

Surgical Treatment Results in Pediatric Supracondylar Humerus Fractures

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Abstract

Aim: This study aims to evaluate the outcomes of cross fixation with Kirschner wire (K-wire) following closed reduction of displaced supracondylar humerus fractures in children.

Materials and Methods: Between December 2012 and June 2015, a total of 32 patients with supracondylar humerus fractures were retrospectively analyzed. Data including demographics, causes and types of fracture, associated injuries, postoperative complications, radiological parameters, and cosmetic and functional outcomes were recorded.

Results: Of the patients, 24 (75%) were males and eight (25%) were females with a mean age of 6.5 years (range 2 to 12 years). The mean follow-up was 19 months (range: 13 to 26 months). None of the patients developed iatrogenic vascular or nerve injuries, and no postoperative complications were observed during follow-up. The functional results according to the Flynn criteria were excellent in 93.4% and good in 6.6% of patients, while cosmetic results were excellent in 93.4%, good in 5.2%, and fair in 1.4%.

Conclusion: Percutaneous fixation with K-wire following closed reduction of displaced supracondylar humerus is a reliable method that can be applied with high success rates in pediatric cases.

Keywords: Child, Flynn criteria, humerus supracondylar fracture, closed reduction, Kirschner wire

Introduction

Supracondylar humerus fractures are second in frequency among the childhood fractures, while they are the most common at 60% in the case of the elbow circumference fractures (1). The incidence of supracondylar fracture is reported to be 1.8/1,000 (1, 2).

Supracondylar fractures are divided into two types as extensor and flexor. Extension-type fractures are more frequent and particularly visible after palm falls when the elbow is hyperextended (3). With many classifications being defined, the Wilkins-modified Gartland classification system is the most commonly used system for the classification of extension-type supracondylar humerus fractures (3).

There are three types in this class. Type 1 covers non-displaced humerus fractures, in type 2 the posterior cortex is intact and angulation at varying degrees is present, and in type 3 the cortical integrity is completely lost (3).

Most supracondylar humerus fractures occur in children aged 5 to 7 years (4). Although many techniques in treatment such as traction, casting after closed reduction, open reduction, and internal fixation are used, the most common method is the closed reduction and percutaneous Kirschner wire (K-wire) technique (4, 5). In this study, we aimed to evaluate the clinical results of displaced supracondylar humerus fractures treated by percutaneous K-wire following closed reduction.



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Materials and Methods

Written informed consent was obtained from each patient. The study was approved by the Necmettin Erbakan University Meram School of Medicine Ethics Committee and was conducted in accordance with the principles of the Declaration of Helsinki.

In this study, 32 patients who were surgically treated by medial and lateral cross-sectional K-wire between December 2012 and June 2015 due to Gartland type 3 humeral supracondylar fractures were retrospectively analyzed. A detailed medical history was obtained from each patient and their relatives. In addition, local and systemic examinations of the patients were also performed. No additional injuries or neurovascular deficits were present in any of the patients. Patients who were scheduled for surgical treatment by evaluating their two-sided radiographs of both elbows were included in the study (Figure 1). The patients underwent operations within the first 12 hours of the injury unless there was an obstruction to emergency surgery. All patients were operated under general anesthesia by a single surgeon (EA). For closed reduction, medial or lateral displacement of the distal segment relative to the humerus shaft was corrected after longitudinal traction was applied to the forearm under the guidance of fluoroscopy. Then, while the elbow was at 120 degrees of flexion and the forearm was in pronation, the thumb was pressed against the olecranon to provide its reduction. After the reduction was controlled by assessment of front and rear views under fluoroscopy, the fixation was performed by cross K-wire. First, K-wire at the lateral position was sent, then the ulnar nerve was secured under the thumb and the medial K-wire was sent when the medial epicondyle was palpated. Afterwards, fixation of the fracture was seen under the fluoroscopy control (Figure 2). Postoperatively, the long arm was splinted and X-ray imaging was performed (Figure 3). It was suggested to the patient and their relatives change the dressing (dressing means "pansuman") every three days.

On day 7, all patients were scheduled for the first follow-up visit. There was no loss of reduction with the radiographs taken (Figure 4). According to the X-ray results in the third week (Figure 5), the splints were removed and elbow movements were started. At four weeks, the K-wires of all patients were removed in an outpatient setting (Figure 6). Based on the literature data, a rehabilitation program was administered to the patients by the parents at home, and the range of motion was examined at six weeks and three months after the operation. After the third month, those who returned to normal range of motion were scheduled for follow-up at six, 12, and 18 months postoperatively (Figure 7).

In our study, radiological parameters and cosmetic and functional results were evaluated. For the functional evaluation, the flexion, extension, and internal and external rotation grades of both arms were examined. The difference between the intact elbow and the operated elbow was assessed by measuring and collecting flexion and extension values. The difference between the good elbow and the operated elbow according to the extent of motion angle was functionally excellent at 0–5 degrees, good at 6–10 degrees, fair at 11–15 degrees, and poor at greater than 15 degrees when the Flynn criteria were applied (Table 1).

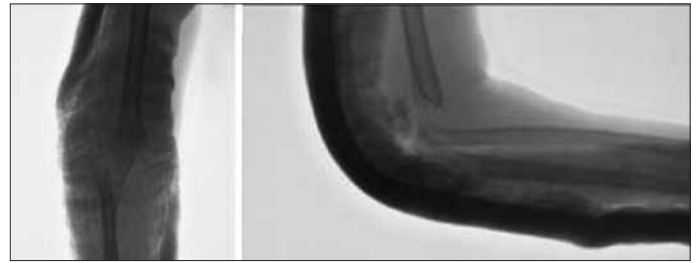


Figure 1. Preoperative supracondylar fracture X-rays (AP and lateral)

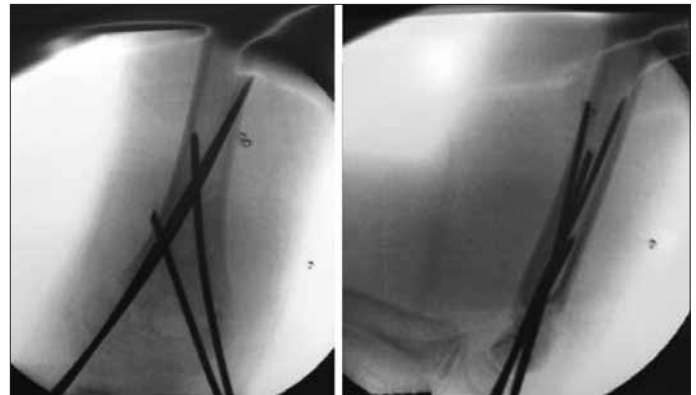


Figure 2. Intraoperative view (AP and lateral)

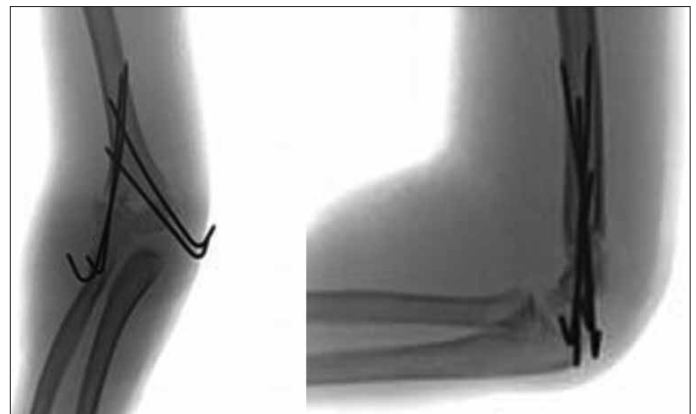


Figure 3. Postoperative X-rays (AP and lateral)

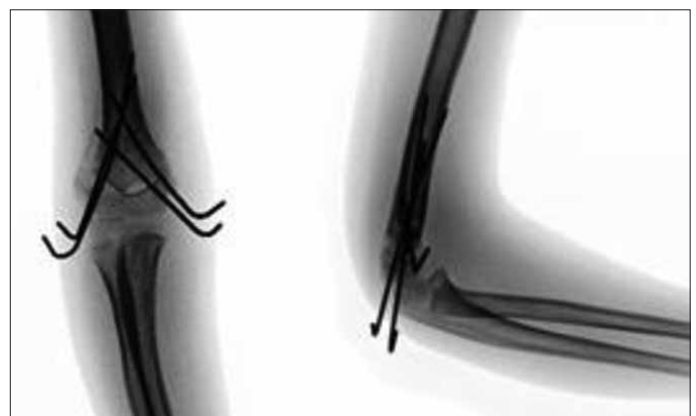


Figure 4. Postoperative 1st week X-rays (AP and lateral)



Figure 5. Postoperative 3rd week X-rays (AP and lateral)

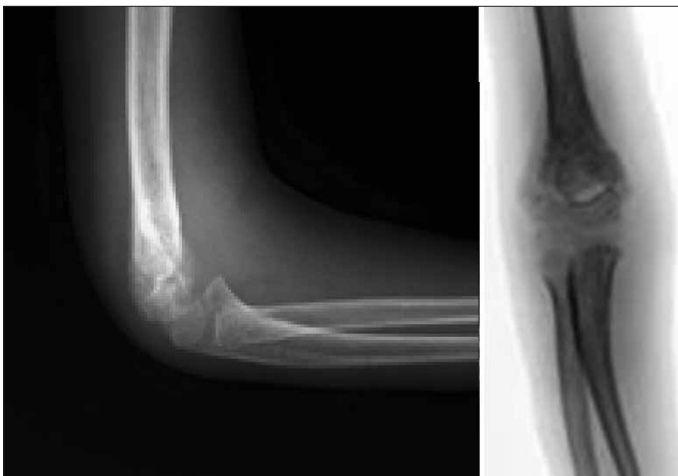


Figure 6. Postoperative 4th week X-rays (AP and lateral)



Figure 7. Postoperative 18th month X-rays (AP and lateral)

Table 1. Flynn criteria

	Change in Carrying Angle of Cosmetic Factor (degrees)	Movement Loss of Functional Factor (degrees)
Excellent	0-5	0-5
Good	6-10	6-10
Fair	11-15	11-15
Poor	>15	>15

For the cosmetic evaluation, the carrying angle from both arms was measured by using a goniometer with the McRae method. The difference was regarded as the loss of the carrying angle, which was assessed by cosmetic criteria based on Flynn's evaluation criteria using the same angle ranges as for the functional evaluation.

Statistical analysis

Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS Inc., Chicago, IL, USA) for Windows, Version 17.0. Descriptive data are primarily presented as means. The chi-square test was used to compare the qualitative data of the patients. Statistical significance was defined at the 5% level ($p < 0.05$) level.

Results

Among the patients, 24 (75%) were males and eight (25%) were females. The mean age was 6.5 years (range: 2–12 years). The mean time to discharge was 1.5 days (range: 1–3 days). No postoperative neurovascular deficits were observed.

The mean time for the removal of the K-wire during follow-up was 4 weeks. The mean follow-up was 19 months (range: 13–26 months). Twelve patients had a simple domestic fall, whereas the fracture developed after the fall in 20 of them while playing outside the home. The functional result according to the Flynn criteria was excellent in 93.4% and good in 6.6% patients, while cosmetic results were excellent in 93.4%, good in 5.2%, and fair in 1.4%. Bone union was not considered a problem on radiological evaluation. None of the patients developed any complications during follow-up.

Discussion

The most common cause of injury in children is falling. Children tend to try to protect themselves by falling on the hand while the upper extremity is in extension position. This reflex mechanism causes injury to the upper extremity. The distal radius is affected most frequently, followed by the elbow. The rate of elbow injuries is greater in children aged 3-11 years compared to those aged 12-14 years (1, 2). In children, supracondylar humerus fractures account for 60% of the elbow fractures. In general, supracondylar humerus fractures are two times more common in males than females (1, 6). In this study, supracondylar fractures all occurred as a result of falling. In addition, these types of fractures were seen three times more in males, and the mean age of fractures was 6.5 years.

The main goal of treatment in supracondylar humerus fractures in children is the full acquisition of elbow movements as well as protection of the patient from any possible neurovascular complications, while obtaining an elbow with cosmetically normal appearance. Review of the literature reveals that there are many publications related to the method of closed reduction and percutaneous wiring. Eksioğlu et al. (7) compared closed reduction and percutaneous K-wire methods with open reduction and internal fixation. In that study, it was emphasized that although closed reduction and percutaneous K-wire technique had less traumatic characteristics due to the fracture line not opening, the open reduction and internal fixation method in closed non-reducible cases is a treatment method that can achieve similarly successful results as closed reduction and per-

cutaneous wiring with the advantages of allowing the fractured line to be seen with full anatomical reduction and reducing the risk of iatrogenic vessel and nerve injury. In the present study, 80.84% of patients with closed reduction and percutaneous fixation reported excellent or good results in cosmetic evaluation, and 80.95% of them had excellent and good results in functional evaluation. Open reduction was not required because all fractures in our study were treated with closed reduction. As a result, in accordance with the literature, most patients had excellent or good cosmetic and functional results.

Iatrogenic ulnar nerve injury can be observed when K-wire is placed from the medial side when performing closed reduction and percutaneous K-wire (8). In a retrospective evaluation of 375 cases treated with closed reduction and percutaneous K-wire, Lyons et al. (9) found that 19 ulnar nerve lesions occurred postoperatively and that 17 of them recovered. Moreover, ulnar nerve lesions resolved spontaneously after surgery; however, if these lesions persisted after 4 months and there were EMG findings, they suggested that exploration could be performed. No ulnar nerve lesions were observed in the present study.

Biomechanical studies have demonstrated the requirement for cross K-wire use to obtain maxillary stabilization in pediatric supracondylar humerus fractures. Eralp et al. (10) compared the results of fixation with a third wire and a conventional cross-fixation in addition to cross K-wire fixation. As a result of that study, they reported that they achieved more stable fixation with three-wire configurations. Likewise, it was determined in biomechanical studies that stable fixation was obtained from cross K-wire fixation and that performing additional K-wire from the lateral side increased the stability (5, 11-13). In the current study, we performed an application of cross K-wire and obtained more stable fixation with additional K-wire from the lateral side. It is also possible that the fixation can be further stabilized by applying two K-wires medially and laterally. Furthermore, Zions et al. (14) reported that the most durable composition of K-wire was two crossed K-wires medially and laterally. In the present study, cross K-wire was applied in all fixations, suggesting that stabilization was sufficient.

Study limitations

The implications of this study are limited by its retrospective design and the relatively small number of patients. In addition, Gartland type 2 fractures and T-type fractures were excluded from the study.

Conclusion

Closed reduction and percutaneous K-wire, which is a well-known treatment method, is accepted as the most current and reliable method. Satisfactory results according to the Flynn criteria obtained with medial-lateral cross K-wire placement following closed reduction suggest that it is safe and acceptable to apply the K-wires transversely following closed reduction with preservation of the ulnar nerve in pediatric displaced supracondylar humerus fractures.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Necmettin Erbakan University Meram School of Medicine.

Informed Consent: Written informed consent was obtained from patient who participated in this study.

Peer-review: Externally peer-reviewed.

Conflict of Interest: No conflict of interest was declared by the authors.

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