Early mobilisation for elbow fractures in adults (Review)

Harding P, Rasekaba T, Smirneos L, Holland AE

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[Intervention Review]

Early mobilisation for elbow fractures in adults

Paula Harding[1], Tshepo Rasekaba[1], Lorena Smirneos[2], Anne E Holland[3]

[1]Department of Physiotherapy, The Alfred Hospital, Melbourne, Australia. [2]The Ian Potter Library, The Alfred Hospital, Melbourne, Australia. [3]Physiotherapy, Alfred Health / La Trobe University, Melbourne, Australia

Contact address: Paula Harding, Department of Physiotherapy, The Alfred Hospital, Commercial Road, Melbourne, Victoria, 3004, Australia. p.harding@alfred.org.au.

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ABSTRACT

Background

A fall on the outstretched arm can result in an elbow fracture. Loss of elbow function is a common problem with these fractures and can have major implications for functional capabilities. It is unknown whether early mobilisation can improve functional outcome without increasing complications.

Objectives

To compare the effects (benefits and harms) of early mobilisation versus delayed mobilisation of the elbow after elbow fractures in adults.

Search strategy

We searched the Cochrane Bone, Joint and Muscle Trauma Group Specialised Register (August 2010), the Cochrane Central Register of Controlled Trials (*The Cochrane Library* 2010, Issue 2), MEDLINE (1950 to August 2010), EMBASE (1980 to August 2010), CINAHL (1982 to June 2010), PEDro (31 May 2010), and ongoing trials registers (April 2010).

Selection criteria

We included randomised and quasi-randomised controlled trials evaluating early mobilisation of the elbow joint after elbow fracture in adults.

Data collection and analysis

Two authors independently selected trials, assessed risk of bias and extracted data. There was no pooling of data.

Main results

We included one trial reporting outcome at follow-up times ranging between two and 47 months for 81 participants with Mason type 1 and 2 radial head fractures. This poorly-reported trial was at particular high risk of detection and reporting biases. The trial found no significant differences between early and delayed mobilisation in the numbers of participants with pain or limitations in their range of elbow motion. All participants were reported as being able to use their arms for full activities of daily living and none had changed their occupation or lifestyle. There was no mention of fracture complications.

Authors' conclusions

There is a lack of robust evidence to inform on the timing of mobilisation, and specifically on the use of early mobilisation, after non-surgical or surgical treatment for adults with elbow fractures.

There is a need for high quality, well-reported, adequately powered, randomised controlled trials that compare early versus delayed mobilisation in people with commonly-occurring elbow fractures, treated with or without surgery. Trials should use validated upper limb function scales, and assessment should be both short-term (to monitor recovery and early complications) and long-term (at least one year).

PLAIN LANGUAGE SUMMARY

Early elbow movement compared to delayed elbow movement after a broken elbow in adults

The elbow plays an important role in any arm movement such as reaching or lifting. A broken bone, commonly referred to as a fracture, in the elbow can result from a simple fall onto an outstretched arm. A fracture may occur in one or more of parts of the three bones that form the elbow joint. These parts are the upper sections of the two forearm bones (the radius and the ulna) and the lower section of the upper arm bone (the humerus). A well-documented problem after an injury to the elbow is elbow stiffness and loss of normal movement. After initial treatment, which may involve surgery for more serious fractures, treatment may involve immediate gentle movement of the elbow, using a sling for support only, or it may involve a period of time resting still in a sling or plaster cast. It is not known which approach results in better movement and function of the elbow after the fracture has healed.

We searched for randomised controlled trials that compared early movement with delayed movement of the elbow after elbow fracture. We included one trial reporting results at times ranging from two to 47 months for 81 people who had had an elbow fracture that involved the head of the radius. The evidence from this trial is of very low quality. The trial found no important differences between early and delayed mobilisation in the numbers of participants with pain or limitations in their range of elbow motion. All participants were reported as being able to use their arms for full activities of daily living and none had changed their occupation or lifestyle. There was no mention of fracture complications.

We concluded that there was a lack of reliable evidence to answer the question of whether early mobilisation improved function without increasing complications in adults with elbow fractures.

BACKGROUND

Description of the condition

The elbow joint acts mainly as a hinge joint connecting the bones of the upper (humerus) and lower (radius and ulna) arm. It has three distinct articulations (joint surfaces): the radiocapitellar, ulnotrochlear and the proximal radioulnar joints (Issack 2006). The movement at the elbow includes bending (flexion) and straightening (extension) that occur at the radiocapitellar and ulnotrochlear joint, and rotation enabling supination (turning palm up) and pronation (turning palm down) that occurs at the proximal radioulnar joint. Elbow fractures can include any or all of the distal (lower) humerus, the proximal (upper) radius or proximal ulna. Radial head (uppermost part of the radius) fractures account for 30% of elbow fractures in adults (Harrison 2007). Two per cent of fractures in adults are fractures of the distal humerus (Robinson 2003). In an epidemiological study in an urban setting in the United Kingdom the annual incidence of distal humerus fractures was 1.5 per 100,000 population; 75% of these injuries were due to falls from a standing height and they were most common in women over the age of 60 years (Watts 2007). The incidence of isolated fractures of the olecranon (proximal end of the ulna) in people older than 16 years old was reported as 1.15 per 10,000 persons in Karlsson 2002. The most common cause of elbow fractures is a fall onto an outstretched arm (Akesson 2006).

Loss of elbow function can have major implications for people's functional capabilities. This includes difficulty returning to activities of daily living (Kim 2005; Rommens 2004), such as the inability to feed oneself or keep basic hygiene (Issack 2006). Jupiter 2003 describes how the post traumatic loss of elbow movement

limits the ability to "put one's hand in the volume of a sphere in space" leading to substantial disability. The range of elbow movement required for most functional tasks is a flexion arc of 30 to 130 degrees (Morrey 1981). However, this relates to activities of daily living and there may be additional functional limitation depending on occupation and hand dominance. Elbow fractures in older people can affect their ability to walk safely or independently if they rely on walking aids.

Description of the intervention

The goals of treatment include returning the patient to their previous levels of activity and function (Ring 1997). The choice of definitive treatment of elbow fractures is influenced by the degree of fracture displacement and involvement of articular surfaces. Undisplaced or minimally displaced fractures are generally managed conservatively. This usually involves a period of immobilisation via an arm immobiliser, collar and cuff sling, or U slab (plaster cast). Displaced fractures, unstable fractures or more complex fractures can require surgery. The aim of operative treatment is to restore the anatomy, secure fixation of the fragments and potentially to allow early mobilisation to prevent joint stiffness (Ring 1997). However, a period of immobilisation is usually employed after surgery. Immobilisation is generally between four to six weeks depending on the type of the elbow fracture but usually two to four weeks for radial head fractures (McRae 1994). Subsequently, upon removal of the external immobiliser, the patient can start moving their elbow. Mobilisation is purposeful movement of the joint through any range of motion. Under some circumstances, a hinged elbow brace may remain in situ but be unlocked to allow bending and straightening of the elbow. Mobilisation involves graded passive or active movements of the elbow joint with the aim of preventing joint stiffness, soft tissue contracture and gradual restoration of normal movement.

How the intervention might work

Immobilisation post injury has traditionally been used in the belief that it aids recovery, decreases pain and swelling, helps the fracture to heal and prevents radiological deformity (Nash 2004). Immobilisation of the elbow post surgery is often employed to ensure stability of the internal fixation and fracture fragments. However, the most common post injury complication for these fractures is elbow stiffness, particularly loss of extension (Issack 2006; Keschner 2007; Kim 2005). According to studies reported by Kim 2005, up to 25% of distal humerus fractures result in elbow stiffness. The increased susceptibility of the elbow to joint contracture from immobilisation is well known (Issack 2006; Keschner 2007; Kim 2005; Morrey 2005). As well as restricting function, elbow joint contracture may require surgical intervention. The management of post traumatic elbow stiffness, however, poses a challenge to surgeons and surgery may not result in successful outcome. The best management approach for elbow stiffness is thus prevention (Kim 2005; Morrey 2005); and some (Kim 2005) have recommended starting range of motion exercises after the resolution of swelling. However, aggressive mobilising may contribute to the development of complications post injury. For instance, forced passive manipulation of the elbow can result in trauma to the brachialis muscle of the arm and to the elbow joint capsule resulting in further swelling and heterotopic ossification (overgrowth of bone) (Issack 2006).

Why it is important to do this review

The ideal length of time to immobilise the elbow following fracture, or conversely when to start elbow mobilisation, to ensure safe recovery of function and fracture healing is not known. However, there are well-established risks of poor functional outcome, elbow stiffness and other adverse outcomes that are challenging to treat. To date there has not been a systematic review of the literature to determine whether early mobilisation results in better outcomes than delayed mobilisation.

OBJECTIVES

To assess the effects (benefits and harms) of early mobilisation of the elbow after initial definitive treatment of elbow fractures in adults.

Early mobilisation of the elbow was compared to later mobilisation after a period of immobilisation. Early mobilisation was based on the investigator's definition. We planned separate comparisons for surgical as opposed to non-surgical definitive treatment.

METHODS

Criteria for considering studies for this review

Types of studies

We included randomised controlled trials and quasi-randomised trials (method of allocating participants to a treatment which is not strictly random, e.g. by date of birth, hospital record number or alternation) evaluating early mobilisation of the elbow joint after elbow fracture in adults.

Types of participants

We included adults (skeletally mature, typically ≥18 years of age) who had sustained isolated elbow fractures (including radial head fractures), which were treated surgically or conservatively (non-surgically).

We stipulated that we would exclude mixed population trials including participants with other upper limb injuries or multi-trauma injuries, such as accompanying head injuries; and trials including more than five per cent of participants with open elbow fractures, unless separate data were available for participants with closed fractures. This latter was because mobilisation may be delayed due to the wound rather than the fracture in open fractures.

Types of interventions

All interventions that promoted movement of the elbow joint (i.e. mobilisation) were eligible for inclusion. These include:

- Active movement: the elbow is moved by the patient through active contraction of the arm muscles without aids or assistance.
- Active assisted movement: the elbow is moved by the patient through a combination of an active contraction of the arm muscles and assistance applied externally such as support by the patient's other arm or by a therapist.
- Passive movement: the elbow is moved by the therapist, the patient (using their other arm) or via a continuous passive movement machine. No active muscle contraction from the patient occurs during this movement of the elbow.

Where possible, the precise nature of the intervention (direction of movement, i.e. flexion/ extension or pronation/ supination, or both; the type of exercise and its intensity, frequency and duration) was documented.

The comparison examined was between early mobilisation versus delayed mobilisation, as defined by the investigators of the included studies. Typically, elbow immobilisation is achieved by a plaster cast, by rigid splinting that may have included a hinged elbow brace that is locked to block elbow movement, or by a sling strapped to the waist with instructions given to the patient not to remove the sling or move the elbow.

Types of outcome measures

Primary outcomes

The primary outcomes were:

- patient-reported upper limb function (such as the Upper Extremity Function Scale (Pransky 1997), and Disabilities of the Arm Shoulder and Hand (DASH) outcome measure (Beaton 2001));
- pain (e.g. visual analogue scale);
- adverse outcomes: including joint contracture, myositis ossificans, fixation failure, malunion, delayed or non-union, and nerve injuries.

Secondary outcomes

The secondary outcome measures included:

- range of motion: flexion/extension, pronation/supination (goniometry, measured in degrees);
- grip strength (e.g. Jamar device);
- return to work and/or sport, activities of daily living;
- quality of life (e.g. Short Form 36).

Information regarding the time frames for outcome measurement was sought.

Search methods for identification of studies

Electronic searches

We searched the Cochrane Bone, Joint and Muscle Trauma Group Specialised Register (August 2010), the Cochrane Central Register of Controlled Trials (*The Cochrane Library* 2010, Issue 2), MEDLINE (1950 to August 2010), EMBASE (1980 to August 2010), CINAHL (1982 to June 2010), and PEDro - the Physiotherapy Evidence Database (31 May 2010). Current Controlled Trials and the World Health Organisation's International Clinical Trials Registry Platform were also searched (24 April 2010) for ongoing and recently completed trials. No language restrictions were applied.

For MEDLINE, we modified the CRD/Cochrane Highly Sensitive Search Strategy (2005 revision) reported in Glanville 2006, and combined this with a subject-specific search strategy (*see* Appendix 1). Search strategies for EMBASE, *The Cochrane Library*, CINAHL, PEDro, Current Controlled Trials, and the International Clinical Trials Registry Platform are also shown in Appendix 1.

Searching other resources

We searched the reference lists of relevant articles and the the titles of posters and presentations from relevant conference proceedings identified on the Internet (Appendix 2).

Data collection and analysis

Selection of studies

Two authors (PH and TR) independently examined the titles, abstracts and keywords to identify potentially relevant trials from

the search results. Full text reports were obtained for all potentially eligible studies. Based on the full text reports, the two authors independently decided on the studies for inclusion. Disagreements were resolved by discussion or arbitrated by an independent third author (AH). A full record of decisions was kept.

Data extraction and management

Trial information and results were extracted independently by two reviewers (PH and TR) using a piloted data extraction form before being entered into Review Manager by the primary reviewer (PH). Data entry was checked by TR. Disagreement was resolved by discussion or, if necessary, arbitration by another author (AH). Where there was incomplete reporting of data or if additional information was required the reviewers (TR and PH) attempted to contact the authors.

Assessment of risk of bias in included studies

Two authors (PH and TR) independently assessed risk of bias using the tool outlined in the Cochrane Handbook for Systematic Reviews of Interventions (Higgins 2008) (*see* Appendix 3). This tool incorporates assessment of randomisation (sequence generation and allocation concealment), blinding (of participants, treatment providers and outcome assessors), completeness of outcome data, selection of outcomes reported and other sources of bias. We considered patient-rated and clinician-rated outcomes separately in our assessment of blinding and completeness of outcome data. Our other source of bias was performance bias where we checked for comparability in the experience of care providers and provision of treatment interventions such as advice on activity. Disagreements were resolved by consensus or third-party arbitration (AH).

Measures of treatment effect

Dichotomous data

Risk ratios (relative risks) and 95% confidence intervals for each outcome were calculated.

Continuous data

Where such data were available, we planned to record either the mean changes from baseline or the mean post-intervention values together with standard deviations for each group. We planned to calculate mean differences for outcomes measured with the same metrics or standardised mean differences for outcomes measured with different metrics and 95% confidence intervals in both cases.

Dealing with missing data

Two authors (PH and TR) attempted unsuccessfully to contact authors for additional information. We stipulated that we would be alert to potential mislabelling or non identification of standard errors and standard deviations. Additionally, unless missing standard deviations could be derived from confidence intervals, P values or standard errors, we stated that we would not assume values in order to present these in the analyses. We planned to perform intention-to-treat analyses to include all people randomised to the intervention groups and to conduct worst and best scenario analyses to investigate effects of dropouts and exclusions. However, insufficient data regarding dropouts were available.

Assessment of heterogeneity

Should pooling be possible in a future update, we plan to assess heterogeneity by visual inspection of the forest plot along with consideration of the I^2 statistic, Chi^2 test and study characteristics.

Assessment of reporting biases

Insufficient data were available to construct funnel plots, as a way of assessing publication bias.

Data synthesis

A pooled quantitative analysis was not performed. If sufficient numbers of clinically homogeneous trials are available in future updates, a pooled quantitative analysis will be performed. A fixed-effect or random effects model will be used depending on the assessment of heterogeneity.

Subgroup analysis and investigation of heterogeneity

There were insufficient data to perform subgroup analyses. Should such data become available in future, we plan subgroup analyses by fracture type (intra-articular versus extra-articular fractures), type of mobilisation (active versus passive) and allocation concealment (yes or no). We would use the test for subgroup differences available in RevMan 5 for the fixed-effect model to determine if the results for subgroups were statistically significantly different.

Sensitivity analysis

Should sufficient data be available in future, we plan to perform sensitivity analysis in order to determine whether there are differences in outcome that could be attributable to the presence or absence of allocation concealment, assessor blinding or use of intention-to-treat analysis.

RESULTS

Description of studies

See: Characteristics of included studies; Characteristics of excluded studies.

Results of the search

The electronic search identified 1031 references. No eligible studies were found by handsearching conference proceedings. Titles and abstracts were screened, and full-text copies of 16 potentially eligible papers obtained. Ten studies were put forward for study selection. One trial was included and nine studies were excluded. No ongoing trials were identified.

Included studies

We included one randomised controlled trial (Unsworth-White 1994) with 98 participants (*see* Characteristics of included studies for details). Unsworth-White 1994 compared early versus delayed mobilisation of conservatively managed radial head fractures (Mason type 1 and 2).

Setting

Unsworth-White 1994 was conducted between 1987 and 1990 in the public hospital setting in the United Kingdom. All patients were recruited from the emergency department and reviewed at a fracture clinic.

Sample size

Unsworth-White 1994 recruited 98 participants but only 81 participants could be traced for follow-up.

Participants

Unsworth-White 1994 included people with isolated Mason type 1 and type 2 radial head fractures. Of the 81 participants available at follow-up, 58 were female and 23 were male. The mean age of the 81 participants was 50.5 years, range 14 to 87 years. It was clear that only a few participants were in the 14 to 17 year category.

Intervention

Unsworth-White 1994 compared three interventions: immediate mobilisation of the elbow post fracture (N = 29), immobilisation of the elbow in 90 degrees flexion by plaster of Paris for two weeks (N = 29), and immobilisation of the elbow in extension by plaster of Paris for two weeks (N = 23).

Outcomes

Unsworth-White 1994 described a standard pro forma that assessed residual pain (classified as either pain or no pain), disability (measure not reported), range of elbow movements (classified as either limited or full) and patients' opinions on the method of treatment. Outcomes were measured at one point in time, on average 25 months after fracture (range 2 to 47 months).

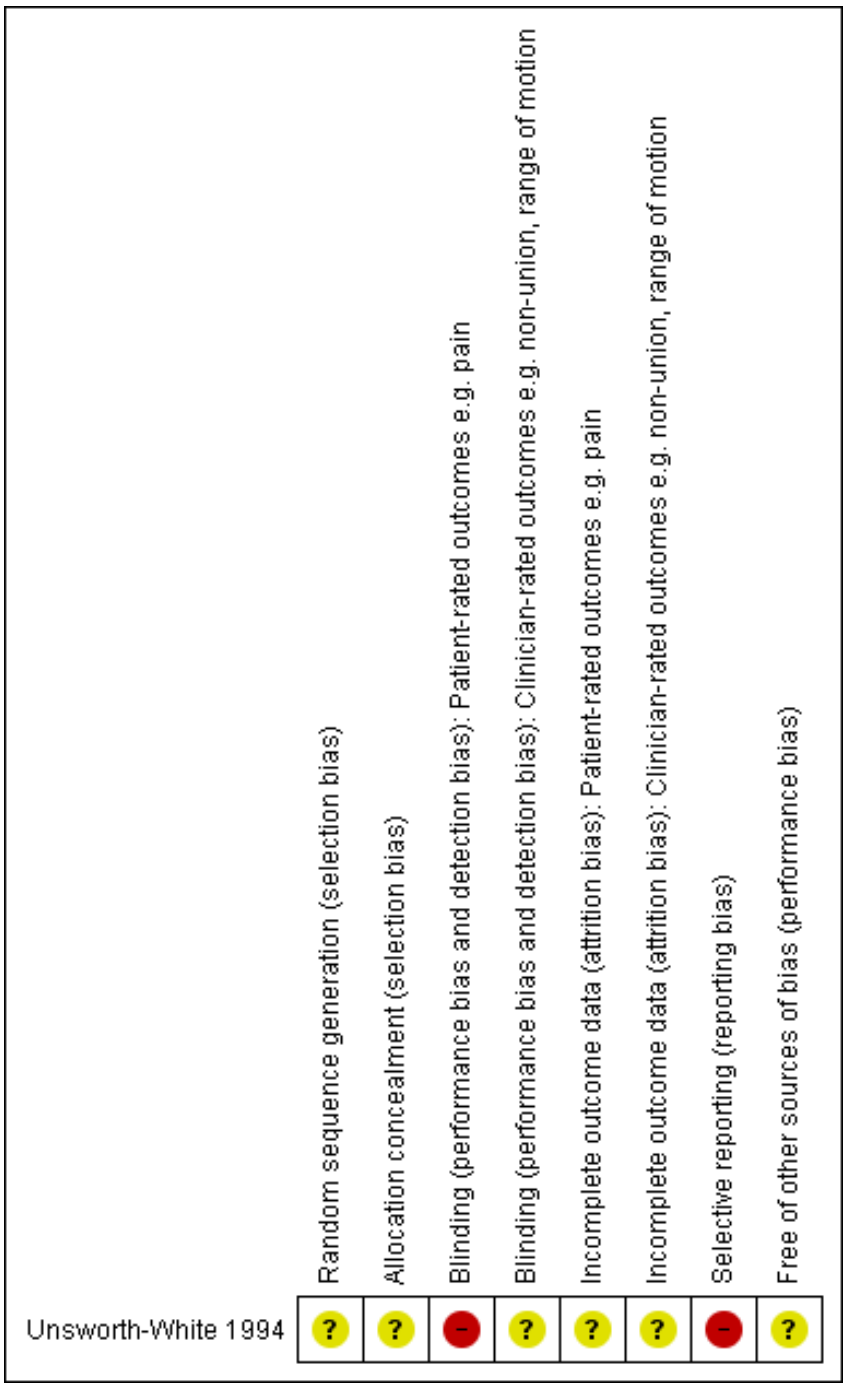
Excluded studies

Nine studies were excluded for reasons given in the Characteristics of excluded studies. Six were excluded because they were not randomised trials; this included Liow 2002, which "did not follow a formal randomisation procedure". Two of the other three randomised trials compared different methods of surgery and the remaining trial excluded elbow fractures.

Risk of bias in included studies

Unsworth-White 1994 had methodological limitations (*see* Figure 1 for a summary of the risk of bias judgements); and was judged at high risk of bias in terms of blinding and selective reporting, and at 'unclear; risk of bias for the other domains.

Figure 1. Risk of bias summary: review authors' judgements about each risk of bias item for each included study.



Allocation

Unsworth-White 1994 did not describe the process of randomisation nor any attempt to conceal allocation of interventions prior to assignment.

Blinding

Blinding of the participants in this trial was not practical, due to the physical nature of the interventions. The assessors were reported as being blinded to the intervention groups for clinician-rated outcomes such as range of motion measures.

Incomplete outcome data

Unsworth-White 1994 failed to provide a complete set of data. Seventeen patients could not be traced by telephone or letter, but the authors stated that these patients were equally divided amongst the three groups and, based on their medical records, none had suffered fracture complications. It was not described at what stage post fracture the medical records of these missing participants were accessed.

Selective reporting

There was no trial protocol available for Unsworth-White 1994, and no results were presented for the short-term follow-up. Results for dichotomous data such as pain or no pain, limited range or full range of motion had to be extracted from the graphs provided in the trial report. No data were provided for disability other than a descriptive statement that no patients had to change their occupation or lifestyle and that all were able to use their arms for full activities of daily living. The investigators did not report results of patients' opinions on the method of treatment.

Other potential sources of bias

Unsworth-White 1994 did not provide any information about the details of the intervention, such as the instructions and exercise protocol given to the patient for mobilisation, dosage and frequency of mobilisation, level of supervision when mobilising the elbow, how many different clinicians were involved or the level of experience of the clinicians involved. It was thus hard to judge on whether there was performance bias resulting from differences in care provided to the three groups other than the trial interventions.

The assessment of participants in Unsworth-White 1994 ranged from two to 47 months. The results of the study may have been influenced by the large range in months, post fracture, that the assessment was completed.

Effects of interventions

Primary outcomes

Upper limb function

No measure for upper limb function was described in Unsworth-White 1994. However, it was reported that "no patients had to change their occupation or lifestyle and all were able to use their arms for full activities of daily living".

Pain

Unsworth-White 1994 did not find any significant difference in pain results between early mobilisation (immediate) compared with immobilisation in a plaster of Paris cast (POP) in either flexion or extension for two weeks.

Results for the number of people with pain are shown in Analysis 1.1.

- early mobilisation (immediate) versus delayed mobilisation (POP for two weeks) (risk ratio (RR) 0.64, 95% CI 0.26 to 1.60)
- early mobilisation (immediate) versus delayed mobilisation (flexion POP for two weeks) (RR 0.45; 95% CI 0.18 to 1.14)
- early mobilisation (immediate) versus delayed mobilisation (extension POP for two weeks) (RR 1.32; 95% CI 0.35 to 4.96)

Unsworth-White 1994 reported that two patients from the delayed mobilisation group (one each from flexion and extension POP groups) had severe pain at follow-up.

Adverse outcomes

Unsworth-White 1994 reported that, based on medical records, none of 17 participants lost to follow-up had had a fracture complication. However, there was no report on complications for the participants included in the analyses.

Secondary outcomes

Range of motion

Unsworth-White 1994 reported that 62 out of 81 patients (77%) had full range of elbow motion at an average of 25 months after their injury. There were no statistically significant differences between early and delayed mobilisation in participants having a limited range of motion.

Results for the number of people with a limited range of motion are shown in Analysis 1.2.

- early mobilisation (immediate) versus delayed mobilisation (POP for two weeks) (RR 0.83; 95% CI 0.35 to 1.94)
- early mobilisation (immediate) versus delayed mobilisation (flexion POP for two weeks) (RR 0.55; 95% CI 0.23 to 1.28)
- early mobilisation (immediate) versus delayed mobilisation (extension POP for two weeks) (RR 2.38; 95% CI to 0.53 to 10.70)

Seventeen participants, all belonging to the early mobilisation and flexion POP groups, had a loss of 10 degrees or more extension; two of these participants also had either limited flexion or rotation. The two participants with limited range of motion in the extension POP group had limited flexion but full extension.

Grip strength

Grip strength was not reported by Unsworth-White 1994.

Return to work

Unsworth-White 1994 reported that "no patients had to change their occupation or lifestyle".

Quality of life

This was not reported by Unsworth-White 1994.

DISCUSSION

Despite a comprehensive search, only one small, poorly reported and methodologically flawed study was identified that met the inclusion criteria for this review.

Summary of main results

One trial reported findings for 81 patients with isolated Mason type 1 and type 2 radial head fractures at follow-up times ranging between two and 47 months. The trial found no significant differences between early and delayed mobilisation in the numbers of participants with pain or limitations in range of elbow motion. All participants were reported as being able to use their arms for full activities of daily living and none had changed their occupation or lifestyle. Complications were not reported.

Overall completeness and applicability of evidence

The objective of the review was to assess the effects of early mobilisation on all types of elbow fractures, including those of the olecranon and distal humerus, and intra-articular elbow fractures. However, only one randomised controlled trial testing the comparison in less severe radial head fractures was included. Additionally, no randomised controlled trials were identified that compared early versus delayed mobilisation of the elbow after surgical intervention. Thus considerations of applicability are limited to the fracture population of the included trial.

Unsworth-White 1994 provided inadequate details on their trial interventions, such as a lack of information on the type and frequency of mobilisation in the immediate mobilisation group. The definition of the outcome measurement was poor and thus unrepeatable. The measurement and reporting of outcome were also inadequate. The presentation of dichotomous data by Unsworth-White 1994 for pain (rated as pain or no pain) and range of motion (rated as limited or not) has limited applicability to clinical practice. Lastly, the clinical significance of a loss of 10º elbow extension, and whether this should be considered an adverse outcome, is unclear. It may be of greater clinical significance when the dominant arm is affected and when occupations, sports or hobbies demand a high level of upper limb function.There was, moreover, no further information regarding the extent of elbow extension loss.

Although Unsworth-White 1994 occurred over 20 years ago, the use of plaster cast for immobilisation of radial head fractures is still used by some health professionals today. Thus the questions asked in this trial remains relevant.

Quality of the evidence

The quality of the available evidence is very low. The included trial was poorly reported and at high risk of detection and reporting biases, and at unknown risk for other biases. One key fault with this trial is that the follow-up was conducted at a specific time point by the investigators rather than at set time points after injury. This resulted in individual trial participants being followed up at times ranging from two to 47 months. It is very likely that this assessment process was not included in the trial protocol, should there have been one available.

Potential biases in the review process

We attempted to reduce the possibility of bias by comprehensive searching of a large number of electronic databases, and of conference proceedings. For future updates, we will attempt to identify non-published studies by contacting content area experts. Attempts were made to contact the authors of the included study to obtain all relevant data but without success, perhaps reflecting that the publication of this trial was over 16 years ago. Publication bias was minimised by obtaining partial translations of studies that were not published in English.

AUTHORS' CONCLUSIONS

Implications for practice

There is a lack of robust evidence to inform on the timing of mobilisation, and specifically on the use of early mobilisation, after non-surgical or surgical treatment for adults with elbow fractures.

Implications for research

There is a need for high quality, well-reported, adequately powered, randomised controlled trials that compare early versus delayed mobilisation in people with commonly-occurring elbow fractures, treated with or without surgery. Specifically, a multi-centre trial that replicates the current variations in the clinical management of conservatively managed radial head fractures would be useful to determine which practice (early versus delayed mobilisation) has greatest influence on function, pain and adverse events. Clinical trials for other fractures of the elbow should also be considered, including displaced elbow fractures that are internally fixed and assessed as stable post operatively. Both short-term (to monitor recovery and early complications) and long-term (at least one year) measurement of outcome is required. Validated, well-defined upper limb functional outcomes measures and quality of life measures should be used in addition to pain, adverse effects and range of motion. The design and reporting of trials should meet the contemporary standards of the CONSORT statement (Schultz 2010).

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REFERENCES

References to studies included in this review

Unsworth-White 1994 *{published data only}*
Unsworth-White J, Koka R, Churchill M, D'Arcy JC, James SE. The non-operative management of radial head fractures: a randomized trial of three treatments. *Injury* 1994;**25**(3):165–7.

References to studies excluded from this review

Helling 2006 *{published data only}*
Helling HJ, Prokop A, Schmid HU, Nagel M, Lilienthal J, Rehm KE. Biodegradable implants versus standard metal fixation for displaced radial head fractures. A prospective, randomized, multicenter study. *Journal of Shoulder and Elbow Surgery* 2006;**15**(4):479–85.

Henriksen 1995 *{published data only}*
Henriksen BM, Gehrchen PM, Jorgensen MB, Gerner-Smidt H. Treatment of traumatic effusion in the elbow joint: a prospective, randomized study of 62 consecutive patients. *Injury* 1995;**26**(7):475–8.

Holdsworth 1987 *{published data only}*
Holdsworth BJ, Clement DA, Rothwell PN. Fractures of the radial head - the benefit of aspiration: a prospective controlled trial. *Injury* 1987;**18**(1):44–7.

Liow 2002 *{published data only}*
Liow RY, Cregan A, Nanda RJ, Montgomery RJ. Early mobilisation for minimally displaced radial head fractures is desirable. A prospective randomised study of two protocols. *Injury* 2002;**33**:801–6.

McKee 2009 *{published data only}*
McKee MD, Veillette CJ, Hall JA, Schemitsch EH, Wild LM, McCormack R, et al.A multicenter, prospective, randomized, controlled trial of open reduction--internal fixation versus total elbow arthroplasty for displaced intra-articular distal humeral fractures in elderly patients. *Journal of Shoulder and Elbow Surgery* 2009;**18**(1):3–12.

Rafai 1999 *{published data only}*
Rafai M, Largab A, Cohen D, Trafeh M. Pure posterior luxation of the elbow in adults: immobilization or early mobilization. A randomized prospective study of 50 cases [Luxation posterieure pure du coude chez l'adulte: immobilisation ou mobilisation precoce. Etude prospective randomisee sur 50 cas]. *Chirurgie de la Main* 1999;**18**(4):272–8.

Schwarz 1983 *{published data only}*
Schwarz N. Conservative therapy of isolated radius head fracture - immobilization or early functional

movement treatment? [Die konservative Therapie der isolierten Radiuskopfchenfraktur – Immobilisation oder fruhfunktionelle Bewegungsbehandlung?]. *Aktuelle Traumatologie* 1983;**13**(3):97–102.

Wallenbock 1994 ***{published data only}***

Wallenbock E, Diethart T, Plecko M, Fuchs B. Experience with internal fixation of fractures of the head of the radius [Erfahrungen zur pffb von isolierten radiuskopfchenfrakturen]. *Langenbecks Archiv fur Chirurgie* 1994;**379**(2):76–9.

Yan 2003 ***{published data only}***

Yan RW, Tan CW, Lu L. Clinical study on early postoperative rehabilitation following intra-articular fractures of the elbow. *Chinese Journal of Rehabilitation Medicine* 2003;**18**(11):673–5. [: CN–00519038]

Additional references

Akesson 2006

Akesson T, Herbertsson P, Josefsson P, Hasserius R, Besjakov J, Karlsson M. Primary nonoperative treatment of moderately displaced two-part fractures of the radial head. *Journal of Bone and Joint Surgery - American Volume* 2006; **88**(9):1909–14. [MEDLINE: 16951104]

Beaton 2001

Beaton DE, Katz JN, Fossel AH, Wright JG, Tarasuk V, Bombardier C. Measuring the whole or the parts? Validity, reliability, and responsiveness of the Disabilities of the Arm, Shoulder and Hand outcome measure in different regions of the upper extremity. *Journal of Hand Therapy* 2001;**14** (2):128–46. [MEDLINE: 11382253]

Glanville 2006

Glanville JM, Lefebvre C, Miles JNV, Camosso-Stefinovic J. How to identify randomized controlled trials in MEDLINE: ten years on [corrected] [published erratum appears in J Med Libr Assoc 2006 Jul;94(3):354]. *Journal of the Medical Library Association* 2006;**94**(2):130–6. [MEDLINE: 16636704]

Harrison 2007

Harrison JWK, Chitre A, Lammin K, Warner JG, Hodgson SP. Radial head fractures in adults. *Current Orthopaedics* 2007;**21**(1):59–64. [EMBASE: 2007141745]

Higgins 2008

Higgins JPT, Altman DG (editors). Chapter 8: Assessing risk of bias in included studies. In: Higgins JPT, Green S (editors). Cochrane Handbook for Systematic Reviews of Interventions Version 5.0.1 (updated September 2008). The Cochrane Collaboration, 2008. Available from www.cochrane-handbook.org.

Issack 2006

Issack PS, Egol KA. Posttraumatic contracture of the elbow: current management issues. *Bulletin of the Hospital for Joint Diseases* 2006;**63**(3-4):129–36. [MEDLINE: 16878834]

Jupiter 2003

Jupiter JB, O'Driscoll SW, Cohen MS. The assessment and management of the stiff elbow. *Instructional Course Lectures* 2003;**52**:93–111. [MEDLINE: 12690843]

Karlsson 2002

Karlsson MK, Hasserius R, Karlsson C, Besjakov J, Josefsson PO. Fractures of the olecranon: a 15- to 25-year followup of 73 patients. *Clinical Orthopaedics and Related Research* 2002;**(403)**:205–12. [MEDLINE: 12360028]

Keschner 2007

Keschner MT, Paksima N. The stiff elbow. *Bulletin of the NYU Hospital for Joint Diseases* 2007;**65**(1):24–8. [MEDLINE: 17539758]

Kim 2005

Kim PD, Grafe MW, Rosenwasser MP. Elbow stiffness: Etiology, treatment, and results. *Journal of the American Society for Surgery of the Hand* 2005;**5**(4):209–16. [EMBASE: 2005557869]

McRae 1994

McRae R. *Practical fracture treatment*. 3rd Edition. New York: Churchill Livingstone, 1994. [: ISBN 0443048096]

Morrey 1981

Morrey BJ, Askew LJ, Chao EY. A biomechanical study of normal functional elbow motion. *Journal of Bone and Joint Surgery - American Volume* 1981;**63**:872–7.

Morrey 2005

Morrey BF. The posttraumatic stiff elbow. *Clinical Orthopaedics and Related Research* 2005;**(431)**:26–35. [MEDLINE: 15685052]

Nash 2004

Nash CE, Mickan SM, Del Mar CB, Glasziou PP. Resting injured limbs delays recovery: A systematic review. *Journal of Family Practice* 2004;**53**(9):706–12. [MEDLINE: 15353159]

Pransky 1997

Pransky G, Feuerstein M, Himmelstein J, Katz JN, Vickers-Lahti M. Measuring functional outcomes in work-related upper extremity disorders. Development and validation of the Upper Extremity Function Scale. *Journal of Occupational and Environmental Medicine* 1997;**39**(12): 1195–202. [MEDLINE: 9429173]

Ring 1997

Ring D, Jupiter JB. Mini-symposium: Elbow problems. (iii) Elbow fractures in the adult. *Current Orthopaedics* 1997;**11**(4):242–8. [EMBASE: 1998021286]

Robinson 2003

Robinson CM, Hill RM, Jacobs N, Dall G, Court-Brown CM. Adult distal humeral metaphyseal fractures: epidemiology and results of treatment. *Journal of Orthopaedic Trauma* 2003;**17**(1):38–47. [MEDLINE: 12499966]

Rommens 2004

Rommens PM, Kuchle R, Schneider RU, Reuter M. Olecranon fractures in adults: factors influencing outcome. *Injury* 2004;**35**(11):1149–57. [MEDLINE: 15488508]

Schultz 2010

Schulz KF, Altman DG, Moher D, CONSORT Group. CONSORT 2010 statement: updated guidelines for

reporting parallel group randomised trials. *BMJ* 2010;**340**: c332. [PUBMED: 20332509]

Watts 2007

Watts AC, Morris A, Robinson CM. Fractures of the distal humeral articular surface. *Journal of Bone and Joint Surgery - British Volume* 2007;**89**(4):510–5. [MEDLINE: 17463121]

* *Indicates the major publication for the study*

CHARACTERISTICS OF STUDIES

Characteristics of included studies *[ordered by study ID]*

Unsworth-White 1994

Methods	A randomised controlled trial of three treatments (participants randomised at presentation)
Participants	Hospital setting, United Kingdom, between 1987 and 1990. 98 consecutive patients with Mason type 1 and type 2 isolated radial head fractures attending the Accident and Emergency department. 81 participants were available for follow-up: 58 female, 23 male. Mean age 50.5, range 14 to 87 years. Inclusion criteria: Mason type 1 fractures (marginal fissure with no displacement) and type 2 (marginal sector with displacement). Exclusion criteria: Mason type 3 fractures, radial neck fractures, other concurrent upper limb injuries, previous elbow injuries, or generalised joint pathology.
Interventions	Three treatment regimens with no routine physiotherapy: 1. Immediate mobilisation (with a triangular support sling): N = 29 (24 female, 5 male, mean age 50.8 (range 14 to 87 years), 22 type 1 fractures and 7 type 2 fractures). 2. Initial immobilisation for 2 weeks in a plaster of Paris cast in 90 degrees of flexion: N = 29 (19 female, 10 male, mean age 51.0 (range 14 to 80 years), 20 type 1 fractures and 7 type 2 fractures). 3. Initial immobilisation for 2 weeks in a plaster of Paris cast in an extended position: N = 23 (15 female, 8 male, mean age 49.7 (range 18 to 80 years), 16 type 1 fractures and 7 type 2 fractures). There are no details of what immediate mobilisation involved including the type and frequency of mobilisation or exercise.
Outcomes	Patients were reviewed at 2 and 6 weeks in a fracture clinic, but outcomes from these assessments are not reported. One assessment was conducted at 2 to 47 months after injury (mean 25 months). A standard pro forma was used to assess: Pain: pain or no pain Disability: not reported how this was assessed nor how impact on occupation or lifestyle was assessed Range of elbow movement: limited range or full range Patient's opinion on method of treatment: not reported how this was assessed
Notes	17 participants could not be traced by phone or letter; however, records indicate they were evenly distributed amongst treatment groups and did not suffer any fracture complications. Sources of funding not stated. Separate data were not available for patients $\geq$ 18 years old (nominal age threshold for adults given in review protocol inclusion criteria).
Risk of bias	

Unsworth-White 1994 (*Continued*)

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote: "Ninety-eight consecutive patients ... with Mason type 1 and 2 radial head fractures were randomised at presentation to one of three treatment regimens." No method of randomisation described. Groups did not contain equal numbers of participants (N = 29, 29, 23).
Allocation concealment (selection bias)	Unclear risk	No description of allocation concealment provided.
Blinding (performance bias and detection bias) Patient-rated outcomes e.g. pain	High risk	Patients could not be blinded to the use of a sling or a plaster cast. Outcomes measures used for pain, disability and patient opinion on method of treatment were patient-rated outcomes.
Blinding (performance bias and detection bias) Clinician-rated outcomes e.g. non-union, range of motion	Unclear risk	Quote: "Eighty-one patients were traced and reassessed by an independent observer who was unaware of the initial treatment." Quote: "A standard pro forma was used to assess residual pain, disability, range of elbow movements and patients' opinion on the method of treatment." It is possible that the assessor would become aware of the patient's treatment group when ascertaining their opinion about the method of treatment.
Incomplete outcome data (attrition bias) Patient-rated outcomes e.g. pain	Unclear risk	Attrition of 17 patients that could not be traced. Authors stated that these patients were evenly distributed amongst the treatment groups and did not suffer any fracture complications, however no data were provided
Incomplete outcome data (attrition bias) Clinician-rated outcomes e.g. non-union, range of motion	Unclear risk	As above.
Selective reporting (reporting bias)	High risk	Although assessed, no results are given for patient's opinions on methods of treatment. Participants were assessed 25 months after injury on average (range 2 to 47 months) rather than at set follow-up periods since

Unsworth-White 1994 (*Continued*)

		injury.
Free of other sources of bias (performance bias)	Unclear risk	No information available in the paper about the instructions provided to immediate mobilisation group, or by whom. The degrees of extension the arm was immobilised in plaster of Paris was not reported.

Characteristics of excluded studies *[ordered by study ID]*

Study	Reason for exclusion
Helling 2006	A prospective, randomised controlled trial comparing surgical management techniques. Biodegradable implants versus standard metal fixation for displaced radial head fractures. No comparison of early versus delayed mobilisation after surgery.
Henriksen 1995	Randomised controlled trial. Sixty two patients with post-traumatic radiologically-visualised effusion of the elbow joint were randomised to immediate active exercises without immobilisation or one week in plaster for immobilisation. Patients with elbow fractures were excluded.
Holdsworth 1987	Not a randomised controlled trial. Retrospective review of people with radial head fractures who all began early range of motion exercises. A randomly selected group received aspiration.
Liow 2002	A trial of early mobilisation versus delayed mobilisation of type 1 and 2 Mason type fractures of the radial head. No formal randomisation procedure was used. Thus, this study did not meet inclusion criteria as a randomised controlled trial or quasi-randomised trial.
McKee 2009	A multicentre, randomised controlled trial of open reduction-internal fixation versus total elbow arthroplasty for displaced intra-articular distal humeral fractures in elderly patients. Standardised post operative protocol used for both groups. Not early versus delayed mobilisation.
Rafai 1999	Randomised controlled trial. Early mobilisation versus immobilisation for posterior dislocation of the elbow in adults. Not elbow fractures.
Schwarz 1983	Retrospective study comparing immediate active motion versus cast fixation in patients with isolated radial head fractures. Not a randomised controlled trial.
Wallenbock 1994	Not a randomised controlled trial as there did not appear to be two groups. Type of intervention not defined.
Yan 2003	Not a randomised controlled trial but a cohort study. Clinical study on early postoperative rehabilitation following intra-articular fractures of the elbow.

DATA AND ANALYSES

Comparison 1. Early mobilisation (sling: immediate) versus delayed mobilisation (POP cast: 2 weeks)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Number of people with pain (mean 25 months (range 2 to 47))	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
1.1 Both cast groups	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
1.2 Flexion cast group	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
1.3 Extension cast group	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
2 Number of people with limited range of elbow motion (mean 25 months (range 2 to 47))	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
2.1 Both cast groups	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
2.2 Flexion cast group	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
2.3 Extension cast group	1		Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]

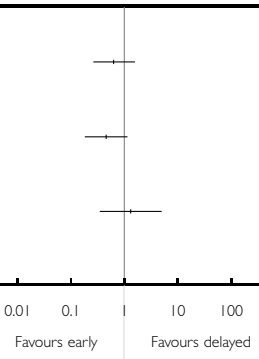
Analysis 1.1. Comparison 1 Early mobilisation (sling: immediate) versus delayed mobilisation (POP cast: 2 weeks), Outcome 1 Number of people with pain (mean 25 months (range 2 to 47)).

Review: Early mobilisation for elbow fractures in adults

Comparison: 1 Early mobilisation (sling: immediate) versus delayed mobilisation (POP cast: 2 weeks)

Outcome: 1 Number of people with pain (mean 25 months (range 2 to 47))

Study or subgroup	Early mobilisation n/N	Delayed mobilisation n/N	Risk Ratio M-H,Fixed,95% CI	Risk Ratio M-H,Fixed,95% CI
1 Both cast groups				
Unsworth-White 1994	5/29	14/52		0.64 [0.26, 1.60]
2 Flexion cast group				
Unsworth-White 1994	5/29	11/29		0.45 [0.18, 1.14]
3 Extension cast group				
Unsworth-White 1994	5/29	3/23		1.32 [0.35, 4.96]



Analysis 1.2. Comparison 1 Early mobilisation (sling: immediate) versus delayed mobilisation (POP cast: 2 weeks), Outcome 2 Number of people with limited range of elbow motion (mean 25 months (range 2 to 47)).

Review: Early mobilisation for elbow fractures in adults

Comparison: 1 Early mobilisation (sling: immediate) versus delayed mobilisation (POP cast: 2 weeks)

Outcome: 2 Number of people with limited range of elbow motion (mean 25 months (range 2 to 47))

Study or subgroup	Early mobilisation n/N	Delayed mobilisation n/N	Risk Ratio M-H,Fixed,95% CI	Risk Ratio M-H,Fixed,95% CI
1 Both cast groups				
Unsworth-White 1994	6/29	13/52		0.83 [0.35, 1.94]
2 Flexion cast group				
Unsworth-White 1994	6/29	11/29		0.55 [0.23, 1.28]
3 Extension cast group				
Unsworth-White 1994	6/29	2/23		2.38 [0.53, 10.70]

APPENDICES

Appendix 1. Search strategies

MEDLINE (Ovid interface)

1. Elbow/in,su or Elbow Joint/in,su
2. (Elbow Joint/ or Elbow/) and exp Fractures, Bone/
3. ((radial or radius) and (head or neck) and fracture*).ab,hw,ti.
4. (proximal and (ulna or ulnar or radius or radial) and fracture*).ab,hw,ti.
5. ((coronoid or olecranon) and fracture*).ab,hw,ti.
6. ((capitel* or capitul*) and fracture*).ab,hw,ti.
7. ((trochlea* or distal) and (humer* or humor*) and fracture*).ab,hw,ti.
8. ((epicondyl* or condyl* or transcondyl* or unicondyl* or intercondyl* or supracondyl*) and (humer* or humor*) and fracture*).ab,hw,ti.
9. (elbow* and fracture*).ab,hw,ti.
10. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9
11. exp Rehabilitation/ or exp Movement/ or exp "Range of Motion, Articular"/ or exp Exercise Movement Techniques/ or "Recovery of Function"/
12. Physical Therapy Department, Hospital/ or exp Physical Therapy Modalities/ or "Physical Therapy (specialty)"/
13. (mobili* or rehabilit* or movement or exercis*).ti,ab,hw.
14. (motion or function or functional).ti,ab,hw.
15. (physiotherap* or (physical adj therap*)).ti,ab,hw
16. 11 or 12 or 13 or 14 or 15

17. 10 and 16
18. limit 17 to ("all infant (birth to 23 months)" or "all child (0 to 18 years)")
19. limit 17 to "all adult (19 plus years)"
20. 18 not 19
21. 17 not 20
22. clinical trial*.af.
23. random*.ti,ab,hw.
24. placebo.ti,ab.
25. (trial or trials).ti,ab.
26. groups.ti,ab.
27. 22 or 23 or 24 or 25 or 26
28. 21 and 27

EMBASE (Ovid interface)

1. Elbow Injury/
2. Elbow/ and exp Fracture/
3. exp Elbow Fracture/ or exp Humerus Supracondylar Fracture/ or exp Olecranon Fracture/ or exp Radius Head Fracture/
4. ((radial or radius) and (head or neck) and fracture*).ab,hw,ti.
5. (proximal and (ulna or ulnar or radius or radial) and fracture*).ab,hw,ti.
6. ((coronoid or olecranon) and fracture*).ab,hw,ti.
7. ((capitel* or capitul*) and fracture*).ab,hw,ti.
8. ((trochlea* or distal) and (humer* or humor*) and fracture*).ab,hw,ti.
9. ((epicondyl* or condyl* or transcondyl* or unicondyl* or intercondyl* or supracondyl*) and (humer* or humor*) and fracture*).ab,hw,ti.
10. (elbow* and fracture*).ab,hw,ti.
11. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10
12. exp Rehabilitation/ or exp Convalescence/ or Mobilization/ or exp "Movement (Physiology)"/
13. exp "Joint Characteristics and Functions"/ or Muscle Stretching/ or exp Exercise/
14. Physiotherapy Practice/ or exp Physiotherapy/ or Physiotherapist/ or exp Kinesiotherapy/
15. (mobili* or rehabilit* or movement or exercis*).ti,ab,hw.
16. (motion or function or functional).ti,ab,hw.
17. (physiotherap* or (physical adj therap*)).ti,ab,hw.
18. 12 or 13 or 14 or 15 or 16 or 17
19. 11 and 18
20. limit 19 to (infant or child or preschool child <1 to 6 years> or school child <7 to 12 years> or adolescent <13 to 17 years>)
21. limit 19 to (adult <18 to 64 years> or aged <65+ years>)
22. 20 not 21
23. 19 not 22
24. clinical trial*.af.
25. random*.ti,ab,hw.
26. placebo.ti,ab.
27. (trial or trials).ti,ab.
28. groups.ti,ab.
29. 24 or 25 or 26 or 27 or 28
30. 23 and 29

The Cochrane Library (Wiley Online Library)

#1. MeSH descriptor Elbow explode all trees with qualifiers: IN,SU
#2. MeSH descriptor Elbow Joint explode all trees with qualifiers: IN,SU
#3. MeSH descriptor Elbow Joint explode all trees
#4. MeSH descriptor Elbow explode all trees

#5. MeSH descriptor Fractures, Bone explode all trees
#6. ((#3 OR #4) AND #5)
#7. (radial or radius):ti,ab,kw and (head or neck):ti,ab,kw and (fracture*):ti,ab,kw
#8. (ulna or ulnar or radius or radial) :ti,ab,kw and (proximal):ti,ab,kw and (fracture*):ti,ab,kw
#9. (coronoid or olecranon) :ti,ab,kw and (fracture*):ti,ab,kw
#10. (capitel* or capitul*):ti,ab,kw and (fracture*):ti,ab,kw
#11. (trochlea* or distal):ti,ab,kw and (humer* or humor*) :ti,ab,kw and (fracture*):ti,ab,kw
#12. (epicondyl* or condyl* or transcondyl* or unicondyl* or intercondyl* or supracondyl*):ti,ab,kw and (humer* or humor*) :ti,ab,kw and (fracture*):ti,ab,kw
#13. (elbow*):ti,ab,kw and (fracture*):ti,ab,kw
#14. (#1 OR #2 OR #6 OR #7 OR #8 OR #9 OR #10 OR #11 OR #12 OR #13)
#15. MeSH descriptor Rehabilitation explode all trees
#16. MeSH descriptor Movement explode all trees
#17. MeSH descriptor Range of Motion, Articular explode all trees
#18. MeSH descriptor Exercise Movement Techniques explode all trees
#19. MeSH descriptor Recovery of Function explode all trees
#20. MeSH descriptor Physical Therapy Department, Hospital explode all trees
#21. MeSH descriptor Physical Therapy Modalities explode all trees
#22. MeSH descriptor Physical Therapy (Specialty) explode all trees
#23. (mobili* or rehabilit* or movement or exercis*):ti,ab,kw
#24. (motion or function or functional):ti,ab,kw
#25. (physiotherap*):ti,ab,kw or (physical NEXT therap*):ti,ab,kw
#26. (#15 OR #16 OR #17 OR #18 OR #19 OR #20 OR #21 OR #22 OR #23 OR #24 OR #25)
#27. (#14 AND #26)

CINAHL (EBSCO host)

S1 (MH “Elbow Injuries+”)
S2 (MH “Elbow Joint/IN/SU”) or (MH “Elbow/IN/SU”)
S3 ((MH “Elbow”) or (MH “Elbow Joint”)) and (MH “Fractures+”)
S4 ((AB (radial or radius) and (head or neck) and (fractur*))) or ((TI (radial or radius) and (head or neck) and (fractur*))) or ((MW (radial or radius) and (head or neck) and (fractur*)))
S5 ((AB (ulna or ulnar or radial or radius) and (proximal) and (fractur*))) or ((TI (ulna or ulnar or radial or radius) and (proximal) and (fractur*))) or ((MW (ulna or ulnar or radial or radius) and (proximal) and (fractur*)))
S6 ((TI (coronoid or olecranon) and (fractur*))) or ((AB (coronoid or olecranon) and (fractur*))) or ((MW (coronoid or olecranon) and (fractur*)))
S7 ((TI (capitel* or capitul*) and (fractur*))) or ((AB (capitel* or capitul*) and (fractur*))) or ((MW (capitel* or capitul*) and (fractur*)))
S8 ((TI (trochlea* or distal) and (humer* or humor*) and (fractur*))) or ((AB (trochlea* or distal) and (humer* or humor*) and (fractur*))) or ((MW (trochlea* or distal) and (humer* or humor*) and (fractur*)))
S9 ((TI (epicondyl* or condyl* or transcondyl* or unicondyl* or intercondyl* or supracondyl*) and (humer* or humor*) and (fractur*))) or ((AB (epicondyl* or condyl* or transcondyl* or unicondyl* or intercondyl* or supracondyl*) and (humer* or humor*) and (fractur*))) or ((MW (epicondyl* or condyl* or transcondyl* or unicondyl* or intercondyl* or supracondyl*) and (humer* or humor*) and (fractur*)))
S10 ((TI (elbow*) and (fractur*))) or ((AB (elbow*) and (fractur*))) or ((MW (elbow*) and (fractur*)))
S11 S1 or S2 or S3 or S4 or S5 or S6 or S7 or S8 or S9 or S10
S12 (MH “Rehabilitation+”) or (MH “Movement+”) or (MH “Range of Motion”) or (MH “Recovery”)
S13 (MH “Physical Therapy Practice”) or (MH “Physical Therapists”) or (MH “Physical Therapy Service”)
S14 (MH “Exercise+”) or (MH “Early Intervention+”)
S15 ((TI (mobili* or rehabilit* or movement or exercis*))) or ((AB (mobili* or rehabilit* or movement or exercis*))) or ((MW (mobili* or rehabilit* or movement or exercis*)))
S16 ((TI (motion or function or functional))) or ((AB (motion or function or functional))) or ((MW (motion or function or functional)))

S17 ((TI (physiotherap*) or (physical therap*))) or ((AB (physiotherap*) or (physical therap*))) or ((MW (physiotherap*) or (physical therap*)))
S18 S12 or S13 or S14 or S15 or S16 or S17
S19 S11 and S18 Limiters - Age Groups: Infant, Newborn 0-1 month, Infant, 1-23 months, Child, Preschool 2-5 years, Child, 6-12 years, Adolescence, 13-18 years
S20 S11 and S18 Limiters - Age Groups: Adult, 19-44 years, Middle Age, 45-64 years, Aged, 65+ years, Aged, 80 and over
S21 S11 and S18
S22 S20 not S21
S23 S19 not S22
S24 "clinical trial*"
S25 TI random* or AB random* or MW random*
S26 TI placebo or AB placebo
S27 ((TI (trial) or (trials))) or ((AB (trial) or (trials)))
S28 TI groups or AB groups
S29 S24 or S25 or S26 or S27 or S28
S30 S23 and S29

PEDro

Simple search strategy selected
Each line refers to a separate search

1. elbow
2. head of radius
3. radial head
4. olecranon
5. distal humer
6. distal humor
7. proximal radius
8. proximal ulna
9. trochlea
10. coronoid
11. capitel
12. capitul
13. upper limb fractur
14. early mobili and fractur
15. late mobili and fractur
16. delayed mobili and fractur

Current Controlled Trials

'All registers' selected
Each line refers to a separate search

1. elbow
2. "head of radius"
3. radial head
4. olecranon
5. (humer% OR humor%) AND distal
6. (radius OR ulna%) AND proximal
7. (trochlea OR coronoid OR capitel% OR capitul%)
8. upper limb% AND fractur%
9. early AND mobili%
10. (late OR delayed) AND mobili%

International Clinical Trials Registry Platform

Each line refers to a separate search

1. elbow
2. head of radius
3. radial head
4. olecranon
5. distal humer*
6. distal humor*
7. proximal radius
8. proximal ulna*
9. trochlea
10. coronoid
11. capitel*
12. capitul*
13. upper limb AND fractur*
14. early mobili*
15. late mobili*
16. delayed mobili*

Appendix 2. Conference proceedings searched

1. TraumaCare 2004. Australasian Trauma Society and Trauma Care International; 2004 October 15-17; Sydney, Australia
2. Trauma Melbourne Conference Trauma Research and Clinical Management Conference 2008. National Trauma Institute; 2008 November 21-22; Melbourne, Australia
3. Trauma Melbourne. Trauma Research and Clinical Management Conference 2009. National Trauma Institute; 2009 November 20-21; Melbourne, Australia
4. AUSTRAUMA^{TM} Trauma and Critical Care Conference; 2007 February 23-24; Sydney, Australia
5. AUSTRAUMA^{TM} Trauma, Critical Care & Emergency Surgery Conference; 2008 February 14; Sydney, Australia
6. SWAN X Trauma Conference; 2002 August 2-3; Liverpool, Australia
7. Southern Trauma Symposium. A Joint Meeting of the Australasian Trauma Society Victorian Major Trauma Services; 2002 November 8-9; Melbourne, Australia
8. Trauma Research Symposium. National Trauma Research Institute; 2005 November 3; Melbourne, Australia
9. Trauma Research Symposium. National Trauma Research Institute; 2006 December 5; Melbourne, Australia
10. Trauma 2006. Annual Scientific Meeting of the Australasian Trauma Society; 2006 September 28-1 October; Gold Coast, Australia
11. Trauma 2007. Annual Scientific Meeting of the Australasian Trauma Society; 2007 October 13-14; Melbourne, Australia
12. Trauma 2009 Combined Australasian Trauma Society and Trauma Association Canada Annual Scientific Meeting; 2009 March 5-7; Auckland, New Zealand
13. Allied Health Trauma Research Symposium: Allied Health Intervention with Trauma Patients, When, How and Why? National Trauma Research Institute; 2006 May 8; Melbourne, Australia
14. Allied Health and Rehabilitation Trauma Seminar. Institute of Trauma and Injury; 2005 September 14; Hornsby, Australia
15. 11th International Congress of Shoulder and Elbow Surgery; 2010 September 5-8; Edinburgh, Scotland
16. American Shoulder and Elbow Surgeons. International Symposium on Shoulder and Elbow Arthroscopy; 2009 October 24; New York. Available at http://www.ases-assn.org/web/meetings/Program%20with%20Faculty%20TENTATIVE.pdf (accessed 26 August 2010)
17. 9th International Congress on Surgery of the Shoulder; 2004 May 2-5; Washington (DC). Available at www.ases-assn.org/web/meetings/9thICSSProgram.pdf (accessed 26 August 2010).

1-15 were searched as hard copies and 16-17 electronically

Appendix 3. Risk of bias assessment tool

Domain	Review authors' judgement*
Sequence generation	Was the allocation sequence adequately generated? YES / NO / UNCLEAR
Allocation concealment	Was allocation adequately concealed? YES / NO / UNCLEAR
Blinding of participants, personnel and outcome assessors *Outcome:* Patient-rated outcomes e.g. DASH, pain	Was knowledge of the allocated intervention adequately prevented during the study? YES / NO / UNCLEAR
Blinding of participants, personnel and outcome assessors *Outcome:* Clinician-rated outcomes e.g. non-union, deformity, range of motion	Was knowledge of the allocated intervention adequately prevented during the study? YES / NO / UNCLEAR
Incomplete outcome data *Outcome:* Patient-rated outcomes e.g. DASH, pain	Were incomplete outcome data adequately addressed? YES / NO / UNCLEAR
Incomplete outcome data *Outcome:* Clinician-rated outcomes e.g. non-union, deformity, range of motion	Were incomplete outcome data adequately addressed? YES / NO / UNCLEAR
Selective outcome reporting	Are reports of the study free of suggestion of selective outcome reporting? YES / NO / UNCLEAR
Other sources of bias Performance bias: for instance, provision of other interventions that should be comparable in both groups (e.g. advice on activity, exercises undertaken, timing of intervention; or clear differences in experience of personal characteristics of treatment providers, especially experience).	Was the study apparently free of other problems that could put it at a high risk of bias? YES / NO / UNCLEAR

Footnotes

DASH: Disabilities of the Arm Shoulder and Hand outcome measure
* In the Risk of bias table, a 'Yes' equates to 'low risk'; and a 'No' equates to 'high risk'.

HISTORY

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CONTRIBUTIONS OF AUTHORS

P Harding conceived and designed the protocol, and coordinated its development. She assisted in the development of the search strategies and wrote and entered the protocol into RevMan. She was the first independent reviewer of the studies resulting from the search strategy and was the primary author of the review.

T Rasekaba assisted with the design and co-ordination of the protocol development. He assisted in the development of the search strategies (PEDro) and assisted with the writing of the protocol, was the second independent reviewer of the studies and contributed to writing the review.

L Smirneos developed the search strategies for MEDLINE, CINAHL, EMBASE, *The Cochrane Library* and assisted with the PEDro database, Current Controlled Trials and WHO International Clinical Trials Registry Platform. She also commented on drafts of the protocol.

A Holland reviewed the design and co-ordination of the protocol development, search strategies and commented on drafts of the protocol and provided expert oversight on the review methodology and review editing.

DECLARATIONS OF INTEREST

None known.

SOURCES OF SUPPORT

Internal sources

- The Alfred, Melbourne, Australia.

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External sources

- No sources of support supplied

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

The following clarification has been added to the Background - Description of the condition: "The range of elbow movement required for functional tasks is a flexion arc of 30 to 130 degrees *(*Morrey 1981*)*."

In the risk of bias assessment tool in our protocol we included 'selection bias' resulting from major imbalances in baseline characteristics under the heading of 'Other sources of bias'. However, this item was not included in the review as 'selection bias' was assessed already in the first two domains of the risk of bias tool.

INDEX TERMS

Medical Subject Headings (MeSH)

Elbow [*injuries]; Movement [*physiology]; Radius Fractures [*rehabilitation]; Recovery of Function; Time Factors

MeSH check words

Adult; Humans