the study sponsor
Blinding (performance bias	Low risk	Quote: "Each patient was assigned either an active or indistinguishable placebo device according to the code devised by the study sponsor”.

and detection bias) wound healed		"All PELUT devices operated silently with no perceivable thermal, tactile or vibratory sensation. Neither patients nor investigators were able to discern any difference between active and placebo devices."
Blinding (performance bias and detection bias) wound area	Low risk	Quote: "...surface area was calculated using computer image analysis."
Incomplete outcome data (attrition bias) wound healed	Unclear risk	Comment: missing data in both groups
Incomplete outcome data (attrition bias) wound area	Low risk	Comment: missing data have been imputed by 2 appropriate methods. The imputation results based on the 2 methods are in agreement.
Incomplete outcome data (attrition bias) time to healing	Unclear risk	Comment: this outcome was not assessed
Selective reporting (reporting bias)	Low risk	Comment: All the specified outcomes in the method section were reported
Other bias	Unclear risk	Comment: Insufficient information to permit judgement on the role played by the sponsor

< = less than
EMT = electromagnetic therapy
h = hour(s)
Hz = Hertz (unit of frequency)
ITT = intention-to-treat (analysis)
mg = milligram
min = minutes
ms = millisecond
mT= milli Tessla (Tesla = SI unit of magnetic flux density)
n = number in sample group
RCT = randomised controlled trial
[α] **Abbreviations** SD = standard deviation

Characteristics of excluded studies [ordered by study ID]

Study	Reason for exclusion
Jeran 1987	Examination of the full-text paper revealed that the study was a controlled clinical trial (CCT) and not a randomised controlled trial (RCT)

Study	Reason for exclusion
Todd 1991	Examination of the full-text paper revealed that the study was a controlled clinical trial (CCT) and not a randomised controlled trial (RCT)

References

Version History