

## Research Article

# Analysis of displaced supracondylar fractures in children treated with closed reduction and percutaneous pinning

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## ABSTRACT

**Background:** Closed reduction is difficult not only to achieve but also to maintain because of the thinness of bone of the distal humerus between the coronoid and olecranon where most supracondylar fractures occurs. For this reason percutaneous pinning techniques have become the treatment of choice for most supracondylar fractures. By this procedure even the displaced and rotated fracture can be treated successfully with minimal incidence of complications. The purpose of this study is to determine the efficacy of management of displaced supracondylar fractures using closed reduction with percutaneous K-wire pinning and to analyze the results, loss of carrying angle, and loss of motion with incidence of complications.

**Methods:** 35 Cases of displaced supracondylar fractures in children aged between 3 and 13 years were treated by closed reduction and percutaneous pinning and were studied prospectively for functional outcome. 30 cases were treated with crossed pinning. 5 cases were treated with lateral pinning.

**Results:** 31(88.6%) of the patients observed satisfactory results. 4 (11.4%) of the patients observed poor results. Of the cases treated by crossed pinning 26 (86.5%) had good results and 4 (13.3%) had poor results. All the patients treated with lateral pinning had excellent results. The difference in the functional outcome between the two groups were statistically significant.

**Conclusion:** The results obtained in this study shows that anatomical reduction by closed method and stabilization with K-wire fixation is the first treatment of choice for displaced supracondylar fractures.

**Keywords:** Displaced supracondylar fracture humerus, K-wire, Percutaneous, Closed reduction and internal fixation

## INTRODUCTION

Mercer Rang uses the old saying, Pity the young surgeon whose first case is a fracture around the elbow, as an introduction to his chapter on elbow fractures, for good reason.

They account for 50% to 70% of all elbow fractures and are seen most frequently in children between the ages of 3 and 10 years the high incidence of residual deformity and the potential for neurovascular complications make supracondylar humeral fractures a serious injury.<sup>1</sup>

The management of displaced supracondylar fracture of the humerus is one of the most difficult of the many fractures seen in children<sup>2</sup> Pitfalls in the management occur frequently and continue to trouble the doctor caring for these patients, especially with respect to displaced supracondylar fractures.<sup>3</sup> Many methods have been proposed for the treatment of displaced supracondylar fractures of the humerus in children, such as closed reduction and plaster of paris slab application, skin traction, overhead skeletal traction, open reduction and internal fixation, and closed reduction and percutaneous pin fixation.<sup>4</sup> Closed reduction is difficult not only to achieve but also to maintain because of the thinness of

bone of the distal humerus between the coronoid and olecranon where most supracondylar fractures occurs. For this reason percutaneous pinning techniques have become the treatment of choice for most supracondylar fractures. Original cross pinning technique of Swenson continued to be used with excellent results and negligible morbidity with the help of modern imaging techniques and improved power equipments.

Percutaneous Pinning as compared to Open Reduction Internal Fixation has less chances of elbow stiffness and is cost effective in terms of no use of suture material, prolonged prophylactic antibiotics and short hospital stay.<sup>7</sup> So, open reduction has generally been reserved for open fractures, irreducible fractures and those associated with vascular complications.<sup>1,7</sup>

DUNLOP introduced skin traction for the treatment of this fracture.<sup>8</sup>

SWENSON introduced his percutaneous pinning method.<sup>9</sup>

ATTENBOROUGH studied remodeling of humerus following this fracture and concluded that unlike lateral and AP shift, rotation and tilt are never fully corrected by remodeling.<sup>10</sup>

FRENCH studied varus deformity following this fracture and concluded that effect of varus tilt is increased by internal rotation deformity.<sup>11</sup>

EL SHERKAWI studied treatment of this fracture by closed reduction and casting. He concluded that this modality of treatment-produced results that were excellent for Type I, good for Type II and unsatisfactory for Type III fractures.<sup>12</sup>

FOWLES et al studied the results of percutaneous pinning of displaced supracondylar fracture of humerus and concluded that percutaneous crossed k-wire fixation is the method of internal fixation for these fractures. The advantage of this method was that the elbow could be put in any degree of flexion making it useful in management of fracture with vascular complication.<sup>13</sup>

FLYNN reported a study on closed reduction and percutaneous k-wire fixation of these fractures. He concluded that the method provides enough stability of the fracture and safety of neurovascular structure, the only disadvantage was to master the technique.<sup>14</sup>

## METHODS

This is a descriptive study, conducted on 35 patients admitted to Department of orthopaedics with displaced supracondylar fracture humerus in children aged 2-13yrs during the period from SEPTEMBER 2013 to SEPTEMBER 2015 were selected. The patients radiograph was taken in Antero-posterior and lateral

views. The diagnosis was established by clinical and radiological examination. In this study, supracondylar fracture of humerus was classified according to Gartland's classification. All patients were taken for elective or emergency surgery as soon as possible after necessary routine investigations and radiographic preoperative work-up.

## Surgical procedure

Under general Anaesthesia/brachial block, closed reduction done by traction and counter traction along the longitudinal axis with elbow in extension and supination were given. Reduction achieved and maintained by forearm pronation. Reduction was confirmed under image intensifier in two views: Antero-posterior view or Jones' view, Lateral view. After confirming satisfactory alignment, reduction was maintained by percutaneous k-wire fixation. K-wires of about 1.2mm to 2.0 mm were used. Either 2 criss-cross pins were used, one from medial epicondyle and one from lateral epicondyle or 3 k-wires were used and at times for 5 patients 2 lateral K-wires were used. Reduction and fixation checked under c-Arm. Above elbow posterior pop splint in 90° elbow flexion of forearm was applied. K-wires were removed at 3 weeks post-operatively after X-Ray confirmation of satisfactory callus formation.

- Pop splint was discarded at the same time and patient was encouraged to do active elbow flexion extension and supination - pronation exercises.

*Functional Results:* The final results were evaluated according to the criteria for grading outcomes Flynn et al.<sup>4,5</sup> The results were graded as excellent, good, fair and poor according to loss of range of motion and loss of carrying angle.

## RESULTS

This was a descriptive study, conducted on 35 cases of type II and type III fresh supracondylar fractures of humerus in children aged between 3 and 13 years who were treated by closed reduction and percutaneous pinning in the orthopaedic department were studied prospectively for functional outcome and loss of range of motion, loss of carrying angle and post-operative complications following treatment. The following observations were made.

**Age:** The age of patients studied, ranged from 3-13 years. The average age was 7.86 years.

**Sex:** Of the 35 patients in the present study, 30 (85.7%) were males and 5 (14.3%) were females.

**Mode of injury:** Of the 35 patients, 29 (82.9%) suffered fall from height and 6 (17.1%) suffered fall while playi

**Side of injury:** Of the 35 subjects, 23 (65.71 %) of them had a left sided fracture and 12 (34.29%) of them had a right sided fracture.

**Type of fracture:** Based on the Gartland's classification, 4 (11.43%) patients had Type II fracture and 31 (88.57%) of them had Type III fracture.

**Type of displacement:** Of the 31 (88.57 %) cases who had Type III fracture, 25 (71.43 %) of them had posteromedial displacement and 5 (14.29 %) of them had posterolateral displacement and 1 (2.86 %) had flexion type of displacement.

**Associated injuries:** Of the 35 patients, 2 patients had radial nerve injury and 1 patients had median nerve injury. In all these cases, nerve functions improved by 6-8 weeks. 3 patients had feeble radial artery pulsation, which improved following closed reduction and pinning.

**Pinning method:** Of the 35 cases, 31 of them underwent criss cross k wire pinning, 4 of them underwent lateral pinning.



Figure 4: Per OP images.



Figure 5: Pre OP.

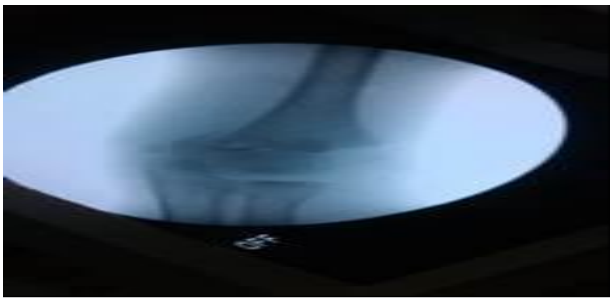


Figure 1: Pre OP C arm images.



Figure 6: Pre OP

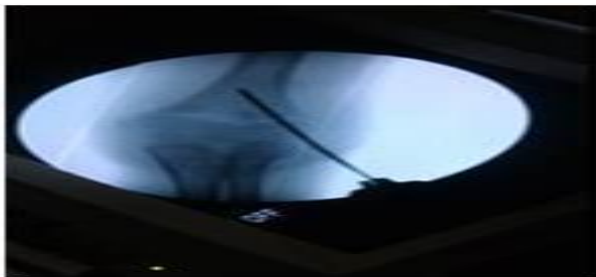


Figure 2: Per OP images.



Figure 7: Post OP.



Figure 3: Per OP images.

Of the 4 patients who had type II fracture, 3 of them underwent crisscross 2K- wire pinning configuration and 1 of them underwent 2 K-wire lateral pinning configuration.

Of the 31 patients, who had type III fracture, 4 of them underwent 2 Lateral K- wire pinning and 27 of them underwent crossed K-wire crossed pinning configuration.

**Functional outcome:** In our series cases treated with 5 (14.3%) lateral pinning showed excellent Satisfactory outcome and out of 31 (88.6%) treated with crossed K-wire crossed pinning cases- 26 (74.3%) showed Satisfactory and 4 (11.4%) showed Unsatisfactory.



Figure 8: Follow up 6 months.



Figure 9: Follow up 6 months.

Table 1: Type of pinning versus outcome.

		Lateral pinning	Cross pinning
Outcome	Satisfactory	14.3%	74.3%
	Unsatisfactory	0%	11.4%
	Total	14.3%	88.6%

**Post-operative complications:**

2 patient developed pin tract infection, which was recognized by the presence of hypertrophic granulation tissue, which healed with antibiotic therapy.<sup>1</sup> patient developed cubitus varus deformity, but maintained good functional movement.<sup>1</sup> patient had iatrogenic ulnar nerve palsy in the present study.

**Range of limitation of flexion:**

Out of the 35 cases, 26 (74.29%) patients had limitation of flexion b/w 0-10°, 7 (20.00%) patients had limitation of flexion b/w 10-20° and 2 (5.71%) patient had >20° limitation of flexion. Average loss 9.4°. The Table 2

shows the number of patients with range of Flexion Limitation in the present study.

Table 2: Range of limitation of flexion.

Flexion limitation	Number of patients/%
0-10 <sup>0</sup>	26(74.29%)
11-20 <sup>0</sup>	7(20%)
>20 <sup>0</sup>	2(5.71%)
Total	35(100%)

**Change in carrying angle**

29 (82.9%) patients had change in carrying angle less than 5°, 3 (8.6%) of them had changes b/w 5-10°, 1 (2.9%) of them had changes >10° and 2 (5.7%) of them had a fixed flexion deformity, because of which carrying angle could not be assessed. The Table 17 and Graph 14, shows the number of patients with Change in Carrying Angle in the present study.

Table 3: Change in carrying angle.

0-5°	29 (82.9%)
6-10°	3 (8.6%)
>10°	1 (2.9%)
Fixed flexion deformity	2 (5.7%)
Total	35 (100%)

Statistical analysis of the data is given below: X2 value is 52.83 and p value = 0.0001 which is statistically significant (p-value<0.05).

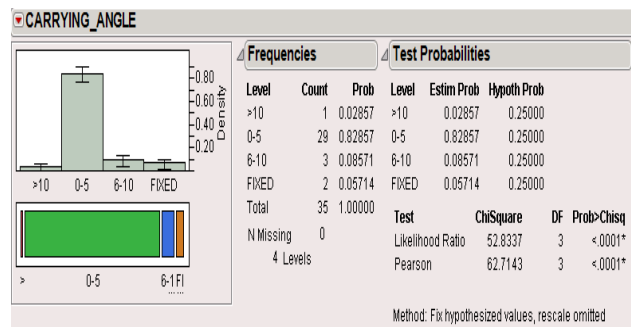


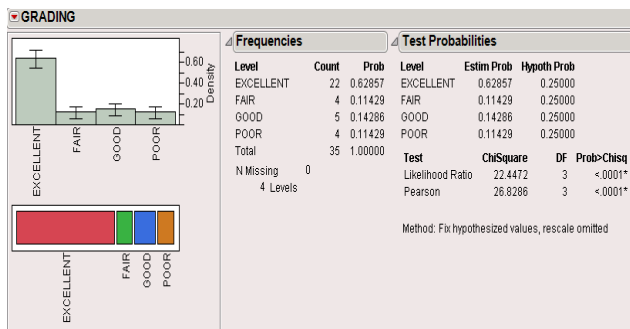
Figure 10: Carrying angle.

Table 4: Duration of movement recovery.

Time range for maximum range of movement recovery /type of fracture	Time range for maximum range of movement recovery (in weeks)	Average time for recovery (in wks)
Type II	11-14	12.75
Type III	10-18	16.0

**Table 5: Flynn et al criteria for grading outcomes.**

Cosmetic factor		Functional factor	
Result	Rating	Carrying angle loss (°)	Motion loss (°)
Satisfactory	Excellent	0 to 5	0 to 5
	Good	5 to 10	5 to 10
	Fair	10 to 15	10 to 15
Unsatisfactory	Poor	Over 15	Over 15



X2 value is 22.44 and p value = 0.0001 which is statistically significant (p-value<0.05).

**Figure 11: Grading.**

Time for maximum range of movement recovery: Of the 35 cases, 4 patients had Type II fracture and 31 of them had Type III fracture. The average time for maximum range of movement recovery was 12.75 weeks for type II fracture and 16.0 weeks for type III fractures. Excluding patients with fixed flexion deformity.

The results of our study of displaced supracondylar fracture by closed reduction and percutaneous K- Wire fixation method showed, according to the criteria for grading outcomes Flynn et al.

**DISCUSSION**

A supracondylar fracture of the humerus is one of the most common injuries in children. Difficulty in treating this fracture lies in the fact that this gets complicated very often. Initial treatment and definitive treatment of this fracture is of utmost importance.

The Supracondylar fractures also occurred most frequently in children between 5 and 10 years of age as reported in other studies. 9 In the present study, the average age was 7.86 years, which is similar to the average age in other studies. Traditionally, boys have had a higher incidence of this type of fracture. In the present study, 30 (85.7%) were male patients and 5 (14.3%) were female patients, which is similar to other studies, showing a male preponderance. Supracondylar fractures result

from a fall on an outstretched arm in up to 70 percent of patients.<sup>15</sup>

In the present study, 29 (82.9%) patients had fall from height and 6 (17.1%) had fall while playing, which is similar to other studies.

The no dominant extremity is most commonly affected. In the present study, 23 (65.71 %) had left sided injury and 12 (34.29%) of them had right sided injury. The other series of study mentioned below also show a preponderance of left sided fractures. In the present study, based on the Gartland’s classification, 4 (11.43%) patients had Type II fracture and 31 (88.57%) of them had Type III fracture. In the present study, 34 (97.15%) were Extension type and 1 (2.85%) was flexion type. Out of the 31 (88.57 %) cases who had Type III fracture, 25 of them had posteromedial posterolateral displacement and 1 had flexion type of displacement. In the present study, of the 35 cases, 31 of them underwent criss cross k wire pinning, 4 of them underwent lateral pinning.

Of the 31 patients, who had type III fracture, 4 of them underwent 2 Lateral K- wire pinning and 27 of them underwent crossed K-wire crossed pinning configuration. Crossed K-wire fixation is a well proven standard procedure in the treatment of supracondylar humerus fractures in children. Weinberg et al. showed in their biomechanical study that crossed K-wires showed the highest stiffness and lowest loss of reduction under cyclic loading. The external fixators proved to be good alternatives.<sup>16</sup> In a study Zionts et al. compared crossed K-wire technique with lateral K-wire fixation alone. Greater stability was achieved with the cross pinning technique.<sup>17</sup> From the results of our study, we cannot state any clear advantage for lateral technique alone because of small number of study.

Out of the 35 cases, treated with 5 (14.3%) lateral pinning showed excellent Satisfactory outcome and out of 31 (88.6%) treated with crossed K-wire crossed pinning cases 26 (74.3%) showed Satisfactory and 4 (11.4%) showed Unsatisfactory. The difference in the functional outcome between the two groups lateral pinning and crossed K-wire crossed pinning was statistically significant, but we cannot state any on the clear advantage for lateral technique because of small number of study.

In the present study, of the 35 cases, 26 (74.29%) patients had limitation of flexion b/w 0-10°, 7 (20.00%) patients had limitation of flexion b/w 10-20° and 2 (5.71%) patient had >20° limitation of flexion. Average loss 9.4° 29 (82.9%) patients had change in carrying angle less than 5°, 3 (8.6%) of them had changes b/w 5-10°, 1 (2.9%) of them had changes >10° and 2 (5.7%) of them had a fixed flexion deformity, because of which carrying angle could not be assessed.

Wang YL et al reported that the uncomplicated distal humerus supracondylar and lateral condylar fractures, it takes 5 weeks'time to restore original elbow range of motion (ROM) recovery after removal of long arm cast without physical therapy.<sup>18</sup>

Out of the 35 cases, 4 patients had Type II fracture and 31 of them had Type III fracture. The average time for maximum range of movement recovery was 12.75 weeks for type II fracture and 16.0 weeks for type III fractures. Excluding patients with fixed flexion deformity.

In the present study, of the of the 35 cases, the clinical outcome grading was measured as per the Flynn et al

criteria for grading outcomes; 22 (62.9%) of the patients observed excellent results and 5 (14.3%) of good results and 4 (11.4%) of the patients observed Fair results that is 31 (88.6%) of satisfactory results. Then 4 (11.4%) of the patients observed Poor results that is Unsatisfactory as per Flynn et al criteria. The Clinical outcome is Compared between others study as given below.

Prieto C et al compared results of this fracture treated with Dunlop traction and with percutaneous pinning. Cubitus varus incidence was 33% in Dunlop traction group and 5% in percutaneous pinning group. Final range of elbow motion was also better in percutaneous pinning group.<sup>19</sup>

**Table 6: Results.**

Treatment	Author	No.	Excellent	Good	Fair	Poor
Percutaneous k wire fixation	Pirone et al	96	75(78%)	15(16%)	1(1%)	5(5%)
Percutaneous k wire fixation	Flynn et al	52	42(80%)	7(14%)	1(4%)	1(4%)
Closed reduction and percutaneous k wire fixation	Present study	35	22(62.9%)	5(14.3%)	4(11.4%)	4(11.4%)

Devakumaran advocated primary open reduction and kwire fixation and obtained 93% excellent a 6.7% good results. He advised minimal tissue trauma, and early mobilisation for better results.<sup>20</sup>

Ziontes et al studied torsional strength of various pin configurations and concluded that two crossed pins provided maximum resistance against rotational displacement, followed by 3 lateral pins and 2 lateral pins.<sup>21</sup>

Almoharji S compared treatment of displaced supracondylar fracture of humerus with closed reduction and casting Vs closed reduction and percutaneous pinning. He concluded the closed reduction and pinning is a preferable method because it shortens hospitalisation time, the elbow can be splinted in a safe and comfortable position, and decrease the risk of compartment syndrome.<sup>22</sup>

Skaggs D et al studied consequences of pin placement in operative treatment of supracondylar fracture of humerus in children and concluded that fixation with only lateral pins is safe and effective for both Gartland type2 and type3 supracondylar fractures, moreover it prevents iatrogenic injury to the ulnar nerve. They do not recommend routine use of crossed pins and if at all medial pin is used, the elbow should not be hyper flexed during its insertion.<sup>23</sup>

Jong S et al treated this fracture with three percutaneous pin fixation; two laterally and one medially. He advised

fixing this fracture with two lateral pins first allows elbow to be extended for safe placement of medial pin.<sup>24</sup>

Eduardo N et al stated the joystick technique is a safe and effective method that can avoid aggressive and frustrating attempts of closed reduction and further open reduction of multidirectionally unstable supracondylar fractures of the humerus in children.<sup>25</sup>

## CONCLUSION

Hence from our study, we observed that closed reduction and percutaneous pinning under C- arm guidance is a simple, cheap and effective method of treatment of displaced supracondylar fractures (type II and type III) humerus in children with relatively fewer complications.

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