Manipulative interventions for reducing pulled elbow in young children (Review)

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[Intervention Review]

Manipulative interventions for reducing pulled elbow in young children

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ABSTRACT

Background

Pulled elbow (nursemaid's elbow) is a common injury in young children. It results from a sudden pull on the arm, usually by an adult or taller person, which pulls the radius through the annular ligament, resulting in subluxation (partial dislocation) of the radial head. The child experiences sudden acute pain and loss of function in the affected arm. Pulled elbow is usually treated by manual reduction of the subluxed radial head. Various manoeuvres can be applied. Most textbooks recommend supination of the forearm, as opposed to pronation and other approaches. It is unclear which manoeuvre is most successful. This is an update of a Cochrane review first published in 2009.

Objectives

The objective of this review is to compare the effectiveness and painfulness of the different methods used to manipulate pulled elbow in young children.

Search methods

We searched the Cochrane Bone, Joint and Muscle Trauma Group Specialised Register, the Cochrane Central Register of Controlled Trials, MEDLINE, EMBASE, CINAHL, LILACS, PEDro, clinical trial registers and reference lists of articles. Date of last search: July 2011.

Selection criteria

Any randomised or quasi-randomised controlled clinical trials evaluating manipulative interventions for pulled elbow were included. Our primary outcome was failure at the first attempt, necessitating further treatment.

Data collection and analysis

Two review authors independently evaluated trials for inclusion and, for the included trials, independently assessed the risk of bias and extracted data.

Main results

One trial with 66 children was newly included in this update. Overall, four trials with 379 children, all younger than seven years old, were included. All four trials compared pronation versus supination. One trial was at high risk of selection bias because allocation was not concealed and all four trials were at high risk of detection bias due to the lack of assessor blinding.

Pronation resulted in statistically significantly less failure than supination (21/177 versus 47/181, risk ratio 0.45; 95% confidence interval 0.28 to 0.73). Pain perception was reported by two trials but data were unavailable for pooling. Both studies concluded that the pronation technique was less painful than the supination technique.

Authors' conclusions

There is limited evidence from four small low-quality trials that the pronation method might be more effective and less painful than the supination method for manipulating pulled elbow in young children. We recommend that a high quality randomised trial be performed to strengthen the evidence.

PLAIN LANGUAGE SUMMARY

Different methods of manipulation for reducing pulled elbow in young children

Pulled elbow is a dislocation of the elbow joint in a young child which is usually caused by an adult, or taller person, suddenly pulling or tugging on the child's arm when it is straight; or when a child pulls away from an adult impulsively. The child immediately complains of pain and cannot use their arm.

Treatment usually consists of manipulating the arm to get the bones of the elbow back into their correct position. It is usually treated by manual intervention. In the typical manoeuvre, called supination, the forearm is twisted or rotated outwards (palm of child's hand faces upwards), sometimes followed by bending of the elbow. While this has become standard practice, it is not always successful. Other methods, particularly the use of pronation, where the forearm is twisted or rotated inwards (palm of child's hand faces downwards), have also been used. These methods are generally safe, although bruising can occur and they can be painful.

This review included four small, low quality trials involving a total of 379 children, all of whom were younger than seven years old. The evidence suggests that the pronation method (with the hand downward) is more successful in repositioning and less painful for children with a pulled elbow.

BACKGROUND

Description of the condition

Pulled elbow (radial head subluxation or nursemaid's elbow) is a painful condition of acute onset, resulting in sudden loss of function in the affected limb of an otherwise healthy child (Hagroo 1995). It is usually caused when an adult (or taller person) holds the child by the hand while walking and suddenly pulls the child away from, for example, a dangerous situation, or merely drags the child up a curb or a step (Salter 1971); or when a child pulls away from an adult impulsively. This sudden pull on the arm in young children (who have relatively lax tissue) pulls the radius through the annular ligament which may partially tear and become entrapped between the radial head and the capitellum (Matles 1967; Stone 1916). This results in subluxation (partial dislocation) of the radial head.

This injury is easily diagnosed on the basis of history and physical examination. The typical presentation is a child who has suddenly cried out with pain and refused to use their arm after a pulling incident, when a snap or click might have been heard (Magill 1954). The arm is held slightly flexed and twisted inward (Asher

1976), with no swelling or bruising (Hardy 1978). Pain is usually felt at the elbow but pain may only be felt at the wrist and/or shoulder (Asher 1976; Griffin 1955). The elbow can usually be flexed and extended, but twisting of the forearm meets resistance and causes pain in the elbow (Hardy 1978).

Pulled elbow is a common injury in young children (Illingworth 1975; Teach 1996). Population-based incidence rates are scarce but an incidence of 1.2% per year in children aged 0 to 5 years in the Aberdeen city area of Scotland has been described and extrapolated to an annual incidence of 50,000 cases per year in England, Wales and Scotland (Jongschaap 1990). In Dutch general practice, an incidence was reported of 2.4 per 1000 person years in children aged 0 to 5 years (Krul 2011). In the United States, the incidence of emergency care visits for pulled elbow was estimated at 2.7 per 1000 children aged 0 to 18 years (Brown 2009). The injury is most common in the left arm and in girls, and a median age of presentation of about two years has been reported (Hagroo 1995; Illingworth 1975).

Description of the intervention

Pulled elbow is usually treated by manual intervention of the subluxed radial head. Various manoeuvres can be applied. Sometimes, these may be in conjunction with application of manual pressure over the radial head. The typical manoeuvre involves supination (Davidson 1998; Eilert 1999; Nocton 2004; Thompson 2004), where the forearm is twisted or rotated outwards (palm of child's hand facing upwards), sometimes followed by flexion of the elbow (Sponseller 2006). While this has become standard practice, it is not always successful. Other methods, particularly the use of pronation, where the forearm is twisted or rotated inwards (palm of child's hand facing downwards), have also been used. Both methods are generally safe, although bruising can occur and they can be painful.

How the intervention might work

The purpose of all manipulative interventions is to reposition both the radial head and the annular ligament, thereby restoring the function of the arm and relieving the pain.

Why it is important to do this review

Pulled elbow is a common and very painful condition in young children. Although most textbooks recommend supination and flexion of the forearm (as opposed to pronation and other approaches), evidence for this advice is usually not presented. It is therefore important to identify and summarise the evidence in order to find the most effective and painless intervention. This is an update of a Cochrane review first published in 2009 (Krul 2009).

OBJECTIVES

To compare the effectiveness and painfulness of the different methods used to manipulate pulled elbow in young children. The primary comparison, as stated a priori, is the pronation method versus the supination method.

METHODS

Criteria for considering studies for this review

Types of studies

Any randomised or quasi-randomised (method of allocating participants to a treatment which is not strictly random: e.g. by date of birth, hospital record number, alternation) controlled clinical trials evaluating manipulative interventions for pulled elbow in young children.

Types of participants

All young children aged from birth up to adolescence, of either sex, diagnosed with an acute pulled elbow, either primary or recurrent. Trials specifically focusing on older children or adults with this condition were excluded. Trials of children undergoing interventions for complete dislocation of the proximal radial head were also excluded.

Types of interventions

Various manoeuvres, such as pronation or supination of the forearm, used for the manual reduction of subluxation of the proximal radial head in the pulled elbow were included. We included interventions that took place in any setting (e.g. hospital, general practice etc).

Types of outcome measures

Primary outcomes

The primary outcome was failure at the first attempt, where success is defined as immediate restoration of a pain-free, fully functioning arm. Failure was defined by the need for subsequent treatment, usually another attempt at reduction, and lack of spontaneous use of the arm by the child.

Secondary outcomes

When available, we also included results on the following outcomes:

- pain and distress during the intervention
- bruising and other adverse effects
- ultimate failure in terms of the need for more intensive intervention, such as general anaesthesia
- recurrence (within one month)

Search methods for identification of studies

Electronic searches

We searched the Cochrane Bone, Joint and Muscle Trauma Group Specialised Register (12th July 2011), the Cochrane Central Register of Controlled Trials (*The Cochrane Library* 2011, Issue 3), MEDLINE (1950 to July 2011), EMBASE (1974 to July 2011), CINAHL (1981 to July 2011), LILACS (Latin American and Caribbean Literature on the Health Sciences: 1982 to July 2011), and PEDro (Physiotherapy Evidence Database: 1929 to July 2011). There were no restrictions based on language or publication status.

In MEDLINE, the subject-specific search was combined with the Cochrane Highly Sensitive Search Strategy for identifying randomised trials: sensitivity- and precision-maximizing version (Lefebvre 2008) (*see* Appendix 1). Search strategies are also shown for the Cochrane Central Register of Controlled Trials, EMBASE, CINAHL, LILACS and PEDro (*see* Appendix 1). Search strategies included all synonyms for pulled elbow.

We searched the following registers of ongoing trials on 22 July 2011 using the term: "pulled and elbow".

- The metaRegister of Current Controlled Trials
- The World Health Organisation International Clinical Trials Registry platform

Searching other resources

We screened reference lists of relevant articles. We contacted all authors who have published a trial on the treatment of the pulled elbow in the last 10 years, asking for additional studies.

Data collection and analysis

Selection of studies

Two review authors (MK and JCvdW) independently screened the results of the searches to identify studies that appeared to meet the inclusion criteria of the review based on title and abstract. These studies were obtained in full text and the above two authors independently applied the review inclusion criteria. Disagreements were resolved by discussion.

Data extraction and management

Using a data extraction form, two review authors (MK and JCvdW) independently extracted data from the included trials. MK and JCvdW entered data into RevMan. Disagreements were resolved by discussion. Extraction of results from graphs in trial reports was considered when data were not provided in the text or tables. We attempted to contact authors of trials not reported in full journal publications for additional information and/or data.

Assessment of risk of bias in included studies

Two review authors (MK and JCvdW) independently assessed methodological quality of the included trials using The Cochrane Collaboration's tool for assessing risk of bias (Higgins 2008). Disagreements were resolved by discussion. Titles of journals, names of authors or supporting institutions were not masked at any stage. The risk of bias 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 parent-rated and clinician-rated outcomes separately in our assessment of blinding and completeness of outcome data. Our other sources of bias were selection bias, where we assessed the risk of bias from imbalances in key baseline characteristics (age, time from injury, primary or recurrent injury); and performance bias, where we checked for comparability in the experience of care providers and subsequent provision of treatment interventions such as slings and advice.

Measures of treatment effect

Quantitative data reported in individual trial reports for the outcomes listed in the inclusion criteria are presented in the text and in the analyses, using risk ratios (RR) with 95% confidence intervals (CI) for dichotomous outcomes. We planned to calculate mean differences for outcomes, such as pain, that are measured with a visual analogue scale. Where different instruments or measures were used, we planned to use the standard mean difference.

Unit of analysis issues

Sometimes children may present with two pulled elbows, which are randomised to one procedure. There is no easy way to include this cluster effect in our analysis. When reported data allowed, we planned to perform sensitivity analyses, with and without these children. Cases of recurrent pulled elbows will be treated the same way as children who present with a pulled elbow for the first time.

Dealing with missing data

Where appropriate, we planned to perform intention-to-treat analyses to include all people randomised to the intervention groups. We planned to investigate the effects of drop outs and exclusions by conducting worst and best case scenario analyses. We were alert to the potential mislabelling or non-identification of standard errors and standard deviations. Unless missing standard deviations could be derived from confidence interval data, we did not assume values in order to present these in the analyses.

Assessment of heterogeneity

We considered whether patient characteristics and the setting of the studies (e.g. emergency departments, general practice) were homogeneous enough from a clinical point of view to allow statistical pooling of the study results. Statistical heterogeneity was assessed by visual inspection of forest plots and calculation of the I^2 statistic and chi^2 test for heterogeneity.

Assessment of reporting biases

If more than 10 studies were available, we planned to construct a funnel plot.

Data synthesis

We statistically pooled the results using a fixed-effect model and 95% confidence intervals when studies were clinically (e.g. regarding the setting, or age of the children) homogeneous. Where there was significant heterogeneity, we planned to use a random-effects model.

Subgroup analysis and investigation of heterogeneity

We planned subgroup analyses by age (0 to 2 years; 2 to 5 years; 6 years and above), clinical setting, and whether it was a primary or recurrent subluxation. Should subgroup analysis be done in a future update, we will investigate whether the results of subgroups are significantly different by inspecting the overlap of confidence intervals, and performing the test for subgroup differences available in RevMan.

Sensitivity analysis

Where possible, we planned sensitivity analyses examining various aspects of trial and review methodology, including the inclusion of trials at high risk of bias (specifically from lack of allocation concealment).

RESULTS

Description of studies

See: Characteristics of included studies; Characteristics of excluded studies; Characteristics of studies awaiting classification; Characteristics of ongoing studies.

Results of the search

For this update (July 2011), we screened a total of 68 records from the following databases: Specialised Register of the Cochrane Bone, Joint and Muscle Trauma Group (one record), Cochrane Central Register of Controlled Trials (21 records), MEDLINE (five records), EMBASE (seven records), CINAHL (31 records), LILACS (no records), PEDro (two records) and The WHO International Clinical Trials Registry Platform (one record). The results from the previous searches (up to January 2009) are shown in Appendix 2.

The search update resulted in the identification of two potentially eligible studies. Upon study selection, one was included (Bek 2009) and the other placed in 'Ongoing studies' (NCT00993954). Overall, there are now four included trials (Bek 2009; Green 2006; Macias 1998; McDonald 1999), one excluded study (Taha 2000), one ongoing trial (NCT00993954), and one study, which is only reported as a conference abstract, continues to await classification (Vidosavljevic 2006).

Included studies

Of the four included trials, three were randomised controlled trials (Green 2006; Macias 1998; McDonald 1999) and one was quasi-randomised (Bek 2009). Details of the individual trials are given in the Characteristics of included studies.

All four trials were performed in paediatric emergency departments or ambulatory care centres. Three trials (Green 2006; Macias 1998; McDonald 1999) were conducted in the USA and one (Bek 2009) in Turkey. Bek 2009 recruited 66 children who were younger than five years of age. Green 2006 recruited 75 children aged between six months and seven years. Macias 1998 recruited 85 children younger than six years, five of whom were enrolled on two separate occasions thus giving a sample size of 90. McDonald 1999 recruited 148 children younger than six years. Of the 356 participants for whom baseline data were available, 59% were girls.

All the included trials compared pronation with supination. The interventions were forced pronation versus supination-flexion in Green 2006; hyperpronation versus supination-flexion in Bek 2009 and Macias 1998; and pronation-flexion versus supination-flexion in McDonald 1999.

All four trials reported on success and failure. A second attempt after a failed first attempt was made at 10 minutes in Green 2006, at 15 minutes in Bek 2009 and Macias 1998, and at 30 minutes in McDonald 1999. Green 2006 and McDonald 1999 also measured pain: in Green 2006, various visual analogue scales

were used by physicians, nurses and parents; while McDonald 1999 used a four point ordinal scale. The doctors performing the reduction manoeuvres in Bek 2009 rated these as easy, moderate or difficult based on the difficulty of the manoeuvre, the child's pain and overall condition.

Excluded studies

One trial (Taha 2000) was excluded because it did not compare different methods of reducing pulled elbow.

Risk of bias in included studies

Figure 1 and Figure 2 summarise our assessment of the risk of bias for the included trials. Comments on the specific items we assessed are given below.

Figure 1. Methodological quality summary: review authors' judgements about each methodological quality item for each included study.

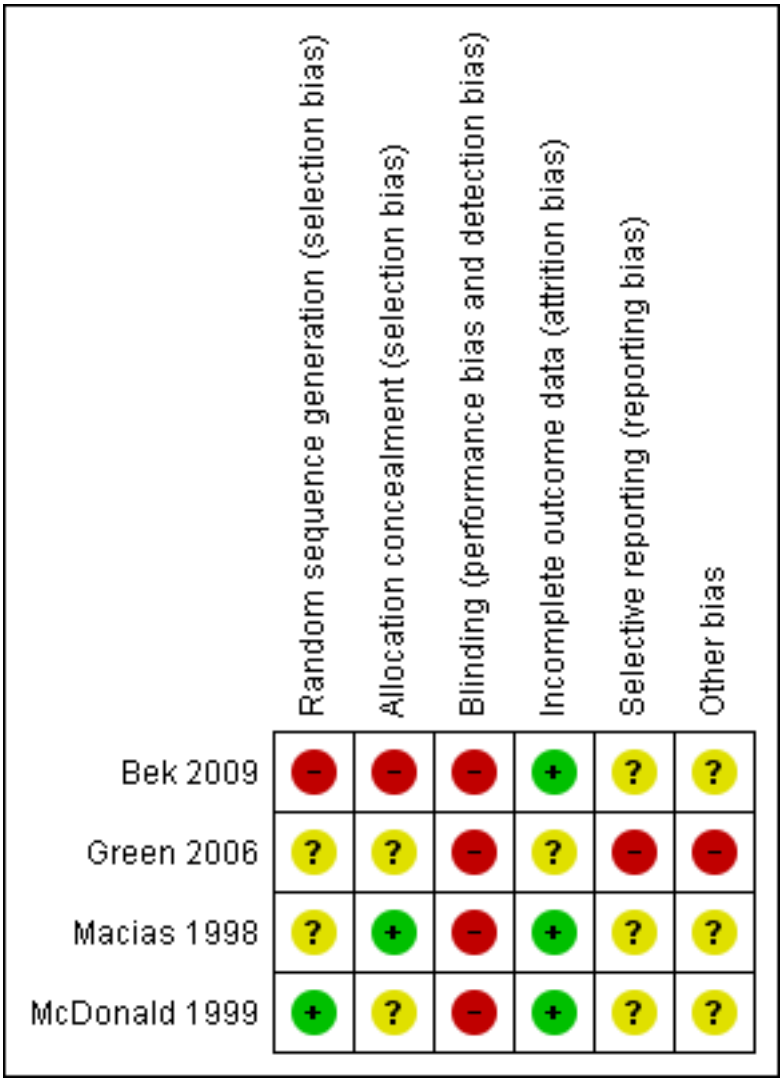
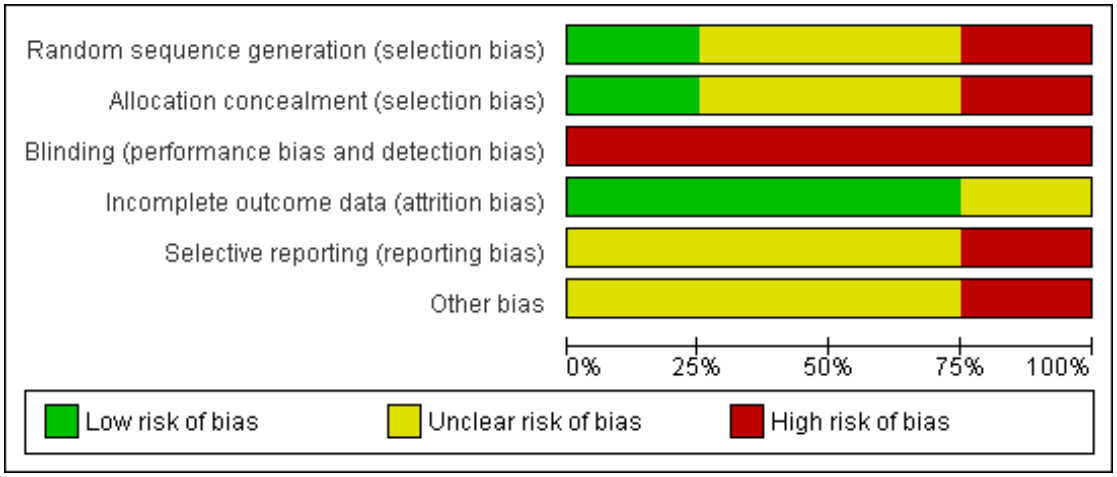


Figure 2. Methodological quality graph: review authors' judgements about each methodological quality item presented as percentages across all included studies.



Allocation

While not reporting the method of sequence generation, Macias 1998 reported that allocation was concealed to the attending physician. Allocation concealment was not mentioned in Green 2006 and McDonald 1999; the associated risk of selection bias in these two trials was judged as 'unclear'. Bek 2009 assigned treatment according to the child's birthday (odd or even) and so was judged at 'high' risk of selection bias since allocation was not concealed.

Blinding

Blinding of either the participants (not possible), the treatment providers (not possible) or the outcome assessors was not done in any of the studies. The lack of blinding is an important but to some extent unavoidable source of bias in all four trials.

Incomplete outcome data

In the trial report of Green 2006, there were discrepancies in the numbers of participants presented in the table of patient characteristics and those in the flow chart: information was missing for two participants in the former. For some participants of McDonald 1999, data on pain scores were missing and unaccounted for.

Selective reporting

In Green 2006, pain was only recorded for successful attempts and not for the nine participants with unsuccessful attempts (9 out of 72 participants). It was unclear whether there was selective reporting in the other three trials.

Other potential sources of bias

There was a considerable difference between the study groups regarding the time of injury in Green 2006. In the other three trials no other potential sources of bias were identified. There was no information on the experience of the attending physicians. However, all reductions in Bek 2009 were performed by one of three final-year trainee doctors, who received a briefing about the reduction techniques before starting the trial. Additionally, some reductions in McDonald 1999 were performed by trainee doctors (residents or senior medical students) under supervision.

Effects of interventions

All four studies provided evidence that pronation was more effective than supination. As these studies were all performed in similar settings and included similar study populations, we decided to pool data on failure rates reported in all four studies. We found a statistically significant difference in favour of the pronation methods (*see* Analysis 1.1: risk ratio 0.45; 95% CI 0.28 to 0.73 (I^2 = 30%)). The omission of Green 2006, which was potentially confounded by the difference in mean time from injury between the two groups, did not affect this finding. The control event rate (supination + flexion) varied: this was 16% in Green 2006, 23% in Macias 1998, and 31% in Bek 2009 and McDonald 1999. However, assuming a mean control event rate of 26% (one in four first attempts using the supination method fail) and an absolute difference of 14%, the number needed to treat (NNT) is close to 7. This means that seven children would need to be treated with the pronation method rather than the supination method to avoid one failure at the first attempt.

Of our secondary outcome measures, pain was measured in two

trials (Green 2006; McDonald 1999) but they used very different measures. Data for pain were unavailable for presentation in the analyses. Moreover, in Green 2006, pain was only assessed for successful attempts. Green 2006 found that, in the successful attempts, the difference in the visual analogue scores (10 cm scale) favoured pronation. The difference was 0.7 cm as perceived by physicians (reported P = 0.11); 1.0 cm by nurses (reported P = 0.03) and 1.7 cm by parents (reported P = 0.04). This last finding was both statistically and clinically significant. McDonald 1999 reported, using a four point ordinal score, that the treating physicians perceived the pronation method to be significantly less painful than supination (reported P = 0.013), but that parental pain scores during reduction were similar for both procedures (reported P = 0.169). In conclusion, both studies found that pronation might be less painful, but lack of assessor blinding and incomplete data may have affected this finding. The subjective assessment by physicians of the reduction manoeuvre based on an assessment of difficulty of manoeuvre, pain and overall condition in Bek 2009 favoured hyperpronation (reported P = 0.003).

The other secondary outcome measures (i.e. bruising and other adverse effects, ultimate failure (in terms of need for more intensive intervention, such as general anaesthesia), and recurrence) were not reported in any of the studies.

Our planned subgroup analyses by age (0 to 2 years; 2 to 5 years; 6 years and above), clinical setting, and whether the subluxation was primary or recurrent were not possible due to lack of data.

DISCUSSION

Summary of main results

The four trials included in this review compared the effectiveness of pronation versus supination for the reduction of subluxation of the radial head in 379 young children (all younger than seven years old). Pooled data from 356 cases for our primary outcome of failure at first attempt showed that pronation resulted in statistically significantly less failure than supination (RR 0.45; 95% CI 0.28 to 0.73). Assuming a mean control event rate of 26% and an absolute difference of 14%, we estimated that seven children would need to be treated with the pronation method rather than the supination method to avoid one failure at the first attempt. Two trials reported that pronation might be less painful but data were not available to confirm this.

Overall completeness and applicability of evidence

The objective of this review was to compare the effectiveness of, and pain associated with, different methods for manipulating the pulled elbow in young children. All included studies addressed our stated primary comparison of pronation versus supination methods. We believe this review provides a relevant answer to the question of effectiveness of these basic procedures, but the evidence is still incomplete and susceptible to bias. In particular, there was insufficient or no evidence on pain, adverse effects or recurrence. Trial settings, care providers and the study populations were comparable in the four trials and the findings of these trials would apply more generally. However, our planned subgroup analyses by age (0 to 2 years; 2 to 5 years; 6 years and above) and clinical setting were not possible.

Quality of the evidence

The quality of evidence was low in all studies, with high risk of bias resulting from lack of allocation concealment in one trial, lack of assessor blinding in all four trials, and a major imbalance in mean time from injury at baseline in one trial. Additionally, there was incomplete assessment of pain in both trials recording this item.

Potential biases in the review process

Although our search was extensive, we cannot exclude the possibility that we have missed relevant evidence. We tried to contact the authors of the original studies but only one replied and this did not result in clarification of methods or results. Our search of grey literature, the pursuit of trials listed in clinical trial registers and the fact that we applied no restrictions based on language or publication status aimed to avoid publication bias, location bias, citation bias, language bias and outcome reporting bias. Given there were only four studies available, we were unable to explore whether publication bias could have occurred. Multiple publication bias did not occur.

Agreements and disagreements with other studies or reviews

We found two other reviews. Lewis 2003, which included the studies by McDonald 1999 and Macias 1998, concluded that pronation with or without elbow flexion should be "the first line method of reduction for pulled elbows". Lewis 2003 pointed out that lack of blinding was a key weakness of these two trials. A recent Dutch review (Knuistingh Neven 2008), which included the studies by Green 2006; Macias 1998; McDonald 1999 but also Taha 2000 (which we excluded), also concluded that the pronation method was more effective than the supination method.

Most textbooks still only suggest the supination method (e.g. Davidson 1998; Eilert 1999; Nocton 2004; Thompson 2004). This is not supported by the findings of this systematic review, which provides some evidence that pronation might be more effective and less painful than supination.

AUTHORS' CONCLUSIONS

Implications for practice

Four studies comparing the pronation method with the supination method provide limited evidence that pronation is more effective and less painful than supination. Many textbooks recommend supination as the preferred method, which notably is not supported by the findings of this systematic review.

Implications for research

It would be useful to replicate the head-to-head comparison of pronation versus supination in a larger randomised controlled trial that conforms to high methodological and reporting standards. As well as rigorous and blinded assessment of failure, recorded outcomes should include our secondary outcome measures: pain and distress during the intervention (both preferably blinded), adverse effects, ultimate failure and recurrence. This further research would provide the conclusive evidence for the most effective method.

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REFERENCES

References to studies included in this review

Bek 2009 *{published data only}*

Bek D, Yildiz C, Köse Ö, ş ehirlioğ lu A, Ba ş bozkurt M. Pronation versus supination maneuvers for the reduction of 'pulled elbow': a randomized clinical trial. *European Journal of Emergency Medicine* 2009;**16**(3):135–8.

Green 2006 *{published data only}*

Green DA, Linares MY, Garcia Peña BM, Greenberg B, Baker RL. Randomized comparison of pain perception during radial head subluxation reduction using supination-flexion or forced pronation. *Pediatric Emergency Care* 2006; **22**(4):235–8. [MEDLINE: 16651912]

Macias 1998 *{published data only}*

* Macias CG, Bothner J, Wiebe R. A comparison of supination/flexion to hyperpronation in the reduction of radial head subluxations. *Pediatrics* 1998;**102**(1):e10. [MEDLINE: 9651462]

Macias CG, Wiebe R, Bothner J. History and radiographic findings associated with clinically suspected radial head subluxations. *Pediatric Emergency Care* 2000;**16**(1):22–5. [MEDLINE: 10698138]

McDonald 1999 *{published data only}*

McDonald J, Whitelaw C, Goldsmith LJ. Radial head subluxation: comparing two methods of reduction. *Academic Emergency Medicine* 1998;**6**(7):715–8. [MEDLINE: 10433531]

References to studies excluded from this review

Taha 2000 *{published data only}*

Taha AM. The treatment of pulled elbow: a prospective randomized study. *Archives of Orthopaedic and Trauma Surgery* 2000;**120**(5-6):336–7. [MEDLINE: 10853908]

References to studies awaiting assessment

Vidosavljevic 2006 *{published data only (unpublished sought but not used)}*

Vidosavljevic M, Pejanovic J, Jovanovic B, Brdar R, Abramovic D, Ducic S, et al.Pronatio dolorosa - radial head subluxation a comparison of reduction techniques: supination/flexion versus hyperpronation - preliminary results [abstract]. *Journal of Bone and Joint Surgery - British Volume* 2006;**88**(Suppl 1):131–2.

References to ongoing studies

NCT00993954 *{published data only}*

NCT00993954. Reduction of radial head subluxation in children via a nurse initiated pathway: A randomized control trial. clinicaltrials.gov/show/NCT00993954 (accessed 22 July 2011).

Additional references

Asher 1976

Asher MA. Dislocations of the upper extremity in children. *Orthopedic Clinics of North America* 1976;**7**(3):583–91.

Brown 2009

Brown D. Emergency department visits for nursemaid's elbow in the United States, 2005-2006. *Orthopaedic Nursing* 2009;**28**(4):161–2.

Davidson 1998

Davidson RS, Hahn M. Musculoskeletal trauma. In: O' Neill JA, Rowe MI, Grosfeld JL editor(s). *Pediatric surgery*. 5th Edition. Mosby, 1998:318.

Eilert 1999

Eilert RR, Georgopoulis G. Orthopedics. In: Hay WW, Hayward AR, Levin MJ, Sondheimer JM editor(s). *Current pediatric diagnosis and treatment*. 14th Edition. London: Prentice Hall International, 1999. [: ISBN 0838512542]

Griffin 1955
Griffin ME. Subluxation of the head of the radius in young children. *Pediatrics* 1955;**15**(1):103–6.

Hagroo 1995
Hagroo GA, Zaki HM, Choudhary MT, Hussain A. A pulled elbow - not the effect of the hypermobility of joints. *Injury* 1995;**26**(10):687–90.

Hardy 1978
Hardy RH. Nursemaid's elbow. *Journal of the Royal College of General Practitioners* 1978;**28**(189):224–6.

Higgins 2008
Higgins JPT, Altman DG (editors). Chapter 8: Assessing risk of bias in included studies Table 8.5a. 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.

Illingworth 1975
Illingworth CM. Pulled elbow: a study of 100 patients. *British Medical Journal* 1975;**2**(5972):672–4.

Jongschaap 1990
Jongschaap HC, Youngson GG, Beattie TF. The epidemiology of radial head subluxation ('pulled elbow') in the Aberdeen city area. *Health Bulletin* 1990;**48**(2):58–61.

Knuistingh Neven 2008
Knuistingh Neven A, Eekhof J. Nursemaid's elbow [Zondagmiddagarmpje]. *Huisarts en Wetenschap* 2008;**51**(13):688–90.

Krul 2011
Krul M. *Musculoskeletal problems in children in general practice (thesis)*. Rotterdam: Erasmus University, 2011.

Lefebvre 2008
Lefebvre C, Manheimer E, Glanville J. Search filters. 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.

Lewis 2003
Lewis D. Reduction of pulled elbows. *Emergency Medicine Journal* 2003;**20**(1):61–2.

Magill 1954
Magill HK, Aitken AP. Pulled elbow. *Surgery, Gynecology & Obstetrics* 1954;**98**(6):753–6.

Matles 1967
Matles AL, Eliopoulos K. Internal derangement of the elbow in children. *International Surgery* 1967;**48**(3):259–63.

Nocton 2004
Nocton JJ. Chapter 44 Arthritis. In: Kliegman RM, Greenbaum LA, Lye PS editor(s). *Practical strategies in pediatric diagnosis and therapy*. 2nd Edition. Philadelphia: Elsevier Saunders, 2004:820. [: ISBN 0721691315]

Salter 1971
Salter RB, Zaltz C. Anatomic investigations of the mechanism of injury and pathologic anatomy of "pulled elbow" in young children. *Clinical Orthopaedics & Related Research* 1971;**77**:134–43.

Sponseller 2006
Sponseller PD. Bone and joint diseases. In: McMillan JA editor(s). *Oski's pediatrics, principles and practice*. 4th Edition. Philadelphia: Lippincott Williams & Wilkins, 2006:2493. [: ISBN 0781738946]

Stone 1916
Stone CA. Subluxation of the head of the radius. *Journal of the American Medical Association* 1916;**67**:28–9.

Teach 1996
Teach SJ, Schutzman SA. Prospective study of recurrent radial head subluxation. *Archives of Pediatrics & Adolescent Medicine* 1996;**150**(2):336–7.

Thompson 2004
Thompson GH. The upper limb. In: Behrman RE, Kliegman RM, Jensen HB editor(s). *Nelson textbook of pediatrics*. 17th Edition. Philadelphia: Saunders, 2004: 2290.

References to other published versions of this review

Krul 2009
Krul M, van der Wouden JC, van Suijlekom-Smit LWA, Koes BW. Manipulative interventions for reducing pulled elbow in young children. *Cochrane Database of Systematic Reviews* 2009, Issue 4. [DOI: 10.1002/14651858.CD007759.pub2]

* *Indicates the major publication for the study*

CHARACTERISTICS OF STUDIES

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

Bek 2009

Methods	Quasi-randomised controlled trial
Participants	Accident and emergency department, Gülhane Military Medical Academy, Ankara, Turkey January to November 2007 Inclusion criteria: aged younger than 5 years of age with a clinical presentation and history suggestive of pulled elbow Exclusion criteria: earlier history of pulled elbow, marked deformity, local swelling and ecchymosis at elbow, and polytraumatised patients 66 patients enrolled, assigned to treatment according to day of birth (odd or even) 26 boys and 40 girls Mean age 28.6 months
Interventions	Hyperpronation versus supination-flexion
Outcomes	Success rate during first attempt, second attempt (same method, 15 minutes later), and third method (alternative method) Combined subjective rating by physician of difficulty of the manoeuvre; child's pain during reduction and overall condition
Notes	

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	High risk	Quasi-randomised (assignment according to odd and even birth date)
Allocation concealment (selection bias)	High risk	Not concealed
Blinding (performance bias and detection bias) All outcomes	High risk	Participants: not possible Treatment provider: not possible Outcome assessor: unclear but probably not blinded
Incomplete outcome data (attrition bias) All outcomes	Low risk	All 66 patients were analysed
Selective reporting (reporting bias)	Unclear risk	No details
Other bias	Unclear risk	Hyperpronation group was 4 months older, but the difference between the two groups was not statistically significant

Green 2006

Methods	RCT
Participants	Emergency department, Miami Children's Hospital, Miami, Florida, USA March 2003 to January 2004 Inclusion criteria: aged between 6 months and 7 years with clinical findings suggestive of radial head subluxation Exclusion criteria: evidence of bony tenderness or swelling 75 children enrolled of whom 3 were excluded due to non-adherence to protocol (1 data form was lost; 2 study packets were completed by residents and not by the attending physician) For pain measurement 9 additional children were excluded due to unsuccessful first attempt of reduction 29 boys and 41 girls. (As well as the 3 exclusions, Table 1 of the article had 2 missing; see Notes) Age 6 months to 7 years
Interventions	Forced pronation versus supination-flexion
Outcomes	Success rate during first attempt and second attempt (with the alternative method), which was done 10 minutes later Pain before, during and 1 minute after successful repositioning using VAS (10 cm). The scale used was not stated, but nurses and physicians were educated on: 0 to 3 years: nonverbal/behavioural scale 3 to adolescence: faces pain rate scale 8 years and older: laminated numeric scale
Notes	Number of participants in flow chart and text do not match with table of baseline characteristics in the paper. The former were assumed to be correct

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	"Randomly assigned using a consecutive case allocation" (p.235)
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding (performance bias and detection bias) All outcomes	High risk	Participants: not possible Treatment provider: not possible Outcome assessor: unclear but probably not blinded
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Table 1 is not clear (data discrepancies in the article)
Selective reporting (reporting bias)	High risk	Pain perception reported for successful reduction only

Other bias	High risk	Considerable baseline imbalance with respect to time of injury (mean time of injury: 6.58 versus 13.47 hours)

Macias 1998

Methods	RCT
Participants	Two urban paediatric emergency departments and two suburban paediatric ambulatory care centres in the USA. June 1996 to May 1997 Inclusion criteria: previously healthy, younger than 6 years with clinical findings suggestive of radial head subluxation Exclusion criteria: point tenderness, local areas of ecchymosis (bruising) or oedema (swelling), deformity and persistent pain 90 episodes (in 85 participants) were included in randomisation, five were excluded because of a fracture, and one patient failed protocol 34 boys and 51 girls Age range: 2 to 68 months, mean 27.7 months 28 (33%) reported a previous episode
Interventions	Hyperpronation versus supination-flexion
Outcomes	Success rate (success was return to baseline function of the arm after 15 minutes) at first attempt, second attempt with same procedure or third attempt with the other procedure
Notes	5 participants enrolled twice (in 4 participants the episodes were more than 2 months apart and 1 patient presented after several days of normal usage of the arm)

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Not reported
Allocation concealment (selection bias)	Low risk	"Technique assignment was unknown to the attending physician at the time of enrolment"
Blinding (performance bias and detection bias) All outcomes	High risk	Participants: not possible Treatment provider: not possible Outcome assessor: unclear but probably not blinded
Incomplete outcome data (attrition bias) All outcomes	Low risk	All 90 participants are reported
Selective reporting (reporting bias)	Unclear risk	No details

Macias 1998 (*Continued*)

Other bias	Unclear risk	No baseline imbalance

McDonald 1999

Methods	RCT
Participants	Emergency department of a tertiary care children's hospital in the USA. July 1996 to December 1997 Inclusion criteria: younger than 7 years presenting with a complaint of an upper extremity injury and who were refusing to use their arm Exclusion criteria: history of neurologic impairment, congential bony malformation, oedema or obvious bony deformity 148 participants enrolled of whom 13 were excluded: 6 had a fracture; 2 spontaneously reduced; in 2 cases the study protocol was not followed; and in 3 cases data were missing 58 boys and 77 girls Age range: 3 months to 6 years
Interventions	Rapid pronation and flexion versus rapid supination and flexion
Outcomes	Success rate (success was defined as using the arm to reach for a toy or piece of candy within 30 minutes after manipulation) after first attempt. If failed, second attempt used same procedure and third attempt used the other procedure Pain during manipulation measured by the physician and the parent on an ordinal scale (0 = no pain, 1 = little pain, 2 = quite a lot of pain, 3 = very bad pain) Parents' scoring sheets were illustrated with descriptive drawings of facial expressions
Notes	

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Blocked randomisation list generated by computer. Trial was balanced after every 10 patients
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding (performance bias and detection bias) All outcomes	High risk	Participants: not possible Treatment provider: not possible Outcome assessor: unclear but probably not
Incomplete outcome data (attrition bias) All outcomes	Low risk	Low risk for primary outcome. Unclear for pain assessments: three participants missing in pronation group
Selective reporting (reporting bias)	Unclear risk	Unsure
Other bias	Unclear risk	No important baseline imbalance

VAS: visual analogue scale

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

Study	Reason for exclusion
Taha 2000	Not investigating methods to reduce the pulled elbow, but about subsequent management

Characteristics of studies awaiting assessment *[ordered by study ID]*

Vidosavljevic 2006

Methods	An eligible comparison but unclear if actually "randomized" as claimed
Participants	Emergency department of University Children's Hospital of Belgrade, Serbia July 2004 to October 2004 54 children less than 4 years old with pulled elbow
Interventions	Hyperpronation versus supination-flexion
Outcomes	Success evaluated by time to return to function, duration of child crying and palpable confirmation of successful reduction. Failure was another attempt using the other method because of non-return of full function after 30 minutes
Notes	This trial was only reported as a conference abstract. The trial authors referred to "preliminary results". A request for further information has been sent

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

NCT00993954

Trial name or title	Reduction of radial head subluxation in children via a nurse initiated pathway: A randomized control trial
Methods	Randomised trial with no assessor blinding
Participants	Inclusion criteria: Aged up to 6 years, physical exam consistent with radial head subluxation which includes not using the affected limb, holding the elbow in extension or slight flexion, forearm in pronation, and patient is distressed only on elbow movement, injury within preceding 12 hours. Exclusion criteria: Deformity of clavicle or arm, swelling of elbow or wrist, significant tenderness on palpation of arm, metabolic bone disease (i.e. osteogenesis imperfecta, neuromuscular disorder that excludes adequate assessment (i.e. severe cerebral palsy)
Interventions	Patients randomised to reduction by nurse or to treatment by Emergency Department (ED) Physician in traditional ED manner. Nurse group will use hyperpronation with extension for first attempt and supination and flexion for second

NCT00993954 (*Continued*)

	attempt. Physician controls will use either method at their discretion
Outcomes	Primary outcome measure: Proportion of patients with successful reduction of radial head subluxation by nurse, compared with physician controls Secondary outcome measures: Time to normal usage (minutes). Time to discharge from ED (minutes). Proportion of patients with presentation compatible with radial head subluxation, have reduction attempted, who are subsequently diagnosed with fracture. Proportion of patients with radial head subluxation not identified by nurse pathway
Starting date	October 2009
Contact information	Andrew Dixon andrew.dixon@albertahealthservices.ca Amy Plint plint@cheo.on.ca
Notes	

DATA AND ANALYSES

Comparison 1. Pronation versus supination

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Failure: second attempt required	4	358	Risk Ratio (M-H, Fixed, 95% CI)	0.45 [0.28, 0.73]

WHAT'S NEW

Last assessed as up-to-date: 11 July 2011.

Date	Event	Description
2 December 2011	New search has been performed	For this first update of the review, the following changes were made: 1. The search was updated to July 2011. 2. One new trial (Bek 2009) was included and one ongoing trial (NCT00993954) was added to 'Ongoing studies'.
2 December 2011	New citation required but conclusions have not changed	3. The conclusions were unchanged.

HISTORY

Protocol first published: Issue 2, 2009

Review first published: Issue 4, 2009

CONTRIBUTIONS OF AUTHORS

Marjolein Krul

Contact author; drafting the protocol; searching the literature; inclusion procedure; data extraction and assessing risk of bias; drafting the text of the review.

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Providing general advice on the protocol and review; methodological advice; inclusion procedure; data extraction and assessing risk of bias.

Lisette WA van Suijlekom-Smit

Providing general advice on the protocol and review.

Bart W Koes

Providing general advice on the protocol and review.

DECLARATIONS OF INTEREST

None known.

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External sources

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INDEX TERMS

Medical Subject Headings (MeSH)

Dislocations [etiology; *therapy]; Elbow Joint [*injuries]; Manipulation, Orthopedic [*methods]; Pronation; Radius [*injuries]; Randomized Controlled Trials as Topic; Sprains and Strains [etiology; *therapy]; Supination

MeSH check words

Child; Child, Preschool; Humans; Infant