

COMPARATIVE STUDY OF FUNCTIONAL OUTCOMES OF DISPLACED SUPRACONDYLAR HUMERUS FRACTURES IN CHILDREN TREATED WITH CROSS VERSUS LATERAL PERCUTANEOUS PINNING

A. Siva Kumar¹, S. Cyril Jonnes², H.M. Mubarak Ali³, N. Vijay⁴

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Corresponding Author:

Dr. A. Siva Kumar,
Email: firenewborn@gmail.com

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¹Associate Professor, Unit III, Trichy SRM Medical College Hospital & Research Centre, Irungalur, India.

Assistant Professor, Unit III, Trichy SRM Medical College Hospital & Research Centre, Irungalur, India.

Assistant Professor, Unit III, Trichy SRM Medical College Hospital & Research Centre, Irungalur, India.

Professor and Chief, Unit III, Trichy SRM Medical College Hospital & Research Centre, Irungalur, India.

ABSTRACT

Background: Supracondylar humerus fractures represent the most frequent type of elbow injury in the paediatric population. Cross pinning is biomechanically stable but carries the risk of ulnar nerve injury, while lateral pinning avoids this risk but has been questioned for stability. **Aim:** To compare the functional outcomes of displaced supracondylar humerus fractures in children treated with cross pinning versus lateral pinning. **Materials and Methods:** A prospective study of 30 children (<15 years) with Gartland type II/III fractures treated with either cross pinning (n=12) or lateral pinning (n=18). Outcomes were assessed using Flynn's criteria, the Mayo Elbow Performance Score (MEPS), the Modified UCLA score, and radiological union parameters. **Results:** All fractures united within a mean of 3.3 weeks. Cross-pinning patients achieved satisfactory results, but two developed transient ulnar nerve injuries. Lateral pinning yielded satisfactory results in 14 of 18 cases, with no nerve injuries. No cases of vascular injury, compartment syndrome, or loss of reduction were seen. **Conclusion:** Both methods, cross pinning and lateral pinning, have been shown to provide satisfactory outcomes. While cross-pinning is the most stable, it carries the risk of ulnar nerve injury. Lateral pinning, however, is a safer alternative, equally stable when performed correctly, and importantly, it avoids nerve complications. This comparison should instill confidence in the management of pediatric fractures.

INTRODUCTION

Supracondylar humerus fractures represent the most common type of elbow injury in the pediatric population, with the highest incidence observed in children aged 5 to 7 years.^[1,2] These fractures are typically caused by falls onto an outstretched hand and are more common in boys and in the non-dominant upper limb. Over time, management of displaced supracondylar fractures has transitioned from conservative methods, such as splinting and traction, to operative stabilization using Kirschner wire (K-wire) fixation, which is now considered the standard of care.

Non-surgical (conservative) management is linked to complications such as reduction loss, compartment syndrome, and malunion.^[4] In pediatric cases, the preferred fixation methods typically involve either a

combination of medial and lateral pins in a crossed configuration or two to three lateral pins. Among these, cross pinning has demonstrated superior stability, better clinical outcomes, and lower morbidity compared to the lateral pin technique^{5,6}. Two principal K-wire fixation methods are employed: cross pinning and lateral pinning. While cross-pinning provides superior biomechanical stability, it is associated with a greater risk of iatrogenic injury to the ulnar nerve. In contrast, lateral pinning reduces the likelihood of nerve damage but has been questioned regarding its ability to maintain stable fracture alignment. Despite extensive research, the debate over the optimal fixation technique continues.^[3]

This study aims to assess and compare clinico-functional outcomes in pediatric patients with

displaced supracondylar humerus fractures treated with either cross-pinning or lateral pinning.

MATERIALS AND METHODS

Study Design: Prospective, hospital-based study conducted at Trichy SRM Medical College Hospital & Research Centre from August 2019 to June 2021.

Sample Size: 30 children under 15 years of age with displaced supracondylar humerus fractures.

Inclusion Criteria: Gartland type II and III displaced fractures.

Exclusion Criteria: Type I fractures, children above 15 years, and pathological fractures.

Procedure: All surgeries were performed with the patients in supine position and under suitable anaesthesia (GA/regional). Patients were randomly allocated to the two pinning methods in randomisation: crossed pinning (n=12) and lateral pinning (n=18). Surgical technique: Crossed pinning, Smooth 2.0 mm K-wire used for children (6-12 years). 1.6 mm K-wires can be used for younger children (2-6 years).

Cross-Pinning: Two pins were inserted through the lateral epicondyle and one pin through the medial epicondyle, such that they cross proximal to the fracture line. Two lateral pins were inserted sequentially in a diverging manner and engaging the opposite cortex. While inserting the medial pin, the ulnar nerve was palpated and retracted posteriorly. Avoid entering through the posterior aspect of the medial epicondyle to reduce the risk of ulnar nerve injury.

Lateral pinning: Three pins are inserted through the lateral condyle sequentially. The first pin was inserted adjacent to the olecranon process and engaged the posterior cortex; then, mechanical stability was assessed. The second pin was inserted through the center of the lateral column, diverging away from the first pin and fixed to the opposite cortex, and the third pin was inserted lateral to the second pin in the lateral condyle and engaged in the opposite cortex, taking a longer span.

Pin separation at fracture site = ≥ 2 mm for better rotational stability.

Postoperative follow-up was conducted at immediate post op day1 follows 2, 4, 8, and 12 weeks. At the 4th week, X-rays were done and radiological union assessed before slab and pin removal. Active elbow exercises started. Final follow-up was done at the 12th week.

Outcome Measures: Flynn's criteria, Mayo Elbow Performance Score (MEPS), Modified UCLA score, and radiographic analysis, including Baumann's angle and anterior humeral line.

Statistical Analysis: Data were analyzed using SPSS v26. Continuous variables were compared using independent t-tests; categorical variables were compared using the chi-square or Fisher's exact test. Kaplan–Meier survival analysis estimated functional

improvement timelines. Significance was set at $p < 0.05$.

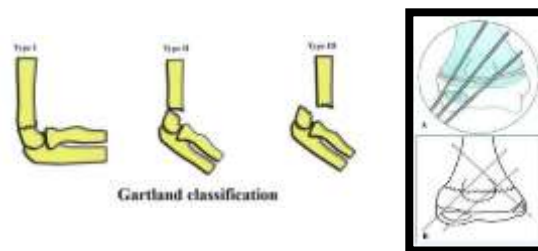


Figure 1: Gartland classification

Figure 2: A. Lateral Pinning technique, B, Cross Pinning



Figure 3: Case Lateral Pinning Group

(A) Lateral Pinning Pre-op

(B) Immediate Pop Slab

(C) Post op X-rays



Figure 4: Cross Pinning Group

(A) Pre Op

(B) Post Op Xray

RESULTS

Table 1: Age distribution of the study population

Age Group (years)	Number of Patients	Percentage
<5	10	33.4%
6–10	14	46.6%
10–15	6	20.0%
Total	30	100%

Table 2: Gender distribution

Gender	Number of Patients	Percentage
Male	18	60%
Female	12	40%
Total	30	100%

Table 3: Mechanism of injury

Mechanism	Number of Patients	Percentage
Fall from height	14	46.7%
Fall while playing	11	36.7%
Fall from a bicycle	5	16.6%
Total	30	100%

Table 4: Comparison of Outcomes Between Cross Pinning and Lateral Pinning Groups (n = 30)

Parameter	Cross Pinning (n = 12)	Lateral Pinning (n = 18)
Method of Reduction	Closed reduction-10 cases	Closed reduction-6 cases
Timing of Surgery	80% operated within 24 hours; 20% after 24 hrs (≤ 1 week)	ated within 24 hours; 20% after 24 hrs (≤ 1 week)
Mean Injury–Surgery Interval	1.85 days	1.88 days
Fracture Union	All united within 3–4 weeks (mean 3.3 weeks)	All united within 3–4 weeks (mean 3.4 weeks)
Range of Motion (Flexion)	6 – Full range of flexion 6- Limitation of terminal flexion	4 – Full range of flexion 10 – Flexion loss 5° – 10° 4 – Flexion loss $>10^{\circ}$
Loss of Carrying Angle	6 – No loss 6 – $<5^{\circ}$ loss	4 – No loss 10 – $<5^{\circ}$ loss 2 – 5° – 10° loss 2 – $>10^{\circ}$ loss
s of Reduction (Radiographic)	None	None
Nerve Injury	2 –Ulnar nerve injury (resolved within 3 weeks)	None
Pin Site Infection	1 case (resolved after pin removal & oral antibiotics)	1 case (resolved after pin removal & oral antibiotics)
Other Complications	one (no vascular injury, compartment syndrome, myositis ossificans, or nonunion)	one (no vascular injury, compartment syndrome, myositis ossificans, or nonunion)
Functional Outcome (Flynn's Criteria)	6 – Excellent 6 – Good	4 – Excellent 10 – Good 4 – Fair

Table 5: Comparison of mean functional scores

Score System	2 months (Mean $\pm$ SD)	6 months (Mean $\pm$ SD)
Modified UCLA Score	28.5 $\pm$ 2.1	32.2 $\pm$ 1.8
Mayo Elbow Score	80.4 $\pm$ 3.6	92.7 $\pm$ 2.4

A total of 30 displaced supracondylar humerus fractures in children were operated on. Out of 30, cross pinning was done in 12 (40%) cases, and lateral pinning in 18 (60%) cases.

Age: Out of 30 children, 18 children were males (60%) and 12 children were females(40%). 10(33.4%) children were under 5 years, 14(46.6%) children were between 6 to 10 years and 6(20.1%) children were 10 to 15 years. The mean age was 7.5 years. Sixteen were left-sided (53.3%) and 14 were right-sided (46.7%) fractures.

Mechanism of Injury: All patients had a history of fall. Of which 14 (46.7%) children had fallen from a height. 11(36.7%) children fell while playing. 5(16.7%) children fell from a bicycle. All patients had extension-type injuries and were type 3 according to the Gartland classification. Out of 30 cases, 16(53.3%) cases were operated on by closed reduction, and 14 (46.7%) cases were operated on by open reduction. Of the 12 cross-pinned cases, 10 underwent closed reduction. Of 18 lateral pinned cases, six were operated on with closed reduction.

Timing of Surgery: Out of 30 cases, 24 (80%) were operated on within 1 day, and 6 (20%) were operated on after 24 hours and within 1 week due to delayed presentation. The mean duration between injury and surgery was 1.85 days in cross pinning, 1.88 days in lateral pinning cases.

Fracture Union: All fractures united within 3 to 4 weeks. The mean duration of fracture union was 3.3 weeks.

Range of Motion (Flexion): Out of 30 cases, 20 patients had limitation of terminal flexion compared with the normal contralateral side. Out of 12 cross-pinned cases, 6 cases had a full range of flexion, and 6 cases developed limitation of terminal flexion. Out of 18 lateral pinned cases, 4 had a full range of flexion, 10 cases had flexion loss between 5 and 10 degrees, and 4 cases had flexion loss of more than 10 degrees.

Loss of Carrying Angle: Out of 12 crossed pin cases, 6 cases showed no loss of carrying angle, and 6 cases showed less than 5 degrees of loss of carrying angle, whereas in lateral pinning, 4 cases showed no loss of carrying angle, and 10 cases showed less than 5 degree loss of carrying angle, 2 cases had 5 to 10 degree loss of carrying angle, and 2 cases had a loss of carrying angle greater than 10 degrees. The loss of carrying angle was due to inadequate initial reduction achieved at the time of surgery.

Loss of Reduction (Radiographic): There was no loss of reduction in both the initial postoperative radiograph and the radiograph taken at the time of Kirschner wire removal. No patient in either the cross-pinning or lateral pinning group had any loss of reduction.

Nerve Injury: Out of 12 cross-pinned cases, 10 cases were treated by closed reduction. Two patients developed postoperative ulnar nerve injury following cross pinning, which resolved completely in 3 weeks after K wire removal. The medial pin was maintained for 2 weeks. Pin removal was performed after 2 weeks, and an above elbow cast was applied for 2 weeks. Nerve injury recovered completely.

One patient in both groups developed a pin-site infection, which resolved with pin removal and oral antibiotics.

No case in either group developed any vascular injury, compartment syndrome, myositis ossificans, or nonunion.

All 12 cross-pinned patients had satisfactory results; 6 had excellent results, and 6 had good results. All 18 laterally pinned cases had satisfactory results. Four had excellent results, 10 had good results, and 4 had fair results.

DISCUSSION

The management of displaced fractures of the supracondylar humerus in children is either closed or open reduction, with maintenance of the reduction using Kirschner wires. The success of surgical

treatment depends upon initial accurate reduction and maintenance of reduction till union.

There is an ongoing debate over the optimal fixation modality for displaced fractures of the supracondylar humerus in children. The most commonly used treatment methods are crossed medial and lateral pinning and lateral pinning alone.

The advantage of cross pinning is its superior fracture stability, but iatrogenic ulnar injury can occur during placement of the medial pin. The advantage of lateral pinning is that iatrogenic ulnar nerve injury is avoided, but it is less biomechanically stable. Biomechanical studies by Hilton et al. [18] using adult cadavers and paediatric bone models have found that cross pinning provides greater rotational stability than lateral pinning. However, by proper pin site of entry, pin configuration, and the number of pins applied via the lateral side, the stability can be equal to that of cross pinning.

In our study of 30 patients, cross pinning was performed in 12 and lateral pinning in 18. All patients had satisfactory results according to Flynn's criteria. Of 12 cross-pinned patients, six had excellent results and six had good results. Of 18 lateral-pinned patients, 4 had excellent results, 10 had good results, and 4 had fair results. Although a divergent or parallel lateral configuration is advised, two patients in our study had a convergent lateral pin configuration and had a good outcome.

Of 12 cross-pinned patients, 6 had less than a 5-degree loss of carrying angle, which was not due to loss of reduction but to inadequate reduction initially. Of 18 cross-pinned patients, 10 had a loss of carrying angle of less than 5 degrees, 2 had a loss of 5-10 degrees, and 2 had a loss of 10-15 degrees. This was also due to an initial inadequate reduction, not to the loss of reduction. These results were comparable to those of the study by Foead et al. [14] who compared the two methods of percutaneous pin fixation for displaced supracondylar humerus fractures in children.

Of 12 crossed pin patients, 6 patients had loss of 5 to 10 degrees of flexion. Of 18 lateral pinned patients, 10 patients had loss of 5 to 10 degrees of flexion, and 4 patients had loss of flexion between 10 and 15 degrees. 4 lateral pinned patients who had flexion loss between 10 and 15 degrees were due to inadequate reduction. A greater number of lateral pinned patients had a loss of flexion of 5-10 degrees compared to the cross-pinning group, due to open reduction. 10 out of 12 cross-pinned cases were done by closed reduction, whereas 6 out of 18 lateral-pinned cases were done by closed reduction. This may have led to greater flexion loss in the lateral pinning group, not due to the pinning configuration. There was no loss of reduction in both the cross pinning and the lateral pinning groups.

This was comparable to Skaggs et al. [15] who reported no loss of reduction in a series of 55 type III fractures treated by lateral pinning. Topping et al. and Foead et al. [14] also reported no loss of reduction in lateral pinning in their series. In our study, we had two cases

of partial ulnar nerve injury in a total of 12 cases of crossed pinning of supracondylar fractures of the humerus in children. Skaggs et al,^[15] reported an 8% rate of ulnar injury in the cross-pinning group. We used the flexion-extension method to avoid injury to the ulnar nerve. In our case, the ulnar nerve injury entirely recovered after 3.3 weeks. We also had no nerve injury in the lateral pinned case, comparable to the Skaggs et al,^[15] study.

CONCLUSION

Both Cross-Pinning and lateral-pinning are effective techniques for managing displaced supracondylar humerus fractures in children. Cross pinning is biomechanically the most stable but carries a risk of iatrogenic ulnar nerve injury. Lateral pinning provides equivalent stability when performed properly and eliminates the risk of nerve injury. We recommend lateral pinning as the preferred technique in most cases, with cross pinning reserved for unstable reductions that require additional stability.

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