

A Comparative Study of Percutaneous K Wire Fixation Techniques Lateral Versus Medial-lateral for Displaced Supracondylar Fracture of the Humerus in Children

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Background & Aims: In pediatric age group injuries; fractures around the elbow joint contribute to about 10%. Supracondylar humeral fractures account for 50-70% of all elbow fractures. There is general accordance in the treatment of undisplaced supracondylar humerus fractures. The controversy arises in the treatment of partially displaced and completely displaced supracondylar fractures of humerus. The study aims to compare clinical and radiological outcome of cases of displaced pediatric supracondylar fracture humerus treated with close reduction & k-wire fixation by cross pinning technique to that of lateral pinning technique and to enlist various complications. **Methods:** A total number of 32 cases diagnosed as displaced supracondylar fracture of humerus satisfying the inclusion and exclusion criteria were selected. The cases were collected from both outpatient and inpatient; Department of Orthopaedics, KIMS, Hubli. The study was conducted for a period of one year from December 2017 to December 2018. **Results:** In our study of 32 children with displaced supracondylar humerus fracture mode of injury in 19 patients was fall on outstretched hand while playing [59%] & 13 patients had alleged history of road traffic accident sustaining direct injury to elbow [41%]. Among the 32 children 6 had come before 24 hours of injury [19%], 19 visited between 24 hours to 48 hours of injury [59%] & rest 7 presented 48 hours after injury. The age group ranged from 3 to 12 years with mean age being 7.4 years. Among 32 children 19 were males [59%] & 13 were females [41%] inferring that males are mostly affected. Involvement of left side [56%] was more than right side [44%]. The condition was classified based on Gartland classification. None of the 32 children had any associated injuries and neurovascular status was normal. Initially the cases were provided by primary splintage of posterior slab with 40 degree flexion. Most of the patients in our study had posteromedial displacement [69%] and rest had postero lateral displacement [31%]. Among the 32 patients 16 underwent cross fixation [50%] & rest 16 patients treated with lateral pinning [50%] & outcome was evaluated clinically by Modified Flynn's criteria. Carrying angle loss was found to be 4.31 ± 1.25 in cross pinning and 4.44 ± 1.59 in lateral pinning representing average of 4.37 ± 1.42 . The flexion loss in our study is reported to be 4.31 ± 1.40 and 4.38 ± 1.45 among cross pinning and lateral pinning group and averaged to be 4.34 ± 1.42 , respectively. Extension loss in our study is reported to be 4.13 ± 1.02 and 4.31 ± 1.82 among cross pinning and lateral pinning groups and average comes to be 4.22 ± 1.42 . The Flynn's criteria were found [table -1] to be Excellent in 13 [81%] among cross pinning group and 12 [75%] patients who underwent lateral pinning. Good outcome seen in 3 [19%] and 4 [25%] patients among cross pinning and lateral pinning group, respectively. Unsatisfactory result was not seen in any patients. Radiological outcome was evaluated by Baumann's angle loss. Average loss of Baumann's angle is reported to be 3.19 ± 1.42 and 3.38 ± 1.78 in lateral pinning and cross pinning group, accounts to be 3.28 ± 1.6 . Excellent outcome was noted in 15 patients each in lateral and cross pinning group. One patient each in lateral and cross pinning group had good outcome. 2 patients of cross pinning fixation had ulnar nerve palsy [6.3%]. No ulnar nerve palsy was reported in lateral pinning fixation. One case has pin tract infection and was treated with regular dressing and local antibiotic infiltration. **Conclusion:** Supracondylar humerus fracture occurs due to fall on outstretched hand or rta causing direct injury to the elbow affecting 3-12

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years age group. Males were most affected. Left side was more affected than right side. Ulnar nerve palsy was seen in cross pinning group but it was resolved within 4 weeks. The lateral pinning and cross pinning techniques employed yielded almost similar results both clinically and radiologically.

Key words: Supracondylar humerus, Gartland classification, K-wire, lateral pinning, cross pinning, Flynn's criteria, Baumann's angle

INTRODUCTION

Fractures around the elbow joint represent ~10% of all pediatric orthopedic injuries and supracondylar humeral fractures account for 50–70% of all elbow fractures,^[1,2] with a peak incidence between 4 and 7 years of age in children.

The management of displaced supracondylar fracture of the humerus is one of the most challenging of the many fractures seen in children. There is a general consensus regarding the treatment of undisplaced supracondylar fracture of the humerus, but treatment of partially displaced and completely displaced supracondylar fracture of the humerus has got considerable controversy.^[3]

Particularly with displaced supracondylar fractures, the doctor caring for these patients has persistent care challenges.^[4]

If not treated effectively, the supracondylar fracture of the humerus can lead to a number of problems, including Volkmann's ischemic contracture, myositis ossificans, neurovascular damage, elbow stiffness, and malunion.^[5]

Children with displaced supracondylar fractures of the humerus may be treated using a variety of techniques, including closed reduction and application of a POP slab, overhead skeletal traction, skin traction, open reduction and internal fixation, and closed reduction and percutaneous pin fixation.^[6]

For displaced supracondylar fractures, closed reduction with plaster of paris slab immobilization has historically been advised; however, loss of reduction results in recurrent manipulation, which is likely to cause malunion, resulting in varus or valgus deformity of the elbow and stiffness.^[7]

Closed reduction with percutaneous pin fixation is now widely accepted and has become the treatment of choice for displaced supracondylar pediatric humeral fractures.^[2,8,9] However, controversy persists between lateral or crossed medial and lateral K wire fixation technique.^[7]

Despite the possibility of iatrogenic ulnar nerve injury, the benefit of medial-lateral entrance pin fixation is likely greater biomechanical stability.^[7,10,11] The benefit of lateral entrance pin fixation, on the other hand, is the avoidance of iatrogenic

ulnar nerve damage; however, the construct may be less biomechanically stable.^[10,12-14]

Traction (skin or skeletal), which has also been used traditionally for many years, has the disadvantage of necessitating a protracted hospital stay.^[6]

In general, open reduction and internal fixation are only used in certain situations, such as open fractures, fractures requiring neurovascular exploration, or irreducible fractures.^[6]

The objective of treating these fractures is to completely restore the distal humerus' architecture while minimizing problems and providing adequate stability to allow early and painless elbow motion.

The most widely acknowledged method of treating displaced supracondylar fractures of the humerus in children has been shown in recent trials to produce satisfactory cosmetic and functional outcomes with closed reduction and percutaneous fixation utilizing "K" wires.

METHODOLOGY

Thirty-two displaced type of supracondylar fractures of the humerus selected from children presenting with displaced supracondylar fracture humerus at both outpatient department (OPD) and inpatient department, in Department of Orthopaedics, KIMS Hubli, treated by closed reduction and percutaneous fixation with Kirschner wires between December 2017 and December 2018 considering the inclusion and exclusion criteria.

Inclusion Criteria

The following criteria were included in the study:

1. Aged between 3 and 12 years
2. Closed and Type 1 open fractures of Gartland Type 2 and 3 displaced Supracondylar humerus fractures
3. Normal neurovascular status of affected limb.

Exclusion Criteria

The following criteria were excluded from the study:

1. Type 3B open fractures
2. Medical contraindications to surgery
3. Inability to take part in post op rehabilitation
4. Epiphysial injuries

5. Fractures requiring open reduction or neurovascular exploration, previous ipsilateral elbow fractures, and floating elbow injury.

All the patients selected for this study were admitted in KIMS hospital were examined according to the protocol and associated injuries fractures if any, were noted. Then the patients radiographs both anteroposterior and lateral views of elbow joint were taken. All fractures were classified according to Gartland's classification.

Gartland's Classification^[15]

- Type I undisplaced
- Type II displaced (with intact posterior cortex)
- Type III completely displaced (no cortical contact)
 - a. Posteromedial
 - b. Posterolateral
- Type IV Multi directional instability.

Before surgery, the necessary laboratory investigations (Hb%, WBC total count, differential count, erythrocyte sedimentation rate, RBS, blood urea, serum creatinine, HIV-I, and II, HbSAg) were done.

As quickly as feasible after the required blood, urine, and radiographic pre-operative work-up, all patients were taken for elective surgery. Injuries were described to patients' attendants, along with any potential sequelae. The need for surgery and its risks was also communicated to the patients' companions. Before surgery, the parents of the youngsters provided their explicit written consent.

Closed reduction and percutaneous "K" wire fixation were done in all patients within 3 days of initial trauma. Temporary closed reduction was done on admission and above elbow posterior pop slab was applied in 80°–90° of flexion at elbow. The limb elevation was given to reduce swelling of the elbow.

Antibiotic post-operative care was given to all patients. Cephalosporins were intravenously administered. It was administered in accordance with the children's body weight before to inducing anesthesia and it was continued for three days following surgery at intervals of every 12 h.

Operative Technique

Under general anesthesia, the patient was placed in the supine position on the operating table with ipsilateral shoulder at the edge of the table. Site of the surgery was thoroughly scrubbed, painted with iodine and spirit, and draped leaving the elbow, lower third of arm, and upper third of forearm exposed. Closed reduction was performed under image intensification. First, longitudinal traction was administered while the forearm was supinated and the elbow was extended. Applying a valgus or varus force at the

fracture site allowed the medial or lateral displacement to be rectified while the traction was kept in place. The elbow was then gently hyperflexed and held in hyperflexion while a force was applied to the distal fragment's posterior surface to correct the posterior displacement.

The medial pin was inserted first if the fracture was of the posteromedial kind. The medial epicondyle's apex was directly through the medial pin. The lateral epicondyle's middle received the lateral pin. Depending on the patients' ages, 1.2–2.0 mm K-wires were used to fix the fractures. The pins were positioned in the coronal plane at a 30° angle to the humerus' long axis. The two pins were inserted subcutaneously. Following the insertion of the pins, the elbow was extended, the carrying angle was measured, and the carrying angle on the normal side was compared.

Under image intensification, the reduction's sufficiency and stability were examined. To prevent migration and to enable removal in the outpatient clinic without anesthesia, the pins were bent and then cutoff outside the skin. After surgery, the elbow was flexed just 90° and the extremity was placed in a well-padded posterior splint. The patient was then moved to the ward once they were awake again.

Post-operative Management

The operated limb was elevated.

A careful observation for any neurovascular deficit was observed at regular interval.

Appropriate antibiotics and analgesics were used.

Patients were discharged on advise to come for regular follow-up at 4 weeks, 3 months, and 6 months, respectively.

For all patients immediate post-operative radiographs were taken to determine the maintenance of the reduction on radiographs.

Follow-up

Four weeks later, the splint and pins were removed.

Active range of motion/physiotherapy exercises was encouraged.

A special mention and warning was given after the removal of splint about avoiding massage and passive stretching of elbow joint.

Further follow-ups were done at 3 months and 6 months, respectively.

By clinical-radiological evaluation for functional result, which included passive range of motion, Flynn criteria

carrying angle measurement, Baumann angle, neurovascular status, superficial and deep infection, and maintenance of reduction (at first follow-up).

Statistical Analysis

It is a comparative study. Data collected are entered and maintained in Excel sheet and analyzed using appropriate statistical test, Chi-square, and student t-tests used to compare data among two groups. $P < 0.005$ was considered to be significant.

DISCUSSION

A comparative study of surgical fixation of pediatric displaced supracondylar fracture humerus by percutaneous cross and lateral pinning carried at KIMS, Hubli between period of December 01, 2017 and December 31, 2018. Thirty-two patients diagnosed with supracondylar fracture humerus are included in the study. Divided into equal group based on technique of percutaneous pinning either cross or lateral.

Demographic profile of patients under study

Age

Age of the patients enrolled for study range from 3 to 12 years, with mean age being 7.4 years. This was similar to the study conducted by Wilkins *et al.*, suggesting peak incidence at the age between 5 and 8 years.^[16] The average age in Farnsworth *et al.*, study was 5.9 ± 2.8 years.^[17]

Gender

Among 32 patients in this study, 19 patients (59%) were males and 13 patients (41%) were females. Similar results were seen in a study conducted by Wilkins *et al.*, and Solak *et al.*, suggesting incidence among males to be 62.85%^[16] and 72.8%^[18] respectively. Pirone *et al.* that reported 52% were males and 48% were females.^[19] Supporting to this there are several studies conducted in India saying higher prevalence of domestic injuries and RTA's among boys compared to girls.^[18]

Mode of Injury

Among 32 patients under study, 19 patients (59%) reported as alleged history of fall on outstretched hand while playing. Thirteen patients (41%) had come with alleged history of RTA sustaining direct injury to elbow.

According to Kanwar *et al.*, fall while playing was leading cause for injury in 52.5% patients, followed by fall from bicycle in 27.5% of patients and 20% of patients was due to fall from tree.^[20] Our study was in accordance with this study findings suggesting that domestic injuries are the common cause for supracondylar fracture humerus in children.

Side Affected

Among 32 patients, 56% of patients had left side involvement while 44% of patients had right side being affected. Mazda *et al.*

reported 65 (56%) fractures on the left side and 55 (44%) on the right side in their study of 116 cases.^[22] Wilkins *et al.* reported in their series, 60.8% on the left side and 39.2% on the right side.^[16] Similar results were observed in study done by Aronson and prager., left side being more affected.^[23] Left-sided injuries occur more compared to right-sided because left upper limb is used more commonly to break the force of the fall. Our study results are consistent with these studies.

Associated Injuries

Among 32 patients, none of the patients had associated injuries and all had normal neurovascular status.

Primary Spintage

All patients presenting to KIMS OPD or casualty with supracondylar fracture humerus are given posterior support slab with 40° flexion, analgesics, and monitored to prevent compartment syndrome.^[24]

Type of Displacement

Most of the patients in our study had posteromedial displacement of supracondylar fracture humerus constitutes 69% and posterolateral displacement seen in 31% cases. Our results are consistent with studies done by Khiary *et al.*, noted 27 patients had posteromedial displacement and 10 had posterolateral displacement^[25] Aronson *et al.* noted 15 (75%) fractures displaced posteromedially and 5 (25%) posterolaterally in their study of 20 cases.^[27] Moreover, Khan *et al.* in their study noted that posteromedial displacement was 2.5 times more common than posterolateral displacement.^[26]

Duration of Injury

Duration of injury is the time duration between time of injury and reporting to hospital. Among 32 patients. 6 (19%) had come before 24 h of injury, 19 (59%) patients visited between 24 h and 48 h, rest of them seven patients presented after 48 h of injury. According to study done by Sandip *et al.*, in rural India noted that average delay in reporting since injury was 1.79 days.^[21] Our study results are consistent with this study. Suggesting we probably need better transport facilities and health education at rural parts of India to access medical facilities in the future.

Type of Percutaneous Pin Fixation Technique

Among 32 patients in the study, 16 (50%) of them under went cross fixation and rest 16 patients (50%) treated with lateral pinning according to computerized random number table.

We have evaluated clinical outcome by modified Flynn's criteria [Table 1]. At the end of follow-up, the carrying loss in the study was found to be 4.31 ± 1.25 in cross pinning and 4.44 ± 1.59 in lateral pinning representing average of 4.37 ± 1.42 . Kumar Prashanth reports carrying loss in their study as 4.12 ± 2.10 among lateral pinning and 3.80 ± 2.02 for cross pinning. In a study conducted by Foad *et al.*, in 66 children

Table 1: Flynn's grading system

Result	Rating	Cosmetic factor: Carrying angle loss (degrees)	Functional factor: Motion loss (degrees)
Satisfactory	Excellent	0–5	0–5
	Good	6–10	6–10
	Fair	11–15	11–15
Unsatisfactory	Poor	>15	>15

with displaced supracondylar fracture humerus, the average carrying angle loss was 3.57° and 3.70° in cross pinning and lateral pinning, respectively. Our study results are consistent with these studies.^[28]

The flexion loss in our study is reported to be 4.31 ± 1.40 and 4.38 ± 1.45 among cross pinning and lateral pinning group and averaged to be 4.34 ± 1.42 , respectively. In a study conducted by Foead *et al.*, the average flexion loss was found to be 7.11 and 11.26 for cross pinning and lateral pinning, respectively. On evaluation, extension loss in our study is reported to be 4.13 ± 1.02 and 4.31 ± 1.82 among cross pinning and lateral pinning groups and average comes to be 4.22 ± 1.42 . Whereas study conducted by Foead *et al.* shows, the average extension loss was found to be 7.14° and 8.68° among cross pinning and lateral pinning, respectively. This was not consistent with our study.

The Flynn's criteria were found to be excellent in 13 (81%) among cross pinning group and 12 (75%) patients who underwent lateral pinning. Good outcome seen in 3 (19%) and 4 (25%) patients among cross pinning and lateral pinning group, respectively. Unsatisfactory result was not seen in any patients. The study conducted by Kanwar *et al.*, Flynn's criteria were excellent in 25% and 40% of patients among lateral pinning and cross pinning, good outcome in 30% of patients in each group, fair results seen in 30% and 20% of patients of lateral pinning and cross pinning group and poor outcome seen in 15% and 10% of patients undergoing lateral and cross pinning.

Mazda *et al.* in a study of 116 patients at final follow-up results are classified according to Flynn's criteria as excellent in 99 patients (91.6%), good in 5 (4.6%), and poor in 4 (3.7%).^[9] Our study results are showing similar trend in clinical outcomes being overall Flynn's outcome as satisfactory, there was no statistically significant difference in Flynn's criteria outcome between lateral and cross pinning group at the end of 6-month follow-up.

Radiological outcome was evaluated by Baumann's angle loss at every follow-up. Average loss of Baumann's angle is reported to be 3.19 ± 1.42 and 3.38 ± 1.78 in lateral pinning and cross pinning group, accounts to be 3.28 ± 1.6 . Excellent outcome was noted in 15 patients each in lateral and cross pinning group. One patient each in lateral and cross pinning

group had good outcome. The average Baumann's angle loss in Khyari *et al.*, reported 5.10 ± 5.0 and 4.8 ± 5.2 among lateral and cross pinning group.^[25] In the study done by Foead *et al.*, the average Baumann's angle loss noted to be 5.30 and 5.96 among lateral and cross pinning group, respectively.^[28] Suggesting no statistical difference between two groups. Hence, our results are in accordance with the above studies.

Thus, based on the above observation

- There is statistically significant satisfactory overall outcome clinically and radiologically among patients treated with cross and lateral pinning for displaced supracondylar fracture humerus
- There is no statistically significant difference ($P > 0.005$) in clinical and radiological outcome achieved with cross pinning and lateral pinning technique
- So, patients with displaced supracondylar fracture humerus treated close reduction and lateral or cross pinning shows equally satisfactory outcome.

Complications

Among 32 patients, two patients under medial-lateral pinning group developed ulnar nerve injury. Two patients developed ulnar nerve neuropraxia post-surgery had resolved on 4th-week follow-up. Incidence of ulnar nerve injury comes to be 6.3% in my study. None of the patients under lateral pinning had ulnar nerve involvement. Lee *et al.* report chances of ulnar nerve injury to be 6.8%. According to Chai *et al.*, iatrogenic ulnar nerve injury is said to be 15% among patients treated by cross pinning. Hence, our study result is in accordance with above studies. A recent meta-analysis has shown lateral pin and medial pin to be associated with median nerve injury rate of 3.4% and 4.1%;^[29] however, we need many more studies further to have a clear conclusion on this.

One of patients had developed pin tract infection. It was treated with regular pin tract dressing and local infiltration of antibiotics Inj. Gentamicin. Incidence of pin tract infection comes to be 3.1%. This is in accordance with the results of study done by Mostafavi *et al.*, where its 5%.

CONCLUSION

In our study, a clinically and radiologically satisfactory outcome in managing patients with displaced pediatric

supracondylar fracture humerus with close reduction and K wire fixation by cross pinning and lateral pinning. Moreover, there is no statistically significant difference in clinical and radiological outcome with cross pinning and lateral pinning techniques employed for treating pediatric displaced supracondylar fracture humerus.

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