



Original Research Article

A prospective study of displaced supracondylar fractures of the humerus in children treated with open reduction and internal fixation with k-wires

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ABSTRACT

Background and Objectives: Supracondylar fractures of the humerus were the most frequent occurrence, accounting for about 65.4% of all fractures around the elbow in infants. Displaced supracondylar humeral fractures need a high degree of respect and difficulty to be treated, as they require correct anatomical reduction and internal fixation to avoid complications. Thus, in this research, we documented the effects of open reduction and internal fixation with K-wires in the displaced (Gartland type III) supracondylar fracture humerus in infants.

Materials and Methods: The prospective study of 25 cases of displaced (Gartland type III) supracondylar fractures treated with open reduction and internal fixation with K-wires were examined at our institution between September 2019 and July 2020 and followed for an average of 6 months.

Results: All Gartland Type III fractures were closed with an average age of 6.3 years in our study of 25 patients, 13 patients had slip fractures while playing, 18 patients had left-hand fractures, and 16 patients had posteromedial displacement. The fracturing of the distal end radius was associated with 2 patients. The majority of patients underwent surgery on the 2nd day and were home on the 3rd postoperative day. 16 had a loss of motion range of 0-5 °; 18 had a loss of motion angle of 0-5 °. 3 patients had inflammation of the superficial pin tract, 2 had traumatic median nerve paralysis, 2 had K-wire migration, 1 had a deformity of the cubitus varus and 1 had >15 loss of motion.

Conclusion: This research shows that anatomical reduction, stable fixation with minimal complications has enhanced open reduction and internal fixation with K-wires. Therefore, the present analysis reveals an open reduction, and K-wire internal fixing is most generally known as an option for the reconstruction of infant supracondylar humerus fractures.

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1. Introduction

A supracondylar humerus fracture is the most frequent elbow injury in infants. It accounts for about 65.4% of all elbow fractures in children. The incident rate rises steadily over the first five years of childhood to a median of 5-7 years of age.

In treatment, the supracondylar fracturing of the humerus demands a great deal of importance and if it is not appropriately treated, it can lead to several complications such as Volkmann's ischaemic contracture, neurovascular injury, ossific myositis, elbow stiffness, and malunion.

Management of the displaced supracondylar fracturing of the humerus is one of the most difficult techniques to avoid complications. It needs correct anatomical reduction and internal fixation. But it's no longer acceptable to

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be near—not bad for a supracondylar fracture. There is no disagreement about the treatment of undisplaced fractures. However, various treatment modalities have been suggested for the treatment of displaced supracondylar humerus fractures in infants, such as closed reduction and plaster application of Paris slab, Skin traction, overhead skeletal traction, closed reduction, and percutaneous pin fixation and open reduction with internal fixation, closed reduction and Posterior intrafocal pinning, closed reduction and Lateral external fixing Closed reduction with a splint or cast immobilization and treatment with traction has historically been prescribed for displaced supracondylar fractures though with difficulties in reduction, loss of reduction postoperatively or during follow up leads to malunion and elbow stiffness.¹

There was a reluctance in the early part of the century to suggest an open reduction of the supracondylar fracture. But several changes have now been made in the medical profession, especially in orthopedic trauma. A higher understanding of the biomechanical quality of implants, the principles of internal fixation, antibiotics for soft tissue care, and asepsis have all contributed to profound improvements. As a result, we have moved from a conservative approach to open fracture mitigation and internal fixation as an acceptable mode of treatment.²

Various studies have shown that open reduction and internal fixation with K-wires provide more stable fixation, enhanced anatomical reduction with decreased complications, for displaced supracondylar humeral fractures. Therefore, the most generally known procedure for displaced (Gartland Type 3) supracondylar humerus fractures in children is now open reduction and K-wire internal fixation.

2. Materials and Methods

It is a prospective study of Humerus in Children with Open Reduction and Internal Fixation with K in the Twenty-five Displaced Extension Shape of Supracondylar Fractures (Gartland Type III) at the Department of Orthopaedics between September 2019 and July-2020.

2.1. Inclusion criteria

1. Less than 15 years of age.
2. By closed reduction, irreducible fracture.
3. With vascular compromise, closed supracondylar fractures.
4. Fractures open.
5. Fracture with the sign of anterior pucker.

2.2. Exclusion criteria

1. Over 15 years of age
2. Medically incompetent patients for surgery.

The university has obtained regulatory clearance for this research. All patients selected for this study were treated and treated, if any, in compliance with the protocol and associated injuries. The x-rays were obtained from two helicopters. A closed reduction trial was done in 7 patients with gross swelling and 4 patients with a pucker sign were taken for elective surgery without a closed reduction at the earliest opportunity. According to Gartland's revised classification, both fractures were graded.

Table 1: Modified Gartland's classification³

Type1	Undisplaced	Fat pad present acutely
Type2	Hinged posteriorly	Anterior humeral line anterior to capitellum
Type3	Displaced	No meaningful cortical continuity
Type4	Displaces in to extension and flexion	Diagnosed with manipulation under image
Medial comminution (not truly separate type)	Collapse of medial column	Loss of baumann angle

The following protocols were followed as soon as the operation was scheduled. Consent for anesthesia and surgery from the patient and attendants.

2.3. Operative technique

The patient was seated in a triangular position under general anesthesia, with a fractured elbow facing the surgeon. Sandbags were placed under the arm; with the elbow flexed, the forearm was left to hang loosely. In all patients, Tourniquet was observed.

In both patients, the conventional posterior procedure was used. The ulnar nerves were not examined. To show the injured location, the Triceps muscle was broken vertically. Hematoma was evacuated and saline wash was provided to visualize the broken site. The fracturing was subsequently reduced, leaving the distal end of the proximal fragment. Taking the decrease calculated by the pillars' medial and lateral morphology into account. If the fracture is posteromedial, the medial pin was first inserted through the medial epicondyle apex after a good reduction has been confirmed. The lateral pin was located obliquely across the fracture site at the center of the lateral epicondyle to form the opposite cortex of the proximal fragment. To participate in the opposite cortex on both sides, fractures were sealed with 1.2 mm-2.0 mm K-wires depending on the patient's age at an angle of 30° in the coronal plane. The stiffness of the fracture was measured, the elbow was extended and the loading angle was decided and on the non-affected foot relative to that. To allow removal in ambulatory clinics

without anesthesia, the pins were twisted and cut out of the tissue. In layers, the wound was closed and sterile wrapping was used. It was released by Tourniquet. Postoperatively, with an elbow flexed to 90°, the extremity was wrapped in a well-padded posterior splint and the patient was transferred to the ward after healing from anesthesia.

2.4. Post-operative management

1. There was an elevation of the controlled limb
2. Kept an hourly BP and TPR table
3. Vigilant measurements were observed at daily intervals for any neurovascular deficit
4. Suitable antibiotics and painkillers have been used
5. The patients were discharged on the recommendation that they should come on the 10th day after surgery.
6. To assess the preservation of the reduction, immediate post-operative radiographs were obtained on all patients. The sutures were withdrawn on the 10th postoperative day.

2.5. Follow up

After 4 weeks, patients were called for follow-up and the POP slab was removed. Yeah. The K. wires were removed after 4 weeks. After the removal of the splint, a special note and caution were issued about preventing massage and passive elbow joint stretching. Active range of motion activities was urged. At 12 weeks and 24 weeks, more follow-ups were conducted. Clinically and radiologically, the patients were tested, measured for a range of motion and carrying angle.

3. Functional results

The final results were calculated based on parameters set by Flynn⁹. In terms of lack of range of motion and loss of load angle, the findings were graded as excellent, decent, average, and poor.

4. Results

In 25 patients operated in our hospitals, observation, and analysis of the results was carried out about age, sex, type of injury, laterality of fracture, fracture pattern, associated injuries. Surgery day, duration of hospital stay, complications of rehabilitation, and functional consequences.

The age distribution in our sequence was 4 to 15 years. The majority of patients, i.e. 18 (72 percent) in the 4-9 age group, followed by 5 (20 percent) in the 10-12 age group, followed by 2 (8 percent) in the 13-15 age group. The average age of patients was 6.3 years. The majority of patients were male, i.e. 17 (68 percent) and 8 (32 percent) were female.

Table 2: Demographic distribution

Age	No of patients	Percentage
4-6	8	32
7-9	10	40
10-12	5	20
13-15	2	8
Gender		
Male	17	68
Female	8	32
Nature of trauma		
Fall from bicycle	8	32
Fall while playing	13	52
Fall from tree	4	16
Laterality of fracture		
Left	18	72
Right	7	28
Fracture pattern		
Type-3posteromedial	16	64
Type-3posterolateral	9	36

The key cause of fracture in our study was dropping while playing in 13 patients (52 percent), followed by a bicycle drop in 8 patients (32 percent) and a tree drop in 4 (16%) of patients. The fracture resulted in 18 (72 percent) patients on the left and 7 (28 percent) patients on the right. In our sample, we had 16 (64 percent) posteromedial displacement patients and 9 (36 percent) posterolateral displacement patients.

Table 3: Time of surgery and hospital stay

Time of surgery (days)	No of patients	Percentage
2ndday	14	56
3rdday	6	24
4thday	2	8
5thday	3	12
Hospital stay (days)		
3	16	64
4	5	20
5	4	16

Both cases included in this research category were fresh fractures that underwent surgery as soon as possible following hospital admission. The mean time between fracture and surgery was 3.1 days. The majority of patients, i.e. 16 (64 percent) of patients, were discharged on the second postoperative day.

At the final follow-up, a 0-5 degree loading angle failure of the affected extremity was found in 18 (72 percent) patients. 11-15 degrees of angle loss was found in just one (4 percent) patient. Gross loss of carrying angle, i.e. more than 15 degrees, is found in 1 of our experiments.

In our sample, 24 (96 percent) of patients had satisfactory outcomes. Of these 24 patients, 18(72 percent) were rated

Table 4: Post operative complications

Complications	No of patients	Percentage
Traumatic median nerve palsy	2	8
Superficial pin tract infection	3	12
Iatrogenic ulnar nerve palsy	0	0
Migration of K-wires	2	8
Restriction of movements	1	4
Operative wound infection	0	0
Cubitus varus	1	4

Table 5: Loss of range of motion and carrying angle loss

Loss of range of motion	No of patients	Percentage
0-5	16	64
6-10	6	24
11-15	2	8
>15	1	4
Carrying Angle Loss		
0-5	18	72
6-10	5	20
11-15	1	4
>15	1	4

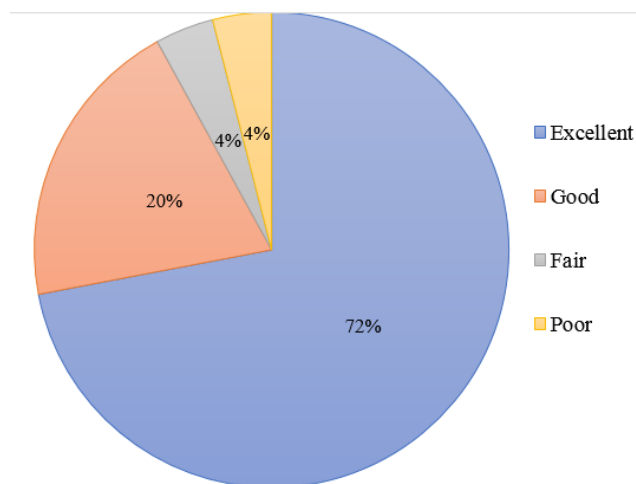


Fig. 1: Functional results based on Flynn's grading system

as excellent, 5(20 percent) were rated as good and 1 patient was rated as fair and 1 (4 percent) patient was rated as poor.

5. Discussion

The most common elbow injury in children is the supracondylar humerus fracture. supracondylar humerus fracturing demands a strong degree of respect in treatment and can lead to neurovascular compromise, problems in achieving or preserving a drop, and poor late results due to elbow stiffness or malunion if not treated properly.

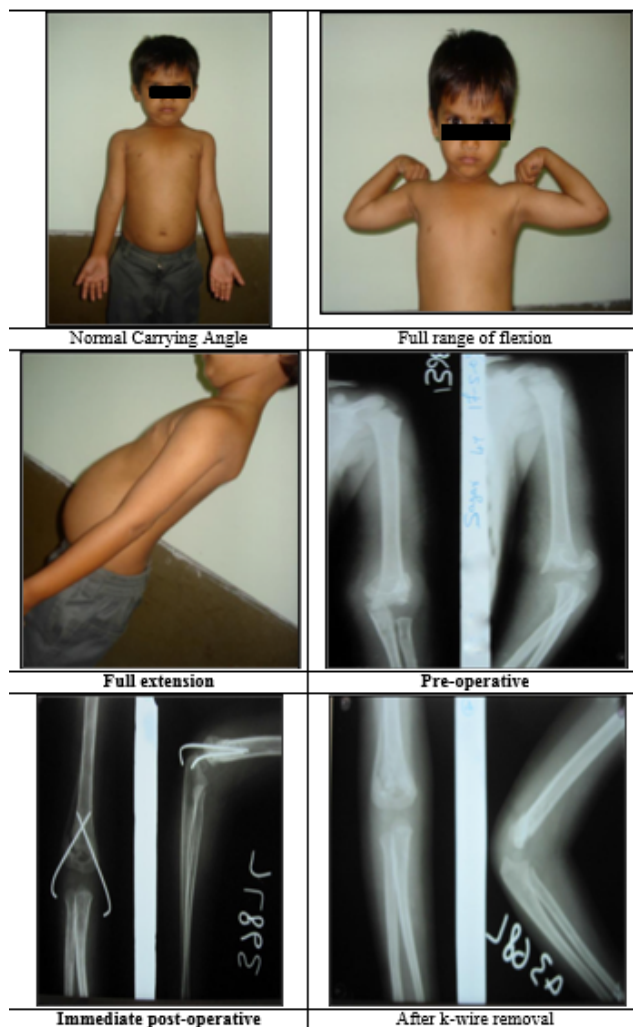


Fig. 2: Clinical cases

The most widely used therapy methods are limited reduction and application of a cast, skeletal traction, closed reduction, and percutaneous K-wire fixation, and open reduction and internal fixation of K-wires. The treatment of supracondylar fractures aims to achieve, with minimum complications, functionally and cosmetically appropriate results while retaining low treatment costs. Open reduction and internal fixation with K-wires ensure more effective fixation, with decreased risks, better anatomical reduction. Thus, the most commonly known treatment of displaced supracondylar humerus fractures in children is open reduction and internal fixation with K-wires.

To verify the arguments of numerous writers on the surgical management of supracondylar fracture humerus in children and the outcome of the treatment of these fractures by open reduction and internal fixation with K-wires, the present analysis was carried out. The age range in our series of 18 patients (72%) was 4-9 years, with a mean age of 6.3 years.

Table 6: In comparison of age with other studies

Series	Average age in years
Ramsey RH et al ⁴	7
Pirone AM, et al ⁵	6.4
Kumar R, et al ⁶	8
Mazda K, et al ⁷	5.7
Wilkin KE, et al ⁸	6.7
Present study	6.3

In our study 68% of the patients were male and 32% were females.

Table 7: In comparison of gender with other studies

Series	Male	Female
Mazda K, et al ⁷	60	40
Pirone AM, et al ⁵	52	48
Present study	68	32

Most of our patients had 13 (52 percent) fractures due to falling while playing, remaining due to falling from the tree and the bicycle. Farnsworth CL et al,⁹ in her series, found that “out of 70% of cases sustained a fracture due to fall. The present sample of 25 patients, 18 (72 percent) of whom were left-sided and 7 (28 percent) right-sided”.

In our sample of 25 patients, 16 (64 percent) had posteromedial displacement, and 9 (36 percent) posterolateral displacement. In our study, two patients had fractures of the distal end of the radius on the same side.

In Mazda et al⁷ series, he found that “out of 116 patients, 7 patients had ipsilateral bone forearm fracture”. Pirone AM et al.⁵, found that “in a sequence of 230 patients, 20 ipsilateral forearm injuries, 18 distal third radius, and ulna fractures, one middle 3rd radius and ulna fractures, and one monteggia fracture-dislocation”. Millis MB et al¹⁰ noted that “8.33% of the fractures associated with it.”

In our sample, 14 (56 percent) of patients worked on the second day of hospitalization. In Ramsey RH, et al,⁴ a review that “out of 15 cases was performed in all cases within 24 hours of injury”.

David L Skaggs et al¹¹, found that “Out of the 204 patients, had an average period of accident and surgery of 1.4 days. In our series, the majority of patients were operated on within 48-72 hours and the delay in service is attributed to eventual hospital admission. In our sequence of 25 patients, roughly 16 (64 percent) of the patients were discharged within 3 days of surgery and 9 (36 percent) of the patients were discharged within 4 days or 5 days due to swelling. These patients were held for observation”.

In our sequence of 25 cases, we had 2 painful and median nerves. Median nerve palsy occurred in a posterolateral displacement patient, but thankfully the patient did not have any vascular injuries.

In the Srivastava¹² study group, we found that “42. 2% of the patient had a nerve injury. We had 3 cases of superficial

pin infection. 2 out of 3 had subsided with antibiotics in 10 days, but one of the patients had no K-wire infection, but there was no deep or bone infection”

In the Srivastava¹² research group of 42 patients, about 14 percent had superficial inflammation of the pine tract.

Ramsey RH, et al⁴ Study we found that “Out of 15 cases, one patient had a pin tract infection healed after 2 weeks of therapy. In our study, we had 1 case of cubitus varus deformity, one case of proximal migration of K-wire, which may be due to failure of piercing in the opposite cortex during insertion. Later on, the K-wire was removed under general anesthesia.”

In our sample of 25 patients, 16 patients had a 0-5° range of motion loss, 6 patients had a 6-10° range, 2 patients had an 11-15° range and only one patient had a >15° range of motion. In the present analysis, a final follow-up of 0-5° of loading angle loss was found in 18 (72 percent) patients, 1 (4 percent) of which had a loading angle loss of more than 15°.

In Ramsey RH, et al⁴ series we found that “Out of 15 patients, 12 were found to be essentially average with a loading angle loss of less than 3-4° but 3 patients had 5 to 15° of varus deformity with substantial elbow movement. Blood and nerve damage could be more serious than the fracture itself, particularly the contracture of Volkmann, which was one of the most terrifying complications. In our sample of 25 patients, the majority of patients underwent surgery in 48 hours. K-wire was removed at 4 weeks and both patients had a radiological union at 4 weeks of follow-up. We began flexion and elbow extension exercises at the end of 4 weeks. In our series, we had 2 traumatic median nerve palsy all healed in 4 to 6 months postoperatively. 3 Patients had superficial pin tract infection and recovered with a course of antibiotics. 1 Patient had proximal and 1 patient had distal K-wire migration, which was removed later. 1 patient had cubitus varus deformity and was recommended to undergo surgical osteotomy, but the patient declined because they had a good range of painless motion with only cosmetic deformity. Also, the newly released Clinical Practice Recommendations of the American Academy of Orthopedic Surgeons 13 accepted that such supracondylar humeral fractures cannot be minimized by a closed procedure. The requirement for an open reduction is determined by the fracture sequence, the soft tissue interposition, the features of the patient, and the expertise of the surgeon. While surgery creates a risk of infection, better outcomes (according to Flynn’s criteria) and reduced risk of neurovascular complications are deemed risk-weighted”.^{13,14}

The findings of our analysis revealed a positive outcome relative to other open-label and internal fixation trials with 96 percent acceptable results based on Flynn’s guidelines for the treatment of supracondylar humerus fracture type III in infants.

Table 8: Comparison between present study and other methods of treating displaced supracondylar fracture

Treatment	Author	Total No. of	Flynn's grading system			
			Excellent	Good	Fair	Poor
Closed reduction and application of a cast	Pirone et al	101	51(51%)	27(27%)	3(3%)	20(20%)
Percutaneous Kirschner-wire fixation	Pirone et al	96	75(78%)	15(16%)	1(1%)	5(5%)
Skeletal traction	Pirone et al	24	16(67%)	5(21%)	1(4%)	2(8%)
Open reduction and internal fixation	Pirone et al	9	6(66%)	1(11%)	0(0%)	2(22%)
Percutaneous Kirschner wire fixation	Flynn et al	52	42(80%)	7(14%)	1(4%)	1(4%)
Open reduction and K- wire fixation	Present study (2019-2020)	25	18(72%)	5(20%)	1(4%)	1(4%)

A more stable fixation, a better anatomical reduction with a negligible complication, is given to conclude open reduction and internal fixation with K-wires. The most widely accepted are open reduction and internal fixation with K-wires.

6. Conclusion

We concluded our series of 25 patients who experienced open reduction and internal fixation with K-wires for a closed extension of the supracondylar fracture type. Open reduction and internal fixation contribute to better fixation, stronger anatomical reduction, and decreased complications. It is therefore a safe and efficient method of fixation, particularly for neurovascular injuries. Cubitus varus deformity is lower relative to other approaches due to improved anatomical reduction and reliable fixing. Elbow stiffness is weaker compared to most treatment approaches owing to early elbow mobilization. Open reduction is completely indicated in patients with neurovascular damage fracture, irreducible fracture, and open fracture. When the supracondylar fractures of the humerus are displaced at the right time, open reduction and internal fixation with K-wires have excellent practical and aesthetic performance.

To infer open reduction and internal fixation with K-wires have a safe fixation, stronger anatomical reduction with limited complications. It is also the most widely accepted treatment modality for displaced supracondylar humeral fractures in children, particularly in patients with neurovascular injuries and irreducible fractures.

7. Conflict of Interest

No conflict of interest.

8. Source of Funding

None.

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