



Comparison of Lateral and Cross Pinning Results in Pediatric Supracondylar Humerus Fractures

Çocuk Suprakondiler Humerus Kırıklarında Lateral ve Çapraz Pinleme Sonuçlarının Karşılaştırılması

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ABSTRACT

Objective: Supracondylar humerus fractures (SHF) occur in the immature skeleton. They account for 60-65% of elbow fractures in children, with the most common age group being 4-7 years. The aim of this study is to compare the radiological and functional outcomes of lateral and cross pinning methods used in the closed surgery of pediatric SHF.

Material and Method: This study was conducted on 46 patients with Gartland type 2 and 3 fractures. Group 1 who underwent only lateral pinning, and Group 2 patients who underwent both lateral and medial pinning. Anteroposterior and lateral elbow radiographs were taken postoperatively, at 3 weeks, and at 12 weeks, and radiological angles were measured and recorded. Elbow joint ROM was measured one year after the operation.

Results: The mean age of the patients was 6.28 ± 0.44 years. The decrease in Baumann angle was $2.61 \pm 0.36^\circ$ in Group 1 and $2.64 \pm 0.38^\circ$ in Group 2. The decrease in carrying angle was $0.80 \pm 0.14^\circ$ in Group 1 and $1.36 \pm 0.26^\circ$ in Group 2. The increase in The lateral capitellohumeral angle (LCHA) was $5 \pm 0.74^\circ$ in Group 1 and $6.72 \pm 0.93^\circ$ in Group 2. The elbow joint range of motion (ROM) was $132.85 \pm 0.76^\circ$ in Group 1 and $132 \pm 1.01^\circ$ in Group 2. Based on the measurements, there was no statistically significant difference in radiological and clinical outcomes between lateral and cross pin configurations.

Conclusion: Considering the possibility of iatrogenic ulnar nerve injury, lateral pinning may be considered a safer method.

Keywords: Cross pinning, pediatric trauma, percutaneous pinning, supracondylar humerus.

ÖZET

Amaç: Suprakondiler humerus kırıkları (SHK), gelişimini tamamlamamış iskelette meydana gelir. Çocuklarda görülen dirsek kırıklarının %60-65'ini oluşturlar ve en sık 4-7 yaş grubunda görülürler. Bu çalışmanın amacı, pediatrik SHK'ların kapalı cerrahisinde kullanılan lateral ve çapraz pinleme yöntemlerinin radyolojik ve fonksiyonel sonuçlarını karşılaştırmaktır.

Gereç ve Yöntem: Bu çalışma, Gartland tip 2 ve 3 kırığı olan 46 hasta üzerinde yürütülmüştür. Sadece lateral pinleme uygulanan hastalar Grup 1'i, hem lateral hem de medial pinleme (çapraz pinleme) uygulanan hastalar ise Grup 2'yi oluşturmuştur. Ameliyat sonrası, 3. haftada ve 12. haftada anteroposterior ve lateral dirsek grafileri çekilmiş ve radyolojik açılar ölçülerek kaydedilmiştir. Dirsek eklemi hareket açıklığı (EHA) ameliyattan bir yıl sonra ölçülmüştür.

Bulgular: Hastaların yaş ortalaması $6,28 \pm 0,44$ yıldır. Baumann açısındaki azalma Grup 1'de $2,61 \pm 0,36^\circ$ ve Grup 2'de $2,64 \pm 0,38^\circ$ idi. Taşıyıcı açıda azalma Grup 1'de $0,80 \pm 0,14^\circ$ ve Grup 2'de $1,36 \pm 0,26^\circ$ idi. Lateral kapitellohumeral açıdaki (LKHA) artış Grup 1'de $5 \pm 0,74^\circ$ ve Grup 2'de $6,72 \pm 0,93^\circ$ idi. Dirsek eklemi hareket açıklığı (EHA) Grup 1'de $132,85 \pm 0,76^\circ$ ve Grup 2'de $132 \pm 1,01^\circ$ idi. Yapılan ölçümlere göre, lateral ve çapraz pin konfigürasyonları arasında radyolojik ve klinik sonuçlar açısından istatistiksel olarak anlamlı bir fark bulunmamıştır.

Sonuç: İyatrojenik ulnar sinir hasarı olasılığı göz önüne alındığında, lateral pinleme daha güvenli bir yöntem olarak değerlendirilebilir.

Anahtar Sözcükler: Çapraz pinleme, pediatrik travma, perkütan pinleme, suprakondiler humerus

Introduction

SHF frequently occurs in the immature skeleton. In children, the incidence of elbow fractures is around 60-65%. The most common age range for these fractures is between 4-7 years old (1). The Gartland classification is generally used to describe these fractures (2). Closed reduction and percutaneous pinning are the most commonly preferred treatment modalities for extension-type supracondylar humerus fractures (1). The most commonly used methods for pinning are medial-lateral crossed pinning or lateral pinning alone (3). Both of these methods have advantages and disadvantages. Crossed pinning provides a biomechanically more stable fixation. However, it can lead to iatrogenic ulnar nerve injury (4,5). Nevertheless, there is still debate regarding which pinning method is more advantageous. The aim of this study is to compare the radiological and functional outcomes of crossed pinning and lateral pinning techniques used in the closed surgery of pediatric SHF (Gartland types 2 and 3).

Material and Method

This study was performed after obtaining approval from the local ethics committee (977/2023). This study was designed retrospectively. Patients who presented to our emergency department between March 1, 2019, and March 1, 2020, and underwent surgery for supracondylar humerus fractures were included in the study. Inclusion criteria for the study were as follows: Gartland type 2 and type 3 SHF, patients who underwent closed reduction and percutaneous pinning, patients between the ages of four and fourteen, and those who sought medical attention within one week after the injury. Exclusion criteria included open fractures, patients who underwent open reduction, and patients with preoperative neurovascular deficits. Out of the total 55 patients who met these criteria, 9 were excluded due to loss of follow-up, and 46 patients were included in the study.

Study Group

Patients who underwent closed reduction and percutaneous pinning due to SHF were divided into two groups: Group 1 consisted of 21 patients who underwent only lateral pinning, and Group 2 included 25 patients who underwent both lateral and medial

pinning. Of the patients included in the study, 15 had type 2 and 31 had type 3 SHF. The number of type 2/type 3 SHF in group 1 and group 2 was 10/11 and 6/19, respectively.

Surgery

Patients underwent closed reduction under general anesthesia. Patients who required open surgical procedures due to inability to achieve closed reduction were not included in the study. The closed reduction was evaluated with fluoroscopy. In Group 1, patients with an acceptable reduction were fixed with 2 Kirschner wires inserted in a divergent manner from the lateral side. In Group 2, after lateral pinning, medial fixation was performed with the ulnar nerve identification.

Follow-Up

Postoperative two-view elbow radiographs were taken at the third, sixth, and twelfth weeks. Baumann, carrying angle, and lateral capitellohumeral angle were measured. Elbow joint range of motion was recorded at least one year postoperatively. Changes in the Baumann angle between postoperative and twelfth-week radiographs were evaluated using the method described by Skaggs et al. (6) there is controversy about the optimal placement of the pins. A crossed-pin configuration is believed to be mechanically more stable than lateral pins alone; however, the ulnar nerve can be injured with the use of a medial pin. It has not been proved that the added stability of a medial pin is clinically necessary since, in young children, pin fixation is always augmented with immobilization in a splint or cast. \nMETHODS: We retrospectively reviewed the results of reduction and Kirschner wire fixation of 345 extension-type supracondylar fractures in children. Maintenance of fracture reduction and evidence of ulnar nerve injury were evaluated in relation to pin configuration and fracture pattern. Of 141 children who had a Gartland type-2 fracture (a partially intact posterior cortex: 1- no displacement, 2- mild displacement (6°-12°), 3- extensive displacement (greater than 12°).

Postoperative Care

Patients were discharged on the second day after surgery. Daily dressing changes were performed at the pin site. Patients were splinted for 3 weeks postoperatively. In the third week, Kirschner wires were removed in the outpatient clinic setting. Passive and

active elbow movements were initiated. Two-way elbow radiographs were taken at the postoperative third, sixth, and twelfth weeks. Incidences of postoperative pin site infection and any neurovascular damage occurring during or after surgery were recorded.

Statistical analysis

As a statistical method, the normal distribution of the data was evaluated by Shapiro-Wilk test and comparisons between the two groups were made by Chi-square, Mann Whitney-U and t-test. In the intergroup statistical analysis, $p < 0.05$ was considered significant.

Results

The mean age of the patients was 6.28 ± 0.44 years (ranging from 2 to 14 years). In Group 1, the mean age was 6.71 ± 0.61 years (ranging from 2 to 11 years), while in Group 2, it was 5.92 ± 0.65 years (ranging from 2 to 14 years). Among the patients, 24 had right elbow SHF, and 22 had left elbow fractures. In Group 1, the gender distribution was 11 females and 10 males, while in Group 2, it was 14 females and 11 males. There were 16 patients with Gartland type 2 fractures and 30 patients with Gartland type 3 fractures. The distribution of type 2 and type 3 fracture numbers in Group 1 and Group 2 was statistically no different ($p = 0.094$).

Table I. Patients' Data

	Group 1 (n=21)	Group 2 (n=25)	<i>p</i>
Age (years)	6.71 ± 0.61	5.92 ± 0.65	0.229
Gender (Female/Male)	11/10	14/11	1.000
Side (Right/Left)	12/9	12/13	0.568
Displacement			
Posterolateral	15	16	0.754
Posteromedial	6	9	
Vascular Injury	0	0	
Compartment Syndrome	0	0	
Ulnar Nerve Injury	0	1 (temporary)	0.359
Infection	1	1	0.901
Hospitalization (day)	2.14 ± 0.15	2.08 ± 0.12	0.740

Upon evaluation of the initial radiographs of the patients, it was observed that 15 patients had posteromedial displacement, and 31 patients had posterolateral displacement. The average length of hospital stay for the patients was 2.10 ± 0.67 days. In Group 1, the length of stay was 2.14 ± 0.15 days, and in Group 2, it was 2.08 ± 0.12 days (Table I).

Figure I. Supracondylar Humerus Fracture in a 6-Year-Old Boy due to a Simple Fall (Group-1)



On the postoperative first-day radiographs of the patients, Baumann angles were measured as an average of 75.90 ± 0.44 degrees in Group 1 and 77.32 ± 0.58 degrees in Group 2. The lateral capitellohumeral angle (LKH) measured on the lateral radiograph was 41.66 ± 0.95 degrees in Group 1 and 39.24 ± 1.05 degrees in Group 2.

Figure II. Supracondylar Humerus Fracture in a 4-Year-Old Girl due to a Simple Fall (Group-2)



On the postoperative third-week radiographs, Baumann angles were measured as an average of 74.23 ± 0.51 degrees in Group 1 and 75.44 ± 0.61

degrees in Group 2. The LCHA measured on the lateral radiograph was 42.28 ± 0.98 degrees in Group 1 and 40.60 ± 1.06 degrees in Group 2. The carrying angle between the humerus shaft and ulna's long axis on anteroposterior radiographs was 9.57 ± 0.49 degrees in Group 1 and 10.20 ± 0.62 degrees in Group 2 (Figure I and II).

Table II. Radiological and Clinical Measurements of Patients

	Grup 1 (n=21)	Grup 2 (n=25)	p
Baumannn post-op	75.90±0.44	77.32±0.58	0.117
Baumannn 3 rd week	74.23±0.51	75.44±0.61	0.158
Baumannn 12 th week	73.19±0.55	74.68±0.59	0.107
LKH post-op	41.66±0.95	39.24±1.05	0.504
LKH 3 rd week	42.28±0.98	40.60±1.06	0.991
LKH 12 th week	43.61±1.27	42.96±1.10	0.078
Carrying angle 3 rd week	9.57±0.49	10.20±0.62	0.237
Carrying angle 12 th week	8.80±0.45	8.84±0.57	0.596
Joint Range of Motion	132.85±0.76	132±1.01	0.535

Figure III. Joint Range of Motion at One Year Postoperative (patient with lateral pinning above, patient with crossed pinning below)



On the postoperative twelfth-week radiographs, Baumann angles were measured as an average of 73.19 ± 0.55 degrees in Group 1 and 74.68 ± 0.59 degrees in Group 2. The LCHA measured on the lateral radiograph was 43.61 ± 1.27 degrees in Group 1 and 42.96 ± 1.10 degrees in Group 2. The carrying angle was 8.80 ± 0.45 degrees in Group 1 and 8.84 ± 0.57 degrees in Group 2. According to the Skaggs

method, all patients in Group 1 were classified as having mild displacement, whereas in Group 2, two patients were considered to have mild displacement due to a 7° angle change (Table II).

The joint ROM, measured earliest at one year postoperatively, was 132.85 ± 0.76 degrees in Group 1 and 132 ± 1.01 degrees in Group 2 (Figure III).

Discussion

According to the results of our study, no statistically significant difference was observed between cross pinning and lateral pinning clinically and radiologically. This situation reveals that medial pinning, which puts the ulnar nerve at risk, does not actually contribute to the clinic. Avoiding this risk may be advantageous for clinicians.

Although there are many configurations discussed in the literature, the two most commonly used methods are lateral and crossed pinning (7,8). Both methods have their disadvantages. In the crossed pinning technique, the possibility of ulnar nerve injury has been found to be higher compared to lateral pinning (9). Iatrogenic ulnar nerve injury has been reported to range from 1.4% to 15.6% in medial pinning (10,11). Ayaş et al. found no difference between cross and lateral pinning in terms of nerve injury (12). However, unlike this study, in the meta-analysis including 22 RCTs, 20 studies showed that the probability of ulnar nerve injury was lower in the lateral pinning technique. No statistically significant difference was noted for other clinical outcomes (13). In our study, only one patient had temporary ulnar nerve injury due to neuropraxia. No statistically significant difference was found between the two groups. Previous studies have found that lateral pinning is biomechanically less stable and has a higher risk of reduction loss (14). However, unlike biomechanical studies, clinical studies reveal that there is no difference in the possibility of reduction loss for both groups (12,15–17).

Both methods share the disadvantage of pin-site infections related to closed pinning. The risk of pin-site infection, which depends on many factors during the preoperative, perioperative, and postoperative periods, is independent of pin configuration. The rates of pin-site infection in pediatric SHF range from

1% to 21% (18–20). In the study conducted by Zhao et al, it was stated that there was no statistically significant difference in terms of postoperative infection between cross-pinning and lateral pinning (16). In our study, pin-site infections were observed in one patient from each group. No statistically significant difference was found between the two groups. The overall infection rate was calculated as 3.57%, which is similar to the literature.

A study reported a higher probability of cubitus varus only in patients treated with lateral pinning (21). In other studies, a decrease in the carrying angle was found to be 4.12°–4.4° for lateral pinning and 3.8°–4.6° for crossed pinning (4,17). In our study, the carrying angle for Group 1 patients was measured as 9.57±0.49° at the third week and 8.80±0.45° at the third month. For Group 2 patients, the carrying angle was 10.20±0.62° at the third week and 8.84±0.57° at the third month. In Group 1, the angle change was 0.80±0.14°, while in Group 2, it was 1.36±0.26°. These values indicate that there was no significant difference between the two groups regarding cubitus varus.

Prashant et al. calculated a decrease in Baumann's angle of 4.74±1.29° for lateral pinning and 4.99±0.87° for crossed pinning (22). Afaque et al. calculated a decrease in Baumann's angle of 2.0±0.7° for lateral pinning and 2.1±0.8° for crossed pinning (4). In our study, Baumann's angle for Group 1 was 75.90±0.44° postoperatively and 73.19±0.55° at the third month, while for Group 2, it was 77.32±0.58° postoperatively and 74.68±0.59° at the third month. The decrease in Group 1 was 2.61±0.36°, while in Group 2, it was 2.64±0.38°. Consistent with previous studies, there was no statistically significant difference between the two groups in terms of the decrease in Baumann's angle (12,16). In the study by Pavone et al., radiographic measurements of the Baumann angle between the injured limb and the normal limb were as follows: Group 1: 5.3° ± 2.12° difference (range 4°–6.6°) and Group 2: 4.9° ± 2.82° difference (range 3.1°–6.7°) (17). According to the Skaggs method based on the decrease in Baumann's angle, two patients in Group 2 were classified as having mild displacement due to a 7° angle loss, while in Group 1, all patients had no displacement with less than 6° angle loss. However, this difference was not statistically significant.

LCHA measured on the lateral radiograph is not commonly used in standard follow-ups. Kiyota et al. calculated LCHA as 47.1° (27°–63°) in normal populations aged 0–11 years (23). In the study conducted by Karagöz et al., it was shown that the lateral capitellohumeral angle increased by 3.20 ± 0.56° after lateral pinning (24). A decrease in this angle is natural due to an extension-type fracture of the supracondylar humerus. In our study, LCHA was 41.66±0.95° for Group 1 and 39.24±1.05° for Group 2 postoperatively. Over time, both groups showed an increase in this angle due to remodeling and active-passive flexion exercises. In Group 1, the angle increased by 5±0.74°, while in Group 2, it increased by 6.72±0.93°. However, there was no statistically significant difference between the two groups in terms of the increase in LCHA.

Joint range of motion measurements were 132.85±0.76° for Group 1 and 132±1.01° for Group 2. This difference was not statistically significant. In the study conducted by He et al., ROM in SHF fixed with K-wire was calculated as 141.75 ± 6.03 degrees (25). In another study, at the final follow-up examination after cross-pinning, the range of motion in the treated arm resulted in values of 103° ± 12.05° for flexion-extension. After lateral pinning, ROM was reported as 110.27° ± 14.39° (17).

One limiting factor of the study is that these measurements were made digitally by calculating from photographs taken after digital meetings with families due to pandemic conditions. According to the data obtained in our study, there was no statistically significant difference between using only lateral or crossed pin configurations in terms of radiological or clinical outcomes.

However, considering the possibility of ulnar nerve injury, lateral pinning may be preferred as a safer method. When making the choice, the structure of the fracture and the surgeon's experience should be taken into account. This study should be supported by larger studies conducted on a wider population.

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