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A Prospective Analysis of Functional Outcome of Pediatric Supracondylar Humerus Fracture Treated with Closed Reduction and Percutaneous Pinning

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Learning Point of the Article:

To assess the effectiveness of closed reduction and percutaneous K-wire fixation in managing displaced supracondylar humeral fracture in children.

Abstract

Introduction: Supracondylar humerus fractures are the most common elbow injuries in children, accounting for approximately 60% of all pediatric elbow fractures, primarily occurring in the first decade of life. These fractures are often associated with complications such as compartment syndrome, neurovascular injury, Volkmann's ischemic contracture, and malunion. The most common complication is cubitus varus deformity. The preferred pinning techniques include either a crossed pin construct or two lateral pins. Among various treatment approaches, closed reduction with percutaneous K-wire fixation has been found to be the most effective, with minimal complications. This study aims to assess the functional and radiological outcomes of pediatric displaced supracondylar humerus fractures managed with closed reduction and percutaneous K-wire fixation.

Materials and Methods: 35 consecutive patients meeting the study's inclusion and exclusion criteria were enrolled. Data are collected and analyzed using Microsoft Excel for statistical calculations.

Results: In this study, 25 children (62%) sustained the fracture within the first decade of life. Males showed a higher incidence than females. The Mayo elbow scores recorded at 6 months was 96.01 ± 2.80. Pin tract infections were observed in 10 patients, while 3 cases presented with cubitus rectus. Clinical outcomes, evaluated using Flynn's criteria, showed fair outcome in 1 case, good outcomes in 3 cases, and excellent outcomes in 31 cases.

Conclusion: Percutaneous pinning after closed reduction, whether using a crossed configuration or lateral pinning remains the preferred treatment for supracondylar fracture of the humerus in pediatric patients. When performed with the proper technique, both configurations yield successful outcomes. This approach is a safe, economical, and least invasive option with low morbidity.

Keywords: Supracondylar humerus fracture, pediatric population, Baumann's angle, Mayo elbow score.

Introduction

Supracondylar humeral fracture accounts for 50–70% of all elbow fractures in children between 1 and 10 [1]. Gartland classification is the most commonly used classification used to guide treatment for fractures. Managing these injuries is difficult due to immediate and long-term complications, such as: (1) compartment syndrome, (2) neurovascular damage, and (3) Volkmann's ischemic contracture and malunion [2, 3]. These fractures are

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Author's Photo Gallery

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Figure 1: (a) Anteroposterior and lateral view of supracondylar fracture-flexion type. (b) Immediate post-operative X-ray showing cross K-wire fixation. (c) 6 weeks post-operative follow-up X-ray after pin removal.

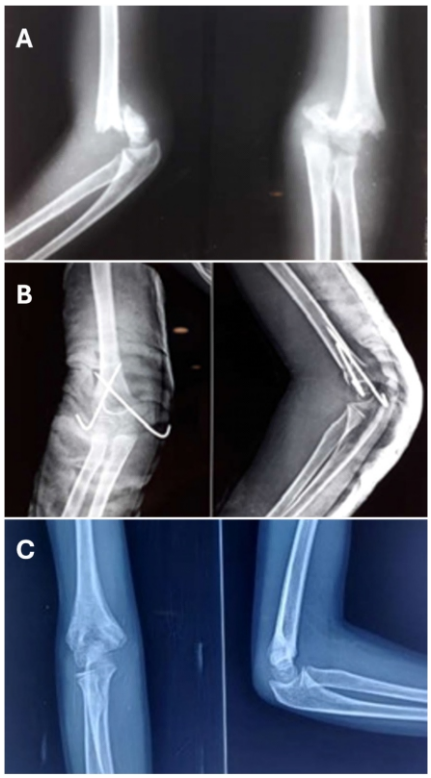

Figure 2: (a) Anteroposterior and lateral view of supracondylar fracture - extension type. (b) Immediate post-operative X-ray showing cross K-wire fixation. (c) 6 weeks post-operative follow up X-ray after pin removal.

either (1) flexion type or (2) extension type (most common) [4]. Extension type is further classified into three types - types - 1 - undisplaced, type - 2 - partially displaced with an intact posterior hinge, and type - 3 - completely displaced.

Type 1 and 2 fractures, treatment involves closed reduction followed by cast application, Dunlop traction, or olecranon traction. Type - 2 and 3 generally require closed reduction and pinning. Closed reduction and plaster of Paris (POP) slab or cast application, Dunlop skin traction, and olecranon traction are associated with high complication rates. Conservative treatment can lead to compartment syndrome, malunion, and loss of reduction [5].

Closed reduction with pinning involves either cross-medial and lateral pins or two lateral pins. This method has shown high success rates according to multiple studies. It has the lowest complication rates.

Objectives

This study aims to assess the effectiveness of closed reduction and percutaneous K-wire fixation in managing displaced supracondylar humeral fracture in children.

Materials and Methods

This prospective observational study was conducted at Chettinad Hospital and Research Institute, Kanchipuram from February 2022 to January 2024. Consecutive patients with displaced supracondylar humerus fractures presenting to the orthopedics outpatient department were included. A detailed history was obtained, followed by a comprehensive general, local, and systemic examination to assess for deformities, neurovascular injuries, and compartment syndrome.

The clinical diagnosis was confirmed using a plain X-ray of the elbow joint in anteroposterior and lateral views. The patient would undergo surgical procedures after obtaining informed written consent from the parent or legal guardian.

Surgical procedure

After pre-operative evaluation, all surgeries were performed under general anesthesia. Closed reduction was achieved using traction and counter - traction along the longitudinal axis with the elbow in extension and supination. The reduction was maintained by forearm pronation and confirmed under an image intensifier in two views - anteroposterior (Jones) and lateral.

Once proper alignment was ensured, percutaneous K-wire fixation was used to stabilize the reduction. K-wire ranging from 1.2 mm to 2.0 mm in diameter was utilized. The number of K-wires was determined based on intraoperative stability - either two cross K-wide fixations or, in cases of instability, an additional lateral K-wire was placed for enhanced fixation. Reduction and fixation were verified under an image intensifier, and a posterior above elbow POP slab was applied in the forearm in 90° flexion.

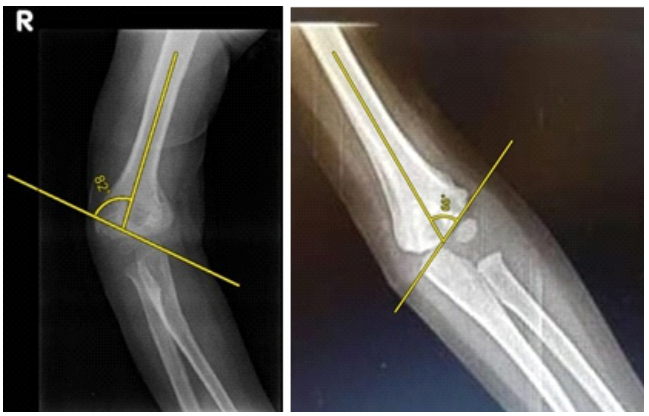

Figure 3: Post-operative follow up X-rays with measurement of Baumann's angle.

Figure 4: Post-operatvie follow up of patients showing full range of motion.

Follow-up

Patient who underwent surgery received pin tract dressing weekly or biweekly. K-wires were removed 4–6 weeks after surgery once an X-ray confirmed with adequate callus formation. Simultaneously, the POP splint was removed, and the patients were encouraged for elbow range of movement. Follow-ups were at 6 weeks, 3 months, and 6 months after surgery. The patients were assessed with Mayo elbow score and Baumann's angle (Table 1).

Results

A total of 35 pediatric patients, aged between 2 and 12 years (mean age: 7.15 years), underwent supracondylar pinning for the supracondylar humerus fractures. Of these, 22 were male and 13 were female. In the study, 21 cases involved the left side, while 14 cases affected the right side. Extension-type fractures were observed in 93% of patients, while 7% had flexion-type fractures. All patients were followed up for a minimum of 6 months. Superficial pin tract infections developed in 10 patients, all of whom recovered after pin removal and oral antibiotics treatment. No cases of severe infection or septic arthritis were reported. Cubitus rectus seen in 3 patients (8%) who showed positive functional outcomes during the follow-up. No instances of neurovascular injury, compartment syndrome, and migration of the pin were observed in this study.

At the 6-month follow-up, the mean Mayo Elbow score was 96.01 ± 2.80. Based on this assessment, 31 patients achieved excellent outcomes, while 3 had good outcomes and 1 had fair outcome. No poor outcomes were recorded. The mean Baumann's angle was 75.90 ± 10.01 (Fig. 1-4].

Discussion

Supracondylar humerus fractures are one of the most common fractures that affect children. It constitutes for more than 50% of elbow fractures. The fractures typically occur within the first 10 years of life and affect the distal humerus, near the metaphysis. It is of two types - flexion and extension type [6]. The standard treatment involves closed reduction followed by percutaneous pin fixation.

Several treatment methods have been used in the management of supracondylar humerus fractures. Non-surgical treatment is generally considered only for fractures that are not displaced or displaced minimally. They are managed with reduction and stabilized with a POP cast. However, in cases of displaced or open fractures, surgical intervention is necessary to prevent complications, such as malunion, cubitus varus, restricted elbow movement, and persistent pain. Open reduction with fixation is recommended in specific scenarios, such as open fractures requiring vascular exploration or fractures that cannot be reduced by closed methods.

In this study, the average age of the children was 7.15 years, ranging from 2 to 12 years. A study conducted in Saudi Arabia by Khan et al. reported a similar mean age of 8.1 years [7]. The majority of our study population was between 5 and 10 years (62%), which is consistent with the findings by Fowels et al. According to Reising et al., supracondylar humerus fractures were common for the ages above 4 years and below 9 years [8].

This study also found that boys were more frequently affected than girls (62.8% vs. 37.2%), a trend that aligns with findings by Devkota et al., who reported male–to-female ratio of 58:44. This difference is due to boys higher level of sports and physical exertion, making them more susceptible to falls and injuries [9].

Among 35 cases, 21 involved the left arm while 14 affected the right side. These findings correspond with those of Devkota et al., who reported a left-to-right arm ratio of 54:48. This pattern is often attributed to the protective function of the non-dominant limb during falls [9].

The clinical outcomes in this study were assessed using the Mayo Elbow score. At the 6 month follow-up, the mean score was 96.01 ± 2.80, which aligns with findings by Sinikumpu et al., who reported a mean score of 96.4 in patients with modified Gartland's type 3 fractures [10]. Similarly, Ulmar et al. documented excellent outcomes, reinforcing the effectiveness of the treatment approach used in this study [11].

On an anteroposterior radiograph, Baumann's angle is defined as

S. No.	Name	Age/sex (years)	Supra condylar humerus fracture		Baumann's angle (degree)	Mayo elbow score (6 months)	Complications
			Side	Type			
1	Iniyan	6/Male	Left	Extension	82.5	99	Cubitus rectus
2	Deepan	2/Male	Right	Extension	73	98	Nil
3	Kiran	7/Male	Left	Extension	73.5	96	Pin tract infection
4	Manoj	6/Male	Right	Extension	72	94	Nil
5	Priyan	6/Male	Left	Extension	65.5	93	Nil
6	Mithra	7/Female	Left	Extension	73	98	Nil
7	Raagul	7/Male	Left	Extension	82	97	Cubitus rectus
8	Ashwini	9/Female	right	Extension	66	95	Nil
9	Raju	12/Male	Left	Flexion	78.5	99	Pin tract infection
10	Pooja	7/Female	Right	Extension	72	98	Nil
11	Punitha	8/Female	Left	Extension	73	99	Nil
12	Mukilan	6/Male	Right	Extension	80.5	97	Nil
13	Sajun	12/Male	Right	Extension	74	84	Pin tract infection
14	Anjali	6/Female	Left	Extension	78	95	Nil
15	Likitha	10/Female	Left	Extension	65.5	90	Pin tract infection
16	Kirthana	8/Female	Right	Extension	66	81	Nil
17	Aadithya	6/Male	Left	Extension	86	96	Cubitus rectus
18	Affrin	5/Female	Right	Extension	76	92	Pin tract infection
19	Nirmala	9/Female	Left	Extension	66.5	95	Nil
20	Kumaran	6/Male	Left	Extension	65	69	Nil
21	Palani	7/Male	Left	Extension	77	94	Nil
22	Panner	8/Male	Right	Extension	71	93	Pin tract infection
23	Jansi rani	8/Female	Left	Extension	69	99	Nil
24	Raja	10/Male	Right	Extension	75.5	97	Nil
25	Priya	8/Female	Right	Flexion	80	98	Nil
26	Kishore	7/Male	Left	Extension	73	94	Nil
27	Shivani	5/Female	Left	Extension	70	98	Pin tract infection
28	Selva	9/Male	Left	Extension	71	96	Nil
29	Ram	8/Male	Right	Extension	79	94	Pin tract infection
30	Shiva	9/Male	Right	Extension	75	99	Pin tract infection
31	Babu	4/Male	Left	Extension	83.5	95	Nil
32	Aathira	5/Female	Left	Extension	64	99	Nil
33	Deepak	9/Male	Left	Extension	85.5	79	Nil
34	Sibi	5/Male	Right	Extension	83.5	95	Pin tract infection
35	Yathesh	4/Male	Left	Extension	67	96	Nil

Table 1: Baumann's angle and Mayo elbow score for the patients who had undergone K-wire pinning.

the angle formed between the physeal line of the lateral condyle and the distal humeral metaphysis in relation to the long axis of the humerus. At 6 months, three patients showed cubitus rectus. The standard Baumann's angle ranges from 64° to 81°. In this study, the mean Baumann's angle at 6 months was 75.90 ± 10.01, which is within the acceptable range.

Similar results were observed in a study by Lee et al., which found no significant changes [12]. In addition, Kitta et al. had used humeral capitellar angle to assess how the fracture fragments were reduced, and specifying the importance of maintaining the carrying angle. The mean humeral capitellar angle was 72.3 [13]. Basaran et al. conducted a similar study, reporting an

insignificant difference between closed reduction with or without a medial incision [14].

Conclusion

Percutaneous pinning after closed reduction, whether using a crossed configuration or lateral pinning remains an effective approach for treating a supracondylar fracture of the humerus in pediatric patients. This technique is an economical and least invasive option with low morbidity.

Clinical Message

Closed reduction and percutaneous pinning is an effective treatment for supracondylar humerus fractures in the pediatric population.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Conflict of interest: Nil **Source of support:** None

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Consent: The authors confirm that informed consent was obtained from the patient for publication of this case report

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