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Functional outcome of paediatric supracondylar humerus fractures treated with lateral crossed pinning and conventional crossed pinning with k-wires

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ABSTRACT

Background: Supracondylar fractures of the humerus constitute the most common paediatric elbow injuries and often require surgical fixation when displaced. Conventional medial-lateral crossed pinning offers good stability but carries a risk of iatrogenic ulnar nerve injury. Lateral crossed pinning (Dorgan's technique) has been proposed as a safer alternative. Objectives were to compare the functional outcomes of paediatric supracondylar humerus fractures treated with lateral crossed pinning (Dorgan's technique) and conventional medial-lateral crossed pinning.
Methods: This observational study was conducted at a tertiary care teaching hospital over 1.5 years (June 2024-December 2025). A total of 52 children (<15 years) with displaced closed supracondylar humerus fractures (Gartland type II and III) underwent closed reduction and percutaneous K-wire fixation using either lateral crossed pinning (n=28) or conventional crossed pinning (n=24). Functional outcomes were assessed at 3 and 6 months using Flynn's criteria, elbow range of motion (EROM), and carrying angle (CSA). Statistical analysis was performed using SPSS version 26.
Results: Most patients were aged 6-10 years (51.9%), with a male predominance (69.2%). At 6 months, excellent outcomes were observed in 50.0% and good outcomes in 25.0% of patients. Mean EROM loss at 6 months was 6.52±2.1° in the lateral crossed pinning group and 6.71±2.2° in the conventional crossed pinning group (p=0.41). Mean CSA loss was 5.87±1.9° and 6.05±2.0°, respectively (p=0.064). No significant difference in functional outcomes was noted. Ulnar nerve injury occurred only in the conventional crossed pinning group.
Conclusions: Lateral crossed pinning provides comparable functional outcomes with a lower risk of ulnar nerve injury, making it a safe and effective alternative.

Keywords: Paediatric supracondylar fracture, Dorgan's technique, K-wire fixation, Flynn's criteria

INTRODUCTION

About 60-70% of paediatric elbow injuries are caused by supracondylar fractures of the humerus, which are the most prevalent type of elbow fracture in children.[1,2] They usually happen to kids aged 5 to 10 and usually happen after they fall on an outstretched hand. The therapy of these fractures is difficult and crucial because of the close proximity of important neurovascular structures surrounding the elbow. These fractures are linked to serious consequences like neurovascular damage, compartment syndrome, malunion, elbow stiffness, and cubitus varus deformity.[3] When treating paediatric supracondylar humerus fractures, the main objective is to minimise complications and enable early mobilisation while achieving stable anatomical reduction.[4] While non-displaced fractures can be managed conservatively, displaced fractures (Gartland type II and III) usually require closed reduction and percutaneous pin fixation, which remains the gold standard of treatment.[4-6]

Because of its improved rotational stability, crossing medial and lateral K-wire fixation has long been regarded as the biomechanically better of the many pinning

procedures. With documented rates ranging from 2 to 8%, the medial pin insertion poses a well-known risk of iatrogenic ulnar nerve injury, which has led to the search for safer but no less stable alternatives.[7,8] To address this concern, lateral crossed pinning using Dorgan's technique was introduced, wherein two lateral pins are inserted in a divergent manner to achieve a crossed configuration within the distal humerus without the need for medial pin placement. This technique aims to provide comparable stability to conventional crossed pinning while significantly reducing the risk of ulnar nerve injury.[8,9]

Despite multiple studies comparing lateral-only pinning and conventional crossed pinning, there remains ongoing debate regarding the optimal fixation technique that ensures the best functional outcome with the least complications.[10] Evaluating outcomes such as range of motion, CSA, stability, and functional recovery is essential for guiding clinical practice, particularly in the paediatric population where long-term elbow function is crucial.[11,12] Therefore, this study aims to evaluate and compare the functional outcomes of paediatric supracondylar humerus fractures treated with lateral crossed pinning (Dorgan's technique) and conventional medial-lateral crossed pinning using K-wires.

METHODS

This observational study was conducted in the department of orthopaedics at a tertiary care teaching hospital after obtaining approval from the institutional ethics committee. The study period was one and a half years, extending from June 1st 2024, to December 31st 2025. Written informed consent was obtained from the parents or legal guardians of all participating children before inclusion in the study. The study population comprised paediatric patients aged less than 15 years who presented with displaced, closed supracondylar fractures of the humerus (Gartland type II and III) during the study period. Patients with Gartland type I fractures, open fractures, fractures requiring open reduction, associated neurovascular compromise, previous ipsilateral elbow fractures, or floating elbow injuries were excluded from the study. The sample size was calculated using a standard formula based on a previous study by Sahu with an expected proportion of excellent outcomes of 88.23% and a relative precision of 10%, yielding a minimum required sample size of 52 patients.[4]

On admission, all patients underwent a thorough clinical evaluation, including assessment of swelling, deformity, skin condition, and detailed neurovascular examination of the affected limb. Standard anteroposterior and lateral radiographs of the elbow were obtained to confirm the diagnosis and classify the fracture according to the Gartland classification. Initial immobilisation with an above-elbow splint was applied after reduction when required. All patients underwent closed reduction and percutaneous fixation with K-wires under general anaesthesia, using image intensifier guidance. Based on the pin configuration used, patients were managed either with lateral crossed pinning (Dorgan's technique) or conventional medial and lateral crossed pinning, as decided by the operating surgeon. Following fixation, an above-elbow posterior slab was applied with the elbow in flexion. Immediate postoperative radiographs were taken to confirm the adequacy of fracture reduction and pin placement.

Postoperatively, patients were monitored for neurovascular status, pin tract infection, and other complications. Patients were discharged once clinically stable and followed up at 6 weeks, 3 months, and 6 months from the date of surgery. K-wires were removed at 6 weeks after radiological confirmation of fracture healing, and gradual elbow mobilization was initiated. During follow-up visits, functional outcome was assessed by measuring EROM, CSA, and evaluating for any neurological deficits. The final outcome was graded using Flynn's criteria, categorizing results into excellent, good, fair, or poor. Radiological assessment was also performed to evaluate fracture union and maintenance of reduction.

All collected data were entered into Microsoft Excel and analysed using SPSS version 26. Continuous variables were expressed as mean and standard deviation, while categorical variables were represented as frequencies and percentages. Comparative analysis between the two pinning techniques was performed, and a p value of less than 0.05 was considered statistically significant.

RESULTS

A total of 52 paediatric patients with displaced supracondylar fractures of the humerus were included in the study. Functional outcomes were assessed at 3 months and 6 months following surgical fixation using either lateral crossed pinning (Dorgan's technique) or conventional medial-lateral crossed pinning. The majority of patients belonged to the 6-10 years age group (51.9%), followed by ≤5 years (26.9%) and 11-15 years (21.2%). There was a clear male predominance (69.2%). Left-sided injuries were more common (61.5%) than right-sided injuries (38.5%). Based on radiological classification, Gartland type III fractures (53.8%) were slightly more frequent than type II fractures (46.2%) (Table 1). Of the 52 patients included in the study, 28 (53.8%) were treated with lateral crossed pinning (Dorgan's technique) and 24 (46.2%) underwent conventional medial-lateral crossed pinning (Figure 1).

At the 3-month follow-up, excellent functional outcome was observed in 46.2% of patients, while 26.9% had good, 17.3% fair, and 9.6% poor outcomes. At 6 months, there was a modest improvement, with excellent outcomes increasing to 50.0%, and fair outcomes reducing to 15.4%, while the proportion of poor outcomes remained unchanged at 9.6% (Table 2). Mean loss of EROM was comparable between the two pinning techniques at both follow-ups. At 3 months, mean EROM loss was 6.75±2.3° in the lateral crossed pinning group and 6.92±2.4° in the

conventional crossed pinning group (p=0.37). At 6 months, the corresponding values were 6.52±2.1° and 6.71±2.2°, respectively (p=0.41), indicating no statistically significant difference between the two techniques (Table 3).

Mean CSA loss also showed no statistically significant difference between the two groups. At 3 months, the mean CSA loss was 5.98±2.0° in the lateral crossed pinning group and 6.12±2.1° in the conventional crossed pinning group (p=0.053). At six months, CSA loss reduced to the 5.87±1.9° and the 6.05±2.0°, respectively (p=0.064) (Table 4).

Table 1: Sociodemographic and clinical profile of the study participants, (n=52).

Variables	Category	N	Percentage (%)
Age group (in years)	≤5	14	26.9
	6-10	27	51.9
	11-15	11	21.2
Gender	Male	36	69.2
	Female	16	30.8
Side of injury	Left	32	61.5
	Right	20	38.5
Gartland type	Type II	24	46.2
	Type III	28	53.8

Table 2: Functional outcome according to Flynn's criteria at 3 and 6 months.

Flynn's criteria	3 months	6 months
Excellent	24 (46.2)	26 (50.0)
Good	14 (26.9)	13 (25.0)
Fair	9 (17.3)	8 (15.4)
Poor	5 (9.6)	5 (9.6)

Table 3: Comparison of EROM loss between pinning techniques.

Follow-up	Lateral crossed pinning	Conventional crossed pinning	P value
3 months	6.75±2.3°	6.92±2.4°	0.37
6 months	6.52±2.1°	6.71±2.2°	0.41

Table 4: Comparison of carrying angle loss between pinning techniques.

Parameters	Lateral crossed pinning	Conventional crossed pinning	P value
CSA loss at 3 months	5.98±2.0°	6.12±2.1°	0.053
CSA loss at 6 months	5.87±1.9°	6.05±2.0°	0.064

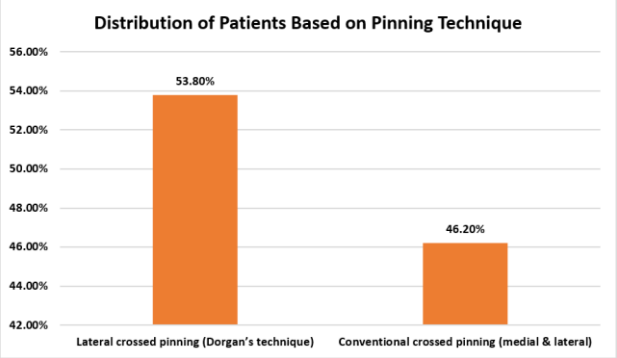

Figure 1: Distribution of patients based on pinning technique.

DISCUSSION

Supracondylar fractures of the humerus remain one of the most common paediatric elbow injuries, and achieving stable fixation while minimizing complications is critical for optimal functional recovery. The present study evaluated and compared the functional outcomes of lateral crossed pinning (Dorgan's technique) and conventional medial-lateral crossed pinning in displaced paediatric supracondylar humerus fractures. In the current study, the majority of patients were between 6 and 10 years of age, with a clear male predominance, which is consistent with the epidemiological trends reported in earlier studies.[1-4] Extension-type Gartland III fractures constituted a slightly higher proportion of cases, similar to findings reported by Sahu and Jairam reflecting the unstable nature of these injuries that often necessitate surgical fixation.[4,6]

Functional outcome assessment using Flynn's criteria demonstrated that most patients achieved excellent to good results at both 3 and 6 months of follow-up. There was a modest improvement in outcomes at 6 months compared to 3 months, indicating progressive recovery of elbow function over time. These findings are comparable with those reported by Mehmet et al, Saha et al and Nayar et al all of whom observed no statistically significant difference in functional outcomes between lateral and crossed pinning techniques.[1-3] The analysis of EROM revealed no statistically significant difference between the two pinning methods at either follow-up interval. Similar observations were reported by Jairam, Sadek, and Sapkota et al who concluded that both fixation techniques provide comparable stability and allow satisfactory restoration of elbow motion when proper reduction and pin placement principles are followed.[6,7,13]

Likewise, CSA loss showed no significant difference between the two techniques at 3 and 6 months. Progressive improvement in CSA over time was observed in both groups, a finding that aligns with previous studies demonstrating acceptable cosmetic outcomes with both fixation methods.[1,7,14] These results suggest that lateral crossed pinning does not compromise coronal plane stability when performed correctly. The findings of this

study reinforce the concept that lateral crossed pinning (Dorgan's technique) offers biomechanical stability comparable to traditional crossed pinning while reducing the risk of ulnar nerve injury. This advantage becomes particularly relevant in settings where swelling and distorted anatomy increase the difficulty of safe medial pin placement.

CONCLUSION

The present study concludes that both lateral crossed pinning (Dorgan's technique) and conventional medial–lateral crossed pinning provide comparable functional outcomes in displaced paediatric supracondylar humerus fractures. At 6 months follow-up, excellent outcomes were observed in 50.0% of patients and good outcomes in 25.0% based on Flynn's criteria. Mean EROM loss at 6 months was 6.52±2.1° in the lateral crossed pinning group and 6.71±2.2° in the conventional crossed pinning group, while mean CSA loss was 5.87±1.9° and 6.05±2.0°, respectively, with no statistically significant difference between the two techniques. Importantly, no cases of iatrogenic ulnar nerve injury were observed in the lateral crossed pinning group, whereas such injuries occurred only in the conventional crossed pinning group, highlighting the safety advantage of lateral crossed pinning without compromising functional recovery.

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

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