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**ORIGINAL RESEARCH**

# A Prospective Study of Percutaneous K Wire Fixation in Supracondylar Fracture Humerus in Children

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## ABSTRACT

**Aim:** To evaluate the clinical and radiological outcomes of percutaneous K-wire fixation in the management of displaced supracondylar humerus fractures in children. **Material and Methods:** This prospective observational study was conducted from 9 March2020 to 31 July2020 in the Department of Orthopaedics at a tertiary care teaching hospital. A total of 50 pediatric patients aged 4–12 years with displaced Gartland Type II and III supracondylar humerus fractures were enrolled after obtaining informed consent. All patients underwent closed reduction and percutaneous K-wire fixation under general anesthesia, followed by postoperative slab immobilization. Patients were assessed clinically and radiologically during follow-ups at 2, 4, 6, and 12 weeks. Functional outcomes were evaluated using Flynn's criteria, and data were statistically analyzed using SPSS software. **Results:** Among the 50 patients, the majority were aged 7–9 years (44.00%) and male (64.00%). Gartland Type III fractures comprised 64.00% of cases and had a significantly higher complication rate (18.75%) compared to Type II (5.56%) ($p = 0.041$). Cross pinning was used in 56.00% of cases, with a lower complication rate (10.71%) than lateral-only pinning (18.18%), though not statistically significant ($p = 0.327$). Postoperative complications included pin site infection (6.00%), loss of reduction (4.00%), nerve injury (2.00%), and cubitus varus (2.00%). Based on Flynn's criteria, 68.00% had excellent outcomes, 20.00% good, 10.00% fair, and 2.00% poor. Poorer outcomes were significantly associated with Type III fractures ($p = 0.038$). **Conclusion:** Percutaneous K-wire fixation is a safe and effective method for treating displaced supracondylar humerus fractures in children, offering excellent functional and cosmetic results with minimal complications when performed using proper technique and imaging guidance.

**Keywords:** Supracondylar fracture, Pediatricorthopedics, K-wire fixation, Functional outcome, Gartland classification



## INTRODUCTION

Supracondylar fractures of the humerus are among the most common types of elbow fractures in children, particularly between the ages of 4 and 10 years. These fractures are typically caused by a fall on an outstretched hand, which transmits force through the forearm to the distal humerus, leading to a fracture just above the elbow joint. The unique anatomy of the pediatric elbow, combined with the biomechanical forces involved in trauma during falls or play activities, makes this site particularly vulnerable. The supracondylar region is the thinnest part of the distal humerus and therefore prone to fracture even with low-impact injuries in children.[1]

The significance of supracondylar fractures lies not only in their frequency but also in the potential for serious complications if not managed appropriately. These fractures can be associated with neurovascular injuries, including damage to the brachial artery and the median, radial, or ulnar nerves. Additionally, malunion, particularly cubitus varus deformity, is a well-documented complication that can result from inadequate reduction and fixation. As such, proper diagnosis, classification, and management of these injuries are essential to ensure favorable outcomes.[2]

The classification of supracondylar humerus fractures most commonly follows the Gartland system, which categorizes these injuries based on the degree of displacement. Type I fractures are nondisplaced, Type II are displaced with an intact posterior cortex, and Type III fractures are completely displaced with no cortical contact. Type III fractures, in particular, pose a greater challenge and often necessitate surgical intervention due to their inherent instability and risk of neurovascular compromise.[3]

Historically, the management of these fractures ranged from closed reduction and casting to open reduction with internal fixation. However, with the evolution of pediatricorthopedic practices and increasing emphasis on minimally invasive

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techniques, closed reduction followed by percutaneous pinning using Kirschner wires (K-wires) has emerged as the standard of care, especially for displaced fractures. This technique offers the advantage of maintaining fracture alignment while minimizing surgical trauma and allowing for early mobilization and functional recovery.[4]

Percutaneous K-wire fixation has become widely accepted due to its relative simplicity, effectiveness in maintaining stable fixation, and favorable long-term outcomes. The approach involves the use of thin, smooth wires inserted through the skin and soft tissue into the bone to hold the fracture fragments in place. Depending on the fracture configuration and surgeon preference, lateral-only pinning or crossed medial and lateral pinning may be employed. Each technique has its own merits and risks, with lateral-only pinning reducing the risk of iatrogenic ulnar nerve injury, while crossed pinning may offer enhanced rotational stability.[5]

Despite its widespread use, several debates persist regarding the optimal pin configuration, timing of surgery, and criteria for open versus closed reduction. Furthermore, the learning curve associated with proper technique and the importance of fluoroscopic guidance to confirm alignment and pin placement cannot be overlooked. Inadequate fixation or malpositioned pins can lead to complications such as loss of reduction, pin tract infection, and secondary deformity.[6,7]

In developing regions and resource-limited settings, timely presentation, availability of surgical expertise, and access to imaging and operative facilities may influence treatment decisions. Hence, studies evaluating the efficacy and safety of percutaneous K-wire fixation in such settings provide valuable insights into the adaptability and outcomes of this technique across diverse clinical environments.[8,9]

The present study aims to prospectively assess the clinical and radiological outcomes of percutaneous K-wire fixation in pediatric patients with supracondylar humerus fractures. It focuses on evaluating the effectiveness of this intervention in terms of fracture stability, functional recovery, complication rates, and overall patient satisfaction. By following a standardized surgical protocol and postoperative rehabilitation regimen, this study endeavors to contribute to the growing body of literature advocating for percutaneous fixation as a reliable and safe modality in pediatricorthopedic trauma care.

## MATERIAL AND METHODS

This prospective observational study was conducted in the Department of Orthopaedics at a tertiary care teaching hospital from 9 March2020 to 31 July2020, after obtaining clearance from the Institutional Ethics Committee. The study aimed to evaluate the clinical and radiological outcomes of percutaneous K wire fixation in the management of supracondylar humerus fractures in children.A total of 50 pediatric patients diagnosed with displaced supracondylar fracture of the humerus (Gartland Type II and Type III) were included in the study. Patients were enrolled consecutively based on eligibility criteria after obtaining written informed consent from parents or guardians.

### Inclusion Criteria

- Children aged between 4 and 12 years.
- Closed supracondylar humerus fractures of Gartland Type II and III.
- Presentation within 7 days of injury.
- Consent from parents or legal guardians.

### Exclusion Criteria

- Open fractures.
- Fractures with neurovascular compromise requiring urgent surgical exploration.
- Pathological fractures.
- Patients with associated ipsilateral limb injuries.
- Medically unfit for anesthesia or surgery.

### Preoperative Assessment

On admission, detailed clinical evaluation including history of trauma, neurovascular examination of the affected limb, and systemic assessment was done. Standard anteroposterior (AP) and lateral radiographs of the elbow were taken to confirm diagnosis and classify the fracture using the Gartland classification.

### Surgical Procedure

All patients underwent closed reduction and percutaneous K wire fixation under general anesthesia in a sterile operation theater. Reduction was achieved under image intensifier guidance by traction and flexion maneuver. Once satisfactory reduction was confirmed radiologically, two or three smooth K wires (1.5–2.0 mm) were inserted percutaneously either in a lateral-only or cross-pin configuration, depending on surgeon's preference and fracture stability. K wires were bent and left outside the skin for easy removal. A posterior above-elbow slab was applied with the elbow in 90–100 degrees flexion.

### Postoperative Protocol

Postoperative radiographs were obtained to assess alignment and fixation. Patients were discharged with instructions for limb elevation and slab care. Sutures were removed after 10–12 days, and the slab was continued for 3–4 weeks. K wires were removed on an outpatient basis at 3–4 weeks postoperatively under aseptic conditions.

### Follow-up and Outcome Assessment

Patients were followed up at 2, 4, 6, and 12 weeks. Clinical and radiographic evaluations were done during follow-up to assess fracture union, range of motion, and complications such as pin site infection, loss of reduction, malunion, or iatrogenic nerve injury. Functional outcome was evaluated using

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Flynn's criteria, which considers carrying angle and range of motion loss compared to the normal side.

**Data Analysis**

All collected data were entered into Microsoft Excel and analyzed using SPSS software version 25.0. Descriptive statistics were used to summarize patient demographics and clinical outcomes. The significance level was set at $p < 0.05$.

## RESULTS

**Table 1: Demographic Profile of Patients**

The study included 50 pediatric patients aged between 4 to 12 years with displaced supracondylar fractures of the humerus. The majority of patients (44.00%) were in the 7–9 years age group, followed by 32.00% in the 10–12 years category and 24.00% in the 4–6 years group. Although the age distribution showed a greater prevalence among middle childhood age, the difference was not statistically significant ($p = 0.421$). In terms of gender distribution, males were more commonly affected than females, accounting for 64.00% of cases, while females comprised 36.00%. However, this difference was also not statistically significant ($p = 0.356$). The right side was more frequently involved, seen in 62.00% of patients, compared to the left side in 38.00%, but this laterality also did not demonstrate statistical significance ($p = 0.217$). These demographic findings suggest that supracondylar fractures are more common in school-age boys and more often affect the right upper limb, but these trends were not statistically significant.

**Table 2: Fracture Classification Based on Gartland Type and Its Association with Complications**

Out of the 50 cases, 36.00% were classified as Gartland Type II fractures, while the remaining 64.00% were Type III, indicating a predominance of more severe, completely displaced fractures. When the incidence of complications was analyzed in relation to fracture type, it was observed that only 1 out of 18 patients (5.56%) with Type II fractures experienced complications. In contrast, 6 out of 32 patients (18.75%) with Type III fractures developed complications. This difference was found to be statistically significant ($p = 0.041$), indicating that more severe (Type III) fractures are significantly associated with higher complication rates. This highlights the importance of early stabilization and vigilant postoperative monitoring in Type III injuries.

**Table 3: Pin Configuration and Associated Complications**

Of the total cases, 56.00% were managed with cross K-wire fixation and 44.00% with lateral-only K-wire fixation. The rate of complications was slightly higher in the lateral-only group (18.18%) compared to the cross pinning group (10.71%). However, this difference did not reach statistical significance ($p = 0.327$). Although cross pinning is traditionally considered more biomechanically stable, the lack of significant difference in complication rates between the two groups in this study suggests that both techniques can be safe and effective when applied appropriately, depending on the case-specific stability achieved during surgery.

**Table 4: Postoperative Complications Observed**

Postoperative complications were observed in a minority of patients, with 6.00% experiencing pin site infections, 4.00% presenting with loss of reduction, 2.00% having iatrogenic nerve injury, and 2.00% developing cubitus varus deformity. Despite these complications, the vast majority of patients (86.00%) had no adverse events postoperatively. The overall statistical analysis showed a highly significant result ($p < 0.001$), indicating a strong tendency toward favorable outcomes with percutaneous K-wire fixation. These findings support the safety of this technique when performed under proper aseptic and image-guided conditions.

**Table 5: Functional Outcome Based on Flynn's Criteria at Final Follow-up**

At the final follow-up, functional outcomes were assessed using Flynn's criteria, which considers range of motion and cosmetic appearance. Most patients (68.00%) achieved an excellent result, followed by 20.00% with good outcomes, 10.00% with fair, and only 2.00% with poor outcomes. When analyzed in relation to fracture severity, it was observed that poorer outcomes were more common in Gartland Type III fractures. For instance, all fair and poor outcomes (100%) occurred in Type III cases. The association between fracture severity and functional outcome was statistically significant ($p = 0.038$), emphasizing that although excellent outcomes can be achieved in the majority, higher fracture grades are more likely to result in functional compromise.

**Table 1: Demographic Profile of Patients (n = 50)**

| Parameter | Number of Patients | Percentage (%) | p-value |
|---|---|---|---|
| Age Group (Years) | | | 0.421 |
| 4–6 | 12 | 24.00% | |
| 7–9 | 22 | 44.00% | |
| 10–12 | 16 | 32.00% | |
| Gender | | | 0.356 |
| Male | 32 | 64.00% | |

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| | | | |
|---|---|---|---|
| Female | 18 | 36.00% | |
| Side of Involvement | | | 0.217 |
| Right | 31 | 62.00% | |
| Left | 19 | 38.00% | |

**Table 2: Fracture Classification Based on Gartland Type and Its Association with Complications**

| Gartland Type | Number of Patients | Percentage (%) | Patients with Complications (%) | p-value |
|---|---|---|---|---|
| Type II | 18 | 36.00% | 1 (5.56%) | |
| Type III | 32 | 64.00% | 6 (18.75%) | 0.041* |

**Table 3: Pin Configuration and Associated Complications**

| Pin Configuration | Number of Patients | Percentage (%) | Complication Rate (%) | p-value |
|---|---|---|---|---|
| Cross K Wire | 28 | 56.00% | 3 (10.71%) | |
| Lateral-only Wires | 22 | 44.00% | 4 (18.18%) | 0.327 |

**Table 4: Postoperative Complications Observed (n = 50)**

| Complication | Number of Patients | Percentage (%) | p-value |
|---|---|---|---|
| Pin site infection | 3 | 6.00% | |
| Loss of reduction | 2 | 4.00% | |
| Iatrogenic nerve injury | 1 | 2.00% | |
| Cubitus varus deformity | 1 | 2.00% | |
| None | 43 | 86.00% | <0.001** |

**Table 5: Functional Outcome Based on Flynn's Criteria at Final Follow-up**

| Flynn's Grade | Number of Patients | Percentage (%) | Associated with Gartland Type III (%) | p-value |
|---|---|---|---|---|
| Excellent | 34 | 68.00% | 18 (52.94%) | |
| Good | 10 | 20.00% | 7 (70.00%) | |
| Fair | 5 | 10.00% | 5 (100.00%) | |
| Poor | 1 | 2.00% | 1 (100.00%) | 0.038* |

## DISCUSSION

In the present study, the majority of children affected by supracondylar humerus fractures were boys (64%) and fell within the 7–9 years age group (44%), which is consistent with the known epidemiological pattern of this injury being more common in young, active male children. This male predominance aligns with the findings of Pirani et al. (2006), who reported in their retrospective review of 140 cases that 68% of supracondylar fracture cases were boys, most commonly between 5 and 9 years of age, suggesting that the higher physical activity levels and risk-taking behavior in boys may contribute to this difference.[10]

Regarding the fracture classification, the current study found that Gartland Type III fractures accounted for 64% of cases, while Type II constituted 36%. Complications were more prevalent in Type III fractures (18.75%) compared to Type II (5.56%), a difference that was statistically significant ($p = 0.041$). This pattern was similarly noted by Otsuka and Kasser (1997), who found that complications such as loss of reduction and nerve palsy were significantly higher in Type III fractures due to the severity of displacement and soft tissue involvement. This highlights the critical importance of timely and appropriate management of completely displaced supracondylar fractures.[11]

In evaluating the surgical technique, our study observed a slightly higher rate of complications in the lateral pinning group (18.18%) compared to the cross pinning group (10.71%), though the difference was not statistically significant ($p = 0.327$). These findings are consistent with those of Skaggs et al. (2004), who concluded that while lateral-entry pinning avoids the risk of ulnar nerve injury associated with medial pins, it may offer less rotational stability, especially in severely unstable fractures. However, when performed meticulously with correct pin spacing and trajectory, lateral-only pinning can still yield satisfactory outcomes, as seen in our study.[12]

The overall complication rate in this study was relatively low, with only 14% of patients experiencing minor complications such as pin site infection (6%), loss of reduction (4%), and iatrogenic nerve injury or deformity (2% each). Notably, the majority of patients (86%) had no complications. Comparable outcomes were reported by Pretell-Mazzini et al. (2010), who found that percutaneous pinning under fluoroscopy minimized the risk of complications and resulted in high success rates when conducted under strict aseptic and image-guided protocols.[13] This underlines the importance of operative precision and proper postoperative care in minimizing adverse events.

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Functional outcomes in the current study were excellent in 68% of patients and good in 20%, with only 10% fair and 2% poor. These results align closely with the findings of Iyengar et al. (2011), who reported that 70% of children achieved excellent functional outcomes based on Flynn's criteria after K-wire fixation for supracondylar fractures. They emphasized that good alignment, early mobilization, and fracture type were critical determinants of outcome.[14] The statistically significant correlation ($p = 0.038$) between Gartland Type III fractures and poorer outcomes in our study further supports this assertion.

Finally, the presence of cubitus varus deformity, though observed in only one patient (2%) in this study, remains a feared cosmetic complication. Our findings correspond with those of Babal et al. (2010), who observed that while the incidence of cubitus varus has declined with improved surgical techniques, it still occurs, especially in cases of malreduction or late presentation.[15] Careful intraoperative assessment and ensuring stable fixation are essential to prevent such deformities.

## CONCLUSION

Percutaneous K-wire fixation is a safe, effective, and minimally invasive technique for the management of displaced supracondylar humerus fractures in children. It provides excellent fracture stability, facilitates early mobilization, and yields satisfactory functional and cosmetic outcomes. The procedure has a low complication rate when performed with proper technique and intraoperative imaging guidance. This study reinforces its role as the preferred treatment modality in pediatric supracondylar fractures.

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