

## Surgical Management of Supracondylar Fracture of Humerus in Children using K Wire Fixation: a Prospective Study

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Received: 22-03-2024 / Revised: 19-04-2024 / Accepted: 30-05-2024

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Conflict of interest: Nil

### Abstract

Supracondylar fractures of the humerus the most common type of elbow fracture in children. Severely displaced supracondylar fractures of the distal humerus in children are a challenging problem. Many treatment methods have been described for the treatment of displaced supracondylar fracture of the humerus, however it has not been reached a consensus for the choice of treatment. The purpose of this study is to clinically asses the outcome of surgically managed supracondylar fracture of humerus using K wire fixation.

**Materials and Method:** 30 Children of supracondylar fracture of humerus treated in the Department of Orthopaedics, Shri Atal Bihari Vajpayee Medical College and Research institute, Bengaluru. Out of a total of 30 cases 24 were treated with closed reduction and internal fixation by k wire and 6 were treated with open reduction and internal fixation with k wire. The average age was 7.1 years. We evaluated the results using FLYNN'S criteria.

**Result:** According to the results of the study, we obtained 21 excellent, 4 good, 4 fair and 1 poor results.

**Conclusion:** The data in the current study shows that surgically managed displaced supracondylar fracture of humerus in children using K wire fixation gives excellent outcomes both radiologically and functionally thus can be deemed as treatment of choice for the same.

**Keywords:** Displaced supracondylar fracture of humerus, closed reduction, open reduction and internal fixation by K wires.

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### Introduction

Supracondylar fracture of humerus accounts for 60% of all fractures about the elbow in children and represent approximately 3% of all fractures in children. The rate of occurrence increases steadily in the first 5 years of life to peak at 5 to 7 years of age. [1,2] It is the fracture of the lower end of the humerus usually involving the thin portion of humerus through the coronoid or olecranon fossae or just above the fossae or through the metaphysis of the humerus. [3] Undisplaced supracondylar fracture of humerus usually require no more than simple immobilisation for comfort and further protection. The management of displaced supracondylar fracture of the humerus is one of the most difficult of the many fracture seen in children. Pitfalls in the management occur frequently and continue to plaque the doctor caring for this patients, specially with respect to displaced supracondylar fractures.

[4]Close reduction with splint or cast immobilisation has traditionally been recommended for displaced supracondylar fracture, but loss of reduction and necessity of repeated manipulation is likely to go for malunion producing varus or valgus deformity of elbow and elbow stiffness. [5] The aims of surgical treatment are to maintain an anatomical position and to prevent varus or valgus deformity. Hence the study was undertaken to study the efficiency of this method i.e internal fixation with k wire and evaluate the clinical outcome. [6]

### Materials and Methods:

The study was conducted in the Department of Orthopaedics, Shri Atal Bihari Vajpayee Medical College and Research institute, Bengaluru. Out of a total of 30 cases 24 were treated with closed reduction and internal fixation by k wire and 6 were

treated with open reduction and internal fixation with k wire. The average age was 7.1 years. We evaluated the results using FLYNN'S criteria.

**Source of Data:** 30 paediatric patients in the age group of 1-18yrs with supracondylar fracture of humerus seeking medical advice in the Department of Orthopaedics, Shri Atal Bihari Vajpayee Medical College and Research institute, Bengaluru. Out of the 30 patients, 24 patients were managed with Closed reduction and internal fixation with K-wire and 6 patients by open reduction and internal fixation.

**Exclusion Criteria:** Supracondylar fractures of humerus in patients aged above 18yrs.

**Methodology:** First the history was elicited from the patient and from patients parents in case of younger children. The nature of the injury that is fall on an outstretched hand, direct injury, road traffic accident was asked. Then time since injury was elicited. After that a detailed examination of the patient was carried out. The general condition of the patient was assessed. Patient with the associated head injury and fractures of the other long bones were given priority for the emergency department. If there were none of the other injuries then local examination of the injured elbow was carried out. It consisted of noting down the deformity, swelling around the elbow, tenderness over the distal end of the humerus and movements of the elbow. The vascular and neurological status of the patient was thoroughly examined. Then x-rays were ordered. The standard anteroposterior and lateral views of the elbow taken in the emergency radiology room. In the mean time the patients were given analgesics and fractured part was splinted temporarily.

The fracture was then classified according to the fracture patterns in x-rays using GARTLAND'S classification.

Type 1 – not displaced

Type 2 – minimally displaced with intact posterior cortex

Type 3 – completely displaced with no cortical contact

a) posteromedial

b) posterolateral

The management Protocol was then drawn according to the fracture type.

### Type 1 Fractures

The patients radiographs were thoroughly scrutinised and fracture pattern was confirmed. The posterior displacement was ruled out by noting down the anterior humeral line. Then a posterior splint was applied to the limb with elbow at 90° flexion and forearm in neutral rotation. A cuff and collar sling was given. Then the plaster instructions were given to the patient and was advised to come

for review after two days. The loosening of the splint if any was corrected and the patient was advised to come after three weeks. At the end of three weeks the posterior splint was removed and the x-rays were repeated to assess the healing. After seeing the x-rays the splint was discontinued in the patient was advised to start active range of motion exercises for the elbow.

### Type 2 Fractures

Radiographs were analysed and the fracture pattern was identified. The anteroposterior x-ray was looked for the coronal displacement and angulation. After confirmation of the type, patient was admitted and he was kept Nil orally. A splint was applied and affected extremity was elevated to minimise the swelling. In the operation room general Anaesthesia was administered. The carrying angle of the normal and affected side was assessed and the noted down. Then closed reduction was carried out giving a longitudinal traction of the forearm by the surgeon and counter traction to the proximal Arm by the assistant. The elbow was flexed up until resistance was felt usually just above 90° of elbow flexion. Then the distal fragment was pushed anteriorly. With that the elbow was flexed up to 120° and the forearm was brought into full pronation. Then the vascular status was assessed. A posterior splint was applied with the elbow in 120° flexion and forearm in flexion. A cuff and collar sling was given. Then the patient was observed in the hospital for 24 hours. Later the patient was discharged with the instructions regarding the plaster complications and advised to come after three weeks. At the end of three weeks the splint was removed and x-rays were repeated. The Carrying angle was assessed and active range of motion exercises was started. Patient was followed up at periodic intervals and each time the carrying angle and functional range of movements were assessed and noted.

### Manipulative Technique:

The patient was hospitalised and advised nil by mouth. The fracture Limb was splinted and elevation was done to reduce the swelling. Then the reduction was carried out under general anaesthesia with full relaxation in the operating room. The carrying angle was assessed and noted down. First the longitudinal traction was applied to the forearm with the elbow in extension and forearm in supination. Counter traction to the proximal arm was provided by the assistant. Then with the traction being maintained, the medial or lateral displacement was corrected by applying of Valgus or varus force at the fracture site. Once length was re-established and the edges of the fragments, were joined, the displacement and the angulation of the distal fragment were corrected by flexing the elbow. At the same time a posteriorly directed force was applied to the anterior portion of the arm over the proximal fragment and and

anteriorly directed force was applied posteriorly over the distal fragment. The reduction was achieved, which was confirmed by full flexion of the elbow. Then the elbow was kept in 120° of flexion and forearm in full pronation in a posterior splint. Cuff and collar sling was applied. The distal vascularity was checked. Patient was discharged on the second day and reviewed after two days and then after one week to see whether reduction was stable clinically and radiologically, then after three weeks. Post operative management as per type 2 fracture was carried out. The results were noted down

**Type 3 Fractures**

The Type 3 fractures were diagnosed with the help of x-rays. These cases where taken up for open reduction and internal fixation immediately once other emergencies of head injuries and of long bones were ruled out. Finally the end result of these fractures management where analysed according to the carrying angle and functional range of movements.

**Open Reduction and Internal fixation (ORIF) with K wires:**

Out of the 30 patients, 6 patients were subjected to open reduction and internal fixation with K wires. In majority of the cases Posterior Campbell’s approach was used. In 1 case with brachial artery injury we have used the anteromedial approach. In 1 Case having radial nerve injury we used anterolateral approach.

**Posterior Approach:**

With the patient under general anaesthesia and in prone position with the elbow supported on the sand bag, extremity was prepared from axilla to wrist and draped. With a posterior Campbells approach, ulnar nerve was isolated, and inverted tongue shaped incision was made over the triceps. All the blood

clots and debris removed from the fracture site. Fracture was reduced and internally fixed with 2 or 3 smooth crossed K wires of diameter 1.5 to 2.5 MM. The pins were introduced with the help of a hand drill. The lateral wire was introduced through the anterior side of the lateral condyle and directed posteriorly into the Posteromedial side of the opposite cortex. The medial wire was started through the posteromedial side of medial condyle and engaged into the anterolateral side of opposite cortex. While introducing the medial wire, greater care was taken to avoid ulnar nerve. By this method, the wires were laid high above the fracture site. The pins were cut percutaneously for easy removal later. After the pins are placed, the elbow is extended and the carrying angle is measured and compared to that on the non-affected side. The stability of the fracture was checked. Then the wound was closed and a drain was kept and a posterior splint was applied with the elbow in 90° flexion and forearm in neutral rotation.

**Postoperative Course:**

Full arm posterior Slab was used, cuff and collar was given and the limb was elevated. The preoperative antibiotics were continued on the day of operation. It was continued for five days after the surgery. Regular dressings were done and routine check x-rays were taken. The sutures were removed on 12th day and patient was discharged. Patients were called at third week for K-wire removal. After the K-wires were removed the posterior slab was discarded, and active movements of the elbow were started. All these cases were advised to attend the outpatient department at regular intervals of 3 weeks, 6 weeks, 3 months, 6 months and 12 months for check up and to note down the progress of union, range of movements at the elbow and onset of any deformity. Range of movements and carrying angle we are measured using Goniometer.

**Table 1: Flynn’s Grading system**

Results	Ratings	Loss of carrying angle(degrees)	Loss of range of movements
Satisfactory	Excellent	0-5	0-5
	Good	6-10	6-10
Unsatisfactory	Fair	11-15	11-15
	Poor	Over 15	Over 15

**Results**

The following observations were made from the data collected during the study. Most of the patients in the present study were in the age group between 5 to 8 years around 53.3%. The youngest was 2 years of old and the eldest was 15 years old. The mean age incidence of supracondylar fractures in the study was 7.1 years. 60% of the cases in the present study were boys and 40% of our cases were girls. The male to female ratio was 1.5:1. The left elbow was involved in 19 (63%) of the cases and right side was

involved in 11(37% ) of the cases in the present study.

In the present study, 86.6% of the cases were due to indirect injury that is fall on an outstretched hand. 13.3% of the cases were due to direct injury to the elbow joint which mostly comprise of the vehicular accidents. The minimum reporting time for hospital since injury was 1 hour. The maximum time since injury was 8 days. The average time of reporting was 1 day. In the present study the percentage of closed fractures were 93.3% and open fractures were 6.6%.

All of the open fractures were high velocity injuries due to vehicular accidents. We had 2 open fractures, which included one case of grade 1 and another case of grade 2 Gustilo and Anderson's classification of open fractures. In the study, we have 29 extension type and 1 flexion type of supracondylar fracture. 50% of the cases were of type 3 fractures, 40% were type 2 and 10% were type 1 fracture according to Gartland's classification. Out of the 15 patients with type 3 fractures, we had 8 patients with

posteromedial displacement and 7 patients with posterolateral displacement pattern. Out of the 30 cases of supracondylar fractures 24 cases were treated with close reduction and internal fixation and 6 cases were treated with open reduction and internal fixation by K wires. The final results of the operative management of the supracondylar fracture of humerus were evaluated using Flynn's criteria based on loss of movements and loss of carrying angle.

**Table 2: Age distribution**

Age group (years)	No. Of cases	Percentage
0-2	1	3.3
3-4	3	10
5-6	10	33.3
7-8	6	20
9-10	6	20
11-12	4	13.4
12-14	--	--
<b>Total</b>	30	100.00

**Table 3: Sex distribution of supracondylar fracture cases.**

Sex	No. Of cases	Percentage
Male	18	60
Female	12	40
<b>Total</b>	30	100

**Table 4: Side affected.**

Side	No. Of cases	Percentage
Right	11	37
Left	19	63
<b>Total</b>	30	100

**Table 5: Mode of injury.**

Mode of injury	No. Of cases	Percentage
Fall on outstretched hand	26	86.6
Direct injury	4	13.4
<b>Total</b>	30	100.0

**Table 6: Type of Fracture.**

Type of Fracture	No. Of cases	Percentage
<b>Closed</b>	28	93.3
<b>Open</b>	2	6.7
<b>Total</b>	30	100.00

**Table 7: Type of supracondylar fracture.**

Type of fracture	No. Of cases	Percentage
Extension type	29	96.6
Flexion type	1	3.4
<b>Total</b>	30	100.0

**Table 8: Classification of fractures (Gartland's)**

Gartland's type	No. Of cases	Percentage
Type 1	3	10
Type 2	12	40
Type 3	15	50
Total	30	100

**Table 9: Fracture pattern (type 3 fractures)**

Fracture pattern	No. Of cases	Percentage
Type 3A posteromedial	8	53.3
Type 3B posterolateral	7	46.7
Total	15	100.0

**Table 10: Final Results of operative management according to FLYNN'S criteria**

Result	Rating	Loss of range of motion	Loss of carrying angle	No. of cases	Percentage
Satisfactory	Excellent	0-5	0-5	21	70
	Good	6-10	6-10	4	13.3
	Fair	11-15	11-15	4	13.3
Unsatisfactory	Poor	>15	>15	1	3.3
	Total			30	

**Complications**

In the present study, we had 1 case of brachial injury, 1 case of radial nerve injury, 2 cases of elbow stiffness, 3 cases of cubitus varus, 1 case of the

cubitus valgus and 1 case of superficial pin tract infection. The total percentage of associated complication was found to be 30%. The most common complication in the study was cubitus varus accounting for 1/3 of the complications.

**Table 11:**

Complications	No. Cases	Percentage
Vascular injury	1	3.3
Volkman's ischaemic contracture		
Nerve injury Radial Median Ulnar	1	3.3
Myositis ossificans		
Elbow Stiffness	2	6.6
Cubitus Varus	3	9
Cubitus valgus	1	1
Superficial pin tract infection	1	1
Total	9	30

**Discussion:**

The aim of this clinical study was to study the Epidemiology of the supracondylar fractures of humerus in children, the mechanism of injury, associated complication and the role of operative management of these fractures. [7] Many methods have been proposed for the treatment of displaced supracondylar fractures of the humerus in children such as close reduction and plaster of Paris slab application, skin traction, overhead skeletal traction, open reduction and internal fixation and close reduction and Percutaneous pin fixation. The present study was conducted to establish that Surgical management with K wires with Slab application can be considered as the treatment of

choice in supra condylar fractures of humerus based on the evaluation of results and functional outcome. [8] During the study period we treated 30 patients of supracondylar fracture of humerus. Majority of the patients reported to the hospital within 12 hours of injury the average reporting time was 24 hours. Most of the children were initially taken to bone setters in their village. [9] After increase in pain and swelling, they reported to our hospital. Few cases were reported from the primary health centres. In the present study 53.3% (16) of the patients were from 5 to 8 years age group with the average age being 7.1 years. Fowles and Kasab have reported an average age incidence of 7.2 years. Minkowitz B and Busch MT have found peak incidence between 5 to 7 years of age. The average age in Pirone AM et al study

was 6.4 years. Mulhall KJ et al reported mean age of 5.9 years in the study. [10] This may be explained by the weak bony architecture and other anatomical factors, which have been explained previously. The sex incidence in the present study was found to be 60% (18) in males and 40% (12) in females. The same has been observed by Fowles and Kassab. D'ambrosia has observed an incidence of 69% in males and 31% in females. Pirone AM et al reported an incidence of 52% of males and 48% of females. [11] This male dominance can be explained as boys are more active and more prone to falls. The most common mode of injury in the present study was due to fall on outstretched hand accounting for 86.6% (26) of the cases and 13.3% (4) of the patients had a direct injury that is fall on the point of the elbow. Our observations is in the concurrence with that of Wright et al that is when a child loses its balance he or she tries to save themselves with an outstretched hand. McDonnell DP and Wilson JC reporting are also coinciding with that of our study. [12] In the present study, 29(96.6%) cases were of extension type, and 1(3.3%) case was of flexion type. Fowles and Kassab have reported extension type 90% and flexion type 10%. Celiker O et al reported incidence of 79.5% of extension type and 20.5% of flexion type in their study. Majority of the cases were of type 3 (50%) fractures and rest of them included type 2 (40%) and type 1 (10%) fracture. Fracture patterns in the present study were 53.3% (8) of posteromedial displacement and 46.6% (7) of posterolateral displacement. [13] Aronson DD et al noted 15(75%) patients of posteromedial displacement and 5(25%) patients of posterolateral displacement in the study of 20 cases. Of the 30 patients in the study the complications we encountered were 1 (3.3%) patient having absent radial pulse on presentation. That case was of type 3 fracture with posterolateral displacement. Close reduction was tried first under general anaesthesia. But the radial pulse did not return. Hence, the fracture was explored and brachial artery was found to be compressed by the Proximal fragment. Fracture fragments were reduced and the compression was relieved and the pulse return. Fracture was stabilised with K wires. Kassab JR has reported cases in which the brachial artery flow was resumed often by simple reduction of the fracture under general anaesthesia. Ottolenghi CA has reported an incidence of 5% of vascular injuries among 830 cases of supracondylar fractures studied. [14] Campbell et al have reported that 38% of the cases had evidence of injury to the brachial artery. The low incidence in the present study has been explained due to the smaller sample size. Moreover in this study we have used only static and dynamic assessment tests clinically. In the present study only 1 (3.3%) patient presented with radial nerve injury. It was operated using antero lateral approach. [15] The injury was of neuropraxia type and recovered completely within 8 weeks. McGraw

et al have reported an incidence of nerve injuries upto 12% of all supra condylar fractures. [16] Eppolito E observed neurological complications in 12 of the 131 patients. The deficit was transient in 10 patients. Radial nerve was involved in 5 patients. Elbow stiffness was also seen in 2 cases in the present study. We defined elbow stiffness as loss of more than 25° of flexion or extension or both. The incidence of elbow stiffness in our study was 6.6%. Mean loss of flexion and extension was found to be 7.3°. Coventry MB and Henderson CC have analysed in detail regarding the follow-up of the range of motion of the elbow. [17] They have reported that fractures treated by closed method, the average loss of flexion was 4° and loss of flexion with open reduction was found to be 6.5°. The greater loss of elbow motion in the study may be attributed to the shorter follow-up period when compared to other studies. [18] 1 case of elbow stiffness was found in patient treated by conservative method. Ogunlade SO et al reported 10.7% had 15° of extension lag at the elbow joint at 6 months. The incidence of cubitus varus deformity in the current study was found to be 3 cases (9%). All of these cases were seen in cases treated with close reduction. We feel that varus deformity was the result of residual displacement of distal fragment in the medial direction and also incomplete correction of internal rotation. This concept is widely excepted by various authors. Ippolito E, Caterini R, Scola E in a long-term follow-up study of 131 patients reported an incidence of 7.5% of Cubitus varus. The incidence of Cubitus varus in close reduction group of the study was 30% and open reduction was nil. Pirone AM et al have reported that incidence of Cubitus varus was 14% with close reduction and cast immobilisation and 11% in open reduction and K wire fixation. We came across 1 case of cubitus valgus (2.5%) in the study, it was a type3 fracture with posterolateral displacement treated by close reduction. We feel that valgus was the result of residual displacement of distal fragment in the lateral direction. Ippolito E reported an incidence of 5.6% of the cubitus valgus treated by Conservative method in the long-term follow-up study. Langenskiold A and Kivilaakso R in a study of 14 cases of elbow deformities have reported cubitus valgus in 3 patients. We had one case of superficial Pin tract infection, which was treated by appropriate antibiotics. The average period of immobilisation in the study was 3.2 weeks. In 2 patients k wire was removed after five weeks. Because they did not turn up for follow-up after four weeks. The average period of follow-up in the study was 8.6 months.

**Change in the Carrying Angle:** The mean change in the carrying angle following operative management was 5.8°.

**Change in Range of Motion:** The mean change in the range of motion following operative management was 7.3°.

From the above mentioned prospective study we found that surgical management with K wire fixation for displaced supracondylar fracture in children results in good functional and cosmetic outcome then treated by conservative approach.

#### Conclusion:

From our study we conclude that Open/Closed reduction and internal fixation with K-wire fixation is an effective and safe method of treatment for supracondylar fracture of humerus in children compared to conservative method with slab application. Supracondylar fracture of humerus is a common injury in children. Common in 5-8 years of age group. Boys are predominantly affected. Male to female ratio is 1.5:1. Right is involved more often than left. Indirect injury due to fall on outstretched hand is most common mode of injury. Extension type is most common type of supracondylar fracture. Results of closed reduction and external immobilisation gives uncertain results. Conservative management in type 3 fracture shows high failure rate due to difficulty in reduction, lost of reduction postoperatively or during follow up. All cases of displaced supracondylar fracture of humerus in children must be treated as an emergency and should be admitted and observed for atleast 24 hours following open reduction. Surgical management with internal fixation with K-wire offers more advantage with fewer complication, more stable fixation and better anatomical reduction with minimal complications. Open reduction and internal fixation with K-wire offers better functional and cosmetic results compared to conservative methods. Hence we conclude that K-wire osteosynthesis is associated with low complication rate and continues to be safe standard procedure for stabilisation and can be advocated as the treatment of choice in Supracondylar humerus fractures in children.

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