

Original Research Article

Pediatric lateral condyle humerus fractures: a comparison of closed reduction with percutaneous pinning and open reduction with internal fixation for displacement over 2 mm

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ABSTRACT

Background: Lateral condylar humerus fractures (LCHFs) with displacement over 2 mm are commonly treated with open reduction and internal fixation (ORIF). However, closed reduction and percutaneous pinning (CRPP) has been proposed as an alternative. Limited research compares these methods for such fractures. This study aimed to evaluate outcomes of CRPP versus ORIF.

Methods: We retrospectively reviewed pediatric patients with LCHFs displaced >2 mm, treated with CRPP or ORIF at five military hospitals between June 2018 and October 2023. Fractures were classified using the Song and Milch systems. We assessed age, sex, fracture characteristics, surgery duration, postoperative care, and complications.

Results: Of 273 patients, 82 had Milch type I and 191 had type II fractures; 78 were Song stage 3, 123 stage 4, and 72 stage 5. CRPP was used in 102 cases, ORIF in 171. Both groups were similar in age, sex, displacement, and immobilization time. CRPP had shorter surgeries and pin durations and did not need a second procedure for pin removal. Most fractures healed without major complications. Common issues included bone spurs, lateral prominences, and reduced carrying angle, but no functional deficits. Aesthetic scarring was more common in ORIF. Elbow function and range of motion were comparable.

Conclusions: CRPP and ORIF both yield good outcomes for pediatric LCHFs with >2 mm displacement. CRPP offers advantages like shorter surgery, no scarring, and avoiding additional procedures.

Keywords: Lateral condylar humerus fractures, Pediatric fractures, Closed reduction and percutaneous pinning, Open reduction and internal fixation

INTRODUCTION

Lateral condylar humerus fractures (LCHFs) are the second most common type of distal humeral fractures in children, accounting for about 17% of pediatric distal humeral fractures.^{1,5,8,10,13} Song classification for lateral condyle fractures in one of the most recent classification systems that we use in our study (Figure 1).²⁰ When these fractures are displaced by less than 2 mm, the traditional treatment is conservative vs closed reduction with percutaneous pinning (CRPP), as these fractures affect the

joint surface.^{6,8,10,13} For fractures with displacements between 2 and 4 mm, CRPP is often recommended because it causes less disruption to surrounding tissues, carries a lower risk of complications like blood vessel damage, non-union, and osteonecrosis, and has the added benefits of shorter surgery times and less visible scar.^{1,2,12,14,19}

Open reduction and internal fixation (ORIF) remains the standard for fractures with displacements over 4 mm.²⁻⁴ However, some studies, like those by Song, suggest that

CRPP can be effective even for fractures with more than 4 mm of displacement, with a reported success rate of 75%.²⁰ Other research, such as that by Justus et al, also found CRPP to be beneficial in more severe cases, although some studies did not replicate these results.²¹

Despite the potential benefits of CRPP, direct comparisons between CRPP and ORIF for fractures displaced by more

than 2 mm are limited. Most existing research has focused on fractures with smaller displacements (2–4 mm), where no major differences in outcomes have been observed between the two approaches. This study aims to directly analyze the outcomes of CRPP and ORIF for fractures displaced by more than 2 mm in our institute.

Stage	Degree of displacement	Fracture pattern	Radiograph views used as basis	Stability
1	≤2 mm	Limited fracture line within the metaphysis	All 4 views	Stable
2	≤2 mm	Lateral gap	All 4 views	Indefinable
3	≤2 mm	Gap as wide laterally as medially	Any of 4 views	Unstable
4	>2 mm	Without rotation of fragment	Any of 4 views	Unstable
5	>2 mm	With rotation of fragment	Any of 4 views	Unstable



Figure 1: Song classification of lateral condyle fracture in pediatrics.²⁰

METHODS

This is a retrospective study of pediatric patients treated for LCHFs at our military hospitals including: King Husein Medical Hospital, Queen Alia Military Hospital, Prince Ali Hospital, and Prince Hashim Bin Abdullah II Hospital between June 2018 and the end October 2023. Patient selection criteria included patients were under 14 years old, had fresh closed fractures, and fractures displaced by more than 2 mm that required surgery.

Patients with open fractures, fractures displaced by less than 2 mm, fractures with associated injuries, or incomplete data were excluded. The patients were divided into three groups - group 1: CRPP which were 102 cases, group 2: CRPP followed by ORIF if CRPP failed which 71 cases, and group 3: immediately managed with ORIF were 100 cases.

Fractures were classified using the Song (Table 1) and Milch classifications (Figure 2).

Type 1:	Non-displaced fracture. Fracture line does not cross through the articular surface
Type 2:	Minimally displaced. Fracture extends to the articular surface, but the capitellum is not rotated or significantly displaced.
Type 3:	completely displaced. Fracture extends to the articular surface, and the capitellum is rotated and significantly displaced.

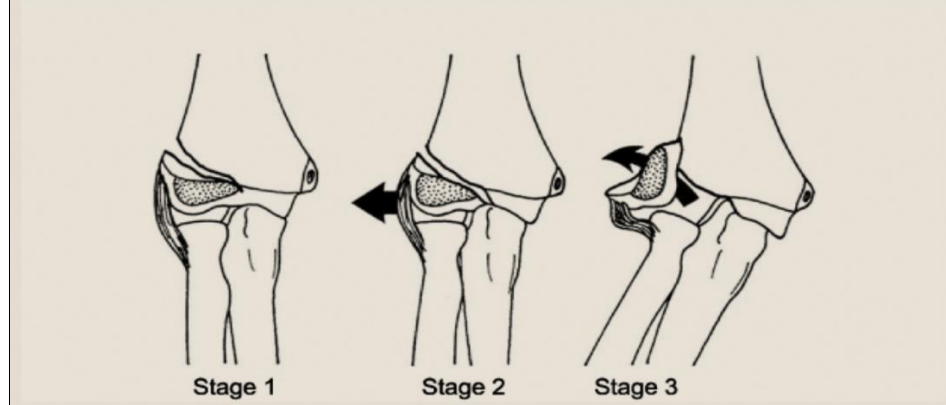


Figure 2: Milch classification for lateral epicondyle fractures in pediatrics.⁸

Surgical technique

CRPP was initially attempted for fractures in groups 1 and 2, following established protocols. If the fracture could not be adequately reduced (less than 2 mm of displacement), ORIF was performed. Group 3 patients underwent ORIF via the traditional lateral approach. The K wires orientation is described through Figures 3 and 4.^{2,7,9,10,13}

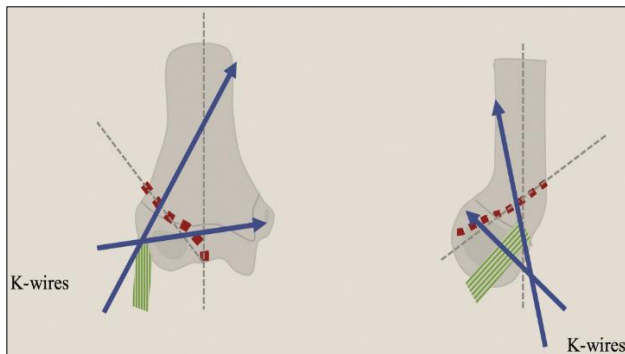


Figure 3: Illustration showing 2 lateral K wires fixation, the 1st K wire is inserted parallel to joint line and the 2nd one makes 60 degrees angle in relation to the 1st K wire to achieve best stability.²²



Figure 4: (a) X-rays showing preoperative lateral condyle fracture, and (b) K wires fixation.²²

Statistical analysis

Continuous variables were compared with independent-samples t-tests, and categorical variables were evaluated

with Chi-square or Fisher's exact tests. A p value of less than 0.05 was considered statistically significant.

RESULTS

A total of 356 LCHFs were treated during the study period. After excluding patients who didn't meet the inclusion criteria, 273 fractures were included in the analysis, divided into - group 1: 102 cases (CRPP), group 2: 71 cases (CRPP followed by ORIF), and group 3: 100 cases (ORIF).

Demographics and baseline data

Regarding demographic analysis, it was summarized in Table 1. No significant differences were found between the groups in terms of age, sex, side of injury, preoperative displacement, postoperative displacement, or the duration of immobilization. However, significant differences were noted in the operative time and pin duration. The CRPP group had significantly shorter surgery times and shorter pin durations compared to the ORIF groups ($p < 0.001$) and much less need for additional surgeries for hardware removal.

The average age was 5.4 years, with 189 boys and 84 girls. Fracture types included 90 were Milch type I, 183 were type II. Regarding song classification, 180 were Song stage 4, and 123 were stage 5 fractures.

CRPP success by fracture type

CRPP was more successful in Milch type II fractures compared to type I ($p = 0.009$), and more successful in song stage 3 than Song stages 4 and 5 ($p = 0.65$) (Table 2).

Follow-up and complications

Through Table 3, we can find that average follow-up period was 15 months (ranging from 8 to 24 months). No significant complications like infection, non-union, delayed union, osteonecrosis, or fishtail deformity were observed in any group. Lateral bone prominences and bone spurs were common but did not cause significant clinical problems. No differences were seen in carrying angle or cubitus varus.

Table 1: Patient demographics.

Variables	Group 1 (n=102)	Group 2 (n=71)	Group 3 (n=100)	Overall (n=273)	P value
Age (years)	5.1±2.5	5.9±2.5	5.3±2.2	5.4±2.3	0.65
Sex					0.27
Male	61	60	68	189	
Female	41	11	32	84	
Side injured					0.75
Right	50	27	50	127	
Left	52	44	50	146	
Pre-op displacement (mm)	8.3±6.1	7.1±4.4	11.2±4.4	11.6±6.1	0.53

Continued.

Variables	Group 1 (n=102)	Group 2 (n=71)	Group 3 (n=100)	Overall (n=273)	P value
Post-op displacement (mm)	1.2±0.5	1.4±0.7	1.1± 0.8	1.3±0.6	0.25
Operation time (min)	32.8±11.8	60.2±8.9	52.7±7.2	43.8±13.1	<0.001
Immobilization (weeks)	4.9± 1.0	4.94±0.7	4.9±0.6	4.8±0.8	0.34
Pin duration (weeks)	5.6±0.8	7.7±2.6	5.9±2.7	6.0±5.5	<0.001
Follow-up (months)	14.7±4.4	13.6±3.3	13.1±3.3	13.8±3.7	0.66
Milch type					0.009
I	18	38	34	90	
II	84	33	66	183	
Song stage					0.65
4	54	33	63	150	
5	48	38	37	123	

Pre-op: pre-operative, post-op: post-operative, statistical significance was set at p<0.05

Table 2: Success rate of CRPP between different fracture types.

Types of LCHFs	Group 1 (n=102)	Group 2 (n=71)	Sum (n=173)	P value
Milch type				0.009
I	18	38	56	
II	84	33	117	
Song stage	0.65			
4	54	33	87	
5	48	38	86	
Sum	102	71	173	

Statistical significance was set at p<0.05

Table 3: Complications and functional outcomes.

Complications	Group 1 (n=102), 45	Group 2 (n=71), 13	Group 3 (n=100), 62	Overall (n=273), 120	P value
Infection	None	None	None	None	/
Delayed union	None	None	None	None	/
Nonunion	None	None	None	None	/
Osteonecrosis	None	None	None	None	/
Fishtail deformity	None	None	None	None	/
Cubitus varus	None	None	None	None	/
Cubitus valgus	None	None	None	None	/
Pain	None	None	None	None	/
Bone spur	102/102	71/71	100/100	273/273	/
Lateral prominence	9/102	16/71	15/100	40/273	0.38
Decreased carrying angle	7/102	6/71	8/100	21/273	0.96
Unaesthetic scar	0/102	22/71	28/100	50/273	<0.001
Additional operation	0/102	71/71	100/100	171/273	<0.001
Range of motion (°)					
Extension	6.2±5.2	6.1±2.2	5.7±2.0	6.3±3.6	0.41
Flexion	132.2±2.4	131.7±2.6	130.7±3.2	131.9±2.9	0.60
Arc	142.1±4.7	140.7±4.5	139.7±3.2	139.8±4.0	0.10

Statistical significance was set at p<0.05

DISCUSSION

This study compares the clinical outcomes of CRPP and ORIF for LCHFs displaced by more than 2 mm. Both techniques yielded favorable results, but CRPP had distinct advantages, such as being less invasive, reducing

surgery time, less visible scars, and lowering the need for secondary surgery to remove hardware.^{4,6,11,14}

The CRPP group had shorter operation times and pin durations and did not require additional surgeries for pin removal. The average follow-up duration was 15 months.

Most of patients achieved fracture healing without complications such as infection, non-union, delayed union, osteonecrosis, fishtail deformity, or abnormal elbow alignment.¹⁷⁻¹⁹

Concerns regarding inadequate reduction with CRPP, which could lead to malunion or growth disturbances, have limited its widespread use. However, our findings show no differences in long-term outcomes when compared to ORIF, and no major complications were observed. Additionally, transitioning from CRPP to ORIF did not negatively impact the results.¹⁴⁻¹⁷

Postoperative care after surgery includes patients to be immobilized in a long-arm cast for 4-6 weeks, with the elbow flexed at 70 to 90°. Pins in the CRPP group were removed 1-2 weeks after the cast was taken off. Functional exercises were started once the cast or pins were removed. Follow-up assessments focused on complications and elbow function, using the Hardacre criteria (Table 4).^{3,11,12,23}

Table 4: Evaluation of treatment outcomes in humeral lateral condyle injuries with Hardacre criteria.²³

Assessment	Criteria
Excellent	Full range of motion
	Normal carrying angle and appearance
	No symptoms
	Complete healing of fracture
Good	Efficient range of motion
	Loss of extension less than 15 degrees
	Mild and subtle deformity
	No arthritic or neurological symptoms
	Complete healing of fracture
Fair	Loss of motion to the extent of disability
	Alterations in carrying angle and prominent deformity
	Presence of arthritic or neurological symptoms
	Presence of non-union or avascular necrosis

Limitations

The limitations we faced in our study were sample size which was affected by COVID crises since that the study analysis were held over June 2018 and October 2023, during which COVID crises has an effect over the sample size. Also, being a retrospective study is another limitation in analysis.

CONCLUSION

Both CRPP and ORIF can provide satisfactory outcomes for pediatric LCHFs. While there were no significant differences in complications or long-term results between the two treatments, CRPP offers several advantages,

including being less invasive, avoiding visible scarring, and eliminating the need for secondary surgery to remove pins. Our study supports the continued exploration of CRPP for treating displaced LCHFs, particularly those classified as Milch type II. Future prospective studies with larger sample sizes and longer follow-up periods are needed to further validate these findings.

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Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Silva M, Cooper SD. Closed reduction and percutaneous pinning of displaced pediatric lateral condyle fractures of the humerus: a cohort study. *J Pediatr Orthop.* 2015;35(7):661-5.
2. Pennock AT, Salgueiro L, Upasani VV, Bastrom TP, Newton PO, Yaszay B. Closed reduction and percutaneous pinning versus open reduction and internal fixation for type II lateral condyle humerus fractures in children displaced >2 mm. *J Pediatr Orthop.* 2016;36(8):780-6.
3. Shaerf DA, Vanhegan IS, Dattani R. Diagnosis, management and complications of distal humerus lateral condyle fractures in children. *Shoulder Elbow.* 2018;10(2):114-20.
4. Abzug JM, Dua K, Kozin SH, Herman MJ. Current concepts in the treatment of lateral condyle fractures in children. *J Am Acad Orthop Surg.* 2020;28(1):e9-e19.
5. Nazareth A, VandenBerg CD, Sarkisova N, Goldstein RY, Andras LM, Lightdale-Miric NR, et al. Prospective evaluation of a treatment protocol based on fracture displacement for pediatric lateral condyle humerus fractures: a preliminary study. *J Pediatr Orthop.* 2020;40(7):e541-6.
6. Ramo BA, Funk SS, Elliott ME, Jo CH. The Song classification is reliable and guides prognosis and treatment for pediatric lateral condyle fractures: an independent validation study with treatment algorithm. *J Pediatr Orthop.* 2020;40(3):e203-9.
7. Foster DE, Sullivan JA, Gross RH. Lateral humeral condylar fractures in children. *J Pediatr Orthop.* 1985;5(1):16-22.
8. Milch H. Fractures of the external humeral condyle. *JAMA.* 1956;160(8):641-6.
9. Hardacre JA, Nahigian SH, Froimson AI, Brown JE. Fractures of the lateral condyle of the humerus in children. *J Bone Joint Surg Am.* 1971;53(6):1083-95.
10. Flynn JM, Skaggs DL, Waters PM. Rockwood and Wilkins' fractures in children. Philadelphia: Lippincott Williams and Wilkins. 2014.
11. Weiss JM, Graves S, Yang S, Mendelsohn E, Kay RM, Skaggs DL. A new classification system predictive of complications in surgically treated pediatric humeral lateral condyle fractures. *J Pediatr Orthop.* 2009;29(6):602-5.

12. Xie LW, Wang J, Deng ZQ, Zhao RH, Chen W, Kang C, et al. Treatment of pediatric lateral condylar humerus fractures with closed reduction and percutaneous pinning. *BMC Musculoskelet Disord*. 2020;21(1):707.
13. Herring JA. Tachdjian's pediatric Orthopaedics: from the Texas Scottish rite hospital for children. Philadelphia: Elsevier Saunders. 2014.
14. Flynn JC, Richards JF Jr. Non-union of minimally displaced fractures of the lateral condyle of the humerus in children. *J Bone Joint Surg Am*. 1971;53(6):1096-101.
15. Flynn JC. Nonunion of slightly displaced fractures of the lateral humeral condyle in children: an update. *J Pediatr Orthop*. 1989;9(6):691-6.
16. Cates RA, Mehlman CT. Growth arrest of the capitellar physis after displaced lateral condyle fractures in children. *J Pediatr Orthop*. 2012;32(8):e57-62.
17. Pribaz JR, Bernthal NM, Wong TC, Silva M. Lateral spurring (over-growth) after pediatric lateral condyle fractures. *J Pediatr Orthop*. 2012;32(5):456-60.
18. Bernthal NM, Hoshino CM, Dichter D, Wong M, Silva M. Recovery of elbow motion following pediatric lateral condylar fractures of the humerus. *J Bone Joint Surg Am*. 2011;93(9):871-7.
19. Mintzer CM, Waters PM, Brown DJ, Kasser JR. Percutaneous pinning in the treatment of displaced lateral condyle fractures. *J Pediatr Orthop*. 1994;14(4):462-5.
20. Song KS, Kang CH, Min BW, Bae KC, Cho CH, Lee JH. Closed reduction and internal fixation of displaced unstable lateral condylar fractures of the humerus in children. *J Bone Joint Surg Am*. 2008;90(12):2673-81.
21. Justus C, Haruno LS, Riordan MK, Wilsford L, Smith T, Antekieier S, et al. Closed and open reduction of displaced pediatric lateral condyle humeral fractures, a study of short-term complications and postoperative protocols. *Iowa Orthop J*. 2017;37:163-9.
22. Stevenson RA, Perry DC. Pediatric lateral condyle fractures of the distal humerus. *Orthop Trauma*. 2018;32(5):352-9.
23. Shabir AD, Tahir AD, Sharief AW, Imtiyaz HD, Shahid H, Reyaz AD. Delayed Operative Management of Fractures of the Lateral Condyle of the Humerus in Children. *Malays Orthop J*. 2015;9(1):18-22.

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