

Supracondylar (fracture) of humerus in paediatric age group treated with closed reduction versus k-wire fixation

Ravi Shankar Kumar¹, Siddhartha Kumar Shrest^{2*}, Benu Gopal Das³

¹Junior Resident, ²Junior Resident, ³Professor, Department of Orthopaedics, MGM Medical College and L.S.K. Hospital Kishanganj, Bihar.

Email: drskshrest@gmail.com

Abstract

Background: The objective of this study is to analyze and present the results obtained with the treatment of unstable supracondylar humerus fractures in pediatric age group, who underwent closed reduction and percutaneous fixation using lateral and crossed Kirschner wires. **Methods:** Children with Type II and Type III fresh supracondylar fracture of humerus aged between 3-13 years. It was prospective type of study, study was done in the Department of Orthopaedics, M.G.M. Medical College and L.S.K. Hospital, Kishanganj, Bihar. Total 30 children with Type II and III of supracondylar fracture of humerus were estimated, during the period of January 2018 to September 2019. **Results:** Closed reduction with cross k-wire or lateral k-wire both showed satisfactory outcomes as a treatment procedure of supracondylar fracture in paediatric age group. In the present study 73.3% were treated with criss-cross pinning and 26.7% with lateral pinning. Final outcome of the present study based on Flynn's criteria showed 73.3% excellent, 13.3% good, 10% fair and only 3.3% poor outcomes. Overall 96.6% patients achieved satisfactory outcomes which is quite comparable to previous similar studies **Conclusion:** 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.

*Address for Correspondence:

Dr Siddhartha Kumar Shrest, Junior Resident, Department of Orthopaedics, MGM Medical College and L.S.K. Hospital Kishanganj, Bihar.

Email: drskshrest@gmail.com

Received Date: 13/12/2019 Revised Date: 22/01/2020 Accepted Date: 02/02/2020

DOI: <https://doi.org/10.26611/1031412>

This work is licensed under a [Creative Commons Attribution-NonCommercial 4.0 International License](https://creativecommons.org/licenses/by-nc/4.0/). 

Access this article online	
Quick Response Code:	Website: www.medpulse.in
	Accessed Date: 05 April 2020

INTRODUCTION

The elbow is the second most common site of occurrence of fractures, of the upper limbs in children, surpassed only by forearm fractures. Around 85% of elbow fractures in children occur in the distal humerus, and of these, 55% to 75% are supracondylar fractures, accounting for 3% of all fractures in children¹⁻⁴. Supracondylar humerus fractures are the most common elbow injury in pediatric age group and the most common paediatric fracture requiring

surgery^{5,6}. Pediatric supracondylar humerus fractures (SCHFs) are common and significant injuries. They are distinctly different from adult supracondylar humerus fractures and thus are approached differently. Supracondylar humerus fractures are mostly caused by direct or indirect low-kinetic energy traumas, such as falls, which makes the occurrence of comminution, bone exposure or association with other fractures less frequent.¹⁻⁴ Supracondylar humerus fractures occur proximal to the articular surface of the distal humerus and may be transverse, oblique, or jagged. Extension type of supracondylar humerus fractures typically result from a fall on to an outstretched hand, usually leading to a forced hyperextension of the elbow. The olecranon acts as a fulcrum which focuses the stress on distal humerus (supracondylar area), predisposing the distal humerus to fracture. The supracondylar area undergoes remodeling at the age of 6 to 7, making this area thin and prone to fractures. Important arteries and nerves (median nerve, radial nerve, brachial artery and ulnar nerve) are located at the supracondylar area and can give rise to

complications if these structures are injured. Most vulnerable structure to get damaged is Median Nerve⁷. Meanwhile, the flexion-type of supracondylar humerus fracture is less common. It occurs by falling on the point of the elbow, or falling with the arm twisted behind the back. This causes anterior dislocation of the proximal fragment of the humerus⁸. **Gartland** described a rotatory and translational deformity, with posterior displacement (extension) of the distal fragment occurring most often⁹. He described three types of extension injury based on degree of displacement: type I, nondisplaced; type II, moderately displaced; and type III, severely displaced injury, and he considered flexion-type injuries separately⁹.

METHODS

Classification System Used: Classification system proposed by **Gartland** was used which defines type-I fractures as undisplaced, type-II fractures as displaced fractures with intact posterior cortex and type III as displaced with no cortical contact and further subdivided it into posteromedial and posterolateral.

Study Setting: Children with Type II and Type III fresh supracondylar fracture of humerus aged between 3-13 years.

Place of Study: Department of Orthopedics, M.G.M. Medical College and L.S.K. Hospital, Kishanganj, Bihar

Period of Study: 18 month.

Study population: Patients admitted to the Orthopedics ward at M.G.M. Medical College Type II and III supracondylar fractures.

Sample Size: Total 30 children with Type II and III of supracondylar fracture of humerus were estimated.

Sample Design: All cases of Type II and III supracondylar fractures of humerus who attended the Orthopedics ward

of M.G.M. Medical College and Hospital, were selected for the study.

Method of Data Collection: 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.

Inclusion criteria:

- All cases of Type II and Type III according to Gartland's classification of supracondylar fractures of humerus.

Exclusion Criteria:

- Patients aged >13 years.
- Patients medically unfit for surgery.
- Patients refused to give written consent.

Definition of Outcome: In this study, we reviewed all the patients to identify the demographic data (age, gender, mechanism of injury), site of injury, type of fracture, post-operative 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: At the end of the study, all the data were compiled and tabulated in a grand chart. Statistical Analysis was done by using SPSS 19.0 software.

RESULTS

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

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 2: Sex Distribution

Sex	Frequency	Percentage
Male	23	76.7
Female	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 3: Side of Fracture

Side	Frequency	Percentage
Left	19	63.3
Right	11	36.7
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 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

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 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

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 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

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 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

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 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

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 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

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 10: Final Outcome based on Flynn’s Criteria

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

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 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

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.

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 in the OPD of Orthopaedics of M.G.M. Medical College and L.S.K. Hospital 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 study¹¹. 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 years¹³. 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] study and observation of Cheng *et al.*^[61]. 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 fragment¹⁵

Pinning Method: In the present study 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. 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 alternatives¹⁶. In a study Zionts *et al.* compared crossed K-wire technique with lateral K-wire fixation alone. Greater stability was achieved with the cross pinning technique¹⁷.

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 group¹⁹. 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 treatment²⁰.

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

1. Rouede RS, Giordano V, Amaral NP. Tratamento cirúrgico das fraturas supracondilianas desviadas do úmero na criança: análise dos resultados de 20 casos. *Rev Bras Ortop.* 2001;36(4):105–110.
2. Cheng JC, Shen WY. Limb fracture pattern in different pediatric age groups: a study of 3,350 children. *J Orthop Trauma.* 1993;7(1):15–22.
3. Canale ST. Fraturas e luxação em crianças. In: Canale ST, editor. *Cirurgia ortopédica de Campbell.* 10a. Manole; São Paulo: 2006. pp. 1437–1453.
4. Amatuzzi MM, Zoppi Filho A, Montenegro NB. Fratura supracondiliana do úmero em crianças: estudo de 90 casos operados. *Rev Bras Ortop.* 1997;32(6):437–442.
5. Williamson DM, Coates CJ, Miller RK, Cole WG. Normal characteristics of the Baumann (humero capitellar) angle: an aid in assessment of supracondylar fractures. *J Pediatr Orthop.* 1992;12:636–639.
6. Khoshbin A, Leroux T, Wasserstein D, Wolfstadt J, Law PW, *et al.* (2014) He epidemiology of paediatric supracondylar fracture fixDtiona population-based study. *Injury* 45: 701-708.
7. Vineet, Kumar; Ajai, Singh (1 December 2016). "Fracture Supracondylar Humerus: A Review". *Journal of Clinical and Diagnostic Research.* 10 (12): 1–6.
8. Eira, Kuoppala; Roope, Parvianien; Tytti, Pokka; Minna, Serlo; Juha-Jaakko, Sinikumpu (11 May 2016). "Low incidence of flexion-type supracondylar humerus fractures but high rate of complications". *Acta Orthopédica.* 87 (4): 406–411.
9. Gartland JJ. Management of supracondylar fractures of the humerus in children. *Surg Gynecol Obstet.* 1959;109:145–154.
10. Chai KK, Saw A, Sengupta S. Supracondylar Fractures of the Humerus in Children – An Epidemiological Study of 132 Consecutive Cases. *Med J Malaysia.*2000; 55: 39-42
11. 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.
12. 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.
13. 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.
14. Wilkins KE, Beaty J. *Fractures in Children.* Philadelphia: Lippincott-Raven, 1996
15. 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.
16. 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.
17. Zions 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.
18. 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.

Source of Support: None Declared
Conflict of Interest: None Declared

Policy for Articles with Open Access:

Authors who publish with MedPulse International Journal of Orthopedics, (Print ISSN: 2579-0889, Online) (ISSN: 2636-4638) agree to the following terms: Authors retain copyright and grant the journal right of first publication with the work simultaneously licensed under a Creative Commons Attribution License that allows others to share the work with an acknowledgement of the work's authorship and initial publication in this journal.

Authors are permitted and encouraged to post links to their work online (e.g., in institutional repositories or on their website) prior to and during the submission process, as it can lead to productive exchanges, as well as earlier and greater citation of published work.