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Routine evaluation of supracondylar humerus fracture percutaneous pin sites does not decrease complications: a retrospective comparative cohort

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Abstract

Background Supracondylar humerus (SCH) fractures are the most common type of pediatric elbow fractures that require surgical intervention. Studies suggest limiting the first postoperative visit to the time of pin removal or limiting radiographs at first postoperative follow-up may not increase complication rates, but few comparative studies exist. This study aims to determine if routinely examining surgical pins sites at the first postoperative visits affects the complication rates or outcomes compared to only evaluating pin sites if a clinical indication exists.

Methods This cohort study retrospectively reviewed patients who were surgically treated for a supracondylar humerus fracture at a Pediatric Level 1 Trauma Hospital from 2011–2017. Clinical records and surgical reports were reviewed, and data was extracted to determine fracture type, surgical treatment, and postoperative course. Complications were recorded.

Results Three hundred and fifty-five patients were included; 138 patients had a routine pin evaluation at first postoperative visit, 183 had no pin evaluation until time of pin removal, and 34 had a clinical indication for pin site evaluation at the initial postoperative visit. No patients in the routine pin evaluation or the no early pin evaluation group had a loss of reduction. In the clinical indication group, three patients returned to the operating room (8.82%) due to a loss of reduction, as determined by radiographs. No significant differences were found in healing outcomes or complications between the group that had a routine evaluation versus the group that did not.

Conclusion Routine pin site evaluation in the initial postoperative setting after closed or open reduction and pinning of supracondylar humerus fractures without clinical indication does not lead to fewer complication, return to operating room, or improved outcomes. The initial dressing and immobilization can be continued until pin removal unless clinical/radiographic indication to evaluate pin sites exists.

Level of Evidence Level III.

Keywords Pin site evaluation, Pediatric supracondylar humerus fractures, Complications

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Introduction

Supracondylar humerus (SCH) fractures are one of the most common childhood elbow fractures, sometimes requiring closed reduction and percutaneous pinning (CRPP) [1]. Several studies suggest that limiting the post-operative clinical visit or radiographs to the time of pin removal may not increase complication rates, but few comparative studies exist [2, 3]. There is concern that as the initial postoperative swelling subsides, the splint or cast could loosen, leading to decreased immobilization of the fracture repair construct. Because of this, many physicians have patients return approximately one week postoperatively for clinical and radiographic evaluation [2, 3].Although there is consensus at our institution in the utility of the one-week postoperative visit, disparity exists in our practice on the need to routinely remove the initial immobilization to evaluate the pin sites prior to casting. Opponents of routine pin evaluation note added visit time, and anxiety, particularly with younger children; Sanborn et al. demonstrated increased anxiety with pin removal [4]. No clear clinical guidelines for pin site evaluation are established. Proponents of pin evaluation at the first postoperative visit cite prevention of early complications or cubitus varus due to loss of reduction and malunion, pin migration, and infection that are recognized and treated at the first postoperative visit [1–3]. Bashyal et al. reported a pin migration rate of 1.8% of total cases and demonstrated that early detection in the first postoperative week allowed for meaningful adjustment prior to healing or loss of fixation.[5] Pin tract infection can also be a problem, and Battle et al. noted a variety of associated risk factors for infection, such as pins that are protruding, excessive tissue necrosis around the pin site, threaded as opposed to smooth pins, and sub-optimal daily cleaning of the pin site [6].

The primary aim of the study was to compare complications and outcomes among three patient cohorts: (1) patients who underwent routine pin site evaluation, (2) patients who had pins evaluated only at the time of pin removal, and (3) patients whose pin sites were evaluated due to clinical indication. A secondary objective was to identify any potential risk factors that may have led to post-surgical complications.

Methods

This retrospective review received Institutional Review Board (IRB) approval (HSC-MS-21–0251). All pediatric patients younger than 16 years old who underwent percutaneous pinning of isolated SCH fractures at a single Pediatric Level 1 Trauma Center from 2011 to 2017 were reviewed. Patients with closed physes, open fractures, were 16 years and older, or had incomplete documentation were excluded. A retrospective chart review was performed in which demographic data (height, weight, age, sex, BMI) and the following variables were collected: method of reduction, Gartland type, initial nerve palsy, vascular status, number of pins placed, lateral vs. lateral + medial placement, time from surgery to first post-operative visit, and initial postoperative radiographs. All patients were treated by a group of board certified pediatric orthopedic surgeons (8) or orthopaedic trauma surgeons (3). Postoperatively, patients underwent either routine pin evaluation or no pin evaluation at the initial postoperative visit unless clinically indicated per practice standards. Patients were retrospectively grouped into three cohorts: 1) routine pin (RP) evaluation at first postoperative visit; 2) no routine pin (NRP) evaluation at first postoperative visit; 3) pin evaluation due to clinical concern (CPE) based on symptoms or radiographic findings. Pin repositioning, return to the operating room (OR), and infections were designated as complications.

Surgical Technique

Patients with closed, displaced Gartland type II-IV SCH fractures were treated with closed or open reduction and percutaneous pinning in the supine position according to the standard technique of the treating surgeons. Routine single dose prophylactic antibiotics were utilized. A fluoroscopic unit or a radiolucent arm board was used as the table. After closed reduction was obtained, two or three divergent lateral entry pins were placed and confirmed bicortical. A medial pin was placed using a mini-open technique with protection of the ulnar nerve in fractures with continued instability on stress views. An open reduction was utilized at the discretion of the treating surgeon upon failure to obtain adequate reduction by closed means. None of the patients had buried pins. A nonadherent gauze and padded felt or gauze pad was placed around the pins and the pins were bent over the pad. A long arm plaster splint or a bivalved long arm cast was placed intraoperatively. Patients who lost reduction and needed surgical intervention underwent a one-staged revision procedure with 3–5 pins (Tables 1 and 2).

Postoperative Care

All patients were seen approximately one-week postoperatively for clinical and radiographic evaluation. Patients who did not undergo RP evaluation had their initial immobilization overwrapped with fiberglass to create a long arm cast. The initial dressing was only removed when clinically indicated (Table 3). Patients who underwent RP evaluation had their split/cast removed and pin sites assessed at the first postoperative visit. A new

Table 1 Demographic, surgical, and complications data for routine pin evaluation and no routine pin evaluation cohorts

	No pin evaluation until cast removal ($n=183$)	Routine pin evaluation ($n=138$)	*p*
Gender			0.023
Female	84 (45.90%)	46 (33.33%)	
Male	99 (54.10%)	92 (66.67%)	
Age (years)	5.82 ± 2.44	5.33 ± 2.12	0.060
BMI	16.98 ± 3.27	16.70 ± 2.99	0.399
Treatment			0.195
CRPP	164 (89.62%)	117 (84.78)	
ORPP	19 (10.38%)	21 (15.22)	
Gartland			0.030
2	2 (1.08%)	3 (2.08%)	
3	172 (94.05%)	134 (97.22%)	
4	9 (4.86%)	1 (0.69%)	
Pin Construct			0.202
Lateral Only	165 (90.16%)	118 (85.51%)	
Lateral & Medial	18 (9.84%)	20 (14.49%)	
Return to OR			0.735
No	181 (98.91%)	137 (99.28%)	
Yes	2 (1.09%)	1 (0.72%)	
Pin Repositioning			1
No	183 (100%)	138 (100%)	
Yes	0	0	
Infection			0.386
No	182 (99.45%)	138 (100%)	
Yes	1 (0.55%)	0	
Loss of Reduction			1
No	183 (100%)	138 (100%)	
Yes	0	0	

long arm cast was then applied. At 3–4 weeks postoperatively, casts were removed in all patients, radiographs performed, and pins removed to begin gentle range of motion.

Statistical Analysis

A descriptive statistical analysis was performed to determine if there was any difference in complication rates between the RP and NRP groups. Patients in the CPE group were evaluated and described separately. The averages of continuous variables were calculated and reported as the mean ± standard error of the mean. Means were compared using the Mann Whitney U Test. Categorical variables were expressed as frequencies and percentages. Fisher exact tests were utilized to compare categorical variables between patient groups. All analyses were performed with an alpha level of 0.05, indicating statistical significance as less than 0.05, in STATA 17.

Table 2 Demographic, surgical, and complications data for routine pin evaluation and clinical indication cohort

	Clinical indicationgroup ($n=34$)
Gender	
Female	14 (41.76%)
Male	20 (58.82%)
Age	5.56 ± 2.51
BMI	16.26 ± 2.99
Treatment	
CRPP	30 (88.24%)
ORPP	4 (11.76%)
Gartland	
2	0
3	33 (97.06%)
4	1 (2.94%)
Pin Construct	
Lateral Only	29 (85.29%)
Lateral & Medial	5 (14.71%)
Return to OR	
No	29 (85.29%)
Yes	5 (14.71%)
Pin Repositioning	
No	33 (97.06%)
Yes	1 (2.94)
Infection	
No	34 (100%)
Yes	0

Table 3 Reported clinical indications for pin evaluation

Clinical indications for pin evaluation ($n=34$)	
Concern for infection/wound check*	11 (32.35%)
Worsening pain*	8 (23.53%)
Worsening fever*	3 (8.82%)
Loose splint	5 (14.71%)
Examination for median nerve palsy	1 (2.94%)
Decreased hand sensation	1 (2.94%)
X-ray changes	3 (8.82%)

*Several patients had multiple indications

Results

Three hundred and fifty-five patients were included. There were 138 patients in the RP cohort, 183 in the NRP cohort, and 34 in the CPE cohort. In the RP group, one patient (0.72%) returned to the operating room for elbow stiffness, which required manipulation under anesthesia with concomitant pin removal

Table 4 Reported complications and infections in routine pin evaluation and no routine pin evaluation cohorts

NPE Group	RP Group
Reported complications or infections per patient	
Transient medial nerve palsy, persistent stiffness	Persistent AIN palsy with possible median nerve involvement
Transient superficial pin site infection; treated with Clindamycin	Persistent distal fishtail deformity
Transient delayed capillary refill	Persistent cubitus varus deformity
Granulation tissue at pin sites; treated with silver nitrate (2 patients)	
Persistent AIN Palsy	
Persistent trochlear dysplasia	

one month postoperatively. Three (2.17%) patients sustained complications that did not require surgical intervention (Table 4). No patients in this cohort sustained an infection. In the NRP group, two (1.09%) patients returned to the OR, one for pin removal due to hypertrophic skin growth one month postoperatively and one for manipulation under anesthesia due to stiffness two months postoperatively. Six (3.27%) patients in this cohort suffered transient or persistent complications, and one (0.55%) suffered a superficial infection three weeks after pin removal. None of these required return to the operating room (Table 4). There were no significant differences in complications between the RP and NRP cohorts (Table 1).

Clinical indication for pin evaluation cohort

Five (14.71%) patients in the CPE cohort had complications, all requiring surgical intervention. Three (8.82%) patients had a loss of reduction. One (2.94%) patient returned to the OR for buried pin removal due to pin migration 3 weeks postoperatively. One (2.94%) patient returned to the OR 28 months postoperatively for resultant cubitus varus deformity correction.

Within the CPE cohort, 11 (32.35%) patients needed their splints removed due to concern for infection/wound check (Table 3). Eight (23.53%) patients had their pin sites evaluated due to worsening pain. Other clinical indications included patient reported worsening fever (n = 3; 8.82%), splint loosening (n = 5; 14.71%), examination for median nerve palsy (n = 1; 2.94%), decreased hand sensation (n = 1; 2.94%), and pin migration or concern for loss of fixation or pin migration based on radiographs (n = 2; 5.88%). There were no patients with infections.

Patients with reduction loss

All three patients with reduction loss had a Gartland type III fracture. Patient one had a loss of reduction that was determined radiographically at the first postoperative visit, which revealed a loss of reduction into humerus in extension and valgus. Their initial reduction was treated via CRPP using a 3 lateral pin construct. This patient underwent revision CRPP 4 days postoperatively with a 5-pin lateral and medial construct (Fig. 1). Patient two had a loss of reduction that was determined radiographically at the first postoperative visit, which revealed a loss of reduction into extension and varus. Their initial

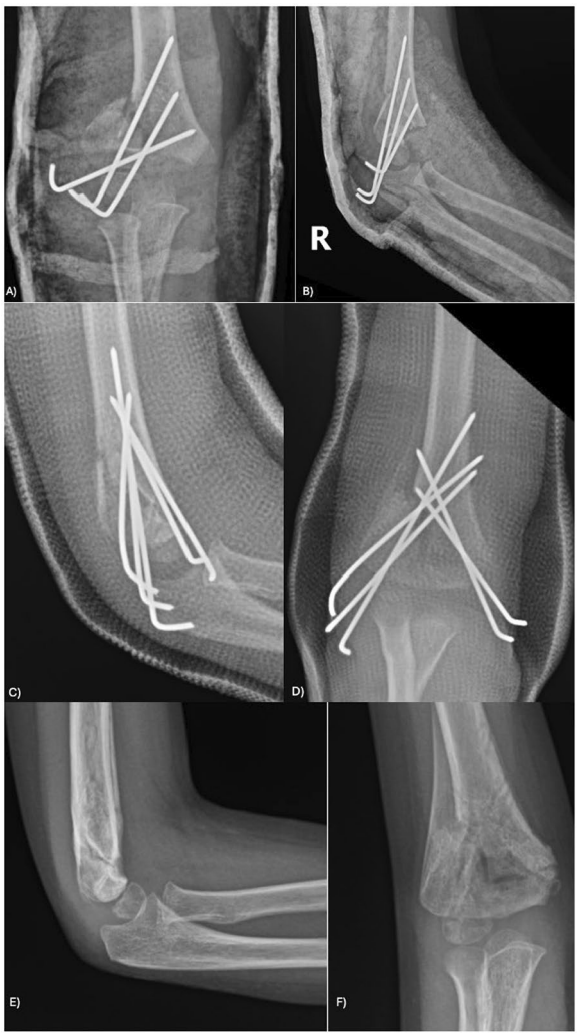

Fig. 1 Routine evaluation pin group patient: initial reduction. **A** and **B** anteroposterior (AP) and lateral radiographic views of failed reduction; **C** and **D** AP and lateral radiographic views status post revision reduction; **E** and **F** AP and lateral radiographic after healed fracture and hardware removal

reduction was treated via CRPP using a 3 lateral pin construct. This patient underwent a revision CRPP 10 days postoperatively with a 3-pin lateral construct. Patient three had a loss of reduction that was determined radiographically at the first postoperative visit, which revealed a loss of reduction with rotational malalignment. Their initial reduction was treated via CRPP using a 2 lateral pin construct. This patient underwent evaluation under anesthesia 17 days postoperatively but had progressive healing, preventing repeat reduction.

Discussion

Overall, there were no significant differences in healing outcomes, complications, or return to OR rates between those that had their pin sites routinely evaluated at the first postoperative visit and those that did not have their pin sites evaluated (return to OR rate NRP: 1.09%, CPE: 0.72%, $p=0.735$). Complications that required surgical intervention in both the NRP and CPE groups were diagnosed at minimum one month postoperatively, thus confirming that pin evaluation at the first postoperative visit did not detect more complications.

Three patients in the CPE evaluation group were found to have a loss of reduction that required a return to the operating room. However, these losses of reduction were all noted on postoperative radiographs. Therefore, routine pin evaluation status did not impact their plan of care, which supports that early postoperative routine pin site evaluation is not necessary to identify complications if radiographs are obtained.

Supracondylar humerus fractures are a common pediatric injury sometimes requiring surgical treatment and postoperative immobilization, with this injury most commonly occurring in 3 to 7 year olds [7–9]. Prior literature has shown that casting and pin removal can serve as a significant source of anxiety for both parents and children [4]. During the first postoperative month, the fewer times the immobilizer is removed and pins evaluated, the less anxiety the parents and the child experience [10]. Balancing patient anxiety with the need to perform clinically important evaluations form the genesis of our hypothesis. While there is sufficient research that identifies complication rates and risk factors for SCH fractures, [11] there is minimal literature on whether routine pin site evaluation can aid in preventing or detecting early clinically silent complications. The results of this study suggest that in the absence of clinical indication, routine pin evaluation does not decrease complication rates. Avoiding early postoperative pin site evaluation may reduce clinic visit time, possible anxiety and noncompliance during recasting, and increase clinical efficiency without adversely affecting outcome. Although our study's return to the OR rate was low (2.25%), the three patients who returned to the OR for loss of reduction did so based on radiographic findings from their first postoperative visit. Therefore, this prevents us from concluding that the first early postoperative visit with radiographs should be eliminated.

Most children that have SCH fractures generally have excellent outcomes and minimal complications when properly treated [10, 11, 16, 17]. Ernat et al. demonstrated no significant differences in functional outcomes between all operatively treated modified Gartland classification types of SCH fractures [13]. Zusman et al. demonstrated that it is unnecessary to obtain a set of radiographs once the pins have been removed, as these radiographs did not lead to a change in the plan of care [14]. Patel et al. verified this with standard of care guidelines, which denotes that patients do not need to be seen in clinic after pin removal unless they have a specific reason to return [15]. Our study adds to the body of evidence that routine pin site examination at the initial postoperative visit without clinical or radiographic concern may not be necessary.

As previously mentioned, the complication rate for closed reduction and percutaneous pinning (CRPP) is extremely low. Combs et al. reported that the rate of pin site infection is 0.81% [16]. Other reported complications include loss of reduction, compartment syndrome, ulnar nerve lesions, and infection [11, 17]. The low complication rate associated with CRPP is consistent with the results of this study.

This study has several limitations. A retrospective review may have missed minor complications such as skin irritation that did not change management or result in additional operative treatment. Additionally, due to the small sample size of our study, there were few patients who developed serious surgical complications. Thus, there may not have been enough complications to make an accurate assessment as to whether routine pin site evaluation was effective at reducing complications. Furthermore, open fractures were excluded from the cohorts, as many surgeons evaluate the traumatic wound in the early postoperative period. Additionally, due to the retrospective nature of this study, comfort level and satisfaction with a postoperative splint immobilization with overwrapping versus being placed into a cast until pin removal were unable to be obtained.

In addition, due to the retrospective design of this study, it is not possible to exclude physician selection bias. Whether routine pin evaluation was completed at first post-operative is dependent on the physician's preference. Within our Pediatric Orthopedics division, we need to come to a consensus and have a standard of care. The only way to resolve this bias is to have a randomized, prospective design.

Based on the results of our retrospective study, routine pin site evaluation in the initial postoperative setting

after closed or open reduction and pinning of supracondylar humerus fractures did not lead to fewer complications, increased return to OR rates, or improved healing outcomes. While we found that routine postoperative pin evaluation is not clinically necessary, early postoperative visits with radiographs are still valuable to identify infrequent but meaningful complications.

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Author contributions
AA: Writing-review and editing, prepared Tables and FiguresBG: Conceptualization, methodology, investigation, writing-original draftRV: Writing-review and editing, prepared Figures 1 and 2LC: Writing-review and editingSY: Writing-review and editingAM: Conceptualization, supervise, writing-review and editing

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Data availability
No datasets were generated or analysed during the current study.

Declarations

Competing interests
The authors declare no competing interests.

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