

## Study of Complex Supracondylar Humerus Fracture and its Functional Outcomes

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### Abstract:

**Introduction:** The fractures, specially upper limb, are frequent among children due to their nature of behaviour. Emergency intervention is usually required. There are two types of managements that are given. Open Reduction and Internal Fixation or Kirschner wire (K-wire), is used as intervention. There are debates regarding the efficacy of the managements. This study also analyzed the other parameters associated with cosmetic and duration of these interventions.

**Aims and Objectives:** This study intends to find out the comparison between the clinical outcome of K-wire and ORIF in terms of efficacy, duration to fracture union and other related findings.

**Materials and Methods:** This retrospective study was conducted by extracting information and records from the hospital who had supracondylar humerus fracture and were given either K-wire or ORIF management. The patients were classified into 2 groups, namely, those patients who were managed with multiple Kirschner wire (K-wire) and those who were managed with Open Reduction and Internal Fixation. After the operation, the patients were followed up after every after 3 weeks of their surgery. At the final follow up (which was about 10 to 14 weeks as per individual patient's requirement), range of motion was tested and clinical outcomes were analyzed.

**Results:** The study has found that the patients whose received K - wire management had significantly lower follow-up time ( $p < 0.05$ ) and duration of surgery ( $p < 0.05$ ). The study further pointed out that the cosmetic outcome was significantly satisfactory ( $p < 0.05$ ) among the K-wire group as compared to ORIF group.

**Conclusion:** The study has concluded that the clinical outcome of both the managements are statistically similar. The acceptable and poor cosmetic outcome between the two groups are insignificant but there is significant difference ( $p < 0.05$ ) between the two groups in case of satisfactory outcome. The study also concluded that the follow up time and mean duration of surgery is significantly less if the patient is managed by K-wire as compared to the patients receiving ORIF management.

**Keywords:** K-Wire, Open Reduction, Internal Fixation, Supracondylar Fracture, Humerus Fracture.

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### Introduction

The most typical type of fracture in children, which accounts for up to 65% of elbow fractures, is a supracondylar fracture of the humerus; in children, it accounts for up to 20%. Infants and children are more likely than adults to sustain an elbow fracture. When children fall, they frequently use an extended arm as a braking technique, which increases the risk of elbow fractures. Fracture patterns and treatment recommendations are frequently described using the modified Gartland classification. Due to the dangers of compartment syndrome, brain injury, and injuries in the vascular system these injuries may be severe. Malunion and deformity can also result from inadequate reduction and fixation. In the long run, some patients who experience a malunion might function satisfactorily [1,2].

Clinical characteristics include a painful, inflamed elbow that is difficult for the patient to move after high-intensity trauma or a big fall. In the following situations, an emergency room orthopedic assessment is recommended: absence of radial pulse, pallor and cold extremities, severe swelling of the forearm or elbow, anterior bruising, skin puckering, or an open injury. The damaged extremity's wrist must be felt for both ulnar and radial pulses. Other perfusion indicators, including temperature, the color of the hand may be pink, oxygen saturation, and capillary refill on a pulse oximeter must be examined in the event of pulselessness. Children who show signs of vascular damage should have an ultrasound with Doppler flow done. The arm and any additional areas of deformities, pain, or tender areas should be seen in a Lateral and anterior-posterior view on the typical

radiography examination of the injured limb. Since supracondylar fractures and forearm fractures often occur together, AP and lateral radiographs of the forearm should also be taken. In order to prevent any nerve injury or the aggravating pain of it by the broken parts of the bone, radiographs should only be taken after the necessary analgesics and splinting of the affected extremity [3,4,5].

In order to address supra-condylar humerus fractures, the modified Gartland classification is now the most popular categorization scheme. Treatment options include surgical management, including open or closed reduction and K-wire fixation, as well as conservative management methods including closed reduction and splinting/casting. Gartland classification is a radiographic classification that does not take the clinical context into account, hence it cannot anticipate the severity of the injury. According to Gartland, there are three main sub-types of the extension kind of supracondylar fracture: Undisplaced transverse fractures are Gartland extension type I injuries. Initial descriptions of Gartland Extension type II fractures called for a reduction since they were "moderately posteriorly displaced." Oblique fractures of the Gartland Extension type III have significant displacement and rotation. Pediatric supracondylar fractures of the humerus are treated using the classification system given by Gartland, although the system's variation, IIa versus IIb, appears to have scanty utility and dependability [6,7,8].

During a radiographic evaluation, it is imperative to check these three vital characteristics of a typical elbow: In all views, the head of the radius must point to the capitellum, the anterior humeral line must cross it in the lateral view, and Baumann's angle must be in the valgus position. When administering care, we must keep in mind that a hand with no pulse and inadequate perfusion requires an immediate reduction rather than an arteriogram. The use of K-wires is always safer when flexion of greater than 90 degrees is required to maintain a reduction, as it increases the risk of compartment syndrome if the fracture is continued past that point [4].

Usually, a fall from a height with the arm extended results in an injury. About 6 years old is the average age. Conservative care is used to treat nondisplaced

fractures using a cast. A cast alone should not be used to repair displaced fractures since this may result in malunions and long-term neurovascular issues. In comparison to immobilization in cast alone, the rate of problems following traction of displaced fractures is significantly reduced. Traction and percutaneous pinning have comparable outcomes, although percutaneous pinning is less expensive, mostly because the hospital stay is reduced. Additionally, there appears to be a decrease in the chance of cubitusvarus deformity. Today, percutaneous pinning and closed reduction are the preferred treatments. The surgeon is free to choose the pin configuration [9].

### Materials and Methods

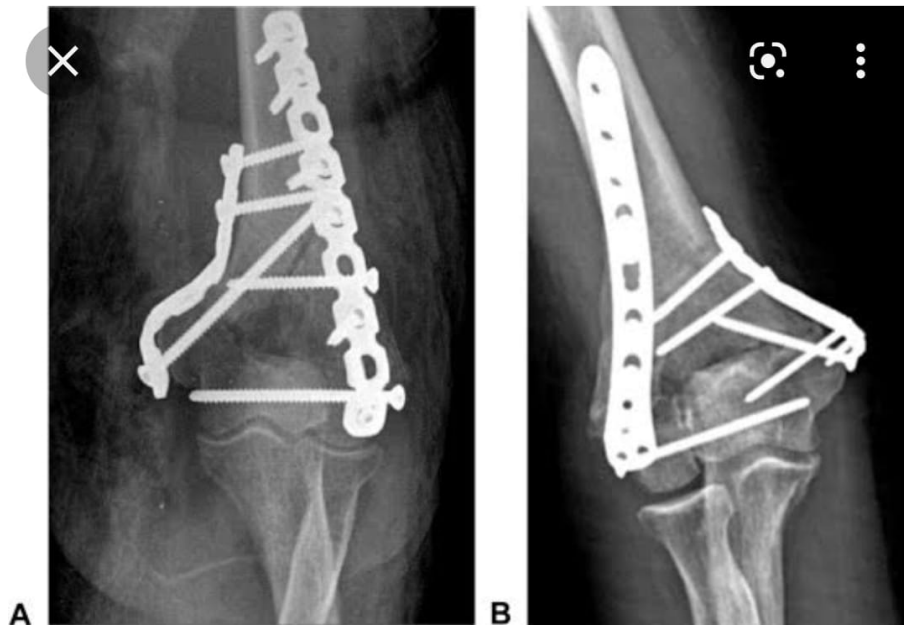
**Study Design:** This is a retrospective cohort study which included patients who visited the orthopaedic department of our hospital. The patients considered in this study visited the hospital from September 2022 to July 2023. The records of the patients were obtained from the hospital and analyzed accordingly. The patients were classified into 2 groups, namely, those patients who were managed with multiple Kirschner wire (K-wire) and those who were managed with Open Reduction and Internal Fixation (ORIF). ORIF was given to the patients in paratricipital approach or tricep sparing approach. The patients were not given olecranon osteotomy and both the groups have been given fixation using transarticular screw (criss-cross type). The patients who received ORIF, were given fixation with 6 screws by using 2-incision technique. Mobilisation of the upper limb of the patients was started at 10th day of the surgery to allow sufficient soft tissue healing. The patients who received K-wires, were given stainless steel K-wires of 1.5 to 2.5 mm in diameter according to the requirement. After the operation, the patients were followed up after every after 3 weeks of their surgery. At the final follow up (which was about 10 to 14 weeks as per individual patient's requirement), range of motion was tested and clinical outcomes were analyzed according to Table 1 [9-10]. The cosmetic outcome was also taken into consideration (Table 2). Individual patient's requirements include the status of bone union, status of soft tissue healing and inflammation, restoration of range of movements. Figure 1 shows the Internal Fixation on X-ray.

**Table 1: Classification of Clinical Outcomes**

Clinical Outcome	Features	Loss of rotation of forearm
Very Poor	Cannot do any activity satisfactorily	
Fair	Mild complaint while doing daily activities	31° to 90°
Good	Mild complaint while doing strenuous activities	11° to 30°
Excellent	No complaint with any activity and specially no complaint with any strenuous activity	Less than 11°

**Table 2: Classification of Clinical Outcomes**

Cosmesis	Patient's features
Excellent	No complaint
Acceptable	Conspicuous but patient is comfortable
Poor	Scar formation which is not tolerated by patient



**Figure 1: Internal Fixation in X-Ray as done in the patients of this study**

**Inclusion and Exclusion Criteria**

The patients who had complex supracondylar humerus fracture from 8 years to 15 years, were included which was initially 70 patients. The patients who were included in this study, followed the management protocol, visited every follow up session.

The patients who had more fractures at different sites other than supracondylar humerus, were excluded. The patients who had chronic malnutrition were also excluded.

After applying inclusion and exclusion criteria, the number of patients considered finally for this study was 50.

**Ethical Approval**

The study has acquired relevant consent from each patient's parents and also obtained the permission from the hospital to obtain the patients' information

and clinical records. The study process has been verified to make it in accordance with Declaration of Helsinki (World Medical Association).

**Statistical Analysis**

The study has used SPSS 25 and excel software for effective statistical analysis. The descriptive measurements were expressed mean±standard deviation. The categorical variables were analyzed by using Pearson's Chi-Square test while continuous variables were analyzed using Mann-Whitney U-test. The study considered  $\alpha = 0.05$  as the level of significance.

**Results**

The study has analyzed the baseline characteristics of the patients and the findings of the patients on arrival. The fractures were classified and analyzed accordingly. The patients were analyzed based on their management received.

**Table 3: The baseline characteristics of the patients in each group**

Parameter	K - wire group n = 25	ORIF group n = 25	p-value
Mean age	11.1±2.4	11.3±2.6	p>0.05
Male/Female	18/7	20/5	p>0.05
<i>Type of supracondylar fracture</i>			
Flexion	1	2	p>0.05
Extension	24	23	p>0.05
<i>Garland Classification</i>			
Type 1	8	10	p>0.05
Type 2	11	11	p>0.05

Type 3	6	4	$p>0.05$
Type 4	0	0	$p>0.05$
<i>Etiology</i>			
Fall	17	14	$p>0.05$
Bicycle accident	3	5	$p>0.05$
Others	5	6	$p>0.05$

The study found and analyzed the several outcome related data including follow-up time, clinical outcome of the patients, superficial infection, cosmetic output, mean duration of surgery and mean time to complete union. The study has found that the patients who received K - wire management had

significantly lower follow-up time ( $p<0.05$ ) and duration of surgery ( $p<0.05$ ). The study further pointed out that the cosmetic outcome was significantly satisfactory ( $p<0.05$ ) among the K-wire group as compared to ORIF group.

**Table 4: The result of the managements given to the patients obtained during follow-up**

Outcome	K - wire group n = 25	ORIF group n = 25	p-value
Follow up time (months)	21±6.5	29.1±7.3	$p<0.05$
Mean duration of surgery (minutes)	61.25±11.25	73.25±18.25	$p<0.05$
Mean time to complete bone union (weeks)	7.6±2.5	9.7±3.1	$p>0.05$
Superficial Infection	0	2	$p>0.05$
<i>Clinical Outcome</i>			
Excellent	22	17	$p>0.05$
Acceptable	3	7	$p>0.05$
Poor	0	1	$p>0.05$
<i>Cosmetic outcome</i>			
Satisfactory	23	15	$p<0.05$
Acceptable	2	6	$p>0.05$
Poor	0	4	$p>0.05$

## Discussion

Children with undisplaced (Gartland Type I) or slightly displaced fractures may benefit from a 3-week above-elbow flexion cast. In order to minimize vascular impairment and compartment syndrome, circumferential casting and excessive flexion should be avoided at first. Gartland Type II fractures need to be reduced closely. After the flexion at 90 degrees using casting or closed reduction, the fracture is stabilized. To prevent complications associated with increased elbow flexion, percutaneous pinning should be performed if more elbow flexion is needed to maintain reduction. Gartland Neurovascular impairment is a unique risk factor for type III fractures. The preferred method of treating displaced fractures is percutaneous pinning and closed reduction. There is an increase in the incidence of residual deformities after close/open reduction and casting of fractures with displacement than after close/open reduction and pinning of fractures with displacement. An open or close reduction and percutaneous pinning is the best treatment for a displaced fracture, preferably within 24 hours, taking into account the orthopedic urgency. An open or closed fixation is necessary for Gartland Type IV fractures due to their highly unstable nature [4,10,11].

In order to prevent open reduction of pediatric supracondylar fractures of the humerus, a closed

reduction was studied on 24 patients with Gartland type 4 fractures. To better manipulate the proximal fragment, a temporary Kirschner wire is placed into the proximal end of the humerus and used as a joystick. These findings imply that the "joystick" reduction technique is a dependable fallback in the event that closed reduction itself fails [12].

A study was conducted on 60 individuals with type 3 Gartland fracture to compare the final result of percutaneous pinning and closed reduction. The first step of the treatment was a closed reduction, which was accompanied by percutaneous pinning using one medial and two lateral K-wires, the latter of which was inserted with the elbow flexed only slightly (90 degrees). The ulnar nerve was checked during surgery, after discharge, at the end of the first two weeks, and at the end of the third and sixth months. This study found that percutaneous pinning and closed reduction using three K-wires in type III displaced supracondylar fractures of the humerus was an effective, safe method with low complications [13].

35 children with displaced supracondylar humerus were evaluated for treatment with lateral pin fixation and closed reduction. Following closed reduction, two crossed or parallel K-wires were used for lateral-pin fixation. All patients achieved union. It did not result in any complications such as injury to

the nerve, compartment syndrome, myositis ossificans, or pin-tract infections. Closed reduction and percutaneous lateral pinning of displaced supracondylar fractures of the humerus were found to be effective in treating displaced fractures in children.[14].

Children between the ages of five and seven are most likely to sustain a supracondylar elbow fracture, and both sexes are equally susceptible to this condition. They can be flexion- or extension-type injuries, with extension-type injuries being more prevalent. In this investigation, our goal was to determine radiographic stability with lateral and crossing wires. We also noted any side effects from the surgical treatment of these injuries. The establishment of good radiographic stability with Baumann angle (BA) and lateral capitellohumeral angle (LCHA) within normal limits was made possible by both lateral and crossing wire arrangements. Both procedures showed no loss of reduction, and in the hands of skilled practitioners, there was little risk of iatrogenic nerve damage [15].

In circumstances where closed reduction has failed and there is vascular damage, open reduction is typically performed. One of the main reasons for closed reduction failure is late presentation. Developing nations frequently have presentations that are late. Operations may be further delayed if OT timing is not available or if there is a labor or equipment shortage. As a result of the procedure's side effect of joint stiffness, the open reduction has a bad reputation. Poorer outcomes are presumably attributable to its employees only in the worst scenarios after exhaustive testing of all other methods. The main issues with open reduction are myositis ossificans and joint stiffness. Two studies that treated late cases with open reduction have documented myositis ossificans, whereas other studies that treated fresh patients with open reduction have not. The prevalence of myositis ossificans is stated to be 6% even in these investigations. This low incidence does not allow for the abandonment of open reduction for humeral supracondylar fractures. According to Flynn's criterion, satisfactory outcomes for an open reduction in new and late cases range from 88% to 100% in different trials [16,17,18].

Traction, percutaneous pinning, closed reduction, open reduction with internal fixation, closed reduction and use of a splint, and traction is all forms of treatment for supracondylar fractures. Swenson was the first to write about crossed-pin fixation of the supracondylar humerus fracture in youngsters. In order to reduce the danger of iatrogenic ulnar nerve injury, additional writers have now described fixing the fracture using Kirschner (K) wires injected from the lateral side. Crossed-pin fixation, developed by Swenson, is still employed today with great success and minimal morbidity. Supracondylar humeral

fractures can be pinched percutaneously, which has various benefits. Rotational displacement, which can cause a cubitusvarus deformity, is prevented by stable fixation. The length of the hospital stay is greatly reduced, and patients can typically be released after the first or second postoperative day. More crucially, the conundrum of whether to risk circulatory compromise in order to strengthen the rigidity of a closed reduction by hyperflexion is avoided. Following internal fracture repair, the elbow can be secured in a safe posture with a splint to improve circulation and reduce the incidence of compartment syndrome. The possibility of brain damage after pin placement and pin tract infection are drawbacks of percutaneous pinning [19,20].

### Conclusion

The study has concluded that the clinical outcome of both the managements are statistically similar. The acceptable and poor cosmetic outcome between the two groups are insignificant but there is significant difference ( $p < 0.05$ ) between the two groups in case of satisfactory outcome. The study also concluded that the follow up time and mean duration of surgery is significantly less if the patient is managed by K-wire as compared to the patients receiving ORIF management. There were some limitation of this study. As this study was retrospectively done, there was lesser number of patients included. So, there is a need to carry out more similar studies to find out the efficiency of these managements on larger population. However, this current study has pointed out clinically important finding that both the managements have similar clinical outcome in terms of efficacy but K-wire management is better than ORIF in case of follow-up time, duration of surgery and cosmetic aspect. So, when these three parameters are more important than the cost, then K-wire can be selected while ORIF can also be considered if the mentioned parameters are not the target of our treatment.

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