A Comparison of Supination/Flexion to Hyperpronation in the Reduction of Radial Head Subluxations

Charles G. Macias, MD*; Joan Bothner, MD‡; and Robert Wiebe, MD§

ABSTRACT. *Objective.* **To compare supination at the wrist followed by flexion at the elbow (the traditional reduction technique) to hyperpronation at the wrist in the reduction of radial head subluxations (nursemaid's elbow).**

Materials and Methods. **This prospective, randomized study involved a consecutive sampling of children younger than 6 years of age who presented to one of two urban pediatric emergency departments and two suburban pediatric ambulatory care centers with a clinical diagnosis of radial head subluxation. Patients were randomized to undergo reduction by one of the two methods and were followed every 5 minutes for return of elbow function. The initial procedure was repeated if baseline functioning did not return 15 minutes after the initial reduction attempt. Failure of that technique 30 minutes after the initial reduction attempt resulted in a cross-over to the alternate method of reduction. The alternate procedure was repeated if baseline functioning did not return 15 minutes after the alternate procedure was attempted. If the patient failed both techniques, radiography of the elbow was performed.**

Results. **A total of 90 patients were enrolled in the study. Five patients were removed from further analysis secondary to a final diagnosis of fracture, 84 were reduced successfully, and 1 failed both techniques. Demographic characteristics of each group were similar. Thirty-nine of 41 patients (95%) randomized to hyperpronation were reduced successfully on the first attempt versus 34 of 44 patients (77%) randomized to supination. Two patients in the hyperpronation group required two attempts versus 10 patients in the supination group. Hyperpronation was more successful; 40 of 41 patients (97.5%) in the hyperpronation group were reduced successfully versus 38 of 44 patients (86%) in the supination group. Of the 6 patients who crossed over from supination to hyperpronation, 5 were reduced on the first attempt and 1 was reduced on the second attempt.**

Conclusions. **In the reduction of radial head subluxations, the hyperpronation technique required fewer attempts at reduction compared with supination, was successful more often than supination, and was often successful when supination failed.** *Pediatrics* **1998;102(1). URL: http://www.pediatrics.org/cgi/content/full/102/1/e10; *radial head subluxation, nursemaid's elbow.***

ABBREVIATION. RHS, radial head subluxation.

Radial head subluxation (RHS), or nursemaid's elbow, is the most common upper extremity injury in children younger than 6 years of age who present to a pediatric emergency department.[1] It typically occurs when axial traction is applied to an arm that is extended while the forearm is pronated[2,3]; the usual history is a pull to the arm.[4,5] Many researchers have attempted to develop an anatomic explanation for why RHS occurs, and this has given rise to multiple theories for the mechanism responsible for RHS. Presumably, the head of the radius, under axial traction with the wrist pronated, becomes trapped distal to the annular ligament.[3] There is an acute onset of pain with movement, and parents may seek medical attention because the child suddenly loses use of the arm.

RHS is an orthopedic injury that is easily treated with no sequelae. The classic reduction technique (Fig 1) involves supination at the wrist followed by flexion at the elbow.[6,7] Studies that have sought to determine the success rates of this technique have described success rates ranging from 80.4%[8] to 92%.[5]

The dramatic nature with which we as practitioners reduce an RHS (ie, supinating the wrist followed by flexing the elbow) may be frightening to both the patient and the parent. Hyperpronation at the wrist (Fig 2) has been used by some as an alternate method of reduction; there is speculation that children complain less with this maneuver.[9] There are no prospective studies that have described its use or compared its success rate with the classic technique of reduction. This study was conducted to compare the supination technique with the hyperpronation technique in the reduction of RHS.

METHODS

The study population comprised children who were enrolled in the emergency department at the Children's Hospital in Denver, CO; the emergency department of Children's Medical Center of Dallas in Dallas, TX; the Children's Hospital After Hours at Saint Anthony's North Hospital in Westminister, CO; and the Children's Hospital After Hours at Porter Littleton Hospital in Littleton, CO. Enrollment extended from June 1996 to May 1997. Informed consent from a parent was obtained for all children included in the study.

From the *Department of Pediatrics, Section of Emergency Medicine, Baylor College of Medicine, Houston, Texas; ‡Department of Pediatrics, Section of Emergency Medicine, University of Colorado Health Science Center, Denver, Colorado; and §Department of Pediatrics, Section of Emergency Medicine, University of Texas Southwestern Medical Center, Dallas, Texas.

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Charles G. Macias, MD, is the principal author of this work.

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Reprint requests to (C.G.M.) Texas Children's Hospital, Pediatric Emergency Medicine, 6621 Fannin St, Suite A165, MC 1-1481, Houston, TX 77030-2399.

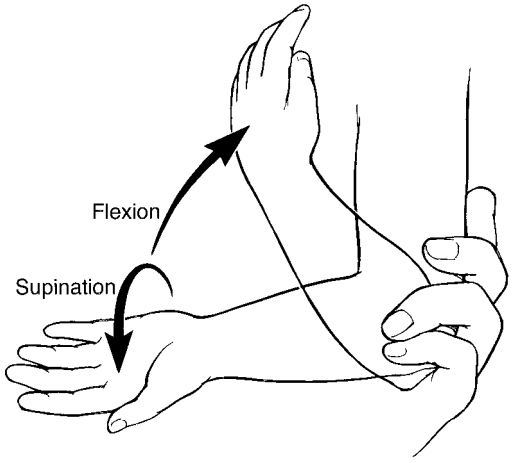

Fig 1. Supination at the wrist followed by flexion at the elbow.

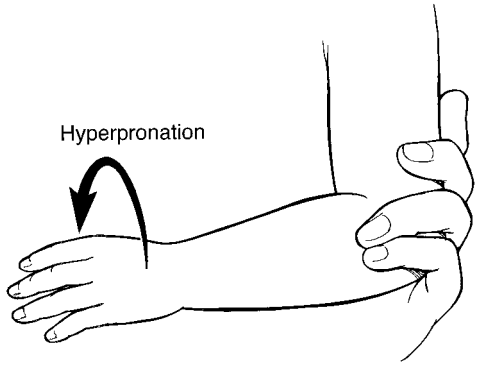

Fig 2. Pronation at the wrist.

Inclusion Criteria

Children were enrolled if they were previously healthy, younger than 6 years of age, and presented with clinical findings suggestive of RHS. Presentation suggestive of RHS included favoring the upper extremity involved and holding the arm with a slightly flexed elbow and a pronated wrist. Point tenderness, local areas of ecchymosis or edema, deformity, and persistent pain were criteria for exclusion. Patients also were included if they presented by referral, with radiographs seen by the emergency medicine physician before enrollment and completion of the protocol.

Attending physicians performed physical examinations on all patients to confirm the suspicion of RHS.

Randomization

Enrollees were randomly assigned to begin the protocol with either the hyperpronation technique or the supination technique via a randomization table (Table 1). Technique assignment was unknown to the attending physician at the time of enrollment.

TABLE 1. Demographic Data

	Hyperpronation (n = 41)	Supination (n = 44)
Gender*		
Female	26 (63%)	25 (57%)
Male	15 (34%)	19 (43%)
Median age,* mo	27	24
Median time from injury,* h	2	3
Number of patients with recurrences	15	13

* Analysis of variance testing for equal means between the two treatment groups (P = NS).

Study Design

The study was a randomized trial involving a consecutive sampling. A history and physical examination were completed on each patient before enrollment. Parents were queried regarding the age and gender of the patient, the time elapsed between occurrence and time of presentation, the mechanism of injury, a history of similar episodes, and a history of any significant trauma or bone disease.

Patients were randomized to undergo reduction by one of two methods: supination or hyperpronation. The supination technique was performed by gripping the patient's elbow in one hand while the patient's elbow was flexed at ~90° and forcefully supinating the wrist. The elbow was then flexed, moving the wrist up toward the shoulder. The hyperpronation technique was performed by gripping the patient's elbow in one hand while forcefully pronating the wrist. Physicians were encouraged to perform the two procedures with equal force. Patients were reexamined every 5 minutes throughout the entire protocol for return of elbow function. The initial procedure was repeated if baseline function did not return 15 minutes after the initial reduction attempt. Failure of that technique 30 minutes after the initial reduction attempt resulted in a cross-over to the alternate method of reduction. The alternate procedure was repeated if baseline functioning did not return 15 minutes after the alternate procedure was attempted. If baseline function did not return 15 minutes after the alternate procedure was repeated, the patient was considered a treatment failure. At this point, radiography of the elbow was performed, and treatment proceeded at the discretion of the emergency medicine physician.

Statistical Analysis

Descriptive Methods

Categorical variables were described in terms of frequencies, whereas continuous variables were described in terms of medians and ranges.

Inferential Methods

For categorical variables, likelihood ratio χ^2 testing was performed to test the hypothesis that the distribution of the dependent variable is the same across each level of the independent variable. For continuous variables, one-way analysis of variance was performed testing for equal means. All analyses were performed in JMP Statistical Discover Software, Version 3.1.

RESULTS

A total of 85 patients, representing 90 episodes of RHS, were enrolled in the study. Five patients were enrolled twice but counted as separate occurrences because all but 1 presented with episodes longer than 2 months apart. The patient who presented several days from the initial episode had successful reduction on the first attempt both times and a history of normal use between the episodes.

Of the 90 cases, there were 6 in which patients failed the entire protocol: 5 patients received radiography and were determined by the emergency medicine physician to have findings consistent with a fracture and, therefore, removed from further analysis (2 in the supination group and 3 in the hyperpronation group). In the other case, the patient failed the protocol without radiographic findings suggestive of a fracture. Patients were reduced successfully in the remaining 84 cases. Of the 85 cases without fractures, 41 were randomized to the hyperpronation treatment group and 44 were randomized to the supination treatment group.

Demographic data for the 85 patients were evaluated. Fifty-one females and 34 males were enrolled with no significant difference in the proportion of females and males randomized to the two treatment

groups ($P = .535$). Ages ranged from 2 to 68 months, with a mean of 27.7 months, with no significant difference in the two treatment groups ($P = .185$). Time between occurrence and presentation ranged from .5 to 56 hours, with a mean of 6 hours, again with no significant difference in the two treatment groups ($P = .194$). Fifty-seven patients presented with a first episode, 18 patients with a second episode, 7 patients with a third episode, and 3 patients with at least an additional episode.

A comparison of the two techniques in terms of the number of successful reductions on the first attempt revealed that the hyperpronation technique was more successful. Thirty-nine of 41 patients (95%) were reduced by hyperpronation on the first attempt compared with 34 of 44 patients (77%) reduced by supination on the first attempt ($P = .014$).

Table 2 demonstrates that the supination technique required a greater number of attempts to reduce RHS than did the hyperpronation technique. Among the 41 patients randomized to hyperpronation, 1 patient required 2 attempts at reduction but was reduced successfully, and 1 patient required 2 attempts at reduction and crossed over to the supination technique. Among the 44 patients randomized to supination, 4 patients required 2 attempts at reduction but were reduced successfully, and 6 patients required 2 attempts at reduction and crossed over to the hyperpronation technique ($P = .046$).

As presented in Table 3, the hyperpronation technique resulted in a greater number of ultimately successful reductions: 97.5% were reduced by hyperpronation in contrast to 86% reduced by supination ($P = .048$).

Seven patients failed the initial technique at reduction and required a cross-over from one technique to another. Six patients crossed over from supination to hyperpronation (5 were reduced on the first attempt and 1 on the second attempt). One patient crossed over from hyperpronation to supination and failed both techniques. That patient was given a sling and an appointment for follow-up with an orthopedics clinic; however, according to the parent's report, the appointment was not kept secondary to regaining full use of the arm within 24 hours.

There were 6 patients whose injury was reported to have occurred ≥24 hours before the time of presentation. Four were randomized to supination and 2 to hyperpronation. Only 2 patients (both in the supination group) did not reduce on the first attempt (but were reduced on the second attempt). There was no significant difference in first attempt success between the patients whose injuries occurred ≥24 hours before presentation and the remaining 79 patients injured <24 hours before presentation, of which 11 did not reduce on the first attempt ($P = .30$).

TABLE 2. Number of Attempts to Achieve Reduction*

Number of Attempts	Hyperpronation ($n = 41$)	Supination ($n = 44$)
1	39 (95%)	34 (77%)
2	1 (2.5%)	4 (9%)
Failed both attempts	1 (2.5%)	6 (14%)

* χ^2 Likelihood ratio test comparing the distribution of the number of attempts at reduction across the two methods ($P = .046$).

TABLE 3. Number of Ultimately Successful Reductions*

	Hyperpronation ($n = 41$)	Supination ($n = 44$)
Successful reductions	40 (97.5%)	38 (86%)
Failed the technique	1 (2.5%)	6 (14%)

* χ^2 Likelihood ratio test comparing the distribution of success versus failure across the two methods ($P = .048$).

DISCUSSION

RHS is a common pediatric injury. The literature suggests that it occurs more frequently in girls,[4,5] which also was documented in our study. It is unclear whether this increased representation of females relates more to the behavior of girls as opposed to boys,[5] to parents' behavior regarding holding the arms of girls more often than boys, or to anatomic differences between boys and girls.

This injury occurs predominantly in toddlers, with a peak incidence between 2 and 3 years of age.[8,9] Fifty percent of our patients were between 20 and 35 months of age. Episodes in children younger than 6 months of age have been noted in the literature.[10] One study reported 6 of 87 episodes in children 6 months old or younger,[8] whereas another reported 6 of 107 patients younger than 1 year.[5] The patients enrolled in this study were as young as 2 months of age. Of 85 patients, there were 4 patients younger than 1 year of age, with only 1 patient younger than 6 months of age.

Early studies report recurrence rates of as low as 5%,[11] whereas more recent studies report recurrence rates of between 26.7% and 39%.[4,5,8] In this study, 32.9% of patients reportedly had at least one previous episode of RHS.

Many authors have described the classic mechanism of injury as a pull. [4,5,11] One such study cites a history of a pull in 93% of patients[5]; however, this may have been attributable, in part, to recall bias in the retrospective collection of data in a subset of their population. A more recent study notes a mechanism of pull to be present in 50.6% of children.[8] This is consistent with our finding of a pull mechanism in 43 of 85 patients (51%) versus 19 (22%) with a history of falling onto the elbow, 2 (2%) with a history of minor direct trauma to the elbow, 3 (4%) with a history of a twisting motion of the arm, and 18 (21%) unknown.

All of our patients had findings consistent with a clinical diagnosis of RHS; therefore, the suspicion of fracture was low. Although a fracture may be exacerbated by a reduction maneuver, the fractures in our group of patients had no significant angulation or displacement despite four attempts at reduction. Because our study did not address specifically the relationship of fractures to the history or clinical findings suggestive of RHS, no conclusions regarding these issues could be made.

Although several maneuvers have been used to reduce an RHS, supination at the wrist followed by flexion at the elbow remains the classically taught

technique. Practitioners will use either flexion or extension at the elbow in combination with supination. The two techniques do not seem to be significantly different in their rates of success.[8] Although prospective evaluations of supination in conjunction with either flexion or extension have been undertaken, there had been, until this study, no prospective evaluation of hyperpronation in comparison with supination. The rate of success of supination in our study is consistent with other studies that reported success rates with supination followed by flexion of 80.4%[8] and 92%.[5] Our overall rate of success of 97.5% by hyperpronation was significantly higher than our success with supination followed by flexion.

The issue of the efficacy of reduction in patients with delayed treatment is controversial. One study reports 5 patients with presentations >24 hours from the time of occurrence. In that group, there was only one successful initial reduction attempt, although all were reduced successfully on a subsequent attempt.[8] It is important to note that all of those reductions involved supination. In our study, there were 6 patients that were ≥24 hours out from the time of injury with no significant difference in the rates of success in terms of reductions on the first attempt. In addition, all patients in the ≥24-hour category were reduced without cross-over to an alternate technique, in contrast to the remaining 79 patients <24 hours out in which 7 patients crossed over. The lack of difficulty in reduction with prolonged periods of delay in our study may be explained by the use of a more effective technique in one third of our patients with prolonged delay. Our findings are more consistent with earlier studies that described a series of 30 patients who had symptoms for 12 to 96 hours, in which only 2 patients did not respond to a first manipulation.[4] One study noted that of children whose visits occurred >2 hours after injury, all had successful reductions, whereas all treatment failures occurred in the group treated before 2 hours.[5] The author of that study suggests that swelling or hemorrhage into the ligament may stiffen it and facilitate successful reduction so that early reduction, before swelling has occurred, is less successful. This theory may not be applicable to our population, given the time frame of 24 hours (markedly longer than the 2-hour time frame in the previous study) for which we analyzed our prolonged delays. The difference in defining prolonged delay may be the reason why we did not find a significantly greater reduction rate in the group with injuries occurring >24 hours before presentation.

CONCLUSIONS

In this randomized trial evaluating the reduction of RHS, the hyperpronation technique was more successful on the first attempt and required fewer attempts at reduction compared with the supination technique. The hyperpronation technique was successful more often than the supination technique. The hyperpronation technique was successful in most cases when the supination technique failed.

Based on the findings of this study, the hyperpronation technique should be considered as a primary technique in the reduction of RHS or as a backup technique when supination fails.

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