The Utility of the Early Postoperative Follow-Up and Radiographs After Operative Treatment of Supracondylar Humerus Fractures in Children

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Background: Supracondylar humerus (SCH) fractures are common elbow injuries in pediatric patients. The American Academy of Orthopedic Surgeons published guidelines for the standard of care in the treatment of displaced SCH fractures, however, no recommendations for follow-up care were made. With the recent push to eliminate unnecessary radiographs and decrease health care costs, many are questioning postoperative protocols. The purpose of our study was to evaluate the utility of the 1-week follow-up appointment after closed reduction and percutaneous pinning (CRPP) of displaced SCH fractures.

Methods: A retrospective review performed at a single institution from 2014 to 2016 included patients under 14 years of age with a closed, displaced SCH fracture treated with CRPP. Exclusion criteria included patients without complete clinical or radiographic follow-up. Variables examined included time to initial follow-up, change in treatment plan after 1-week x-rays, complications, demographics, fracture type, pin number and configuration, reduction parameters, immobilization, time to pin removal, duration of casting, and clinical outcome.

Results: A total of 412 patients were divided into 2 groups based on time to initial follow-up. Overall, 368 had an initial follow-up at 7 to 10 days (group 1) and 44 at 21 to 28 days (group 2). There was no difference in age, sex, fracture type, pin configuration, or a number of pins between groups. Statistically significant findings included time to initial follow-up and days to pin removal (group 1 at 26.2 d vs. group 2 at 23.8 d), type of immobilization (group 1 with 5% circumferential casts and group 2 with 70%), and time to surgery (26.2 vs. 62.9 h, respectively). There was no significant difference in complication rates and only a 0.5% rate of change in management in group 1.

Conclusions: Early postoperative follow-up and radiographs did not change the patient outcome and might be eliminated in children with displaced SCH fractures treated with CRPP. Given the current focus of on efficiency and cost-effective care, eliminating the 1-week postoperative appointment would improve appointment availability and decrease medical cost.

Level of Evidence: Level III—Therapeutic.

Key Words: trauma, supracondylar humerus fractures, clinical management

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Supracondylar humerus (SCH) fractures are the most common elbow injury in the pediatric population.[1] Two thirds of pediatric patients hospitalized for elbow injuries have an SCH fracture.[2,3] Surgical treatment with closed reduction and percutaneous pinning (CRPP) has become the standard of care for the management of Wilkins modification of the Gartland classification type II, III, and flexion type fractures.[4–6] Over the past decade, several studies have reviewed the utility of postoperative radiographs at initial and final follow-up visits. However, to date, there remains no clear consensus among pediatric orthopaedic surgeons for postoperative follow-up protocols in surgically treated SCH fractures.

As the pendulum has swayed toward surgical treatment for all SCH fractures greater than a Wilkins modified Gartland type I, the use of clinical resources postoperatively continues to increase. At many institutions, patients are seen at postoperative week 1 (7 to 10 d) and again at postoperative weeks 3 to 4 (21 to 28 d) with radiographs follow-up. This accounts for a significant amount of clinical visits in pediatric trauma clinics, substantial time off from work for families and exposes children to multiple radiographs that may be unnecessary.[7–12]

In the age of health care reform and efficiency-focused care, our institution asked how we could improve the clinical efficiency and cost-effective care in patients with SCH fractures. The purpose of our study was to examine the utility of the early postoperative follow-up appointment and radiographs at 7 to 10 days after CRPP for SCH fractures. We hypothesized that the early postoperative follow-up appointment and radiographs may be unnecessary for Wilkins modified Garland type II and III fractures with inherent stability, but may still be necessary

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for those fractures with less stability on intraoperative examination.

METHODS

Following Institutional Review Board approval, we retrospectively reviewed a convenience sample of consecutive series of cases with displaced SCH fractures (Wilkins modified Gartland type II, III, and flexion)[4,6] treated with CRPP between August 2014 to August 2016 inclusive. All patients were treated at a single institution by a group of 11 fellowship-trained pediatric orthopaedic surgeons. Patients were identified in the electronic medical record database using Current Procedural Terminology code 24538 for operatively treated SCH fractures. Patients aged 14 years or younger were included for analysis. Exclusion criteria included open fractures, open reduction, intra-articular fractures, and patients without complete clinical or radiographic follow-up at all timepoints. Medical records were reviewed for demographic information (age, sex, extremity), fracture type, pin number, and configuration, immobilization type, postoperative complications, time to first follow-up, time to pin removal, and clinical outcome (pain and range of motion). In addition, any changes to routine management after a follow-up were recorded.

Patient radiographs were measured and evaluated using our institutional PACS system. Radiographs from all timepoints were included: preoperative, intraoperative, initial postoperative, pin removal, and final follow-up radiographs. Radiographs were evaluated for Wilkins modification of Gartland classification, pin configuration, and reduction parameters. Measurements included the anterior humeral line,[13] Baumann angle,[14] and lateral rotation percentage[15] and were completed by a fellowship-trained pediatric orthopaedic surgeon.

Patients were placed into one of 2 groups based on time to initial follow-up. Patients seen for their first postoperative follow-up at 7 to 10 days (week 1) with radiographs were group 1. Patients seen for their first follow-up at 21 to 28 days (weeks 3 to 4) with radiographs were placed in group 2.

Mean and SD were calculated for continuous characteristics. Counts and percentages are reported for categorical characteristics. The distribution of the data was assessed for normality using histograms and Shapiro-Wilk test. Statistical analysis was performed to evaluate differences between the 2 groups. Continuous variables were compared using the Mann-Whitney test. Categorical variables were compared using the χ^2 test or Fisher exact test as appropriate. A P-value <0.05 was considered statistically significant. Data were analyzed using Stata 14.2 (StataCorp., College Station, TX).

RESULTS

We identified 412 patients that met inclusion criteria and were included in the analysis. Group 1 included 368 patients and all 11 pediatric orthopaedic surgeons. Group 2 included 44 patients and 3 of the 11 pediatric orthopaedic surgeons. No patients were lost to follow-up. The groups showed no difference in age, sex, fracture type, pin configuration, or a number of pins used (Tables 1, 2). The mean age at the time of surgery was 6.2 years for both groups.

TABLE 1. Demographics

	Group 1 (N = 368)	Group 2 (N = 44)	*P*
Age [mean (range)]	6.2 (2.41)	6.2 (2.44)	0.9117
Sex (female) [n (%)]	182 (47)	18 (41)	0.284
Fracture type [n (%)]			
II	134 (37)	14 (33)	0.715
III	229 (62)	29 (67)	
Flexion type	3 (1)	0	

The difference in time to surgery between the 2 groups was found to be statistically significant ($P < 0.001$). The mean time from injury to surgical fixation in group 1 was 26.24 hours with 8% (28/368) having "late" surgery. Although the mean time to surgery in group 2 was 62.9 hours with 50% (22/44) having later surgery. Table 3 outlines time to treatment for each surgeon. Fracture type was not statistically different between groups ($P = 0.715$). In group 1, 134 patients (37%) were type II and 229 patients (62%) were type III, and 3 patients (1%) were flexion type fractures. In group 2, 14 patients (33%) were type II, 29 patients (67%) were type III and no patients were flexion type fractures. Table 4 summarizes a number of pins used and configuration compared with fracture type between the 2 groups.

Differences between the groups in immediate postoperative immobilization was found to be statistically

TABLE 2. Comparison Between Patients With and Without First Week Follow-Up

	n (%)		
	Group 1 (N = 368)	Group 2 (N = 44)	*P*
No. pins [mean (range)]	2.60 (2)	2.47 (2)	0.0742
Pin configuration (lateral)	346 (94)	44 (100)	0.1123
Days to first FU [mean (SD)]	7.66 (2.16)	23.45 (4.51)	0.0001*
Days to pin removal	26.22 (4.2)	23.88 (4.18)	0.0001*
No. complications	17 (4.6)	0	0.145
Type of immobilization			
Cast bivalved	177 (49)	12 (28)	0.0001*
Cast univalved	71 (19)	1 (2)	
Splint	98 (27)	0	
Circumferential	19 (5)	31 (70)	
Pain at FU	4 (1.10)	0	0.638
Duration of casting	26.16 (4.6)	26.05 (3.9)	0.9053
Fluoro anterior	2.04 (0.7)	2.02 (0.63)	0.8463
Fluoro Baumann	71.93 (5.08)	72.11 (4.8)	0.8297
Pin removal AHL	1.96 (0.67)	1.95 (0.64)	0.9091
Pin removal Baumann	73.42 (5.09)	72.72 (5.7)	0.3445
Pin removal lateral rotation	4.79 (9.5)	3.71 (9.25)	0.8479
Final FU AHL	2.05 (0.63)	1.66 (0.58)	0.3081
Final FU Baumann	74.5 (5.02)	72.7 (3.76)	0.4187
Final FU lateral rotation	4.41 (10.15)	3.66 (6.35)	0.8479
Change of management after first week FU	2 (0.5)	0	0.628
Change of management after pin removal	12 (3.3)	2 (5)	0.634

*$P < 0.05$.
AHL indicates anterior humeral line; FU, follow-up.

TABLE 3. Average Time From Injury to Surgery For Each Surgeon

Surgeon	Average Time to Surgery (h)	n/N (%) Treated Early Within 24 h	Treated After 48 h
1	29	46/58 (79)	7 (12)
2	34	44/62 (71)	11 (18)
3	33	43/53 (81)	7 (13)
4	120	0	1 (100)
5	29	36/49 (73)	6 (12)
6	25	40/56 (71)	5 (9)
7	34	28/40 (70)	4 (10)
8	25	9/11 (82)	1 (9)
9	27	50/59 (85)	3 (5)
10	13	19/19 (100)	0
11	25	5/6 (83)	1 (17)

significant ($P < 0.001$). In group 1, 49% of patients (177 patients) were placed into a bivalved cast, whereas only 28% of patients (12 patients) were in roup 2. Overall, 19% of patients (71 patients) in group 1 were placed into a univalved cast. In group 2, only 2% of patients (1 patient) were placed into a univalved cast. A circumferential cast (no valving) was used in only 5% of patients (19 patients) in group 1, but 70% of patients (31 patients) in group 2. No splints were placed on patients in group 2. In group 1, 27% of patients (98 patients) were placed into a splint postoperative. The duration of immobilization was not found to be significantly different between the 2 groups. Both groups averaged 26 days of immobilization postoperatively.

A number of days to follow-up was significantly different between the 2 groups. Group 1 followed up at an average of 7.66 days from date of surgery. Group 2 followed up at an average of 23.45 days. ($P < 0.001$). Two patients in group 1 had a change in fracture management after the initial follow-up (0.5%). One was found to have a superficial pin site infection and was given oral antibiotics. The other was found to have a loss of reduction on routine 1-week follow-up radiographs and was taken to the operating room for remanipulation and pinning.

Initial reduction parameters on radiographs, anterior humeral line, and Baumann angle, were not significantly different ($P = 0.84$ and 0.82, respectively). In both groups, the anterior humeral line passed through the middle one third of the capitellum on final intraoperative radiographs. Baumann angle averaged 71.9 and 72.1 degrees in groups 1 and 2, respectively.

TABLE 4. Distribution of Fractures and Number of Pins For Patients in Groups 1 and 2

	Group 1 [n (%)]			Group 2 [n (%)]	
	Type II (N = 126)	Type III (N = 236)	Flexion Type (N = 3)	Type II (N = 22)	Type III (N = 21)
2 lateral	101 (80)	43 (17)	2 (67)	16 (73)	9 (43)
3 lateral	25 (20)	191 (81)	1 (33)	6 (27)	10 (48)
Cross pin	0	1 (1)	0	0	2 (9)

TABLE 5. Type of Complications

	No. Patients
Buried pins	4
Cast slipped of before cast removal/ erythema	2
Olecranon bursitis	1
Superficial pin infection	1
Loss of fixation and alignment	1

Days to pin removal was found to be significantly different between the 2 groups ($P < 0.001$). Group 1 average days to pin removal was 26.22 days. Group 2 average days to pin removal was 23.88 days. Following pin removal, 12 patients (3.3%) in group 1 and 2 patients (5%) in group 2 had a change in fracture management ($P = 0.63$). The change in fracture management at pin removal for all 14 of these patients was placement back into a cast for extended immobilization based off radiographic findings. Although 4 patients in group 1 reported pain at follow-up and no patients in group 2 reported pain, this was not found to be significantly different between the 2 groups ($P = 0.64$).

Postoperative complications were recorded in both groups. Nine complications (a complication rate of 2.4%) were reported in group 1. No complications were reported in group 2. Only 2 complications required early intervention and a change in fracture management at initial follow-up. All 9 complications are listed in Table 5. The patient with loss of fixation had operative revision after week 1 follow-up. The superficial pin site infection was treated with oral antibiotics. Eight nerve injuries (all in group 1) were present preoperatively and resolved postoperatively within the follow-up period without complication.

DISCUSSION

SCH fractures are one of the most common injuries that pediatric orthopaedic surgeons treat. They account for a significant number of emergency room visits, operative cases and follow-up visits in pediatric hospitals. The American Academy of Orthopedic Surgeons has submitted guidelines on the standards of care without recommendations regarding the postoperative follow-up.[16] There continues to be a failure of consensus among pediatric orthopaedic surgeons regarding the protocol for postoperative follow-up care and radiographs in this injury.

Early postoperative follow-up appointments (7 to 0 d) have been universally accepted as the standard of care for many fracture patterns.[15,17–19] Pain assessment, maintenance of fracture reduction and dressing care may all be addressed in the first postoperative visit.

The 2 groups in our study varied based on timing to the first postoperative visit. Historically, SCH fracture treatment consisted of a postoperative appointment at 7 to 10 days for repeat radiographs to evaluate fracture alignment and possible cast change or overwrap. The second postoperative appointment occurred between

weeks 3 to 4 for pin removal and repeat radiographs to evaluate bony healing.

SCH fractures have an extremely low rate of postoperative complications. The most common complications that may occur include malunion, restricted elbow range of motion and cubitus varus. Numerous studies have quoted between a 1% and 4% loss of reduction that requires a return to the operating room.[11,12] With the significantly low likelihood of loss of fracture reduction, some surgeons at our institution found it unnecessary to see patients with a stably fixed SCH fracture for a 1-week postoperative visit with radiographs.

Group 1 in our study consisted of the patients treated with both a 1-week and 3- to 4-week postoperative follow-up appointment and radiographs. Group 2 consisted of the patients who were seen first at 3 to 4 weeks for radiographs and pin removal. The 2 groups consisted of patients of similar demographics, distribution of fracture types (II, III, and flexion), pin configurations and a number of pins used. Between our 2 patient groups, we found no significant difference in patient outcomes whether they had a 1-week follow-up visit or not.

Previous studies have shown very low rates of loss of reduction, especially when rotational stability has been confirmed intraoperatively. These studies found that "technical errors" in pin configuration accounted for the majority of fractures that loss reduction in the early postoperative period.[7,20] Others have evaluated the utility of the 1-week postoperative visit and found that this visit did not significantly alter the clinical decision making of the physician or the clinical outcome of the patient.[8,12]

Our study only had 1 patient (0.5%) from group 1 that returned to the operating room for revision of fixation after a 1-week follow-up visit. This patient had a type III fracture and technical errors of pin placement were noted on review of the initial radiographs.

Several recent studies have evaluated the utility of radiographs at the 3- to the 4-week postoperative follow-up visit. Some studies confirm our findings, that radiographs may be safely delayed until the time of pin removal.[8,9] While others have examined whether radiographs immediately before pin removal are necessary,[10–12] Schlechter and Dempewolf[10] and Karalius et al[12] both concluded that radiographs are unnecessary before pin removal at 3 weeks. Garg et al[11] was unable to conclusively recommend the complete elimination of radiographs at the time of pin removal.

In our study, all patients received radiographs before pin removal at the 3- to the 4-week postoperative follow-up visit. The clinical decision for pin removal was not altered for any patient based on radiographic findings. However, in 14 patients [12 patients in group 1 (3.3%) and 2 patients in group 2 (5%)], the clinical management was changed and patients recasted for additional time based off radiographic findings.

Time to surgery was found to be significantly different between our 2 study groups. Group 1 had an average time to surgery of <24 hours, whereas group 2 was treated in <72 hours. One aspect our study was unable to evaluate was the amount of soft tissue damage surrounding the injury. Although the severity of the fractures may have appeared similar on radiographs, there is a possibility that fractures in group 1 had greater soft tissue injury leading to the decision for earlier surgery versus discharge to home and surgery on an outpatient basis. In addition, group 2 had a significantly greater number of circumferential casts placed following fixation. This may also be an indicator of greater soft tissue injury. The increased amount of swelling in group 1 patients likely drove the decision making the process for bivalve, univalve, or splint immobilization more frequent use. Use of a circumferential cast also negates the need for the patient to been seen at 1 week for overwrap or transition to cast if the fracture is stable.

The treatment of SCH fractures can be a significant financial burden for patient families and to the health care system. Patients not only bear the cost of an emergency room visit, radiographs, operating room charges, and hospital stay but potentially 2 to 4 additional follow-up appointments (facility fee: $125) and radiographs (2 view elbow: ~$670). In addition, there is potentially missed work and loss of wages for the caregiver to bring the patient to their follow-up visits, transportation costs and school absence for each visit required. Reducing the number of postoperative visits and studies necessary after treatment of SCH fractures could have a tremendous effect in decreasing medical cost and resources. National Health Expenditures[21] were reported as $3.2 trillion dollars in 2015. Of that, 19.8% was spent on physician and clinical services. Routine diagnostic imaging accounts for a large portion of our annual health expenditures. On average, patients with SCH fractures receive at least 4 sets of elbow radiographs (at presentation, intraoperative, week 1 postoperative, and weeks 3 to 4 postoperative).

Cost reduction, resource utilization and clinical efficiency in patient care have been a focus among pediatric hospitals over the past decade. On the basis of our study, if patients in group 1 had not been scheduled for a 1-week follow-up appointment and only come to a 3- to 4-week follow-up for pin removal, 368 clinical appointments would have opened over a 2-year period. In addition, 368 radiographic orders and patient waiting times would have been eliminated.

LIMITATIONS

There were several limitations to this study. We used a convenience sample of consecutive cases in our institution. The number of patients and group distribution was limited due to the retrospective nature of this study. All follow-up protocols were based on surgeon preference (including immobilization). Time to surgery may have been influenced by surgeon comfort with discharging and scheduling outpatient surgery or operating room availability at time of injury presentation.

CONCLUSIONS

We believe that this study suggests that the need for early postoperative follow-up at 7 to 10 days for patients with surgically treated (CRPP) SCH fractures may be unnecessary. Although limited by the retrospective nature

of our study, we believe that the 1-week follow-up appointment and radiographs at 7 to 10 days may be unnecessary for many fractures. Future studies are needed in a prospective design to better evaluate the true need for 1-week follow-up.

We propose the creation of a best practices protocol for the treatment of closed, displaced SCH fractures that are treated by CRPP. Follow-up should be based on the evaluation of fracture stability in the operating room. Intraoperative evaluation should consist of flexion, extension, rotation, and varus/valgus stress of the construct. If stable, the patient should be immobilized and follow-up at 3 to 4 weeks for radiographs and removal of pins. We believe that 3- to 4-week postoperative radiographs at pin removal should be maintained at this timepoint due to the altered clinical care needed in some patients. If the construct is unstable on intraoperative examination, the surgeon should (1) reevaluate the pin construct (placement and divergence) and (2) add a third pin (lateral or cross pin). If the stability of the fracture remains questionable, the patient should follow-up at 7 to 10 days postoperative with scheduled radiographs. All other patients should follow-up at 3 to 4 weeks for pin removal and radiographs out of the cast.

REFERENCES

1. Otsuka NY, Kasser JR. Supracondylar fractures of the humerus in children. *J Am Acad Orthop Surg*. 1997;5:19–26.
2. Kasser JR, Beaty JH. Supracondylar fractures of the distal humerus. In: Beaty JH, Kasser JR, Wilkins KE, Rockwood CE, eds. *Rockwood and Wilkins' Fractures in Children*, 6th ed. Philadelphia, PA: Lippincott Williams and Wilkins; 2006:543–589.
3. Skaggs DL, Flynn JM. Supracondylar fractures of the distal humerus. In: Flynn JM, Skaggs DL, Waters PM, eds. *Rockwood and Wilkins' Fractures in Children*, 8th ed. Philadelphia, PA: Lippincott Williams and Wilkins; 2015:581–628.
4. Gartland JJ. Management of supracondylar fractures of the humerus in children. *Surg Gynecol Obstet*. 1959;109:145–154.
5. Abzug JM, Herman MJ. Management of supracondylar fractures in children: current concepts. *J Am Acad Orthop Surg*. 2012;20:69–77.
6. Wilkins KE. Fractures and dislocations of the elbow region. In: Rockwood CA, Wilkins KE, King RE, eds. *Fractures in Children Vol 3*. Philadelphi, PA: JB Lippincott Co.; 1984:363–575.
7. Zenois M, Ramachandran M, Milne B, et al. Intraoperative stability testing of lateral-entry pin fixation of pediatric supracondylar humeral fractures. *J Pediatr Orthop*. 2007;27:695–702.
8. Karamitopoulos MS, Dean E, Littleton AG, et al. Postoperative radiographs after pinning of supracondylar humerus fractures: are they necessary? *J Pediatr Orthop*. 2012;32:672–674.
9. Ponce BA, Hedequist DJ, Zurakowski D, et al. Complications and timing of follow-up after closed reduction and percutaneous pinning of supracondylar humerus fractures. *J Pediatr Orthop*. 2004;24:610–614.
10. Schlechter JA, Dempewolf M. The utility of radiographs prior to pin removal after operative treatment of supracondylar humerus fractures in children. *J Child Orthop*. 2015;9:303–306.
11. Garg S, Bloch N, Cyr M, et al. Routine radiographs at the time of pin removal after closed reduction and percutaneous pinning for type 2 supracondylar humerus fractures do not change management: a retrospective cohort study. *J Child Orthop*. 2016;10:329–333.
12. Karalius VP, Stanfield J, Ashley P, et al. The utility of routine postoperative radiographs after pinning of pediatric supracondylar humerus fractures. *J Pediatr Orthop*. 2017;37:e309–e312.
13. Herman MJ, Boardman MJ, Hoover JR, et al. Relationship of the anterior humeral line to the capitellar ossific nucleus: variability with age. *J Bone Joint Surg*. 2009;91:2188–2193.
14. Worlock P. Supracondylar fractures of the humerus: assessment of cubitus varus by the Baumann angle. *J Bone Joint Surg Br*. 1986; 68-B:755–757.
15. Gordon JE, Patton CM, Luhmann SJ, et al. Fracture stability after pinning of displaced supracondylar distal humerus fracture in children. *J Pediatr Orthop*. 2001;21:313–318.
16. Park MJ, Ho CA, Larson AN. AAOS appropriate use criteria: management of pediatric supracondylar humerus fractures. *J Am Acad Orthop Surg*. 2015;23:e52–e55.
17. Boyd DW, Aronson DD. Supracondylar fractures of the humerus: a prospective study of percutaneous pinning. *J Pediatr Orthop*. 1992; 12:189–194.
18. Kallio PE, Foster BK, Paterson DC. Difficult supracondylar elbow fractures in children:analysis of percutaneous pinning technique. *J Pediatr Orthop*. 1992;12:11–15.
19. Topping RE, Blanco JS, Davis TJ. Clinical evaluation of crossed-pin versus lateral-pin fixation in displaced supracondylar humerus fractures. *J Pediatr Orthop*. 1995;15:435–439.
20. Sankar WN, Hebela NM, Skaggs DL, et al. Loss of pin fixation in displaced supracondylar humeral fractures in children: causes and prevention. *J Bone Joint Surg Am*. 2007;89:713–717.
21. US Centers for Medicare & Medicaid Services. National Health Expenditure Data; 2018. Available at: www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/NationalHealthExpendData/index.html. Accessed June 6, 2018.