

## Original Research Article

# CROSS PINNING VERSUS LATERAL PINNING IN THE MANAGEMENT OF TYPE III SUPRACONDYLAR FRACTURE OF HUMERUS IN PEDIATRIC AGE

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## ABSTRACT

**Background:** Supracondylar fractures of the humerus are the most common elbow fractures in children, with Gartland Type III fractures requiring operative stabilization because of their inherent instability and risk of neurovascular complications. Closed reduction with percutaneous Kirschner wire fixation is the standard treatment; however, the optimal pin configuration remains controversial. While crossed pinning provides greater mechanical stability, lateral pinning is preferred by many surgeons because it minimizes the risk of iatrogenic ulnar nerve injury. The aim is to compare the functional and radiological outcomes of crossed pinning and lateral pinning in the management of Gartland Type III supracondylar fractures of the humerus in the pediatric age group.

**Materials and Methods:** This prospective comparative study included 30 children with closed Gartland Type III supracondylar fractures treated between January 2020 and January 2021. Fourteen patients underwent lateral pinning (Group A) and sixteen underwent crossed pinning (Group B). Patients were followed clinically and radiologically until fracture union and subsequently assessed using Flynn's criteria. Postoperative Baumann's angle, carrying angle, range of motion, fracture union, and complications were evaluated.

**Results:** The mean age was  $7.2 \pm 2.2$  years in Group A and  $6.28 \pm 2.0$  years in Group B. The mean postoperative Baumann's angle was  $69.4^\circ$  in Group A and  $71.2^\circ$  in Group B, while the mean carrying angle was  $11.5^\circ$  and  $9.2^\circ$ , respectively. Fracture union was achieved in all patients at a mean of five weeks. Mean elbow flexion was  $130.5^\circ$  in the lateral pinning group and  $142^\circ$  in the crossed pinning group, with extension loss of  $5^\circ$  and  $2^\circ$ , respectively. According to Flynn's criteria, excellent outcomes were observed in 78.6% of Group A and 81.25% of Group B. Two cases of transient ulnar nerve palsy occurred in the crossed pinning group, whereas one case of pin loosening was observed in the lateral pinning group. Superficial pin tract infection occurred in one patient in each group.

**Conclusion:** Both crossed pinning and lateral pinning are effective treatment methods for Gartland Type III supracondylar fractures in children, providing excellent fracture union and satisfactory functional outcomes. Crossed pinning demonstrated slightly better radiological alignment and elbow range of motion but was associated with a higher incidence of transient ulnar nerve injury. Lateral pinning achieved comparable clinical outcomes while avoiding ulnar nerve complications. Appropriate pin configuration should be selected based on fracture stability and surgeon experience.

**Keywords:** Supracondylar fracture humerus, Pediatric elbow fracture, Gartland Type III, Cross pinning, Lateral pinning, Kirschner wire fixation, Flynn criteria.

## INTRODUCTION

Supracondylar fractures of the humerus are the most common elbow fractures in children and represent approximately 50–70% of all pediatric elbow injuries. These fractures occur predominantly in children between five and seven years of age, with a slight male predominance. The usual mechanism of injury is a fall onto an outstretched hand, resulting in an extension-type fracture in nearly 95% of cases, while flexion-type injuries are relatively uncommon. Owing to their close relationship with the brachial artery and major nerves around the elbow, displaced supracondylar fractures constitute orthopedic emergencies requiring prompt diagnosis and appropriate treatment to prevent neurovascular complications and permanent functional impairment.<sup>[1,2]</sup>

The widely accepted Gartland classification categorizes extension-type supracondylar fractures into Type I, Type II, and Type III according to the degree of displacement. Gartland Type III fractures are characterized by complete displacement with disruption of both cortical columns and periosteal hinge, making them inherently unstable. These injuries usually require operative management because closed reduction followed by cast immobilization alone carries a high risk of redisplacement, malunion, cubitusvarus deformity, elbow stiffness, and functional limitation.<sup>[3,4]</sup>

Closed reduction and percutaneous Kirschner wire fixation have become the standard treatment for displaced supracondylar fractures in children because it provides stable fixation while minimizing soft-tissue dissection and preserving fracture biology. Early surgical stabilization permits maintenance of reduction, decreases the incidence of deformity, and facilitates satisfactory functional recovery. Despite the widespread acceptance of this technique, the optimal configuration of Kirschner wires remains a matter of debate among pediatric orthopedic surgeons.<sup>[5,6]</sup>

Cross pinning, consisting of one medial and one lateral Kirschner wire, has traditionally been considered the most stable construct because it offers superior resistance to rotational and angular displacement. However, insertion of the medial pin carries a recognized risk of iatrogenic ulnar nerve injury, particularly when performed without adequate protection of the nerve. To avoid this complication, many surgeons advocate lateral-only pin fixation, which eliminates the need for medial pin placement while reducing the likelihood of nerve injury. Nevertheless, concerns remain regarding whether lateral pinning alone provides sufficient mechanical stability in completely displaced fractures.<sup>[7,9]</sup>

Biomechanical investigations have demonstrated conflicting findings regarding the relative stability of cross pinning and lateral pinning. Although crossed pin constructs generally exhibit greater torsional stability in laboratory studies, clinical investigations

have reported comparable rates of fracture union, maintenance of reduction, elbow function, and patient satisfaction when appropriately placed divergent lateral pins are used. Consequently, the decision regarding pin configuration continues to depend on fracture characteristics, surgeon experience, and intraoperative assessment of stability.<sup>[10-12]</sup>

The outcome of supracondylar fracture treatment should be evaluated not only by radiological union but also by restoration of elbow function, carrying angle, cosmetic appearance, and avoidance of complications. Flynn's criteria remain one of the most widely accepted methods for assessing both cosmetic and functional outcomes after treatment of pediatric supracondylar fractures. Other important outcome measures include range of motion, Baumann's angle, carrying angle, time to union, and complications such as pin tract infection, loss of reduction, cubitusvarus, nerve palsy, and vascular compromise.<sup>[13-15]</sup>

Although numerous studies have compared cross pinning with lateral pinning, differences continue to exist regarding their relative stability, complication profile, and functional outcomes, particularly in completely displaced Gartland Type III fractures. Further prospective evaluation is required to determine whether the additional stability achieved with cross pinning justifies the potential risk of ulnar nerve injury or whether lateral pinning can provide equivalent clinical outcomes with fewer complications. Therefore, the present study was undertaken to compare cross pinning and lateral pinning in the management of Gartland Type III supracondylar fractures of the humerus in the pediatric age group, with emphasis on fracture stability, functional outcome, radiological results, and procedure-related complications.

## MATERIALS AND METHODS

A prospective study comprising of 30 cases of displaced fracture supracondylar humerus, treated by lateral and cross pinning, was conducted between Jan 2024 and Jan 2026.

### Inclusion Criteria

Children with closed extension Type III of supracondylar fracture of humerus

### Exclusion Criteria:

1. Type I and Type II injuries,
2. flexion type injuries,
3. compound fractures and
4. patients above the age of 13 years

### Method:

A prospective study with 30 cases of displaced fracture supracondylar humerus, treated by lateral (group A n=14) and cross pinning (group B n=16), assessed functional and radiological outcome in post op and in follow up.

- Preoperative work-up was done (clinical and radiological examination), haematological investigation done

- Fracture classified under Gartland classification.
  - Informed consent taken for surgery
- Regular three weekly follow-ups were done till radiological union followed by long-term follow-up at one and two years respectively. The final results were analysed using the Flynn criteria

#### Operative Technique

After general anesthesia, patient kept in supine position on ot table with affected limb off the table. After proper painting and draping, fracture is reduced by traction and counter traction with hyperflexion of elbow and pronation of forearm.

Reduction confirmed under c-arm, applied 1.5 or 2 mm k wires as lateral pinning or cross pinning, precaution taken to not injury any neurovascular structure

After proper k wire purchase, wire bent and cut, applied pin tract dressing and kept elbow splint in 90 flexion.

#### Post Operative Follow Up

After surgery, patient shifted to post op ward. Regular dressing, initial three days IV antibiotics, analgesic given.

K wires are removed at 3 weeks, Range of movement exercise are started.

Radiological and function outcome measured at 3 weeks, 6 weeks, 3months and 6 month.

## RESULTS

A total of 30 pediatric patients with Gartland Type III supracondylar fractures of the humerus were included in this prospective study. Fourteen patients underwent closed reduction and lateral pinning (Group A), while sixteen patients were treated with crossed medial-lateral pinning (Group B).

The mean age of patients in Group A was  $7.2 \pm 2.2$  years, whereas the mean age in Group B was  $6.28 \pm 2.0$  years. Overall, 18 patients (60%) were male and 12 (40%) were female [Table 1], demonstrating a male predominance. The left elbow was involved in 16 patients (53.3%) and the right elbow in 14 patients (46.7%) [Table 2].

The most common mechanism of injury was a fall while playing, accounting for 24 patients (80%), followed by road traffic accidents in 4 patients (13.3%) and falls from height in 2 patients (6.7%) [Table 3]. According to Gartland classification, 24 patients (80%) had Type IIIA fractures and 6 patients (20%) had Type IIIB fractures [Table 4]. Group A included 12 (85.7%) Type IIIA and 2 (14.3%) Type IIIB fractures, whereas Group B included 12 (75%) Type IIIA and 4 (25%) Type IIIB fractures.

**Radiological Outcome:** Postoperative radiological assessment demonstrated satisfactory restoration of fracture alignment in both groups. The mean Baumann's angle was  $69.4^\circ$  in the lateral pinning group (Group A) and  $71.2^\circ$  in the crossed pinning

group (Group B), indicating comparable maintenance of coronal alignment following fixation.

The mean carrying angle at final follow-up was  $11.5^\circ$  in Group A and  $9.2^\circ$  in Group B. Both values were within the acceptable physiological range, with slightly better restoration of carrying angle observed in the crossed pinning group.

Radiological union was achieved in all patients. The mean time to fracture union was 5 weeks in both groups, with no case of delayed union or non-union.

**Functional Outcome:** Functional assessment at the final follow-up demonstrated satisfactory elbow motion in both treatment groups. In the lateral pinning group, the mean elbow flexion was  $130.5^\circ$ , with a mean extension loss of  $5^\circ$ . In the crossed pinning group, the mean flexion was  $142^\circ$ , with a mean extension loss of  $2^\circ$ . Although patients treated with crossed pinning achieved a greater range of elbow motion, both groups demonstrated good functional recovery with near-complete restoration of elbow movement. [Table 7]

**Complications:** Postoperative complications were minimal. Superficial pin tract infection occurred in two patients (6.7%), one patient in each group, and resolved completely with local pin-site care and oral antibiotics. Two patients (12.5%) in the crossed pinning group developed transient postoperative ulnar nerve neuropraxia, both of whom recovered completely during follow-up without requiring further intervention. One patient (7.1%) in the lateral pinning group developed pin loosening, which did not affect fracture union or the final functional outcome. No patient developed compartment syndrome, vascular injury, deep infection, non-union, or cubitusvarus deformity during the follow-up period. [Table 5].

**Flynn's Functional Assessment:** According to Flynn's criteria, excellent results were achieved in 11 patients (78.6%) in Group A and 13 patients (81.25%) in Group B. Good results were observed in 2 patients (14.3%) in Group A and 3 patients (18.75%) in Group B. One patient (7.1%) in the lateral pinning group had an unsatisfactory result, whereas no unsatisfactory outcome was observed in the crossed pinning group.

Overall, satisfactory outcomes (excellent and good) were obtained in 29 of the 30 patients (96.7%) [Table 8]. Although crossed pinning showed slightly better radiological alignment, greater elbow range of motion, and a higher proportion of excellent Flynn scores, both crossed pinning and lateral pinning provided reliable fracture stabilization, timely union, and excellent functional recovery. The main disadvantage of crossed pinning was the occurrence of transient ulnar nerve neuropraxia, whereas lateral pinning was associated with one case of pin loosening.

**Table 1: Gender distribution.**

| Gender | Number |
|--------|--------|
| Male   | 18     |
| Female | 12     |

**Table 2: Side distribution**

| Side  | Number |
|-------|--------|
| Right | 14     |
| Left  | 16     |

**Table 3: Mode of injury**

| Mode of injury  | Number |
|-----------------|--------|
| Playing         | 24     |
| Rta             | 04     |
| Fall rom height | 02     |

**Table 4: Fracture type**

| Fracture type | Number |
|---------------|--------|
| 3A            | 24     |
| 3B            | 06     |

**Table 5: Complication**

| Comlication        | Group a | Group b |
|--------------------|---------|---------|
| Infection          | 1       | 2       |
| Ulnar nerve injury | 0       | 1       |
| Pin loosening      | 1       | 1       |

**Table 6: Duration of union**

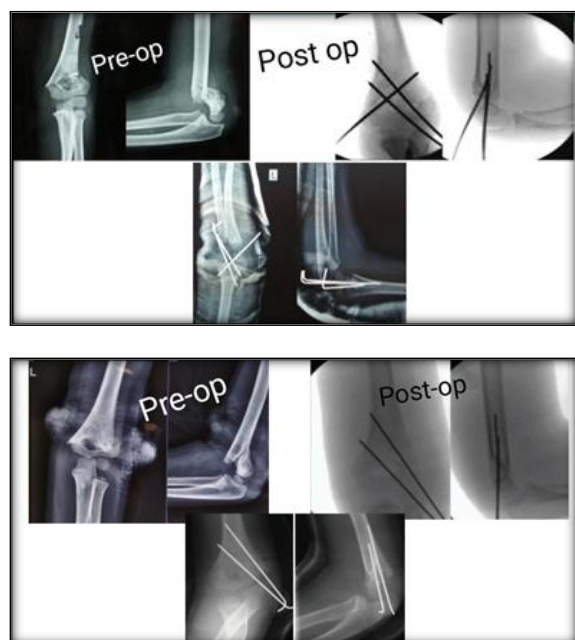
| Union   | Numbers |
|---------|---------|
| 5 weeks | 13      |
| 4weeks  | 17      |

**Table 7: Functional outcome- Last Follow-up**

| Range of movements | Group a           | Group b          |
|--------------------|-------------------|------------------|
| Flexion            | 130. <sup>0</sup> | 142 <sup>0</sup> |
| Extension          | 5 <sup>0</sup>    | 3 <sup>0</sup>   |

**Table 8: Result analyzed- Flynn Criteria**

| Flynn criteria | Group a | Group b |
|----------------|---------|---------|
| Excellent      | 11      | 13      |
| GOOD           | 02      | 03      |
| Unsatisfied    | 01      | 00      |



## DISCUSSION

Supracondylar fractures of the humerus are the most common elbow fractures in children and continue to

be one of the most challenging injuries because of their association with neurovascular complications, malunion, and elbow stiffness. Closed reduction and percutaneous Kirschner wire fixation remains the gold standard for displaced Gartland Type III fractures. However, the optimal pin configuration remains controversial, with crossed pinning providing superior mechanical stability and lateral pinning minimizing the risk of iatrogenic ulnar nerve injury. The present prospective study compared these two fixation methods with respect to radiological restoration, functional outcome, fracture union, and complications.

The mean age of children in the present study was 6.7 years, which is comparable to previous reports by Skaggs et al., Kocher et al., and Brauer et al., who reported the peak incidence between 5 and 8 years of age.<sup>[16-18]</sup> Similar to these studies, male children (60%) were affected more frequently than females, and injuries occurred predominantly during play (80%), reflecting the high level of outdoor physical activity in this age group.

Radiological restoration following fracture fixation is an important predictor of long-term elbow function. In the present study, the mean postoperative Baumann's angle was 69.4° in the lateral pinning

group and 71.2° in the crossed pinning group. Both values fall within the accepted physiological range and indicate satisfactory restoration of coronal alignment. Kocher et al. reported no significant difference in postoperative Baumann's angle between crossed and lateral pinning, while Skaggs et al. also demonstrated satisfactory maintenance of reduction using divergent lateral pins when proper pin placement was achieved.<sup>[17,19]</sup> Our findings therefore support the observation that anatomical reduction rather than pin configuration alone determines postoperative alignment.

The mean carrying angle in our study was 11.5° in Group A and 9.2° in Group B. These values are comparable with normal pediatric carrying angles reported in the literature and indicate satisfactory cosmetic restoration. Flynn et al. emphasized that preservation of carrying angle is one of the most important determinants of cosmetic outcome after supracondylar fracture fixation.<sup>[20]</sup> The slightly lower carrying angle observed in the crossed pinning group may reflect better maintenance of fracture reduction; however, the difference was not clinically significant. Fracture union was achieved in all patients at a mean duration of five weeks irrespective of pin configuration. Similar union times have been reported by Pirone et al. and Saha, who observed radiological union between four and six weeks following percutaneous pin fixation.<sup>[21,22]</sup> This confirms that both crossed and lateral pinning provide adequate stability to permit timely fracture healing in children.

Recovery of elbow motion is another important indicator of successful treatment. In the present study, patients treated with crossed pinning achieved a mean flexion of 142° with only 2° extension loss, whereas the lateral pinning group demonstrated a mean flexion of 130.5° and 5° extension loss. Although crossed pinning produced a slightly greater range of motion, both groups achieved satisfactory functional recovery. Similar observations were reported by Kocher et al., who found no significant difference in long-term elbow motion between the two fixation methods.<sup>[17]</sup> Zhao et al., in their meta-analysis, also concluded that functional outcomes were comparable between crossed and lateral pinning despite biomechanical differences.<sup>[23]</sup>

According to Flynn's criteria, satisfactory results (excellent and good) were obtained in 96.7% of patients. Excellent outcomes were observed in 78.6% of patients treated with lateral pinning and 81.25% treated with crossed pinning. These findings closely resemble those reported by Flynn et al., Skaggs et al., and Kocher et al., who documented satisfactory outcomes in more than 90% of pediatric supracondylar fractures managed with percutaneous pin fixation.<sup>[17,19,20]</sup> Therefore, both techniques can provide excellent cosmetic and functional results when anatomical reduction and stable fixation are achieved.

The complication profile observed in our study was comparable with published literature. Two patients

(12.5%) in the crossed pinning group developed transient ulnar nerve neuropraxia, while no ulnar nerve injury occurred following lateral pinning. Both patients recovered completely without surgical intervention. This finding agrees with the systematic review by Brauer et al. and the meta-analysis by Zhao et al., which demonstrated a significantly higher incidence of iatrogenic ulnar nerve injury following crossed pinning.<sup>[18,23]</sup> Slobogean et al. similarly concluded that medial pin insertion remains the principal risk factor for postoperative ulnar nerve palsy and recommended careful insertion techniques or mini-open exposure when medial pinning is required.<sup>[24]</sup>

Superficial pin tract infection occurred in one patient from each group and resolved with local care and oral antibiotics. Pin loosening occurred in one patient treated with lateral pinning without affecting fracture union or functional outcome. Comparable low rates of pin tract infection have been reported in previous studies and are generally attributed to good pin-site care and early pin removal after fracture union.<sup>[19,21]</sup> Although crossed pinning demonstrated marginally better radiological alignment, greater elbow motion, and a slightly higher proportion of excellent Flynn scores, these advantages must be balanced against the increased risk of iatrogenic ulnar nerve injury. Conversely, lateral pinning provided comparable functional and cosmetic outcomes while eliminating the risk associated with medial pin insertion. These findings support previous randomized trials and systematic reviews suggesting that both techniques are effective for Gartland Type III supracondylar fractures when accurate reduction and appropriate pin placement are achieved. The choice of fixation should therefore be individualized according to fracture configuration, intraoperative stability, and surgeon experience.

## CONCLUSION

The present prospective study demonstrates that both crossed pinning and lateral pinning are safe and effective methods for the management of Gartland Type III supracondylar fractures of the humerus in the pediatric age group. Both techniques achieved satisfactory fracture union at a mean duration of five weeks, with excellent radiological alignment and favorable functional outcomes according to Flynn's criteria.

Although crossed pinning showed marginally better restoration of Baumann's angle, carrying angle, and elbow range of motion, the overall functional and cosmetic outcomes were comparable between the two groups. However, crossed pinning was associated with a higher incidence of transient iatrogenic ulnar nerve palsy, whereas lateral pinning avoided this complication and was associated with only one case of pin loosening that did not influence the final outcome.

Based on the findings of the present study, crossed pinning may be preferred when maximum mechanical stability is required, provided meticulous care is taken during medial pin insertion to protect the ulnar nerve. Conversely, lateral pinning offers comparable clinical and radiological results with a lower risk of nerve injury and remains an excellent option in appropriately reduced and stable fractures. Therefore, the choice of pin configuration should be individualized according to fracture pattern, intraoperative stability, and surgeon experience, as both techniques provide reliable fracture fixation and excellent clinical outcomes when performed with proper surgical technique.

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