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ORIGINAL CLINICAL ARTICLE

Pediatric supracondylar humerus fractures: treatment by type of orthopedic surgeon

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Abstract
Purpose Outcomes in children with supracondylar humerus fractures were stratified by type of treating orthopedic surgeon: pediatric orthopedic surgeon and nonpediatric orthopedic surgeon.
Methods The outcome factors in 444 children examined included: open reduction rate, complications, postoperative nerve injury, repinning rate, need for physical therapy, and residual nerve palsy at final follow-up.
Results For the severe fractures, significantly more fractures were treated by open reduction in the pediatric orthopedic surgeon group than in the nonpediatric orthopedic surgeon group. There were no other significant differences in outcomes between the fractures treated by the pediatric orthopedic surgeons and nonpediatric orthopedic surgeons.
Conclusions This study supports the assertion that both pediatric and nonpediatric orthopedic surgeons in an academic setting have sufficient training, skill, and experience to treat these common injuries.

Keywords Supracondylar humerus fractures · Children

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Introduction

Supracondylar fractures of the humerus are the most common operative fractures in children [1]. These injuries are cared for by orthopedic surgeons: pediatric orthopedists, general orthopedists and orthopedic surgeons who subspecialize in other orthopedic areas ("nonpediatric" orthopedic surgeons).

Over the past decade these supracondylar fractures have gone from being treated as an emergency to being treated the day after admission [2–5]. There is still no consensus on which supracondylar humerus fractures can be treated in a delayed fashion, and delayed treatment may increase the need for an open reduction [6, 7]. The "pulseless" supracondylar fracture remains an emergency [8, 9]. The second recent trend is that divergent lateral pinning has replaced cross pinning, reducing ulnar nerve injuries [10].

In many academic centers the treatment of the supracondylar humerus fractures is performed exclusively by the pediatric orthopedic surgeons. In our academic practice, both the pediatric and "nonpediatric" orthopedic surgeons treat these fractures. As with many academic medical centers, orthopedic residents are present and involved for all cases. We used this retrospective study to look at differences in outcomes based on orthopedic specialty versus subspecialty training. We hypothesized that outcomes would be improved when the supracondylar fracture was treated by a pediatric orthopedic surgeon.

Materials and methods

Institutional review board approval was obtained. A retrospective review of patient charts from 1994 to 2004 was undertaken. The 444 children were stratified based on the type of orthopedist treating the patient: pediatric orthopedic surgeon versus a "nonpediatric orthopedic surgeon." The pediatric orthopedic surgeon was an American Board of Orthopedic Surgery Board Certified or Board Eligible orthopedic surgeon who did an additional year of training in pediatric orthopedic surgery and practices full time pediatric orthopedics with the exception of call, which includes both pediatric and adult patients two to three times a month. A "nonpediatric orthopedic surgeon" is an American Board of Orthopedic Surgery Board Certified or Board Eligible orthopedic surgeon who did an additional year of training in an orthopedic subspecialty and practice full time in that subspecialty except for call two to three times a month, which includes both emergent pediatric and adult orthopedic surgery. Orthopedic subspecialties include total joint reconstruction, sports, foot and ankle, and adult trauma.

Demographic, preoperative data and outcomes were used to compare the two groups. Demographic and preoperative data collected on the patients included: age, sex, modified Gartland classification [1, 11, 12], preoperative nerve injury, and vascular injury. Outcome data collected included the rate of open reduction versus closed reduction and percutaneous pinning, complications, postoperative nerve injury, and need for further surgery (repeat reduction and pinning or an open reduction). The need for repinning was determined by a postoperative malreduction. Other outcomes included physical therapy as an indication of elbow stiffness and persistent nerve injury at final follow-up. The postoperative carrying angle was not measured, so it was not part of the collected data.

The details of the treatment of supracondylar fractures at our institution are salient to this study. We practice at a children's hospital for which the emergent night and weekend call is covered by an academic university practice comprised of both pediatric orthopedists and nonpediatric orthopedists. Orthopedic surgery residents are involved in the care of all patients. Each case has one to two residents involved and an orthopedic surgeon attending. The attending is either a pediatric orthopedic surgeon or a "nonpediatric orthopedic surgeon." The attending was present for the critical portion of each case. As with all cases at our medical center, the attending surgeon supervises the resident surgeon. Supracondylar fractures with neurologic injury were treated early or late at the discretion of the attending orthopedist. There was no attempt at a reduction in the emergency department. Fractures treated over 12 h after admission were splinted in extension, and the child was admitted and treated the next day.

Early in the series these fractures were cared for on the night of admission by the orthopedic surgeon on call in a shared call system between pediatric orthopedists and nonpediatric orthopedists. Weekend cases for 9 years of the series were operated by the pediatric or nonpediatric orthopedist on call. Cases late in the series that were felt to be nonemergent by the surgeon on call were routinely transferred by the nonpediatric orthopedist on call to a pediatric orthopedist for operative treatment the next morning and subsequent care. This late period was 1 year, with 40 of the 446 fractures treated.

Physical therapy was ordered for children with elbow stiffness at 1 month after the cast was removed. The emergently treated fractures were also transferred to the pediatric orthopedic service for subsequent care. Following treatment, all children were given follow-up appointments 6 months after injury. For the purposes of this study, the last clinic note was designated the final follow-up.

Statistical analysis

All outcomes were measured on a categorical scale, so Pearson chi-square tests were performed to compare the pediatric orthopedic surgeons group to the nonpediatric orthopedic surgeons group. For some outcomes with low frequencies, Fisher's exact tests were used.

We collected data on age, sex, modified Gartland classification, preoperative nerve injury, and preoperative vascular injury, so that the difference in these characteristics between the two groups could be adjusted for multivariant logistic regression models [13]. The significance level (alpha) was set at 0.05.

Results

Demographic data and preoperative data

A total of 444 children with operatively treated supracondylar fractures were examined: 209 males and 235 females with an average age of 5.7 years (3 months to 13.8 years) (Table 1). One percent was modified Gartland extension type I [1, 11, 12], 42% were modified Gartland II [1, 11, 12], 54% were modified Gartland III [1, 11, 12], and 3% were flexion-type fractures. Forty-five percent of the fractures treated within 12 h of injury were treated by pediatric orthopedists, and 55.1% of these early fractures were treated by nonpediatric orthopedists.

The average age and gender distribution was not significantly different for those treated by pediatric orthopedists and those treated by nonpediatric orthopedists (Table 1). The proportion of modified Gartland type-III fractures was higher for the nonpediatric orthopedists

Table 1 Demographics and characteristics of the groups

Characteristic	Pediatric orthopedic surgeons ($N = 271$)	Nonpediatric orthopedic surgeons ($N = 173$)	p*
Age (years)	5.5 ± 2.7	5.9 ± 2.6	0.106
Sex			0.635
Male	130 (48.0%)	79 (45.7%)	
Female	141 (52%)	94 (54.3%)	
Gartland III	116 (42.8%)	123 (71.1%)	<0.001
Flexion type	13 (4.8%)	1 (0.6%)	0.013
Preoperative neurological injury	38 (14.0%)	37 (21.4%)	0.043
Preoperative vascular injury			0.456
Pulseless	5 (1.8%)	5 (2.9%)	
Diminished pulse	9 (3.3%)	9 (5.2%)	
Treatment time			<0.001
Within 12 h	88 (32.5%)	108 (62.4%)	
Delayed	183 (67.5%)	65 (37.6%)	

* The p value for age was based on a two-sample independent t test. Others were based on Pearson chi-square tests

($p < 0.001$). A higher proportion of pediatric orthopedists treated the flexion-type fractures ($p = 0.013$) (Table 1).

Vascular injury was present in 6.4% of children; 4.1% had a diminished pulse, and 2.3% were pulseless. All were treated within 12 h of injury except one that had a diminished pulse. The incidence was the same in both groups ($p = 0.502$). For the modified Gartland III fractures the vascular injury rate was 10.9% with no difference in the incidence based on type of treating orthopedic surgeon ($p = 0.984$).

Outcome data

Six percent of the fractures were treated by open reduction, and 94% were treated by closed reduction and percutaneous pinning. For the modified Gartland type-III fractures, 16.5% of the supracondylar fractures treated by pediatric orthopedic surgeons were treated with an open reduction, whereas 4.9% of the fractures treated by nonpediatric orthopedists were treated with open reduction, which was significantly different ($p = 0.003$) (Table 3). After controlling for all covariants in a logistic regression, pediatric orthopedists were still more likely to treat modified Gartland III fractures with an open reduction than nonpediatric orthopedists ($p = 0.014$).

The repinning rate for the nonpediatric orthopedists was 1.8% and for the pediatric orthopedists was 2.3%, which was not significantly different ($p = 0.766$) (Table 2). For modified Gartland type-III fractures, the repinning rate was 3.4% for pediatric orthopedists and 3.3% for nonpediatric orthopedists, which was not significantly different ($p > 0.99$).

The complication rate was 16.8% for the pediatric orthopedists and 22.7% for the nonpediatric orthopedists, which was not significantly different ($p = 0.10$) (Tables 2, 3). The complication rate for the modified Gartland III fractures was 28.5%, which was not significantly different when the complications were stratified by type of surgeons ($p = 0.936$). The flexion-type complications were 21.4%, which when based on type of surgeon was not significantly different ($p = 0.763$).

The postoperative neurologic injury rate for the children cared for by pediatric orthopedists was 3.4% and for nonpediatric orthopedists was 6.8%, which was not different ($p = 0.093$). For modified Gartland type-III fractures, the postoperative nerve injury rate was 6.9% for pediatric orthopedists and 9.8% for nonpediatric orthopedists, which was not significantly different ($p = 0.448$). For both groups the injury rate was higher for the nonpediaric orthopedic surgeon, but the numbers were not significantly different.

Table 2 Outcomes for all supracondyle fractures

Outcome	Pediatric orthopedic surgeons ($N = 271$)	Nonpediatric orthopedic surgeons ($N = 173$)	p*
Complication	46 (17%)	39 (22.5%)	0.146
Postoperative neurologic injury	9 (3.3%)	12 (6.9%)	0.08
Open reduction	20 (7.4%)	6 (3.5%)	0.085
Repinning	5 (1.8%)	4 (2.3%)	0.741
Need for physical therapy	48 (17.7%)	36 (20.8%)	0.4
Residual nerve palsy at final follow-up	8 (3.0%)	9 (5.2%)	0.228

* The p value for repinning was based on a Fisher's exact test. Others were based on Pearson chi-square tests

Table 3 Outcomes of modified Gartland III supracondylar fractures

Outcome	Pediatric orthopedic surgeons ($N = 116$)	Nonpediatric orthopedic surgeons ($N = 123$)	p*
Complication	34 (29.3%)	34 (27.5%)	0.775
Postoperative nerve injury	8 (6.9%)	12 (9.8%)	0.425
Open reduction	19 (16.5%)	6 (4.9%)	0.003
Repinning	4 (3.4%)	4 (3.3%)	>0.99
Need for physical therapy	33 (28.4%)	33 (27%)	0.81
Residual nerve nerve palsy at final follow-up	4 (5.2%)	9 (7.3%)	0.494

* The p value for repinning was based on a Fisher's exact test. Others were based Pearson chi-square tests

Nineteen percent of the children were sent to physical therapy. There was no difference in the incidence of physical therapy based on type of orthopedic surgeon ($p = 0.344$). For modified Gartland III fractures, 27.7% had physical therapy. Again there was no difference in incidence based on type of orthopedic surgeon ($p = 0.810$).

Discussion

This is the first study to compare the results of pediatric supracondylar fractures stratified by type of treating orthopedic surgeon. This series has the advantage of being a large series with groups that are well matched by age and sex. The patients treated by nonpediatric orthopedists had more severe fractures. Despite this handicap, the outcomes measured were no different between the two groups. Perhaps the outcome measures that we used were not able to discriminate between good and excellent outcomes, which could explain why the outcomes were the same despite the increased severity of fracture in the nonpediatric orthopedic group.

This study is limited as it is retrospective. A prospective study looking at this question would be difficult to enact at our institution. Another limitation is that these children were treated at an academic Childrens' Hospital with orthopedic surgery residents present for all surgical cases. The attending for these cases was present for all cases. Part of their role is to supervise the resident surgeons. The results of this study cannot be generalized to the nonacademic setting.

The pediatric orthopedists had a significantly higher rate of treating the severe fractures with an open reduction, which may result from a higher comfort level with the open approach and the increasing evidence of good outcomes when an open reduction is required [6]. This series had an open reduction rate of 6%, which was similar to previous series [2, 3, 14, 15]. The increased swelling in the soft tissues that are splinted and not reduced overnight may in part explain the significantly higher open reduction rate by the pediatric orthopedic surgeons [6]. This study has no ability to determine the skill level of the nonpediatric orthopedists to perform an open reduction of a supracondyler fracture, although all were American Board of Orthopedic Surgery Board Certified or Board Eligible.

There was no difference in the incidence of postoperative nerve injury between pediatric orthopedists and nonpediatric orthopedists. These iatrogenic injuries are predominately ulnar nerve injuries from the placement of a medially based pin. In the last 10 years, crosspinning has largely been replaced by lateral pinning, which has a lower incidence of iatrogenic ulnar nerve injury [10, 14, 16–18].

The flexion-type fractures had similar outcomes to modified Gartland type-III extension fractures [19]. In this series there were significantly more flexion-type fractures treated by pediatric orthopedists.

The need for physical therapy was not reported in previous series and was higher in the modified Gartland type-III fractures. Parents of children with more severe fractures can be counseled that their children may require physical therapy routinely. The value of reporting the incidence of physical therapy is limited as it depends on a surgeon's preference. However, it is a general indicator of prolonged postoperative elbow stiffness.

Our series had a number of nonpediatric orthopedists who treated supracondylar fractures infrequently. Despite this infrequency, we found no difference in outcomes between the two groups. This study is limited by the fact that residents were part of the team treating all of these children. This study with a comparable complication rate to other published series [14, 20–22] supports the assertion that both pediatric and nonpediatric orthopedists have sufficient training, skill, and experience to treat these common injuries in an academic setting.

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