

Percutaneous lateral only Kirschner wire fixation in supracondylar humerus fractures in children.

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Abstract

Background and Aim: Supracondylar fractures of humerus is the commonest injury in children, and it constitutes about 65.4% of all fractures about the elbow in children. There is a lot of controversy regarding the optimum pin configuration in the treatment of supra condylar fractures in children. Lateral pinning has fewer complications with regards to ulnar nerve injury but is said to be bio mechanically less stable than crossed pinning. In this study, we have evaluated the functional outcome of lateral only pinning in treatment of supracondylar humerus fractures.

Materials and Methods: Twenty-five patients with supracondylar fractures admitted between Jan 2021 and June 2022 were recruited into the study. All patients were operated with closed reduction and percutaneous

lateral pin fixation. Results were analyzed using Flynn's criteria. All patients were followed up to 6 months post-operatively.

Results: Twenty - five supra condylar fractures of humerus, aged between 3 to 13 years, were treated using close reduction and percutaneous lateral only Kirschner (K) wire fixation under the c-arm image intensifier. Above elbow slab was applied in all cases for at least 4 weeks.

The slab and K-wires were removed after 4 weeks and elbow range of motion exercise was started. 36% had excellent, 16% good, and 48% had fair results at 8th weeks, which was improved to 60% excellent, 16% good, 24% fair and no poor result at final follow-up. There was no iatrogenic neuro logical injury either for the ulnar or for the radial nerves.

2 patients developed superficial pin tract infection postoperatively and were treated conservatively with good healing and no long-term sequelae.

Conclusion: Closed reduction and percutaneous lateral pinning proved an efficient, reliable, and safe method in the treatment of supracondylar fractures of the humerus in children.

Keywords: Supra condylar fracture, humerus, closed reduction, lateral pinning

Introduction

A distal humerus fracture immediately above the elbow joint is known as supracondylar humerus fracture. One of the most common fractures in children is supracondylar fracture of humerus.^[1-3]

Children between the age of 4 to 7 years are most likely to sustain a supracondylar fracture of humerus, which accounts for 50-70% of all fractures in this area.^[4-5]

Over 95% of cases include a fall on to an extended arm, which is most common mechanism of injury.^[6] Another mechanism of injury is direct trauma to the posterior region of the flexed elbow, causing the distal fragment to deviate anteriorly.

Gartl and classification is most commonly used to classify supracondylar humerus fractures. Gartl and classification is divided into 3 types (i.e., type I: undisplaced or minimally displaced, type II: displaced, but with intact posterior cortex, and type III: completely displaced with no cortical contact).^[7] 11.3% of patients experience trauma related nerve injury, while vascular lesion accounts for less than 1% of these fractures. Anterior Interosseus Nerve is the most common nerve injured in the extension type of supracondylar humerus fractures.

Ulnar nerve is the most common nerve injured in flexion type of supracondylar humerus fractures. Additionally,

iatrogenic injury to ulnar nerve could occur during percutaneous fixation of the medial column of the distal humerus.^[8]

Following a fall, the child usually complains of an elbow pain or failure to use the upper extremity, which may be associated with neurovascular injuries or deformities.^[9] The majority of neurovascular injuries are neuropraxias ranging from 5-19%. According to the reports, 5-12% of patients suffer from neurovascular injuries, therefore when examining the patient, the neurovascular condition should be evaluated and recorded.^[9-12]

The most common residual deformity following supracondylar fractures is cubitus varus, which is usually due to malreductions that promote distal fragment to go into rotational displacement. Other causes include growth arrest caused by physal injuries and medial column comminution developing reduction loss during the follow-up.^[13]

The goal of surgical treatment of displaced and unstable fractures (Gartl and types II and III) is to obtain a stable reduction, prevent neurovascular injuries, avoid compartment syndrome, and lower the risk of residual deformities, particularly cubitus varus.

Closed reduction and percutaneous Kirschner wire (K-wire) fixation is the standard treatment for supracondylar humerus fracture. Different configurations can be utilised to achieve this fixation; the most commonly used are 2 crossed wires and fixation in the lateral column.^[14,15]

According to the biomechanical trials, the configuration that shows most stable fixation while fixing the supracondylar fractures is placement of 2 crossed K-wires,^[16] one in the lateral column of the distal end of the humerus and the other in the medial column of the distal end of humerus. Due to the close anatomical relationship

of ulnar nerve with the posterior surface of the medial epicondyle, there is risk of iatrogenic injury to the ulnar nerve. To minimize this complication, alternatively the supra condylar humerus fractures can be fixed with parallel or divergent K-wires only at the lateral column of the humerus.

This configuration is less stable and could lead to residual deformities such as cubitus varus but also avoids injury to ulnar nerve. To conclude, the most effective technique for the treatment of displaced supracondylar humerus fractures is still up for debate.

[17,18]

Aims and objectives

Aim

To study the results obtained by the management of Supracondylar fractures of humerus by lateral only K-wire fixation

Objective

To study the efficacy and functional outcome in patients treated with lateral only K-wires in supracondylar fracture of humerus and evaluate the results in terms of:

- Duration of immobilization
- Treatment related complications
- Prevention of deformity due to malunion

Materials and methods

This prospective study was carried out at Department of Orthopaedics at PCMC's PGI YCM Hospital, Pimpri from Jan 2021 to June 2022. It was approved by institutional medical ethics committee. A written informed consent was obtained from all the patients (by their parents). A total of 25 children with supracondylar humerus fracture were included in this study. Inclusion Criteria: i. Fresh Gartl and type I, type II and type III fractures, ii. before fusion of physeal line of humerus, iii. Supra condylar fractures without neuro vascular

complications. Exclusion criteria: i. Neurovascular complications, ii. Malunited fractures, iii. Fractures more than 2-week-old, iv. Poor general health of the patient, v. Comminuted fractures. Out of 25 patients 14 were male and 11 were female, 16 were Gartl and Type II supracondylar humerus fractures and 9 were Gartl and Type III supracondylar humerus fractures. All patients were operated under general anaesthesia within 24 h after trauma using the percutaneous lateral pin fixation. Under general anaesthesia, using c-arm image intensifier, closed reduction was done.

The fracture is first reduced in the coronal plane with the elbow in extension while gentle longitudinal traction is applied. At the same time counter traction is given by an assistant by holding proximal portion of arm. Rotation of the fragment is corrected by pronating or supinating the forearm. Finally, the extension is corrected by pushing the olecranon while flexing the elbow.

Fracture is stabilized by maintaining the elbow in maximum flexion to stabilize the fracture When satisfactory reduction is achieved then fixation is done by 2 lateral K-wires of 1.8- or 2.0-mm size. In the lateral fixation technique, the first K-wire is inserted within the lateral column and should achieve strong purchase in the medial cortex of the proximal fragment.

It can either engage, or just penetrate, this cortex. The second K-wire is inserted from the lateral side into the medial column through the capitellar secondary ossification Centre. Occasionally K-wire can be inserted through the lateral column and pass through the olecranon fossa to achieve 4 cortices purchase for a more stable fixation.

The pins are bent and cut off outside the skin and a well-padded, above elbow slab is applied. The elbow can be held in any position without losing the reduction, and the

optimum position, usually 60-90° of elbow flexion, allowed free blood flow. Follow up was done on OPD basis at 1, 3 months and 6 months post operatively. The follow up included clinical and radiological evaluation and results were assessed based on: i. Pain, ii. Swelling, iii. Tender ness at fracture site, iv. Movements of elbow, v. Carrying angle, vi. Union of the fracture, vii. Baumann’s angle.

Results

There were 25 children in this study, 14 children were male and 11 children were females. The children were aged 3 years to 13 years. There were 13 left sided and 12 right-sided fractures. 16 were Gartl and Type II supracondylar humerus fractures and 9 were Gartl and Type III supracondylar humerus fractures. All the cases were treated by two lateral parallel or divergent K-wires. During follow-up, we did not found secondary displacement of wires and loss of reduction. Post-operatively, two (8%) patients got pin tract infection, which was superficial and healed after removing pins and oral antibiotic administration and 1(4%) developed elbow stiffness which improved with physiotherapy. Post-operatively there was no ulnar nerve injury in any patients. Callus formation was seen in all patients at the 4th week postoperatively before removing the K-wires. The fracture united in majority of the cases at 4th week post-operatively with mean fracture union time being 4.52 weeks with a SD of 0.7 weeks.

Among study participants, mean elbow flexion was 122.2 degrees with a SD of 12.68 degrees at 3 months follow up and 127.2 degrees with a SD of 13.1 degrees at 6 months follow up. Among study participants, mean elbow Extension lag was 2.2 degrees with a SD of 0.8 degrees at 3 months follow up and 1.3 degrees with a SD of 0.2 degrees at 6 months follow up.

Among study participants, mean post operative Baumann’s angle was 69.24 with a SD of 8.09, mean post operative Carrying angle was 8.16 with a SD of 3.06. Results were analysed using Flynn’s criteria and DASH score. All patients were followed at 1,3 and 6 months post-operatively.

According to Flynn’s criteria, 36% had excellent, 16% good, and 48% had fair results at 3 months, which was improved to 60% excellent, 16% good, 24% fair and no poor result at the final 6 months follow-up.

According to DASH score, 28% had excellent, 44% good, and 28% had fair results at 3 months, which was improved to 44% excellent, 32% good, 24% fair and no poor result at the final 6 months follow-up. During this study, complications like vascular injury, compartment syndrome, myositis ossifications, cubitus varus, significant mal-union and non-union were not seen.

Table 1: Post operative complications

Complications	Number of Patients	Percentage
Nil	22	88
Superficial infection	2	8
Elbow stiffness	1	4

Table 2: Flynn criteria

Results	Rating	Loss of carrying angle (degrees)	Loss of Motion (degrees)
Satisfactory	Excellent	0-5	0-5
	Good	5-10	5-10
	Fair	10-15	10-15
Unsatisfactory	Poor	>15	>15

QuickDASH-9

INSTRUCTIONS: This questionnaire asks about your symptoms as well as your ability to perform certain activities. Please answer every question, based on your condition in the last week, by circling the appropriate number. If you did not have the opportunity to perform an activity in the past week, please make your best estimate of which response would be the most accurate. It doesn't matter which hand or arm you use to perform the activity; please answer based on your ability regardless of how you perform the task.

Rate your ability to do the following activities in the last week by circling the number below the appropriate response.

	NO DIFFICULTY	MILD DIFFICULTY	MODERATE DIFFICULTY	SEVERE DIFFICULTY	UNABLE
1. Open a light or new jar.	0	1	2	3	4
2. Do heavy household chores (e.g., wash walls, floors).	0	1	2	3	4
3. Carry a shopping bag or briefcase.	0	1	2	3	4
4. Wash your back.	0	1	2	3	4
5. Use a knife to cut food.	0	1	2	3	4
6. Recreational activities in which you take some force or impact through your arm, shoulder or hand (e.g., golf, hammering, tennis, etc.).	0	1	2	3	4

	NOT AT ALL	SLIGHTLY LIMITED	MODERATELY LIMITED	VERY LIMITED	UNABLE
7. During the past week, to what extent has your arm, shoulder or hand problem interfered with your normal social activities with family, friends, neighbors or groups?	0	1	2	3	4

	NOT AT ALL	SLIGHTLY LIMITED	MODERATELY LIMITED	VERY LIMITED	UNABLE
8. During the past week, were you limited in your work or other regular daily activities as a result of your arm, shoulder or hand problem?	0	1	2	3	4

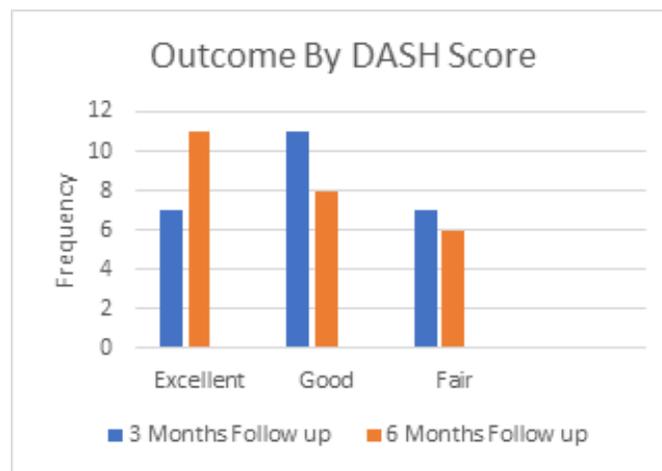
	NONE	MILD	MODERATE	SEVERE	EXTREME
9. Arm, shoulder or hand pain.	0	1	2	3	4

A QuickDASH-9 score may not be calculated if there is greater than 1 missing item.
 QuickDASH-9 SCORE = [(sum) x 1.1] x 5/9, a missing response is added as the average of the remaining.

Table 4: Results according to DASH Score

Outcome by DASH Score	3 Months follow up (Patients/ Percentage)	6 Months follow up (Patients/ Percentage)
Excellent	7 (28%)	11 (44%)
Good	11 (44%)	8(32%)
Fair	7 (28%)	6(24%)
Poor	0	0

Graph 2: Results according to DASH Score



Discussion

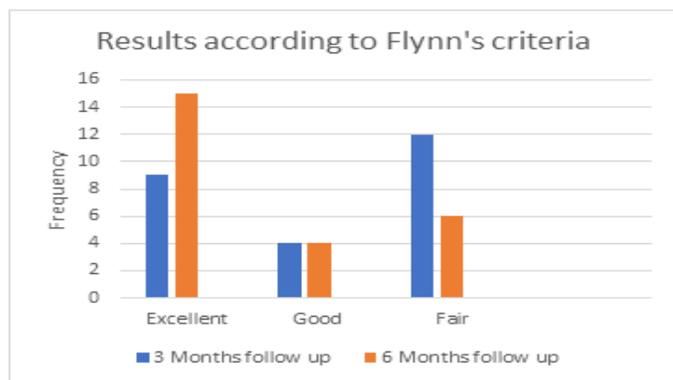
The aims in the management of the supracondylar fracture are to reduce and fix the fracture whilst reducing morbidity and deformity. Iatrogenic ulnar nerve injury and loss of anatomical reduction are the two demerits that lead to malunion with poor functional outcome. The two techniques that are debated are cross K wire fixation and lateral only K wire fixation. Advantage of using cross K wires is that it increases the stability of fracture fixation there by decreasing the chances of loss of reduction but it increases the risk of iatrogenic ulnar nerve injury. On the other hand lateral k wire fixation avoids ulnar nerve injury but has been debated for its stable fixation. Bio mechanical studies suggest that crossed wires provide greater torsional stability. [19-22] The strength using crossed wires can be further

This score rates the ability of patients to perform different activity and graded them into different category. The subjective and objective and radiographic findings was quantified by demerit system of Gartl and werley. The outcome of fracture grade as Excellent, Good, Fair and Poor based on scores 0-5,6-15,16-35 and >35 respectively.

Table 3: Results according to Flynn's criteria

Flynn's Criteria		3 Months follow up (Patients/ Percentage)	6 Months follow up (Patients/ Percentage)
Satisfactory	Excellent	9 (36%)	15 (60%)
	Good	4 (16%)	4 (16%)
	Fair	12 (48%)	6 (24%)
Unsatisfactory	Poor	0	0

Graph 1: Results according to Flynn's criteria



improved by increasing the number of wires and divergence of the wires in the distal humerus^[22]. Failures of laterally placed wires have been reported that are thought to be due to poor technique in reduction and fixation.

Increased incidence of iatrogenic nerve injury has been observed with cross K wire fixation when a medial wire is used. In a study done by Skaggs et al^[23], 124 children were treated with only lateral entry pins and the outcome was no loss of reduction and zero ulnar nerve injury. In another study of Skaggs et al^[24] Of 204 children who had a Gartl and Type III fracture, 51 were treated with lateral pins only and 153 were treated with crossed pins. The configuration of the pins did not affect the Baumann's angle in Gartl and Type III fractures. The most common complication in the treatment of closed reduction and percutaneous pinning of displaced supra condylar fractures of the humerus is iatrogenic ulnar nerve palsy when cross K wire fixation is done as observed in several studies.^[25-29] The rate of ulnar nerve injuries varies in different studies. Lyons et al.^[25] have reported this number as 6%, Royce et al.^[27] as 3%, Agus et al.^[28] as 58%. It is found that post-operative nerve palsies after percutaneous pinning was with direct injury to the nerve, not after manipulation of closed reduction.^[26,27,30]

In this study there were no iatrogenic nerve injuries, there was no loss of range of motion and all cases had satisfactory result according to Flynn's criteria and DASH score.



Fig 1: Pre op X ray

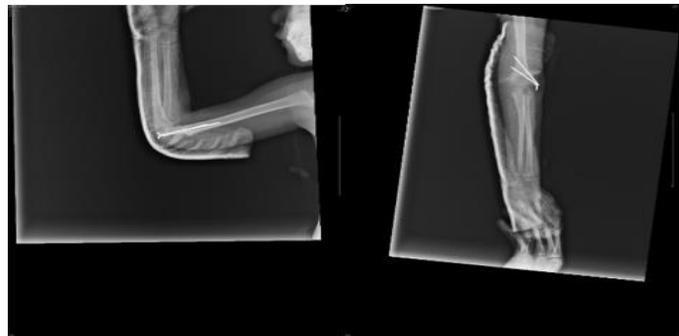


Fig 2: Immediate Post operative X ray

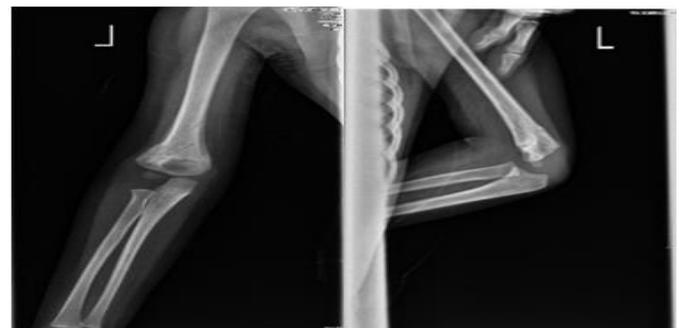


Fig 3: 6 months follow up x ray



Figure 4: 6 month follow up clinical image

Conclusion

Supracondylar fractures of humerus are common in children due to anatomical characteristics of

distal end of humerus and elbow in the pediatric age group. Supracondylar fractures of humerus are more common in boys than girls. As the incidence of malunion is high anatomical reduction must be achieved before Kirschner's wire fixation. Rigid fixation can be achieved by lateral Kirschner's wire fixation put through the lateral epicondyle. The method is safe, simple and effective. This method also prevents iatrogenic injury to ulnar nerve. With this technique, consistently satisfactory results can be obtained both cosmetically and functionally. By this method, we achieved early mobilization of the elbow with good range of movement and fewer complications.

Hence, we conclude that closed reduction and Lateral only Kirschner's wire fixation is a safe, effective and reliable treatment option for supra condylar fracture of humerus in children with consistently reproducible results.

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