



Functional and radiological comparison of lateral pinning versus cross pinning in displaced pediatric supracondylar humerus fractures

Baris Acar ^{a, ID, *}, Saltuk Bugra Tekin ^{a, ID}, Ahmet Sinan Kalyenci ^{a, ID}, Ahmet Senel ^{a, ID}

^aIstanbul Training and Research Hospital, Clinic of Orthopaedic and Traumatology, Istanbul, Türkiye

*Corresponding author: brs.acar90@gmail.com (Baris Acar)

■ MAIN POINTS

- Supracondylar humerus fractures are the most common pediatric elbow fractures.
- Lateral pinning and cross pinning provide comparable radiological and functional outcomes.
- Medial pinning may carry a risk of ulnar nerve injury, especially when performed without a mini incision.
- We recommend using a mini medial incision over the medial epicondyle to reduce ulnar nerve injury risk.

Cite this article as: Acar B, Tekin SB, Kalyenci AS, Senel A. Functional and radiological comparison of lateral pinning versus cross pinning in displaced pediatric supracondylar humerus fractures. *Ann Med Res.* 2025;32(11):481–485. doi: [10.5455/annalsmedres.2025.06.143](https://doi.org/10.5455/annalsmedres.2025.06.143).

■ ABSTRACT

Aim: The aim of this study is to compare the commonly used cross pinning and lateral pinning techniques in the surgical treatment of pediatric supracondylar humerus fractures by evaluating clinical and radiological outcomes.

Materials and Methods: Between 2018 and 2024, patients who had surgical treatment for Gartland type 3 supracondylar humerus fractures were included in the study. Patients were divided into two groups based on the surgical technique: lateral pinning (Group 1) and cross pinning (Group 2). Patients with a minimum follow-up of 6 months were included in the study. Demographic data including age, sex, side, mechanism of trauma were recorded. Clinical evaluation was performed using Flynn's criteria. Radiological evaluation included assessment of fracture union, Baumann's angle and its change from 0 to 6 months, carrying angle, lateral humerocapitellar angle (LHCA), and its 0 to 6-month change. Complications and additional procedures were also recorded.

Results: Group 1 consisted of 32 patients, while Group 2 included 28 patients. The demographic data showed no statistically significant differences between the two groups. Based on Flynn's criteria, outcomes in Group 1 were classified as excellent in 24 (75%) patients, good in 5 (15.6%), fair in 3 (9.4%), and none were considered poor. In Group 2, 20 (71.4%) patients achieved excellent results, 7 (25%) were rated as good, 1 as fair (3.6%), and no poor outcomes were observed. Functional outcomes were similar in both groups ($p: 0.488$). The groups showed comparable results in terms of both the Baumann's angle and its change, carrying angle, LHCA and its change. Ulnar nerve injury developed in 2 patients in Group 2 and resolved with conservative follow-up.

Conclusion: In the management of pediatric supracondylar humerus fractures, lateral and cross pinning techniques yield comparable clinical and radiological results. To prevent ulnar nerve palsy in the cross-pinning technique, a mini medial incision can be used to protect the ulnar nerve.

Keywords: Gartland, Pediatric, Pinning, Supracondylar

Received: Jun 05, 2025 **Accepted:** Aug 04, 2025 **Available Online:** Nov 25, 2025



Copyright © 2025 The author(s) - Available online at annalsmedres.org. This is an Open Access article distributed under the terms of Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License.

■ INTRODUCTION

Supracondylar humerus fractures represent the most frequent type of elbow fracture in children, comprising about 3–5% of all pediatric fractures and 50–60% of those involving the elbow [1,2]. These fractures predominantly occur in children aged about 6 years and are caused by low-energy trauma [3]. Closed reduction with percutaneous pinning remains the widely accepted method of treatment; however, the optimal pinning configuration that provides stability and best clinical outcomes is still debated [4].

Lateral pinning and medial-lateral crossed pinning are the two

commonly used techniques for supracondylar humerus fracture fixation. Lateral pinning is favored for reducing iatrogenic ulnar nerve injury, while medial-lateral crossed pinning is considered biomechanically superior in terms of rotational stability [5]. Despite the biomechanical advantages of medial-lateral crossed pinning, the risk of ulnar nerve injury remains a major concern. Studies have reported an incidence of iatrogenic ulnar nerve injury ranging from 2% to 15% with crossed pinning techniques [5]. This has led many surgeons to prefer lateral pinning, particularly in cases where adequate stability can be achieved without a medial pin. However, clinical

studies have reported comparable functional and radiological outcomes between the two techniques [6].

The choice between lateral and crossed pinning is often influenced by fracture pattern, experience of the surgeon, and patient-specific anatomical characteristics. In this study, we aim to evaluate and compare the clinical outcomes of lateral pinning and medial-lateral cross pinning in displaced pediatric supracondylar humerus fractures.

■ MATERIALS AND METHODS

This retrospective study was initiated with the approval of our hospital Ethics Committee (91 decision numbered and 18.04.2025 dated). Patients under 12 years of age who underwent surgery for displaced supracondylar humerus fractures between 2018 and 2024 were included. Open fractures, Gartland type I and II fractures, fractures with concomitant injuries, and cases requiring open reduction were excluded. Group 1 included patients who underwent lateral pinning, while Group 2 consisted of those treated with cross pinning.

Surgical procedure

Closed reduction was attempted in all patients, and if successful, percutaneous pinning was performed. In the lateral pinning group, two or three parallel or divergent K-wires were inserted through the lateral condyle, ensuring stability. In the crossed pinning group to all patients, after inserting two lateral K-wires, the elbow was extended to less than 45° to palpate the medial epicondyle and minimize the risk of ulnar nerve injury before placing the medial K-wire. Additionally, the ulnar nerve was palpated and pushed posteriorly to protect it. If the medial epicondyle could not be palpated due to edema, a stab incision was made to expose the medial epicondyle for K-wire placement. A mini medial incision was performed in 10 patients due to local edema obscuring anatomical landmarks (Figure 1).

Postoperative care and rehabilitation

All patients were immobilized with a long-arm brace postoperatively. Pin site dressings were performed every 2–3 days. At the 4th week, the brace was removed, and passive range of motion exercises were initiated. K-wires were removed once callus formation was observed, typically around the 6th week, and patients were referred to the physical therapy department for rehabilitation.

Functional and radiological evaluation

Demographic data, including age, sex, dominant hand, mechanism of injury, and follow-up duration, were recorded. At the final follow-up, range of motion and carrying angle were measured. Functional outcomes were assessed using Flynn's criteria, which include two factors: cosmetic and functional. Based on these criteria, patients were categorized as poor, fair,

good, or excellent. Radiological evaluation included measurements of Baumann's angle and the lateral humerocapitellar angle (LHCA) on postoperative radiographs. Changes in these angles were assessed on follow-up radiographs at 6 months. Additionally, carrying angles were measured during the latest clinical follow-up. The carrying angle describes the angle between the axes of the arm and forearm in the coronal plane. The Baumann angle is the angle between the longitudinal axis of the humeral shaft and the physal line of the lateral condyle on an anteroposterior (AP) radiograph of the elbow. The Lateral Capitellohumeral Angle (LCHA) is the angle between the longitudinal axis of the humeral shaft and the axis of the capitellum on a lateral elbow radiograph (Figure 2).

Statistical analysis

Statistical analysis was performed using IBM SPSS Statistics version 23.0 (Armonk, NY: IBM Corp.). We used the independent samples t-test to analyze continuous variables, including age, operative time, and radiographic angles (Baumann's angle, Lateral Humerocapitellar Angle (LHCA), and carrying angle). Normality was assessed using the Shapiro-Wilk test, and homogeneity of variances was evaluated with Levene's test. For categorical variables such as sex, dominant side, and mechanism of injury, we used the chi-square test, applying Yates' continuity correction for all 2×2 tables. Fisher's exact test was used for comparisons involving complications due to small expected frequencies. We also compared Flynn's functional scores between the groups using a Pearson's chi-square test on a 4×2 contingency table. Additionally, a post-hoc power analysis was conducted based on the difference in the LHCA between the groups. The observed mean difference was 3.7° with a pooled standard deviation of 4.78°, which corresponds to a Cohen's d effect size of 0.776. This analysis indicated an achieved power of 83.9% at a significance level of $p < 0.05$, confirming that we had sufficient power to detect meaningful differences. A p-value of less than 0.05 was considered statistically significant.

■ RESULTS

The study included 32 patients in Group 1 and 28 patients in Group 2. The mean age of the patients was 6.99 ± 0.87 years, with a mean follow-up duration of 64.25 ± 22.9 months. The most common mechanism of injury for the majority of patients in both groups was a fall from the same level. In Group 1, 28.1% of patients had a fracture on their dominant side, compared to 21.4% (6 patients) in Group 2. A comparison of demographic data revealed no significant differences between the groups (Table 1).

Functional and radiological outcomes

According to the Flynn's criteria, 24 patients in Group 1 and 20 patients in Group 2 achieved an excellent outcome, and no patient in either group was classified as having a poor outcome. There was no statistically significant difference in car-

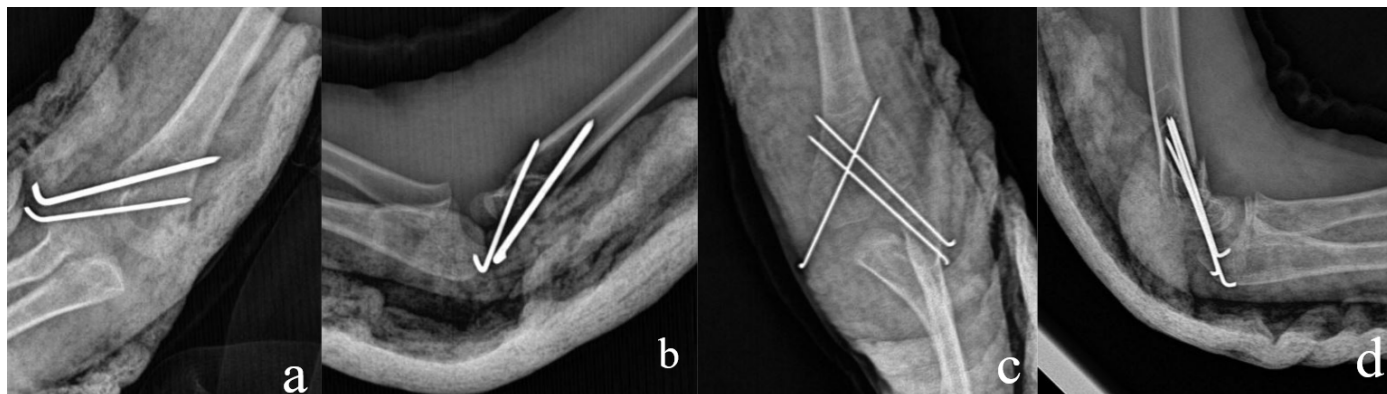


Figure 1. a) Lateral pinning at anteroposterior elbow graphy, b) Lateral pinning at lateral elbow graphy, c) Cross pinning at anteroposterior elbow graphy, d) Cross pinning at lateral graphy.

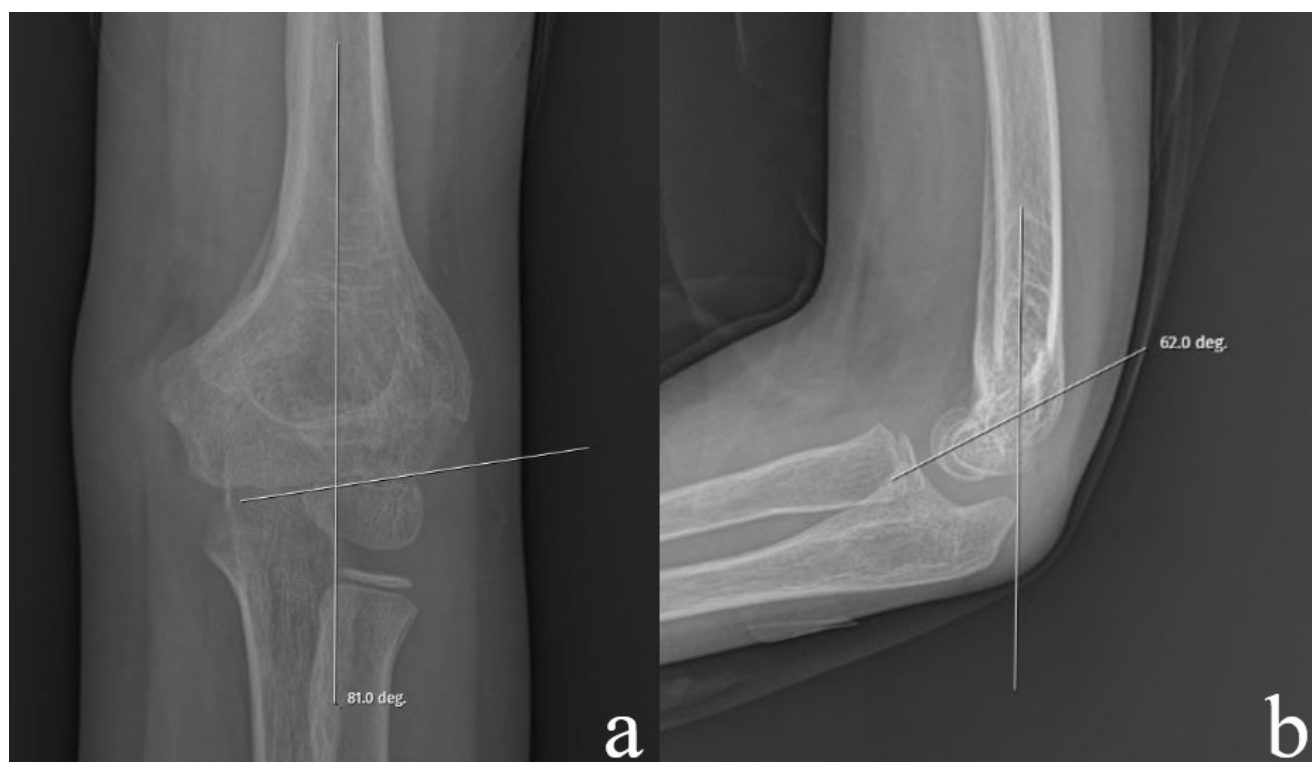


Figure 2. a) Baumann angle b) Lateral Capitellohumeral angle.

Table 1. Demographic data of the patients included in the study.

	Group 1 (n:32) (lateral pinning)	Group 2 (n:28) (cross pinning)	P value
Age	6.8 ± 0.9	7.2 ± 0.8	0.075
Follow-up (months)	35.25 ± 15.2	29 ± 17.1	0.134
Female/Male	12/20	9/19	0.871*
Dominant Side	9 (28.1%)	6 (21.4%)	0.765*
Falling from height	12 (37.5%)	9 (32.1%)	0.871*
Fall from the same level	20 (62.5%)	19 (67.9%)	0.871*

* Yates corrected chi-square.

rying angles between the two groups ($p=0.246$). Radiological comparisons showed that the mean Baumann's angle was $78 \pm 3.2^\circ$ in Group 1 and $78.6 \pm 3.1^\circ$ in Group 2. The mean Lateral Humero capitellar Angle (LHCA) was $41.1 \pm 5.7^\circ$ in

Group 1 and $44.8 \pm 3.6^\circ$ in Group 2, a difference that was not statistically significant ($p=0.179$). At the 6-month follow-up, changes in both the Baumann's angle and LHCA were similar between the groups ($p=0.607$ and $p=0.146$, respectively) (Table 2).

Complications

No patient in either group experienced a nonunion. Pin-site infections occurred in three patients in the lateral pinning group and two patients in the cross-pinning group; all were successfully treated with local pin-site care. Ulnar nerve injury developed in two patients in Group 2 (the cross-pinning group), with complete recovery observed during follow-up. Both patients with ulnar nerve palsy had undergone closed medial pinning without a mini-incision (Table 1).

Table 2. Clinical and radiological comparison.

	Group 1 (n:32) (lateral)	Group 2 (n:28) (cross)	P value
Carrying angle	9.9 ± 2.4	9.2 ± 2.2	0.246
Baumann's angle	78 ± 3.2	78.6 ± 3.1	0.465
Change in Baumann's angle	2.0 ± 0.7	2.1 ± 0.8	0.607
LHCA	41.1 ± 5.7	44.8 ± 3.6	0.179
Change in LHCA	3.2 ± 0.9	3.6 ± 1.2	0.146
Union	32 (100%)	28 (100%)	1
Flynn's score			0.488
Excellent	24 (75%)	20 (71.4%)	
Good	5 (15.6%)	7 (25%)	
Fair	3 (9.4%)	1 (3.6%)	
Poor	0 (0.0%)	0 (0.0%)	
Complications			
-Ulnar nerve injury	0 (0.0%)	2 (7.1%)	0.214*
-Compartment syndrome	0 (0.0%)	0 (0.0%)	1*
-Infection	3 (9.4%)	2 (7.1%)	1*

*Fisher's exact test.

DISCUSSION

In our cohort, the majority of patients shared similar demographic characteristics and trauma mechanisms, which were primarily low-energy falls from the same level. This finding is consistent with previous reports highlighting the frequent occurrence of supracondylar humerus fractures in young children due to low-energy falls [7-9]. Most patients in both groups sustained fractures on their non-dominant side, and there was no significant difference in laterality between the groups. This finding aligns with prior studies that show no significant dominance-related difference in the distribution of these pediatric fractures. Functional outcome evaluations, using Flynn's criteria, revealed no significant difference between the two groups. The majority of patients in both groups achieved excellent results, reflecting the overall success of both surgical techniques. This is consistent with other studies reporting comparable functional outcomes with both methods despite their biomechanical differences [10, 11]. The absence of any patients with poor outcomes further supports the effectiveness of both techniques when applied appropriately.

The decision to use two or three lateral pins was based on an intraoperative assessment of fracture stability. In most cases, two divergent lateral pins provided sufficient fixation, especially when the medial cortex remained intact after reduction. However, a third lateral pin was inserted to enhance mechanical stability in fractures exhibiting medial comminution, rotational instability, or inadequate purchase with only two pins. This approach is supported by studies indicating that two properly placed lateral pins can offer comparable biomechanical strength to cross-pinning in certain fracture types [12,13]. Nevertheless, in unstable or high-grade Gartland type III fractures, additional fixation may be necessary to prevent loss of reduction. Therefore, the pin configuration should be customized based on the specific fracture pattern and intraoperative findings.

From a radiological standpoint, we found no significant differences in the Baumann angle or the Lateral Humero-capitellar Angle (LHCA) between the groups. The Baumann angle, a key measure for assessing distal humerus alignment, was similar in both groups and fell within the expected range for optimal alignment. Similarly, the LHCA, which evaluates the relationship between the humeral shaft and the capitellum, showed no significant difference at initial presentation or at the 6-month follow-up. Our results are consistent with a meta-analysis by Zhao et al., which found no difference in the Baumann angle between the two techniques [14]. Yawar et al. similarly reported that both the Baumann angle and LHCA were within normal limits and comparable between groups [15]. A meta-analysis by Na et al. also concluded that both techniques provided comparable radiological healing [16].

Our study's complication rates were low, with no instances of nonunion in either group. Pin-site infections were relatively uncommon and were successfully managed with local care, which is consistent with findings in the literature [17]. Ulnar nerve injury, a well-known concern with the medial pinning technique, was reported in two patients in the cross-pinning group. In both cases of transient ulnar nerve palsy, serial neurological assessments were performed at one, three, and six weeks postoperatively. Both patients achieved a full recovery by three months without the need for surgical intervention. Although patient compliance can be a concern in pediatric populations, clinical symptoms were clearly documented by both the surgical team and the parents, minimizing the risk of misclassification. Some authors suggest that exploration of the ulnar nerve may be warranted in cases of closed medial pinning if symptoms persist beyond 3 to 6 weeks [18]. However, in our experience, conservative observation is often sufficient for mild neurapraxia without motor deficits or worsening signs. Revision surgery, such as pin removal or repositioning, should be considered only when symptoms do not resolve or if clinical deterioration is observed.

The most notable finding from our study is the potential for a mini-incision over the medial epicondyle to reduce the risk of ulnar nerve injury during cross-pinning. This technique allows for better visualization of anatomical landmarks and should be considered in challenging cases with significant edema. Our findings support those of Umar Hasan et al., who recommended lateral pinning, noting the higher risk of ulnar nerve injury with cross-pinning despite similar functional outcomes [19]. Similarly, a meta-analysis by Xing et al. of 19 randomized controlled trials reported an increased incidence of ulnar nerve injury with cross-pinning [20]. The fact that no ulnar nerve injuries occurred in our lateral pinning group highlights a primary advantage of this technique.

Limitations

Our study has several limitations. First, it is a retrospective study, lacking both randomization and a large sample size. Additionally, the variation in the number of pins used be-

tween groups may have influenced mechanical stability and could potentially affect outcomes. Future prospective, randomized studies with larger patient cohorts are needed to confirm our findings.

■ CONCLUSION

Both lateral and cross-pinning techniques yield similar radiological and functional outcomes. To reduce the risk of ulnar nerve injury during cross-pinning, we recommend using a stab incision over the medial epicondyle.

Ethics Committee Approval: Ethical approval for this study was obtained from the University of Health Sciences Istanbul Training and Research Hospital Clinical Research Ethics Committee (approval number: 91 date: 19.04.2025).

Informed Consent: Written informed consent was obtained from the patient's parents for their anonymized information to be published in this article.

Peer-review: Externally peer-reviewed.

Conflict of Interest: The authors declare no conflicts of interest in this study.

Author Contributions: BA: Conception, Design, Analysis and Interpretation, Writing; SBT: Data collection, Writing, Analysis and interpretation; ASK: Conception, Materials, Data collection; AŞ: Writing- Literature Review, Supervision, Critical Review.

Financial Disclosure: The authors received no financial support for this article.

■ REFERENCES

1. Vuillermin C, May C, Kasser J. Closed Reduction and Percutaneous Pinning of Pediatric Supracondylar Humeral Fractures. *JBJS Essent Surg Tech*. 2018;8(2):e10. doi: [10.2106/JBJS.ST.16.00011](https://doi.org/10.2106/JBJS.ST.16.00011).
2. Maccagnano G, Noia G, Coviello M, Stigliani C, Cassano GD. et al. Surgical strategies in pediatric supracondylar humeral fractures: our experience. *Acta Biomed*. 2023;94(S2):e2023170. doi: [10.23750/abm.v94iS2.13814](https://doi.org/10.23750/abm.v94iS2.13814).
3. Muslu O, Cengiz T, Aydın Şimşek Ş, Yurtbay A, Keskin D. Radiological and Clinical Outcomes of Pediatric Patients With a Supracondylar Humerus Fracture Surgically Treated With Closed Reduction and Percutaneous Pinning. *Cureus*. 2023;15(11):e49358. doi: [10.7759/cureus.49358](https://doi.org/10.7759/cureus.49358).
4. Mahan ST, Miller PE, Park J, Sullivan N, Vuillermin C. Fully displaced pediatric supracondylar humerus fractures: Which ones need to go at night? *J Child Orthop*. 2022;16(5):355-365. doi: [10.1177/18632521221119540](https://doi.org/10.1177/18632521221119540).
5. Graff C, Dounas GD, Sung J, Kumawat M, Huang Y, Todd M. Management of iatrogenic ulnar nerve palsies after cross pinning of pediatric supracondylar humerus fractures: A systematic review. *J Child Orthop*. 2022;16(5):366-373. doi: [10.1177/18632521221124632](https://doi.org/10.1177/18632521221124632).
6. Vescio A, Carlisi G, Macrì VR, Sanzo F, Gigliotti G. et al. The Effect of Fracture Patterns, Pinning Configuration, Surgeon Experience and Subspecialty on Short-Term Radiological Outcomes of Pediatric Supracondylar Humeral Fractures Treated in the Prone Position: A Case-Series. *Healthcare (Basel)*. 2023;11(19):2648. doi: [10.3390/healthcare11192648](https://doi.org/10.3390/healthcare11192648).
7. Kumar V, Singh A. Fracture Supracondylar Humerus: A Review. *J Clin Diagn Res*. 2016;10(12):RE01-RE06. doi: [10.7860/JCDR/2016/21647.8942](https://doi.org/10.7860/JCDR/2016/21647.8942).
8. Transtrum MB, Sanchez D, Griffith S, Godinez B, Singh V. et al. Predictors Associated with the Need for Open Reduction of Pediatric Supracondylar Humerus Fractures: A Meta-analysis of the Recent Literature. *JB JS Open Access*. 2024;9(3):e24.00011. doi: [10.2106/JBJS.OA.24.00011](https://doi.org/10.2106/JBJS.OA.24.00011).
9. Bašković M, Pešorda D, Zaninović L, Hasandić D, Lohman Vuga K, Pogorelić Z. Management of Pediatric Elbow Fractures and Dislocations. *Children (Basel)*. 2024;11(8):906. doi: [10.3390/children11080906](https://doi.org/10.3390/children11080906).
10. Naik LG, Sharma GM, Badgire KS, Qureshi F, Waghchoure C, Jain V. Cross Pinning Versus Lateral Pinning in the Management of Type III Supracondylar Humerus Fractures in Children. *J Clin Diagn Res*. 2017;11(8):RC01-RC03. doi: [10.7860/JCDR/2017/28481.10351](https://doi.org/10.7860/JCDR/2017/28481.10351).
11. Radaideh AM, Rusan M, Obeidat O, Al-Nusair J, Albustami IS, Mohaidat ZM, Sunallah AW. Functional and radiological outcomes of different pin configuration for displaced pediatric supracondylar humeral fracture: A retrospective cohort study. *World J Orthop*. 2022;13(3):250-258. doi: [10.5312/wjo.v13.i3.250](https://doi.org/10.5312/wjo.v13.i3.250).
12. Zions LE, McKellop HA, Hathaway R. Torsional strength of pin configurations used to fix supracondylar fractures of the humerus in children. *J Bone Joint Surg Am*. 1994;76(2):253-6. doi: [10.2106/00004623-199402000-00013](https://doi.org/10.2106/00004623-199402000-00013).
13. Lee SS, Mahar AT, Miesen D, Newton PO. Displaced pediatric supracondylar humerus fractures: biomechanical analysis of percutaneous pinning techniques. *J Pediatr Orthop*. 2002;22(4):440-3. PMID: [12131437](https://pubmed.ncbi.nlm.nih.gov/12131437/).
14. Zhao H, Xu S, Liu G, Zhao J, Wu S, Peng L. Comparison of lateral entry and crossed entry pinning for pediatric supracondylar humeral fractures: a meta-analysis of randomized controlled trials. *J Orthop Surg Res*. 2021;16(1):366. doi: [10.1186/s13018-021-02505-3](https://doi.org/10.1186/s13018-021-02505-3).
15. Yawar B, Khan MN, Asim A, Qureshi A, Yawar A. et al. Comparison of Lateral and Crossed K-wires for Paediatric Supracondylar Fractures: A Retrospective Cohort Study. *Cureus*. 2022;14(7):e27267. doi: [10.7759/cureus.27267](https://doi.org/10.7759/cureus.27267).
16. Na Y, Bai R, Zhao Z, Han C, Kong L. et al. Comparison of lateral entry with crossed entry pinning for pediatric supracondylar humeral fractures: a meta-analysis. *J Orthop Surg Res*. 2018;13(1):68. doi: [10.1186/s13018-018-0768-3](https://doi.org/10.1186/s13018-018-0768-3).
17. Combs K, Frick S, Kiezbak G. Multicenter Study of Pin Site Infections and Skin Complications Following Pinning of Pediatric Supracondylar Humerus Fractures. *Cureus*. 2016;8(12):e911. doi: [10.7759/cureus.911](https://doi.org/10.7759/cureus.911).
18. Brauer CA, Lee BM, Bae DS, Waters PM, Kocher MS. A systematic review of medial and lateral entry pinning versus lateral entry pinning for supracondylar fractures of the humerus. *J Pediatr Orthop*. 2007(2):181-6. doi: [10.1097/bpo.0b013e3180316cf1](https://doi.org/10.1097/bpo.0b013e3180316cf1).
19. Hasan SU, Pervez A, Usmani SUR, Tahseen MU, Asghar S. et al. Comparative analysis of pinning techniques for supracondylar humerus fractures in paediatrics: A systematic review and meta-analysis of randomized controlled trials. *J Orthop*. 2023;44:5-11. doi: [10.1016/j.jor.2023.08.005](https://doi.org/10.1016/j.jor.2023.08.005).
20. Xing B, Dong B, Che X. Medial-lateral versus lateral-only pinning fixation in children with displaced supracondylar humeral fractures: a meta-analysis of randomized controlled trials. *J Orthop Surg Res*. 2023;18(1):43. doi: [10.1186/s13018-023-03528-8](https://doi.org/10.1186/s13018-023-03528-8).