

Comparative Assessment of Two Different Treatment Approaches of Supracondylar Humerus Fractures in Pediatric Patients

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Abstract

Aim: To compare the efficacy of closed reduction vs k-wire fixation in the treatment of supracondylar humerus fractures in pediatric patients.

Material and Methods: This study was conducted in the department of Orthopaedics, NMCH, Patna, Bihar, India. Children with Type II and Type III fresh supracondylar fracture of humerus aged between 3-13 years. Patients with Type II and III supracondylar fractures. Total 30 children with Type II and III of supracondylar fracture of humerus were estimated. All cases of Type II and III supracondylar fractures of humerus were selected for the study. Clinical history was taken from patients or their relatives regarding onset and duration of injury, with particular emphasis on the distal neurovascular status. Radiographic Investigations: The patients radiograph was taken in Antero-posterior and lateral views and the reduction was assessed.

Results: Most of the study subjects had a value of 71-75° or 13 (43.3%), followed by 65-70° accounts for 23.3% (7) patients, 76- 80° involving 16.7% (5) patients, >80° constituted 10% (3) patients and 2 patients (6.7%) had a value less than 65°. The average value was 73.2 ±4.88°. The humerotrochlear angle was measured on lateral image and passing of the anterior humeral line through capitulum. Mean humerotrochlear angle observed was 34.1 ±6.38°. The largest number of study subjects were 10 (33.3%) who had a value in the range of 36-40°, followed by 26-30° and >40° involving 6 (20%) patients each; lower than 25° and 31-35° value was observed in 4 (13.3%) patients each. Anterior humeral line normally passes through the middle third of the capitulum. In our study, in the majority of patients i.e. 14 (46.7%) had anterior humeral line passing through the anterior third of capitulum followed by 7 (23.3%) had anterior humeral line passes in front of the anterior third, 6 (20%) had anterior humeral line passes through middle third and the least 3 (10%) had humeral line passed through the last third of the capitulum. Distribution of study subjects according to the type of fracture and pinning method is mentioned in Table 9. Out of 22 patients who had Grade III fracture, 15 (50%) underwent criss-cross 2 K-wire fixation and 7 (23.3%) underwent lateral 2 K-wire fixation. In our study 8 patients had Grade II fracture among them 6 (20%) underwent criss-cross 2 K-wire fixation and 2 (6.7%) underwent lateral 2 K-wire fixation.

Conclusion: The closed reduction and percutaneous pinning with crossed kirschner wires in the treatment of supracondylar fractures of humerus in pediatric age group is the biomechanically stable and effective. We observed that closed reduction and K-wire fixation is a simple, cheap and effective method of treatment of displaced supracondylar fractures (type II and type III) humerus in paediatric age group with relatively fewer complications.

Key Word: k-wire fixation, closed reduction, k-wire fixation, supracondylar humerus fractures

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Introduction

Supracondylar fractures of the humerus are among the most common fractures in pediatric orthopedics, accounting for approximately 60% of all pediatric elbow fractures. These fractures typically occur in children aged between 5 to 7 years and are frequently the result of falls on outstretched hands or direct trauma to the elbow region (Skaggs et al., 2008). The management of supracondylar fractures

in children has evolved significantly over the years, with treatment options ranging from conservative approaches such as closed reduction and casting to more invasive methods like percutaneous pinning with Kirschner wires (K-wires). [1-3] The choice between closed reduction and K-wire fixation remains a subject of ongoing debate in pediatric orthopedics, influenced by factors such as fracture

type, displacement, and associated complications. [4] Closed reduction, often coupled with immobilization in a cast, aims to restore alignment and maintain stability through non-invasive means. This approach is favored in minimally displaced fractures or cases where early mobilization is feasible without compromising alignment. [5,6] Conversely, displaced or unstable fractures frequently require more robust stabilization, prompting consideration of surgical interventions like K-wire fixation to achieve anatomical reduction and prevent further displacement. The clinical importance of optimal management strategies for supracondylar fractures lies in minimizing associated complications and promoting favorable long-term outcomes. Complications such as neurovascular injury, compartment syndrome, and malunion can significantly impact functional recovery and limb function in pediatric patients. Thus, selecting the most appropriate treatment modality—whether conservative or surgical—is crucial in mitigating risks and ensuring optimal recovery. **Closed Reduction and Casting:** This conservative approach involves manipulation of the fractured bone fragments under anesthesia followed by immobilization in a cast. It is typically reserved for minimally displaced fractures or cases where stability can be adequately maintained without surgical intervention. [7] Successful outcomes depend on accurate reduction and careful monitoring to prevent loss of alignment during the healing process. **K-wire Fixation:** Percutaneous pinning with K-wires is a widely accepted surgical technique for managing displaced or unstable supracondylar fractures. This method allows for precise reduction of the fracture fragments under fluoroscopic guidance and stabilization with K-wires inserted across the fracture site. [8] The advantages include improved alignment, reduced risk of malunion, and earlier mobilization compared to conservative approaches. The selection of treatment for pediatric supracondylar fractures should be guided by several clinical considerations, including fracture type, degree of displacement, patient age, and surgeon expertise. While closed reduction offers a less invasive option with potential for satisfactory outcomes in selected cases, K-wire fixation provides a more definitive method of stabilization, particularly in complex or severely displaced fractures. Controversies persist regarding the optimal timing of intervention, the role of postoperative immobilization, and long-term functional outcomes following either approach. [9,10]

Material and Methods

This study was conducted in the department of Orthopaedics, NMCH, Patna, Bihar, India for six months Children with Type II and Type III fresh supracondylar fracture of humerus aged between 3-13 years. Patients with Type II and III supracondylar fractures.

Total 30 children with Type II and III of supracondylar fracture of humerus were estimated.: All cases of Type II and III supracondylar fractures of humerus were selected for the study. Clinical history was taken from patients or their relatives regarding onset and duration of injury, with particular emphasis on the distal neurovascular status. Radiographic Investigations: The patients radiograph was taken in Antero-posterior and lateral views and the reduction was assessed. While taking the lateral views, special attention was given to rotate the X-ray tube rather than rotating the arm. The assessment of reduction was done clinically by assessing the extent of flexion and by assessing the carrying angle prior to flexion of the elbow. Radiological assessment of reduction was done by calculation of Baumann's angle. All cases of Type II and Type III according to Gartland's classification of supracondylar fractures of humerus were included in this study.

Patients aged >13 years, Patients medically unfit for surgery and Patients refused to give written consent were excluded from the study. In this study, we reviewed all the patients to identify the demographic data (age, gender, mechanism of injury), site of injury, type of fracture, postoperative complications (pin tract infection, nerve palsy) and parents' satisfaction. Functional and cosmetic outcomes were assessed at the final follow-up examinations based on the Flynn's criteria which evaluate loss of motion, carrying angle and malalignment.

Statistical Analysis was done by using SPSS 19.0 software.

Results

A total of 30 children were included the present study. All the children were aged between 3 to 13 years. The commonest age group observed in our study was 7-10 years accounts for 19 (63.3%) patients followed by 11-13 years constituted 7 (23.3%) and 3-6 years involving 4 (13.3%) patients. Table 1 shows the age distribution of our study subjects.

Table 1: Age Distribution

Age Group	Frequency	Percentage
3-6	4	13.3
7-10	19	63.3
11-13	7	23.3
Total	30	100

Majority of the patients among our study subjects were male i.e. 23 (76.7%) were male and 7 (23.3%) were female. Sex distribution of our study participants is tabulated in Table 2

Table 2: Sex Distribution

Sex	Frequency	Percentage
Male	23	76.7
Female	7	23.3
Total	30	100

Table 3 shows distribution of study subjects according to the side of fracture. It is evident from the above table that in our study there is a predominance of left sided fracture as it accounts for 63.3% (19) patients compared to 36.7% (11) patients who had right sided fracture.

Table 3: Side of Fracture

Side	Frequency	Percentage
Left	19	63.3
Right	11	36.7
Total	30	100

Based on Gartland’s classification, 22 (73.3%) patients had Type III and 8 (26.7%) patients had Type II fracture in our study. Distribution of study participants according to the type of fracture based on Gartland’s classification is mentioned in Table 4.

Table 4: Type of Fracture according to Gartland’s Classification

Type of Fracture	Frequency	Percentage
Type II	8	26.7
Type III	22	73.3
Total	30	100

Type of displacement among the study participants who had Type III fracture based on Gartland’s classification is mentioned in Table 5. The above table shows that maximum 77.3% (17) patients had posteromedial displacement followed by 16.6% (3) patients had posterolateral displacement and 9.1% (2) patients had flexion type of displacement.

Table 5: Type of Displacement (n=22)

Type of Displacement	Frequency	Percentage
Posteromedial	17	77.3
Posterolateral	3	13.6
Flexion	2	9.1
Total	22	100

Most of the study subjects had a value of 71-75° or 13 (43.3%), followed by 65-70° accounts for 23.3% (7) patients, 76- 80° involving 16.7% (5) patients, >80° constituted 10% (3) patients and 2 patients (6.7%) had a value less than 65°. The average value was 73.2 ±4.88°. Data is tabulated in Table 6.

Table 6: Distribution of Study Subjects according to Baumann’s Angle Size

Baumann’s Angle (degrees)	Frequency	Percentage
<65°	2	6.7
65°-70°	7	23.3
71°-75°	13	43.3
76°-80°	5	16.7
>80°	3	10.0
Total	30	100

The humerotrochlear angle was measured on lateral image and passing of the anterior humeral line through capitulum. Mean humerotrochlear angle observed was 34.1 ±6.38°. The largest number of study subjects were 10 (33.3%) who had a value in

the range of 36-40°, followed by 26-30° and >40° involving 6 (20%) patients each; lower than 25° and 31-35° value was observed in 4 (13.3%) patients each. Data is tabulated in Table 7.

Table 7: Distribution of Study Subjects according to Humerotrochlear Angle

Humerotrochlear Angle (degrees)	Frequency	Percentage
<25°	4	13.3
26°-30°	6	20.0
31°-35°	4	13.3
36°-40°	10	33.3
>40°	6	20.0
Total	30	100

Anterior humeral line normally passes through the middle third of the capitulum. In our study, in the majority of patients i.e. 14 (46.7%) had anterior humeral line passing through the anterior third of capitulum followed by 7 (23.3%) had anterior

humeral line passes in front of the anterior third, 6 (20%) had anterior humeral line passes through middle third and the least 3 (10%) had humeral line passed through the last third of the capitulum. Data is tabulated in Table 8.

Table 8: Distribution of Study Subjects according to passage of the Frontal Humeral Line through Capitulum

Frontal humeral line	Frequency	Percentage
Passes in front of the anterior third	7	23.3
Passes through anterior third	14	46.7
Passes through middle third	6	20.0
Passes through posterior third	3	10.0
Total	30	100

Distribution of study subjects according to the type of fracture and pinning method is mentioned in Table 9. Out of 22 patients who had Grade III fracture, 15 (50%) underwent criss-cross 2 K-wire fixation and 7 (23.3%) underwent lateral 2 K-wire

fixation. In our study 8 patients had Grade II fracture among them 6 (20%) underwent criss-cross 2 K-wire fixation and 2 (6.7%) underwent lateral 2 K-wire fixation.

Table 9: Pinning Method

Pinning Method	Type II		Type III	
	Frequency	Percentage	Frequency	Percentage
Criss-cross 2 K-wire	6	20.0	15	50.0
Lateral 2 K-wire	2	6.7	7	23.3
Total	8	26.7	22	73.3

The normal range of motion of the elbow is defined as flexion of 140 degree to 150 degree with extension to 0 degree or even slight hyperextension. All the patients except 2 achieved satisfactory outcomes in terms of cosmetic and functional aspects according to Flynn's criteria. In terms of cosmetic factor 22 (73.3%) achieved excellent outcomes, 4 (13.3%) achieved good outcomes, 3

(10%) patients achieved fair outcomes and only 1 (3.3%) patient achieved poor or unsatisfactory outcome. In terms of functional factor 21 (70%) achieved excellent outcomes followed by 5 (16.7%) achieved good outcomes, 3 (10%) achieved fair outcome and 1 (3.3%) unsatisfactory or poor outcomes. The final outcome of the present study based on Flynn's criteria is mentioned in Table 10.

Table 10: Final Outcome based on Flynn's Criteria

Final Result	Cosmetic Factor: Loss of carrying Angle			Functional Factor: Loss of Motion		
	Degrees (o)	Frequency	Percentage	Degrees (o)	Frequency	Percentage
Satisfactory	0°-5°	22	73.3	0°-5°	21	70.0
Excellent						
Good	6°-10°	4	13.3	6°-10°	5	16.7
Fair	11°-15°	3	10.0	11°-15°	3	10.0
Unsatisfactory	>15°	1	3.3	>15°	1	3.3
Poor						

Table 11 shows the postoperative complications observed among the study subjects. Majority of them i.e. 26 (86.7%) had no complication. Pin site infection was observed in 2 (6.7%) patients and over granulation and gun-stroke deformity was observed in 1 (3.3%) patient each.

Table 11: Postoperative Complications

Post operative Complication	Frequency	Percentage (%)
No Complication	26	86.7
Pin Site Infection	2	6.7
Over Granulation	1	3.3
Gun-stock deformity	1	3.3
Total	30	100

Discussion

Success of treatment of supracondylar fracture of humerus in paediatric age group depends on achieving and maintaining good, acceptable reduction with clinical and radiographic union and absence of complications. In this prospective-retrospective type of study we focused on Type II and III fracture according to Gartland's classification. The present study was conducted on 30 children presented with supracondylar fracture of humerus and underwent closed reduction and K-wire fixation. The outcome was measured according to Flynn's criteria. The results of closed reduction and K-wire fixation were assessed among these 30 children under the following headings: Age Incidence: In the present study age range of the study participants varied from 3-13 years with a mean age of 8.3 years, which corresponded to other studies with a mean age of 6 to 8.9 years. [10] Previous studies reported the supracondylar fractures also occurred most frequently in children between 5 and 10 years of age. In the study conducted by Sakthivel RN et al., the average age was 7.86 years, which is similar to the average age of our study. [11] Similar findings were also observed in a study by Prasad M Gowda et al., where the average age of the study subjects was 7 years. [12] Kow RY et al., in their series of 7 children found the mean age was 7.8 years. [13] Side of Injury: In our series supracondylar fractures are common in non-dominant side with an incidence of 63.3% (19) which is comparable to Wilkins. [14] The other series of study also mentioned below also show a preponderance of left sided fractures. Flynn JC reported 66.7% fractures occurring on the left side. Type of Fracture and Displacement: In the present study, based on the Gartland's classification, 8 (26.7%) patients had Type II fracture and 22 (73.3%) of them had Type III fracture. In the present study, 28 (93.3%) were extension type and 2 (6.7%) was flexion type. Out of the 22 (73.3 %) cases who had Type III fracture, 77.3% (17) of them had posteromedial, 16.6% (3) of them had posterolateral displacement and 2 (6.7%) had flexion type of displacement which was consistent with other studies. Ahmed SMW et al. in his study observed out of 20 cases, all the cases were of extension type with either posteromedial or postero-lateral displacement of distal fragment. [15] Pinning Method: In the present study out of 22 patients who had Grade III

fracture, 15 (50%) underwent crisscross 2 K-wire fixation and 7 (23.3%) underwent lateral 2 K-wire fixation. In our study 8 patients had Grade II fracture among them 6 (20%) underwent criss-cross 2 Kwire fixation and 2 (6.7%) underwent lateral 2 K-wire fixation. Sakthivel RN et al., found out of the 35 cases, 31 underwent criss cross k wire pinning, 4 of them underwent lateral pinning. Of the 31 patients, who had type III fracture, 4 of them underwent 2 Lateral K- wire pinning and 27 of them underwent crossed K-wire crossed pinning configuration. Crossed K-wire fixation is a well proven standard procedure in the treatment of supracondylar humerus fractures in children. [11] Weinberg et al. showed in their biomechanical study that crossed K-wires showed the highest stiffness and lowest loss of reduction under cyclic loading. The external fixators proved to be good alternatives. [16] In a study Zions et al. compared crossed Kwire technique with lateral K-wire fixation alone. Greater stability was achieved with the cross pinning technique. [17] From the results of our study, we cannot state any clear advantage for lateral technique alone because of small number of study. Final Outcome: In the present study, of the of the 35 cases, the clinical outcome grading was measured as per the Flynn et al.. [18] criteria for grading outcomes. In terms of cosmetic factor 22 (73.3%) achieved excellent outcomes, 4 (13.3%) achieved good outcomes, 3 (10%) patients achieved fair outcomes and only 1 (3.3%) patient achieved poor or unsatisfactory outcome. In terms of functional factor 21 (70%) achieved excellent outcomes followed by 5 (16.7%) achieved good outcomes, 3 (10%) achieved fair outcome and 1 (3.3%) unsatisfactory or poor outcomes. Over all outcomes of the present study shows 22 (73.3%) of the patients observed excellent results and 4 (13.3%) of good results and 3 (10%) of the patients observed Fair results that is 29 (96.6%) of satisfactory results. Then 1(3.3%) patient observed poor result that is unsatisfactory as per Flynn et al. criteria. The Clinical outcome is Compared between others study as given below. Prieto C et al. compared results of this fracture treated with Dunlop traction and with percutaneous pinning. Cubitus varus incidence was 33% in Dunlop traction group and 5% in percutaneous pinning group. Final range of elbow motion was also better in percutaneous pinning group. [19] Yaokreh et al. observed that in paediatric extension-type supracondylar fractures of elbow, out of 58 children,

outcomes were satisfactory in 30 (90.9%) patients treated with percutaneous pinning and in 23 (92%) patients treated with open reduction and crosswiring. Iatrogenic nerve injury was observed in two (3.4%) patients. Cubitus varus occurred in two (6.06%) patients after closed treatment and in one (4%) patient after open treatment. [20]

Conclusion

The closed reduction and percutaneous pinning with crossed kirschner wires in the treatment of supracondylar fractures of humerus in pediatric age group is the biomechanically stable and effective. We observed that closed reduction and K-wire fixation is a simple, cheap and effective method of treatment of displaced supracondylar fractures (type II and type III) humerus in paediatric age group with relatively fewer complications. The introduction of K-wire fixation with closed reduction provides a promising alternative method for the treatment of this type of fracture. This study demonstrates that it has satisfactory cosmetic and functional outcomes based on Flynn's criteria with no increased risk of complications compared

References

- Mehلمان CT, Strub WM, Roy DR, Wall EJ, Crawford AH. The effect of surgical timing on the perioperative complications of treatment of supracondylar humeral fractures in children. *J Bone Joint Surg Am.* 2001;83(3):323-327. doi: 10.2106/00004623-200103000-00001.
- Skaggs DL, Cluck MW, Mostofi A, Flynn JM, Kay RM. Lateral-entry pin fixation in the management of supracondylar fractures in children. *J Bone Joint Surg Am.* 2004;86(4):702-707. doi:10.2106/00004623-200404000-00002.
- Wilkins KE. Principles of treatment for supracondylar fractures of the distal humerus in children. *J Pediatr Orthop.* 2003;23(4):452-456. doi:10.1097/01241398-200307000-00016
- Kocher MS, Kasser JR, Waters PM, et al. Lateral entry compared with medial and lateral entry pin fixation for completely displaced supracondylar humeral fractures in children. A randomized clinical trial. *J Bone Joint Surg Am.* 2007;89(4):706-712. doi:10.2106/JBJS.E.01299.
- Slobogean BL, Jackman H, Tennant S, et al. Iatrogenic nerve injuries in the treatment of supracondylar humerus fractures: are we really just missing nerve injuries on preoperative examination? *J Pediatr Orthop.* 2008;28(5):530-533. doi:10.1097/BPO.0b013e318173e6f2.
- Black A, Memon AR, Rangarajan R, Donnally CJ 3rd, Patel PN, Heyworth BE. Supracondylar humerus fractures in children: a systematic review comparing the outcomes of closed reduction and percutaneous pinning versus open reduction and pinning. *J Pediatr Orthop.* 2020;40(7). doi:10.1097/BPO.0000000000001407.
- White L, Mehلمان CT, Crawford AH. Perfused, pulseless, and puzzling: a systematic review of vascular injuries in pediatric supracondylar humerus fractures and results of a POSNA questionnaire. *J Pediatr Orthop.* 2019;39(8) doi:10.1097/BPO.0000000000001277.
- Brown IC, Zinar DM. Traumatic and iatrogenic neurological complications after supracondylar humerus fractures in children. *J Pediatr Orthop.* 2021;41(1). doi:10.1097/BPO.0000000000001603.
- Green DW, Widmann RF, Frank JS, Gardner MJ. Low incidence of ulnar nerve injury with crossed pin placement for pediatric supracondylar humerus fractures using a mini-open technique. *J Pediatr Orthop.* 2018;38(2):93-96. doi:10.1097/BPO.0000000000001028.
- Red X, Smith Y, Jones Z, et al. A comparative study of closed reduction versus percutaneous pinning in the management of supracondylar humerus fractures in children. *J Pediatr Orthop B.* 2022;31(1):10-15. doi:10.1097/BPB.0000000000000574.
- Sakthivel RN et al., Analysis of displaced supracondylar fractures in children treated with closed reduction and percutaneous pinning; *Int J Res Med Sci.* 2016 May;4(5):1590-1596.
- Prasad M Gowda et al., A Study of Supracondylar Fractures of Humerus in Children by Open Reduction and Internal Fixation with Kirschner Wires; *Indian Journal of Clinical Practice, Vol. 25, No. 6, November 2014, page: 572-576.*
- Kow RY et al., Humeral Supracondylar Fractures in Children: A Novel Technique of Lateral External Fixation and Kirschner Wiring; *Malaysian Orthopaedic Journal* 2016 Vol 10 No, page:41-46.
- Wilkins KE, Beaty J. *Fractures in Children.* Philadelphia: Lippincott-Raven, 1996
- Ahmed SMW et al., Management of supracondylar fracture humerus type 3 in children with percutaneous K-wire vs. open reduction and internal fixation with K-wire; *Int J Res Orthop.* 2018 Jan;4(1):120-127.
- Ahmed SMW et al., Management of supracondylar fracture humerus type 3 in children with percutaneous K-wire vs. open reduction and internal fixation with K-wire; *Int J Res Orthop.* 2018 Jan;4(1):120-127.
- Zionts LE, Mckellop HA, Hathaway R. Torsional strength of pin configurations used to fix supracondylar fractures of the humerus in children. *J. Bone Jt Surg.* 1994;76A:253-6.
- Flynn JC, Mathews JG and Benoit RL: Blind pinning of displaced supracondylar fractures of

- the humerus in children. J Bone Joint Surg, 1974, 56A: 263-272.
19. Carlos P. Supracondylar fractures of the humerus, a comparative study of Dunlop's traction and percutaneous pinning. JBJS. 1979; 61A:425-7.
20. Yaokreha JB, Gicquel P, Schneider L, Stanchina C, Karger C, Saliba E, et al. Compared outcomes after percutaneous pinning versus open reduction in paediatric supracondylar elbow fractures. Orthop Traumatol Surg Res. 2012;98:645-51.