Rehabilitation for distal radial fractures in adults (Review)

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ABSTRACT

Background
Fracture of the distal radius is a common clinical problem, particularly in older white women with osteoporosis.

Objectives
To examine the effects of rehabilitation interventions in adults with conservatively or surgically treated distal radial fractures.

Search strategy
We searched the Cochrane Bone, Joint and Muscle Trauma Group Specialised Register (December 2005), the Cochrane Central Register of Controlled Trials (*The Cochrane Library* Issue 4, 2005), MEDLINE, EMBASE, CINAHL, AMED, PEDro, OTseeker and other databases, conference proceedings and reference lists of articles. No language restrictions were applied.

Selection criteria
Randomised or quasi-randomised controlled trials evaluating rehabilitation as part of the management of fractures of the distal radius sustained by adults. Rehabilitation interventions such as active and passive mobilisation exercises, and training for activities of daily living, could be used on their own or in combination, and be applied in various ways by various clinicians.

Data collection and analysis
The authors independently selected and reviewed trials. Study authors were contacted for additional information. No data pooling was done.

Main results
Fifteen trials, involving 746 mainly female and older patients, were included. Initial treatment was conservative, involving plaster cast immobilisation, in all but 27 participants whose fractures were fixed surgically. Though some trials were well conducted, others were methodologically compromised.

For interventions started during immobilisation, there was weak evidence of improved hand function for hand therapy in the days after plaster cast removal, with some beneficial effects continuing one month later (one trial). There was weak evidence of improved hand function in the short term, but not in the longer term (three months), for early occupational therapy (one trial), and of a lack of differences in outcome between supervised and unsupervised exercises (one trial).

For interventions started post-immobilisation, there was weak evidence of a lack of clinically significant differences in outcome in patients receiving formal rehabilitation therapy (four trials), passive mobilisation (two trials), ice or pulsed electromagnetic field (one trial), or whirlpool immersion (one trial) compared with no intervention. There was weak evidence of a short-term benefit of continuous passive motion (post external fixation) (one trial), intermittent pneumatic compression (one trial) and ultrasound (one trial). There was weak evidence of better short-term hand function in participants given physiotherapy than in those given instructions for home exercises by a surgeon (one trial).

Authors' conclusions
The available evidence from randomised controlled trials is insufficient to establish the relative effectiveness of the various interventions used in the rehabilitation of adults with fractures of the distal radius.

PLAIN LANGUAGE SUMMARY

Rehabilitation as part of treatment for adults with a broken wrist

Particularly in older women, a broken wrist (comprising a fracture at the lower end of one of the two forearm bones) can result from a fall onto an outstretched hand. Treatment usually includes putting the bone fragments back in place, if badly displaced, and immobilising the wrist in a plaster cast. Exercises and other physical interventions are used to help restore function and speed up recovery.

The 15 randomised controlled trials included in this review tested 13 comparisons in a total of 746 mainly female and older people. Initial treatment was plaster cast immobilisation in all but 27 participants who had surgery. Some trials were well conducted but others were methodologically compromised and none provided conclusive evidence.

There was weak evidence that rehabilitation (hand therapy or task-orientated therapy) started during immobilisation improved hand function after plaster cast removal but not in the longer term (two trials). There was weak evidence that outcome after supervised exercises started during immobilisation did not differ from outcome after unsupervised exercises (one trial).

The rest of the interventions under test were started post-immobilisation, mainly after removal of the plaster cast. There was weak evidence indicating that formal rehabilitation therapy (four trials), passive mobilisation of the wrist joint complex by the therapist while the patient remained inactive (two trials), ice or pulsed electromagnetic field (one trial), or whirlpool immersion of the injured forearm (one trial) did not improve outcome. There was weak evidence of a short-term benefit of using a continuous passive motion device (after external fixation) (one trial), intermittent pneumatic compression (one trial) and ultrasound (one trial). There was weak evidence of better short-term hand function in participants given physiotherapy than in those given instructions for home exercises by a surgeon (one trial).

We concluded that there was not enough evidence available to determine the best form of rehabilitation for people with wrist fractures.

BACKGROUND

Fracture of the distal radius is one of the most common fractures in many predominantly white and older populations (Sahlin 1990; Singer 1998). It has been estimated that a 50 year old white woman in the USA or Northern Europe has a 15% lifetime risk of a distal radius fracture; whereas a white man of the same age has a lifetime risk of a little over 2% (Cummings 1985). A recent prospective survey, conducted in six centres in the UK, of Colles' fracture in patients aged 35 years and above, reported the overall annual incidence of this fracture to be 9/10,000 in men and 37/10,000 in women (O'Neill 2001). Distal radial fractures are usually treated on an outpatient basis, with around 20% of patients (mainly older people) requiring hospital admission (Cummings 1985; O'Neill 2001).

Most fractures of the distal radius in older people result from low-energy trauma, such as a fall from standing height or less. In younger adults, these injuries are usually sustained through high-energy trauma, such as a traffic accident. The pattern of incidence reflects the bone loss from osteoporosis in older people as well as an increased number of falls by older women (Nguyen 2001).

These fractures are generally closed and usually involve displacement of fracture fragments. They may be either extra-articular (leaving the articular or joint surface of the distal radius intact) or intra-articular (the articular or joint surface is disrupted). Numerous classifications have been devised to define and group different fracture patterns (Chitnavis 1999). Simple classifications based on clinical appearance, and often named after those who described them, remain in common use. In particular, "Colles' fracture" is still the terminology used for a fracture in which there is an obvious and typical clinical deformity (commonly referred to as a 'dinner fork' deformity) of dorsal displacement, dorsal angulation, dorsal comminution (fragmentation), and radial shortening.

The majority of distal radial fractures are treated conservatively (non-operatively). This usually involves the reduction of the fracture if displaced, and forearm immobilisation in a plaster cast or brace for around six weeks. Operative treatment usually involves either closed or open reduction followed by external or internal fixation and a similar period of immobilisation. The variety of 'definitive' treatment options is shown in two separate Cochrane reviews of conservative (Handoll 2003a) and surgical management of these fractures (Handoll 2003b).

These injuries can result in increased morbidity, with long-term functional impairment, pain and deformity (Handoll 2003a; Handoll 2003b). They are also associated with a high incidence and variety of complications; for example, serious complications, such as persistent neuropathies of the median, ulnar or radial nerves, have been reported in one in three patients (Cooney 1980). One major complication is reflex sympathetic dystrophy (RSD), also referred to as algodystrophy, Sudeck's atrophy, complex regional pain syndrome and shoulder-hand syndrome. Serious cases of RSD require many months of therapy to alleviate symptoms (pain, tenderness,

impairment of joint mobility, swelling, dystrophy, vasomotor instability) (Atkins 1996).

Rehabilitation refers to the overall process of helping people to make the best possible recovery from their injury. The issues surrounding the rehabilitation of patients with a distal radial fracture can be expressed in terms of four basic questions:

- What sort of intervention(s) should be used?
- Who should provide them?
- When and for how long?
- Why?

A variety of interventions are available for use. Advice, patient education and supervision for active and passive mobilisation exercises, continuous passive motion, strengthening exercises, supportive splints, physical methods of pain management such as transcutaneous electrical nerve stimulation (TENS), heat treatment, massage, wound care, manual aids and occupational/home assessment are some of the more common therapeutic methods used to maximise the patient's functional recovery (Collins 1993). A small selection of these, commonly advice and mobility exercises, may be employed on a general basis for all patients. Usually though, interventions are selected and adapted by clinicians to meet the specific rehabilitation challenges presented by individual patients. Specific rehabilitation programmes of usually physical interventions (primarily exercises) based on a standardised protocol may also be applied; but, because it is not always possible to standardise to the last detail, some flexibility is common. Although drugs may be prescribed, for instance for pain relief, these are not reviewed here.

As well as the doctors, commonly orthopaedic surgeons, providing the 'definitive treatment', other clinicians are often involved in the rehabilitation of patients with these injuries. These other clinicians may be physiotherapists, occupational therapists or nurses, many of whom are specialised in hand and/or upper limb therapy. The distinctions between the activities and roles of these clinicians often overlap and also vary geographically. Generally physiotherapists aim to restore or achieve optimal movement and physical function of the patient. Occupational therapists share this aim but focus on helping patients to achieve independence in activities of daily living. Nurses often play a varied role, including that of rehabilitation, but plaster cast management and care of surgical wounds would be typical activities. These latter activities are viewed as part of definitive treatment for the purposes of this review.

The issue of when to commence rehabilitation is controversial. Rehabilitation could start as soon as possible after injury and continue throughout, or rehabilitation could be seen as a subsequent stage in patient management and undertaken after the definitive treatment is over. Therefore, the two key phases for management of these injuries are during definitive treatment, usually involving immobilisation, and post-immobilisation (after plaster cast or external fixator removal). Upon receiving initial treatment, for example fracture reduction and application of a plaster cast, patients are usually given instructions to carry out straightforward exercises. These typically include elevation of the injured arm in the first few days post-injury and exercising of the non-immobilised joints in order to alleviate and/or counter swelling and stiffness. More extensive and intensive rehabilitation intervention is more frequent post-immobilisation, where limited range and quality of movement, reduced grip strength, and pain are typical reasons for initiating rehabilitation interventions.

The 'why' question mainly concerns the clinical indication for the intervention(s). Our main focus is on studying the effects of rehabilitation interventions on preventing complications associated with the fracture and/or treatment and on optimising functional recovery and achievement of activities required for daily living. Rehabilitation interventions may also be prescribed to treat complications, such as RSD, of these fractures. We acknowledge the difficulties in distinguishing the two situations since there will be overlap but, given our main aim, we noted the reasons for starting or providing the interventions in individual trials. The aims, including intended trial populations, and primary outcome(s) of individual trials helped us to distinguish between those trials evaluating interventions to resolve or prevent 'problems' and those investigating treatment options for complications. The latter were not included in this review. Similarly excluded were trials primarily investigating interventions for pain relief, acceleration of bone healing, osteoporosis or secondary prevention of fractures.

This review aimed to determine the effectiveness of rehabilitation intervention(s) for adults with conservatively or surgically treated distal radial fractures. Rehabilitation may take the form of an overall package of care or a single intervention, such as passive mobilisation. We intended to examine the methods of providing rehabilitation, including who provided the care and its timing.

OBJECTIVES

We aimed to examine the evidence from randomised controlled trials for the effects (benefits and harms) of rehabilitation interventions in adults with conservatively or surgically treated distal radial fractures.

The following specific objectives were defined *a priori.*

(1) To compare the provision of rehabilitation intervention (of any kind) versus no intervention.

The rehabilitation intervention could be multi-component or involve a single modality (e.g. advice for home exercises) and, whilst available to all patients allocated the rehabilitation intervention, its application (use of specific modalities, extent) may vary according to the perceived needs of individual patients.

(2) To compare any type of rehabilitation intervention versus any other type of rehabilitation intervention.

This covers comparisons of different rehabilitation interventions, either in different combinations of rehabilitation modalities or different single modalities. We considered the examination of variation in single modalities to be optional and that the inclusion of trials of any such comparisons was likely to be deferred until the use of the modality had been evaluated.

(3) To compare any method (context) of delivering or providing rehabilitation interventions versus any other method of delivering or providing rehabilitation interventions.

This includes comparisons of supervised therapy versus home exercises, different methods of supervised therapy (e.g. individual versus group instruction), and the frequency and duration of rehabilitation (where rehabilitation is provided to all participants). It also includes comparisons of rehabilitation intervention when delivered by individual professionals with different levels or backgrounds of expertise or training. In the first instance, the various professions were grouped into four categories: doctors; physiotherapists or occupational therapists; hand or upper limb clinical specialists but not doctors; and others (e.g. nurses).

For each of these three comparisons we set up separate comparisons according to whether the rehabilitation intervention was provided during immobilisation or post-immobilisation.

CRITERIA FOR CONSIDERING STUDIES FOR THIS REVIEW

Types of studies

We considered any randomised or quasi-randomised (method of allocating participants to a treatment that is not strictly random e.g. by date of birth, hospital record number and alternation) clinical trials of rehabilitation interventions for adults with distal radial fractures.

Types of participants

Patients of either sex who have completed skeletal growth and who are receiving treatment for a fracture of the distal radius.

The characteristics of the participants included in the trials were noted, particularly age, gender, employment, type of fracture (especially whether intra-articular or extra-articular), type of treatment, functional and mental status, and co-morbidities. We stipulated beforehand that trials evaluating treatment only for patients with established complications, such as wound infection and RSD, would be excluded; but not those where the clinical indication could be regarded as a 'problem' which may or may not lead to a complication.

Types of intervention

All randomised controlled trials evaluating rehabilitation as part of the conservative or operative treatment of fractures of the distal radius. Examples of rehabilitation interventions are active (under control of the patient) and passive (usually performed by the therapist while the patient remains 'passive') mobilisation exercises, continuous passive motion devices, strengthening exercises, heat treatment, massage, provision of manual aids, occupational and home assessment, advice and patient education. These may be used in combination or individually, and applied in various ways, by various clinicians.

We proposed in our protocol to exclude trials comparing different techniques, timing (duration, frequency) and intensity of single rehabilitation modalities until the effectiveness of the modality itself had been examined. The one trial identified in this category (Coyle 1998) was excluded for other reasons.

We stipulated beforehand that all drug trials and trials specifically aimed at analgesia, acceleration of fracture healing, treatment of osteoporosis and secondary prevention of injuries would be excluded. Also excluded were trials evaluating the duration of immobilisation or limited mobilisation through dynamic external fixation; these are covered in other reviews (Handoll 2003a; Handoll 2003b).

Types of outcome measures

(1) Functional outcomes (including impairment):
Range of movement (digits, wrist, forearm, elbow and shoulder mobility), pain, grip strength, activities of daily living including return to previous employment. Also included are patient functional assessment instruments such as Short Form-36 (SF-36), the Disability of the Arm, Shoulder and Hand questionnaire (DASH) and the Patient-Rated Wrist Evaluation (PRWE) (MacDermid 2000).

Some people have questioned the inclusion of some of the measures listed in this category. We acknowledge that range of motion, grip strength and pain might be classed as measures of impairment and might moreover be considered to be clinical outcomes rather than functional ones. We nonetheless retain these in the functional outcome category for consistency with the literature on these fractures.

(2) Clinical outcomes:
Residual soft tissue swelling, early and late complications including reflex sympathetic dystrophy (RSD).

(3) Resources:
Number of outpatient attendances, clinician consultations and other costs.

(4) Others:
Malunion, cosmetic appearance, compliance and patient satisfaction.

SEARCH METHODS FOR IDENTIFICATION OF STUDIES

See: Cochrane Bone, Joint and Muscle Trauma Group methods used in reviews.

Electronic searches

We searched the Cochrane Bone, Joint and Muscle Trauma Group Specialised Register (December 2005), the Cochrane Central Register of Controlled Trials (*The Cochrane Library* Issue 4, 2005), MEDLINE (1966 to November week 3 2005), EMBASE (1988 to 2005 week 49), CINAHL (1982 to December week 1 2005), AMED (Allied and Complementary Medicine) (1985 to December 2005), LILACS - the Latin American and Caribbean Health Sciences Database (www.bireme.br/bvs/I/ibd.htm using the 'Clinical Trials in LILACS' link (accessed 2 December 2005), PEDro - Physiotherapy Evidence Database (www.pedro.fhs.usyd.edu.au/index.html accessed 2 December 2005), OTseeker - The Occupational Therapy Systematic Evaluation of Evidence Database (www.otseeker.com accessed 2 December 2005), the Cochrane Rehabilitation and Related Therapies Field database (September 2001), and reference lists of articles. No language restrictions were applied.

The search strategies for the current (Wiley InterScience and Wiley CD-ROM) and previous (Update Software) interfaces of *The Cochrane Library* are shown in Table 01.

In MEDLINE (OVID-WEB) the following search strategy was combined with all three sections of the optimal MEDLINE search strategy for randomised trials (Higgins 2005a).
1. exp Radius Fractures/
2. Wrist Injuries/
3. (((distal adj3 (radius or radial)) or wrist or colles or smith$2) adj3 fracture$).ti,ab.
4. or/1-3

Similar search strategies used for CINAHL (OVID-WEB) and EMBASE (OVID-WEB) are shown in Table 02.

We also searched Current Controlled Trials at www.controlled-trials.com (accessed June 2005) and the UK National Research Register at www.update-software.com/national/ (up to Issue 4, 2005) for ongoing and recently completed trials.

Other sources

We handsearched the Journal of Bone and Joint Surgery (British Volume) supplements (1996 onwards), Orthopaedic Transactions, various supplements of Acta Orthopaedica Scandinavica, final programmes of SICOT (1996 & 1999) and SICOT/SIROT (2003), and the British Orthopaedic Association Congress (2000, 2001, 2002 and 2003). We also searched the abstracts of the American Society for Surgery of the Hand annual meetings (2000 to 2005: www.assh.org), the American Orthopaedic Trauma Association annual meetings (1996 to 2004: www.ota.org/education/amabstracts.htm), American Academy of Orthopaedic Surgeons annual meeting (2004 and 2005: www.aaos.org/wordhtml/libscip.htm).

We also scrutinised weekly downloads from AMEDEO (http://www.amedeo.com) of "Fracture" articles in new issues of 17 journals (Acta Orthop Scand; Am J Orthop; Arch Orthop Trauma Surg; Clin J Sport Med; Clin Orthop; Emerg Med Clin North Am; Foot Ankle Int; Injury; J Accid Emerg Med; J Am Acad Orthop Surg; J Arthroplasty; J Bone Joint Surg Am; J Bone Joint Surg Br; J Foot Ankle Surg; J Orthop Trauma; J Trauma; Orthopedics) and of "Rehabilitation Medicine" articles in new issues of 10 journals (Am J Phys Med Rehabil; Arch Phys Med Rehabil; BMJ; Clin Rehabil; J Rehabil Med; J Am Geriatr Soc; JAMA; Lancet; Phys There; Scand J Rehabil Med).

METHODS OF THE REVIEW

All three review authors assessed potentially eligible trials for inclusion. Any disagreement was resolved through discussion. Titles of journals, names of authors or supporting institutions were not masked at any stage. All three authors independently assessed the methodological quality of included studies and any disagreement was resolved by discussion. In the first version of the review, two authors (HH and TH) extracted data and any discrepancies were resolved through discussion by the three authors. In subsequent versions, all three authors performed independent data extraction.

We contacted all trialists for additional details of trial methodology and results.

Quality assessment

A modification of the Cochrane Bone, Joint and Muscle Group quality assessment tool (*see* Group details) was used in the evaluation of the included studies. The scoring scheme for 12 aspects of trial validity, plus brief notes of coding guidelines for some items, is shown in Table 03. From the third update (Issue 3, 2006) of the review, the scores of the individual items were no longer summed.

Data analysis

Where available and appropriate, we presented quantitative data, both dichotomous and continuous, for outcomes listed in the inclusion criteria. Relative risks and 95% confidence intervals were calculated for dichotomous outcomes, and mean differences and 95% confidence intervals calculated for continuous outcomes. We stipulated beforehand that results of comparable groups of trials would be pooled using the fixed-effect model and 95% confidence intervals. Furthermore, heterogeneity between comparable trials would be tested using a standard chi-squared test and considered to be statistically significant at $P < 0.10$; and we would inspect the I^2 statistic (Higgins 2003). Where there was significant heterogeneity between the results of individual trials, and when considered appropriate, the results of the random-effects model were to be

viewed and presented instead of those from the fixed-effect model. However, data pooling was only possible in one case but was abandoned given the clear heterogeneity in the results of the two trials involved.

Generally, the results were presented for the final follow-up time for which they were available. However, limited interim results have been presented from some trials. (We were mindful of the intention stated in our protocol that we would note interim results where a marked and important difference in the timing of recovery has occurred.)

While not yet possible, we planned, wherever possible, to analyse separately the results from surgically treated patients to those from patients receiving non-surgical treatment. Planned subgroup analyses, as described below, were also not possible.

Subgroup analysis

We planned subgroup analyses by age (younger adults, older adults), gender, employment status, type of fracture (primarily extra-articular versus intra-articular fractures), co-morbidities, and prior functional and mental status. To test whether the subgroups were statistically significantly different from one another we planned to test the interaction using the technique outlined by Altman 2003 both here and in the sensitivity analyses described below.

Sensitivity analysis

We planned sensitivity analyses examining various aspects of trial and review methodology, including the effects of missing data, study quality (specifically allocation concealment and outcome assessor blinding), and inclusion of trials only reported in abstracts.

DESCRIPTION OF STUDIES

In this substantive update, we identified six new studies and one full report of a trial (Maciel 2005) formerly listed as an ongoing study. Of these, three studies (Cheing 2005; Cooper 2001; Maciel 2005) were included, three studies (Haren 2004; Rodrick 2004; Zwang 2005) were excluded and one (Duvoric 2005) awaits assessment, pending acquisition of a paper copy and translation. We excluded one study (Schwartz-Jensen 2002) previously in 'Studies awaiting assessment' because we were unable to locate a source to contact for the information required for trial inclusion.

Of 33 eligible studies, 15 are included and 14 are excluded for reasons given in the 'Characteristics of excluded studies' table. Three others are listed as ongoing studies, although one has yet to begin (Kay 2003) and two are completed awaiting publication (McPhate 1998; Woodbridge 2003). Further information is required to process the final study (Duvoric 2005).

Most of the included studies were fully reported in medical journals. Reports of two trials (Bache 2001; Rozencwaig 1996) are only available as abstracts; although one (Bache 2001) has been prepared for journal publication (September 2001). The full report of one trial (Cooper 2001) is only available as a Master's thesis. We received additional information from the trialists of 10 trials, including an interim draft for Bache 2001. The trials were initially identified in the following ways: Cochrane Bone, Joint and Muscle Trauma Group Specialised Register (1); Cochrane Central Register of Controlled Trials (2), MEDLINE (3); CINAHL (1); PEDro (1); National Research Register (1); bibliography checking (1); handsearching (3); AMEDEO (1); and personal contact (1).

The periods over which individual trials were conducted spanned about three decades from the early 1970s (Pasila 1974) onwards. Although the provision of care took place in several local locations for some trials, all were co-ordinated from single centres within one of seven countries (Australia (4 trials), Canada (1 trial), Denmark (3 trials), Finland (1 trial), Hong Kong (1 trial), UK (4 trials), USA (1 trial)). Translations were obtained for the two trials in Danish (Gronlund 1990; Svensson 1993).

The 15 included studies recruited a total of 746, mainly female and older, patients. Aside from Rozencwaig 1996, which provided no information on gender or age, all trials recruited more female than male participants; the proportion of females ranging from 58% (Basso 1998) to 100% (Svensson 1993). Where provided, median or mean ages of trial populations ranged between 53 years (Kay 2000) and 76 years (Watt 2000). The youngest participant (15 years) appeared in Basso 1998 and the oldest (93 years) in Gronlund 1990. Lower age limits were set by nine trials (Bache 2001: 50 years; Basso 1998: 15 years; Cooper 2001: 16 years; Gronlund 1990: 45 years; Maciel 2005: 18 years; Pasila 1974: 16 years; Svensson 1993: 55 years; Taylor 1994: 35 years; Wakefield 2000: 55 years). An upper limit of 65 years was applied in Pasila 1974.

Fracture type was broadly defined as either distal radial fracture in seven trials or Colles' fracture in the other eight trials. The majority of participants were initially treated conservatively, involving plaster cast immobilisation. Exceptions were 13 participants in Kay 2000 and seven participants in both Maciel 2005 and Rozencwaig 1996 whose fractures were surgically fixed.

Further details of the individual studies are provided in the 'Characteristics of included studies' table.

All trials had two intervention groups with the exception of Cheing 2005, which had four intervention groups. Table 04 presents a summary of the rehabilitation interventions, the care providers, when the interventions were started, where they were provided and for how long. Comments mainly describing treatment provided to all trial or all control group participants of individual trials are also given. The following summary presents the trials according to the comparisons implied in the review objectives, split by the timing of the intervention.

Comparisons

(1) Rehabilitation intervention versus no intervention

Thirteen trials fell into this category, two of which (Cooper 2001; Gronlund 1990) started during the definitive treatment period. Six trials (Bache 2001; Christensen 2001; Cooper 2001; Gronlund 1990; Maciel 2005; Wakefield 2000) evaluated a multi-component intervention, whereas the other seven (Basso 1998; Cheing 2005; Kay 2000; Rozencwaig 1996; Svensson 1993; Taylor 1994; Toomey 1986) examined single interventions. Cheing 2005 also examined the combined effect of two single interventions.

(1a) Rehabilitation started during the definitive treatment period

Cooper 2001 compared "early therapeutic intervention", with weekly contact with a member of the hand therapy team, started within four days of injury and plaster cast application versus no intervention in 17 people. All participants received instructions for home exercises during plaster cast immobilisation and an individualised home programme of exercises post immobilisation with a criteria-based offer to attend a hand therapy group. Gronlund 1990 compared the provision of "occupational therapy" one to three days after the application of a plaster cast to no provision in 40 participants. All participants received instructions for exercises and other information after their initial treatment and, if judged necessary, were referred to occupational therapy after the plaster cast removal.

(1b) Rehabilitation started post-immobilisation

Four trials evaluated the provision of routine therapy following plaster cast removal. Christensen 2001 compared the provision of around twice weekly "occupational therapy", until the therapist perceived a lack of progress, with no provision in 32 participants. All participants received instructions from an occupational therapist for exercises to be performed on a thrice-daily basis at home. Bache 2001 and Wakefield 2000 compared the provision of routine physiotherapy with no provision in 98 and 96 participants respectively. The content of the physiotherapy was at the discretion of the physiotherapist in both trials; however, there was restriction to a set of agreed modalities in Bache 2001. All participants received instructions for home exercises from a physiotherapist within one week of plaster removal in Bache 2001, and at the fracture clinic on the same day as plaster cast removal in Wakefield 2000. Maciel 2005 compared the regular attendance of "activity-focussed" physiotherapy for up to six weeks with the option of a single advice session from a physiotherapist solely to clarify home exercises in 41 of the 45 people recruited into the trial. All participants of Maciel 2005 were taught home exercises and received information from a physiotherapist on the day of cast removal.

Rozencwaig 1996 investigated the addition of continuous passive motion to occupational therapy versus occupational therapy alone following external fixation in seven participants.

Cheing 2005 tested the application of pulsed electromagnetic field (PEMF) or ice, or both for 30 minute sessions over five consecutive days in 83 participants. The four intervention groups were: PEMF plus ice pack; sham PEMF plus ice pack; PEMF; sham PEMF. All participants received a "standard" home exercise programme.

Two studies evaluated passive mobilisation given post-immobilisation by experienced physiotherapists. Kay 2000 compared a six week course of passive mobilisation with no passive mobilisation in 40 participants, 13 of whom had been initially treated with pins and plaster. All participants received initial physiotherapy including advice and instructions for home exercises and were monitored for progression with correction if necessary. Taylor 1994 compared five minutes of passive mobilisation with soft-tissue massage (sham treatment) within twice weekly treatment sessions at the physiotherapy department in 30 participants. All participants received advice and instruction for home exercises.

Svensson 1993 evaluated 20 minutes of intermittent pneumatic compression before each of nine sessions of occupational therapy; these were started around 25 days following plaster cast removal in 43 participants who had been referred to the rheumatological department.

Basso 1998 compared the active versus sham application of low frequency, long-wave ultrasound to the back of the affected wrist for five minutes following plaster cast removal in 38 participants. All participants were given instructions to move their hand as much as possible. Physiotherapy was provided only if "hand function was poor".

Toomey 1986 compared forearm immersion in a whirlpool with the wrapping of the forearm in two towels during the first 15 minutes of 12 sessions of physiotherapy, scheduled over six weeks following plaster cast removal, in at least 24 participants. In this review, participants treated with two towels are considered as a no intervention or control group.

(2) One rehabilitation intervention versus another rehabilitation intervention

(2a) Rehabilitation started during the definitive treatment period

No trial was available.

(2b) Rehabilitation started post-immobilisation

Watt 2000 compared the routine referral for physiotherapy with the provision by an orthopaedic surgeon or registrar of a home exercise sheet and simple home instructions at an outpatient clinic following plaster cast removal in 18 participants. The content of the physiotherapy was at the discretion of the therapist but always included active exercises, instructions for a home exercise programme and advice; passive joint mobilisation was used in 47% of the treatments.

One of the comparisons undertaken in Cheing 2005 was that of pulsed electromagnetic field treatment versus ice in 44 participants. All participants received a home exercise programme.

(3) Different methods (contexts) of delivering or providing various rehabilitation interventions

(3a) Rehabilitation started during the definitive treatment period

Pasila 1974 compared supervised therapy at the physical medicine department with home exercises; both were started after initial treatment in 135 participants. The same oral and written instructions for exercising non-involved joints were provided to participants by a physiotherapist in the supervised group, and the surgeon or physician in the control group. No other physiotherapy was carried out.

(3b) Rehabilitation started post-immobilisation

No trial was available.

METHODOLOGICAL QUALITY

The methodological quality scores based on trial reports were generally encouraging and often enhanced on the receipt of additional information from trialists. Lack of blinding of participants and providers, often unavoidable here, and short-term follow up were frequently the reasons for lower quality scores. A summary of the individual aspects of trial quality follows a table of the scores for individual trials in the text below. Information specific to the first three items of the quality score is given in the methods section of the 'Characteristics of included studies' table.

Quality scores

1 2 3 4 5 6 7 8 9 10 11 12 Study ID
1 1 1 3 0 0 3 3 1 3 3 0 Bache 2001
0 3 3 0 3 3 1 3 1 3 1 0 Basso 1998
1 3 0 3 3 0 3 3 3 3 1 0 Cheing 2005
3 1 3 3 0 0 3 1 1 1 1 1 Christensen 2001
3 3 0 1 0 0 1 3 3 3 3 0 Cooper 2001
3 1 1 1 0 0 1 3 1 3 1 0 Gronlund 1990
3 3 3 3 0 0 3 3 3 3 3 0 Kay 2000
3 1 3 1 0 0 1 3 3 3 3 1 Maciel 2005
1 0 0 0 0 0 3 1 1 3 1 0 Pasila 1974
0 3 0 0 0 0 0 1 1 0 0 0 Rozencwaig 1996
1 1 0 1 0 0 3 3 3 3 1 0 Svensson 1993
0 3 0 1 1 0 3 3 3 3 1 0 Taylor 1994
1 0 3 3 0 0 3 3 3 3 1 0 Toomey 1986
3 1 3 3 0 0 3 3 0 3 3 1 Wakefield 2000
3 1 3 3 0 0 1 1 1 1 3 0 Watt 2000

Allocation concealment (item 1) was confirmed or considered as secure in seven trials (Christensen 2001; Cooper 2001; Gronlund 1990; Kay 2000; Maciel 2005; Wakefield 2000; Watt 2000). Some, probably small, potential for disclosure of allocation was considered for two trials (Bache 2001; Svensson 1993), both using sealed envelopes. Allocation concealment was less likely but still possible in Cheing 2005 which used a non-replacement drawing of lots method. Neither Pasila 1974 nor Toomey 1986 provided any information on their method of randomisation. Allocation concealment was considered unlikely in Taylor 1994, where a coin was tossed, or in the two trials using quasi-randomised methods based on dates of birth (Basso 1998) and alternation (Rozencwaig 1996).

Intention-to-treat analysis (item 2) was confirmed or considered very likely in six studies (Basso 1998; Cheing 2005; Cooper 2001; Kay 2000; Rozencwaig 1996; Taylor 1994). We assumed that the fewer people in the control group of Cheing 2005 was a random effect. The lack of data for post-randomisation exclusions was a common reason for a reduced score for this item. The decision to follow up a subgroup of 66 participants at six months in Wakefield 2000 meant that this scored low despite a specific claim of intention-to-treat analysis. Pasila 1974 failed to provide details of 39 participants who had dropped out of the trial, and there was a possibility that participants had been excluded but not reported in Toomey 1986. Allied to this, but not scored, was loss to follow up. Over a quarter of trial participants were lost from follow up in Pasila 1974 and Svensson 1993.

Blinding of outcome assessors (item 3) was reported in nine studies and considered safe in seven of these. Bache 2001 reported that some participants discussed their treatment with the blinded assessor despite being requested not to do so beforehand; this may have happened in some of the other trials too and so this trial may have been unfairly penalised here for its fuller account of methodological difficulties. There was a lack of information to ensure assessor blinding in Gronlund 1990.

Seven trials provided sufficient information indicating either the similarity in key baseline characteristics, such as gender, age, fracture type and prior treatment (item 4), or had adjusted for confounding in their analyses (Bache 2001). The lower score for this item in Cooper 2001 reflects the clinically significant difference in the mean ages of the two groups (60.75 versus 69.67 years). Three trials did not score for this item; Basso 1998 due to a lack of information on key characteristics, and Pasila 1974 and Rozencwaig 1996 because they failed to provide baseline data or confirmation of baseline comparability.

As indicated above, blinding of participants and treatment providers (items 5 and 6) was impractical in most of these studies. The claimed "double-blind protocol" using a sham (ultrasound) control seemed likely in Basso 1998, but there seemed to be a moderate chance of unblinding of the sham control (soft-tissue massage) in Taylor 1994. Though the use of sham pulsed electromagnetic field (PEMF) treatment allowed participant blinding in Cheing 2005, participants were not blinded for the ice treatment aspect of this trial.

Comparability of care programmes (item 7), comprising interventions other than the trial interventions, is generally hard to confirm. However, it was considered likely in nine trials and fairly likely in five others (Basso 1998; Cooper 2001; Gronlund 1990; Maciel 2005; Watt 2000). The main reasons for the slight reservations concerning care programme comparability for the last five trials were the possible provision of physiotherapy for poor hand

function in Basso 1998, the potential for an important difference between the two groups in the duration of plaster cast immobilisation in Cooper 2001, general practitioner referrals for therapy in the control groups in Gronlund 1990 and Watt 2000, and lack of information in Maciel 2005. Rozencwaig 1996 provided no information to judge this item.

All trials provided details of initial treatment and 11 provided sufficient trial inclusion and exclusion criteria to define the study population (item 8).

Trials evaluating single modalities (e.g. passive mobilisation: Kay 2000; Taylor 1994) generally scored better for description of interventions (item 9) than trials testing multi-component interventions (e.g. physiotherapy: Bache 2001; Wakefield 2000; Watt 2000) that were partly or wholly left to the discretion of therapists. The emphasis on standardisation for this item does penalise these more pragmatic trials, which attempt to reflect normal practice. However, it also reflects the possibility of confounding due to variation in the intervention.

The definition (item 10) of outcome measurement was clear enough to give a good idea of what was recorded in most studies. Fewer trials were rated as having good quality outcome measurement, including active follow up (item 11). In particular, there was completely inadequate information on outcome assessment for Rozencwaig 1996, which scored zero for both items. It is worthy of note that the comprehensiveness, aptness or overall validity of outcome assessment were not scored in item 11; hence Watt 2000, which only reported on the 'functional' outcomes of grip strength and wrist extension, could still attain the top score reflecting active follow up and the good quality measurement of these two outcomes of impairment (*see* 'Types of outcome measures'). Although follow up in Cheing 2005 was systematic and active, its lower score for this item reflects its failure to record outcome after the end of treatment.

The length of overall follow up (item 12) ranged from four days to nine months. Only two trials followed up participants for six months or over (Christensen 2001; Wakefield 2000).

RESULTS

The outcomes reported in the included studies trial reports are listed in the 'Characteristics of included studies' table. The results presented below are ordered by the comparisons given in the 'Description of studies' section.

(1) Rehabilitation intervention versus no intervention

(1a) Rehabilitation started during the definitive treatment period

Occupational or other hand therapy

Two trials (Cooper 2001; Gronlund 1990) provided routine therapy during plaster cast immobilisation. Cooper 2001 evaluated "early therapeutic intervention" started within four days of injury and plaster cast application versus no intervention in 17 people. Gronlund 1990 compared the provision of "occupational therapy" one to three days after the application of a plaster cast to no provision in 40 participants. Pooling was considered despite the differences between the interventions of these two trials. However, no data were available for pooling and the results of the trials are presented separately in the text below.

After plaster cast removal, one participant of the treatment group versus five participants in the control group of Cooper 2001 met the criteria for attendance of the hand therapy group classes (*see* Analysis 01.01: relative risk (RR) 0.23, 95% confidence interval (CI) 0.03 to 1.54). At four weeks post immobilisation, Cooper 2001 reported there were no statistically significant differences between the two groups in the Disability of the Arm, Shoulder and Hand (DASH) questionnaire scores (median: 22.50 versus 45.00 (higher scores = greater disability); reported P = 0.06) or time to perform the nine hole peg test (median: 19.00 versus 27.00 seconds; reported P = 0.12). This contrasts with the results of statistically significant differences between the two groups at four days post immobilisation (median DASH scores: 46.00 versus 61.00, reported P = 0.02; median nine hole peg test time: 22.00 versus 48.00 seconds, reported P = 0.02). At four weeks post immobilisation, the intervention group had statistically and clinically significantly better grip strength (*see* Analysis 01.02: mean difference (MD) 7.28 kg, 95% CI 1.24 to 13.32 kg), and range of motion (*see* Analysis 01.03, supination: MD 18.33 degrees, 95% CI 6.41 to 30.25 degrees; extension: MD 10.94 degrees, 95% CI 0.80 to 21.08 degrees; ulnar deviation: MD 15.03 degrees, 95% CI 9.78 to 20.28 degrees). The difference in oedema was not statistically significant (*see* Analysis 01.04). Though pain was less in the intervention group, the differences were not statistically significant (*see* Analysis 01.05, any pain at rest: 0/8 versus 4/9, RR 0.12, 95% CI 0.01 to 1.99). Cooper 2001 reported there were no statistically significant differences between the two groups in the pain during activity (median visual analogue scale (0: none to 100 mm: worst imaginable): 25.50 versus 41.00, reported P = 0.63). Finger mobility was statistically significantly better in the early therapy group (*see* Analysis 01.06), perhaps reflecting the attention paid to finger exercises in this group. Three types of pinch grip were also reported to be statistically significantly better in the early therapy group (e.g. median 'tip pinch grip': 4.00 versus 2.25; reported P = 0.04). There were no cases of reflex sympathetic dystrophy.

Of the 17 participants in Gronlund 1990 assigned to occupational therapy, 16 were provided with appliances, such as angled knives, and 10 were given home help. Plaster cast fitting problems were found in four participants and were resolved by a subsequent visit to the casualty ward. Nine occupational therapy participants were found not to have understood the core instructions for exercises and information provided by an occupational therapist to all trial participants after their initial treatment. Following plaster cast removal at five weeks, the functional scores (Stewart 1984) of the

17 participants allocated to occupational therapy were reported as being statistically significantly better than those for the 23 participants in the group receiving no occupational therapy (median score 13 versus 18; reported P < 0.05). Stewart 1984 based their functional grading scheme on Gartland 1951 and graded 9 to 14 as "fair" and 15 and above as "poor". Wrist mobility also tended to be greater in the occupational therapy group (median percentage range of motion compared with unaffected wrist: 60% versus 50%; reported P = non significant (NS)). However at three months, both groups had similar hand function (median functional score: 10 versus 9; reported P = NS) and wrist mobility (median relative mobility: 80% versus 80%). Similar numbers of participants in the two groups developed reflex sympathetic dystrophy (*see* Analysis 01.07: 3/17 versus 2/23; RR 2.03, 95% CI 0.38 to 10.84). There were no cases of median or ulnar nerve compression or tendon rupture. All of the participants of the occupational therapy group who had been questioned expressed satisfaction with the intervention and indicated that they had not been inconvenienced. Control-group participants were not asked about their understanding of the initial set of instructions, nor to rate satisfaction or convenience. The numbers in either group referred for occupational therapy after the plaster cast removal at five weeks were not recorded (Gronlund 2001).

(1b) Rehabilitation started post-immobilisation

Physiotherapy or occupational therapy

Routine provision of therapy after plaster cast removal was compared with no provision in four trials (Bache 2001; Christensen 2001; Maciel 2005; Wakefield 2000). All participants in each of these trials received instructions for home exercises from either an occupational therapist (Christensen 2001) or a physiotherapist (Bache 2001; Maciel 2005; Wakefield 2000). Pooling was considered despite the differences between the interventions of the four trials. However, no data were available for pooling and the results of the four trials are presented separately in the text below.

No statistically significant differences were reported between the two groups in functional scores (Solgaard 1988 based on Gartland 1951) in Christensen 2001, at either three (median score: 8 versus 6) or nine months (median score: 3 versus 2). (In this functional grading scheme, Solgaard rated a grade of 0 to 2 as "excellent", 3 to 7 as "good" and 8 to 18 as "fair".) Grip strength was also similar in the two groups (*see* Analysis 02.03) at the two follow-up times. Participants allocated occupational therapy attended an average of 37.5 therapy sessions (range 22 to 90 sessions), of overall duration averaging 11.4 hours (range 6 to 22 hours). No participants in the control group received occupational therapy.

Bache 2001 found that while the baseline patient characteristics of the two groups were generally comparable, the participants allocated physiotherapy were more "symptomatic", with significantly reduced wrist extension (median: 15 versus 25 degrees; reported P = 0.03), and tendencies to poorer pronation (P = 0.05), supination (P = 0.06) and ulnar deviation (P = 0.08). (Adjustments were made for multiple testing throughout the analysis of this trial.) The trialists considered that the outcome in both groups at 12-weeks follow up was acceptable with no statistically significant differences between the two groups found for any of the six range of movement measures, the functional status scores (Levine 1993), pain scores or grip strength. This suggests a trend to a greater improvement over time from a more unfavourable starting position in the physiotherapy group; as reported by Bache 2001. In the light of the differences observed at baseline, the findings of an "Area under the curve" analysis, which included the results from the baseline, at four weeks, and where available, at 12 weeks for 81 of the 98 participants, were presented. There were no statistically significant differences in the outcome measures aside from supination which was significantly better in the control group (adjusted P = 0.04); this reflected the better baseline scores for this outcome measure in the control group, which persisted throughout follow up. Similar numbers of participants in the two groups developed complications: reflex sympathetic dystrophy (two versus three) and carpal tunnel syndrome (two versus two); five of these participants (four with RSD; one with CTS) were excluded from 12-weeks follow up; and complications (one RSD; one CTS) developed in two physiotherapy-group participants at the end of the study. The median duration of treatment for participants allocated physiotherapy was 35 days (range 1 to 142 days) and the median number of contacts was three (range 1 to 16). Four physiotherapy participants were referred to occupational therapy. None of the control group participants retained in the trial received physiotherapy or occupational therapy, aside from the advice and instructions given initially to all trial participants.

Wakefield 2000 similarly found no statistically significant differences between the two groups in overall function (Sheehan 1983) (presented as the degree of difficulty in carrying out activities of daily living relative to the unaffected side), relative grip strength, or pain, at three or six-months follow up (*see* Analyses 02.02; 02.04 and 02.05). Of the measures for range of motion, the only statistically significant difference between the two groups was in wrist flexion and extension relative to the unaffected side at six months (MD 12.20%, 95% CI 5.41 to 18.99%); *see* Analyses 02.07 and 02.08. Functional assessment at six months was limited to 66 participants, compared with 90 at three months. No significant differences between the two groups were reported in any of the measures of quality of life at six months, as assessed from questionnaire data from 50 participants. Participants allocated physiotherapy attended a median of three sessions (range 1 to 22 sessions). Two participants in the control (no physiotherapy) group were referred for physiotherapy after the three-month assessment due to problems with returning to full function.

The most recent addition to this category (Maciel 2005) found no statistically significant differences between up to six weeks of "activity-focused" physiotherapy compared with one advice session (control group) in terms of overall function, or in terms of pain, activity or disability as rated by the Patient-Rated Wrist Evalua-

tion (PRWE) (MacDermid 2000) at 24 weeks: *see* Analyses 02.01. They also found no statistically significant differences between the two groups in grip strength, and in wrist extension and flexion results (*see* Analyses 02.03 and 02.06). These results, however, applied to just 33 (73%) of the 45 people originally recruited into the trial. Of these 45, baseline measurements were not available for four people. A further four people in each group "withdrew" by the 24-weeks follow up. Of the four participants in the physiotherapy group, two failed to attend, one was "too busy", and the fourth sought a second orthopaedic opinion. For the control group, two failed to attend, one died and one required a "general anaesthetic manipulation procedure". Maciel 2005 reported no adverse events related to the interventions. The mean number of treatment sessions in the physiotherapy group was 4.4 compared with 0.9 in the control group (*see* Analysis 02.09).

Continuous passive motion

Very limited information and results are available for Rozencwaig 1996; a very small trial of seven participants who had been treated with external fixation. The three participants given continuous passive motion (CPM) therapy on top of the usual occupational therapy took less time to achieve a completely independent status than the four control (no CPM) group participants (*see* Analysis 03.01: MD -1.80 weeks, 95% CI -3.24 to -0.36 weeks). Rozencwaig 1996 reported that the recovery of range of motion of the affected wrist was also quicker in participants receiving CPM.

Pulsed electromagnetic field (PEMF)

The final outcome assessment for Cheing 2005 preceded the last treatment session on the fifth day. The results for pain, oedema (volume) and range of motion are presented in Analyses 04.01 and 04.02. In these, the results for two intervention groups (PEMF plus ice; PEMF) were combined for the PEMF group, and the results of the two intervention groups (sham PEMF plus ice; sham PEMF) were combined for the sham group. None of the differences between the combined PEMF groups and combined sham PEMF groups were statistically significant. There were no adverse effects recorded.

Ice

As above, the final outcome assessment for Cheing 2005 preceded the last treatment session on the fifth day. The results for pain, oedema (volume) and range of motion are presented in Analyses 05.01 and 05.02. In these, the results for two intervention groups (PEMF plus ice; sham PEMF plus ice) were combined for the ice group, and the results of the two intervention groups (PEMF; sham PEMF) were combined for the control group. Pain was statistically significantly less in the combined ice groups (visual analogue scale: MD -0.82 cm, 95% -1.33 to -0.31 cm). In contrast, extension was significantly better in the control groups (MD -8.89 degrees, 95% CI -13.57 to -4.21 degrees). This, however, should be seen in the context of the significantly higher baseline extension mean value for the control groups: this was 8.44 degrees greater than that of the combined ice groups. Differences between the two groups in the other outcome measures were not statistically significant. There were no adverse effects recorded.

Pulsed electromagnetic field (PEMF) plus ice

The combined intervention was compared with sham PEMF alone in 39 participants of Cheing 2005. The results for pain, oedema (volume) and range of motion at the final assessment on the fifth day are presented in Analyses 06.01 and 06.02. Only the differences between the two groups in extension in favour of the control group (MD -9.20 degrees, 95% CI -16.79 to -1.61 degrees), and ulnar deviation in favour of the combined intervention group (MD 3.80 degrees, 95% CI 0.65 to 6.95 degrees) were statistically significant. Again, the more favourable result in the control group for extension may reflect the significantly higher baseline extension mean value for this group (this was 11.6 degrees higher than that of the combined intervention group). There were no adverse effects recorded.

Passive mobilisation

Though the format and context of the passive mobilisation differed considerably in the two trials investigating this modality (Kay 2000; Taylor 1994), there are sufficient similarities, including the declared experience of the physiotherapists involved, in the two trials to consider pooling. In the event, this was only possible for one outcome (number of treatments). However, pooling revealed highly statistically significant heterogeneity. We decided in this update not to pool these results but to present the results of the two trials separately (*see* Analysis 07.05).

Results of Kay 2000 were unavailable for one person, who withdrew because he found passive mobilisation too uncomfortable. Of the 39 participants remaining, no statistically significant differences were found between the two groups at six weeks for grip strength (*see* Analysis 07.01), range of motion (*see* Analysis 07.02), web space angle (*see* Analysis 07.03), finger movements (flexor deficit: reported $P > 0.25$; extensor deficit: reported $P > 0.39$) or visual analogue pain scores (0: no pain to 10: worst imaginable; median scores extracted from graph 1.25 versus 1.0; reported $P = 0.63$). Likewise no statistically significant differences between the groups were reported for subjective disability: visual analogue scores (0: no difficulty to 10: extreme difficulty; median scores extracted from graph: 2 versus 2; reported $P = 0.43$); or in the performance of six functional tests (reported $P > 0.18$); most participants were able to perform the latter without difficulty at six weeks. The four participants in the passive mobilisation group with complications present at six weeks had been treated conservatively; two had carpal tunnel syndrome, one had complex regional pain syndrome (RSD), ongoing from the start of the trial, and one participant had a malunited fracture. One osteoporotic participant in the control group who had received pins and plaster had unresolved finger stiffness at six weeks. Overall, there was no statistically significant difference in the numbers of participants with complications at six weeks (4/19 versus 1/20; RR 4.21, 95% CI 0.52 to 34.37; $P = 0.18$; analysis not shown). Participants al-

located passive mobilisation received on average six more treatments than those in the control group (MD 5.90, 95% CI 5.40 to 6.40; *see* Analysis 07.05). Kay 2000 calculated that the mean total of hospital reimbursement, based on 1997 to 1998 costings, was nearly three times greater for the passive mobilisation group ($457 versus $161; Australian dollars).

Discharge from physiotherapy, at an average of 26 days, in Taylor 1994 was at the discretion of physiotherapists, who based their decision on an acceptable range of motion or an assessment that no further benefit from therapy was to be expected. Participants receiving passive mobilisation tended to have slightly more treatment and took longer to be considered ready for discharge, but neither result was statistically significant (*see* Analyses 07.05 and 07.06). There was no statistically or clinically significant difference between participants receiving passive mobilisation and those receiving soft-tissue massage (control group) in wrist extension at end of therapy (*see* Analysis 07.04: MD -2.14 degrees, 95% CI -10.44 to 6.16 degrees). Taylor 1994 reported that subgroup analyses looking at wrist extensions attained by both groups of participants treated by three out of the four therapists involved showed no significant differences. They suggested that this finding showed that no one therapist was more proficient at applying passive joint mobilisation.

Intermittent pneumatic compression

Data for three participants, excluded due to RSD, psychiatric hospitalisation and death, were not provided in Svensson 1993. It is also likely that nine of the remaining 40 participants were unavailable for outcome assessment at three months. Svensson 1993 reported that grip strength and the various measures of movement tended to be better in the group given intermittent pneumatic compression at the start of each session of occupational therapy. However, only the results for wrist extension were statistically significantly better in the compression group (median 58 degrees versus 45 degrees; reported $P < 0.05$). A similarly non-statistically significant tendency for less pain at rest and during function was reported for the compression group. No reduction in oedema could be demonstrated for either group of participants. Only a few participants in each group (numbers not stated) were considered to require further occupational therapy after three weeks.

Ultrasound

Basso 1998 found no significant difference between participants allocated active ultrasound and those allocated sham ultrasound (control) in the loss of active flexion-extension wrist motion relative to the unaffected wrist (median loss: 15% versus 15%); *see* Analysis 08.01. Based on persistent radiocarpal pain and delayed recovery of hand function, fewer ultrasound participants were referred for physiotherapy at eight weeks (*see* Analysis 08.02: 2/19 versus 8/19; RR 0.25, 95% CI 0.06 to 1.03). There was no indication whether any participants received physiotherapy before eight weeks.

Whirlpool

As mentioned in the above section on methodological quality, it was not clear whether any participants were excluded from Toomey 1986 because of lack of improvement or deterioration in their condition. Also unclear is how many participants stopped treatment before the scheduled 12 sessions, and whether early curtailment was instigated by the therapist or the patient. By the end of treatment, at a maximum of six weeks, there were no statistically significant differences between those participants whose affected forearm was immersed in a whirlpool or wrapped in two towels (control group) in grip strength, pain or forearm and wrist range of motion (*see* Analyses 09.01, 09.02 and 09.03). Although, as seen in Analysis 09.04, finger flexion tended to be worse in the whirlpool group, and statistically significantly worse for flexion of the long finger (MD -7.50 degrees, 95% CI -13.52 to -1.48 degrees), Toomey 1986 questioned the clinical significance of these results. Follow up immediately after the session (whirlpool or towel) revealed a statistically significantly higher oedema in the whirlpool group (*see* Analysis 09.05: MD 72.92 ml, 95% CI 5.89 to 139.95 ml), without statistically significant differences in strength, pain, or forearm and wrist range of motion. Long-term oedema was not statistically significant between the two groups (*see* Analysis 09.05). Participants were reported as finding the whirlpool comfortable and pleasant; no comments from the towel group were reported. Toomey 1986 referred to whirlpool baths as being an "expensive modality" but did not quantify costs.

(2) One rehabilitation intervention versus another rehabilitation intervention

(2a) Rehabilitation started during the definitive treatment period

No trials were identified.

(2b) Rehabilitation started post-immobilisation

Physiotherapy versus instructions for home exercises by an orthopaedic surgeon

The results for one uncooperative participant in the physiotherapy group and one participant referred to physiotherapy by their general practitioner in the control (instructions from an orthopaedic surgeon) group were excluded from the analyses of Watt 2000. At an average of six-weeks follow up, the median grip strength of the physiotherapy group participants was reported to be significantly greater (10.0 kg versus 5.3 kg). Wrist extension was also found to be significantly better in the physiotherapy group (*see* Analysis 10.01: MD 17.40 degrees, 95% CI 6.49 to 28.31 degrees). Physiotherapy group participants attended an average of five sessions.

Pulsed electromagnetic field (PEMF) versus ice

The final outcome assessment for Cheing 2005 which compared these two interventions preceded the last treatment session on the fifth day. The results for pain, oedema (volume) and range of motion at the final assessment are presented in Analyses 11.01 and 11.02. Only the differences between the two groups in pain, which favoured ice (visual analogue scale: MD 1.10 cm, 95% CI

0.48 to 1.72 cm), and extension, which favoured PEMF (MD 8.40 degrees, 95% CI 2.32 to 14.48 degrees) were statistically significant. Notably, these are consistent with similar differences in baseline values: the mean initial pain was significantly greater in the PEMF group (4.3 cm versus 3.4 cm); but the difference in baseline extension (33.9 degrees versus 28.4 degrees) between the two groups was not statistically significant. There were no adverse effects recorded.

(3) Different methods (contexts) of delivering or providing various rehabilitation interventions

(3a) Rehabilitation started during the definitive treatment period

Exercise therapy supervised by a physiotherapist versus instructions for the same exercises given by an orthopaedic surgeon

At 12 weeks follow up, Pasila 1974 found no significant differences in strength or range of motion between supervised participants and those given instructions by a surgeon after initial treatment (*see* Analyses 12.01 and 12.02: all data extracted from graphs in the trial report). (The relatively low mean values for radial deviation were not explained.) The results of 39 participants who had dropped out of the study were excluded from the analyses. Pasila 1974 reported that the 96 remaining participants returned to work approximately seven weeks after their injury, there being no statistically significant difference between the two groups for this outcome. Whilst over half of the participants (48/92) were reported as having a "positive attitude", at 12 weeks there was no indication if this differed between the two groups. The physiotherapy group participants visited the physical medicine department an average of four times (range 1 to 12 times) before they were able, in the therapist's opinion, to continue training on their own.

(3b) Rehabilitation started post-immobilisation

No trial was available.

DISCUSSION

We set out to determine the effectiveness of rehabilitation interventions for adults with conservatively or surgically treated distal radial fractures. This encompassed the four basic questions stated in the 'Background': essentially, what interventions should be provided, by whom, when and for how long, and why? The variation in interventions, providers, timing, definitive treatment and patient characteristics makes this a complex and extensive area to review. We restricted the evidence to that from randomised or quasi-randomised trials since these are generally less susceptible to systematic bias, specifically selection bias, than other study designs. Inevitably this has reduced the quantity of available evidence with only 15 trials involving 746 participants included so far. A further limitation is that only three of the 13 comparisons covered by these 15 trials were evaluated by more than one trial. Despite clearly different characteristics of trials testing essentially the same comparisons, pooling of trial results was nevertheless considered but was not done.

Although our search strategy was comprehensive and without language or publication restrictions, it is possible that we may have missed some trials and findings. In particular, there may be trials that were only reported at conferences, or mixed population trials that included, but did not emphasise, patients with wrist fractures. We also point out that pursuing and obtaining unpublished trials and materials is very time consuming and can be frustrating for both review and trial authors. We are very grateful to all the people who have provided additional information and trial materials.

Conversely, our inclusion of evidence from 'grey' literature, such as conference proceedings (Rozencwaig 1996), or pre-publication reports (Bache 2001) may also be questioned. We consider that in general such evidence is valid. However, the few trials in the review ruled out sensitivity analysis to explore the consequences of including such trials. Similarly, aside from specifying study design, from the outset we have been lenient in our inclusion of trials with potentially defective or inadequately reported methodology. Here again, sensitivity analyses could not be performed but we have taken care to interpret the available evidence in the context of its probable internal (freedom from bias) and external (applicability) validity.

We assessed the methodological quality of the included trials by adapting the scoring scheme used in our other reviews (Handoll 2003a; Handoll 2003b). A new item covering the description of the interventions was added; this penalised pragmatic trials of multi-component interventions but also reflected the potential confounding effect of the variation of application of such interventions. Carrying out assessment of these trials for this review highlighted the sometime subjective nature of scoring decisions as well as some of the ambiguities in the scheme that make it difficult to be consistent. Nonetheless, agreement on the scores by the three reviewers for all items and for all trials was achieved. The items in our scheme cover many of the key aspects of a well run and well reported randomised trial. Crucially, these include ways of diminishing the potential for systematic biases: selection, performance, attrition and detection (Higgins 2005b). There is empirical evidence to show that the validity of the results of a trial can be affected by the failure to conceal, or to confirm the concealment of, treatment allocation; to undertake intention-to-treat analysis; or to blind outcome assessors. It is thus encouraging to find that allocation concealment was considered secure in seven trials, intention-to-treat analysis confirmed in six trials, and secure blinding of assessors likely in seven trials; however, only one trial scored full marks for all three items (Kay 2000). Blinding of participants and care providers was not practical for many of these trials, and some lower scores in other items will reflect the reporting rather than the performance of trials. One general failing of the included trials was the short-term, and sometimes sub-optimal, follow up. These were insufficient to ascertain functional recovery fully. In

particular, the follow up of patients up to when they are discharged rather than at set times can be administratively convenient but could be a source of serious bias. Another inadequate approach, taken by Cheing 2005, is the timing of final assessment before the time of last treatment.

The results of small trials need to be interpreted with care, even if they appear methodologically sound. While small trials may provide robust evidence of effect in some areas of health care, it is less likely that the trials in this review, all with under 50 participants in each intervention group at follow up, could provide conclusive evidence to establish the superiority of one intervention over another. Furthermore, the apparent comparability of results of interventions tested within some trials should not be interpreted as evidence of no effect or no difference. The lack of compatible outcome data from the few trials essentially testing similar comparisons generally prevented pooling; thus the deficiency in data from individual trials could not be countered through meta-analysis.

One reason for the scarcity of trials may be because the evaluation of rehabilitation interventions is difficult to do well. These are generally complex interventions with considerable variation in practice including the often adaptive nature of rehabilitation, where treatment is varied according to the perceived needs and progress of individual patients. These problems are addressed to some extent by pragmatic trials; these aim to evaluate the effects of interventions in real clinical situations (Wakefield 2000a). But, even for pragmatic trials, there remains a substantial risk of confounding by other factors that could influence trial results.

Confounders include imbalances of known and unknown prognostic factors, including patient and fracture characteristics, in the quality and effectiveness of the initial treatment, and in the skill and expertise of the various clinicians involved. One important point linked to this, as stressed by Oskarsson 1997, is that physiotherapy (and other rehabilitation therapy) "cannot be expected to counterbalance unsatisfactory primary treatment or complications caused by a compound and difficult fracture". An important confounder reflects the personal aspect of these studies; for example, the inter-personal skills of the care provider(s) and motivation of the trial participants could influence the results considerably. There is also the reactive nature of many of these interventions where the basis for progression of, or modification to, the intervention, as well as the timing of completion, is discretionary. The criteria for progression and discharge in most of the included trials were discretionary and though some prior consensus was evident in some of these trials, the criteria were not very specific and could be a major source of variation. For example, participants in Christensen 2001 attended a minimum of 22 therapy sessions, whereas this was the maximum value in Wakefield 2000; yet in both trials the criteria for discharge was basically when the therapist considered no further progress could be made. This highlights that both the immediate and ultimate clinical relevance of the criteria used need to be examined and resolved. Related to this is the reminder in Taylor 1994 that an improvement over the treatment session, as assessed by a therapist, is "of lesser clinical consequence if this improvement is not transferred to a greater rate of improvement over the rehabilitation programme", or indeed in ultimate outcome. There are also difficulties in interpretation of results based on the incomplete or premature ascertainment of outcome, or non-validated scales or scoring systems; recent progress in the development and evaluation of patient-rated functional instruments (MacDermid 2000) should help in future trials. Indeed, validated functional instruments were used in two of the three recently included trials (Cooper 2001; Maciel 2005).

Even supposing sound methodology and sufficient power for clinically important outcomes, interpreting the applicability of the results of these trials presents some difficulties. Generalising the results of a trial is hampered if information is missing or incomplete on interventions; intended and actual characteristics of trial participants; overall care programmes and providers; and measurement of outcome. There are also limitations of interpreting comparisons of multi-component interventions: it is impossible to derive the optimal format of the intervention or the relative effectiveness of its individual components. Changes in definitive treatment may also affect the applicability of the trial results: for instance, in the duration and form of immobilisation, or selection of patients for surgery. The identity of the care provider can also impinge on outcomes as the roles of separate professions, such as occupational therapists and physiotherapists, vary in time and place, but can overlap to a great extent (Smith 2000).

All these factors should be considered in interpreting the findings of trials. Below we highlight specific issues for the individual comparisons.

(1) Rehabilitation intervention versus no intervention

(1a) Rehabilitation started during the definitive treatment period

Occupational or other hand therapy

In a small trial of just 17 participants, Cooper 2001 found that early therapy during the period of plaster cast immobilisation resulted in superior functional and clinical results at four days after removal of plaster cast. Fewer, but not statistically significantly fewer, people in the early therapy group met the criteria for attending the post-immobilisation hand therapy classes. By four weeks, the differences in DASH scores and the time to perform the nine hole peg test (measuring dexterity) were no longer statistically significant but grip strength, wrist and finger mobility were still better in the early therapy group. As well as the small sample size, there are potential problems with confounding in Cooper 2001 due to differences in baseline characteristics (in particular, the early intervention group was on average nine years younger than the control group) and care programmes (there was no information on the numbers requiring longer plaster cast immobilisation). Thus, these promising results need confirmation in a larger sample size,

with a longer duration of follow up. For older people with stable fractures treated with plaster casts, Gronlund 1990 found that early "occupational therapy" resulted in significantly better hand function at cast removal but not at 13 weeks. Assessment at occupational therapy revealed a need for manual aids, home help and plaster cast adjustment as well as a lack of understanding of the instructions for exercises and advice initially provided to all trial participants. Small sample size and incomplete assessment of outcome, for instance in the numbers referred for occupational therapy after plaster cast removal, mean that there was insufficient evidence to confirm either a lack of longer-term difference in outcome or a short-term advantage of early occupational therapy.

(1b) Rehabilitation started post-immobilisation

Physiotherapy or occupational therapy

Although four trials (Bache 2001; Christensen 2001; Maciel 2005; Wakefield 2000) addressed essentially the same issue, namely routine or formal provision of therapy in addition to instructions for home exercises after plaster cast removal, the form of the therapy varied. In particular, the therapy tested by the newly included trial in this category (Maciel 2005) was specifically focussed on restoring optimal motor performance of activities that were limited in the individual participants. Of particular note is that participants attended on average 37 therapy sessions in Christensen 2001, whereas the median number of sessions or contacts was three in both Bache 2001 and Wakefield 2000, and averaged 4.4 sessions in Maciel 2005. Three trials (Bache 2001; Christensen 2001; Wakefield 2000) focused on older people and all four trials excluded those with serious complaints already manifest at cast removal, such as pain (Christensen 2001) or RSD (Bache 2001; Maciel 2005; Wakefield 2000). Three trials (Bache 2001; Maciel 2005; Wakefield 2000 explicitly selected patients who were able to understand instructions. None of the trials found a clinically significant effect of the routine provision of either occupational therapy (Christensen 2001), physiotherapy (Bache 2001; Wakefield 2000) or "activity-focussed" physiotherapy (Maciel 2005). Individually, none of these trials provide sufficiently robust evidence to confirm this. All are prey to a type 2 error (false conclusion of no difference). Baseline differences hampered the analysis of the results of Bache 2001, but there was some evidence that the physiotherapy group tended to improve more from a less favourable starting position. Based on subgroup analyses, Wakefield 2000 found a statistically significantly enhanced wrist extension and flexion in the physiotherapy group at six months, but dismissed this as being clinically irrelevant. The loss to follow up of eight (19.5%) of the 41 participants who started the trial interventions in Maciel 2005 could also have given rise to important bias. Ultimately, no pooling of data was possible and at best the general agreement in these four studies can only be viewed as weak evidence.

Continuous passive motion

Inadequate information and sample size, and potentially flawed methodology mean that no conclusions can be drawn of the effectiveness of continuous passive motion supplementary to occupational therapy following the removal of external fixation (Rozencwaig 1996).

Pulsed electromagnetic field (PEMF)

The timing of outcome assessment for Cheing 2005, being both very short and premature, was a serious flaw. This, together with baseline imbalances in some outcome measures, that would be less likely with a larger sample size, mean that the lack of significant differences between participants given PEMF and those given sham PEMF in pain, volume and range of motion cannot be taken as evidence of no effect for PEMF.

Ice

As above, the serious flaws of Cheing 2005 mean that the findings of statistically significantly less pain in the ice treatment group but worse extension results in this group, probably reflecting poorer initial values for wrist extension, have to be viewed with considerable caution. The clinical significance of a difference of 0.82 cm on a 0 to 10 cm visual analogue scale is not established, and whether this difference would anyway have persisted after the end of treatment is not answered by Cheing 2005.

Pulsed electromagnetic field (PEMF) plus ice

Again, serious deficiencies in the measurement of outcome and baseline imbalances in Cheing 2005 mean that no conclusions can be drawn on the effectiveness of a combined treatment of PEMF with ice after plaster cast removal.

Passive mobilisation

Differences in the format and context of supplementary passive mobilisation and the lack of comparable outcomes hindered pooling of the results of the two small trials (Kay 2000; Taylor 1994) investigating this modality. Both trials found no significant differences in short-term outcome; this was primarily active wrist extension in Taylor 1994. Kay 2000 estimated additional passive mobilisation to be nearly three times as expensive as a regimen of advice and exercises alone. While soft-tissue massage was used in Taylor 1994 as a placebo, it may still have a therapeutic role, for instance in redistributing tissue fluid, and thus potentially diminish the effects of passive mobilisation. Aside from a short follow up, Kay 2000 was methodologically sound, whereas methodological shortcomings of Taylor 1994 include the incomplete assessment of outcome and the variable and short-term follow up. Overall, neither of these trials was sufficient to take their lack of significant differences as evidence of no effect.

Intermittent pneumatic compression

Svensson 1993 reported an improved wrist extension and tendencies for improvements in other outcomes for intermittent pneumatic compression as a supplement to occupational therapy. Given this was a small, inadequately reported and potentially flawed trial, with missing results for 12 out of 43 participants, the available evidence is insufficient to confirm this.

Ultrasound

Ultrasound did not affect wrist motion but may have resulted in a lower referral rate for physiotherapy at eight weeks (P = 0.05) in Basso 1998. Baseline and care programme comparability were not confirmed in this small quasi-randomised trial and overall the evidence is insufficient.

Whirlpool
Whirlpool bath immersion prior to exercises, reported as common in Canadian physiotherapy departments in the early 1980s, resulted in interim oedema without clinically significant differences in outcome by the end of treatment in Toomey 1986. The inadequate sample size, unresolved questions on participant numbers, and a variable and short-term follow up amount to potentially flawed and insufficient evidence for this modality.

(2) One rehabilitation intervention versus another rehabilitation intervention

(2b) Rehabilitation started post-immobilisation

Physiotherapy versus instructions for home exercises by an orthopaedic surgeon
One small trial (Watt 2000) found significantly better grip strength and wrist extension at six weeks in participants given physiotherapy. These promising yet preliminary results need confirmation with larger numbers, longer-term follow up, and a more comprehensive appraisal of outcome, and replication in different settings.

Pulsed electromagnetic field (PEMF) versus ice
Ideally, the effects of the two interventions should be established before a comparison of their relative effects. This is not the case so far. As described above, the serious deficiencies in the measurement of outcome and baseline imbalances in the trial testing this comparison (Cheing 2005) mean that no conclusions can be drawn on the relative effectiveness of PEMF versus ice in treating pain, swelling and stiffness after plaster cast removal.

(3) Different methods (contexts) of delivering or providing various rehabilitation interventions

(3a) Rehabilitation started during the definitive treatment period

Exercise therapy supervised by a physiotherapist versus instructions for the same exercises given by an orthopaedic surgeon
The serious methodological flaws, including a nearly 30% loss to follow up, and inadequate sample size of Pasila 1974 mean that the lack of statistically significant differences in various measures of recovery between the two participant groups cannot be considered as reliable evidence. Noteworthy is that this was a comparatively young population, over two-thirds of whom were under 40 years old, and thus not generally representative.

AUTHORS' CONCLUSIONS

Implications for practice

There is insufficient evidence from randomised trials to determine how best to manage the rehabilitation of adults with fractures of the distal radius. It is not possible to establish exactly what rehabilitation intervention is necessary for acceptable functional recovery, or what type of rehabilitation specialists should provide this care, or when or for how long this care should be provided, or in what circumstances it should be provided.

The findings of this review should not be construed as a basis for the non-provision of any rehabilitation intervention for people with these injuries. Clearly, general advice and instruction on mobilisation should be given to all patients with these fractures. Equally, additional therapy may be necessary for patients with complications or serious functional impairment. Whilst many people with these fractures will make a satisfactory recovery, it should be remembered that the consequences of a bad outcome might include disabling pain (Fisk 1991), loss of independence (Scaf-Klomp 2001) and that, for many patients, these fractures indicate an increased risk of further fracture in the future (Senanayake 2001).

Implications for research

Further research is warranted to identify effective rehabilitation interventions for these common fractures in adults. One priority area is an examination of the provision, mode and format of advice and instruction for home exercises both during the definitive treatment period and post-immobilisation. Research would also be worthwhile to identify interim and intermediate functional outcomes, which correlate with long-term outcome and which can be used to indicate the need for more extensive rehabilitation, and act as criteria for progressing and discharging people from rehabilitation. These research aims need good quality generally applicable evidence from methodologically sound and sufficiently powered trials, preferably multi-centred. These trials require easily applied standardised materials, comprehensive assessment of outcome with the use of validated measures, and long-term follow up.

Consideration should also be given to the potential differences in impact of rehabilitation in different participant groups and circumstances. There is a notable absence of research evidence for rehabilitation after surgery.

NOTES

In the first, a minor update published in Issue 2, 2003, the search for trials was extended to January 2003. We identified five new studies, three of which were ongoing, one of which was excluded and one of which was placed in studies awaiting assessment. There were no changes made to the conclusions.

In the second, a minor update published in Issue 3, 2004, the search for trials was extended to January 2004. We identified no new studies nor publications of studies listed as ongoing or pending. There were no changes made to the conclusions.

In the third, a minor update published in Issue 4, 2004, all changes resulted from copy-editing. There were no changes made to the conclusions.

POTENTIAL CONFLICT OF INTEREST

None known.

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** Indicates the major publication for the study*

TABLES

Characteristics of included studies

Study	Bache 2001
Methods	Method of randomisation: sealed envelopes contained in a box Assessor blinding: yes for objective measures; some participants revealed their treatment despite requests not to do so beforehand Intention-to-treat analysis: likely, but post randomisation exclusions: 4 developed RSD and 1 developed CTS Loss to follow up: 18 (+ above 5 exclusions) (at 12 weeks)
Participants	Selly Oak Hospital, Birmingham, UK 98 participants Inclusion criteria: distal radius fracture, treated by plaster cast immobilisation, living at home, age over 50 years, participants able to follow an exercise programme independently, informed consent.

Characteristics of included studies (*Continued*)

	Exclusion criteria: medical history of dementia, Alzheimer's or psychiatric or confused state, multiple limb fractures or bilateral fracture, requiring physiotherapy for other reasons, pre-existing inflammatory joint disorder. Past medical history of wrist problems or operations on affected side. Early manifestation of RSD or CTS. Classification: AO and Frykman Sex: 82 female (84%) Age: median 69 years; range 50-92 years Assigned: 43/55 [physiotherapy / control] Assessed: 36/45 (at 4 weeks); 35/40 (at 12 weeks)
Interventions	Timing of intervention: following plaster cast removal (5-6 weeks immobilisation). All participants given explanation of home care based on standardised advice and exercise sheet by physiotherapist. (1) Referral for routine physiotherapy at outpatients clinic. Contents of treatment at discretion of physiotherapists; these involved different combinations of physiological mobilisation, progressive active exercise, passive stretching, accessory movements of wrist and radioulnar joints. Discharge criteria: functional ROM, full function, plateau of improvement. (2) Home exercises alone.
Outcomes	Length of follow up: (median) 12 weeks; also (median) 4 weeks. (1) Functional: grip strength, ROM (pronation; supination; flexion; extension; radial deviation; ulnar deviation); functional analysis scale (Levine 1993), pain (VAS). Referral to occupational therapy. (2) Number of contacts with physiotherapist; duration of physiotherapy, reasons for discharge. (3) Complications: CTS & RSD (mainly excluded from follow up).
Notes	Draft trial report received from Mrs Sarah Bache, now based in Australia, on 30 August 2001, and further details on 5 September. Further discussion on outcome measures on 12 September with feedback from trial statistician Louise Hiller.
Allocation concealment	B – Unclear

Study	**Basso 1998**
Methods	Quasi-randomised: by year of birth Assessor blinding: yes Intention-to-treat analysis: likely Loss to follow up: none probably
Participants	Edgeware General Hospital, UK 38 participants Inclusion criteria: Colles' fracture, manipulated and treated with plaster cast. Complete transverse extra-articular break with minimal degree of dorsal displacement and comminution. Exclusion criteria: (often by example of the 13 excluded participants) age < 15 years, intra-articular involvement, palmar/no displacement, severe dorsal comminution, damage to ulnar styloid, severe disruption of DRUJ (>25 degrees dorsal displacement or >6 mm radial shortening) and triangular fibrocartilage, carpal injury, inadequate reduction, more than one manipulation, open fracture, multiple trauma, history of injury to the contralateral wrist, inability to cope with measuring technique, very poor hand function following POP removal. Classification: none Sex: 22 female (58%) Age: median 57 years [ultrasound] and 63 years [control]; range 15-69 years Assigned: 19/19 [ultrasound / control] Assessed: 19/19 (at 8 weeks)
Interventions	Timing of intervention: following plaster cast removal (on average after 4 weeks immobilisation; range 3 to 8 weeks). All participants were given instructions to use hands as much as possible. No physiotherapy "unless hand function was poor".

	(1) Ultrasound: 46.39 kHz at intensity 74 W/cm2 applied for 5 minutes to back of wrist. Joint actively mobilised during treatment. (2) Sham ultrasound. Joint actively mobilised for 5 minutes but machine not active (generator still switched on).
Outcomes	Length of follow up: 8 weeks; also 2 weeks and to end of treatment for those prescribed physiotherapy after 8 weeks. (1) Functional: ROM (extension-flexion) loss. (2) Referral for physiotherapy at 8 weeks, length of follow up.
Notes	Request for further information sent 8 August 2001
Allocation concealment	C – Inadequate

Study	**Cheing 2005**
Methods	Method of randomisation: by drawing lots (non-replacement method) Assessor blinding: no Intention-to-treat analysis: likely Loss to follow up: none
Participants	Queen Elizabeth Hospital, Hong Kong 83 participants Inclusion criteria: "stable"' distal radial fracture treated by closed reduction and 6 weeks plaster cast immobilisation. Informed consent. Able to communicate independently. Exclusion criteria: RSD, inflammatory arthritis, perivascular disease, previous fracture or neurovascular injuries in the affected hand, heart disease, use of heart pacemaker or other auxiliary organs, tuberculosis, viral infections, juvenile diabetes, mycosis, internal haemorrhages, or pregnancy. Recently had deep X-Ray therapy or pulsed electromagnetic treatment during immobilisation period. Classification: None given Sex: 55 female (66%) Age: mean 63 years; range 17-80 years Assigned: 23/22/22/16 [PEMF + ice/ sham PEMF +ice/ PEMF / sham PEMF] Assessed: 23/22/22/16 (at 5 days)
Interventions	Timing of intervention: 3-4 days following plaster cast removal (6 weeks immobilisation). All treatments were 30 minutes for 5 consecutive days. After the first treatment, the participants were taught and given written instructions for a home exercise programme of active wrist and finger mobilisation exercises and advised to do these twice a day for 20 minutes each session. Exercise compliance was checked by the physiotherapist at each treatment session. (1) Pulsed electromagnetic field (PEMF) at 50 Hz with a field intensity of 99 gauss, and ice (1 kg pack of flaked ice wrapped in towel and placed dorsally). (2) Sham PEMF and ice. (3) PEMF. (4) Sham PEMF.
Outcomes	Length of follow up: 4 days (before the 5th treatment session); also 2 days (before 3rd session). (1) Functional: pain (VAS during mobilisation), ROM (pronation; supination; flexion; extension; radial deviation; ulnar deviation). (2) Clinical: oedema. Adverse events ("none reported").
Notes	Reply received from A/Prof Cheing on 9 December 2005 who provided further details of the methods, including randomisation, and also stated there were no adverse events reported.
Allocation concealment	B – Unclear

Study	**Christensen 2001**
Methods	Method of randomisation: use of sealed envelopes (concealment confirmed by trialist)

Characteristics of included studies (*Continued*)

	Assessor blinding: yes Intention-to-treat analysis: likely but for 2 excluded from analyses (1 death and 1 with severe pain after cast removal) Loss to follow up: none (except 2 exclusions)
Participants	University Hospital Gentofte, Denmark 32 participants Inclusion criteria: Colles' fracture, treated with plaster cast. Exclusion criteria: none provided. Classification: Older's classification Sex: (of 30) 27 female (90%) Age: (of 30) mean 66 years; range 46-82 years Assigned: 16/16 [occupational therapy / control] Assessed: 16/14 (at 9 months)
Interventions	Timing of intervention: following plaster cast removal (5 weeks immobilisation). All participants were given instructions by occupational therapist for shoulder, wrist and fingers exercises to be performed thrice daily at home. (1) Occupational therapy involving active joint exercises for wrist, elbow and shoulder; oedema prevention; coordination exercise; coarse and fine motor-function exercise; strengthening exercise; sensation exercise; ADL training. "Distributed" around twice weekly sessions until therapist considered no further progress was being made. (2) Home exercises only.
Outcomes	Length of follow up: 9 months; also 3 months. (1) Functional: grip strength, Solgaard modified Gartland and Werley score. (2) Number of sessions and overall duration of occupational therapy.
Notes	Replies received 20 and 21 August 2001.
Allocation concealment	A – Adequate

Study	**Cooper 2001**
Methods	Method of randomisation: independent person generated sealed numbered opaque envelopes using a random numbers table - researcher had no knowledge of allocation in advance Assessor blinding: no Intention-to-treat analysis: yes Loss to follow up: none
Participants	Pilgrim Hospital, Boston, UK 17 participants Inclusion criteria: Distal radial fracture treated conservatively with closed reduction and immobilisation, age > 16 years (adult), willing and able to attend the department for assessment and treatment. informed consent. Exclusion criteria: frail elderly people with mobility problems preventing attendance, impaired mental or cognitive ability, multiple fractures or extensive soft tissue injuries, surgical treatment or pre-morbid neurological conditions. Classification: None given Sex: 16 female (94%) Age: mean 65.5 years; range 41-81 years Assigned: 8/9 [early intervention / control] Assessed: 8/9 (at 4 weeks post removal of plaster cast)
Interventions	Timing of intervention: within 4 days of fracture (routinely 4 weeks immobilisation, or, for some, 6 weeks) All participants received home treatment programme including written advice about skin care, control of oedema, wrist and forearm exercises at fracture clinic and cast application. Post-immobilisation care programme for all participants comprised an individualised home programme and, where prespecified criteria were met, attendance of a hand therapy group

Characteristics of included studies (*Continued*)

	(1) "Early therapeutic intervention" with oedema management, active range of movement of uninvolved joints (fingers, elbow, shoulder and neck), monitoring of plaster cast, written information and contact number of project team. Weekly contact with member of hand therapy team. (2) "Standard intervention" only, started after plaster cast removal.
Outcomes	Length of follow up: 4 weeks post immobilisation; also 4 days. (1) Functional: grip strength, ROM (pronation; supination; flexion; extension; radial deviation; ulnar deviation), functional dexterity (9-hole peg test), pain at rest or during activity (VAS), DASH functional scores, finger movement (total active movement), opposition of thumb (Kapandji scores), pinch grip, and referral to hand therapy. (2) Clinical: oedema. Complications: RSD (complex regional pain syndrome 1).
Notes	Trial was part of a masters degree in hand therapy
Allocation concealment	A – Adequate

Study	**Gronlund 1990**
Methods	Method of randomisation: involved envelopes - stated to be single-blind by trialist Assessor blinding: yes Intention-to-treat analysis: probably Loss to follow up: probably none
Participants	Fredenksberg Hospital, Alsgarde, Denmark 40 participants Inclusion criteria: Colles' fracture, unilateral fracture, suitable for plaster cast: stable fracture in plaster, attendance at casualty ward within 24 hours of injury, age > 45 years, (implied: resident in hospital catchment area). Exclusion criteria: unstable fracture (reduced position could not be maintained in plaster), wrist arthritis, other fracture in same limb, neuromuscular pain in limb, dementia or some other condition making participation difficult. Classification: Older Sex: 35 female (88%) Age: median 74.5 years; range 47-93 years Assigned: 17/23 [occupational therapy / control] Assessed: 17/23 (at 13 weeks)
Interventions	Timing of intervention: following reduction and application of plaster cast. (Approximately 5 weeks immobilisation.) All participants given advice about active movement exercises of shoulder and fingers and information on the problems of plaster casts after application of cast (in casualty). (1) Participant attended rheumatoid disorder outpatients clinic 1-3 days after initial treatment. Instructions for hand pumping exercises, active finger, elbow, shoulder movements, assessment of the need for appliances (e.g. angled knives), and for home help provided by occupational therapist. Referral to occupational therapist for rehabilitation if required after plaster cast removal. (2) Referral to occupational therapist for rehabilitation if required after plaster cast removal.
Outcomes	Length of follow up: 13 weeks; also 5 and 9 weeks. (1) Functional: modified Stewart 1984 (modified Gartland and Werley) functional score (subjective pain, limitations of movement and function; ROM, grip strength, median nerve compression), movement, use of analgesia. (2) Clinical: oedema, abnormal sweating, colour, temperature. Complications: RSD, median & ulnar nerve compression, tendon rupture. (3) Use of appliances, home help, plaster cast problems, participant satisfaction, understanding of instructions given at casualty: for intervention group participants only.
Notes	Translation from Danish by Dr Michael Bird.

	Further details of trial received 20 August 2001. Nine participants previously unaccounted for had unstable fractures, and were re-admitted, some fractures were fixed with Hoffman external fixation, and were not included in trial.
Allocation concealment	A – Adequate

Study	**Kay 2000**
Methods	Method of randomisation: use of computer generated random numbers table (concealment confirmed by trialist) Assessor blinding: yes for objective measures Intention-to-treat analysis: baseline data not given for one non-compliant participant Loss to follow up: 1
Participants	Royal Adelaide Hospital, Australia 40 participants Inclusion criteria: distal radial fracture treated with plaster cast or pins and plaster cast, informed consent. Exclusion criteria: inability to understand written / spoken English, previous wrist fracture on affected side within last 20 years or any time if residual impairment, concurrent ipsilateral upper limb fracture, open reduction and internal fixation. Classification: AO Sex: 27 female (68%) Age: mean 53 years Assigned: 20/20 [passive mobilisation / control] Assessed: 19/20 (at 6 weeks)
Interventions	Timing of intervention: following pins and/or plaster cast removal (approximately 6 weeks immobilisation). All participants attended physiotherapy for initial treatment - standardised advice on fracture protection, swelling control, skin care and functional activities. Instructed and asked to practice a home exercise programme - active exercises, soft tissue stretches, stabilising exercises, gentle grip strengthening. All provided with a booklet outlining advice and illustrating exercises. All 3 physiotherapists were experienced in hand therapy. (1) 6 week course of passive mobilisation; grading left to physiotherapists. Twice weekly for first 3 weeks and once weekly for next 3 weeks. (2) Review at 1 week. Subsequent appointments at physiotherapist's discretion for monitoring and any correction. Always, progression and assessment at 3 weeks and assessment at 6 weeks.
Outcomes	Length of follow up: 6 weeks; also 3 weeks. (1) Functional: subjective pain and functional disability, ability to perform 6 functional tests, grip strength, ROM (pronation; supination; flexion; extension; radial deviation; ulnar deviation), thumb motion, web space. (2) Clinical: complications (continuing, newly occurring): carpal tunnel syndrome, malunion, marked stiffness and dysfunction of wrists and fingers (RSD?). (3) Number of attendances of physiotherapy, costs.
Notes	Further details of trial received from Sandra Kay 13 & 17 August 2001.
Allocation concealment	A – Adequate

Study	**Maciel 2005**
Methods	Method of randomisation: use of sealed envelopes (concealment stated in report, envelope picked by trial participants after their giving consent) Assessor blinding: yes, independent and blinded examiner for objective measures Intention-to-treat analysis: problems though reported as done. No baseline measurement and thus data for 4 excluded ("did not enter study": 1 failed to attend, 1 readmitted comorbidity, 1 with RSD treatment scheduled, 1 failed inclusion) after randomisation.

Characteristics of included studies (*Continued*)

	Loss to follow up: 8 (including 1 death, 1 seeking another orthopaedic opinion, and 1 remanipulation under general anaesthesia) (24 weeks) (+4 not 'entered' into trial - see above)
Participants	Western General Hospital, Footscray, Australia 45 participants but baseline data for only 41 participants Inclusion criteria: distal radial fracture treated with plaster cast (34 participants) or K-wire(s) and plaster cast (7 participants), cast removed, age 18 years or over, ability to understand written and spoken English, willingness to participate. Exclusion criteria: signs or symptoms of "complex regional pain syndrome" (RSD), documented evidence of psychiatric disorder, pre-existing upper limb inflammatory joint condition, external or internal fixation in situ (apart from K-wire), concurrent upper limb fracture requiring treatment. Classification: AO Sex: 31 female (76%) Age: mean 56 years Assigned: 23/18 [activity focussed / single session] Assessed: 19/14 (at 24 weeks)
Interventions	Timing of intervention: following plaster cast removal (and on average 44 days immobilisation). Participants were taught routine exercises by a physiotherapist on the day of cast removal. The exercises focussed on the return of active movement to the wrist. All participants received a sheet with information and details of home exercises (Taylor, personal communication). (1) Regular attendance of activity-focussed physiotherapy for up to 6 weeks. The total number of sessions was based on the clinical judgement of the treating physiotherapist in consultant with the patient. Physiotherapy usually stopped on return to regular wrist activity. Activity-focussed physiotherapy involved an assessment and treatment approach that focussed on restoring optimal motor performance of activities that were limited. The emphasis was on skill acquisition. Manual therapy was used to address impairments where these affected the execution of a task. The principles of 'motor learning' were applied as required. (2) Single session of advice within one week of entry comprising clarification of exercises from the physiotherapist.
Outcomes	Length of follow up: 24 weeks; also 6 weeks. (1) Functional: subjective pain, activity and disability within the PRWE (Patient-Rated Wrist Evaluation) score (higher % = worse outcome); grip strength, ROM (flexion; extension). (Pronation and supination, ability to make a fist and thumb motion indicated as being recorded in the trial details when ongoing.) (2) Clinical: adverse effects. (3) Number of attendances of physiotherapy. (Adherence to instructions and home exercises reported in trial details when ongoing.)
Notes	Information on this trial was originally presented under Maciel 2002 in the 'Characteristics of ongoing studies' table. Some of the information (especially the outcomes measured) provided by Nick Taylor in 2002 and 2004 was not provided in the full report of this trial.
Allocation concealment	A – Adequate

Study	**Pasila 1974**
Methods	Method of randomisation: "random sample" at hospital admission Assessor blinding: no Intention-to-treat analysis: no Loss to follow up: 39
Participants	University Central Hospital, Helsinki, Finland 135 participants; data for 96 provided Inclusion criteria: Colles' fracture, displaced "typical radial fracture", aged 16 to 65 years. Exclusion criteria: see above. Classification: Older Sex: (of 96) 89 female (93%)

Characteristics of included studies (*Continued*)

	Age: < 40 years: 67; 40-60 years: 20; > 60 years: 9 Assigned: ?/? [physiotherapy / control] Assessed: 48/48 (probably; at 12 weeks)
Interventions	Timing of intervention: following reduction under local anaesthetic and application of plaster cast. Approximately 5 weeks immobilisation. (1) Participant directed to physical medicine department on day after treatment to receive oral and written instructions for active exercises and supervision of these. Participant attended until able in the physiotherapist's opinion to carry on training on their own. (2) Physician/surgeon provided the same oral and written instructions to participant after reduction and initial treatment. Participants asked to continue active movement training at re-examination times.
Outcomes	Length of follow up: 12 weeks; also 5 and 8 weeks. (1) Functional: grip strength (and hand pumping power), ROM (pronation; supination; flexion; extension; radial deviation; ulnar deviation), return to work. (2) Clinical: hand volume (no data). (3) Subjective attitude of participants (undefined). (4) Number of sessions of physiotherapy.
Notes	Request for further information sent 1 August 2001. However, last publication of Pasila identified in 1982 and envelope returned stamped "Unknown".
Allocation concealment	B – Unclear

Study	**Rozencwaig 1996**
Methods	Quasi-randomised: alternation/odd and even clinic numbers Assessor blinding: unlikely Intention-to-treat analysis: likely Loss to follow up: none
Participants	Oschsner Clinic, New Orleans, USA 7 participants Inclusion criteria: unstable distal radial fracture treated with external fixation. Exclusion criteria: none provided. Classification: none Sex: no data Age: no data Assigned: 3/4 [continuous passive motion / control] Assessed: 3/4 (recovery)
Interventions	Timing of intervention: after external fixation (lasting 6-8 weeks). All participants had "traditional occupational therapy" consisting of heat modalities, active-assisted ROM, mobilisation, passive ROM, progressing to strengthening when appropriate (avoiding excessive force), in an outpatient setting. (1) Continuous passive motion. Therapist instructed participants on the use of CPM. Probably: CPM device use 4-6 hours a day over 1 month. (2) Control: occupational therapy only.
Outcomes	Length of follow up: until recovery (1) Functional: functional evaluation score (0: dependent to 7: independent), ROM.
Notes	Only reported in a conference proceedings abstract. Further details received from Dr Richard Rozencwaig (29 August & 4 September 2001). Also, from Susan Fortier (17 October 2001) in association with Dr Jefferson Kaye). Confirmation of no other publication past or forthcoming; no further details available.
Allocation concealment	C – Inadequate

Characteristics of included studies (*Continued*)

Study	**Svensson 1993**
Methods	Method of randomisation: involved sealed envelopes Assessor blinding: no Intention-to-treat analysis: no, 3 participants excluded Loss to follow up: 9 (+3 excluded)
Participants	Bispebjerg Hospital, Copenhagen, Denmark 43 participants Inclusion criteria: Colles' fracture, age 55+ years, female, referred to rheumatological ward for rehabilitation of hand function after plaster cast removal. Consent. Exclusion criteria: previous fracture of same forearm/hand, reflex dystrophy, ipsilateral hemiparesis or other neurological disease, infectious skin disease, disfiguring rheumatic disease. Classification: Frykman Sex: all female (100%) Age: (of 40) median 72 years; range 55-90 years Assigned: 17/23 [compression / control] Assessed: ?/? (31 at 3 months)
Interventions	Timing of intervention: following plaster cast removal; first occupational therapy treatment median 25 days, range 1-46 days. All participants had occupational therapy thrice weekly for 3 weeks followed by further treatment as required. Instruction for home exercises for daily practice given on first session. Approximately 1 hour sessions involved limber-up in tepid water 10 minutes, venous pump exercise (elevated arm), range of motion, grip strength, pinch exercises. Guidance for ADL. (1) 20 minutes of intermittent pneumatic compression before OT session. Flowtron Air. Continuously variable pressure 30-70 mmHg, cycle time 2 minutes. (2) Control: no compression.
Outcomes	Length of follow up: 3 months; also 3 weeks. (1) Functional: use of hand in daily skills (VAS), pain at rest or during function (VAS), grip strength, ROM (pronation; supination; flexion; extension; radial deviation; ulnar deviation; finger abduction, thumb opposition). (2) Clinical: oedema. Complications: no mention. (3) Number of sessions. Patient satisfaction.
Notes	Incomplete translation from Danish by Kirsten Lone Jensen. Request for further information sent 30 August 2001.
Allocation concealment	B – Unclear

Study	**Taylor 1994**
Methods	Method of randomisation: coin toss for first patient of every pair, second patient allocated to other group Assessor blinding: no Intention-to-treat analysis: likely Loss to follow up: none
Participants	Box Hill Hospital, Victoria, Australia 30 participants Inclusion criteria: Colles' fracture, treated with plaster cast. Exclusion criteria: < 35 years, multiple concurrent upper limb fracture. Classification: not stated Sex: 24 female (80%) Age: mean 63 years; range 39-78 years Assigned: 15/15 [passive mobilisation / massage] Assessed: 15/15 (at discharge)
Interventions	Timing of intervention: within 3 working days following plaster cast removal (6 weeks immobilisation).

Characteristics of included studies (*Continued*)

	All participants had twice weekly treatment at physiotherapy department by experienced orthopaedic physiotherapists. All received standard regime of heat (wax or hot pack), active exercise (exercise card for home use - patients taught free, stretch and strengthening exercises, and supervised at each treatment session) and home advice (use of affected arm for ADL: but avoid excessive force). Discharge at discretion of physiotherapists - acceptable ROM/function or no further benefit expected. All 4 physiotherapists had attended a course on passive mobilisation. (1) Passive mobilisation for up to 5 minutes. (2) Sham: 5 minutes of soft tissue massage.
Outcomes	Length of follow up: until discharge (mean 26 days) (1) Functional: wrist extension. (2) Number of sessions and time until discharge.
Notes	Further details of trial received from Dr Nick Taylor 27-28 July 2001.
Allocation concealment	C – Inadequate

Study	**Toomey 1986**
Methods	Method of randomisation: not stated Assessor blinding: yes Intention-to-treat analysis: likely but some participants may have been excluded Loss to follow up: probably none
Participants	Montreal General Hospital, Canada 24(?) participants Inclusion criteria: Colles' fracture, treated with plaster cast immobilisation referred to Physical Medicine Department. Exclusion criteria: associated fractures or conditions such as shoulder-hand syndrome, rheumatoid arthritis, brachial plexus injuries. Occupational therapy for involved hand. No consent. Classification: own: undisplaced/displaced/ulna fracture/comminuted Sex: 20 female (83%) Age: mean 60 years; range 40-80 years Assigned: 12/12 (probably) [whirlpool / towel] Assessed: 12/12 (by end of treatment, 6 weeks maximum)
Interventions	Timing of intervention: on average 6 days following plaster cast removal (mean 6 weeks immobilisation). All scheduled for 12 sessions, twice weekly, lasting 45 minutes each of physiotherapy. (No occupational therapy was given.) Each session, after the trial interventions (see below), participants received massage, joint mobilisation, active and resistive exercises. (1) Whirlpool. Seated participants had hand, wrist and forearm in whirlpool at room temperature for first 15 minutes of each session. (2) Towel. Seated participants had hand and wrist in two standard hospital towels for first 15 minutes of each session.
Outcomes	Length of follow up: until discharge (maximum 6 weeks). (1) Functional: grip strength, pain, ROM (pronation; supination; flexion; extension; radial deviation; ulnar deviation; finger flexion). (2) Clinical: hand volume.
Notes	Report indicated that if patient's condition did not improve and an alternative treatment was warranted or if it worsened, then he/she was removed from the trial. No details are given of whether this happened. Request for further information sent 8 August 2001
Allocation concealment	B – Unclear

Study	**Wakefield 2000**
Methods	Method of randomisation: numbered sealed envelopes opened at fracture clinic; use of random numbers generated using computer programme in blocks of 10 by independent colleague.

Characteristics of included studies (*Continued*)

	Assessor blinding: yes for objective measures ROM and grip strength Intention-to-treat analysis: claimed but decided to follow up only 66 participants to 6 months Loss to follow up: 6 (at 3 months)
Participants	From Edinburgh Royal infirmary, UK 96 participants Inclusion criteria: radiologically confirmed distal radial fracture, treated with plaster immobilisation, attending outpatients, age over 55 years, informed consent. Exclusion criteria: mental test score <8, participation in another clinical trial, bilateral wrist fractures, previous fracture of unaffected wrist, surgical treatment of wrist, clinical signs of RSD at time of plaster cast removal. Classification: AO Sex: 87 female (91%) Age: mean 73 years; range 55-90 years Assigned: 49/47 [physiotherapy / control] Assessed: 47/43 (at 3 months); 34/32 (at 6 months)
Interventions	Timing of intervention: following plaster cast removal (and on average 37 days immobilisation). All participants were taught home exercises by the physiotherapist at the fracture clinic. (1) Referral for routine physiotherapy at participant's local hospital/clinic (there were 4 hospitals and 11 health clinics). Contents of treatment at discretion of therapists (all were qualified state registered physiotherapists); these involved different combinations of active exercises, passive accessory movements and stretches, and strengthening and functional exercises. (2) Home exercises as taught at outpatients only.
Outcomes	Length of follow up: 6 months (from fracture); also 3 months. (1) Functional: grip strength, ROM (pronation-supination; flexion-extension, radial-ulnar deviation); functional score relating to ADL (Sheehan 1983); pain; QOL (physical & mental health SF-36, UK version); total outcome score (from grip, ROM and functional score). Control group participants requiring physiotherapy. (2) Number of physiotherapy attendances. (3) Complications (no information).
Notes	Reason given for reduction in numbers at last follow-up: "Preliminary analysis indicated that sufficient numbers of patients had been recruited and therefore only 66 were followed up at six months." Further details of trial received from Mrs Alison Wakefield 10 September 2001.
Allocation concealment	A – Adequate

Study	**Watt 2000**
Methods	Method of randomisation: random number tables, sealed envelopes opened by orthopaedic surgeon Assessor blinding: yes for ROM and grip strength Intention-to-treat analysis: no, 2 participants excluded Loss to follow up: none
Participants	Box Hill Hospital, Victoria, Australia 18 participants Inclusion criteria: Colles' fracture, treated with plaster cast, attending outpatients, no "significant past history". Exclusion criteria: see above. Classification: Frykman Sex: 17 female (94%) Age: mean 76 years Assigned: 9/9 [physiotherapy / control] Assessed: 8/8 (at 6 weeks)
Interventions	Timing of intervention: following plaster cast removal (and on average 43 days immobilisation) (1) Referral for routine physiotherapy at physiotherapy department. Contents of treatment at discretion of hospital therapists, always included active exercises including home exercise programme, advice and, for 47% of all treatments, passive joint mobilisation.

	(2) Home exercise sheet and simple home instructions given at outpatients by orthopaedic surgeon/registrar.
Outcomes	Length of follow up: 6 weeks (1) Functional: grip strength, wrist extension. (2) Number of physiotherapy attendances of intervention group. (3) Non compliance.
Notes	Further details of trial received from Dr Nick Taylor 27 July 2001.
Allocation concealment	A – Adequate

ADL: activities of daily living
AO: Arbeitsgemeinschaft fur Osteosynthesefragen / Association for the Study of Internal Fixation (or ASIF)
CTS: carpal tunnel syndrome
DASH: Disabilities of the Arm, Shoulder and Hand outcome measure
DRUJ: distal radial ulnar joint
OT: occupational therapy
PEMF: pulsed electromagnetic field
POP: plaster of Paris
PRWE: Patient-Rated Wrist Evaluation
QOL: quality of life
ROM: range of movement
RSD: reflex sympathetic dystrophy
VAS: visual analogue scale or score

Characteristics of excluded studies

Study	Reason for exclusion
Can 2001	Non-randomised comparative study: participants were matched according to their age, sex, pain intensity level, range of motion and treatment procedures before study completion.
Coyle 1998	Trial of 8 participants involving a "single subject, multi-element design" comparison of two techniques of passive immobilisation: passive sustained stretches and oscillations, their order and timing within a series of 6 treatment sessions. The study design, basically resulting in comparisons involving individual participants, was considered potentially misleading and unsuitable for this review.
Haren 2000	Randomised trial of manual lymph drainage in 29 participants treated with external fixation. Only oedema reported; no recording of functional outcomes.
Haren 2004	Randomised trial of manual lymph drainage in 51 participants with oedema after fixation of their fracture. Only oedema was reported in conference abstract; no recording of functional outcomes.
Hunt 2001	Non-randomised study. Prospective series of 13 participants compared with 13 retrospective control participants.
Jarvis 2001	Non-randomised study involving a prospective series and retrospective control series.
Neeman 1988	Single-subject (N of 1) trial evaluating application of orthokinetic orthoses. As well as questions over the actual trial methods, the N of 1 study design is aimed at a specific patient and thus inappropriate for making generalisations.
Nikolova 1969	Comparative study involving participants with established complications (reflex sympathetic dystrophy, delayed callus formation, painful joint stiffness), an unknown number of whom had had fractures of the distal radius. There is no indication that this is a randomised trial and the treatment of established complications is not in the scope of this review.
Oskarsson 1997	Non-randomised prospective comparative study. Referral to physiotherapy based on patient request and/or severe stiffness.
Pasila 1980	Randomised trial of Movelat cream versus placebo in 104 Colles' fracture participants with persistent problems with mobilisation of their wrist and hand after removal of plaster cast at five weeks. Drug trials are not included in this review.

Characteristics of excluded studies (*Continued*)

Ramesh 1998	Non-randomised study. Prior treatment of participants differed in the two groups.
Rodrick 2004	Pilot study - thus probably small - reported in a conference abstract that compared retrograde massage versus manual oedema mobilisation in a mixed population with wrist disorders. There was no mention of distal radial fractures.
Schwartz-Jensen 2002	We were unable to locate a source to contact for the information required for the inclusion of this pilot study, reported only in a conference abstract, testing individual occupational therapy during the immobilisation period in 29 people with a distal radial fracture.
Zwang 2005	Randomised trial of gripping exercises in 43 participants reported only on bone density, width and mineral content. No reporting of functional outcome.

Characteristics of ongoing studies

Study	**Kay 2003**
Trial name or title	The effect of an advice and exercise programme on patients with distal radius fractures - a randomised controlled study.
Participants	Adults with "uncomplicated" distal radial fractures. Will exclude those treated with external fixators or open reduction and internal fixation. Estimated sample size: 54.
Interventions	Following removal of plaster cast. (1) Physiotherapy intervention will consist of an advice and exercise programme, initially instructed, and reinforced with a written programme in booklet format. Advice will consist of that needed for swelling control, fracture protection and hand use etc. Exercises will be instructed and be included in written and diagram format in the same booklet, and will be for ROM, stretching and strengthening. (2) Control group will have no physiotherapy input.
Outcomes	Length of follow up: probably 3 months Range of movement, grip strength, pain (VAS), DASH and possibly PRWE questionnaires.
Starting date	Start date: 2006 Time for recruitment: 18 months
Contact information	Sandra Kay Physiotherapy Department Royal Adelaide Hospital North Terrace Adelaide South Australia 5000 Australia Email: Skay@mail.rah.sa.gov.au
Notes	Information provided on 17 January 2003. The trial has yet to start since inter-rater reliability testing for ROM showed some problems which need to be resolved beforehand. On 23 February 2004, Sandra Kay indicated that the study start had been postponed until April 2004. It is likely that only the DASH questionnaire will be used. On 27 October 2005, Sandra Kay indicated that the study start had again been postponed due to staff shortages and the need to train a new staff member for outcome assessment.

Study	**McPhate 1998**
Trial name or title	Physiotherapy treatment of Colles fractures: hands off or hands on.
Participants	32 women over 50 who had sustained a Colles fracture.
Interventions	All participants received a comprehensive regime of home exercises which were progressed at each session.

Characteristics of ongoing studies (*Continued*)

	(1) Passive mobilisation of wrist and carpal bones for extension and supination, plus exercise instruction. (2) Exercise instruction only.
Outcomes	Pain (VAS), active wrist extension (goniometer), grip strength (Jamar dynamometer)
Starting date	Unknown start date. Study recruitment completed.
Contact information	Margaret McPhate c/o Physiotherapy Department St Vincent's Public Hospital 41 Victoria Parade Fitzroy Victoria 3065 Australia
Notes	Confirmation received via Sandra Kay (17 January 2003) that the study was in the process of being written up by Margaret McPhate. Email requesting direct confirmation and further details sent to Margaret McPhate on 22 January 2003. Requests for clarification on current status sent 6 and 19 February 2004. Correspondence from Sandra Kay (27 October 2005) notified that Margaret McPhate was now in Canberra. The study was pending some reanalysis of the data. Email from Kim Brock at St Vincent's on 05 December 2005 confirmed that the study was not yet published.

Study	**Woodbridge 2003**
Trial name or title	Randomised trial testing the order of provision of rehabilitation interventions to patients with distal radial fractures after plaster cast removal.
Participants	80 participants, aged 18 and above, with distal radial fractures referred for rehabilitation after plaster cast removal.
Interventions	Participants referred for rehabilitation which comprised four sessions a week: 2 physiotherapy and 2 occupational therapy. Rehabilitation interventions were standardised where possible. (1) Physiotherapy session before occupational therapy session. (2) Occupational therapy session before physiotherapy session.
Outcomes	Length of follow up: 6 months Range of motion, grip strength, pinch strength, time to meet discharge criteria (attainment of 1/2 grip strength and 2/3 active ROM), Jebsen test (dexterity), DASH
Starting date	Start date: mid 1998 Study recruitment completed.
Contact information	Sarah Woodbridge Senior Occupational Therapist Derbyshire Royal Infirmary London Road Derby DE1 2QY Tel: +44 1332 347141 Email: Sarah.Woodbridge@sdah-tr.trent.nhs.uk
Notes	Randomised using computer generated randomisation list. Lead investigator (Sarah Woodbridge) confirmed that the completed study was being written up for publication (January 2003). Further contact (23 February 2004) revealed that preparation of the written report had been delayed due to various spin-off studies: such as on DASH and relationship with other outcome measures. The trial report would probably be drafted in the next six months.

Characteristics of ongoing studies (*Continued*)

Further contact (9 November 2005) revealed that preparation of the written report had been delayed due to unforeseen circumstances. However, some consideration would be given to the request for a copy of the report (if it could be found) sent to the original funders of the trial (Action Research).

DASH: Disability of the Arm, Shoulder, and Hand questionnaire
PRWE: Patient-Rated Wrist Evaluation
ROM: range of movement
VAS: visual analogue scale

ADDITIONAL TABLES

Table 01. Search strategies for The Cochrane Library

Wiley InterScience	Wiley CD-Rom	Update Software
#1 MeSH descriptor Radius Fractures explode all trees in MeSH products	#1 MeSH descriptor radius fractures explode all trees	#1. RADIUS FRACTURES explode all trees (MeSH)
#2 MeSH descriptor Wrist Injuries explode all trees in MeSH products	#2 MeSH descriptor wrist injuries explode all trees	#2. WRIST INJURIES explode all trees (MeSH)
#3 (#1 OR #2)	#3 (#1 or #2)	#3. (#1 or #2)
#4 ((distal near radius) or (distal near radial)) in Title, Abstract or Keywords in all products	#4 ((distal in All Text near/6 radius in All Text) or (distal in All Text near/6 radial in All Text))	#4. ((distal near radius) or (distal near radial))
#5 (colles or smith or smiths) in Title, Abstract or Keywords in all products	#5 (colles in Record Title or smith in Record Title or smiths in Record Title)	#5. (colles:ti or smith:ti or smiths:ti)
#6 wrist* in Title, Abstract or Keywords in all products	#6 (colles in Abstract or smith in Abstract or smiths in Abstract)	#6. (colles:ab or smith:ab or smiths:ab)
#7 (#4 OR #5 OR #6)	#7 wrist* in All Text	#7. wrist*
#8 fractur* in Title, Abstract or Keywords in all products	#8 (#4 or #5 or #6 or #7)	#8. (#4 or #5 or #6 or #7)
#9 (#7 AND #8)	#9 fracture* in All Text	#9. fracture*
#10 (#3 OR #9)	#10 (#8 and #9)	#10. (#8 and #9)
	#11 (#3 or #10)	#11. (#3 or #10)

Table 02. Search strategies for CINAHL and EMBASE (OVID-WEB)

CINAHL	EMBASE
1. Radius Fractures/	1. (((distal adj3 (radius or radial)) or wrist or colles$2 or smith$2) adj3 fracture$).tw.
2. Wrist Injuries/	2. Colles Fracture/ or Radius Fracture/ or Wrist Fracture/ or Wrist Injury/
3. or/1-2	3. or/1-2
4. (((distal adj3 (radius or radial)) or wrist or colles or smith$2) adj3 fracture$).ti,ab.	4. exp Randomized Controlled trial/
5. or/3-4	5. exp Double Blind Procedure/
6. exp Clinical Trials/	6. exp Single Blind Procedure/
7. exp Evaluation Research/	7. exp Crossover Procedure/
8. exp Comparative Studies/	8. or/4-8
9. exp Crossover Design/	9. ((clinical or controlled or comparative or placebo or prospective$ or randomi#ed) adj3 (trial or study)).tw.
10. clinical trial.pt.	10. (random$ adj7 (allocat$ or allot$ or assign$ or basis$ or divid$ or order$)).tw.
11. or/6-10	11. ((singl$ or doubl$ or trebl$ or tripl$) adj7 (blind$ or mask$)).tw.
12. ((clinical or controlled or comparative or placebo or prospective or randomi#ed) adj3 (trial or study)).tw.	
13. (random$ adj7 (allocat$ or allot$ or assign$ or basis$ or divid$ or order$)).tw.	

Table 02. Search strategies for CINAHL and EMBASE (OVID-WEB) (*Continued*)

CINAHL	EMBASE
14. ((singl$ or doubl$ or trebl$ or tripl$) adj7 (blind$ or mask$)).tw. 15. (cross?over$ or (cross adj1 over$)).tw. 16. ((allocat$ or allot$ or assign$ or divid$) adj3 (condition$ or experiment$ or intervention$ or treatment$ or therap$ or control$ or group$)).tw. 17. or/12-16 18. or/11,17 19. and/5,18	12. (cross?over$ or (cross adj1 over$)).tw. 13. ((allocat$ or allot$ or assign$ or divid$) adj3 (condition$ or experiment$ or intervention$ or treatment$ or therap$ or control$ or group$)).tw. 14. or/9-13 15. or/8,14 16. Animal/ not Human/ 17. 15 not 16 18. and/3,17

Table 03. Methodological quality assessment scheme

Items	Scores	Notes
(1) Was the assigned treatment adequately concealed prior to allocation?	3 = method did not allow disclosure of assignment. 1 = small but possible chance of disclosure of assignment or unclear. 0 = quasi-randomised or open list/tables.	Cochrane code (see Handbook): Clearly yes = A; Not sure = B; Clearly no = C.
(2) Were the outcomes of trial participants who withdrew described and included in the analysis (intention to treat)?	3 = withdrawals well described and accounted for in analysis. 1 = withdrawals described and analysis not possible, or probably no withdrawals. 0 = no mention, inadequate mention, or obvious differences and no adjustment.	
(3) Were the outcome assessors blinded to treatment status?	3 = effective action taken to blind assessors. 1 = small or moderate chance of unblinding of assessors, or some blinding of outcomes attempted. 0 = not mentioned or not possible.	
(4) Were important baseline characteristics reported and comparable?	3 = good comparability of groups, or confounding adjusted for in analysis. 1 = confounding small, mentioned but not adjusted for, or comparability reported in text without confirmatory data. 0 = large potential for confounding, or not discussed.	The principal confounders considered were age, gender, type of fracture, type of treatment, existing co-morbidities (arthritis), prior functional and mental status, and complications.
(5) Were the participants blind to assignment status after allocation?	3 = effective action taken to blind participants. 1 = small or moderate chance of unblinding of participants. 0 = not possible, or not mentioned (unless double-blind), or possible but not done.	
(6) Were the treatment providers blind to assignment status?	3 = effective action taken to blind treatment providers. 1 = small or moderate chance of	

Table 03. Methodological quality assessment scheme (*Continued*)

Items	Scores	Notes
	unblinding of treatment providers. 0 = not possible, or not mentioned (unless double-blind), or possible but not done.	
(7) Were care programmes, other than the trial options, identical?	3 = care programmes clearly identical. 1 = clear but trivial differences, or some evidence of comparability. 0 = not mentioned or clear and important differences in care programmes.	Examples of clinically important differences in other interventions were: differences in treatment intervention (e.g. surgery, plaster cast; duration of immobilisation), differences in call back times for assessment, clinician experience and speciality.
(8) Were the inclusion and exclusion criteria for entry clearly defined?	3 = clearly defined (including type of treatment). 1 = inadequately defined. 0 = not defined.	
(9) Were the interventions clearly defined (including who provided the care)?	3 = clearly defined interventions are applied with a standardised protocol and care providers identified. 1 = clearly defined interventions are applied but the application protocol is not standardised or care providers identified. 0 = intervention and/or application protocol are poorly or not defined.	
(10) Were the outcome measures used clearly defined?	3 = clearly defined. 1 = inadequately defined. 0 = not defined.	
(11) Were the outcome measures clinically useful - with adequate accuracy, precision and considerations of observer variation - including active follow-up?	3 = optimal. 1 = adequate. 0 = not defined, not adequate.	
(12) Was the timing (e.g. duration of surveillance) clinically appropriate?	3 = optimal. (> 1 year) 1 = adequate. (6 months - 1 year) 0 = not defined, not adequate. (< 6 months)	

Table 04. Summary of rehabilitation interventions

Study ID	What	Who	When	Where	How long	Comments
	Intervention	Provider	Started	Location	Duration	Treatment for all or control group participants
Bache 2001	Physiotherapy	Physiotherapist	Within a week of plaster cast removal; 5-6 weeks immobilisation	Outpatients clinic	Contents and discharge at discretion of physiotherapists	All participants taught home exercises by physiotherapist at outpatients

Table 04. Summary of rehabilitation interventions (*Continued*)

Study ID	What	Who	When	Where	How long	Comments
						clinic
Basso 1998	Ultrasound	Not reported	After plaster cast removal; average 4 weeks immobilisation	Fracture clinic?	5 minutes	Sham control. All participants given instructions. Physiotherapy only if poor hand function
Cheing 2005	Pulsed electromagnetic field (PEMF) or ice, or both	Physiotherapist	After plaster cast removal; average 6 weeks immobilisation	Outpatients clinic?	30 minutes on each of 5 consecutive days	Sham PEMF. All participants taught home exercises by physiotherapist at outpatients clinic
Christensen 2001	Occupational therapy	Occupational therapist	After plaster cast removal; 5 weeks immobilisation	Rheumatology department	Twice weekly sessions until progress plateau	All had instructions for home exercises by occupational therapist
Cooper 2001	'Early' therapy - oedema management, exercises, monitoring, information	Hand therapist	After initial treatment; within 4 days of fracture	Clinic?	During immobilisation, routinely 4 weeks but up to 6 weeks as required. Weekly contact.	All had instructions for home programme: skin care, exercises, oedema control at fracture clinic. Post-immobilisation care comprised an individualised home programme and, if required, attendance of hand therapy group.
Gronlund 1990	Occupational therapy	Occupational therapist	After initial treatment; 1-3 days after plaster cast application	Rheumatoid disorders outpatients clinic	Single session with referral as required	All had instructions for home exercises by occupational therapist at casualty ward. Referral for occupational

Table 04. Summary of rehabilitation interventions (*Continued*)

Study ID	What	Who	When	Where	How long	Comments
						therapy if required after plaster cast removal
Kay 2000	Passive mobilisation	Physiotherapist	After plaster cast or plaster & pins removal; about 6 weeks immobilisation	Physiotherapy	6 week course	All attended physiotherapy for initial advice and instructions for home exercises given by physiotherapists
Maciel 2005	"Activity-focussed" physiotherapy	Physiotherapist	After plaster cast or plaster & pins (K-wire) removal; about 6 weeks immobilisation	Physiotherapy?	Up to 6 weeks, until return to regular wrist activity	All participants taught routine exercises by physiotherapist at fracture clinic on day of cast removal. Control group had single session of advice on exercises from physiotherapist within one week of trial entry
Pasila 1974	Advice & Instructions provided by physiotherapist; supervised exercises	Physiotherapist	After initial treatment; day after plaster cast application	Physical medicine department	Until physiotherapist considered patient able to carry on unsupervised	Control group had same oral & written instructions provided by physician/ surgeon
Rozencwaig 1996	Continuous passive motion	"Therapist", probably occupational therapist	After external fixation for 6-8 weeks	Not reported. Clinic?	Not reported. Until criteria for recovery met?	All participants had occupational therapy
Svensson 1993	Intermittent pneumatic compression	Occupational therapist	After plaster cast removal; treatment started 1-46 days afterwards	Rheumatological ward	20 minutes before each occupational therapy sessions: thrice weekly for 3 weeks	All participants had occupational therapy. Instructions for exercises given on first session
Taylor 1994	Passive	Physiotherapist	Within 3	Physiotherapy	5 minutes	Sham control:

Table 04. Summary of rehabilitation interventions (*Continued*)

Study ID	What	Who	When	Where	How long	Comments
	mobilisation		working days after plaster cast removal; 6 weeks immobilisation	department	during twice weekly physiotherapy sessions; sessions ended when acceptable function or function plateau	soft tissue massage. All participants had physiotherapy
Toomey 1986	Whirlpool	Physiotherapist	Within 6 days after plaster cast removal; average 6 weeks immobilisation	Physical medicine department	First 15 minutes scheduled twice weekly physiotherapy over 6 weeks.	Control group: towel wrap for 15 minutes
Wakefield 2000	Physiotherapy	Physiotherapist	After plaster cast removal; average 37 days immobilisation	Local hospital or clinic	Contents and discharge at discretion of physiotherapists	All participants taught home exercises by physiotherapist at fracture clinic
Watt 2000	Physiotherapy	Therapist; probably physiotherapist	After plaster cast removal; average 43 days immobilisation	Physiotherapy department	Contents and discharge at discretion of therapists	Control group had oral and written instructions provided by surgeon/registrar

ANALYSES

Comparison 01. Early (during immobilisation) occupational or hand therapy

Outcome title	No. of studies	No. of participants	Statistical method	Effect size
01 Meeting criteria for attendance of post-immobilisation hand therapy group			Relative Risk (Fixed) 95% CI	Totals not selected
02 Grip strength (kg) at 4 weeks (post immobilisation)			Weighted Mean Difference (Fixed) 95% CI	Totals not selected
03 Range of motion at 4 weeks (post immobilisation)			Weighted Mean Difference (Fixed) 95% CI	Totals not selected
04 Oedema (ml) at 4 weeks (post immobilisation)			Weighted Mean Difference (Fixed) 95% CI	Totals not selected
05 Any pain at rest at 4 weeks (post immobilisation)			Relative Risk (Fixed) 95% CI	Totals not selected
06 Finger mobility at 4 weeks (post immobilisation)			Weighted Mean Difference (Fixed) 95% CI	Totals not selected
07 Complications			Relative Risk (Fixed) 95% CI	Totals not selected

Comparison 02. Post immobilisation occupational or physiotherapy

Outcome title	No. of studies	No. of participants	Statistical method	Effect size
01 Patient-Rated Wrist Evaluation (PRWE) at 24 weeks (%: 100% = worst results)			Weighted Mean Difference (Fixed) 95% CI	Totals not selected
02 Activities of daily living scores (% of unaffected side)			Weighted Mean Difference (Fixed) 95% CI	Totals not selected
03 Grip strength (kg)			Weighted Mean Difference (Fixed) 95% CI	Totals not selected
04 Grip strength (% of unaffected side)			Weighted Mean Difference (Fixed) 95% CI	Totals not selected
05 Pain (VAS: none to worst imaginable at 10 cm)			Weighted Mean Difference (Fixed) 95% CI	Totals not selected
06 Range of motion at 24 weeks			Weighted Mean Difference (Fixed) 95% CI	Totals not selected
07 Range of motion (% of unaffected side) at 3 months			Weighted Mean Difference (Fixed) 95% CI	Totals not selected
08 Range of motion (% of unaffected side) at 6 months			Weighted Mean Difference (Fixed) 95% CI	Totals not selected
09 Number of treatments			Weighted Mean Difference (Fixed) 95% CI	Totals not selected
10 Complications			Relative Risk (Fixed) 95% CI	Totals not selected

Comparison 03. Continuous passive motion (CPM) (post external fixation)

Outcome title	No. of studies	No. of participants	Statistical method	Effect size
01 Time to recover independence (weeks)			Weighted Mean Difference (Fixed) 95% CI	Totals not selected

Comparison 04. Pulsed electromagnetic field (PEMF) (post immobilisation)

Outcome title	No. of studies	No. of participants	Statistical method	Effect size
01 Pain and volume at day 5			Weighted Mean Difference (Fixed) 95% CI	Totals not selected
02 Range of motion at day 5			Weighted Mean Difference (Fixed) 95% CI	Totals not selected

Comparison 05. Ice (post immobilisation)

Outcome title	No. of studies	No. of participants	Statistical method	Effect size
01 Pain and volume at day 5			Weighted Mean Difference (Fixed) 95% CI	Totals not selected
02 Range of motion at day 5			Weighted Mean Difference (Fixed) 95% CI	Totals not selected

Comparison 06. Pulsed electromagnetic field (PEMF) plus ice (post immobilisation)

Outcome title	No. of studies	No. of participants	Statistical method	Effect size
01 Pain and volume at day 5			Weighted Mean Difference (Fixed) 95% CI	Totals not selected
02 Range of motion at day 5			Weighted Mean Difference (Fixed) 95% CI	Totals not selected

Comparison 07. Passive mobilisation (post immobilisation)

Outcome title	No. of studies	No. of participants	Statistical method	Effect size
01 Grip strength (kg) at 6 weeks			Weighted Mean Difference (Fixed) 95% CI	Totals not selected
02 Range of motion at 6 weeks			Weighted Mean Difference (Fixed) 95% CI	Totals not selected
03 Web space angle (degrees) at 6 weeks			Weighted Mean Difference (Fixed) 95% CI	Totals not selected
04 Wrist extension at discharge (4 weeks)			Weighted Mean Difference (Fixed) 95% CI	Totals not selected
05 Number of treatments			Weighted Mean Difference (Fixed) 95% CI	Totals not selected
06 Time to discharge (days)			Weighted Mean Difference (Fixed) 95% CI	Totals not selected
07 Complications at 6 weeks			Relative Risk (Fixed) 95% CI	Totals not selected

Comparison 08. Low frequency, long-wave ultrasound (post immobilisation)

Outcome title	No. of studies	No. of participants	Statistical method	Effect size
01 Greater than 30% loss of wrist motion (flexion-extension) at 8 weeks			Relative Risk (Fixed) 95% CI	Totals not selected
02 Referral for physiotherapy			Relative Risk (Fixed) 95% CI	Totals not selected

Comparison 09. Whirlpool (post immobilisation)

Outcome title	No. of studies	No. of participants	Statistical method	Effect size
01 Grip strength at end of treatment (kg)			Weighted Mean Difference (Fixed) 95% CI	Totals not selected
02 Pain (scale 0: no pain to 5: excruciating) at end of treatment			Weighted Mean Difference (Fixed) 95% CI	Totals not selected
03 Range of motion at end of treatment			Weighted Mean Difference (Fixed) 95% CI	Totals not selected
04 Finger flexion at end of treatment			Weighted Mean Difference (Fixed) 95% CI	Totals not selected
05 Oedema (ml)			Weighted Mean Difference (Fixed) 95% CI	Totals not selected

Comparison 10. Post immobilisation physiotherapy versus instructions from physician

Outcome title	No. of studies	No. of participants	Statistical method	Effect size
01 Wrist extension (degrees) at 6 weeks			Weighted Mean Difference (Fixed) 95% CI	Totals not selected

Comparison 11. Pulsed electromagnetic field (PEMF) versus ice (post immobilisation)

Outcome title	No. of studies	No. of participants	Statistical method	Effect size
01 Pain and volume at day 5			Weighted Mean Difference (Fixed) 95% CI	Totals not selected
02 Range of motion at day 5			Weighted Mean Difference (Fixed) 95% CI	Totals not selected

Comparison 12. Supervised training by physiotherapist versus instructions by physician (from definitive treatment)

Outcome title	No. of studies	No. of participants	Statistical method	Effect size
01 Strength and power at 12 weeks			Weighted Mean Difference (Fixed) 95% CI	Totals not selected
02 Range of motion at 12 weeks			Weighted Mean Difference (Fixed) 95% CI	Totals not selected

INDEX TERMS

Medical Subject Headings (MeSH)

Fractures, Bone [rehabilitation]; Radius Fractures [*rehabilitation]; Wrist Injuries [*rehabilitation]

MeSH check words

Adult; Aged; Female; Humans; Male

COVER SHEET

Title

Rehabilitation for distal radial fractures in adults

Authors

Handoll HHG, Madhok R, Howe TE

Contribution of author(s)

Helen Handoll (HH) initiated and co-ordinated the production of the review, starting with the compilation of the first draft of the protocol and subsequent revisions in RevMan. Rajan Madhok (RM) arranged funding for the initial review. RM and Tracey Howe (TH) critically rewrote the protocol.
HH located the review studies. All three authors selected studies, critically reviewed the included studies and piloted the quality assessment and data extraction forms. HH and TH extracted trial details and results. HH contacted all trialists for further information. HH compiled the first draft and all subsequent revisions in RevMan. TH and RM critically reviewed and checked all review drafts.
For the first and second updates: HH searched for further review studies, contacted trialists, and compiled the first drafts, which were then critically reviewed by TH and RM.
For the third update, HH located the review studies and contacted trialists. All three authors selected studies, and extracted data and quality assessed the newly included studies. HH compiled the first draft and all subsequent revisions in RevMan. TH and RM critically reviewed and checked all review drafts. All three authors are guarantors of the review.

Issue protocol first published

2001/4

Review first published

2002/2

Date of most recent amendment

08 June 2006

Date of most recent SUBSTANTIVE amendment

09 May 2006

What's New

In this substantive update (Issue 3, 2006) the search for trials was updated to December 2005. We identified six new studies and one full report of a trial formerly listed as an

ongoing study. Of these, we included three studies, excluded three studies and placed one study into 'Studies awaiting assessment'. We further excluded one study previously awaiting assessment. There were several format changes made to comply with the Cochrane Style Guide (October 2005). Graphical presentations of the results were modified with totals removed in all cases. There were no substantive changes made to the conclusions.
For details of previous updates, please see 'Notes'.

Date new studies sought but none found	14 December 2005
Date new studies found but not yet included/excluded	Information not supplied by author
Date new studies found and included/excluded	23 November 2005
Date authors' conclusions section amended	Information not supplied by author
Contact address	Dr Helen Handoll University of Teesside c/o University Department of Orthopaedic Surgery Royal Infirmary of Edinburgh Old Dalkeith Road Little France Edinburgh EH16 4SU UK E-mail: h.handoll@ed.ac.uk Tel: +44 131 2423499 Fax: +44 131 2426467
DOI	10.1002/14651858.CD003324.pub2
Cochrane Library number	CD003324
Editorial group	Cochrane Bone, Joint and Muscle Trauma Group (formerly the Musculoskeletal Injuries Group)
Editorial group code	HM-MUSKINJ

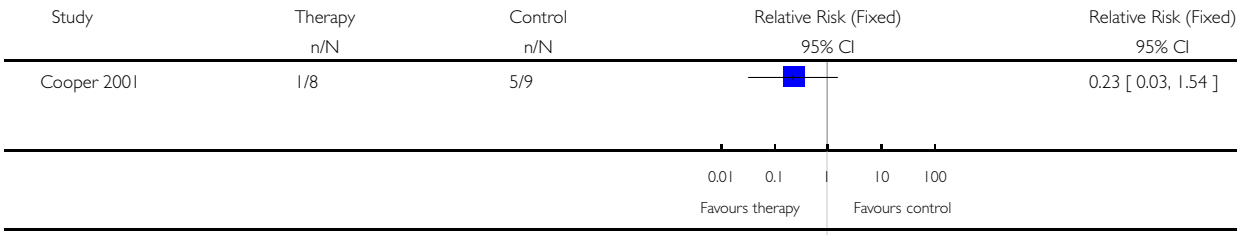
GRAPHS AND OTHER TABLES

Analysis 01.01. Comparison 01 Early (during immobilisation) occupational or hand therapy, Outcome 01 Meeting criteria for attendance of post-immobilisation hand therapy group

Review: Rehabilitation for distal radial fractures in adults

Comparison: 01 Early (during immobilisation) occupational or hand therapy

Outcome: 01 Meeting criteria for attendance of post-immobilisation hand therapy group



Analysis 01.02. Comparison 01 Early (during immobilisation) occupational or hand therapy, Outcome 02 Grip strength (kg) at 4 weeks (post immobilisation)

Review: Rehabilitation for distal radial fractures in adults

Comparison: 01 Early (during immobilisation) occupational or hand therapy

Outcome: 02 Grip strength (kg) at 4 weeks (post immobilisation)

Study	Therapy		Control		Weighted Mean Difference (Fixed)	Weighted Mean Difference (Fixed)
	N	Mean(SD)	N	Mean(SD)	95% CI	95% CI
Cooper 2001	8	17.15 (7.29)	9	9.87 (5.07)		7.28 [1.24, 13.32]

Analysis 01.03. Comparison 01 Early (during immobilisation) occupational or hand therapy, Outcome 03 Range of motion at 4 weeks (post immobilisation)

Review: Rehabilitation for distal radial fractures in adults

Comparison: 01 Early (during immobilisation) occupational or hand therapy

Outcome: 03 Range of motion at 4 weeks (post immobilisation)

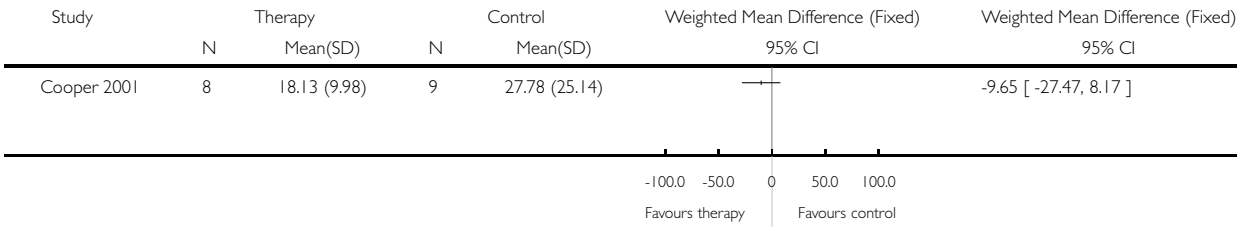
Study	Therapy		Control		Weighted Mean Difference (Fixed)	Weighted Mean Difference (Fixed)
	N	Mean(SD)	N	Mean(SD)	95% CI	95% CI
01 Pronation (degrees)						
Cooper 2001	8	85.00 (11.65)	9	75.22 (13.94)		9.78 [-2.39, 21.95]
02 Supination (degrees)						
Cooper 2001	8	85.00 (7.56)	9	66.67 (16.39)		18.33 [6.41, 30.25]
03 Flexion (degrees)						
Cooper 2001	8	51.75 (10.62)	9	42.22 (9.83)		9.53 [-0.24, 19.30]
04 Extension (degrees)						
Cooper 2001	8	54.38 (12.06)	9	43.44 (8.79)		10.94 [0.80, 21.08]
05 Radial deviation (degrees)						
Cooper 2001	8	19.75 (4.80)	9	17.78 (5.40)		1.97 [-2.88, 6.82]
06 Ulnar deviation (degrees)						
Cooper 2001	8	35.25 (7.19)	9	20.22 (2.54)		15.03 [9.78, 20.28]

Analysis 01.04. Comparison 01 Early (during immobilisation) occupational or hand therapy, Outcome 04 Oedema (ml) at 4 weeks (post immobilisation)

Review: Rehabilitation for distal radial fractures in adults

Comparison: 01 Early (during immobilisation) occupational or hand therapy

Outcome: 04 Oedema (ml) at 4 weeks (post immobilisation)

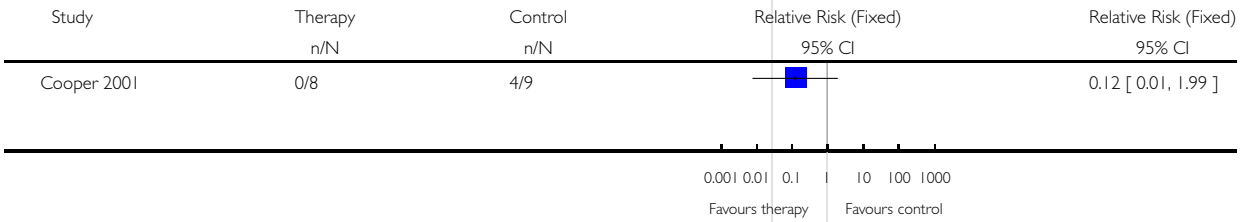


Analysis 01.05. Comparison 01 Early (during immobilisation) occupational or hand therapy, Outcome 05 Any pain at rest at 4 weeks (post immobilisation)

Review: Rehabilitation for distal radial fractures in adults

Comparison: 01 Early (during immobilisation) occupational or hand therapy

Outcome: 05 Any pain at rest at 4 weeks (post immobilisation)



Analysis 01.06. Comparison 01 Early (during immobilisation) occupational or hand therapy, Outcome 06 Finger mobility at 4 weeks (post immobilisation)

Review: Rehabilitation for distal radial fractures in adults

Comparison: 01 Early (during immobilisation) occupational or hand therapy

Outcome: 06 Finger mobility at 4 weeks (post immobilisation)

Study	Therapy N	Therapy Mean(SD)	Control N	Control Mean(SD)	Weighted Mean Difference (Fixed) 95% CI	Weighted Mean Difference (Fixed) 95% CI
01 Kapandji score (thumb opposition, 1 to 10 locations of increasing difficulty)						
Cooper 2001	8	9.13 (0.83)	9	6.67 (1.58)		2.46 [1.28, 3.64]
02 Index finger TAM (total active motion) (degrees)						
Cooper 2001	8	247.38 (18.21)	9	206.44 (15.48)		40.94 [24.77, 57.11]
03 Middle finger TAM (degrees)						
Cooper 2001	8	252.38 (11.24)	9	209.33 (17.18)		43.05 [29.39, 56.71]
04 Ring finger TAM (degrees)						
Cooper 2001	8	253.63 (13.44)	9	208.11 (16.72)		45.52 [31.17, 59.87]
05 Little finger TAM (degrees)						
Cooper 2001	8	255.63 (13.20)	9	211.89 (17.67)		43.74 [29.01, 58.47]

Analysis 01.07. Comparison 01 Early (during immobilisation) occupational or hand therapy, Outcome 07 Complications

Review: Rehabilitation for distal radial fractures in adults

Comparison: 01 Early (during immobilisation) occupational or hand therapy

Outcome: 07 Complications

Study	Therapy n/N	Control n/N	Relative Risk (Fixed) 95% CI	Relative Risk (Fixed) 95% CI
01 Reflex sympathetic dystropy				
× Cooper 2001	0/8	0/9		Not estimable
Gronlund 1990	3/17	2/23		2.03 [0.38, 10.84]
02 Median nerve compression				
× Gronlund 1990	0/17	0/23		Not estimable
03 Ulnar nerve compression				
× Gronlund 1990	0/17	0/23		Not estimable
04 Tendon rupture				
× Gronlund 1990	0/17	0/23		Not estimable

Analysis 02.01. Comparison 02 Post immobilisation occupational or physiotherapy, Outcome 01 Patient-Rated Wrist Evaluation (PRWE) at 24 weeks (%: 100% = worst results)

Review: Rehabilitation for distal radial fractures in adults

Comparison: 02 Post immobilisation occupational or physiotherapy

Outcome: 01 Patient-Rated Wrist Evaluation (PRWE) at 24 weeks (%: 100% = worst results)

Study	Therapy		Control		Weighted Mean Difference (Fixed)	Weighted Mean Difference (Fixed)
	N	Mean(SD)	N	Mean(SD)	95% CI	95% CI
01 Overall result						
Maciel 2005	19	21.40 (24.50)	14	24.80 (22.20)		-3.40 [-19.42, 12.62]
02 Pain items						
Maciel 2005	19	26.30 (25.40)	14	28.90 (21.30)		-2.60 [-18.57, 13.37]
03 Activity items						
Maciel 2005	19	19.60 (29.40)	14	24.70 (26.40)		-5.10 [-24.23, 14.03]
04 Disability items						
Maciel 2005	19	13.70 (23.90)	14	18.30 (25.00)		-4.60 [-21.54, 12.34]

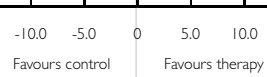
Analysis 02.02. Comparison 02 Post immobilisation occupational or physiotherapy, Outcome 02 Activities of daily living scores (% of unaffected side)

Review: Rehabilitation for distal radial fractures in adults

Comparison: 02 Post immobilisation occupational or physiotherapy

Outcome: 02 Activities of daily living scores (% of unaffected side)

Study	Therapy		Control		Weighted Mean Difference (Fixed)	Weighted Mean Difference (Fixed)
	N	Mean(SD)	N	Mean(SD)	95% CI	95% CI
01 3 months						
Wakefield 2000	47	88.30 (9.60)	43	87.60 (9.84)		0.70 [-3.32, 4.72]
02 6 months						
Wakefield 2000	34	94.50 (8.75)	32	94.20 (8.49)		0.30 [-3.86, 4.46]



Analysis 02.03. Comparison 02 Post immobilisation occupational or physiotherapy, Outcome 03 Grip strength (kg)

Review: Rehabilitation for distal radial fractures in adults

Comparison: 02 Post immobilisation occupational or physiotherapy

Outcome: 03 Grip strength (kg)

Study	Therapy N	Therapy Mean(SD)	Control N	Control Mean(SD)	Weighted Mean Difference (Fixed) 95% CI	Weighted Mean Difference (Fixed) 95% CI
01 3 months						
Christensen 2001	16	10.70 (5.28)	14	10.82 (4.25)		-0.12 [-3.53, 3.29]
02 24 weeks						
Maciel 2005	19	19.00 (14.00)	14	20.80 (11.10)		-1.80 [-10.37, 6.77]
03 9 months						
Christensen 2001	16	13.76 (4.77)	14	13.91 (3.97)		-0.15 [-3.28, 2.98]

Analysis 02.04. Comparison 02 Post immobilisation occupational or physiotherapy, Outcome 04 Grip strength (% of unaffected side)

Review: Rehabilitation for distal radial fractures in adults

Comparison: 02 Post immobilisation occupational or physiotherapy

Outcome: 04 Grip strength (% of unaffected side)

Study	Therapy N	Therapy Mean(SD)	Control N	Control Mean(SD)	Weighted Mean Difference (Fixed) 95% CI	Weighted Mean Difference (Fixed) 95% CI
01 3 months						
Wakefield 2000	47	41.60 (29.48)	43	40.70 (30.16)		0.90 [-11.44, 13.24]
02 6 months						
Wakefield 2000	34	68.50 (35.57)	32	67.30 (35.64)		1.20 [-15.99, 18.39]

Analysis 02.05. Comparison 02 Post immobilisation occupational or physiotherapy, Outcome 05 Pain (VAS: none to worst imaginable at 10 cm)

Review: Rehabilitation for distal radial fractures in adults

Comparison: 02 Post immobilisation occupational or physiotherapy

Outcome: 05 Pain (VAS: none to worst imaginable at 10 cm)

Study	Therapy		Control		Weighted Mean Difference (Fixed)	Weighted Mean Difference (Fixed)
	N	Mean(SD)	N	Mean(SD)	95% CI	95% CI
01 3 months						
Wakefield 2000	47	1.40 (1.60)	43	1.40 (1.70)		0.00 [-0.68, 0.68]
02 6 months						
Wakefield 2000	34	0.90 (1.60)	32	0.80 (1.40)		0.10 [-0.62, 0.82]

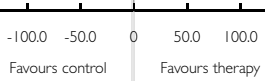
Analysis 02.06. Comparison 02 Post immobilisation occupational or physiotherapy, Outcome 06 Range of motion at 24 weeks

Review: Rehabilitation for distal radial fractures in adults

Comparison: 02 Post immobilisation occupational or physiotherapy

Outcome: 06 Range of motion at 24 weeks

Study	Therapy		Control		Weighted Mean Difference (Fixed)	Weighted Mean Difference (Fixed)
	N	Mean(SD)	N	Mean(SD)	95% CI	95% CI
01 Flexion (degrees)						
Maciel 2005	19	50.70 (15.60)	14	51.30 (11.60)		-0.60 [-9.88, 8.68]
02 Extension (degrees)						
Maciel 2005	19	56.70 (16.50)	14	54.30 (14.40)		2.40 [-8.18, 12.98]



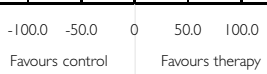
Analysis 02.07. Comparison 02 Post immobilisation occupational or physiotherapy, Outcome 07 Range of motion (% of unaffected side) at 3 months

Review: Rehabilitation for distal radial fractures in adults

Comparison: 02 Post immobilisation occupational or physiotherapy

Outcome: 07 Range of motion (% of unaffected side) at 3 months

Study	Therapy N	Therapy Mean(SD)	Control N	Control Mean(SD)	Weighted Mean Difference (Fixed) 95% CI	Weighted Mean Difference (Fixed) 95% CI
01 Pronation-supination						
Wakefield 2000	47	92.70 (6.86)	43	93.20 (6.56)		-0.50 [-3.27, 2.27]
02 Flexion-extension						
Wakefield 2000	47	82.90 (1.80)	43	80.00 (12.46)		2.90 [-0.86, 6.66]
03 Radial-ulnar deviation						
Wakefield 2000	47	85.10 (16.45)	43	81.80 (16.39)		3.30 [-3.49, 10.09]



Analysis 02.08. Comparison 02 Post immobilisation occupational or physiotherapy, Outcome 08 Range of motion (% of unaffected side) at 6 months

Review: Rehabilitation for distal radial fractures in adults

Comparison: 02 Post immobilisation occupational or physiotherapy

Outcome: 08 Range of motion (% of unaffected side) at 6 months

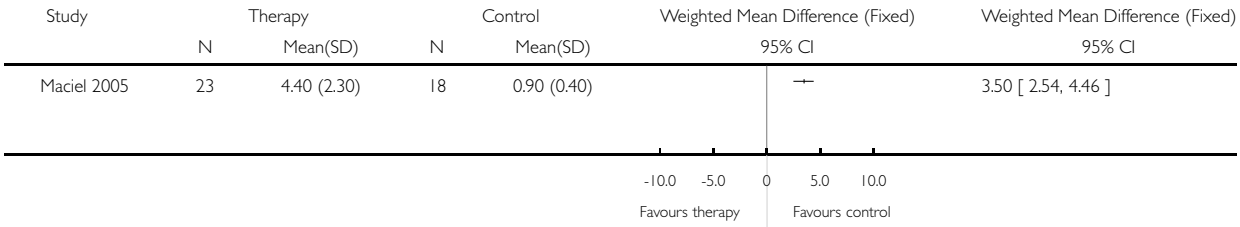
Study	Therapy N	Therapy Mean(SD)	Control N	Control Mean(SD)	Weighted Mean Difference (Fixed) 95% CI	Weighted Mean Difference (Fixed) 95% CI
01 Pronation-supination						
Wakefield 2000	34	96.50 (4.66)	32	95.60 (4.53)		0.90 [-1.32, 3.12]
02 Flexion-extension						
Wakefield 2000	34	96.60 (13.99)	32	84.40 (14.14)		12.20 [5.41, 18.99]
03 Radial-ulnar deviation						
Wakefield 2000	34	94.20 (16.91)	32	91.00 (16.97)		3.20 [-4.98, 11.38]

Analysis 02.09. Comparison 02 Post immobilisation occupational or physiotherapy, Outcome 09 Number of treatments

Review: Rehabilitation for distal radial fractures in adults

Comparison: 02 Post immobilisation occupational or physiotherapy

Outcome: 09 Number of treatments

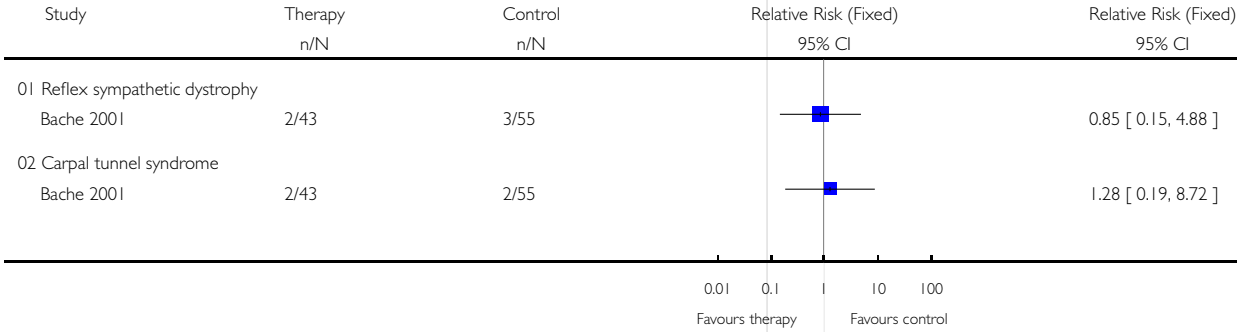


Analysis 02.10. Comparison 02 Post immobilisation occupational or physiotherapy, Outcome 10 Complications

Review: Rehabilitation for distal radial fractures in adults

Comparison: 02 Post immobilisation occupational or physiotherapy

Outcome: 10 Complications

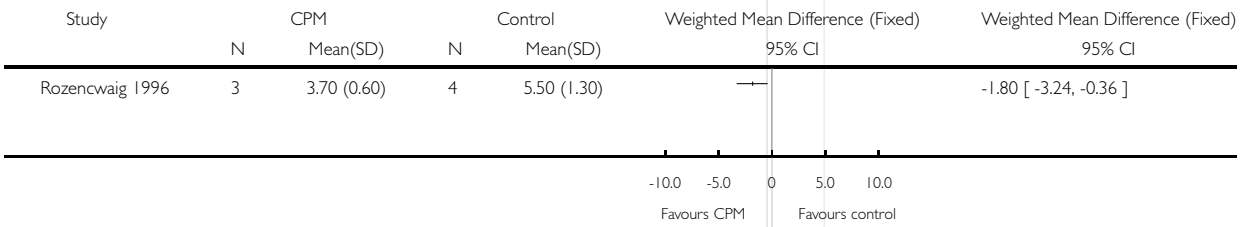


Analysis 03.01. Comparison 03 Continuous passive motion (CPM) (post external fixation), Outcome 01 Time to recover independence (weeks)

Review: Rehabilitation for distal radial fractures in adults

Comparison: 03 Continuous passive motion (CPM) (post external fixation)

Outcome: 01 Time to recover independence (weeks)



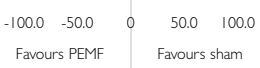
Analysis 04.01. Comparison 04 Pulsed electromagnetic field (PEMF) (post immobilisation), Outcome 01 Pain and volume at day 5

Review: Rehabilitation for distal radial fractures in adults

Comparison: 04 Pulsed electromagnetic field (PEMF) (post immobilisation)

Outcome: 01 Pain and volume at day 5

Study	PEMF N	PEMF Mean(SD)	Sham N	Sham Mean(SD)	Weighted Mean Difference (Fixed) 95% CI	Weighted Mean Difference (Fixed) 95% CI
01 Pain (scale 0: no pain to 10 cm: worst imaginable) during active wrist movements						
Cheing 2005	45	2.94 (1.36)	38	2.58 (0.98)		0.36 [-0.14, 0.86]
02 Volume (ml)						
Cheing 2005	45	432.60 (74.70)	38	421.79 (59.24)		10.81 [-18.02, 39.64]



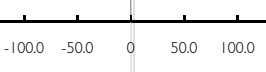
Analysis 04.02. Comparison 04 Pulsed electromagnetic field (PEMF) (post immobilisation), Outcome 02 Range of motion at day 5

Review: Rehabilitation for distal radial fractures in adults

Comparison: 04 Pulsed electromagnetic field (PEMF) (post immobilisation)

Outcome: 02 Range of motion at day 5

Study	PEMF N	PEMF Mean(SD)	Sham N	Sham Mean(SD)	Weighted Mean Difference (Fixed) 95% CI	Weighted Mean Difference (Fixed) 95% CI
01 Pronation (degrees)						
Cheing 2005	45	69.55 (17.88)	38	66.63 (19.16)		2.92 [-5.11, 10.95]
02 Supination (degrees)						
Cheing 2005	45	57.01 (23.48)	38	60.27 (26.75)		-3.26 [-14.19, 7.67]
03 Flexion (degrees)						
Cheing 2005	45	45.02 (12.30)	38	43.17 (11.97)		1.85 [-3.38, 7.08]
04 Extension (degrees)						
Cheing 2005	45	41.64 (10.18)	38	41.56 (12.51)		0.08 [-4.89, 5.05]
05 Radial deviation (degrees)						
Cheing 2005	45	12.56 (9.73)	38	11.04 (5.85)		1.52 [-1.88, 4.92]
06 Ulnar deviation (degrees)						
Cheing 2005	45	20.45 (4.65)	38	18.34 (5.10)		2.11 [-0.01, 4.23]



Analysis 05.01. Comparison 05 Ice (post immobilisation), Outcome 01 Pain and volume at day 5

Review: Rehabilitation for distal radial fractures in adults

Comparison: 05 Ice (post immobilisation)

Outcome: 01 Pain and volume at day 5

Study	Ice N	Ice Mean(SD)	No ice N	No ice Mean(SD)	Weighted Mean Difference (Fixed) 95% CI	Weighted Mean Difference (Fixed) 95% CI
01 Pain (scale 0: no pain to 10 cm: worst imaginable) during active wrist movements						
Cheing 2005	45	2.40 (1.23)	38	3.22 (1.16)		-0.82 [-1.33, -0.31]
02 Volume (ml)						
Cheing 2005	45	423.80 (58.10)	38	432.21 (78.38)		-8.41 [-38.56, 21.74]

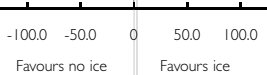
Analysis 05.02. Comparison 05 Ice (post immobilisation), Outcome 02 Range of motion at day 5

Review: Rehabilitation for distal radial fractures in adults

Comparison: 05 Ice (post immobilisation)

Outcome: 02 Range of motion at day 5

Study	Ice N	Ice Mean(SD)	No ice N	No ice Mean(SD)	Weighted Mean Difference (Fixed) 95% CI	Weighted Mean Difference (Fixed) 95% CI
01 Pronation (degrees)						
Cheing 2005	45	68.92 (19.02)	38	67.38 (17.81)		1.54 [-6.39, 9.47]
02 Supination (degrees)						
Cheing 2005	45	55.69 (26.64)	38	61.83 (22.94)		-6.14 [-16.81, 4.53]
03 Flexion (degrees)						
Cheing 2005	45	44.34 (11.36)	38	43.98 (13.03)		0.36 [-4.95, 5.67]
04 Extension (degrees)						
Cheing 2005	45	37.53 (13.45)	38	46.42 (8.02)		-8.89 [-13.57, -4.21]
05 Radial deviation (degrees)						
Cheing 2005	45	11.99 (9.93)	38	11.74 (5.43)		0.25 [-3.13, 3.63]
06 Ulnar deviation (degrees)						
Cheing 2005	45	20.01 (4.90)	38	18.86 (4.81)		1.15 [-0.94, 3.24]



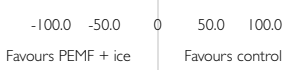
Analysis 06.01. Comparison 06 Pulsed electromagnetic field (PEMF) plus ice (post immobilisation), Outcome 01 Pain and volume at day 5

Review: Rehabilitation for distal radial fractures in adults

Comparison: 06 Pulsed electromagnetic field (PEMF) plus ice (post immobilisation)

Outcome: 01 Pain and volume at day 5

Study	PEMF + Ice		Control		Weighted Mean Difference (Fixed)	Weighted Mean Difference (Fixed)
	N	Mean(SD)	N	Mean(SD)	95% CI	95% CI
01 Pain (scale 0: no pain to 10 cm: worst imaginable) during active wrist movements						
Cheing 2005	23	2.60 (1.50)	16	3.10 (1.10)		-0.50 [-1.32, 0.32]
02 Volume (ml)						
Cheing 2005	23	437.00 (67.00)	16	438.00 (73.00)		-1.00 [-46.05, 44.05]



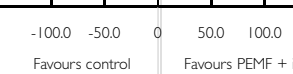
Analysis 06.02. Comparison 06 Pulsed electromagnetic field (PEMF) plus ice (post immobilisation), Outcome 02 Range of motion at day 5

Review: Rehabilitation for distal radial fractures in adults

Comparison: 06 Pulsed electromagnetic field (PEMF) plus ice (post immobilisation)

Outcome: 02 Range of motion at day 5

Study	PEMF + ice		Control		Weighted Mean Difference (Fixed)	Weighted Mean Difference (Fixed)
	N	Mean(SD)	N	Mean(SD)	95% CI	95% CI
01 Pronation (degrees)						
Cheing 2005	23	67.40 (20.60)	16	61.30 (21.60)		6.10 [-7.42, 19.62]
02 Supination (degrees)						
Cheing 2005	23	50.70 (26.30)	16	59.40 (26.40)		-8.70 [-25.52, 8.12]
03 Flexion (degrees)						
Cheing 2005	23	46.10 (11.70)	16	44.10 (13.20)		2.00 [-6.04, 10.04]
04 Extension (degrees)						
Cheing 2005	23	36.70 (13.30)	16	45.90 (10.80)		-9.20 [-16.79, -1.61]
05 Radial deviation (degrees)						
Cheing 2005	23	13.70 (12.80)	16	12.20 (6.30)		1.50 [-4.57, 7.57]
06 Ulnar deviation (degrees)						
Cheing 2005	23	20.40 (4.70)	16	16.60 (5.10)		3.80 [0.65, 6.95]



Analysis 07.01. Comparison 07 Passive mobilisation (post immobilisation), Outcome 01 Grip strength (kg) at 6 weeks

Review: Rehabilitation for distal radial fractures in adults

Comparison: 07 Passive mobilisation (post immobilisation)

Outcome: 01 Grip strength (kg) at 6 weeks

Study	Passive mobilisation		Control		Weighted Mean Difference (Fixed)	Weighted Mean Difference (Fixed)
	N	Mean(SD)	N	Mean(SD)	95% CI	95% CI
Kay 2000	19	17.30 (7.40)	20	20.00 (13.30)		-2.70 [-9.41, 4.01]

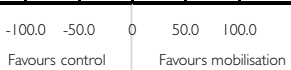
Analysis 07.02. Comparison 07 Passive mobilisation (post immobilisation), Outcome 02 Range of motion at 6 weeks

Review: Rehabilitation for distal radial fractures in adults

Comparison: 07 Passive mobilisation (post immobilisation)

Outcome: 02 Range of motion at 6 weeks

Study	Passive mobilisation		Control		Weighted Mean Difference (Fixed)	Weighted Mean Difference (Fixed)
	N	Mean(SD)	N	Mean(SD)	95% CI	95% CI
01 Pronation (degrees)						
Kay 2000	19	77.60 (8.40)	20	75.30 (7.90)		2.30 [-2.82, 7.42]
02 Supination (degrees)						
Kay 2000	19	70.30 (10.20)	20	66.30 (15.80)		4.00 [-4.31, 12.31]
03 Flexion (degrees)						
Kay 2000	19	51.80 (10.70)	20	50.50 (13.40)		1.30 [-6.29, 8.89]
04 Extension (degrees)						
Kay 2000	19	61.60 (13.20)	20	58.30 (12.60)		3.30 [-4.81, 11.41]
05 Radial deviation (degrees)						
Kay 2000	19	20.00 (5.30)	20	18.50 (5.40)		1.50 [-1.86, 4.86]
06 Ulnar deviation (degrees)						
Kay 2000	19	22.40 (6.10)	20	19.50 (6.70)		2.90 [-1.12, 6.92]



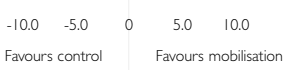
Analysis 07.03. Comparison 07 Passive mobilisation (post immobilisation), Outcome 03 Web space angle (degrees) at 6 weeks

Review: Rehabilitation for distal radial fractures in adults

Comparison: 07 Passive mobilisation (post immobilisation)

Outcome: 03 Web space angle (degrees) at 6 weeks

Study	Passive mobilisation		Control		Weighted Mean Difference (Fixed)	Weighted Mean Difference (Fixed)
	N	Mean(SD)	N	Mean(SD)	95% CI	95% CI
Kay 2000	19	46.80 (6.30)	20	48.00 (8.20)		-1.20 [-5.78, 3.38]



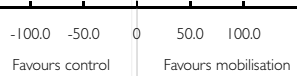
Analysis 07.04. Comparison 07 Passive mobilisation (post immobilisation), Outcome 04 Wrist extension at discharge (4 weeks)

Review: Rehabilitation for distal radial fractures in adults

Comparison: 07 Passive mobilisation (post immobilisation)

Outcome: 04 Wrist extension at discharge (4 weeks)

Study	Passive mobilisation		Control		Weighted Mean Difference (Fixed)	Weighted Mean Difference (Fixed)
	N	Mean(SD)	N	Mean(SD)	95% CI	95% CI
Taylor 1994	15	52.73 (13.67)	15	54.87 (9.08)		-2.14 [-10.44, 6.16]



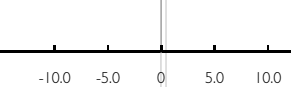
Analysis 07.05. Comparison 07 Passive mobilisation (post immobilisation), Outcome 05 Number of treatments

Review: Rehabilitation for distal radial fractures in adults

Comparison: 07 Passive mobilisation (post immobilisation)

Outcome: 05 Number of treatments

Study	Passive mobilisation		Control		Weighted Mean Difference (Fixed)	Weighted Mean Difference (Fixed)
	N	Mean(SD)	N	Mean(SD)	95% CI	95% CI
Kay 2000	19	9.10 (0.70)	20	3.20 (0.90)		5.90 [5.40, 6.40]
Taylor 1994	15	7.30 (2.45)	15	6.50 (2.50)		0.80 [-0.97, 2.57]

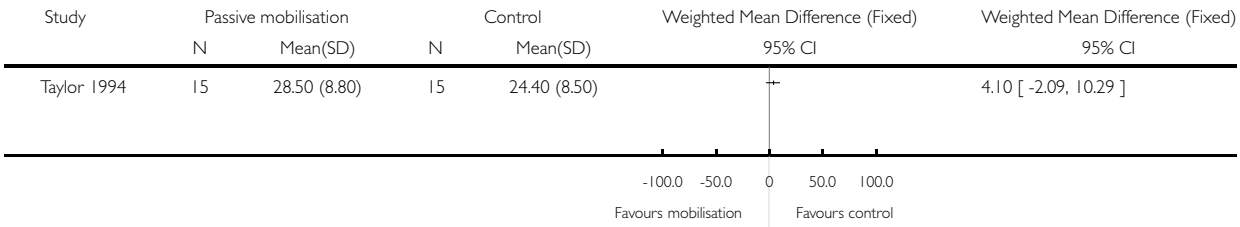


Analysis 07.06. Comparison 07 Passive mobilisation (post immobilisation), Outcome 06 Time to discharge (days)

Review: Rehabilitation for distal radial fractures in adults

Comparison: 07 Passive mobilisation (post immobilisation)

Outcome: 06 Time to discharge (days)

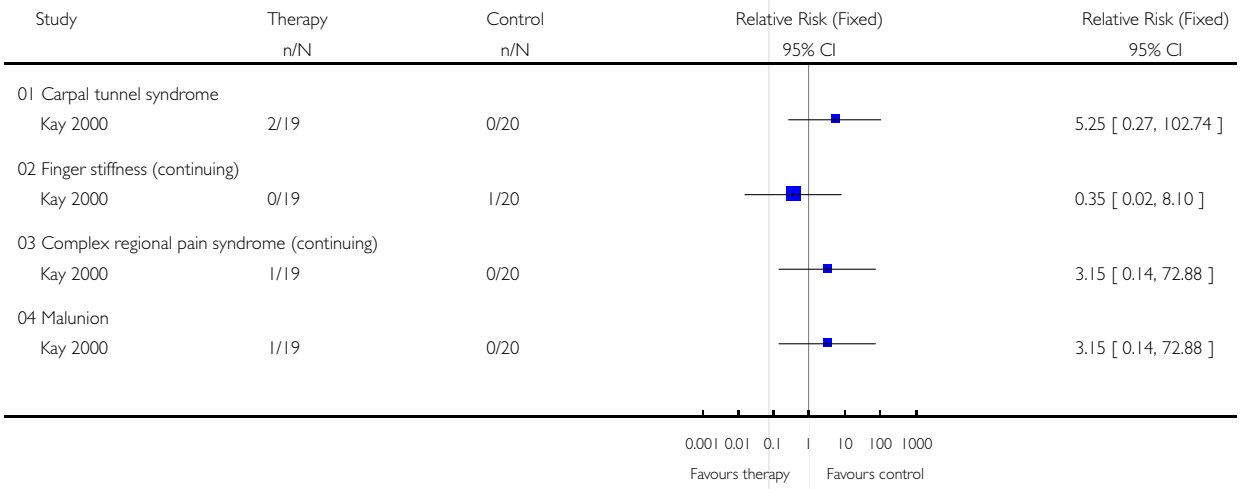


Analysis 07.07. Comparison 07 Passive mobilisation (post immobilisation), Outcome 07 Complications at 6 weeks

Review: Rehabilitation for distal radial fractures in adults

Comparison: 07 Passive mobilisation (post immobilisation)

Outcome: 07 Complications at 6 weeks

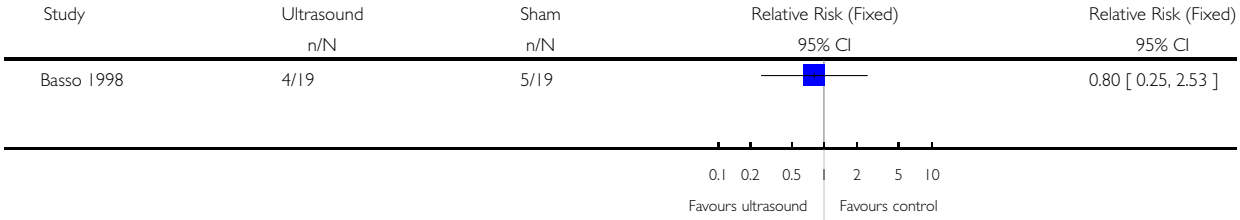


Analysis 08.01. Comparison 08 Low frequency, long-wave ultrasound (post immobilisation), Outcome 01 Greater than 30% loss of wrist motion (flexion-extension) at 8 weeks

Review: Rehabilitation for distal radial fractures in adults

Comparison: 08 Low frequency, long-wave ultrasound (post immobilisation)

Outcome: 01 Greater than 30% loss of wrist motion (flexion-extension) at 8 weeks

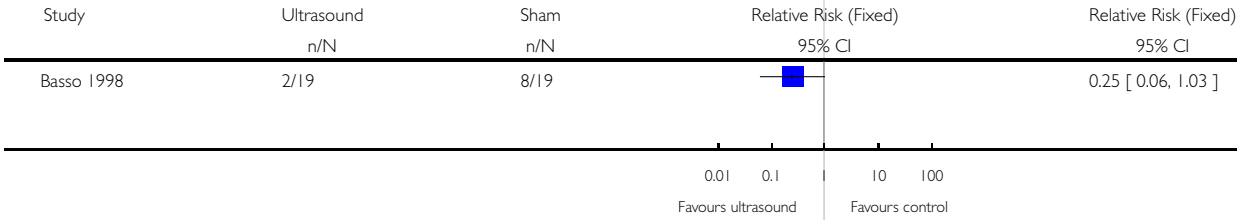


Analysis 08.02. Comparison 08 Low frequency, long-wave ultrasound (post immobilisation), Outcome 02 Referral for physiotherapy

Review: Rehabilitation for distal radial fractures in adults

Comparison: 08 Low frequency, long-wave ultrasound (post immobilisation)

Outcome: 02 Referral for physiotherapy

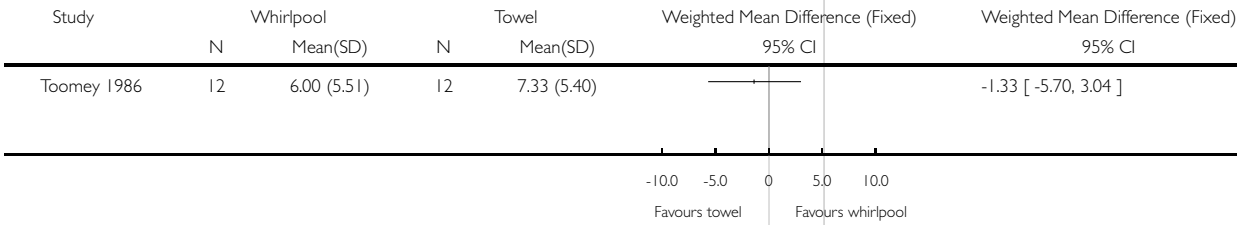


Analysis 09.01. Comparison 09 Whirlpool (post immobilisation), Outcome 01 Grip strength at end of treatment (kg)

Review: Rehabilitation for distal radial fractures in adults

Comparison: 09 Whirlpool (post immobilisation)

Outcome: 01 Grip strength at end of treatment (kg)



Analysis 09.02. Comparison 09 Whirlpool (post immobilisation), Outcome 02 Pain (scale 0: no pain to 5: excruciating) at end of treatment

Review: Rehabilitation for distal radial fractures in adults

Comparison: 09 Whirlpool (post immobilisation)

Outcome: 02 Pain (scale 0: no pain to 5: excruciating) at end of treatment

Study	Whirlpool		Towel		Weighted Mean Difference (Fixed)	Weighted Mean Difference (Fixed)
	N	Mean(SD)	N	Mean(SD)	95% CI	95% CI
Toomey 1986	12	0.42 (0.52)	12	0.67 (0.89)		-0.25 [-0.83, 0.33]

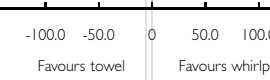
Analysis 09.03. Comparison 09 Whirlpool (post immobilisation), Outcome 03 Range of motion at end of treatment

Review: Rehabilitation for distal radial fractures in adults

Comparison: 09 Whirlpool (post immobilisation)

Outcome: 03 Range of motion at end of treatment

Study	Whirlpool		Towel		Weighted Mean Difference (Fixed)	Weighted Mean Difference (Fixed)
	N	Mean(SD)	N	Mean(SD)	95% CI	95% CI
01 Pronation (degrees)						
Toomey 1986	12	77.92 (12.52)	12	77.92 (7.82)		0.00 [-8.35, 8.35]
02 Supination (degrees)						
Toomey 1986	12	75.00 (16.92)	12	74.17 (14.60)		0.83 [-11.81, 13.47]
03 Flexion (degrees)						
Toomey 1986	12	56.67 (13.86)	12	56.67 (15.42)		0.00 [-11.73, 11.73]
04 Extension (degrees)						
Toomey 1986	12	43.33 (13.54)	12	48.75 (21.23)		-5.42 [-19.67, 8.83]
05 Radial deviation (degrees)						
Toomey 1986	12	17.50 (6.23)	12	17.92 (8.11)		-0.42 [-6.21, 5.37]
06 Ulnar deviation (degrees)						
Toomey 1986	12	24.58 (4.50)	12	24.58 (4.98)		0.00 [-3.80, 3.80]



Analysis 09.04. Comparison 09 Whirlpool (post immobilisation), Outcome 04 Finger flexion at end of treatment

Review: Rehabilitation for distal radial fractures in adults

Comparison: 09 Whirlpool (post immobilisation)

Outcome: 04 Finger flexion at end of treatment

Study	Whirlpool		Towel		Weighted Mean Difference (Fixed)	Weighted Mean Difference (Fixed)
	N	Mean(SD)	N	Mean(SD)	95% CI	95% CI
01 Thumb MCP (metacarpal phalange) flexion (degrees)						
Toomey 1986	12	49.58 (12.70)	12	55.83 (9.73)		-6.25 [-15.30, 2.80]
02 Index finger MCP flexion (degrees)						
Toomey 1986	12	79.58 (10.76)	12	87.08 (7.82)		-7.50 [-15.03, 0.03]
03 Long finger MCP flexion (degrees)						
Toomey 1986	12	82.92 (9.16)	12	90.42 (5.42)		-7.50 [-13.52, -1.48]
04 Ring finger MCL flexion (degrees)						
Toomey 1986	12	82.08 (12.70)	12	87.92 (5.42)		-5.84 [-13.65, 1.97]
05 Little finger MCP flexion (degrees)						
Toomey 1986	12	82.50 (13.73)	12	87.50 (7.54)		-5.00 [-13.86, 3.86]

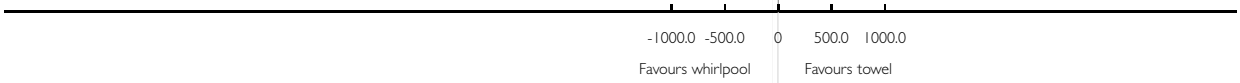
Analysis 09.05. Comparison 09 Whirlpool (post immobilisation), Outcome 05 Oedema (ml)

Review: Rehabilitation for distal radial fractures in adults

Comparison: 09 Whirlpool (post immobilisation)

Outcome: 05 Oedema (ml)

Study	Whirlpool		Towel		Weighted Mean Difference (Fixed)	Weighted Mean Difference (Fixed)
	N	Mean(SD)	N	Mean(SD)	95% CI	95% CI
01 Short term: at end of each session						
Toomey 1986	12	592.50 (97.13)	12	519.58 (67.84)		72.92 [5.89, 139.95]
02 At end of treatment						
Toomey 1986	12	558.33 (80.77)	12	510.00 (69.12)		48.33 [-11.82, 108.48]



Analysis 10.01. Comparison 10 Post immobilisation physiotherapy versus instructions from physician, Outcome 01 Wrist extension (degrees) at 6 weeks

Review: Rehabilitation for distal radial fractures in adults

Comparison: 10 Post immobilisation physiotherapy versus instructions from physician

Outcome: 01 Wrist extension (degrees) at 6 weeks

Study	Physiotherapy		Home exercises		Weighted Mean Difference (Fixed)	Weighted Mean Difference (Fixed)
	N	Mean(SD)	N	Mean(SD)	95% CI	95% CI
Watt 2000	8	55.70 (6.80)	8	38.30 (14.20)		17.40 [6.49, 28.31]

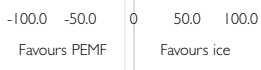
Analysis 11.01. Comparison 11 Pulsed electromagnetic field (PEMF) versus ice (post immobilisation), Outcome 01 Pain and volume at day 5

Review: Rehabilitation for distal radial fractures in adults

Comparison: 11 Pulsed electromagnetic field (PEMF) versus ice (post immobilisation)

Outcome: 01 Pain and volume at day 5

Study	PEMF		Ice		Weighted Mean Difference (Fixed)	Weighted Mean Difference (Fixed)
	N	Mean(SD)	N	Mean(SD)	95% CI	95% CI
01 Pain (scale 0: no pain to 10 cm: worst imaginable) during active wrist movements						
Cheing 2005	22	3.30 (1.20)	22	2.20 (0.87)		1.10 [0.48, 1.72]
02 Volume (ml)						
Cheing 2005	22	428.00 (82.00)	22	410.00 (47.00)		18.00 [-21.49, 57.49]



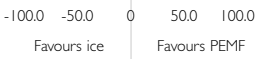
Analysis 11.02. Comparison 11 Pulsed electromagnetic field (PEMF) versus ice (post immobilisation), Outcome 02 Range of motion at day 5

Review: Rehabilitation for distal radial fractures in adults

Comparison: 11 Pulsed electromagnetic field (PEMF) versus ice (post immobilisation)

Outcome: 02 Range of motion at day 5

Study	PEMF		Ice		Weighted Mean Difference (Fixed)	Weighted Mean Difference (Fixed)
	N	Mean(SD)	N	Mean(SD)	95% CI	95% CI
01 Pronation (degrees)						
Cheing 2005	22	71.80 (14.50)	22	70.50 (17.20)		1.30 [-8.10, 10.70]
02 Supination (degrees)						
Cheing 2005	22	63.60 (20.10)	22	60.90 (27.00)		2.70 [-11.37, 16.77]
03 Flexion (degrees)						
Cheing 2005	22	43.90 (12.90)	22	42.50 (11.00)		1.40 [-5.68, 8.48]
04 Extension (degrees)						
Cheing 2005	22	46.80 (5.20)	22	38.40 (13.60)		8.40 [2.32, 14.48]
05 Radial deviation (degrees)						
Cheing 2005	22	11.40 (4.70)	22	10.20 (5.50)		1.20 [-1.82, 4.22]
06 Ulnar deviation (degrees)						
Cheing 2005	22	20.50 (4.60)	22	19.60 (5.10)		0.90 [-1.97, 3.77]



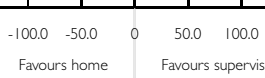
Analysis 12.01. Comparison 12 Supervised training by physiotherapist versus instructions by physician (from definitive treatment), Outcome 01 Strength and power at 12 weeks

Review: Rehabilitation for distal radial fractures in adults

Comparison: 12 Supervised training by physiotherapist versus instructions by physician (from definitive treatment)

Outcome: 01 Strength and power at 12 weeks

Study	Supervised		Home		Weighted Mean Difference (Fixed)	Weighted Mean Difference (Fixed)
	N	Mean(SD)	N	Mean(SD)	95% CI	95% CI
01 "Grip strength" (kg/cm2)						
Pasila 1974	48	0.29 (0.13)	48	0.31 (0.16)		-0.02 [-0.08, 0.04]
02 Hand pumping power (mmHg)						
Pasila 1974	48	221.90 (88.00)	48	244.80 (76.50)		-22.90 [-55.89, 10.09]



Analysis 12.02. Comparison 12 Supervised training by physiotherapist versus instructions by physician (from definitive treatment), Outcome 02 Range of motion at 12 weeks

Review: Rehabilitation for distal radial fractures in adults

Comparison: 12 Supervised training by physiotherapist versus instructions by physician (from definitive treatment)

Outcome: 02 Range of motion at 12 weeks

Study	Supervised N	Supervised Mean(SD)	Home N	Home Mean(SD)	Weighted Mean Difference (Fixed) 95% CI	Weighted Mean Difference (Fixed) 95% CI
01 Pronation (degrees)						
Pasila 1974	48	67.50 (13.20)	48	70.40 (11.30)		-2.90 [-7.82, 2.02]
02 Supination (degrees)						
Pasila 1974	48	78.00 (20.80)	48	78.00 (16.20)		0.00 [-7.46, 7.46]
03 Flexion (degrees)						
Pasila 1974	48	42.40 (12.10)	48	43.50 (11.50)		-1.10 [-5.82, 3.62]
04 Extension (degrees)						
Pasila 1974	48	49.70 (14.10)	48	48.00 (11.50)		1.70 [-3.45, 6.85]
05 Radial deviation (degrees)						
Pasila 1974	48	1.90 (11.30)	48	2.10 (9.50)		-0.20 [-4.38, 3.98]
06 Ulnar deviation (degrees)						
Pasila 1974	48	38.20 (8.70)	48	37.60 (10.40)		0.60 [-3.24, 4.44]