

# COMPARISON OF THE TWO METHODS OF PERCUTANEOUS K – WIRE FIXATION IN DISPLACED SUPRACONDYLAR FRACTURE OF HUMERUS IN CHILDREN

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## ABSTRACT

**Objectives:** To compare the effectiveness and safety of fractures treated by percutaneous medial–lateral cross K-wire fixation and 2–lateral K-wire fixation.

**Methodology:** Randomized controlled trial was conducted from January 2008 to July 2009 in Orthopedics unit of Hayatabad Medical Complex Peshawar. A total of 50 patients of displaced supracondylar fracture of humerus presenting between age 1-12 years were randomly allocated in two groups of 25 patients in each group and were subjected to medial lateral cross K wire fixation and 2 lateral K wire fixation.

**Results:** Mean age of patients was  $7.02 \pm 2.25$  years. 72% of patients with carrying-angle loss was excellent results and 28% good results. The mean loss of elbow flexion and loss of elbow extension were  $8.38^\circ \pm 3.10$  and  $7.26^\circ \pm 3.22$  respectively. In Patients with med-lat cross K-wire fixation group 72 % were excellent results and 28% good results, while similar results were found in 2-lateral K- wire fixation group. The 4% iatrogenic ulnar nerve injuries occurred with the med-lat cross K-wire fixation group, while no neurological injury occurred with 2 lateral K wire fixation with p value of 0.312. Hence, there was no significant difference in the incidence of ulnar nerve injury between the two groups of patients.

**Conclusion:** Both techniques appear to be effective, 2 lateral K-wire fixation is as effective in term of stability as medial-lateral cross K- wire fixation but with less chance of iatrogenic ulnar nerve injury.

**Key words:** Supracondylar fractures, Percutaneous, K- wire, ulnar nerve.

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## INTRODUCTION

Supracondylar fractures of the distal humerus are the most common elbow fracture in children<sup>1-3</sup>. It is a fracture that occurs at the supracondylar area or the metaphysis of the distal humerus. Of all the fractures in the upper limb the supracondylar fracture of the humerus is not only the most common injury but can result in serious complications if not treated appropriately.

There are two types of supracondylar

fractures of humerus in children according to the direction of distal fragment ie Extension type (97% to 99 %) & Flexion type (1-3%)<sup>4,5</sup>. It generally occurs as a result of fall onto the outstretched hand with the elbow in full extension while flexion type is generally believed to be a fall directly onto the elbow<sup>6</sup>. The modified Gartland classification of supracondylar humeral fractures is the most commonly accepted and used system<sup>7</sup>.

Type 1 – Undisplaced fractures

Type 2 – Partially displaced fractures (with intact posterior cortex) &

Type 3 – Completely displaced fractures (no cortical contact)

3A – Posteromedial (90%)

3B – Posterolateral (10%)

Elbow fractures treatment in children remained a great challenge for surgeons since Hippocrates. Proper training is needed to adopt recent advances by young surgeons to deal with these challenges<sup>8</sup>. Closed reduction and Percutaneous pin fixation is widely accepted treatment for displaced humeral supracondylar fractures in

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children, but the best pin configuration is debatable. Percutaneous pinning is safe, cost effective, timing saving and provides greater skeletal stability with excellent result<sup>8</sup>.

The recommended methods of Percutaneous K- wire fixation varies among authors. Medial- Lateral cross fixation was the gold standard but it places the ulnar nerve at risk<sup>9-11</sup>. Recent studies have shown that two well-placed lateral pins either two parallel or two cross pins engaging medial cortex provide sufficient fixation with lowest risk of iatrogenic ulnar nerve injury<sup>12-14</sup>. Current interest is mainly focus on the pin configuration for fixation that provides adequate stability with the lowest risk of iatrogenic ulnar nerve injury. Therefore, this study has been conducted to compare the outcome of treatment with medial-lateral K- wire fixation and two lateral K- wire fixations.

## METHODOLOGY

This randomized control study was conducted in 18 months period from 22-01-08 to 21-07-09 with follow up of six months in orthopedic department of Postgraduate Medical institute, Hayatabad Medical Complex Peshawar. All children with displaced supracondylar fracture of humerus (Gartland II & III), between 1-12 years of age and those presenting within 3 days of injury were included in study.

Patients presenting with neurovascular complications, undisplaced supracondylar fractures (Gartland type I), patients in which closed reduction of fracture were not possible and in which open reduction and internal fixation (ORIF) had been done and Open supracondylar fracture were excluded from study.

All patients who presented to orthopedic unit of this institute with the displaced supracondylar fracture of humerus fulfilling our inclusion criteria had been admitted and recruited in our study. All procedures and protocols used in this study had been approved by the medical ethics committee of our institution.

Back slab were applied, neurovascular

status were analyzed. After obtaining the informed consent for the study and surgery, the patients were kept fasted for surgery. Baseline investigations were performed. Surgery was arranged on the same day or the following morning. The patients were randomly allocated in two groups by lottery method. Patients in group A were subjected to medial-lateral cross K- wire fixation, while patients in group B were subjected to 2- lateral K- wire fixation.

Surgery was performed by senior orthopedic consultant or senior orthopedic trainees under direct supervision. After general anesthesia was administered, the patient was placed supine with the injured upper arm at the side of the table. Image intensifier was placed along the table from caudal end of the patient. The injured elbow was placed on the plate of the image intensifier. Since the pediatric elbow is relatively small, the plate of image intensifier usually sufficed to function as an arm support. Closed manipulative reduction was performed and the reduction was confirmed with the image intensifier. If the reduction was acceptable, the surgeon scrubbed, cleaned, and draped the injured arm to the axilla. The image intensifier draped. The fracture was again reduced and subsequently fixed with K-wire according to the selected configuration.

After the procedure, neurovascular status reviewed again. Reduction and fixation of fracture confirmed by radiographs, and the patients discharged on the first or second postoperative day. All the patients followed up at the orthopedic out-patient department for minimal of six months at interval of 2 weeks, 4 weeks, 12 week and 24 weeks. Back slab removed after 2 weeks. The second visit was at 4<sup>th</sup> weeks and K- wire removed and physiotherapy was advised. The radiological evaluations performed by obtaining standard anteroposterior and lateral radiographs of the distal humerus.

Flynn's criteria for grading involved the evaluation of carrying angle loss and total range of motion loss. In ordered to compare the stability of both methods of fixation, we modified the second component of the grading system and looked

**Table 1: Modified Flynn Criteria for Reduction Assessment**

	Loss of carrying angle (degrees)	Loss of motion(degrees)	
		Loss of flexion	Loss of extension
Excellent	0 -5	0 – 5	0 – 5
Good	6 – 10	6 – 10	6 – 10
Fair	11 – 15	11 – 15	11 – 15
Poor	>15	>15	>15

separately into extension loss and flexion loss<sup>17</sup> (Table 1) Loss of carrying angle, loss of elbow flexion, loss of elbow extension, loss of Baumann angle and loss of metaphyseal-diaphyseal angle, the ulnar nerve injury and compartment syndrome assessed by comparing the treated side with uninjured side, and then these compared between the two groups treated with the two methods of fixations.

## RESULTS

A total of 50 patients treated with two methods of percutaneous K- wire fixation with 25 patients in each group. Patients followed for 24 weeks by comparing the stability and safety of the two methods. The mean age was  $7.02 \pm 2.25$  years. The age ranged from 1 to 12 years. There were 33(66%) male and 17(34%) female. Left side 38(76%) was the most dominant site of fracture as compared to the right side 12 (24%).

At the final follow-up, using Flynn's modified criteria 36 patients (72%) out of 50 patients with carrying-angle loss considered to be excellent results and 14(28%) good results. Patient with medial-lateral cross K-wire fixation 18 patients (72 %) considered excellent results and 7(28%) good results, while in patient with 2-lateral K- wire fixation 18 patient (72 %) were excellent results and 7(28%) good results.

The mean loss of elbow flexion was  $8.38 \pm 3.10$ . The mean loss of elbow flexion in patients treated with medial-lateral cross fixation and 2-lateral K-wire fixation was  $8.36 \pm 3.13$  and  $8.40 \pm 3.14$  respectively. Out of 25 patients treated with medial-lateral cross K-wire fixation were 5(20%) excellent results, 14(56%) good results, 5(20%)

fair results and 1(4%) poor results. Out of 25 patients treated with 2 laterals K-wire fixations were 5(20%) excellent results, 12(48%) good results, 7(28%) fair results and 1(4%) poor results.

The mean loss of elbow extension was  $7.26 \pm 3.22$ . The mean loss of elbow extension in patients treated with medial-lateral cross fixation and 2- lateral K-wire fixation was  $7.08 \pm 3.27$  and  $7.44 \pm 3.22$  respectively. Out of 25 patients treated with medial-lateral cross K-wire fixation were 7(28%) excellent results, 13(52%) good results, 4(16%) fair results and 1(4%) poor results. Out of 25 patients treated with 2 laterals K-wire fixations were 6(24%) excellent results, 14(56%) good results, 5(20%) fair results.

Analyses with Student *t* test of the carrying-angle loss, elbow extension loss, and elbow flexion loss indicated that there were no significant difference in these parameters between patients who had medial-lateral cross K- wire fixation and those who had 2-lateral K-wire fixation (Table 2).

The Baumann angle loss and Metaphyseal-Diaphyseal angle loss were measured in 50 patients. The mean Baumann angle loss in the medial-lateral cross K-wire fixation group and the 2-lateral K- wire fixation group was  $5.56 \pm 1.80$  and  $5.16 \pm 2.64$  respectively. The mean MD angle loss in the medial-lateral cross K-wire fixation group and the 2-lateral K wire fixation group was  $2.44 \pm 1.22$  and  $2.40 \pm 1.23$  respectively. Analyses of both the Baumann angle loss and the MD angle loss using Student *t* test showed no significant difference between medial-lateral cross K-wire fixation and 2-lateral K-wire fixation (Table 3). 1(4%) iatrogenic ulnar nerve injury occurred with

**Table 2: Analysis of Carrying-Angle Loss, Elbow Extension Loss, and Elbow Flexion Loss between the Medial-Lateral Pin Fixation and 2-Lateral Pin Fixation By Using Student *t* Test**

Parameter	Medial-lateral K wire fixation (mean $\pm$ SD)	2-lateral K wire fixation (mean $\pm$ SD)	P value (student <i>t</i> test)
Carrying-angle loss	4.32 $\pm$ 1.24	4.32 $\pm$ 1.81	0.273
Elbow extension loss	7.08 $\pm$ 3.27	7.44 $\pm$ 3.22	0.835
Elbow flexion loss	8.36 $\pm$ 3.13	8.40 $\pm$ 3.14	0.572

**Table 3: Analysis of Baumann Angle loss and MD angle loss using Student *t* test**

Parameter	Medial-lateral cross K- wire fixation (mean $\pm$ SD)	2 – lateral K wire fixation (mean $\pm$ SD)	P value (student <i>t</i> test)
Baumann angle loss	5.56 $\pm$ 1.80	5.16 $\pm$ 2.64	0.535
MD angle loss	2.44 $\pm$ 1.22	2.40 $\pm$ 1.32	0.912

medial-lateral K – wire fixation. The mechanism of injury was extreme hyper flexion of the elbow during fixation of the fracture and spontaneous recovery was noted 12<sup>th</sup> week postoperatively. The iatrogenic ulnar nerve injury between the medial-lateral cross K-wire fixation groups and the 2-lateral K-wire fixation group was analyzed using the crossed table method and Fisher's exact test. The p value was 0.312. Hence, there was no significant difference in the incidence of ulnar nerve injury between the two groups of patients. The compartment syndrome did not occurred in any of the two methods of fixation.

All data as compiled and calculated with SPSS version 10. The descriptive measure, like mean  $\pm$  Standard Deviation were calculated for age and frequency / percentage were calculated for others quantitative variables. For carrying angle, elbow flexion, elbow extension, Baumann angle, and MD angle, we looked into the value of differences comparing the treated side with the uninjured side. We then compared these values between the 2 groups treated with different method of fixation and analyzed them statistically with Student *t* test. The p value had been taken less than 0.05 as level of significance. Since the incidence of nerve injuries was small in number, we used Fisher's exact test to compare the 2 methods of fixation.

## DISCUSSION

Supracondylar fracture in children is one of the most common and challenging injury. Closed reduction and Percutaneous pin fixation is widely accepted treatment for displaced humeral supracondylar fractures in children, but the best pin configuration is debatable. In our study, we found no significant differences in terms of loss of reduction, the Baumann angle, carrying angle, elbow motion and iatrogenic ulnar nerve injury between the two primary treatment methods involving use of either crossed medial - lateral or two lateral K- wires.

The reported risk of loss of reduction following lateral K- wire fixation has also varied widely. A recent systematic review of comparing medial and lateral pin fixation with lateral entry pin fixation revealed Medial/lateral pin entry provides a more stable configuration, and the probability of deformity or loss of reduction is 0.58 times lower than with isolated lateral pin entry, the rate of displacement following lateral entry pin fixation was 2.1%. When the prospective studies alone were analyzed, there were no significant difference in the probability of iatrogenic nerve injury or deformity and displacement<sup>18</sup>. Skaggs et al. reported no loss of reduction after fixation of fifty-five type-III

fractures with two or three lateral entry pins. The risk of displacement after lateral entry pin fixation can be reduced by emphasizing proper pin-placement technique, with divergent pins, pins that engage the lateral and central columns, and use of a third lateral pin if needed<sup>13,19</sup>.

Lateral entry pin fixation has been compared with medial and lateral entry fixation in numerous retrospective case series of extension supracondylar fractures of the humerus in Children. In a review of fifty two completely displaced extension type supracondylar fractures of humerus treated with two different pin fixation techniques Kocher et al. found no patient in either group had a major loss of reduction. Six of the twenty-eight patients treated with lateral entry and one of the twenty-four treated with medial and lateral entry had a mild loss of reduction; this was not a significant difference. There were no cases of iatrogenic ulnar nerve injury in either group<sup>20</sup>. Skaggs et al. reported no difference in maintenance of reduction between the two methods, but iatrogenic ulnar nerve injury was seen in 10.6% (seventeen) of 160 cases treated with a medial pin<sup>21</sup>. In a study of forty-seven children in whom a type-III supracondylar fracture had been treated with crossed pins (twenty-seven patients) or with lateral pins only (twenty), Topping et al. found no loss of reduction in either group and one ulnar nerve injury in the group with crossed pins<sup>22</sup>. Similarly, in a study of fifty-six fractures, Shamsuddin et al. found three iatrogenic ulnar nerve injuries associated with medial and lateral entry pin fixation and two iatrogenic radial or anterior interosseous nerve injuries associated with lateral entry pin fixation, although there was no difference in loss of reduction<sup>23</sup>.

Foad et al. performed a randomized clinical trial in which thirty-four type-II or III fractures were treated with medial and lateral pin fixation and thirty-two were treated with lateral pin fixation<sup>17</sup>. Straight lateral skin traction was used prior to closed reduction and pinning. There were no significant differences in terms of loss of reduction, the Baumann angle, or elbow motion between the two groups. There were five iatrogenic ulnar nerve injuries in the medial and lateral entry group, and there were two iatrogenic ulnar nerve injuries and one iatrogenic radial nerve injury in the lateral entry group.

Based on these clinical and radiological parameters, we were not able to find any difference in the loss of reduction and iatrogenic ulnar nerve injury with the 2 methods of pin fixation. All patients had their reduction performed under the guidance of an image intensifier. Only satisfactory reduction based on carrying angle and

Baumann angle assessed on the table were accepted. Since the enrolments of both groups were randomized, and the standard protocol of reduction was applied for both groups. Therefore, we can consider that there was no difference in the stability of fixation and iatrogenic ulnar nerve injury caused by either the medial -lateral pin fixation or 2- lateral pin fixation.

## CONCLUSION

From this study, we concluded that there were no significant difference in the stability provided by medial-lateral K- wire fixation and 2-lateral K wire fixation in both coronal and sagittal planes. There was also no significant difference in the incidence of ulnar nerve injuries between the 2 methods of fixation, although there is a trend to suggest that more injury occurred in the medial-lateral K - wire fixation group. Both techniques appear to be effective, 2 lateral K-wire fixation is as effective in term of stability as medial-lateral cross K- wire fixation but with less chance of iatrogenic ulnar nerve injury.

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#### **CONTRIBUTORS**

WA collected the data, did literature search and performed the cases under supervision. NR helped in collecting the data and literature search. MJI and MAK supervised the research and performed a few cases.

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