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ORIGINAL ARTICLE

Time of Return of Elbow Motion after Percutaneous Pinning of Pediatric Supracondylar Humerus Fractures

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Abstract The most common treatment for displaced pediatric supracondylar humerus fractures is closed reduction and percutaneous pinning. However, the time for return of elbow motion after treatment of these injuries is not well documented. To describe the return of elbow motion after closed reduction and percutaneous pinning of these fractures we retrospectively reviewed 63 patients (age range, 1.6–13.8 years) with displaced supracondylar fractures of the humerus stabilized with either two or three lateral entry pins. Pins were removed by 3 to 4 weeks. No patient participated in formal physical therapy. At each followup, elbow range of motion (ROM) was recorded for the injured and uninjured extremities. Elbow ROM returned to 72% of contralateral elbow motion by 6 weeks after pinning and progressively increased to 86% by 12 weeks, 94% by 26 weeks, and 98% by 52 weeks. After closed reduction and percutaneous pinning of a displaced, uncomplicated, supracondylar humerus fracture, 94% of the child's normal elbow ROM should be expected by 6 months after pinning. Further improvement may occur up to 1 year postoperatively. This information may be helpful in advising parents what to expect after their child's injury. **Level of Evidence:** Level IV, therapeutic study. See the Guidelines for Authors for a complete description of levels of evidence.

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Each author certifies that his or her institution has approved the human protocol for this investigation and that all investigations were conducted in conformity with ethical principles of research.

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Introduction

Supracondylar fractures of the humerus are common elbow injuries in children. Currently, the most popular management of these fractures that are displaced is closed reduction and percutaneous pinning [9, 11, 21]. Numerous studies have documented excellent functional outcome with elbow motion within 5° of the motion of the uninjured elbow in the majority of patients [7, 8, 13, 16, 18]. Elbow motion within 5° of the motion of the uninjured elbow was reported in 94% (77 of 82) of patients by Mazda et al. [8] at a 28-month mean followup, in 92% (58 of 63) of patients by Shim and Lee [16] at a 17-month mean followup, and in 90% (55 of 61) of patients by Lee et al. [7] at a 28-month mean followup. Pirone et al. [13] reported that after a 4.6-year mean followup patients lost 6° flexion but gained 2° extension.

Despite the popularity of this treatment, there are no well-documented descriptions of the time of the expected return of motion after treatment of a displaced supracondylar fracture of the humerus. Some authors have noted rapid recovery of elbow motion after closed reduction and percutaneous pinning. Herring [5] indicated that 6 to 8 weeks after removal of the cast and pins, it was extremely unusual to find more than a 10° to 15° difference in flexion and extension. Shrader [17] stated it is the rare child who does not have full ROM 6 to 8 weeks after

immobilization is discontinued. Topping et al. [20] expected return of motion 1 month after pin removal and would initiate physical therapy if motion had not been regained at that time, but they did not provide data for elbow motion. Similarly, Otsuka and Kasser [11] suggested that after closed reduction and pinning of a supracondylar fracture, full use of the elbow should be expected over the ensuing 3 weeks after removal of the cast and pins. In contrast, Rang [14] suggested that after treatment of a supracondylar fracture in a child, the parents should be warned it may take at least 3 months for the elbow to gain full movement. Flynn et al. [3] reported recovery of elbow ROM was complete by 1 year postoperatively. Similarly, Dameron [2] stated that achieving maximum elbow motion after such injuries took 12 months or more and there was considerable individual variation among patients in this regard.

To our knowledge, only the study by Keppler et al. [6] provided elbow motion data at specific times. However, all fractures were treated by open reduction and 22 of 43 children underwent physical therapy as part of the randomized study protocol. Twelve to 13 weeks after surgery there was an average loss of 20° and 35° elbow motion in children with and without physical therapy, respectively. In contrast, Skaggs et al. [19] observed that at a mean of 8.7 weeks after surgery, 92% (174 of 189) of patients had full ROM and only 1.6% (three of 189) of patients had loss of elbow motion of 10° or greater. However, their study included only Type 2 fractures according to the Wilkins' modification of the Gartland classification for supracondylar fractures of the humerus in children [21], whereas previous studies included Types 2 and 3 fractures. Thus, the less severe nature of Type 2 fractures may be associated with an earlier return of elbow motion. No study to our knowledge has investigated the return of elbow ROM at specific times or ascertained whether Types 2 and 3 fractures differ in return of motion.

The purpose of our study therefore was to describe the return of elbow motion after closed reduction and percutaneous pinning of displaced supracondylar fractures of the humerus in children. We also determined if the return of motion differs between Types 2 and Type 3 fractures.

Materials and Methods

We retrospectively reviewed the records of 141 consecutive patients with 141 displaced, supracondylar fractures of the humerus treated between January 2001 and April 2004. Seventy-eight patients were excluded: forty-five patients were treated nonoperatively, six had associated nerve injuries, two had flexion-type injuries, and 25 were followed up for less than 12 weeks; therefore, we included the remaining 63 patients (who all had extension-type fractures with no nerve injuries, were treated operatively, and had a minimum 12-week followup) in the study. There were 34 boys and 29 girls. The mean age of the patients was 5.3 years (range, 1.6–13.8 years). Thirty-three fractures involved the left extremity and 30 involved the right. We obtained prior Institutional Review Board-approval.

One of us (LZ, treating surgeon) classified the fractures according to the Wilkins' modification of the Gartland classification for supracondylar fractures of the humerus in children [21]. A Type 1 fracture is not displaced. A Type 2 fracture has a greenstick pattern, which is extended without translation with a portion of the posterior cortex intact. A Type 3 fracture is completely displaced with no intact cortex; 41 patients (68%) had Type 2 fractures and 22 (32%) had Type 3 fractures. All fractures were closed.

All patients received general anesthesia and underwent closed reduction of their fractures in the operating room. All patients were treated under the direction of one attending pediatric orthopaedic surgeon (LZ). The fractures were stabilized with either two or three lateral entry pins followed by application of a long arm cast or a splint that was changed to a long arm cast when elbow swelling had improved. In general, the Type 2 fractures were fixed with two pins and the Type 3 fractures were fixed with three pins. The pins generally were removed by 3 to 4 weeks and the cast was discontinued at the same time. No patient had formal physical therapy. Patients were encouraged to actively use the extremity as tolerated, but were advised to avoid sports activities and physical education classes at school for at least another 9 weeks. At each subsequent followup, the elbow ROM was recorded for the injured and uninjured extremities by one examiner (LZ, treating surgeon) using a standard plastic goniometer.

We compared total elbow loss of motion in patients with Type 2 and Type 3 fractures using a two-sample t-test. A parametric test was selected based on skewness and kurtosis testing that showed normal distribution of the motion data.

Results

Elbow motion after closed reduction and percutaneous pinning of displaced supracondylar fractures returned to a mean of 72% of contralateral elbow motion by 6 weeks after pinning and progressively increased to 86% by 12 weeks, 94% by 26 weeks, and 98% by 52 weeks (Table 1). Six weeks after pinning, the loss of elbow ROM averaged 45° (28%) compared with the uninvolved elbow with a mean loss of extension of 23° and a mean loss of flexion of 22°. Motion returned to 72% of the contralateral elbow motion. Twelve weeks after pinning, the loss of

Table 1. Elbow range of motion after closed reduction and percutaneous pinning

Followup (weeks)	Extension loss (degrees)	Flexion loss (degrees)	Total loss of motion (degrees)	Total loss of motion as percent of contralateral elbow motion
6	23 (22)	22 (12)	45 (28)	28% (18)
12	9 (11)	13 (9)	22 (17)	14% (11)
26	2 (7)	8 (7)	10 (9)	6% (6)
52	0 (6)	4 (5)	4 (10)	2% (7)

Data are presented as mean (standard deviation).

Table 2. Comparison of elbow ROM between patients with Type II and Type III fractures

Followup (weeks)	All fractures (number)	Total loss of elbow ROM (degrees)	Type 2 (number)	Total loss of elbow ROM (degrees)	Type 3 (number)	Total loss of elbow ROM (degrees)	Comparison Type 2 versus Type 3
6	63	45 (28)	41	39 (29)	22	56 (22)	$p = 0.03$
12	63	22 (17)	41	20 (18)	22	26 (15)	$p = 0.17$
26	35	10 (9)	20	7 (8)	15	12 (10)	$p = 0.18$
52	18	4 (10)	10	2 (9)	8	7 (11)	$p = 0.37$

ROM = range of motion; ROM data presented as mean (standard deviation).

motion averaged 22° (14%) and children had regained 86% of elbow motion. By 26 weeks after pinning, the loss of motion had decreased to 10° (6%) and by 52 weeks, the loss of motion had decreased further to 4° (2%).

At the 6-week followup children who had Type 3 injuries had greater ($p = 0.03$) loss of elbow motion (56% loss) compared with those with Type 2 injuries (39% loss) (Table 2). There was no difference in the percentage of loss of motion between the two injury types by 12 weeks and thereafter.

Discussion

Closed reduction and percutaneous pinning is the most commonly used treatment method for displaced supracondylar fractures of the humerus in children [9, 11, 21]. Excellent functional results have been reported [7, 8, 13, 16, 18], however, to our knowledge, there are no published descriptions of the time of the return of motion after treatment of these injuries. We aimed to assess return of elbow motion after closed reduction and percutaneous pinning of displaced pediatric supracondylar fractures.

Our study is limited by incomplete patient followup. Unfortunately, many of the 63 study patients did not return to the clinic for all scheduled visits; 35 of 63 (56%) returned for the 26-week followup and 18 of 63 (29%) for the 52-week followup. The almost full return of elbow ROM documented in the literature [7, 8, 13, 16, 18] in patients with these injuries may potentially explain their not seeking further care for their injury. In addition, patients referred to our institution for surgical treatment of their injuries may have continued followup with their primary care physicians. Another limitation of our study is that our findings may not be generalizable because all patients were under the care of one pediatric orthopaedic surgeon; however, the potentially confounding effect of treatment differences on outcome may have been minimized. Another limitation is that measurements were made by one observer, which may have introduced systematic bias; however, this avoided the confounding effect of interobserver variability. Based on their study of the reliability of goniometric measurements, Boone and coworkers [1] recommended the same tester be used when the effects of treatment are being evaluated. Furthermore, they reported one measurement per session was as reliable as taking the average of repeated measurements in one session. Rothstein et al. [15] concluded the intratester reliability was high for measuring flexion and extension of the elbow using a small plastic goniometer. Another limitation of our study is that pronation and supination were not specifically measured, but loss of forearm rotation has not been reported as a problem with these injuries. Finally, the majority of supracondylar fractures in our series were Type 2 fractures, so our overall findings may not be generalizable to all fractures. For this reason, we described the return of motion in the separate subgroups of Types 2 and 3 fractures, but the number of Type 3 fractures was small.

The time and progression of return of elbow motion after closed reduction and percutaneous pinning of supracondylar humerus fractures has not been specifically studied. Keppler et al. [6], in the subgroup of supracondylar humerus fractures treated by open reduction, pinning, and no physical therapy, reported the loss of motion was 72° at 6 to 7 weeks after surgery, 35° at 12–13 weeks, and 5° at 56–60 weeks.

Our data suggest after closed reduction and percutaneous pinning of a supracondylar fracture, elbow motion gradually recovers during the ensuing 6 months by which time 94% of the child's normal ROM should be expected. We also found additional improvement of elbow motion may be anticipated up to 1 year after the injury. This finding is in agreement with that of others who observed recovery of the ranges of flexion and extension usually are complete by 1 year [3, 10, 12]. Failure to gain full ROM has been attributed to either incomplete reduction or severe associated soft tissue injury [4, 6, 10], and such factors could have accounted for some of the loss of motion observed in our patients.

Results of our study help us advise parents what to expect after treatment of their child's injury to avoid undue concern. We observed loss of motion of 45° by 6 weeks and 22° by 12 weeks postoperatively, but there was substantial improvement with subsequent followup. After closed reduction and percutaneous pinning of a displaced, uncomplicated, extension-type supracondylar humerus fracture, 94% of the child's normal elbow ROM should be expected by 6 months after pinning. Additional improvement may be anticipated to occur as much as 1 year after the injury.

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