

FUNCTIONAL OUTCOME OF SURGICAL FIXATION OF SUPRACONDYLAR HUMERUS FRACTURES IN CHILDREN BY LATERAL PINNING AND CROSSED PINNING: A COMPARATIVE INTERVENTIONAL STUDY

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Received : 13/01/2023
Received in revised form : 20/02/2023
Accepted : 06/03/2023

Keywords:
Children, Cross pinning, Lateral pinning, Supracondylar fractures humerus.

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DOI: 10.47009/jamp.2023.5.2.240

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2023; 5 (2); 1133-1139



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Abstract

Background: Displaced supracondylar fractures of humerus are one of the most common fractures in paediatric age group with preferred treatment being close reduction with percutaneous K-wire fixation. **Materials and Methods:** This is a prospective interventional study of 30 patients done over a period of 1 year from May 2021- June 2022 to assess the clinical, radiological and functional outcome of Surgical Fixation of Supracondylar Humerus Fracture by Lateral Pinning and Crossed pinning in Children at the Department of Orthopaedics and Traumatology, Thiruvavur Medical College and Hospital, Thiruvavur, Tamil Nadu, India. **Result:** Patients were assessed by Flynn's criteria. Results were excellent in 93% and good in 6.7 % of cross pinning group and for lateral pinning group, excellent in 93.3% and fair in 6.7% cases which were not statistically significant ($P = 0.97$). **Conclusion:** With the use of the specific techniques employed in this study, both lateral entry pin fixation and medial and lateral entry pin fixation are effective in the treatment of completely displaced (type III) extension supracondylar fractures of the humerus in children.

INTRODUCTION

Supracondylar humeral fractures (SCHFs) are the most common type of fractures in the pediatric children accounting for 7-9 percentages of childhood fractures with peak incidence between 4-7 years of age.^[1,2] Children are susceptible to this fracture, due to the bending function of the elbow, the weak metaphyseal sclerotic of the distal humerus, and the thin ridge of the metaphyseal bone between the coronoid fossa and the olecranon fossa. It has been reported that more than 95% of all SCHFs are extension-type injuries that occur during falls on an outstretched hand.^[3,4] This type of fracture are troublesome injury with complications including neurovascular injuries, elbow stiffness, fascial compartment syndrome, malunion, and, especially, elbow varus deformities.^[5] An SCHF has a great impact on the function and appearance of the elbow joint in children.^[6] Extension-type injuries are classified according to Gartland's criteria as type I

(non-displaced and stable), type II (hinged fractures with intact posterior cortex), and type III (completely displaced).^[7] Closed reduction and internal fixation using percutaneous pinning are the main treatments for SCHF.

Various studies have reported, crossed pinning is superior in providing biomechanical stability, and there is increased risk of iatrogenic ulnar nerve injury due to the medial pin position. Conversely, lateral pinning may be less stable biomechanically but avoids ulnar nerve injury.^[8,9]

The purpose of this study will be to evaluate the carrying angle functional and radiological outcome analysis using closed reduction and lateral pinning and crossed pinning with k wires in the management of displaced supracondylar fracture of humerus and to analyze the results with incidence of complications.

Aims and Objectives

1. To assess the functional outcome after treatment of displaced supracondylar fracture humerus in

- children managed with lateral pinning and crossed pinning.
- To assess the anatomical reduction of fracture and restoration of Carrying angle and Baumann's angle.

MATERIALS AND METHODS

This is a prospective Interventional study consisting of 30 cases of displaced supracondylar fracture of humerus in children which were treated by closed reduction and stabilized by lateral pinning or crossed pinning with Kirschner's wire. The study was conducted in Government Thiruvapur Medical College and hospital in Department of Orthopaedics between May 2021 to June 2022. All patients who were operated during this period were included in this study. Institutional Ethical Committee approval was obtained before the start of the study.

Inclusion Criteria

- All children with Closed Extension type Gartland type- II and III supracondylar humerus presenting within a week.
- All displaced supracondylar humerus fractures.
- Age < 15 years
- No previous ipsilateral elbow injury.

Exclusion Criteria

- Those who are not willing for the study
- Open fractures
- Compartment syndrome
- Associated with neurovascular compromise

All the patients admitted in our tertiary Care hospital were selected. Detailed history and examination of the patient was done according to the protocol. The required information was recorded in the proforma prepared. The patient's radiograph was taken in Antero- posterior and lateral views. The diagnosis was made by clinical and radiological examination.

In this study, supracondylar fracture of humerus was classified according to Gartland's classification.

- Type I: Un displaced Supracondylar fracture of humerus
- Type II: Displaced Supracondylar fracture with intact posterior cortex.
- Type III: Displaced Supracondylar fracture with no cortical contact.

Technique

All patients admitted are resuscitated in trauma care and evaluated using trauma series radiographs if found necessary and with opposite normal side radiographs. Fractures are selected for this pinning technique using inclusion and exclusion criteria. Patient's parents / guardian was counselled regarding advantages, disadvantages and possible complications of this procedure and a written consent was obtained. These patients were divided in group A and group B. Each group consisted of 15 patients. The fracture of patients in group A was fixed with two or three lateral Kirschner wires and

Group B was fixed with medial and lateral (crossed) Kirschner wires con- figuration.

Standard anteroposterior and lateral radiographs of the involved elbow were taken, and the fracture type was noted. The cases were treated on an emergency basis with closed reduction and percutaneous pinning, under the guidance of C-arm image intensifier. The patient was positioned supine on the operating table with affected limb being placed on a side table or over the sterile draped C-arm image intensifier. Then, a step-wise closed manipulation was performed. Assessment of reduction was done under image intensifier by taking anteroposterior and lateral views; lateral view was taken by external rotation of shoulder. Maintenance of reduction was achieved by passing two crossed K-wires from both the medial and the lateral epicondyles (cross pinning) or by passing two K-wires from the lateral condyle in a divergent fashion (lateral pinning).

Table 1: Flynn's criteria

Result	Rating	Cosmetic factor (carrying angle loss) Degree	Functional factor (Motion loss) degree
Satisfactory	Excellent	0-5	0-5
	Good	5-10	5-10
	Fair	10-15	10-15
Unsatisfactory	Poor	>15	>15

When crossed pinning was employed, the lateral pin was inserted first so that the medial pin can be placed with the elbow in less flexion to avoid ulnar nerve injury. Once the pins were in place, the elbow was extended and the adequacy of reduction was assessed with anterior posterior and lateral images. After leaving about 1 cm of the pins outside the skin, pins were bent and cut off and well-padded posterior above elbow slab was applied with elbow flexed to 90° or less as tolerated. Immediately in the post-operative period, the neurovascular status of the limb was assessed.

On 3rd/4th post-operative day slab was removed. The limb and wound and position of pins were inspected and a new well-fitted splint was reapplied. At 4 weeks, slab and pins were removed, and range of motion exercises were started in consultation with physiotherapist. Thereafter, the patient was regularly followed up at weekly interval of 2 weeks, 4 weeks, 6 weeks, monthly interval of 4 months, 6 months, 8 months, 10 months, and 12 months. At each review, patients were assessed clinically and radiologically. Finally, the functional outcome was assessed by Flynn's criteria (Table 1). The results were graded as excellent, good, fair or poor according to the range of motion and loss of carrying angle.

RESULTS

In this study groups A and B were compared with respect to Sex distribution, Hand dominance, Fracture side, Mode of injury, Fracture

characteristics, Loss of carrying angle and Loss of Baumann's angle and Loss of range of elbow movement. Total of 30 patients were Included in this study who were operated for Type II and type III supracondylar fracture of humerus.

In this study the average age was found to be 7 years in the age group of 3-15 years. In the present study, 21 were male patient and 9 were female patients showing a male preponderance. The most common mode of injury was fall from height. The present study shows that left sided injury is more common as compared to right sided injury. We found that Gartland type III fractures have higher incidence as compared to type II fractures. 22 of the patients had type III fracture and 8 had type II fracture. In our study, there was one patient with pin tract site infection which was treated with antibiotic therapy. Another patient had anterior weakness of thumb and index finger pincer movement preoperatively, which recovered after 8 weeks.

Carrying Angle: In Group A (Lateral pinning) -11 patients had change in carrying angle less than 5 degree, 4 of them had change between 5-10 degree and none of them had change in carrying angle more than 10 degree. Average carrying loss in this study group was 4.8 degree.

In Group B (Crossed pinning) -12 patients had change in carrying angle less than 5 degree, 3 of them had change between 5-10 degree and none of them had change in carrying angle more than 10 degree. Average carrying loss in our study was 4.7 degree. [Table 2]

Baumann's Angle: In Group A (Lateral pinning) 9 patients had change in Baumann's angle less than 5-degree, 6 of them had change between 6- 15 degree and none of them had change in Baumann's angle more than 15 degree.

Group B (Crossed pinning) 10 patients had change in Baumann's angle less than 5 degree, 5 of them had change between 6- 10 degree and none of them had change in Baumann's angle more than 11 degree. [Table 3]

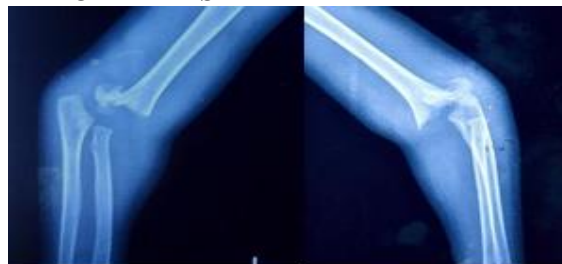
Restriction of Elbow Movement: In Group A the average restriction of flexion was found to be 6.6 degrees. Out of 15 patients, 11 had restriction of flexion upto 5 degrees, 3 had restricted flexion ranging from >5 to 10 degrees, 1 child had restriction of flexion between 10 to 15 degrees and no patients had restricted flexion from 15 to 20 degrees.

In Group B Among 15 patients the average restriction of flexion was found to be 6 degrees. 12 had restriction of flexion up to 5 degrees, 2 had restricted flexion ranging from >5 to 10 degrees, 1 child had restriction of flexion between 10 to 15 degrees and no patients had restricted flexion from 15 to 20 degrees. [Table 4]

In the present study, of the 30 cases, the clinical outcome grading was measured as per the Flynn et al criteria for grading outcomes; in Lateral pinning group 14 (93.3%) of the patients observed excellent

results and 1 (6.7%) of good results with satisfactory results. In Cross pinning group 14 (93.3%) of the patients observed excellent results and 1 (6.7%) of fair results with satisfactory results. [Table 5]

PRE-OP X-RAYS



POST-OP X-RAYS



FINAL FOLLOW-UP



Table 2: Distribution of the study participants according to Loss of carrying angle of affected limb as compared to normal side during final follow up

Loss of carrying angle	Group A (Lateral pinning)	Percentage	Group B (Crossed pinning)	Percentage
Up to 5	11	73.3%	12	80.0%
6 to 10	3	20.0%	2	13.3%
11 to 15	1	6.7%	1	6.7%
Total	15	100.0%	15	100.0%

P > 0.05 Not significant by applying Chi square Test

Table 3: Distribution of Baumann's Angle

Change of Baumann's angle (degree)	Group A (Lateral pinning)		Group B (Crossed pinning)	
	Number	Percentage	Number	Percentage
0-5	9	60%	10	66.6%
6-10	6	40%	5	33.4%
11-15	0	0%	0	0%
>15	0	0%	0	0%
Total	15	100%	15	100%

P > 0.05 Not significant by applying Chi square Test

Table 4: Distribution of the study participants according to Restriction of flexion movement

Restriction of Elbow flexion	Group A (Lateral pinning)	Percentage	Group B (Crossed pinning)	Percentage
Up to 5	11	73.3%	12	80.0%
6 to 10	3	20.0%	2	13.3%
11 to 15	1	6.7%	1	6.7%
16 to 20	0	0%	0	0%
Total	15	100.0%	15	100.0%

P > 0.05 Not significant by applying Chi square Test

Table 5: Distribution of the study participants outcomes as per Flynn criteria

Flynn criteria		Group A (Lateral pinning)		Group B (Crossed pinning)	
		N	Percentage	N	Percentage
Satisfactory	Excellent	14	93.3%	14	93.3%
	Good	0	0%	1	6.7%
	Fair	1	6.7%	0	0%
Unsatisfactory	Poor	0	0%	0	0%
Total		15	100%	15	100%

P > 0.05 Not significant by applying Chi square Test

Crossed Pinning - Case 1

PRE-OP X-RAYS



POST-OP X-RAYS



FINAL FOLLOW-UP



DISCUSSION

Age Incidence

The study done by Devkotta P in the age group of 4-10 years showed that the average age of occurrence of supracondylar humerus fracture was 7 years.^[10]

Mahan ST conducted a study on displaced supracondylar fractures of elbow in children which showed the average age to be 7.2 years in the age group of 5-10 years.^[11]

The study done by Otsuka and Kasser showed the average age to be 6.6 years and 8 years in respective age groups of 2-13 years and 5-12 years.^[12]

In this study the average age was found to be 7 years in the age group of 2-15 years which was quite similar to the previous studies.

Sex Distribution

Traditionally boys have had a higher incidence of supracondylar humerus fractures. In the present study, 21 (70%) were male patient and 9 (30%) were female patients showing a male preponderance.

A Meta analysis by Woratanarat et.al in which 75% of the participants were males and 25% were females.^[13]

Mode of Injury

Supracondylar fracture of humerus occurs commonly due to fall from height and fall while playing. In our study, we found that the most common mode of injury was fall from height. 63% injuries occurred due to fall from height and 37% of the injuries occurred due to fall while playing which is similar to the study done by Zhong ZP et al which showed 70% cases occurred due to fall from height.^[14]

Side of Injury

Studies have shown that the left sided extremity is more commonly involved. The present study shows that left sided injury is more common i.e., 63.33% as compared to right sided injury, which occurred in 36.67% of the participants. The other series of study mentioned below also show a preponderance of left sided fractures.

The Mahan ST et al study shows a 60.8% incidence of left sided fractures while Gadgil et. al. observed

left sided fractures in 63% percent of the patients.^[15,16]

A Meta analysis by Woratanarat et.al which showed similar results of left sided affection in 65% of the patients.^[13]

Type of Fracture

In our study, we found that type III fractures have higher incidence as compared to type II fractures. 22 (73.33%) of the patients had type III fracture and 8 (26.67%) had type II fracture, according to Gartland classification. As seen in the studies done by Dekker et al which shows 62.03% of type III fractures and 37.97% of type II fractures.^[17]

Prashant et al also observed similar results in their study with type III fracture being present in 64.95% of the cases and type II in 35.05% of the cases.^[18]

Type of Displacement

In the study it was found that, out of the 22 patients who had Gartland type III fractures, 14 (63.63%) had posteromedial displacement, 8 (36.36%) had posterolateral displacement.

The observed results are similar to that seen in the studies by Prashant et al which showed that posteromedial displacement was the more common type accounting for 81% of the type III supracondylar humerus fractures and 19% were having posterolateral displacement.^[18]

The study done by Zhao et al showed that 90% of type III fractures were with posteromedial displacement while posterolateral displacement accounted for only 10% of the displaced fractures.^[19]

Post Operative Complications

In our study, there was one patient with pin tract site infection which was cured with antibiotic therapy. A single patient had anterior interosseous nerve injury preoperatively which recovered after treatment for 8 weeks.

In Srivastava, study group of 42 patients about 14% had superficial pin tract infection, while 1 patient (2%) had iatrogenic ulnar nerve palsy.^[20]

In study by Karapinar et al 1 patient had developed cubitus varus deformity among 62 enrolled patients and 2 patients (3.3%) developed iatrogenic ulnar nerve palsy.^[21]

Change In Carrying Angle

Of the 30 patients enrolled in our study,

Group A (Lateral pinning) -11(73.3%) patients had change in carrying angle less than 5 degree, 4 (26.7%) of them had change between 5-10 degree and none of them had change in carrying angle more than 10 degree. Average carrying loss in this study, group was 4.8 degree.

Group B (Crossed pinning) -12(80%) patients had change in carrying angle less than 5 degree, 3 (20%) of them had change between 5-10 degree and none of them had change in carrying angle more than 10 degree. Average carrying loss in our study was 4.7 degree. [Table 2]

The study conducted by Abdel karim et al show average carrying angle loss was 5.8 degree and

study conducted by Anwar et al show average carrying angle loss was 6.2 degree.^[22,23]

Change In Baumann's angle

Of the 30 patients enrolled in our study, in Group A (Lateral pinning) 9 (60 %) patients had change in Baumann's angle less than 5 degree, 6 (40%) of them had change between 6- 15 degree and none of them had change in Baumann's angle more than 15 degree.

Group B (Crossed pinning)- 10 (66.6%) patients had change in Baumann's angle less than 5 degree, 5(33.4%) of them had change between 6- 10 degree and none of them had change in Baumann's angle more than 11 degree. [Table 3]

Restriction of Elbow Movement

In our study, among the 30 participants, in Group A the average restriction of flexion was found to be 6.6 degrees. Out of 15 patients, 11 had restriction of flexion up to 5 degrees, 3 had restricted flexion ranging from >5 to 10 degrees, 1 child had restriction of flexion between 10 to 15 degrees and no patients had restricted flexion from 15 to 20 degrees.

Group B Among 15 patients the average restriction of flexion was found to be 6 degrees. 12 had restriction of flexion up to 5 degrees, 2 had restricted flexion ranging from >5 to 10 degrees, 1 child had restriction of flexion between 10 to 15 degrees and no patients had restricted flexion from 15 to 20 degrees. [Table 4]

Functional Outcome

In the present study, of the 30 cases, the clinical outcome grading was measured as per the Flynn et al criteria for grading outcomes; in Lateral pinning group 14 (93.3%) of the patients observed excellent results and 1 (6.7%) of good results with satisfactory results. In Cross pinning group 14 (93.3%) of the patients observed excellent results and 1 (6.7%) of fair results with satisfactory results. There were no significant differences ($p > 0.05$) between groups. [Table 5]

CONCLUSION

The treatment of displaced supracondylar fractures should ideally be as minimally invasive as possible, they must have a quick learning curve, and they need to carry low rates of complications both early and late.

Although closed reduction and percutaneous pinning stabilization is the current gold standard in managing displaced supracondylar fractures of the humerus in children, there is still controversy on the pin configuration of K-wires based on fracture stability biomechanics and ulnar nerve safety. In the present study, using Flynn's score 100 % of the patients achieved a satisfactory outcome and there were no significant complications in the present series other than one case of anterior interosseous nerve injury.

Hence from our study, it can be concluded that closed reduction with lateral pinning or crossed pinning is a simple, cheap and effective method of treatment with relatively fewer complications for displaced supracondylar humerus fractures in children.

REFERENCES

1. Cheng JC, Lam TP, Maffulli N. Epidemiological features of supracondylar fractures of the humerus in Chinese children. *J Pediatr Orthop B*. 2001;10(1): 63–7.
2. Lu D, Wang T, Chen H, Sun LJ. Management of pin tract infection in pediatric supracondylar humerus fractures: a comparative study of three methods. *Eur J Pediatr*. 2017;176(5):615–20.
3. Mahan ST, May CD, Kocher MS. Operative management of displaced flexion supracondylar humerus fractures in children. *J Pediatr Orthop*. 2007;27(5): 551–6.
4. Mehlman CT, Denning JR, McCarthy JJ, Fisher ML. Infantile supracondylar humeral fractures (patients less than two years of age): twice as common in females and a high rate of malunion with lateral column-only fixation. *J Bone Joint Surg Am*. 2019;101(1):25–34.
5. Gadgil A, Hayhurst C, Maffulli N, Dwyer JS. Elevated, straight-arm traction for supracondylar fractures of the humerus in children. *J Bone Joint Surg Br*. 2005;87:82–7.
6. Kocher MS, Kasser JR, Waters PM, Bae D, Snyder BD, Hresko MT, 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):706–12.
7. Gong HS, Chung MS, Oh JH, Cho HE, Baek GH. Oblique closing wedge osteotomy and lateral plating for cubitus varus in adults. *Clin Orthop Relat Res*. 2008;466(4):899–906.
8. Gartland JJ. Management of supracondylar fractures of the humerus in children. *Surg Gynecol Obstet*. 1959;109:145–54.
9. Leitch KK, Kay RM, Femino JD, Tolo VT, Storer SK, Skaggs DL. Treatment of multidirectionally unstable supracondylar humeral fractures in children. A modified Gartland type-IV fracture. *J Bone Joint Surg Am*. 2006;88(5):980–5.
10. Devkota P, Khan JA, Acharya BM, Pradhan NM, Mainali LP, Singh M, Shrestha SK, Rajbhandari AP. Outcome of supracondylar fractures of the humerus in children treated by closed reduction and percutaneous pinning. *JNMA J Nepal Med Assoc* 2008;47(170):66–70.
11. Mahan ST, May CD, Kocher MS. Operative management of displaced flexion supracondylar humerus fractures in children. *J Pediatr Orthop*. 2007;27(5): 551–6.
12. Otsuka NY, Kasser JR. Supracondylar fractures of the humerus in children. *J Am Acad Orthop Surg*. 1997;5(1):19–26.
13. Woratanarat P, Angsanuntsukh C, Rattanasiri S, Attia J, Woratanarat T, Thak-kintian A. Meta-analysis of pinning in supracondylar fracture of the humerus in children. *J Orthop Trauma*. 2012;26(1):48–53.
14. Zhong ZP, Cao J. Comparison of two approaches for the treatment of supracondylar fractures in children by K-wires. *Zhongguo Gu Shang*. 2009 Oct;22(10):767–9.
15. Mahan ST, May CD, Kocher MS. Operative management of displaced flexion supracondylar humerus fractures in children. *J Pediatr Orthop*. 2007;27(5): 551–6.
16. Gadgil A, Hayhurst C, Maffulli N, Dwyer JS. Elevated, straight-arm traction for supracondylar fractures of the humerus in children. *J Bone Joint Surg Br*. 2005;87:82–7.
17. Dekker AE, Krijnen P and Schipper IB. Results of crossed versus lateral entry K-wire fixation of displaced pediatric supracondylar humeral fractures: A systematic review and metaanalysis. *Injury* 2016;47(11):2391–2398.
18. Prashant K, Lakhotia D, Bhattacharyya TD, Mahanta AK, Raoof A. A comparative study of two percutaneous pinning techniques (lateral vs medial-lateral) for Gartland type III

- pediatric supracondylar fracture of the humerus. *J Orthop Traumatol*. 2016;17(3):223–9.
19. Zhao JG, Wang J, Zhang P. Is lateral pin fixation for displaced supracondylar fractures of the humerus better than crossed pins in children? *Clin Orthop Relat Res*. 2013;471(9):2942–53.
 20. Srivastava. The results of open reduction and pin fixation in displaced supracondylar fractures of the humerus in children. *Med J Malaysia*. 2000; 55 (suppl.): 44-48.
 21. Karapinar L, Ozturk H, Altay T, Kose B. Closed reduction and percutaneous pinning with three Kirschner wires in children with type III displaced supracondylar fractures of the humerus. *Aeta Orthop Traumatol Turc*. 2005;39(1):23-9.
 22. Abdel Karim M, Hosny A, Nasef Abdelatif NM, Hegazy MM, Awadallah WR, Khaled SA, et al. Crossed wires versus 2 lateral wires in management of supracondylar fracture of the humerus in children in the hands of junior trainees. *J Orthop Trauma*. 2016;30(4):e123–8.
 23. Anwar W, Rehman N, Iqbal MJ, Khan MA. Comparison of the two methods of percutaneous K–wire fixation in displaced supracondylar fracture of humerus in children. *J Postgrad Med Inst (Peshawar-Pakistan)*. 2011;25: 351–61.