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Original Research

Immobilization Following Operative Treatment of Lateral Condyle Fractures: Early Motion Is Safe

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ABSTRACT

Background: Immobilization is required following operatively treated lateral condyle fractures to provide adjunct stability. However, there is no clear consensus regarding the optimal duration of postoperative immobilization. This study aims to compare an early motion (EM) protocol of four weeks or less of immobilization to a six-week or longer immobilization period, evaluating the differences in postoperative range of motion (ROM), healing, and complications.

Methods: We performed a retrospective, single center cohort study of acute, isolated, lateral condyle fractures in pediatric patients presenting from 2013 to 2024 treated operatively with either closed reduction and percutaneous pinning (CRPP) or open reduction and internal fixation (ORIF). Patients were categorized into an EM group, with four weeks or less of total immobilization, or a standard motion (SM) group, with six weeks or greater of total postoperative immobilization. We compared the ROM at interval follow-up, complications, and radiographic union between groups. Univariate statistical analyses were performed with IBM SPSS Statistics v29.

Results: A total of 174 elbows (174 patients, 60 [34%] female, mean age 6.5 ± 2.5 years) were included: 78 in the EM group, and 96 in the SM group. There were no differences in age, sex, Song classification, or open vs closed reduction. There was no significant difference in loss of elbow ROM ($P = .71$), complication rates ($P = .73$), or radiographic union rates ($P = 1.00$) between groups. In the EM group, two patients experienced malunion/nonunion that required a return to the operating room. In the SM group, two patients underwent a return to the OR due to malunion/nonunion, and a soft tissue infection at the site of implant occurred in one patient. Subanalysis of patients with loss of ROM ≥15° compared to all other patients found significantly lower rates of radiographic union and higher complication rates; however, there was no difference in the duration of cast immobilization between these groups.

Conclusions: For acute, isolated lateral condyle fractures, an EM immobilization protocol allowing motion at four weeks or less yields similar outcomes compared to a longer protocol.

Key Concepts:

(1) There is significant heterogeneity in postoperative immobilization protocol for isolated lateral condyle fractures in pediatric patients.
(2) Early mobilization may allow a faster return to activities without an increased risk of complications compared to longer immobilization protocols.
(3) Patients who exhibit postoperative stiffness were significantly more likely to demonstrate radiographic nonunion (9% vs 1%, $P = .04$) and have a postoperative complication (19% versus 2%, $P = .001$) versus the remainder of the cohort.

Level of Evidence: Level IV, Retrospective Cohort Study

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Introduction

Lateral condyle fractures in children are intra-articular fractures through the cartilaginous distal humerus [1,2]. Treatment can include long-arm casting, closed reduction and percutaneous pinning (CRPP), or open reduction and internal fixation (ORIF), depending on the displacement and rotation of the fracture fragment [3,4]. Operative management of this fracture pattern is challenging; closed reductions often require an arthrogram to assess articular congruity [5], and direct visualization of the medial fracture line during open reduction requires adequate exposure of the entire anterior distal humerus [6]. Anatomic reduction of these fractures is paramount due to the significant rate of complications following surgery [7], including nonunion [8] and stiffness [9,10]. Although stiffness has been associated with a longer period of immobilization [10], and some evidence exists that only three weeks of immobilization is required following open reduction and pinning of lateral condyle fractures [11], there remains little consensus or further evidence examining the length of immobilization following operative treatment of these injuries. Given the positive impact that shorter immobilization may have on recovery of elbow range of motion (ROM), some surgeons at our institution follow an early motion (EM) post-operative protocol, discontinuing immobilization and starting elbow ROM at four weeks postoperatively. In this investigation, we aimed to compare outcomes and complications between this EM cohort and a traditional protocol cohort with six weeks of postoperative immobilization. We hypothesized that outcomes and complications would be similar between these groups and that an EM protocol would be safe following surgical management of pediatric lateral condyle fractures.

Methods

We conducted a retrospective review of all operatively managed pediatric lateral condyle fractures at our tertiary care pediatric hospital from 2013 to 2024 after obtaining institutional board approval. We

Table 1.
Differences between group 1 (early motion) and group 2 (standard immobilization).

	Group 1 (≤four weeks immobilization) N = 78	Group 2 (≥six weeks immobilization) N = 96	*p* values
Sex			
Female	32 (41%)	28 (29%)	0.11*
Male	46 (59%)	68 (71%)	
Mean age (years)	7.0 ± 3.0	6.1 ± 2.0	0.09†
Song classification			
1	0 (0%)	0 (0%)	0.07‡
2	2 (3%)	0 (%)	
3	13 (17%)	8 (8%)	
4	38 (48%)	45 (47%)	
5	25 (32%)	43 (45%)	
Reduction method			
Open	61 (78%)	74 (77%)	1.00*
Closed	17 (22%)	22 (23%)	
Fixation type			
K-Wires	52 (67%)	91 (95%)	<0.001*
Screws	18 (23%)	3 (3%)	
Both K-Wires + Screws	8 (10%)	2 (2%)	
Radiographic union	76 (97%)	93 (97%)	1.00‡
Flynn criteria			
0–5°	47 (60%)	53 (55%)	0.71‡
5–10°	14 (18%)	19 (20%)	
10–15°	5 (6%)	4 (4%)	
>15°	12 (16%)	20 (21%)	
Complication			
Y	3 (4%)	6 (6%)	0.73‡
N	75 (96%)	90 (94%)	
Complication types			
Infection	0 (0%)	2 (2%)	1.00‡
Return to OR due to malunion/nonunion	2 (3%)	3 (3%)	
None	75 (96%)	90 (93%)	
Other§	1 (1%)	2 (2%)	

* *Chi Square.*
† *Mann-Whitney U.*
‡ *Fisher's Exact.*
§ *Re-fracture, delayed union, AVN, contracture.*

queried our institution's electronic medical record for the following Current Procedural Terminology (CPT) codes: 24582 (percutaneous skeletal fixation of humeral condylar fractures, medial or lateral, with manipulation) or 24,579 (open treatment of humeral condylar fracture, medial or lateral, including internal fixation when performed). From that query, we identified skeletally immature patients with isolated lateral condyle fractures treated with either CRPP or ORIF with a minimum of two months of follow-up. All patients were treated by a fellowship-trained pediatric orthopaedic surgeon. We excluded skeletally mature patients, polytraumatic injuries, or patients without at least 3 months of follow-up data.

Preoperatively, we collected demographic data (age, gender, and body mass index [BMI]) and classified each patient according to the Song criteria [12]. Based on the operative note and fluoroscopic images, we recorded reduction (open vs closed) and fixation type (screws vs Kirshner wires). We evaluated all follow-up imaging to evaluate for radiographic union (defined by as bridging callus with stable fracture alignment at the 8 week mark) and noted any complications, including avascular necrosis (AVN), infection, or refracture, and each patient was categorized according to the Flynn criteria [13] based on review of the clinical documentation of loss of ROM compared to a normal of 0–130°, which was recorded starting three months postoperatively.

Patients were divided into two groups based on the length of total immobilization following fixation: an EM (EM) cohort and a standard motion (SM) cohort. Patients in the EM cohort had immobilization discontinued with pin removal and were allowed to start ROM at four weeks or less after surgery, while the SM cohort had a total length of immobilization six weeks or longer. We did not include patients who had between four and six weeks of immobilization. Demographic data and outcomes were compared between these two cohorts using either the Chi-square test, Fisher exact test, or Mann–Whitney *U* test depending on variable type. Statistical significance was set at $P = .05$. Analysis was performed with IBM SPSS Statistics v29 (SPSS Inc., Chicago, IL).

Results

A total of 174 patients met the inclusion criteria; 78 in the EM cohort and 96 in the SM cohort. The mean age was 6.5 ± 2.5 years, and 60 patients were female (34%) (see Table 1).

There was no difference in age, gender, BMI, or Song classification between groups. The cohorts were equally likely to undergo open vs closed reduction, but the EM group was more likely to be fixed with a screw-only construct (23% vs 3%, $P < .001$). Additionally, there was no difference in postoperative ROM according to the Flynn criteria or in

Table 2.
Differences between group 1 (early motion) and group 2 (standard immobilization) in patients with K-wire fixation.

	Group 1 (≤four weeks immobilization) N = 52	**Group 2 (≥six weeks immobilization) N = 91**	**P-values**
Sex			
Female	20 (38%)	27 (30%)	0.36*
Male	32 (62%)	64 (70%)	
Mean age (years)	5.4 ± 2.0	6.0 ± 1.9	0.16†
Song classification			
1	0 (0%)	0 (0%)	**0.02**‡
2	2 (4%)	0 (0%)	
3	11 (21%)	8 (9%)	
4	23 (44%)	41 (45%)	
5	16 (31%)	42 (46%)	
Reduction method			
Open	39 (75%)	71 (78%)	0.84*
Closed	13 (25%)	20 (22%)	
Radiographic union	50 (96%)	87 (96%)	1.00‡
Flynn criteria			
0–5°	32 (62%)	51 (56%)	0.75‡
5–10°	11 (21%)	18 (20%)	
10–15°	2 (4%)	3 (3%)	
>15°	7 (13%)	19 (21%)	
Complication			
Y	2 (4%)	5 (5%)	1.00‡
N	50 (86%)	86 (95%)	
Complication types			
Infection	0	0	0.70‡
Return to OR due to malunion/nonunion	2 (4%)	3 (3%)	
None	50 (96%)	86 (95%)	
Other*	0	2 (2%)	

The p values in bold denote statistical significance.
* *Chi Square.*
† *Mann-Whitney U.*
‡ Fisher's exact test.

complication rates. A secondary analysis was performed between the EM and SM cohorts for patients treated with K-wire fixation (see Table 2).

Again, no differences were found in postoperative ROM or rate of union, although there was a difference in distribution of the Song classification with more Song 3 in the EM group and more Song 5 in the late motion group ($P = .02$). Notably from a technique perspective this did not translate to a more open reduction in one group vs another.

Finally, patients who lost greater than 15 degrees of ROM (Flynn Group 4) were compared to the remainder of the cohort (Flynn groups 1–3). The Flynn 4 patients were significantly more likely to demonstrate radiographic nonunion (9% vs 1%, $P = .04$) and have a postoperative complication (19% vs 2%, $P = .001$) (see Table 3). The distribution of Flynn criteria was not related to immobilization time in the larger cohort ($P = .71$) or in the K wire only cohort ($P = .75$).

Discussion

The algorithm to treat lateral condyle fractures is generally based on the degree of displacement according to the Song Classification. Displaced fractures are treated operatively, with the degree of displacement and surgeon preference dictating exposure and fixation strategy [1]. Postoperatively, there is little consensus on the optimal duration of immobilization, although six weeks is commonly reported. This variability was reflected at our institution, where both four weeks and six weeks of immobilization are followed depending on surgeon preference. We utilized this variation into a retrospective cohort analysis comparing outcomes between the two groups and found no difference in stiffness and complications. These data suggest that early mobilization is safe following either CRPP or ORIF of pediatric lateral condyle fractures. To our knowledge, this is the first investigation to directly compare immobilization lengths. Thomas et al. retrospectively reviewed children treated with open reduction of lateral condyle fractures who were mobilized at three weeks with only one case of nonunion [11], but the investigation lacked a comparison group and did not include patients treated with CRPP. Longer immobilization was a risk factor for stiffness in a retrospective investigation by Bernthal et al. [10] in both CRPP and ORIF patients, however, the mean immobilization was greater than six weeks for the entire study population. Surgeons may consider our findings in the context of the body of literature when making immobilization decisions following lateral condyle ORIF or CRPP as early mobilization may lower the burden of care for patients and families.

Stiffness is among the most frustrating complications following lateral condyle fixation and is well investigated. Previously identified risk factors for stiffness outside from longer immobilization [10] include older age, open reduction, and associated dislocation [9]. We performed a secondary analysis of the 32 patients in our study population who lost more than 15 degrees of terminal ROM (Flynn Type 4) during the follow-up period vs the remainder of the cohort. We did not find either

Table 3.
Comparison of Flynn criteria group 4 (>15° loss of ROM) vs ≤15° loss of ROM.

	>15° Loss of ROM (N = 32)	≤15° Loss of ROM (N = 142)	P-values
Sex			
Female	13 (41%)	47 (33%)	0.54*
Male	19 (59%)	95 (67%)	
Mean age (years)	6.5 ± 2.5	6.4 ± 2.7	0.85†
Song classification			
1	0 (0%)	0 (0%)	0.65‡
2	0 (0%)	2 (2%)	
3	2 (6%)	19 (13%)	
4	15 (47%)	68 (48%)	
5	15 (47%)	53 (37%)	
Reduction method			
Open	26 (81%)	109 (77%)	0.65*
Closed	6 (19%)	33 (23%)	
Immobilization group			
≤four Weeks	12 (38%)	66 (46%)	0.43*
≥six Weeks	20 (63%)	76 (54%)	
Radiographic union	91%	99%	**0.04**‡
Complication			
Y	6 (19%)	3 (2%)	**0.001**‡
N	26 (81%)	139 (96%)	
Complication types			
Infection	1 (3%)	0 (0%)	**0.002**‡
Return to OR due to malunion/nonunion	3 (9%)	2 (1%)	
None	26 (82%)	139 (98%)	
Other§	2 (6%)	1 (1%)	

ROM, range of motion.
The p values in bold denote statistical significance.
* *Chi Square.*
† *Mann-Whitney U.*
‡ *Fisher's Exact.*
§ *Re-fracture, delayed union, AVN, contracture.*

longer immobilization or type of reduction to be associated with stiffness. Interestingly, the children who experienced stiffness were revealed to have a higher rate of nonunion (91% vs 99%, $P = .04$) and complications (19% vs 2%, $P = .001$). Notably, neither of these variables was associated with immobilization time. We theorize that imperfect reduction in this intra-articular fracture may lead to stiffness in the postoperative period, and future studies analyzing this relationship may be beneficial.

Our study is not without limitations, including those inherent with retrospective analysis. First, the EM cohort had a higher rate of screw fixation than the SM cohort. A subsequent secondary analysis of patients treated only with Kirshner wires between groups showed no differences between the groups in stiffness, outcomes, or demographic findings but did show a difference in distribution of the Song classification between groups ($P = .02$). To address this, we completed analysis of the rate of closed vs open reduction and stiffness by Song type, and there were no significant differences in either group ($P = .26$ and $P = .65$, respectively). Finally, loss of ROM was identified by clinical documentation, which may vary depending on the individual surgeon and may have not been taken at the exact same time postoperatively due to heterogeneity in follow-up intervals.

In conclusion, we found no significant difference in outcomes or complications in operatively treated pediatric lateral condyle fractures immobilized for four weeks compared with those immobilized for six weeks. Early mobilization appears to be safe and can be considered in the postoperative treatment protocol to bring them more in line with other pediatric elbow fractures.

Ethics approval and consent

The author(s) declare that no patient consent was necessary as no images or identifying information are included in the article.

Author contributions

Nakul S. Talathi: Writing – review & editing, Writing – original draft, Methodology, Investigation, Data curation. **Casey Kuka:** Writing – review & editing, Writing – original draft, Investigation, Data curation. **Maia D. Regan:** Writing – review & editing, Writing – original draft, Investigation, Data curation. **John W. Stelzer:** Writing – review & editing, Writing – original draft, Investigation. **Keith D. Baldwin:** Writing – review & editing, Writing – original draft, Methodology, Data curation, Conceptualization. **Christine M. Goodbody:** Writing – review & editing, Writing – original draft, Investigation.

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Declaration of competing interests

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Christine Goodbody reports a relationship with OrthoPediatrics Corp that includes: consulting or advisory. Keith D. Baldwin reports a relationship with OrthoPediatrics Corp that includes: travel reimbursement. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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