

Percutaneous Lateral versus Crossed Pinning for Gartland Type III Supracondylar Humerus Fractures in Children: A Comparative Study

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Abstract

Background: Gartland type III supracondylar fractures of the humerus are common displaced elbow injuries in children requiring stable fixation to achieve satisfactory functional and cosmetic outcomes. Although crossed medial-lateral pinning provides biomechanical stability, it carries a risk of iatrogenic ulnar nerve injury. Lateral-entry pinning avoids medial pin placement but may offer comparatively less stability. This study compared the clinical, radiological, and functional outcomes of the two fixation techniques.

Methods: This comparative observational study included 52 children aged 2–12 years with Gartland type III supracondylar fractures of the humerus treated with closed reduction and percutaneous Kirschner wire fixation at the Department of Orthopaedics, Medical College Kota. Twenty children underwent lateral-entry pinning, while 32 underwent crossed medial-lateral pinning. Patients were followed for a mean duration of 17.53 months. Outcomes assessed included fracture union, loss of elbow range of motion, change in carrying angle, complications, and functional results according to the Mitchell and Adams criteria.

Results: The mean age of the study population was 5.67 years, and 73.1% were boys. All fractures united radiologically, and no patient developed cubitus varus deformity. The mean loss of elbow range of motion was 9.2° in the lateral-pinning group and 7.2° in the crossed-pinning group ($p = 0.204$). The mean loss of carrying angle was 3.3° and 2.5°, respectively ($p = 0.345$). Excellent functional outcomes were observed in 70.0% of children treated with lateral pinning and 81.3% of those treated with crossed pinning, while the remaining children in both groups had good outcomes; no poor outcomes were recorded. The difference in functional outcome was not statistically significant ($p = 0.366$). Pin-tract infection occurred in five patients (9.6%). Iatrogenic ulnar nerve palsy occurred in one patient (5.0%) in the lateral-pinning group and three patients (9.4%) in the crossed-pinning group. All iatrogenic nerve palsies recovered completely.

Conclusion: Both lateral-entry and crossed medial-lateral pinning provided satisfactory functional and radiological outcomes in children with Gartland type III supracondylar humerus fractures. Although crossed pinning showed numerically better preservation of elbow motion and carrying angle, the differences were not statistically significant. Lateral-entry pinning remains an effective alternative, particularly when medial pin placement poses a potential risk to the ulnar nerve.

Keywords: Supracondylar Humerus Fracture; Paediatric Fracture; Gartland Type III; Lateral Pinning; Crossed Pinning; Kirschner Wire Fixation.

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Introduction

Supracondylar fractures of the humerus account for a substantial proportion of childhood fractures and commonly occur following a fall on an outstretched hand. [1] Displaced extension-type injuries may lead to malunion, cubitus varus, elbow stiffness, neurovascular compromise, compartment syndrome, and Volkmann ischaemic contracture if reduction is inadequate or unstable.[2,3] Closed reduction with percutaneous pin fixation has

become the preferred treatment for displaced Gartland type III fractures because it permits stable fixation while avoiding the morbidity of open reduction. [1] The two commonly used configurations are crossed medial-lateral pinning and lateral-only pinning. Crossed pinning is biomechanically stable, particularly against rotational and varus-valgus forces, but medial pin placement can endanger the ulnar nerve. Lateral

pinning avoids a medial pin but has been considered less stable in some settings. [4,5,6] This study compared clinical, radiological, and functional outcomes following lateral-only and crossed medial-lateral percutaneous pinning in children with Gartland type III supracondylar fractures of the humerus.

Materials and Methods

Study design and participants: A comparative observational study was conducted in the Department of Orthopaedics, Medical College Kota for the period of 6 months from July 2025 to Dec 2025. Fifty-two children aged 2–12 years with Gartland type III supracondylar fractures of the humerus were included. Both sexes and either side of injury were eligible. Children with Gartland type I or II fractures and those requiring open reduction were excluded.

Patients were evaluated clinically at presentation, including documentation of swelling, skin condition, distal perfusion, radial pulse, and motor-sensory function of the median, radial, and ulnar nerves. Standard anteroposterior and lateral radiographs of the elbow were obtained, and fracture displacement was recorded.

Surgical Technique: All procedures were performed urgently under general anaesthesia with fluoroscopic guidance. With the child in the supine position, closed reduction was achieved by stepwise manipulation. Reduction was assessed clinically by restoration of carrying angle and radiologically using anteroposterior, lateral, and Jones views. Twenty children underwent fixation with two lateral-entry K-wires, inserted either in a parallel or divergent/crossed lateral configuration. Thirty-two children underwent crossed fixation with one lateral and one medial K-wire. In the crossed-pinning technique, the lateral pin was inserted first; the medial pin was then introduced with the elbow in relatively less flexion to reduce the risk of ulnar nerve injury. Choice of fixation method was based on the operating surgeon's preference. Following satisfactory fluoroscopic confirmation, wires were bent and cut with

approximately 1 cm remaining outside the skin. A well-padded posterior above-elbow slab was applied with the elbow flexed to 90 degrees or less according to tolerance. Postoperative neurovascular status was reassessed in all patients.

Follow-up and Outcome Assessment: K-wires were removed at 3–4 weeks as an outpatient procedure. The slab was maintained for four weeks, after which active elbow motion was encouraged. Passive stretching and forceful manipulation were avoided. Follow-up assessments were scheduled at 6 weeks, 3 months, 6 months, and subsequently at six-month intervals.

At follow-up, pain, elbow appearance, carrying angle, flexion-extension range of motion, neurological status, and radiographic union or malalignment were recorded. Functional outcome was graded using Mitchell and Adams criteria:

- **Excellent:** change in carrying angle less than 5 degrees and loss of elbow motion less than 10 degrees.
- **Good:** change in carrying angle of 5–15 degrees and loss of motion of 10–20 degrees.
- **Poor:** change in carrying angle greater than 15 degrees and loss of motion greater than 20 degrees.

Ethical approval was gained from the institutional Ethical committee.

Statistical Analysis: Data were analysed using the independent-samples t-test for continuous variables and chi-square or Fisher's exact test for categorical variables. A p-value below 0.05 was considered statistically significant.

Results

Baseline Characteristics: The study included 52 children: 20 treated with lateral pinning and 32 treated with crossed pinning. The mean age was 5.67 years. Boys comprised 73.1% of the cohort, and the left side was involved in 63.46% of cases. Posteromedial displacement was identified in 67.8% of fractures, while posterolateral displacement was present in 32.7%.

Table 1: Baseline characteristics of the study cohort

Characteristic	Overall cohort, n=52
Mean age	5.67 years
Male sex	38 (73.1%)
Left-sided injury	33 (63.46%)
Posteromedial displacement	35 (67.3%)
Posterolateral displacement	17 (32.7%)
Lateral pinning	20 (38.46%)
Crossed pinning	32 (61.53%)
Mean follow-up	17.53 months

Preoperative nerve injury occurred in five children (9.61% cases), three median nerve injuries and two

radial nerve injuries. There was no ulnar nerve involvement in the present study.

Children presenting with preoperative neurological deficits underwent detailed documentation of motor and sensory function as part of the initial neurovascular examination. All patients were managed as per the protocol described. Neurovascular status was reassessed immediately after fixation and at each follow-up visit. No patient required nerve exploration or additional operative intervention for a preoperative nerve deficit. All preoperative radial and median nerve palsies recovered completely with observation within 3–4 months.

Complications: Pin-tract infection occurred in five patients: two in the lateral-pinning group and three in the crossed-pinning group. These infections were

managed with early wire removal, when necessary, antibiotics, wound care, and continued immobilisation; all resolved without persistent sequelae. Three children in the crossed-pinning group developed iatrogenic ulnar nerve palsy, whereas one in the lateral-pinning group developed ulnar nerve injury. Of the four ulnar nerve palsies, two were limited to paraesthesia in the ulnar distribution and resolved within one week. The others involved motor and sensory deficits and recovered completely by four months. Thus, all iatrogenic nerve injuries were transient, with no persistent neurological deficit at final follow-up. The difference between groups was not statistically significant ($p = 0.566$).

Table 2: Complications in lateral pinning group and crossed pinning group in the present study

Complication	Lateral pinning, n=20	Crossed pinning, n=32	Total, n=52
Pin-tract infection	2 (10.0%)	3 (9.4%)	5 (9.6%)
Iatrogenic ulnar nerve palsy	1 (5.0%)	3 (9.4%)	4 (7.7%)
No recorded complication	17 (85.0%)	26 (81.3%)	43 (82.7%)

Functional and Radiological Outcomes: All fractures united radiologically. No child developed cubitus varus deformity. The mean loss of elbow motion was slightly greater after lateral pinning (9.2 degrees) than crossed pinning (7.2 degrees), but the difference was not statistically significant

($p=0.204$). Similarly, loss of carrying angle was marginally greater in the lateral-pinning group (3.3 degrees) compared to the crossed-pinning group (2.5 degrees), which was not statistically significant ($p=0.345$).

Table 3: Post-operative outcomes in lateral pinning group and crossed pinning group in the present study

Outcome	Lateral pinning, n=20	Crossed pinning, n=32	p-value
Mean loss of range of motion	9.2 degrees	7.2 degrees	0.204
Mean loss of carrying angle	3.3 degrees	2.5 degrees	0.345
Excellent functional outcome	14 (70.0%)	26 (81.3%)	
Good functional outcome	6 (30.0%)	6 (18.8%)	
Poor functional outcome	0	0	
Difference in outcome distribution			0.366

Discussion

This comparative study evaluated 52 children with Gartland type III supracondylar fractures of the humerus treated by closed reduction and percutaneous K-wire fixation. Thirty-two children underwent crossed medial-lateral pinning and 20 underwent lateral-entry pinning. The principal finding was that both constructs produced satisfactory functional and cosmetic results, with no statistically significant difference in loss of elbow motion, loss of carrying angle, or final functional outcome. However, transient iatrogenic ulnar nerve palsy occurred in both groups, though it was more frequent in the crossed-pinning group. The demographic profile of the present series is consistent with the established epidemiology of paediatric supracondylar fractures. The mean age was 5.67 years, with peak incidence between 5 and 8 years, similar to the mean age of 6.7 years reported by Wilkins [7]. Boys constituted 73.1% of the cohort, comparable with the male

predominance reported by Wilkins [7] (62.8%) and Solak and Aydin [8] (72.8%). The left side was affected in 63.46% of cases, approximately 1.7 times more often than the right side, which is comparable to the twofold predominance of left-sided injuries reported by Aronson and Prager [5].

A fall on the outstretched hand was the most frequent mechanism of injury in the present study, occurring in 96% of cases. Posteromedial displacement was observed in 67.8% of fractures, while posterolateral displacement was present in 32.7%. This pattern is similar to prior series, in which posteromedial displacement was reported in 75% of cases by Wilkins [7] and Aronson and Prager, and in 82% by Mostafavi and Spero [9]. Neurological injury is an important concern in displaced supracondylar humerus fractures, both as a consequence of the initial trauma and as a potential complication of fixation. Preoperative nerve injury was documented in five children (9.6%), involving three median nerve injuries and

two radial nerve injuries; no child had a preoperative ulnar nerve deficit. This incidence is comparable to the 7.7% reported by Wilkins [7]. All preoperative neurological deficits recovered completely within 4 months, supporting the accepted observation that most nerve injuries associated with closed extension-type supracondylar fractures are neuropraxias and recover with observation after stable reduction. Complete recovery of all preoperative deficits within 3–4 months supports observation after adequate reduction and stabilisation in the absence of clinical features suggesting nerve entrapment.

The mean follow-up period in the present study was 17.53 months, ranging from 5 to 36 months. This was similar to the 17.2-month mean follow-up reported by Aronson and Prager and was adequate to assess fracture union, elbow alignment, recovery of motion, and resolution of neurological deficits. All fractures united, with a mean time to radiological union of 7.6 weeks, comparable to the 7.2 weeks reported by Mostafavi and Spero [9].

Pin-tract infection occurred in five children (9.6%): two children in the lateral-pinning group and three in the crossed-pinning group. This incidence is slightly higher than the 5% infection rate reported by Mostafavi and Spero [9]. In the present series, infection with pin loosening required early K-wire removal at two weeks in affected cases, followed by antibiotics, regular wound dressing, and continued immobilisation. All infections resolved without persistent infection or loss of fracture union. Nevertheless, these children showed relatively greater loss of elbow motion and carrying angle, highlighting the importance of pin-site care and early recognition of infection.

Iatrogenic ulnar nerve palsy was observed in three of 32 children treated with crossed pinning (9.4%), and in one of 20 children treated with lateral-entry pinning (5.0%). Although the difference was not statistically significant because of the small sample size ($p = 0.566$), the finding is clinically meaningful. Both nerve palsies recovered completely: two resolved within one week, whereas the other recovered by four months. The observed rate is comparable to the 8% reported by Skaggs et al. [10] and 5% reported by Solak and Aydin [8] following medial pin placement.

The medial K-wire is the likely mechanism of iatrogenic ulnar nerve injury during crossed fixation. The association between medial pin insertion and ulnar nerve injury is well recognised. In this study, the lateral wire was inserted first, and the medial wire was placed with the elbow in less flexion to reduce the risk of ulnar nerve injury. These measures help maintain palpability of the medial epicondyle and reduce the risk of anterior displacement of the ulnar nerve. Despite these

precautions, the occurrence of four total transient palsies indicates that meticulous technique is required regardless of the chosen configuration. Lateral-only fixation may still be advantageous in a grossly swollen elbow, where reliable palpation of the medial epicondyle is difficult.

The mean loss of elbow range of motion was 7.2 degrees in the crossed-pinning group and 9.2 degrees in the lateral-pinning group. Although the crossed configuration had a numerically smaller motion loss, the difference was not statistically significant ($p = 0.204$). The motion loss in the crossed-pinning group is comparable to the 7.8 degrees reported by Nacht et al. [4], while the result in the lateral-pinning group is comparable to the 10-degree loss reported by Aronson and Prager [5]. Importantly, no substantial improvement in elbow motion was observed after six months in the current series, suggesting that most recovery of movement occurred within the early postoperative period.

Loss of carrying angle was also slightly lower after crossed pinning than lateral pinning, at 2.5 degrees and 3.3 degrees, respectively. This difference was not statistically significant ($p = 0.345$). The mean loss of carrying angle after lateral pinning was similar to the 2.2 degrees reported by Aronson and Prager [5]. No child developed cubitus varus deformity, and all families were satisfied with the cosmetic appearance of the elbow. This contrasts with the overall 13% rate of cubitus varus reported by Davis et al. [11].

The small numerical advantage in carrying-angle preservation with crossed pinning may reflect the greater mechanical stability of crossed K-wire constructs. Zionts et al. [12] demonstrated that crossed pinning provides greater resistance to rotational, varus, and valgus forces than lateral-only fixation in biomechanical testing. However, biomechanical superiority does not necessarily produce better clinical results when reduction is adequate and lateral wires are placed with appropriate separation and bicortical purchase. In support of this, Skaggs et al. [10] reported no clinically important difference in stability between crossed and lateral-entry constructs.

Functional outcome, assessed by the Mitchell and Adams criteria, was excellent in 81.3% and good in 18.8% of children treated with crossed pinning. The corresponding results after lateral pinning were 70.0% excellent and 30.0% good. No poor outcome was recorded in either group, and the difference between groups was not statistically significant ($p = 0.366$). The proportion of excellent outcomes after crossed pinning was comparable to the 88% reported by Mostafavi and Spero [9]. The lateral-pinning group showed a lower proportion of excellent outcomes than the 88% excellent and

12% good outcomes reported by Aronson and Prager [5]; however, all children in the present lateral-pinning cohort still had either excellent or good results.

The findings therefore suggest that the quality of reduction and secure pin placement are more important than the specific pin configuration in determining final elbow alignment and function. Crossed pinning remains a valid option when enhanced stability is required, provided that the medial pin is inserted with strict attention to ulnar nerve protection. Lateral-entry pinning is an effective alternative that is particularly useful in markedly swollen elbows. This study has limitations. The sample size was modest, and the groups were unequal, with more children managed by crossed pinning. Allocation to pin configuration was based on surgeon preference rather than randomisation, creating a possibility of selection bias.

In addition, the retrospective-prospective design and absence of standardised assessment of fracture severity beyond Gartland type III may have influenced comparison between groups. These limitations mean that the observed lack of statistical difference should be interpreted cautiously. Larger prospective randomised studies using uniform pin number, pin diameter, and lateral-pin configuration would better define whether clinically meaningful differences exist between the two techniques.

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