Original Article

# Comparative study of closed reduction and internal fixation of supracondylar fracture of humerus in children by lateral pinning and cross pining

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**ABSTRACT:**

***Background:*** *Supracondylar injuries of the humerus are the most prevalent elbow injury among pediatric patients. The conventional treatment of displaced fractures involves closing the reduction as well as percutaneous Kirchner wire pinning, using either lateral pin fixation or cross pin fixation. The objective of the study is to evaluate and contrast the results of lateral vs bilateral percutaneous pinning in pediatric patients with supracondylar humeral injuries.*

***Methods:*** *A comparative cross-sectional study was conducted at the National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR) between July 2017 to June 2019. Children were classified into two groups according to the percutaneous pinning technique: Lateral pinning (n=15) and Crossed pinning (n=15). Both groups were comparable in terms of age, gender, injury duration, along with degree of fracture displacement. The chi-square test and t-tests for independence were employed. The results were reported as mean, frequency, along with percentage, with $P < 0.05$ indicating statistical significance, using SPSS software.*

***Result:*** *The average age of patients was 6.86 ± 2.53 years for group I and 6.57 ± 2.41 years for group II overall. In the cohort with dual lateral K-wire fixation, 20% achieved exceptional outcomes, 66.67% obtained good outcomes, and 13.33% realized fair outcomes. In the medial-lateral K-wire fixation cohort, 20% achieved exceptional outcomes, 60% attained satisfactory results, and 20% exhibited acceptable results, with a P value of 0.881, signifying statistical insignificance. In the medial-lateral cross K-wire fixation group, the incidence of iatrogenic ulnar nerve injuries was 6.67%, while the two lateral K-wire fixation group reported no neurological injuries, yielding a P value of 0.664. Thus, the difference in the incidence of ulnar nerve injury between the two patient cohorts was not significant.*

***Conclusion:*** *Both fixation methods exhibit effectiveness; the application of two lateral K-wires offers stability akin to medial-lateral cross K-wire fixation while mitigating the danger of iatrogenic ulnar nerve injury.*

**Key Words:**
Supracondylar humeral fractures, K-wire fixation, cross pinning, lateral pinning.

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## Introduction

The supracondylar injury of the humerus is the second most common fracture in children, representing 16.6% of occurrences, and is the most frequent injury occurring before to the age of seven. Approximately two-thirds of pediatric elbow injuries need hospitalization and surgical intervention. The main complications associated with supracondylar humerus injuries are compartment syndrome, neurovascular injury, Volkmann's ischemia contracture, myositis ossificans, as well as angular deformities.1

Supracondylar injuries of the humerus in youngsters, which result in significant swelling, pose a difficult problem. Certain displaced fractures can be stabilized and effectively controlled with closed reduction using a long arm back slab and collar cuff. The citation for this source is Flynn, et al., 1974 2.

Typically, Type III fractures are treated by performing closed reduction and retrograde percutaneous pinning using Kirschner wires. K wires possess the benefit of being user-friendly, cost-effective, and resulting in a shorter duration of hospitalization 1. Several techniques for stabilizing displaced supracondylar fractures of the humerus in children are currently used. One such method is the crossed K-wire fixation, where a wire is inserted through each of the epicondyles. Another technique involves inserting two K-wires through the lateral epicondyle, placed parallel to each other and spaced more than 10 mm apart, as suggested by Judet 3.

Due to the challenge of effectively reducing and immobilizing fractures, the widely accepted treatment approach is to stabilize the decreased fractures with percutaneously implanted pins. The potential for iatrogenic ulnar nerve injury is a constant issue when inserting the medial pin. From a biomechanical perspective, the use of two lateral pins for fixation is less reliable since it may permit the fracture to rotate, causing the medial column to rotate towards the back. The study revealed that the force needed to achieve a 10° rotation is 37% lower when using two lateral parallel pins compared to using medial and lateral pins. Some researchers have suggested that using two lateral cross-pins for fixation can offer a biomechanically stable result while minimizing the danger of ulnar nerve injury (El-Adl, et al., 2008).

This study aims to examine the effects of percutaneous pinning from the lateral side against both sides in children with supracondylar fractures of the humerus, as different orthopedic surgeons may have varying opinions on the matter.

## Methods

This comparative cross-sectional research included children with Gartland classes II and III supracondylar humeral fractures, who sought treatment in the emergency outpatient service and were subsequently admitted to NITOR between July 2017 and June 2019. This research involved 30 patients aged 2 to 12 years for the assessment of displaced supracondylar fractures of the humerus. Patients with open fractures, pathological fractures, non-displaced fractures, fractures accompanied by compartment syndrome, and any associated injuries were excluded from the research. All children presenting at the emergency or outpatient department with displaced supracondylar humeral fractures underwent physical examination and radiographic evaluation. The children were classified into two groups according to the percutaneous pinning method employed: (A) Fifteen children had two wires inserted from the lateral epicondyle, and (B) Fifteen children had two wires put in a crossing configuration. The two groups were analyzed for gender distribution, mean age, kind of fracture, and duration between injury and surgery.

Following data collection, the information was analyzed and verified to guarantee consistency and reduce errors. This data was transferred to a designated master sheet for processing and analysis. The user entered data into the computer and saved it in version 20.00 of the Statistical Package for Social Sciences (SPSS) program. The obtained data was meticulously re-evaluated to guarantee its quality and reliability. The research used stringent statistical analysis, computation, and testing to ascertain the correlation between variables in accordance with the study's objectives.

## Surgical procedure

Both surgeries were conducted with the patient under general anesthesia. The operations were conducted in the operating theater under aseptic circumstances, using a C-arm image intensifier, a collection of hand drills or electric drills, K-wires, and a wire cutter.

The patient, under general anesthesia, was positioned supine on the operating table, with the child's arm resting on a radiolucent arm board. The limb was enveloped from the axilla to the digits. The wrist and distal forearm were grasped to provide mild traction, maintaining forearm supination and bending the elbow at about 20 degrees. This was executed to avert any strain on the neurovascular systems resulting from the anterior displacement of the proximal piece. An assistant administers counter traction to the arm. The arm restored its former length within three to four minutes after traction. It mitigated the fracture's impaction. Thereafter, any lateral or inward/outward inclination was corrected by using the fingers on the proximal section and the thumb on the distal section.

The carrying angle was evaluated in this position and compared to the angle on the unaffected side. The reduction in the frontal plane was confirmed with fluoroscopy (C-arm). The posterior displacement was corrected by applying traction to the forearm with the active hand, while the lower humerus was securely grasped by the opposite hand, with the thumb placed over the olecranon. The forearm was consistently flexed as the thumb advanced the distal segment and the fingers retracted the proximal section, with the elbow bent at a 90-degree angle. The elbow may be bent to an angle of 120 degrees without difficulty in an optimal reduction. The distal element is stabilized by the triceps bridge in a condition of acute flexion.

Flexing the swollen elbow may compress the brachial artery. To avert this perilous state, the radial pulse must be evaluated at each phase of flexion. To guarantee vascular safety, it is crucial to refrain from elbow flexion in instances of vascular compromise and to retain the elbow at a lower angle. The decrease was confirmed using fluoroscopic imaging in anteroposterior, lateral, and oblique views. At times, in difficult situations, the C-arm was adjusted rather than the patient's arm. The existence of a well aligned anterior humeral line crossing the capitellum, a Baumann angle above 10 degrees, and intact medial and lateral columns on oblique views all indicate effective reduction.

The fracture was stabilized after achieving sufficient reduction. In 15 patients, two K-wires with diameters ranging from 1.5 to 1.8 mm were inserted through the lateral epicondyle using either a manual drill or an electric drill. In an additional 15 patients, one K-wire was put into both the lateral and medial epicondyle. The lateral pins were set up 10° posterior to the humerus' coronal plane and 30° to 40° upward and inward with respect to the sagittal plane. Using a similar method, the medial pin was put through the medial epicondyle's midline. In the ulnar groove, the ulnar nerve was purposefully evaded.

The pins were introduced to the opposing cortex, 3 cm proximal to the insertion point. The pin locations were confirmed with a fluoroscope. Upon the successful evaluation of the post-reduction fluoroscopic pictures, the ends of the pins were excised beyond the skin's surface. An extensively padded long-arm plaster splint was applied. The elbow was kept in a perpendicular orientation, while the forearm was twisted to place the palm downward.

Subsequent to the reduction surgery, all patients were hospitalized and monitored for a period of 24 hours. The leg was positioned at breast level with the aid of a cushion.

## Results

**Age distribution:**

The average age was 6.86 ± 2.53 years for group-I and 6.57 ± 2.41 years for group-II patients. The age range ranged from 2 to 12 years. No substantial difference existed between the age groups of patients in group I and group II.

**Table-I: Distribution of patients according to Age (n=30)**

| Group-I (n=15) | | Group-II (n=15) | | | | |
|---|---|---|---|---|---|---|
| Value | | | | | | |
| Age group | Frequency | % | Frequency | % | t | P value |
| 1-6 | 7 | 46.67 | 7 | 46.67 | .3212 | 0.7504 |
| 7-12 | 8 | 53.33 | 8 | 53.33 | | |
| Mean ± SD | 6.86 ± 2.53 | | 6.57 ± 2.41 | | | |

**Sex distribution:**

In group I and group II, 11 patients (73.3%) were male and 4 cases (26.7%) were female. Following the chi-square test, no significant difference in sex distribution was observed between Group I and Group II.

**Table-II: Distribution of patients according to Sex (n=30)**

| Group-I | | Group-II | | Total | | |
|---|---|---|---|---|---|---|
| Sex | Frequency | % | Frequency | % | Frequency | % | P-value |
| Male | 11 | 73.30 | 11 | 73.30 | 22 | 73.30 | |
| Female | 4 | 26.70 | 4 | 26.70 | 8 | 26.70 | 0.659 |
| Total | 15 | 100 | 15 | 100 | 30 | 100 | |

**Causes of injury:**

There were 3 case fall from bed, 06 cases fall from the tree, 2 stumbling and 4 fall from bicycle in group-I. While in group II 4 case fall from bed, 7 cases fall from the tree, 2 stumbling and 2 fall from bicycle.

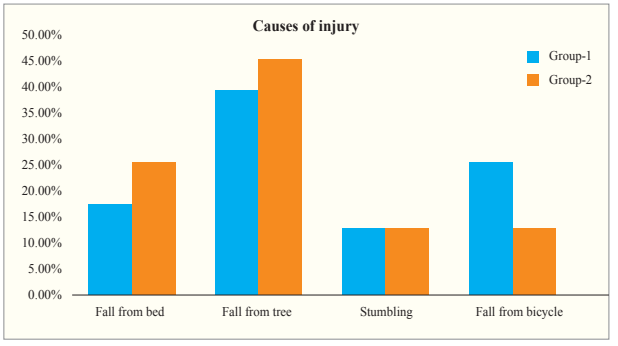
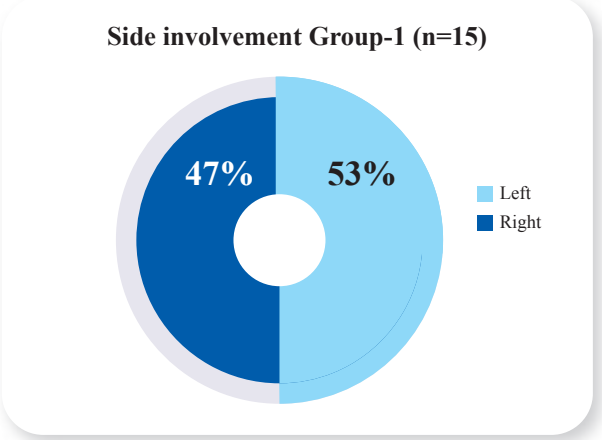



Figure-1: Causes of injury in group I and II.

**Clinical information**

**Fracture side:**

In this research, left-side participation was seen in 8 instances and right-side involvement in 7 cases in group I, while left-side participation was noted in 10 cases and right-side participation in 5 cases in groupII.



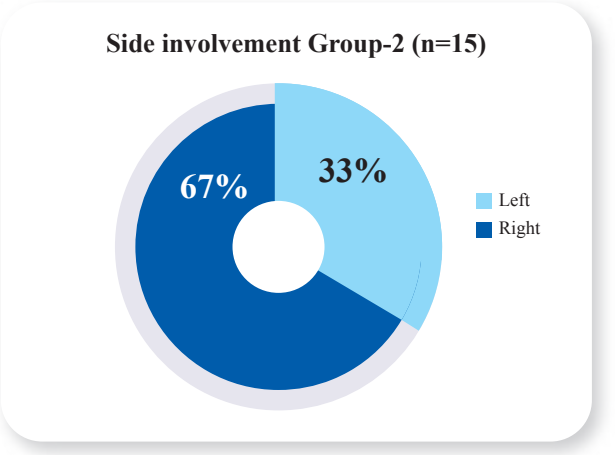




**Figure-2: Distribution of patients according to side involvement.**

**Time interval between injury and surgery:**

In group I, the interval between injury and operation ranged from a least of 2 hours to a highest of 24 hours, with a mean ± SD of 9.20 ± 7.20. In group II, the interval ranged from a least of 3 hours to a highest of 48 hours, with a mean ± SD of 9.60 ± 11.01. No substantial difference was seen between group I and group II regarding the time period between injury and operation.

**Table-Ill: Distribution of patients according to time interval between injury and surgery (n=30)**

| Group | Age of injury in hours | | | | |
|---|---|---|---|---|---|
| | Minimum | Maximum | Mean ± SD | t value | p value |
| Group-I | 2 | 24 | 9.20 ± 7.20 | -0.12 | 0.907 |
| Group-II | 3 | 48 | 9.60 ±11.01 | | |

**Post-operative hospital stay:**

Minimum and maximum post-operative hospital stays were 1 and 2 days in group I and group II.

**Table IV: Distribution of patients according to post-operative hospital treatment time (n=30)**

| Group | Hospital Stay in day | | | | |
|---|---|---|---|---|---|
| | Minimum | Maximum | Mean ± SD | t value | p value |
| Group-I | 2 | 2 | 1.40± 0.51 | 0.756 | 0.456 |
| Group-II | 1 | 2 | 1.26±0.46 | | |

**Post-operative range of motion of Elbow**

**Table-V: Patient distribution based on Flynn's criteria for loss of elbow flexion (n=30)**

| Loss of range of motion in degrees | Group-I (n=15) Frequency | % | Group-II (n=15) Frequency | % | P value |
|---|---|---|---|---|---|
| No loss of flexion | 2 | 13.33 | 1 | 6.67 | 0.821 |
| 1-5 | 1 | 6.67 | 2 | 13.33 | |
| 6-10 | 10 | 66.67 | 9 | 60 | |
| 11-15 | 2 | 13.33 | 3 | 20 | |

**Post-operative Carrying angle**

**Table VI: Patient distribution based on Flynn's criterion for carrying angle loss (n=30)**

| Loss of carrying angle in degrees | Group-I (n=15) Frequency | % | Group-II (n=15) Frequency | % | P value |
|---|---|---|---|---|---|
| No loss | 2 | 13.33 | 1 | 6.67 | 0.821 |
| 1 -5 | 1 | 6.67 | 2 | 13.33 | |
| 6-10 | 10 | 66.67 | 9 | 60 | |
| 11-15 | 2 | 13.33 | 3 | 20 | |

**Complications:**

**Table-VII: Distribution of complications (n=30)**

| Complications Degrees | Group-I (n=15) Frequency | % | Group-II (n=15) Frequency | % | P value |
|---|---|---|---|---|---|
| Pin tract infection | 2 | 13.3 | 3 | 20.0 | 0.664 |
| Fracture blister | 2 | 13.3 | 1 | 6.7 | |
| Ulnar N. injury | 0 | 0.0 | 1 | 6.7 | |
| No complication | 11 | 73.3 | 10 | 66.7 | |

**Functional Outcome:**

The functional result was assessed using Flynn's grading system. This research reported 3 instances with outstanding, 10 with good, and 2 with acceptable functional results in group I. In group II, the functional outcomes were classified as outstanding (3), good (9), and fair (3). Following the chi-square analysis, no significant difference was seen between the two groups.

**Table-VIII: Comparison of functional outcome between two groups (n=30)**

| Functional outcome | Group-I (n=15) Frequency | % | Group-II (n=1.5) Frequency | % | P value |
|---|---|---|---|---|---|
| Excellent | 3 | 20 | 3 | 20 | 0.881 |
| Good | 10 | 66.67 | 9 | 60 | |
| Fair | 2 | 13.33 | 3 | 20 | |
| Failure | 0 | 0.0 | 0 | 0.0 | |

## Discussion

Supracondylar injuries within the humerus are the most frequent injuries occurring within the metaphysis on the distal humerus in pediatric patients. If inadequately managed, these fractures may result in considerable complications. The distinctive anatomical features of the distal humerus and the laxity of the ligaments in the elbow joint make the fractures are more likely to occur in the supracondylar area. The reference is from Foead et al. (2004).4

The research was carried out at NITOR from July 2017 to June 2019. Gartland's classification has been employed to categorize supracondylar fractures during this series- The degree of elbow edema and the frequency of neurovascular issues are closely correlated with the dislocation. Only children with type III as well supracondylar humeral fractures were included in this study. An elevated level of edema is linked to these fractures. In this group, fractures occurred more often in men (22 cases, 73.3%) than in women (8 instances, 26.67%). In all supracondylar fracture studies, there was a male preponderance, with rates of 77% (El-Adl et al., 2008), 70%, and 60%. No scientist has offered a reason for the heightened prevalence of men.

The main cause of supracondylar injury in this research was linked to falling from a tree. Contributing variables included occurrences such as falling off a bed, cycling, and tripping. No immediate injuries were reported, and all patients had their elbows completely extended at the time of the fall. The forearm's posture upon contact dictates the distal fragment's placement, particularly in the posterolateral and posteromedial areas. A large percentage of patients in this cohort had posteromedial displacement.

This research indicates that the left side was more actively involved in 19 of 30 patients, or 63.33% of the total. The occurrence of right-side fractures was 11 instances, or 36.67% of the total. The increased susceptibility of the left side is likely because to children often extending their left elbow to absorb the force of a fall. Prior research by Anwar et al. (2011) and Sarwar (2003) has shown a greater prevalence of participation on the left side. 6.7

Treatment modalities for displaced supracondylar fractures of the humerus in pediatric patients include closed reduction and external immobilization. Closed reduction and percutaneous fixation

iii) Employment of overhead skeletal traction.

iv)Execution of open reduction along with internal fixation.

The preferred treatment method for them is primary closure reduction and percutaneous pinning. The citation originates from Cekanauskas et al. (2003). 8. The sample in this research was categorized into two groups: Fifteen patients in group I had closed reduction and percutaneous fixation of the lateral epicondyle of the humerus with two K-wires, facilitated by a C-arm image intensifier. The limb is stabilized using a back slab, preserving the elbow at a 90° flexion angle. The pins were removed after a period of three weeks. All fractures effectively healed after about four weeks. Of the 15 patients, 3 (20%) achieved exceptional results, 10 (66.67%) attained satisfactory outcomes, and 2 (13.33%) realized moderate outcomes.

Fifteen patients in group II received closed reduction and percutaneous K-wire fixation using both the medial and lateral epicondyles of the humerus, facilitated by C-arm imaging. The limb is secured in a back slab, preserving the elbow at a flexion angle of 90°. The pins were removed after a period of three weeks. All fractures consolidated around four weeks later. Of the 15 patients, 3 people (20%) achieved excellent results, 9 individuals (60%) attained satisfactory outcomes, and 3 individuals (20%) realized moderate outcomes. The findings of lateral pin fixation showed an 86.67% probability of excellent and good outcomes. Conversely, medial-lateral pin fixation had an 80% probability of excellent and favorable results. The final outcome underwent statistical analysis, indicating a little difference, notwithstanding the potential for ulnar nerve damage in medial-lateral pin fixation. A distinct investigation revealed that the functional outcome after cross pinning was excellent in 84% of cases and adequate in 16% of cases, with no occurrences of poor outcomes. The findings of patients managed with lateral pinning shown a 77% rate of excellent outcomes and a 23% rate of satisfactory outcomes, with no occurrences of bad results. 9.

No vascular problems were noted in this experiment. In this series, one in every fifteen individuals has been recorded to suffer from transient ulnar neuropathy. Neuropraxia is likely caused by a traction injury during the pinning technique, namely owing to medial pin fixation. The nerve completely restored its normal function. This research included surgical operations performed by seasoned orthopedic surgeons and advanced orthopedic trainees under meticulous supervision, leading to a reduced occurrence of ulnar nerve palsy. Volkmann's ischemia is a serious complication that may arise after a supracondylar fracture of the humerus. The neurovascular structure's heightened vulnerability to fracture leads to the elevated incidence of this illness. The proportion in the Flynn series was 18 percent. Volkmann's ischemia was not detected in this study. In the postoperative phase, percutaneous pinning facilitates the immobilization of the elbow at an angle below 90 degrees. This enhances venous blood flow and significantly reduces the risk of developing compartment syndrome. Ten. Flynn et al. (1974) found an incidence of 18% vascular complications and 8% neurological issues in their study of 72 displaced supracondylar fractures.

In this cohort, 5 patients (16.67%) had pin tract infections. The superficial infection was cured with antibiotic treatment based on culture and sensitivity results. Nonetheless, some scar tissue remained, which did not influence the ultimate result. Accurate pin insertion requires comprehensive proficiency in the procedure. There was no shattered pin or any growing abnormalities. Cubitus varus deformity is the most prevalent long-term complication of supracondylar fracture. The cubitus varus deformity results from the postero-medial inclination of the distal piece. The limited follow-up duration precluded the evaluation of any late problems in this investigation. Vaidya's 2009 research demonstrated the absence of iatrogenic ulnar nerve damage patients in

group A, which had lateral pin fixation. The reduction in carrying angle was quantified at 3.70°, categorized as exceptional in 25 patients, good in 3 patients, and fair in 1 patient. Three iatrogenic ulnar nerve injuries were noted in group B, where bilateral fixation was performed using pins. The reduction in carrying angle was quantified at 3.57°, classified as exceptional in 24 patients, acceptable in 5 patients, and fair in 2 patients. The two groups were juxtaposed. The differences that were observed were not statistically significant, except for three cases in group B that had iatrogenic ulnar nerve damage, which may be compared to this study's results.

Anwar et al.'s 2011 research revealed that 72% of individuals in the medial lateral group had exceptional outcomes, whilst 28% received satisfactory results. The lateral group is equivalent to the preceding group. In the medial lateral group, there was a 4% incidence of iatrogenic ulnar nerve injury. No neurological impairment was seen in the lateral group. The two groups were juxtaposed. The computed p-value was 0.312. The statistical difference was insignificant, with the exception of two patients in the medial lateral cross K-wire fixation group who had iatrogenic ulnar nerve injury. These instances may be juxtaposed with the results of this research.

Our aim is to achieve a positive outcome for both practicality and aesthetics. The optimal choice for this treatment is closed reduction and percutaneous K-wire fixation via the lateral epicondyle. This approach requires a C-arm image intensifier, currently available at our center and specialized facilities.

## Conclusions

This comparative investigation demonstrates that both fixation procedures are successful; two lateral K-wire fixation provides stability comparable to medial-lateral cross K-wire fixation, but with a reduced risk of iatrogenic ulnar nerve damage. However, it is advisable to do such a research with a substantial sample size over an extended duration to observe late issues.

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**Authors' contributions:** M.H.S, M.R.H, M.I.A and M.R.H wrote the main manuscript text and M.H, I.A.I, M.R.H supervision. All authors reviewed the manuscript.

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