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Analysis of the outcome of cross K-Wire fixation and lateral K-Wire fixation in displaced supracondylar fracture of Humerus in children: A prospective comparative study

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Abstract
Background: Supracondylar humerus fractures (SHF) are among the most common fractures in children, often requiring surgical intervention for displaced fractures. Various pin fixation techniques, including cross pinning and lateral pinning, are commonly used to maintain reduction. The preferable method fixation remains debated considering the complications and the biomechanical stability of fixation.
Objective: This study aims to compare the outcomes of two K-wire fixation techniques—cross pinning and lateral pinning—in paediatric patients with displaced supracondylar humerus fractures.
Methods: An institution-based prospective study was conducted at Medical College and Hospitals, Kolkata, over 18 months (January 2021 to June 2022). Thirty paediatric patients under 18 years with displaced supracondylar humerus fractures were recruited. Fifteen patients were treated with cross K-wire fixation, while 15 received lateral K-wire fixation. Clinical and radiological outcomes, including range of motion, ulnar nerve palsy, fracture reduction stability, and Baumann's angle, were assessed at 3 weeks, 6 weeks, 3 months, and 6 months postoperatively.
Results: Out of 30 patients, 26 showed satisfactory results according to Flynn's criteria. No loss of reduction occurred in either group. However, more patients in the lateral pinning group experienced mild loss of flexion (4 to 7 degrees). Three patients in the cross pinning group had partial ulnar nerve injuries, which fully recovered within 3 weeks. No nerve injuries were noted in the lateral pinning group.
Conclusion: Cross pinning offers greater stability for displaced supracondylar humerus fractures but carries a risk of ulnar nerve injury. Lateral pinning provides comparable stability and is a safer option to avoid nerve injury. Both techniques are effective in maintaining reduction, but lateral pinning may be preferred in cases where nerve injury is a concern.

Keywords: Supracondylar humerus fracture, pediatric, K-wire fixation, cross pinning, lateral pinning, ulnar nerve injury, biomechanics, fracture stability

Introduction

Supracondylar humerus fractures (SHF) are one of the most prevalent types of fractures in children, representing 50-70% of elbow fractures. These fractures often require surgical intervention, especially when they are completely displaced. The most common age group affected is between 5 and 7 years, and boys experience a higher incidence than girls, with a ratio of 3:2 [1].

The medial and lateral columns of the distal humerus are linked by a narrow segment of bone between the olecranon fossa at the back and the coronoid fossa at the front. This thin bony connection makes the area particularly prone to fractures.

Displaced SHF in children most commonly treated with closed reduction and percutaneous pin fixation [2-4]. Surgical intervention is typically required for completely displaced fractures. Various pin fixation methods have been outlined, such as crossed pinning and lateral pinning techniques [5-6].

Biomechanical research has demonstrated that the greatest stability is achieved with two crossed pins inserted from the medial and lateral condyles [7-8]. Ulnar nerve injury, which occurs in up to 6% of cases with the use of a medial pin, is a common complication. This risk is particularly high when the medial epicondyle is difficult to palpate due to swelling around the elbow [9].

Several techniques for Kirschner (K) wire fixation are used in supracondylar humerus fractures, with conventional K wire fixation being the most widely employed surgical method. However, there is ongoing debate regarding the ideal K wire configuration for displaced Gartland type II and III fractures [1].

In our study, we compared the outcomes of displaced supracondylar fractures treated with two different fixation methods. One group was fixed using the conventional cross K wire technique, while the other group underwent fixation with two K wires placed from the lateral to the medial side. The study was designed to provide insight into the progress and results of treatment with these different approaches throughout the course of therapy.

Materials and Methods

This prospective study was conducted at a Medical College and Hospital in Kolkata, with ethical approval from the institution's Ethics Committee, over an 18-month period (January 2021 to June 2022). The study aimed to assess the outcomes of two different K-wire fixation techniques for supracondylar humerus fractures in pediatric patients under 18 years of age. A total of 30 patients participated, with 15 receiving cross K-wire fixation and the remaining 15 receiving lateral K-wire fixation. Inclusion criteria focused on patients with supracondylar humerus fractures, while excluding those with open fractures, undisplaced fractures, comorbidities, or neurovascular issues. Follow-up evaluations were performed at 3 weeks, 6 weeks, 3 months, and 6 months, including both clinical and radiological assessments such as range of motion, ulnar nerve function, post-operative reduction stability, and Baumann's angle.

Surgical procedures followed strict aseptic protocols. Displaced supracondylar fractures were treated using two different K-wire fixation techniques: one group received fixation with two lateral K wires, while the other group underwent fixation with two crossed K wires. The surgery was performed under general anesthesia, with the patient in a supine position. Traction was applied to reduce the fracture in the transverse plane, followed by manipulation in the medio-lateral plane (Figure 1). The elbow was then flexed, and the olecranon was pushed anteriorly to correct any sagittal deformity (Figure 2). Satisfactory reduction was assessed based on the following criteria: In the anteroposterior radiograph, Baumann's angle should be greater than 10 degrees, in the oblique radiograph, both the medial and lateral columns should remain intact and in the lateral view, the anterior humeral line should pass through the middle third of the capitellum. For cross pinning (Figures 2, 3, and 4), the lateral pin was inserted first, followed by the medial pin, ensuring precautions to avoid ulnar nerve injury. For lateral pinning, two wires were placed in either a divergent or parallel configuration (Figures 5 and 6) and checked for rotational stability. If instability was noted, a third pin was added. The elbow was stabilized in 60 to 90 degrees of flexion, depending on the vascular status. If a gap was observed at the fracture site or if the fracture could not be reduced with a rubbery feel, there was a possibility of median nerve and brachial artery entrapment, requiring open reduction.

All patients were administered intravenous antibiotic prophylaxis. The K-wire was removed at three weeks, after which active elbow movements were encouraged. Follow-up imaging, including digital X-rays of the elbow joint, was conducted at each visit to monitor fracture healing. The goal of the study was to offer comparative data on both the clinical and radiological outcomes of the two fixation techniques in pediatric patients with supracondylar humerus fractures.

Results

This comparative study was carried out at Medical College and Hospitals, involving 30 patients who met the inclusion criteria for supracondylar humerus fractures and were treated with K-wire fixation, either through lateral pinning or cross pinning. The study spanned 18 months, from January 2021 to June 2022, with 10 months dedicated to patient recruitment, 6 months for follow-up, and 2 months for statistical analysis. The findings of this study are summarized in Table 1.

Discussion

The treatment of displaced supracondylar humerus fractures in children typically involves either closed or open reduction, followed by stabilization using Kirschner wires. The success of the surgical approach largely depends on achieving an accurate initial reduction and maintaining that reduction until the fracture heals.

There is ongoing debate about the optimal pin fixation technique for displaced supracondylar humerus fractures in children. The most commonly used methods are crossed medial and lateral pinning, and lateral pinning alone.

Cross pinning offers the advantage of providing the greatest stability for the fracture. However, it carries the risk of iatrogenic ulnar nerve injury during the placement of the medial pin. On the other hand, lateral pinning eliminates the risk of ulnar nerve injury but offers slightly less biomechanical stability.

Biomechanical studies conducted by Hilton *et al*. [10], using both adult cadaver and paediatric bone models, have shown that cross pinning offers greater rotational stability compared to lateral pinning. However, with careful attention to the pin entry site, pin configuration, and the number of pins inserted from the lateral side, lateral pinning can provide stability comparable to that of cross pinning.

In our study, 30 patients were included, with 15 patients receiving lateral pinning and 15 patients undergoing cross pinning. According to Flynn's criteria [11], 26 patients achieved satisfactory outcomes. Among the 15 patients who underwent lateral pinning, 5 experienced a loss of carrying angle of less than 5 degrees, which was attributed to inadequate initial reduction rather than loss of reduction. Similarly, among the 15 patients who received cross pinning, 10 had a loss of carrying angle of less than 5 degrees, which was also due to initial inadequate reduction and not a result of loss of reduction.

These findings align with the study by Foead *et al*. [12], who compared the two methods of percutaneous pin fixation for displaced supracondylar humerus fractures in children.

Among the 15 patients who underwent lateral pinning, 5 experienced a loss of 5 to 10 degrees of elbow flexion, and 2

patients had a loss of flexion between 10 to 15 degrees. In the 15 patients who received cross pinning, 2 patients had a loss of flexion between 5 to 10 degrees. The two lateral pinning cases with a flexion loss of 10 to 15 degrees were attributed to inadequate initial reduction. A higher number of patients in the lateral pinning group experienced a loss of 5 to 10 degrees of flexion compared to the cross pinning group, which was likely due to open reduction.

Of the 15 cases in each group, 13 lateral pinning and 13 cross pinning procedures were performed with closed reduction. This may have contributed to the greater loss of flexion observed in the lateral pinning group, rather than being related to the pinning configuration itself.

There was no loss of reduction observed in either the cross pinning or lateral pinning groups. This finding is consistent with the results reported by Skaggs *et al.* [13], who found no loss of reduction in a series of 55 type III fractures treated with lateral pinning. Similarly, Topping *et al.* and Foead *et al.* [12] also reported no loss of reduction in their lateral pinning series.

In our study, there were 3 cases of partial ulnar nerve injury among the 15 patients who underwent crossed pinning for supracondylar humerus fractures in children. This is similar to Skaggs *et al.* [13], who reported an 8% incidence of ulnar nerve injury in the cross pinning group. To minimize the risk of ulnar nerve injury, we used the flexion-extension method during the procedure. In our cases, the ulnar nerve injuries fully recovered within 3 weeks. Additionally, no nerve injuries were observed in the lateral pinning group, which aligns with the findings of Skaggs *et al.* [13].

Table 1: Comparison of Clinical and Radiological Outcomes between Group A and Group B

Particulars		Group A	Group B	P value
Age (Yrs)		5.3±2.55	4.7±1.98	0.399015
Sex	Female	10	11	0.690328
	Male	5	4	
Side	Right	3	5	0.408961
	Left	12	10	
Injury to surgery time (Hrs)		16.6±2.82	15.8±4.84	0.455765
Reduction	Open	2	2	1
	Closed	13	13	
Displacement	Posteromedical	11	14	0.141645
	Posterolateral	4	1	
Post op loss of reduction	Yes	0	0	1
	No	15	15	
Post op neurological deficit	Yes	0	3	0.067889
	No	15	12	
Pin tract infection	Yes	1	2	0.542802
	No	14	13	
Loss of carrying angle	Yes	0	0	1
	No	15	15	
Range of motion	Total range	131.33	128.67	0.651109
Bauman angle loss		5±0.76	5±0.84	0.692417
Flynn's criteria	Satisfactory	13	13	1
	Unsatisfactory	2	2	
Follow up		6.13±1.68	5.67±1.39	0.323839

Fig 1: Reduction technique applying traction

Fig 2: Followed by elbow flexed and olecranon pushed anteriorly

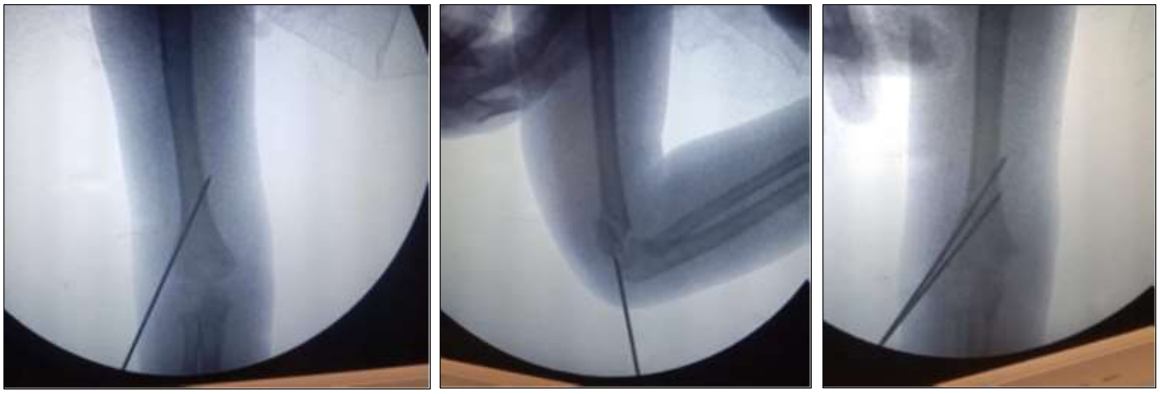

Fig 3-5: Intraoperative X rays of cross k-wire fixation

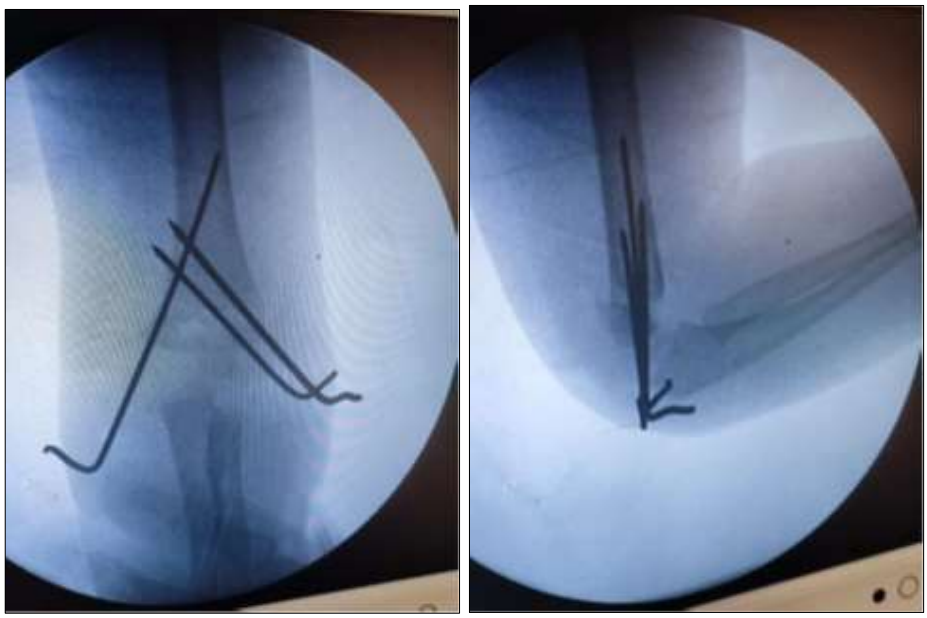

Fig 6, 7: Intraoperative X rays of lateral k-wire fixation

Fig 8: Preoperative X ray

Fig 9: Preoperative X ray

Fig 10: Preoperative and postoperative X rays of lateral k-wire fixation

Fig 11: Postoperative range of motion after 3 months (of lateral k-wire fixation)

Fig 12: Postoperative range of motion after 3 months (of lateral k-wire fixation)

Conclusion

Cross pinning is considered the most stable method for maintaining the reduction of supracondylar humerus fractures in children. Lateral pinning, however, offers comparable stability in preserving the reduction of these fractures. Despite taking measures to protect the ulnar nerve, cross pinning carries a definite risk of iatrogenic ulnar nerve injury. On the other hand, lateral pinning is considered a safer option to minimize the risk of nerve damage during the management of supracondylar humerus fractures in children.

Conflict of Interest

Not available.

Financial Support

Not available.

Limitations

The small sample size, single-center study, exclusion of patients with medical comorbidities, and the relatively short follow-up period limit the generalizability and strength of the study's conclusions.

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