Mini-CAT **Fredrique Green**

Clinical Question:

A 3-year-old female brought in by her mother to the pediatric emergency department (ED) for a complaint of left elbow pain, onset 1 hour ago after her mother pulled her left arm at the wrist to get her out of the car. Physical examination findings were consistent with a radial head subluxation, and the pediatric ED attending performed a successful supination and flexion maneuver to reduce the subluxation. This was my first time seeing radial head subluxation, and I have read in the past that although supination and flexion is performed more often, hyperpronation is a more effective technique, which begged the following question:

PICO Question:

Is the hyperpronation (HP) technique more successful than the supination and flexion (SF) technique at reducing radial head subluxation in pediatric patients?

P	I	C	O
Pediatrics	Hyperpronation	Supination-flexion	Reduction
Radial head subluxation		Supination and flexion	Pain
Nursemaid's elbow			Effectiveness
Young children			Attempts

<u>Search Strategy</u>:

- PubMed:
  - nursemaid's elbow supination flexion hyperpronation effectiveness → 5 results
  - radial head subluxation children hyperpronation supination flexion → 11 results
    - Filters: 2018-2024 → 5 results
  - radial head subluxation reduction technique attempts → 12 results
- Cochrane:
  - nursemaid's elbow hyperpronation supination flexion → 1 result
  - radial head subluxation reduction technique effectiveness → 2 results
- TRIP Database:
  - radial head subluxation reduction technique attempts → 85 results
    - Filters: 2018-2024 → 24 results
- Google Scholar:
  - radial head subluxation children hyperpronation supination flexion → 6,580 results
    - Filters: 2018-2024 → 1,810 results

I started by selecting articles that directly compared my intervention (HP) to the comparison (SF) for my problem (radial head subluxation), and that also aimed to measure my outcome. Of those, I chose articles with primary and secondary outcomes that I felt best defined a "successful" reduction and were also clinically applicable. This yielded articles that sought to measure first attempt success, second attempt success, and pain. I made sure to choose articles that were of the highest level of evidence (meta-analysis, systematic review), but I noticed that the authors of all the reviews I chose noted that their evidence was of low quality and that randomized controlled trials should be done to produce higher quality evidence to better support their findings. For this reason, I also selected a study with a design as close to a randomized controlled trial as possible. Lastly, I selected articles that were published recently (no earlier than 2018).

Articles Chosen:

Article 1:

Bexkens R, Washburn FJ, Eygendaal D, van den Bekerom MP, Oh LS. Effectiveness of reduction maneuvers in the treatment of nursemaid's elbow: A systematic review and meta-analysis. *Am J Emerg Med*. 2017;35(1):159-163. doi:10.1016/j.ajem.2016.10.059

Abstract: **Background/Aim:** Nursemaid's elbow usually occurs in young children when longitudinal traction is placed on the arm. Several manipulative maneuvers have been described, although, the most effective treatment technique is yet unclear. The aim of this systematic review and meta-analysis was to compare the two most commonly performed maneuvers (supination-flexion and hyperpronation) in the treatment of nursemaid's elbow. **Methods:** A literature search was performed in PubMed, Embase, and Cochrane databases to identify randomized controlled trials comparing supination-flexion and hyperpronation. Data were extracted and pooled independently by two authors. Methodological quality assessment of included studies was performed. Meta-analysis was performed using a fixed-effect model in case of homogeneity across studies, and using a random-effect model in case of heterogeneity. Heterogeneity was calculated with the χ2 test and inconsistency in study effects across trials was quantified by I2 values. **Results:** Seven randomized trials, including 701 patients (62% female), were included. A total of 350 patients were treated with the hyperpronation maneuver versus 351 patients who underwent the supination-flexion maneuver. Meta-analysis showed that hyperpronation was more effective than supination-flexion (risk ratio, 0.34; 95% confidence interval, 0.23 to 0.49; I2 , 35%). The absolute risk difference between maneuvers was 26% in favor of hyperpronation, resulting in a number needed to treat of 4 patients. Trials lacked blinding of assessors and universal pain measures. **Conclusions:** Hyperpronation was more effective in terms of success rate and seems to be less painful compared to the supination-flexion maneuver in children with nursemaid's elbow.

Effectiveness of reduction maneuvers in the treatment of nursemaid's elbow: A systematic review and meta-analysis

Article 2:

Krul M, van der Wouden JC, Kruithof EJ, van Suijlekom-Smit LW, Koes BW. Manipulative interventions for reducing pulled elbow in young children. *Cochrane Database Syst Rev*. 2017;7(7):CD007759. Published 2017 Jul 28. doi:10.1002/14651858.CD007759.pub4

Abstract

Background

Pulled elbow (nursemaid's elbow) is a common injury in young children. It often 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. It can also be caused by a fall or twist. 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 commonly, supination of the forearm, often combined with flexion, and (hyper-)pronation. It is unclear which is most successful. This is an update of a Cochrane review first published in 2009 and last updated in 2011.

Objectives

To compare the effects (benefits and harms) 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: September 2016.

Selection criteria

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, assessed risk of bias, and extracted data. We pooled data using a fixed-effect model.
Main results
Overall, nine trials with 906 children (all younger than seven years old and 58% of whom were female) were included, of which five trials were newly identified in this update. Eight trials were performed in emergency departments or ambulatory care centres, and one was performed in a tertiary paediatric orthopaedic unit. Four trials were conducted in the USA, three in Turkey, one in Iran, and one in Spain. Five trials were at high risk of selection bias because allocation was not concealed and all trials were at high risk of detection bias due to the lack of assessor blinding. Eight trials compared hyperpronation with supination-flexion. We found low-quality evidence that hyperpronation resulted in less failure at first attempt than supination-flexion (9.2% versus 26.4%, risk ratio (RR) 0.35; 95% confidence interval (CI) 0.25 to 0.50; 811 participants, 8 studies). Based on an illustrative risk of 268 failures at first attempt per 1000 children treated using supination-flexion, this amounted to 174 fewer failures per 1000 children treated using hyperpronation (95% CI 134 to 201 fewer). Based on risk differences data, we also estimated a number needed to treat of 6 (95% CI 5 to 8); this means that six children would need to be treated with the hyperpronation method rather than the supination-flexion method to avoid one additional failure at the first attempt. The very low-quality evidence (from four studies) for pain during or after manipulation means that it is uncertain whether there is or is not a difference between pronation and supination-flexion. There was very low-quality evidence from six studies that repeat pronation may be more effective than repeat supination-flexion for the second attempt after initial failure. The remaining outcomes were either not reported (adverse effects, recurrence) or unsuitable for pooling (ultimate failure). Ultimate failure, reported for the overall population only because of the differences in the study protocols with respect to what to do after the first attempt failed, ranged from no ultimate failures in two studies to six failures (4.1% of 148 episodes) in one study. One trial compared supination-extension versus supination-flexion. It provided very low-quality evidence (downgraded three levels for very serious risk of bias and serious imprecision) of no clear difference in failure at first attempt between the two methods.
Authors' conclusions
There was low-quality evidence from eight small trials that the pronation method may be more effective at first attempt than the supination method for manipulating pulled elbow in young children. For other outcomes, no conclusions could be drawn either because of very low-quality evidence or the outcomes not being reported. We suggest that a high-quality randomised clinical trial comparing hyperpronation and supination-flexion is required to provide definitive evidence. We recommend that this is preceded by a survey among clinicians to establish the extent of clinical equipoise and to optimise the study design and recruitment.

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6483272/

Article 3:

Bertucci N, Cowling K. Is Hyperpronation More Effective Than Supination for Reduction of a Radial Head Subluxation? *Annals of Emergency Medicine*. 2018;72(5):586-587. doi:https://doi.org/10.1016/j.annemergmed.2018.01.002

METHODS: DATA SOURCES The authors searched the Cochrane Bone, Joint and Muscle Trauma Group specialized register, the Cochrane Central Register of Controlled Trials, MEDLINE, EMBASE, the Cumulative Index of Nursing and Allied Health, LILACS, and PEDro. For this update of a previously published Cochrane review, the searches were limited to 2011 onward. **STUDY SELECTION** Randomized and quasi-randomized controlled clinical trials that evaluated manipulative interventions for radial head subluxation were included. **DATA EXTRACTION** Trials were screened for inclusion independently by 2 review authors. For the included trials, the 2 authors independently extracted data and assessed the risk of bias. The results were statistically pooled with a fixed-effect model and presented as relative risk with 95% confidence intervals (CIs). Statistical heterogeneity was assessed by forest plots, I 2 statistic, and c 2 test for heterogeneity.

https://www.annemergmed.com/action/showPdf?pii=S0196-0644%2818%2930002-7

Article 4:

Gunaydin YK, Katirci Y, Duymaz H, et al. Comparison of success and pain levels of supination-flexion and hyperpronation maneuvers in childhood nursemaid's elbow cases. *Am J Emerg Med*. 2013;31(7):1078-1081. doi:10.1016/j.ajem.2013.04.006

Abstract

Objective: The aim of this study was to compare the hyperpronation (HP) and the supination-flexion (SF) reduction techniques for reducing nursemaid's elbow in terms of efficacy and pain.

Methods: This prospective, pseudorandomized, controlled, nonblinded study was conducted in an urban tertiary care emergency department between October 1, 2009, and October 1, 2010. A total of 150 patients (51 males [34%] and 99 females [66%] between the ages of 0 to 6 years) were included in the study. When the first reduction attempt failed, second attempt was performed using the same technique. After failure of the second attempt, reduction technique was changed to an alternate technique. Level of pain was evaluated using the Modified Children's Hospital of Eastern Ontario Pain Scale in 113 patients older than 1 year who had a successful reduction process on the first attempt.

Results: Successful reduction was accomplished in 121 (80.7%) of the patients during the first attempt, in 56 (68.3%) of the patients using the SF technique and in 65 (95.6%) of the patients using the HP technique ($P < .001$). At the end of total attempts, we found that the SF (59/84) technique was less successful than the HP (91/93) technique ($P < .001$). The pain levels of the both techniques were not statistically different.

Conclusion: The HP technique was found to be more successful compared with the SF technique in achieving reduction. We were unable to find any significant difference in pain levels observed between the 2 techniques.

Comparison of success and pain levels of supination-flexion and hyperpronation maneuvers in childhood nursemaid's elbow cases

Summary of the Evidence:

Author (Date)	Level of Evidence	Sample/Setting (# of subjects/ studies, cohort definition etc.)	Outcome(s) studied	Key Findings	Limitations and Biases
Rens Bekens, MD; Frederic J. Washburn, BSc; Denise Eygendaal, Prof., MD, PhD; Michel P.J. van den Bekerom, MD; Luke S. Oh, MD	Systematic review and meta-analysis	7 trials published between 1998 and June 6th, 2016, yielding: 701 patients (62% female, 38% male) of which 350 patients were treated with HP maneuver and 351 patients underwent the SF maneuver; all included studies were	1) Primary: failure rate of reducing nursemaid's elbow at first attempt (i.e. another reduction attempt deemed necessary or if child did not demonstrate a fully functional and pain-free arm after the maneuver) 2) Secondary: pain during or	1) HP was more effective than SF (Risk Ratio [RR] 0.34; 95% CI, 0.23 to 0.49; I2 = 35%). 2) For HP, the number needed to treat was 3.8, meaning for every 4 children treated with HP, there will be one less failure at first attempt. 3) 5 studies assessed pain	Data on pain perception was not able to be pooled due to the heterogeneity of pain measures used. Impossibility of blinding subjects, providers, and assessors after allocation of treatment intervention meant quality of evidence was low in all of the studies.

		(quasi-)randomized controlled trials performed in either the emergency department or outpatient clinic.	after the maneuver, adverse effects (hematoma, infection, nerve injury, and subsequent surgery), recurrence rate	perception, but varied widely in assessment methods. HP was perceived as less painful by physicians and parents in some studies, while others found no difference.	
Marjolein Krul, Johannes C van der Wouden, Emma J Kruithof, Lisette WA van Suijlekom-Smit, Bart W Koes, Cochrane Bone, Joint and Muscle Trauma Group	Systematic review and meta-analysis	9 studies yielding a total of 906 children, all < 7 years old; ~60% female. 8 studies were performed in emergency departments or ambulatory care centers. 1 study was performed in a specialist pediatric orthopedic unit. 8 trials compared pronation versus supination. 1 compared two methods of supination.	1) Failure: second attempt required 2) Failure: continued failure after second attempt using same method 3) Pain during intervention 4) Adverse effects (e.g. bruising) 5) Ultimate failure 6) Recurrence (within 1 month)	1) Hyperpronation method may be more successful in repositioning at first attempt for children with a pulled elbow. 2) Hyperpronation had an estimated number needed to treat of 6 (i.e. 6 children would need to be treated with the hyperpronation method rather than the supination-flexion method to avoid one additional failure at the first attempt). 3) There was insufficient evidence to draw any conclusions about which of the two methods was more painful. 4) Where there was a second attempt using the same method, pronation may be more successful as a second attempt.	The quality of evidence for individual outcomes was either low (characterized as: 'further research is very likely to have an important impact on our confidence in the estimate of effect') or very low (characterized as: 'we are very uncertain about the estimate') because of the very serious risk of bias due to selection bias (the majority of the trials were quasi-randomized) and performance and detection biases reflecting the lack of blinding.

				5) None of the studies reported on side effects or how many children had another pulled elbow subsequently (recurrence).	
Nicholas Bertucci, DO Kathleen Cowling, DO, MS	Systematic review	9 trials of 811 children (mean age = 2 years). Hyperpronation was performed on 402 children; 409 children received the supination technique.	1) First-attempt success with hyperpronation versus supination-flexion technique for reduction of radial head subluxation. 2) Second attempt success with same technique as the failed first attempt. 3) Pain during techniques.	1) Hyperpronation resulted in less failure on both the initial and second attempt. 2) First-attempt manual reduction among the 881 participants was 90.8% (365 participants out of 402) with hyperpronation and 73.6% (301 participants out of 408) with supination-flexion 3) When measuring the second attempt success as performed with the same technique as used in the original failed attempt: hyperpronation technique showed 70% success on the second attempt of the hyperpronation technique; supination and flexion showed 30% success on the second attempt. 4) Only 4 trials reported pain measures and all	Quality of evidence is low.

				used different measurement techniques; authors concluded that data for pain was incomplete. 5) Hyperpronation is more effective than supination-flexion for nursemaid's elbow in young children.	
Yahya Kemal Gunaydin, Yavuz Katirci, Hikmet Duymaz, Kubilay Vural, Huseyin Cahit Halhalli, Mehtap Akcil, Figen Coskun	Pseudorandomized controlled trial	150 patients consisting of 51 males (34%) and 99 females (66%) between the ages of 0 to 6 years	1) First attempt success 2) Second attempt success 3) Evolution of pain (before, during, after reduction)	1) Hyperpronation had a successful reduction rate during the first attempt of 95.6%. Supination-flexion had a first attempt success rate of 68.3% 2) Overall success rate of both techniques on first attempt: 80.7% 3) Pain levels significantly decreased after reduction in both groups. 4) Pain levels during the reduction process were significantly higher compared to before and after reduction, but there was no statistical difference between the two techniques. 5) The authors recommend - based on the study's findings -	1) Randomization based on even/odd date of admission led to slight disparity in treatment group subject numbers, reducing study power 2) The study design was unblinded design with predetermined treatment methods (except for instances of patient or caregiver preference), which potentially yielded bias 3) Pain evaluation was performed using the Modified Children's Hospital of Eastern Ontario Pain Scale (mCHEOPS) before, during, and after reduction, but there are limitations to using mCHEOPS for pain assessment in patients younger than 1 year

				that the HP technique should be the first choice for reduction in NE injuries.	

Conclusion(s):
Article 1: This systematic review analyzed 7 trials between 1998 and 2016. The data revealed that HP was significantly more effective than SF, with a lower failure rate at the first reduction attempt. However, pain perception outcomes varied across the 7 studies, making it difficult to draw a definitive conclusion about pain associated with either technique. The authors' findings were consistent with previous reviews, further supporting HP as the preferred method for reduction. Their review addressed the need for standardized pain assessment methods.

Article 2: The systematic review found that HP demonstrated a significantly lower risk of failure at the first attempt compared to SF, suggesting it may be more effective for initial reduction. Repeat HP was also more successful over repeat SF when second attempts were necessary. Evidence regarding pain during or after manipulation was inconclusive due to very low-quality and contradictory data, so no conclusions could be drawn about pain. Based on their findings, the authors suggest that HP might be more effective than SF at reducing nursemaid's elbow, challenging the common textbook recommendation of SF for reduction of nursemaid's elbow. However, they also acknowledged that the evidence is low-quality and they recommended that further high-quality randomized controlled trials are needed to confirm their findings, as well as address gaps in understanding pain associated with both techniques.

Article 3: The systematic review analyzed 9 trials involving 906 children with radial head subluxation and results showed that HP had a higher success rate on the first attempt compared to SF. Additionally, in cases of primary failure with HP, a second attempt with the same technique yielded significantly higher success rates than switching to SF. While attempts were made to assess pain differences between the techniques, incomplete data (only 4 trials reported pain measures, and each used different measurement techniques) hindered conclusive findings. The authors of the review underscored the need for further high-quality randomized clinical trials to validate their findings that HP is superior to SF and to provide more definitive guidance.

Article 4: The study enrolled 150 patients and found that the HP technique was significantly more successful than the SF technique in achieving reduction during a first attempt (95.6% success rate and 68.3% success rate, respectively). While there were no significant differences in pain levels between the two techniques, the study suggests that HP is the more successful method for reduction in nursemaid's elbow. injuries, based on their findings. The authors acknowledge the limitations of their study, including: randomization based on even/odd date of admission that could potentially create bias still, as well as the exclusion of patients older than 6 years. Yet, despite these limitations, the study's findings support the authors' recommendation for HP as the first-choice reduction technique for nursemaid's elbow.

Overall conclusion: The results of the systematic reviews and pseudo-randomized trial consistently indicate that hyperpronation (HP) is more effective than supination-flexion (SF) for reducing nursemaid's elbow in young children. Across all articles, HP yielded higher success rates, particularly on the first attempt and on the second attempt regardless of which technique was used first. Pain perception outcomes varied across studies, and the data was overall inconclusive, highlighting a need to fill the gap in the research regarding pain associated with HP and SF when reducing radial head subluxation. The findings of the articles - which date back as far as 1998 - have a consensus that HP is potentially more effective than SF in successfully reducing nursemaid's elbow, challenging the traditional recommendation of SF as the preferred method. However, the quality of evidence

across the studies is generally low, highlighting the need for more high-quality randomized controlled trials to confirm these findings.

Clinical Bottom Line:
The combined evidence from the four chosen articles suggests that hyperpronation (HP) is more effective than supination-flexion (SF) for reducing radial head subluxation (nursemaid's elbow) in young children. Findings show a consistent trend that indicates a lower failure rate at the first reduction attempt with HP, and a higher success rate of reduction with HP overall (across first and second attempts). A risk ratio of ~0.34 suggests that the risk of failure at the first attempt with HP is approximately one-third of the risk of failure with SF, making HP more effective for reducing nursemaid's elbow. In addition, the number needed to treat (NNT) shows that if 4 patients are treated with HP instead of SF, it could prevent 1 failure during the first attempt. Combined, these findings suggest a **substantial magnitude of effect** favoring HP over SF in achieving successful reduction. Further, 3 of the 4 articles chosen are of Level 1 evidence, which strengthens the reliability of their findings due to the rigorous design and data collection.

However, despite the inherent strength of these systematic reviews and meta-analyses, it must be acknowledged that collectively, the **weight of their evidence is:** of low-quality. This is true due to: 1) lack of true randomization across the included studies; 2) lack of blinding either participants or performers across the included studies; 3) heterogeneity amongst pain assessment scales across the included studies, which produced inconclusive data about one of the outcomes (pain). The pseudo-randomized, unblinded controlled trial conducted by Gunaydin YK, Katirci Y, Duymaz H, et al. also shares these limitations, opening up the potential for bias and weakening the reliability of the evidence. And so I agree with the authors that more high-quality randomized controlled trials must be conducted to confirm the superiority of HP over SF and address the gaps in our knowledge of pain perception. Nevertheless, the results of these articles are notable and could provide faster, more successful results in a clinical setting.

HP’s consistent demonstration as a more successful reduction technique across multiple systematic reviews and a would support a recommendation of HP as the first-choice technique for reducing nursemaid's elbow, challenging the traditional clinical preference for SF. **Clinically**, adopting HP as the first-choice reduction technique for nursemaid's elbow could potentially lead to more successful outcomes and improved patient comfort, pending future, more robust evidence.