

# Operative and fluoroscopy times in pediatric supracondylar humeral fracture surgery: A comparison between lateral and cross K-wire fixation techniques

## Pediyatrik suprakondiler humerus kırığında ameliyat ve floroskopi süresi: Lateral ve çapraz K teli tespiti tekniklerinin karşılaştırılması

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### ABSTRACT

**Objective:** Although various treatment options have been described for treating this injury, in our study common types of treatment methods for 132 Gartner Type III supracondylar humerus fractures were examined. Cross pinning and Lateral Pinning (Lateral Divergent or Dorgan's Lateral pinning) methods were included and fluoroscopy time, reduction time and pinning time were examined among other parameters.

**Methods:** From January 2013 to January 2014, we retrospectively included all children between 2 and 12 years of age who had surgery for Gartland type III supracondylar humerus fracture within 12 hours after the injury. From 132 patients, 68 patients were in cross-pinning group and 64 patients were in lateral pinning group which consisted of 31 patients in the divergent pinning and 34 patients in Dorgan's type pinning group. Minimum follow-up time was 6 months after surgery and operation time, fluoroscopy time, reduction time, pinning time, neurovascular status of the extremity before and after treatment, Flynn criteria and postoperative complications were evaluated among other parameters.

**Results:** In both groups satisfactory results were obtained according to Flynn criteria. Application of lateral pinning techniques lasted statistically significantly longer to achieve final pinning configuration than cross-pinning group (p:0.007). Though not statistically significant fluoroscopy time and total surgery time were longer in the lateral pinning. In subgroup analysis there weren't any statistically difference in any compared parameter between lateral divergent pin placement and Dorgan's lateral pin placement. Two patients, who were treated with cross-pinning technique had ulnar palsy which completely resolved conservatively at fifth month postoperatively.

**Conclusion:** It takes more attempt thus more time to achieve good configuration when lateral pinning methods are selected to treat Gartland type 3 injuries. In the other hand iatrogenic ulnar nerve injury is a problem with cross pinning technique.

**Keywords:** Dorgan, pin, fluoroscopy, divergant, supracondylar, humerus, pediatric

### ÖZ

**Amaç:** Bu yaralanma için çeşitli tedavi yöntemleri tanımlanmışsa da çalışmamızda 132 Gartner tip III kırık için sıklıkla kullanılan tedavi yöntemleri incelenmiştir. Çapraz telleme ve lateralden telleme (Lateral diverjan veya Dorgan metodu) yöntemleri dahil edilerek floroskopi süresi, redüksiyon süresi ve tel tespiti süresi birçok diğer parametreyle birlikte incelenmiştir.

**Yöntem:** Ocak 2013'ten Ocak 2014'e kadar 2 ile 12 yaş arası Gartland tip III suprakondiler humerus kırığı sonrası 12 saat içinde cerrahi geçiren tüm hastalar çalışmaya alındı. Yüz otuz iki hastadan 68'i çapraz telleme grubundayken, 64 hasta lateralden telleme grubunu oluşturmaktaydı. Lateral telleme grubu 31 diverjan telleme grubu ile 34 Dorgan tipi telleme grubundan oluşmaktaydı. Cerrahi sonrası minimum takip süresi 6 ay olmakla beraber, ameliyat süresi, floroskopi süresi, redüksiyon süresi, tel tespit süresi, tedavi öncesi ve sonrası nörovasküler durum, Flynn kriterleri ve ameliyat sonrası komplikasyonlar diğer parametrelerle beraber değerlendirildi.

**Bulgular:** Her iki grupta da Flynn kriterlerine göre tatmin edici sonuçlar alınmıştır. Lateralden k teli tespit yöntemleri kullanıldığında çapraz telleme grubuna göre tel tespiti süresi açısından istatistiksel olarak daha uzun sürede ameliyatın son haline ulaşılmıştır (p:0.007). Lateral k teli tespitinde floroskopi ve ameliyat süresi daha uzun sürede istatistiksel olarak anlamlı değildi. Altgrup analizlerinde lateral diverjan tel tespitiyle Dorgan yöntemi tel tespiti karşılaştırıldığında herhangi bir parametrede istatistiksel fark saptanmadı. Çapraz telleme yöntemi kullanılan iki hastada ulnar palsi mevcuttu ancak beşinci ayda konservatif olarak tamamen gerilediği gözlemlendi.

**Sonuç:** Gartland tip 3 yaralanmaların tedavisinde iyi bir tel dizilimi elde etmek için lateralden telleme yöntemleri kullanıldığında daha fazla deneme ve dolayısıyla daha fazla vakit gerekmektedir. Diğer taraftan iatrogenik ulnar sinir yaralanması çapraz telleme ile ilişkili bir sorundur.

**Anahtar kelimeler:** Dorgan, tel, floroskopi, diverjan, suprakondiler, pediatrik

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## INTRODUCTION

Treatment of supracondylar humeral fractures in children is a common practice for an orthopedic surgeon who works at a Level 1 trauma center. Various treatment options have been described for treating this injury. In our study common types of treatment methods for 132 Gartner Type III supracondylar humerus fractures are examined. Cross pinning and Lateral Pinning (Lateral Divergent or Dorgan's Lateral pinning) methods are included and fluoroscopy time, reduction time and pinning time are examined among other parameters <sup>(1-3)</sup>.

## PATIENTS and METHODS

From January 2012 to January 2013, 156 children between 2 and 12 years of age had surgery in our institution for the supracondylar humerus fracture within 12 hours after the injury. Twenty-four patients were lost to follow-up or had missing data. All patients had Gartland type III humerus supracondylar fracture, 68 patients were in cross-pinning group and 64 patients in the lateral pinning group which consisted of 31 patients in the divergent pinning and 34 patients in Dorgan's group. All medical records and radiograms were retrospectively evaluated before surgery, intraoperatively, before, and three months after pin removal. The parameters as age, and gender of the patients, laterality, and type of the fracture (posteromedial or posterolateral), operation time, fluoroscopy time, reduction time, pinning time, neurovascular status of the extremity before and after reduction, pin configuration, Flynn criteria and postoperative complications were evaluated.

Patients who had neurologic or vascular problems before surgery were excluded. Patients with open and concomitant fractures, and those aged less than 2, and more than 12 years of age were excluded from the study. All included patients had been treated with closed reduction and pinning techniques as shown in the literature (Figures 1a,b and c) <sup>(1-3)</sup>.

Most of the patients had their casts removed at third, and fourth weeks, and then practiced full ROM exercises.

Surgery was done under general anesthesia mostly under iv ketamine administration which was dosed up to 4 mg/kg. All patients were positioned supine on a fracture table and closed reduction was performed under the fluoroscopic guidance. When closed reduction was achieved, then percutaneous fixation with either crossed pinning or lateral pinning was done according to surgeon's preferred treatment. A member out of the surgical team noted the time spent for fracture reduction, pin fixation, fluoroscopy imaging and surgery. Fluoroscopy time in seconds and counts were also obtained from the fluoroscopy machine itself. All the patients were assessed carefully for vascular impairment and neurological status before and after surgery. During postoperative follow-up period postoperative complications as pin site infection and pin loosening complications were assessed.

The results were tabulated as frequency distribution for different qualitative values. Using the standard version of the SPSS program v. 21, as quantitative variables the arithmetic means and standard deviations were calculated. Comparisons between those with and without satisfactory outcomes were done using  $\chi^2$  (chi-square) test of significance. Correlation between groups was assessed with partial correlation test.

## RESULTS

Both groups had satisfactory results according to the Flynn criteria (Table 1). There weren't any significant difference between groups regarding age, and gender of the patients, laterality, and type of fracture (posteromedial or posterolateral), Flynn criteria and postoperative complications (Table 1). Lateral pinning techniques significantly took more pinning time to have final pinning configuration than cross-pinning group ( $p: 0,007$ ) (Table 2). Although fluoroscopy time and total surgery time were longer, but of

**Table 1. Baseline characteristics of 132 patients.**

Baseline Characteristics	Lateral Pinning (n: 64)	Cross Pinning (n:68)	P Value
Male Sex (% of patients)	38 (59,4%)	43 (63,2%)	>0,5
Age (years, mean value)	5,34 ±2,98	7,03±2,81	>0,5
Side (% of patients)			
Left	40 (62,5 %)	47 (69,1%)	>0,5
Right	24 (37,5%)	21 (30,8%)	
Types of Displacement			
Posteromedial	33 (51,6%)	41 (60,3%)	>0,5
Posterolateral	31 (48,4%)	27 (39,7%)	
Flynn Criteria			
Excellent	56	54	>0,5
Good	6	9	
Fair	2	5	
Poor	0	0	
Postoperative Complications	2 Ulnar Deficits	none	>0,5

**Table 2. Time spent for fluoroscopic imaging, fracture reduction, krischner wire fixation and surgery.**

	Lateral Pinning Median±IQR*	Cross Pinning Median±IQR*	P Value
Fluoroscopy Count	19±23,5	17±11	0,608
Fluoroscopy Time (seconds)	23±28,5	21±14	0,661
Reduction Time (minutes)	10,5±20	13±10	0,155
Pinning Time (minutes)	13,1±10,0	9,34±2,81	0,007
Surgery Time (minutes)	25±24	22±12	0,505

\* IQR: Inter Quartile Range

statistically significant in the lateral pinning technique group (Table 2).

In the cross-pinning group there were 43 boys (63.2% of 68), and 41 of them had posteromedially displaced fractures (60,3%). According to Flynn criteria 54 of them had achieved excellent (79.4%), 9 of them good (13.2%) and 5 of them fair (7.3%) operative results. In lateral pinning group there were 38 boys (59.4% of 64), and 33 of them had posteromedially displaced fractures (51.6%). According to Flynn criteria 56 of them had achieved excellent (87,5%), 6 of them good (9,4%) and 2 of them fair (3,1%) operative results. In subgroup analysis there weren't any significant difference between lateral divergent pinning group and Dorgan's pinning group regarding age, and gender of the patients, laterality and type of fracture (posteromedial or posterolateral), operation time, fluoroscopy time, reduction time, Flynn criteria and postoperative complications.

**Table 3. Correlation between variables.**

	Fluoroscopy	r*	p value
Age	Time(sn)	-0,007	0,937
Age	Reduction Time(m)	-0,116	0,210
Age	Pinning Time(m)	-0,044	0,638
Fluoroscopy Time(s)	Reduction Time(m)	0,633	<0,001
Fluoroscopy Time(s)	Pinning Time(m)	0,53	<0,001
Fluoroscopy Time(s)	Surgery Time(m)	0,821	<0,001

\* r = partial correlation coefficient

Fluoroscopic imaging time, reduction time, pinning time and operative time were assessed with partial correlation test (Table 3). Fluoroscopy time was significantly correlated with reduction time, pinning time and operative time (p<0.001).

Two patients (2.9% of 68 patients) who were treated with cross pinning technique had ulnar nerve deficit which completely resolved conservatively at postoperative fifth month. There weren't any postoperative radial or median nerve deficit, and any pin site infection or pin loosening was not observed during follow-up period.

## DISCUSSION

Treating fractures of supracondylar humerus in children is a common practice for a pediatric orthopedic surgeon who works at a level 1 trauma center. There isn't an ideal method for treating this injury but

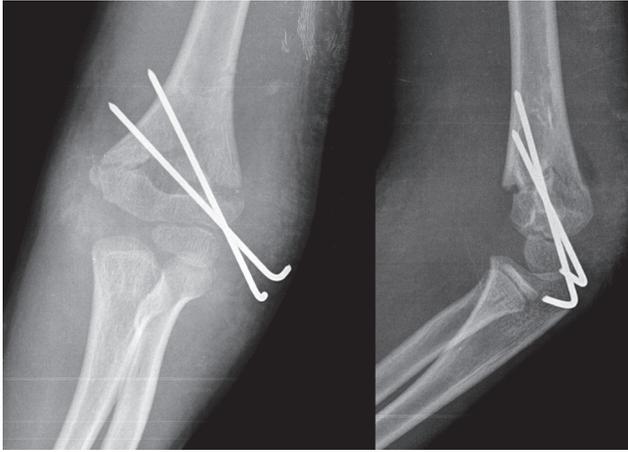


Figure 1a.

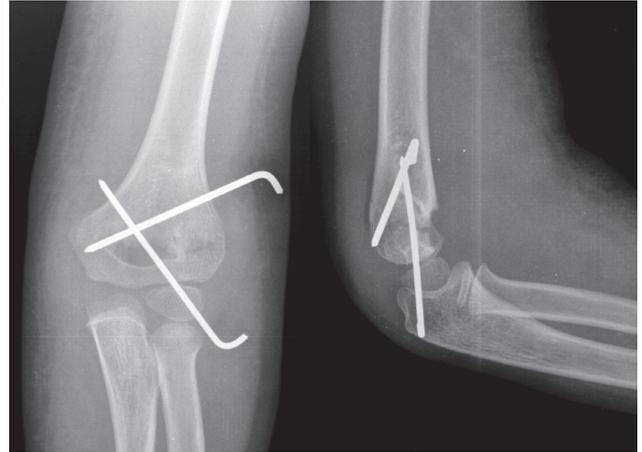


Figure 1b.

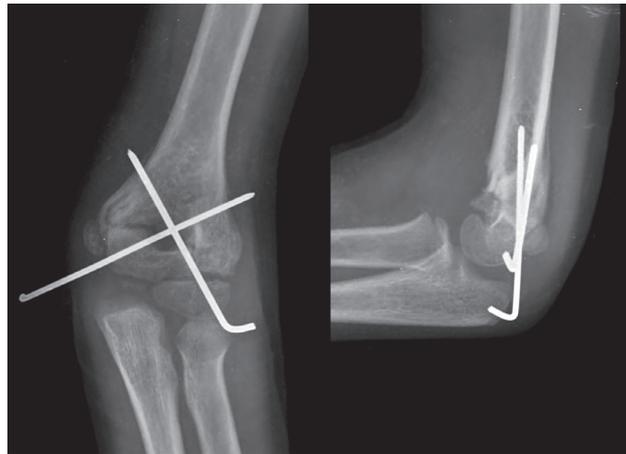


Figure 1c.

Gartland type 3 fractures are best treated by closed reduction and pin placement <sup>(4-6)</sup>. Gentle reduction and lateral pin placement have been advocated by various authors because medial pin placement is strongly associated with ulnar nerve dysfunction which has been documented in 5 to 11% of the cases <sup>(7-9)</sup>. In our series there were two complete ulnar nerve deficits all of which were in the cross-pinning group. These patients treated conservatively and their hand was fully functional in fifth month postoperatively without any additional surgery.

It is surgeon's choice to place another pin either laterally or medially as one lateral pin doesn't make stable construct as expected. This pin can be placed medially into the lateral cortex (cross pinning), later-

ally into the medial cortex with some divergence (lateral divergent pinning) or laterally into the medial condyle (Dorgan's pinning method). Marshland and David's methods yielded stiffer constructs with medial or lateral crossed pins and above all a recent review on biomechanical studies showed no statistically significant differences between the two cross pins and two divergent lateral pins <sup>(10,11)</sup>. Memisoglu et al showed that Dorgan's lateral pin configuration has been found biomechanically as stable as cross pin configuration and superior to lateral pinning methods <sup>(12)</sup>. As these two lateral entry pinning methods need good pin configuration for biomechanical stability, surgeons have to spent more time for surgery and they will use more fluoroscopy to achieve good con-

figuration<sup>(13-15)</sup>. Also multiple pinning attempts would be needed when good stability couldn't be achieved but young growing physis is vulnerable to multiple penetrations<sup>(16)</sup>.

Although age of the patient wasn't correlated with fluoroscopy, reduction or pinning time, it was clear that fluoroscopy time (in seconds) was significantly correlated with reduction, pinning and operative times (in minutes). With growing age, it didn't took extra time for reduction or pin placement but when more fluoroscopy needed in the operation room, the time spent for reduction, pinning and surgery also increased.

In this study we showed that placing an additional lateral pin instead of medial pin to make cross pin configuration takes approximately additional 4 minutes to achieve the final construct (Table 2). It is not a significant increase in time, but additional pin placement attempts result in good pin configuration or stable reduction. However, though not statistically significant, both surgical team and patient are exposed to extra gamma radiation; and fluoroscopy time increases while the surgeon tries to insert a lateral pin in the lateral pinning group ( $p>0.05$ ). Fluoroscopy was used for approximately 22 seconds in 132 patients, while in some studies this time interval ranged between 25 and 55 seconds<sup>(13-15,17)</sup>.

## CONCLUSION

It takes more time thus more attempts and more radiation exposure to achieve good pin configuration when lateral pinning methods are selected to treat Gartland type 3 injuries. On the other hand iatrogenic ulnar nerve injury is a problem with cross- pinning technique.

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