

Functional and Radiological Outcome of Displaced Supracondylar Humerus Fracture in Children: A Prospective Observational Study

Faiz Khan¹, Nandakumar Rengarajan², Muthulingam Manoharan³, Dhanasekaran Rajarajan⁴

ABSTRACT

Introduction: Around 60% of all the elbow injuries in the first decade, supracondylar fractures of the humerus are the most widely recognized elbow injuries in youngsters. Accompanied with problems like compartment disorder, neurovascular harm, Volkmann's ischemic contracture, and malunion. The most widely recognized choice of pinning is either cross-pin fashion or two parallel pins. Closed reduction and percutaneous K-wire fixation are best with the least problems in contrast with different modalities. In our study, we want to assess the functional and radiological outcome of pediatric displaced supracondylar humerus fracture treated with closed reduction percutaneous K-wire fixation.

Materials and methods: Sixteen patients were selected for the study based on the inclusion and exclusion criteria based on the consecutive sampling. For all patients, the standard technique of percutaneous K wire fixation was performed, and patients were evaluated on 6 weeks, 3 months, and 6 months with functional scoring by Flynn et al. Criteria and Mayo elbow scoring and radiological scoring with Baumann's angle.

Results: Ten children (62.5%) were affected in their first decade of life, with a clear male predilection than females. Mayo elbow scoring was 2.5, 6.0, and 3.75 at 6 weeks, 3 months, and 6 months. Pin-tract infection (4), two cases of malunion of our study population. In all 16 cases, the union was achieved with 14 cases satisfactorily excellent and satisfactorily good in 1 case and unsatisfactorily poor in 1 case.

Conclusion: Closed reduction and percutaneous pinning are the treatment of choice for pediatric supracondylar humerus fractures with Modified Gartland's type II and type III. Appropriate pinning technique ensures a successful outcome with cross configuration providing excellent outcome with good rotational stability. Closed reduction and percutaneous pinning is a safe, cost-effective, less morbid procedure.

Keywords: Fracture, Humerus, K-wire, Pinning, Supracondylar.

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INTRODUCTION

Around 60% of all elbow injuries in the initial decade of life, supracondylar fractures of the humerus are the most widely recognized elbow injuries in youngsters.¹ These injuries can be perhaps the hardest to treat, attributable to the presence of related prompt and late problems like compartment disorder, neurovascular injury, Volkmann's ischemic contracture, and malunion.²⁻⁴ These injuries are broadly classified as extension and flexion types with the former being more common.^{5,6} Extension injuries are further sub-classified as undisplaced fractures (type I), partially displaced fractures with intact posterior hinge (type II), and completely displaced fractures (type III) according to Modified Gartland's Classification. While the overall agreement for type I and a few type II fractures has been closed reduction and cast application, Dunlop traction, or Olecranon traction. Type II and type III generally warrants closed reduction and pinning. Conservative treatment is related to complexities like loss of reduction, compartment syndrome, and malunion.⁷ The most widely recognized decision of pinning is either a medial or lateral pin in a cross manner or two lateral pins.^{2,3} Closed reduction and percutaneous K-wire fixation are most effective with the least complication compared to other modalities. The purpose of the study is to assess the functional and radiological outcome of pediatric displaced supracondylar humerus fractures treated with closed reduction percutaneous K-wire fixation.

¹⁻⁴Department of Orthopedics, Mahatma Gandhi Medical College and Research Institute, Sri Balaji Vidyapeeth, Puducherry, India

Corresponding Author: Nandakumar Rengarajan, Department of Orthopedics, Mahatma Gandhi Medical College and Research Institute, Sri Balaji Vidyapeeth, Puducherry, India, Phone: +91 9003493650, e-mail: nandu1953@gmail.com

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MATERIALS AND METHODS

It is a prospective observational study done between January 2019 and May 2020. Patients presenting with displaced supracondylar humerus fractures presenting to outpatient and inpatient services of the department of orthopedics were enrolled in the study by consecutive sampling. All patients with closed supracondylar humerus fractures in the age group (2–12 years) with Modified Gartland's type II and type III who were willing to take part in the study were included. Those who were unfit for surgery and/or unfit for anesthesia and open fracture with neurovascular injury were excluded from the study.

All patients were selected for the study based on the inclusion and exclusion criteria based on the consecutive sampling. The sample size taken was 16 patients. The study was conducted in our institute over 18 months following the ethical committee's approval. Sixteen patients admitted to the Department of Orthopedics with displaced supracondylar fracture humerus in children aged 2–12 years during the period from January 2019 to May 2020 were selected. The patient's radiographs were taken in anteroposterior and lateral views. The diagnosis was established by clinical and radiological examination. In this study, the supracondylar fractures of the humerus were classified according to Modified Gartland's Classification. All patients underwent elective or emergency surgery as soon as possible after necessary routine investigations and radiographic preoperative work-up.

PROCEDURE

Under general anesthesia/regional anesthesia, closed reduction was done by traction and counter traction along the longitudinal axis with an elbow in extension and supination. The reduction is achieved and maintained by forearm pronation. The reduction was confirmed under image intensifier in two views: Anteroposterior view or Jones view, Lateral view. After confirming satisfactory alignment, the reduction was maintained by percutaneous *K*-wire fixation. *K*-wires of about 1.2–2.0 mm were used. Based on intraoperative stability number *K*-wire either 2 cross *K*-wire fixation or lateral *K*-wire fixation is done. Reduction and fixation checked under c-Arm (Fig. 1). Above elbow, posterior pop splint in 90° elbow flexion of the forearm was applied. *K*-wires were removed within 4–6 weeks postoperatively after X-ray confirmation of satisfactory callus formation. Follow-up was done at 6 weeks, and 3rd and 6th months postoperatively. A pop splint was discarded at the same time and the patient was encouraged to do active assisted elbow flexion, extension, and supination–pronation exercises.

Patients were followed up at 6 weeks, 3 months, and 6 months for functional outcome using Flynn et al.'s Criteria (which categorizes outcome as excellent, good, fair, and poor based on the degree of motion loss and carrying angle)* and Mayo elbow score (100 point scoring system) involving pain, motion, stability,

and daily function and graded as excellent (>90), good (75–89), fair (74–60), and poor (<60)*. The radiological outcome was evaluated with Baumann's angle at each follow-up to assess for cubitus varus deformity.

STATISTICAL ANALYSIS

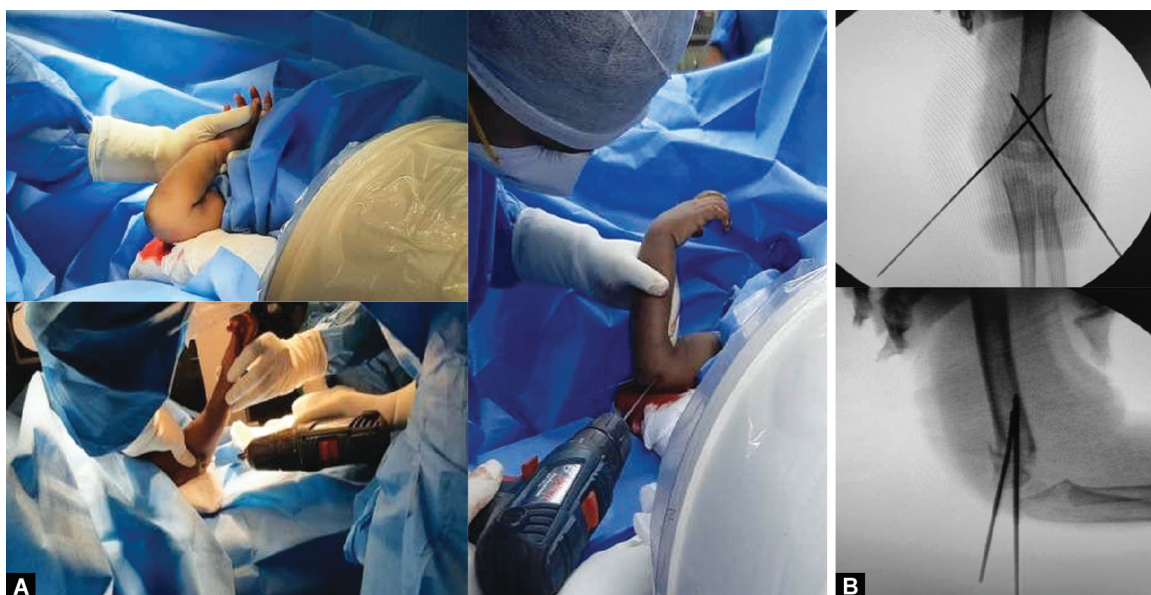
The data were analyzed with Statistical Package for Social Sciences (SPSS) for Windows 25.0 (SPSS, Inc., Chicago, IL, USA). Descriptive statistics in the form of numbers, percentages, mean and standard deviation were given for demographic details.

RESULTS

A total of 16 patients were evaluated out of which 25% of the patients were under 5 years of age, 62.5% of the patients were between 5 years and 10 years of age groups and 12.5% of the patients were 10 and 12 years. 62.5% were boys and the rest were girls. The left side was involved in 68.8% of the patients and the rest were right side. Out of 16 patients, 15 (93.75%) had extension type fracture and 1 (6.25%) had flexion type as per Modified Gartland's Classification. In the majority (68.75%) of the patients, cross fixation wire was used. Lateral fixation wire was used in 31.25% of the patients. Pin-tract infection (PTI) was 4 of the patients. One patient showed cubitus varus and one of the patients showed cubitus rectus complications. 56.3% removed pin in 4 weeks whereas 43.7% of the patients removed pin in 6 weeks. All 11 patients with cross *K*-wire fixation showed excellent outcome at 6 months whereas 3 out of 5 with lateral *K*-wire fixation showed excellent outcome at 6 months (Fig. 2) shows the outcome of the patients on each follow-up by Flynn et al.'s Criteria and (Fig. 3) shows Mayo elbow score. The mean Baumann's angle at 6 months follow-up for all patients was 74.93 ± 9.73 as shown in Figure 4 and calculation of Baumann's angle as shown in Figure 5.

DISCUSSION

The present study was a prospective observational study conducted on a cohort of 16 children with supracondylar humeral fractures managed with *K* wire pinning, in two configurations namely



Figs 1A and B: Procedure of *K*-wire fixation with closed reduction with medial pinning and lateral pinning with C-arm confirmation



Figs 2A and B: Functional outcome by Flynn et al. criteria

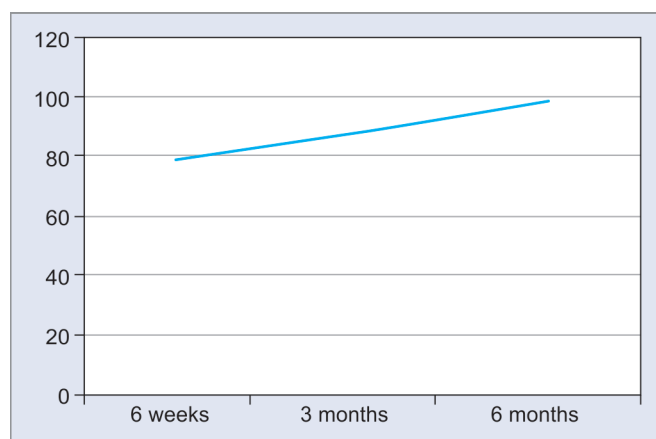


Fig. 3: Functional outcome by Mayo elbow scoring

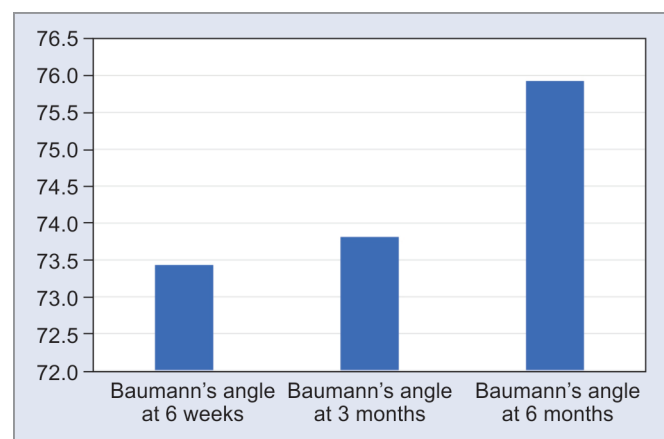


Fig. 4: Radiological outcome by Baumann's angle

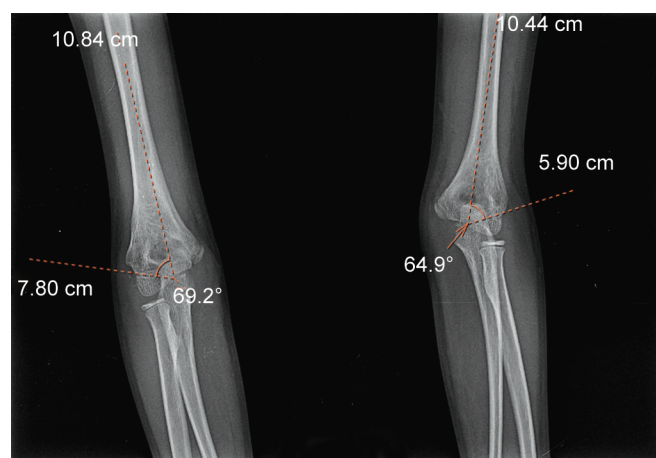


Fig. 5: Calculation of Baumann's angle

the crossed and lateral *K*-wire pinning. Supracondylar humerus fractures are generally of two categories, namely extension type and flexion type.

Fracture of the supracondylar humerus is managed by closed reduction and percutaneous pin fixation. In our study, maximum cases underwent cross configuration *k*-wire fixation and had no complications with successful prognosis (Fig. 6), this was similar to

Krusche-Mandl et al.'s study reported a successful prognosis with a minimal incidence of complication in their cases treated with percutaneous cross *K* wires.⁴

Closed reduction and internal fixation employing percutaneous crossed Kirschner wires were first put forth by Swenson. However, the risk of ulnar nerve injury by medial *K*-wire was a big concern. Subsequently, studies have reported fracture fixation utilizing 2 Kirschner wires inserted from the lateral aspect to minimize the risk of ulnar nerve damage. Despite this, the original crossed pinning technique of Swenson continues to be used with excellent results and negligible morbidity.⁸

Studies assessing biochemical aspects recommend that crossed wire pinning provides higher torsional stability.⁹ Brauer et al. in their systematic review reported deformity probability level, from loss of position was 0.58 less with the crossed wires than the lateral configuration pinning.⁷ It is important to employ the correct technique in wire placement in lateral pinning. Divergent wires both in the AP and lateral views are found to have similar biomechanical stability compared to crossed *K*-wires.¹⁰⁻¹²

Flynn's Criteria

Clinical outcome was measured using Flynn's criteria at 6 weeks, 3 months, and 6 months which graded based on elbow motion and carrying angle. The carrying angle was quantified by a full circle goniometer and by comparing it with the contralateral hand.



Figs 6A to E: Sequential follow-up X-rays of 5-year-old child with cross-configuration pinning: (A) At presentation; (B) Postoperative images; (C) Postoperative 6 weeks. Final follow-up: (D) X-rays; (E) Clinical images

Only one patient (6.25%) had an unsatisfactory outcome as there was medial comminution with physal injury. This was almost similar to the finding of Krusche-Mandl et al.,⁴ 6.4% were graded unsatisfactory.⁴ Naik also reported 80% excellent results in their patients.¹³

Mayo Elbow Score

Clinical outcome in the present study was analyzed using the Mayo elbow score. Almost all the patients had excellent outcomes, the findings were similar to the study conducted Yi-An Li et al.¹⁴ where the functional outcome was assessed by the Mayo elbow performance index score. At the last follow-up, Mayo elbow performance index scores showed excellent results (>90 scores). Also, our study was in concordance with the study by Sinikumpu et al.¹⁵ where excellent results were achieved with a 96.4 mean value. A study by Ulmar et al. showed excellent results in 46 patients (>90 points as per Mayo elbow grading) which was parallel to our study.¹⁶

Baumann's Angle

There was no significant difference in Baumann's angle till the last follow-up which was similar to the findings noted in the study of Lee et al. wherein no significant differences were noted in their study population at 1 or –5 weeks following the operation.¹⁷ Kocher et al. also reported no significant difference with regards to Baumann angle, alteration in the Baumann angle.² Kitta et al. also employed Baumann's angle. Their study found that the mean Baumann's angle in the closed reduction percutaneous pinning and open reduction internal fixation was 72.3 and though it was not significant statistically.¹⁸ Basaran et al. also had a similar study experience with no significant difference in closed reduction with and without medial incision, having no difference in Baumann angle.¹⁹ Gopinathan et al. evaluated the effect of delay between injury and surgery of 7 days on the final Baumann's angle and the functional outcome. No significant difference was demonstrated.¹⁹ Afaq et al. also reported that no significant difference in Baumann's angle.¹²

Complications

Infection: Complications of PTI 4 (25%) were noted in our study population. The study of Afaq et al. also reported PTI in 2 of their cases which were managed by oral antibiotics.¹² Devkota reported eight (7.84%) cases in their study developed PTIs, which were superficial and healed with the removal of pins and administration of oral antibiotics.²⁰ Similarly, in our study, all PTIs were superficial and healed with the removal of pins and administration of oral antibiotics. No deep infection or septic arthritis was found. This PTI was probably due to poor pin tract care.

Nerve injury: A study by Afaq et al. reported tingling sensation and numbness in the region of ulnar nerve distribution.¹² In a study by Krusche-Mandl et al. found no case of iatrogenic ulnar nerve injury which was similar to our study.⁴ None of the patients had any ulnar nerve injury. Shim et al. also agreed with the findings in his study treated with closed reduction cross fixed K pinning and reported no iatrogenic ulnar nerve palsy in their cases.²¹

Deformity: There was one case reported with cubitus rectus 1 (6.25%) (zero degrees of carrying angle) and cubitus varus 1 (6.25%) at the end of the follow-up similarly cubitus rectus (zero degrees of carrying angle) was noted in a study by Krusche-Mandl which regained with the good functional outcome with subsequent follow-up.⁴

CONCLUSION

Closed reduction and percutaneous pinning are the treatment of choice for pediatric supracondylar humerus fractures with Modified Gartland's type II and type III. Appropriate pinning technique ensures a successful outcome with cross configuration providing excellent outcome with good rotational stability. Closed reduction and percutaneous pinning is a safe, cost-effective, less morbid procedure.

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