

Comparison of traditional and Dorgan's lateral cross-wiring of supracondylar humerus fractures in children

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ABSTRACT

الأهداف: تقييم نتائج تقنية التثبيت التقليدي بالعضلة الأنسية والوحشية وتثبيت العضلة الوحشية بتقنية دورقان لكسر العضد فوق اللقمة لدى الأطفال.

الطريقة: في هذه الدراسة قمنا بتقييم 51 طفل في قسم جراحة عظام الأطفال، جامعة هران، كلية العلوم الطبية، سانليورفا، تركيا خلال الفترة من فبراير 2005م إلى يناير 2009م. اشتملت المجموعة الأولى التقليدية على 25 شخص (16 ذكر، 9 أنثى)، متوسط العمر 6.5 ± 3.3 عام، واشتملت المجموعة الثانية على تقنية دورقان للعضلة الوحشية واشتملت على 26 شخص (19 ذكر، 7 أنثى) متوسط العمر 7.1 ± 2.8 عام. قمنا بتقييم النتائج الوظيفية، والتجميلية طبقاً للمتطلبات المذكورة مع فليان. أجري الفحص العصبي لما قبل وبعد العملية. كان متوسط فترة المتابعة 18.4 ± 1.7 شهر في المجموعة الأولى 16.3 ± 1.7 شهر في المجموعة الثانية.

النتائج: قمنا بمراجعة النتائج العصبية، والوظيفية، والتجميلية على 51 مريض. لم تظهر أي اختلافات إحصائية بين المجموعات للجنس، والعمر، وفترة المتابعة، ونوع الكسر، والنتائج الوظيفية، والعصبية، والعملية. على الرغم من أن إصابات العصب لعظم الزند علاجية المنشأ حدثت في 2 مريض (8%) تمت معالجتهم بتقنية تثبيت العضلة الوحشية والإنسية التقليدية (المجموعة الأولى). لا توجد إي إصابات للعصب في المجموعة التي تمت معالمتها باستخدام تقنية دورقان لتثبيت العضلة الوحشية (المجموعة الثانية).

خاتمة: نوصي باستخدام تقنية دورقان لتثبيت العضلة الوحشية والتي تعد طريقة فعالة مثل طريقة التثبيت باستخدام العضلة الوحشية والإنسية وتمنع إصابات العصب الزندي العلاجية المنشأ.

Objectives: To evaluate the outcomes of traditional medial-lateral and Dorgan's lateral cross-wiring of supracondylar humerus fractures in children.

Methods: In our retrospective study, we evaluated 51 children in the Department of Orthopedic Surgery, Harran University Medical Faculty, Sanliurfa, Turkey

between February 2005 and January 2009. Group 1 (traditional) included 25 (16 male and 9 female, mean age 6.5 ± 3.3 years) and group 2 (Dorgan's lateral) included 26 (19 male and 7 female, mean age 7.1 ± 2.8 years) patients. Functional and cosmetic results were evaluated according to Flynn et al's criteria. Preoperative and postoperative neurologic examination was performed. The mean follow-up periods were 18.4 ± 1.7 months in group 1 and 16.3 ± 1.7 months in group 2.

Results: The neurologic, functional, and cosmetic results of 51 patients were reviewed. There were no statistically significant differences found between the groups for gender, age, follow-up periods, fracture types, neurological or function, and cosmetic results. Although postoperative iatrogenic ulnar nerve injuries occurred in 2 (8%) patients treated with the traditional medial-lateral (group 1) cross-wiring technique, no nerve injury occurred in the Dorgan's lateral group (group 2).

Conclusion: We recommend Dorgan's lateral cross-wiring technique as it is as effective as the traditional medial-lateral cross-wiring technique, and prevents iatrogenic ulnar nerve injuries.

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Supracondylar humerus fractures (SHFs) are among the most common fractures in children, and completely displaced fractures usually necessitate surgical treatment.¹ The thin ridge of bone present in the antero-posterior plane between the coronoid and olecranon fossae contributes to supracondylar humerus fracture instability. In SHFs of children, stable fixation

is important to prevent severe angulation deformities.^{1,2} The most commonly accepted treatment for the displaced SHFs in children is closed reduction and percutaneous pin fixation.³⁻⁵ Several pin fixation techniques have been described including crossed pins and lateral pins.^{6,7} Biomechanical studies have shown that the maximum stability was provided by 2 crossed pins placed from the medial and lateral condyles.^{8,9} Although ulnar nerve injury from use of a medial pin is common, and this possibility is most likely to occur when the medial epicondyle cannot be palpated in swollen elbows.¹⁰ To avoid ulnar nerve injuries, 2 parallel Kirshner (K) wires may be placed through the lateral cortex as an alternative method of fixation, but this configuration is thought to be biomechanically less stable than the cross-wire configuration.² The lateral cross-wiring technique was named after Mr. John Dorgan, Consultant Orthopedic Surgeon, AlderHey Children's Hospital, Liverpool, who was the originator of this lateral cross-wiring technique.¹¹ This study aims to evaluate the functional-cosmetic outcomes, and the ulnar nerve complication rate for traditional medial-lateral and Dorgan's lateral cross-wiring of SHFs in children.

Methods. A retrospective review of 2 groups of children who underwent percutaneous cross-wiring of displaced supracondylar extension type fractures of the humerus in the Department of Orthopedic Surgery, Harran University Medical Faculty, Sanliurfa, Turkey between February 2005 and January 2009 was carried out. Written informed consent was obtained from all parents and the study was approved by the Local Research Ethics Committee. Children with closed and unilateral SHFs were included in this study. Any children with associated injury, nerve lesion, infection, non-union or malunion were excluded. Age ranges of children are from 2-13 in group 1, and from 2-12 in group 2. All patients were operated upon within 12 hours of trauma and placed in a supine position under general anesthesia; a tourniquet was not applied. The first reduction maneuver was performed with traction applied to the forearm with an assistant applying countertraction. First, the translation of the fracture was reduced, then rotational displacement was corrected with pronation and supination of the forearm. Finally, the forearm was fixed in full pronation and the elbow in hyperflexion, and K-wires were inserted. The C-arm fluoroscopy was used during the reduction procedure for subsequent evaluation of the fragments. Two (1.6-2 mm) K-wires were used to stabilize all 51 fractures. Following reduction, in group 1 the first wire was introduced through the lateral condyle across the fracture and into

the medial cortex, and the second wire was introduced into the medial condyle through the opposite lateral cortex. In group 2 (Dorgan's percutaneous lateral cross-wiring technique) the first wire was introduced through the lateral condyle across the fracture and into the medial cortex. The second wire was introduced through the lateral cortex, proximal to the fracture line, and driven in an antegrade direction across the fracture line into the medial condyle. The medial condyle should not be penetrated to avoid ulnar nerve injury, but cortical involvement could be achieved (Figures 1 & 2). Care was taken to cross the wires above the fracture line, and an above-the-elbow cast was applied. Postoperative immediate neurological assessment for median, ulnar, and radial nerves, and anteroposterior and lateral x-rays were performed. Patients with iatrogenic ulnar nerve lesions in group 1 were followed up without any treatment. The mean hospitalization period was 1.7 days (range 1-5 days). The cast and K-wires were removed after 3 weeks, and followed with gentle active elbow exercises. Physiotherapy was only necessary in patients with neurological problems. At the last follow-up, anteroposterior and lateral radiographs of the elbows were taken, and range of motion at the elbow and carrying angle were assessed by goniometer at both elbows. Functional and cosmetic results were evaluated according to the criteria proposed by Flynn et al.¹²

Using the Statistical Package for Social Sciences (SPSS Inc., Chicago, IL, USA), analysis was carried out using Mann-Whitney U test, Chi square test, and Fisher exact test. A p -value ≤ 0.05 was considered significant.

Results. The patients' demographic data are shown in Table 1. All fractures were reduced by closed reduction. Any patients failed to be reduced closely were excluded from the study. There was no statistical significant difference between groups in terms of gender, age, follow-up periods, fracture types, functional or cosmetic results. In group 1, the functional results were satisfactory (excellent, good, or fair) in 24 (96%) patients, and poor in one (4%) patient, while cosmetic results were satisfactory in all patients (100%). In group 2, both functional and cosmetic results were satisfactory in all patients (100%). Although there was no significant difference between groups, 2 (8%) iatrogenic ulnar nerve injuries were noted in group 1 postoperatively (probably due to medial pinning), and none in group 2. These patients presented with a Gartland type III fracture, of the extension type. The ulnar nerve injuries resolved within 2-3 months without any treatment, and physiotherapy could be performed. There was no recorded iatrogenic radial and median nerve injury in

all patients. Four patients (7.8%) developed minor pin tract infection that were managed successfully with proper oral antibiotics, and did not require early removal of the wire. No deep infection or compartment syndrome was observed. One patient in group 1 with poor results had 18° limited extension, and 15° varus.

Discussion. There is a lack of uniformity of opinion concerning the ideal method of treatment of displaced supracondylar fractures in children. Several treatment modalities have been recommended.^{13,14} Closed manipulation and percutaneous K-wire stabilization is the accepted, and most popular treatment of displaced supracondylar fractures of the humerus in children.^{3-6,14} Biomechanical studies have demonstrated that crossed pin constructs are significantly more stable than lateral pin fixation alone.^{2,9} The cross-wire technique was popularized in recent years by several authors.^{11,14-16} Authors studied resistance to internal rotation using cadaveric elbows, and found crossed pins to be the most rigid configuration. The torque required to produce

10° of rotation averaged 37% less with 2 parallel pins, and 80% less with 2 crossed lateral pins (inserted via the lateral condyle and crossed at the fracture site).⁸ Lee et al,² using a saw-bone model, found that 2 divergent lateral K-wires were comparable to cross-wires in extension, varus, valgus, and rotational loading, but were inferior in axial rotation testing. The 2-wire cross fixation is the most commonly used and good results have been reported, but injury of the ulnar nerve when

Table 1 - Patient's data in the traditional medial-lateral group (group 1), and Dorgan's lateral cross-wiring group (group 2).

Variables	Group 1 (n=25)	Group 2 (n=26)
<i>Gender</i>		
Male, n (%)	16 (64)	19 (73)
Female, n (%)	9 (36)	7 (27)
Mean age ± SD, years	6.5 ± 3.3	7.1 ± 2.8
Mean follow up ± SD, months	18.4 ± 1.7	16.3 ± 1.7
<i>Fracture type (Gartland)</i>		
Type II, n (%)	8 (32)	6 (23)
Type III, n (%)	17 (68)	20 (77)

SD - standard deviation

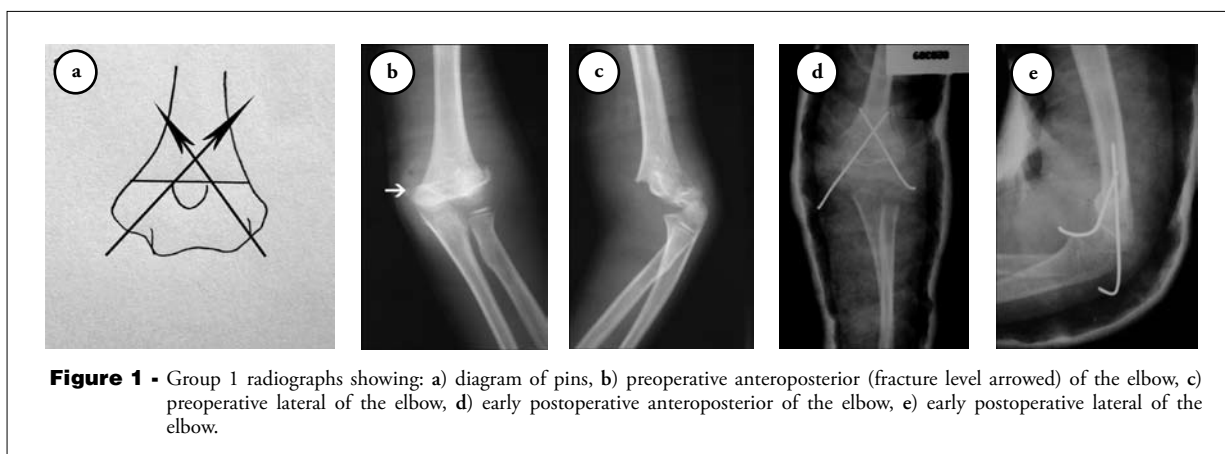


Figure 1 - Group 1 radiographs showing: a) diagram of pins, b) preoperative anteroposterior (fracture level arrowed) of the elbow, c) preoperative lateral of the elbow, d) early postoperative anteroposterior of the elbow, e) early postoperative lateral of the elbow.

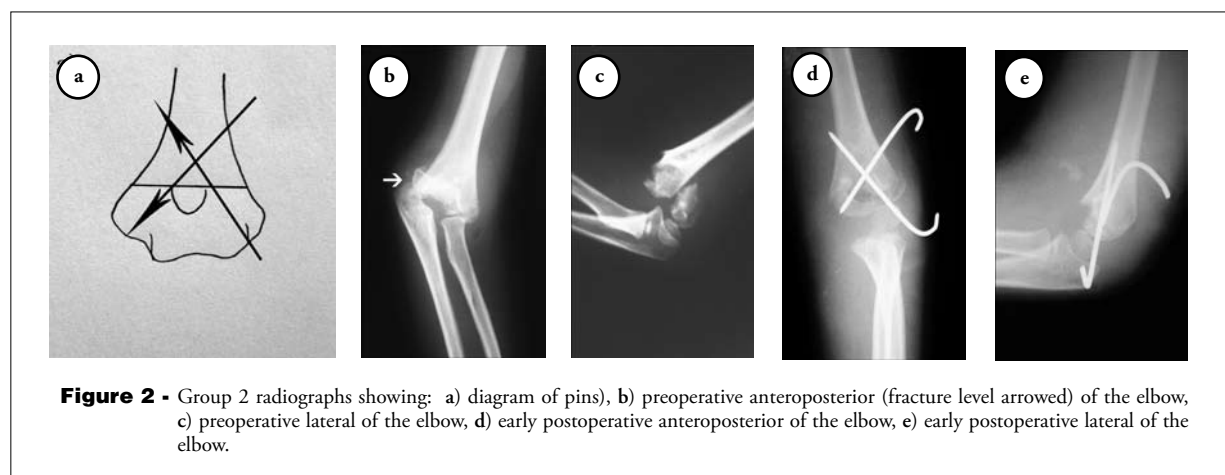


Figure 2 - Group 2 radiographs showing: a) diagram of pins, b) preoperative anteroposterior (fracture level arrowed) of the elbow, c) preoperative lateral of the elbow, d) early postoperative anteroposterior of the elbow, e) early postoperative lateral of the elbow.

inserting the medial wire has been documented ranging from 2-8%.^{3-5,14} In our study, 8% iatrogenic ulnar nerve injury were noted in group 1. Several modified fixation methods have been reported to prevent ulnar nerve injury and fracture redisplacement.^{1,4,15} New studies showed that insertion of 2 lateral cross pins will provide a biomechanically stable fixation avoiding the risk of ulnar nerve.^{11,14-16}

In our study, we retrospectively evaluated 2 fixation techniques for SHFs in children, the traditional medial-lateral and the Dorgan's percutaneous lateral cross-wiring technique. While both techniques have included similar biomechanical advantage to each other, in the lateral cross-wiring technique, the ulnar nerve is not at risk, unless the proximally inserted wire is driven through the medial condyle. Theoretically, the radial nerve could be injured during insertion of the more proximal wire. However, the radial nerve is situated anterior to the lateral intermuscular septum at this level, and can be avoided by entering the skin posterior to the mid-coronal plane.¹⁴

When we compare our findings of iatrogenic ulnar nerve injury in 2 patients of group 1, with none in group 2, we find that the most frequent problem faced while performing medial K-wire is iatrogenic ulnar nerve injury.^{10,14,16,17} However, we also found that the ulnar nerve remains safe when performing cross K-wire application laterally.

This is a retrospective review and based only on clinical findings, and we consider this limitations of our study.

El-Adl et al¹⁴ reported 6 (8.6%) minor pin track infections in his 70 patient series. All patients improved after pin removal and on oral antibiotics. In a 20 patient series by Shannon,¹¹ only one minor pin track infection was seen, and treated by oral antibiotics without early removal of the pin. In the present study, 4 patients (7.8%) developed minor pin tract infection that was managed successfully with proper oral antibiotics, and did not require early removal of the wire. No deep infection and compartment syndrome were observed. While cross pinning of displaced supracondylar fractures in children provides the best biomechanical stability, in the present study the poor results of one patient in group 1 is due to insufficient fixation. However, we recorded a 98% satisfactory result in our series.

In summary, we conclude that while both closed reduction and percutaneous fixation techniques provide the best mechanical stability and good union rate, Dorgan's lateral cross-wiring technique has the advantage of avoiding injury to the ulnar nerve. Further larger prospective series, with longer follow-up is mandatory to support these results.

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