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## Outcome analysis of cross pinning in supracondylar fractures of humerus in children

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### Abstract

**Background:** Supracondylar humerus fractures are one of the commonest fractures in the paediatric age group. Displaced supracondylar fractures of humerus in children is commonly treated by closed or open reduction and K wire fixation. Cross pinning and lateral pinning are the commonest configurations used for fixation. The configuration of wires is debatable although cross pinning is biomechanically more stable, there is a risk of iatrogenic ulnar nerve injury. Recent studies suggest lateral pinning if properly done has equal stability and there is no risk of iatrogenic ulnar nerve injury. functional outcome of displaced supracondylar fractures of humerus in children treated with cross pinning Inclusion criteria included Age less than 16 yrs, Gartland type II and type III fractures and Cases managed by closed or open reduction and stabilized by Kirschner wires. Patient with Age more than 16 years, Gartland type I fractures, Compound fractures, Patient presenting with associated neurovascular deficit were excluded.

**Materials and Methods:** This is a randomized prospective study from November 2019 to April 2021. A total of 30 patients of displaced supracondylar fracture aged between 2-12 years without any compound injury were enrolled for the study. The cosmetic and functional outcomes were evaluated by Modified Flynn's criteria.

**Results:** As per Modified Flynn's criteria, all patients treated with cross pinning had satisfactory results. There was no statistically significant difference with regard to functional outcome, cosmetic outcome and loss of reduction. There was one case of iatrogenic ulnar nerve injury in cross pinning group.

**Conclusion:** cross pinning provides good stability and functional outcome. Cross pinning has a definitive risk of iatrogenic ulnar nerve injury.

**Keywords:** Supracondylar fractures of humerus, Kirschner wires, Gartland type II and type III fractures, cross pinning

### Introduction

Supracondylar humeral fractures are the most common paediatric elbow fractures, accounting for 3% of all children's fractures [1-5]. Supracondylar fracture of the humerus is the most common elbow injury in children and makes up approximately 60% of elbow injuries [6]. It is the fracture, which involves the lower end of the humerus usually involving the thin portion of humerus through olecranon fossa, or just above the fossa through the metaphysis.

They occur primarily in the first decade of the life, with a peak incidence between 5-8years [7]. The average age at fracture was 6.7 years, incidence of left-sided fracture was 60.8%, 62% were boys and 1% were of the open type [8].

They have the highest complication rate for elbow fractures in this age group [9-11]. Undisplaced fractures are treated conservatively with above elbow slab/cast. Displaced fractures are reduced by closed or open method and then stabilized with Kirschner wires to avoid loss of reduction. Kirschner wires may be applied in numerous configurations to stabilize the reduced fracture.

One of the configurations is insertion of one pin medially and one pin laterally through the corresponding epicondyles. Although this configuration is biomechanically more stable, there is a risk of iatrogenic ulnar nerve injury during insertion of medial pin. Most of these nerve injuries recover completely over the duration two to three months. Rarely it may lead to permanent ulnar nerve deficit leading to functional disabilities. To overcome this complication, two or three Kirshner wires were inserted through lateral epicondyle.

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But lateral pinning is biomechanically less stable as rotation at fracture site may occur. It has been argued that the lateral pinning if done by proper technique provides almost equal stability similar to cross pinning without any risk of iatrogenic ulnar nerve injury.

The aims and objectives of the present study are to evaluate the advantages, disadvantages and possible complications associated with fixation of supracondylar fractures with cross pinning.

**Materials and Method**

The proposed study is a hospital based observational prospective study conducted on children less than 16years of age who as admitted and treated by surgical management after obtaining their written and informed consent from November 2019 to April 2021.

Inclusion criteria included Age less than 16 yrs, Gartland type II and type III fractures and Cases managed by closed or open reduction and stabilized by Kirschner wires. Patient with Age more than 16 years, Gartland type I fractures, Compound

fractures Patient presenting with associated neurovascular deficit were excluded.

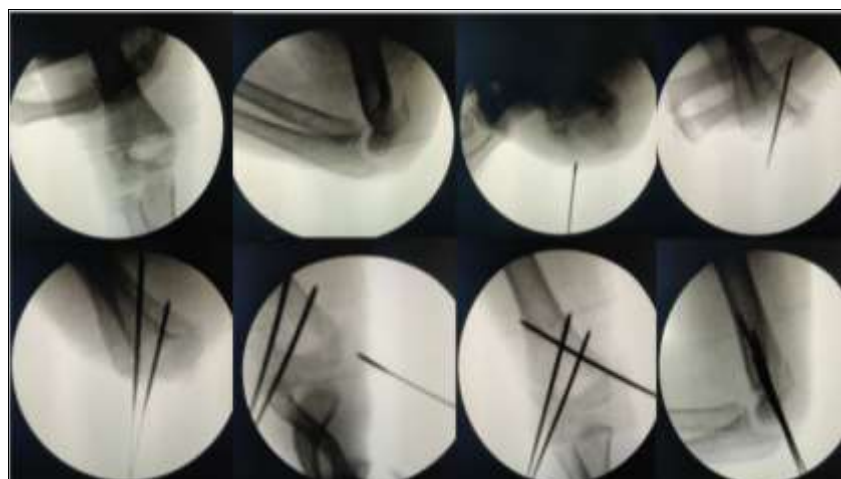
All patients were taken up for surgery under General Anaesthesia. Supine with ipsilateral shoulder at the edge of the table, Technique of closed reduction and internal fixation: Traction along the longitudinal axis with the elbow in extension and supination were given. At the same time counter traction was applied by an assistant by holding proximal portion of arm. Medial or lateral displacements were corrected by valgus or varus forces respectively.

After that, both the posterior displacement and angulation was corrected by flexing the elbow and applying posteriorly directed force from anterior aspect of proximal fragment and then anteriorly directed force from posterior aspect of distal fragment.

Reduction was confirmed under image intensifier in anteroposterior view or Jone’s view and Lateral views. After confirming satisfactory alignment, reduction was maintained by percutaneous k-wire fixation. Above elbow posterior pop splint in 90° elbow flexion of forearm was applied.



**Fig 1:** Closed Reduction and K-wire Fixation



**Fig 2:** Closed Reduction and K Wire Introduction

In postoperative, Full arm posterior slab was used, cuff and collar were given. The limb was elevated. The preoperative antibiotics were continued parenterally on the day of operation. It was continued for 3 to 5 days, keeping a watch on body temperature and the wound.

As patient regained consciousness, he was advised to do active finger movements.

Dressings were changed usually on 2nd, 5th and 10th day. Check X-ray was taken routinely. Sutures removed on 10th day and patient was discharged.

Patients were called at third or fourth week for K-wire removal. After the k-wires were removed the posterior slab was discarded, and active movements of elbow was started. Special mention was made to avoid oil massage and passive stretching which is advocated by unqualified medical personnel.

All these cases were advised to attend the outpatient department at regular intervals of 3 weeks, 6 weeks, 3 months, 6 months for checkup and to note down the progress

of union, range of movement at elbow and onset of any deformity. Range of movements and carrying angle were measured using goniometer.

Check X-ray were taken postoperatively at the end of 3-4 weeks, 3 months and 6 months. The following were noted in the postoperative X-Rays for adequacy of reduction. (Anterior humeral line, Crescent sign, Baummann's angle)

Baummann's angle was measured in immediate post op x ray, and the x ray before k wire removal at three or four weeks. Loss of reduction is determined by change in baumann's angle. The displacement is graded by Skaggs *et al* <sup>[11]</sup>.

**Table 1:** Loss of Reduction

Displacement	Change in Baumann's angle
No	<6 degree
Mild	6-12 degree
Major	>12 degree

The cosmetic and functional outcome were assessed using Modified Flynn's criteria <sup>[20]</sup>.

**Table 2:** Modified Flynn's Criteria Grades

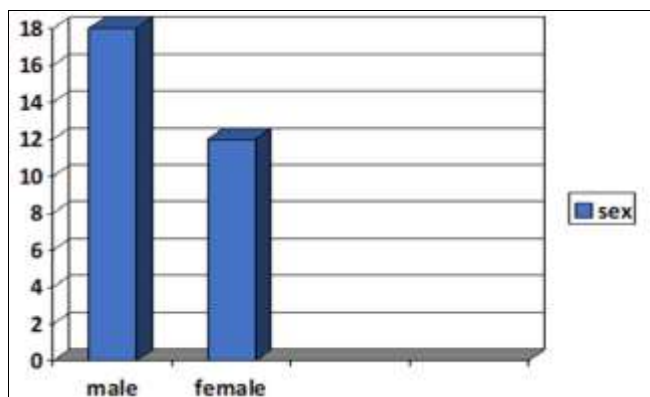
Results	Rating	Cosmetic factor: Carrying angle loss (Degrees)	Functional factor: Total range of elbow motion loss (Degrees)
Satisfactory	Excellent	0-5	0-5
	Good	5-10	5-10
	Fair	10-15	10-15
Unsatisfactory	Poor	>15	>15

**Results**

In sex distribution, 18(60%) children were males in cross pinning and 12(40%) children were females in cross pinning.

**Table 3:** Sex distribution

Male	18
Female	12
Total	30



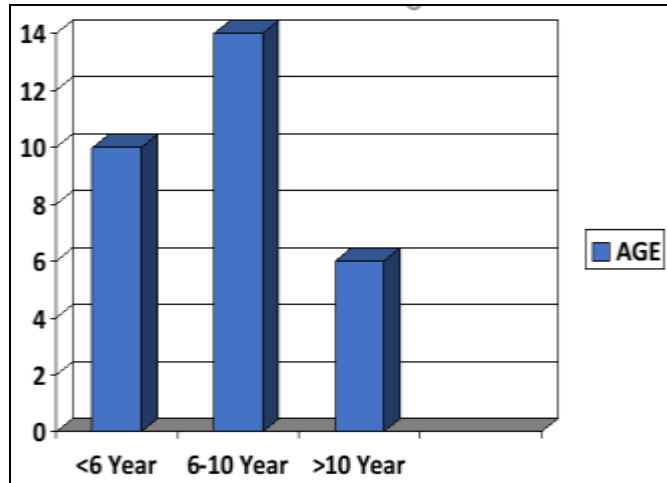
**Fig 3:** Sex Distribution

In age distribution, 10(33.33%) children were under 6 years, 14(46.66%) children were between 6 to 10 years and 6(20%) children were above 10 years.

Mean age was 7.26 years. (Range from 2 years to 12years).

**Table 4:** Age Distribution

Age Group	Cross Pinning
<6 Years	10
6-10 Years	14
>10 Years	6

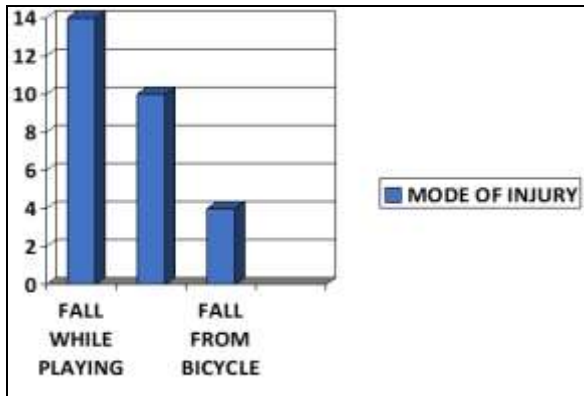


**Fig 4:** Age Distributio

In mode of injury, All patients had a history of fall. 14 (46.66%) children fell down while playing, 10(33.33%) children had fall from height and 4(13.33%) children in lateral pinning group fell-down from bicycle.

**Table 5:** Mode of Injury

Mode Of Injury	Cross Pinning
Fall While Playing	14
Fall From Height	10
Fall From Bicycle	4

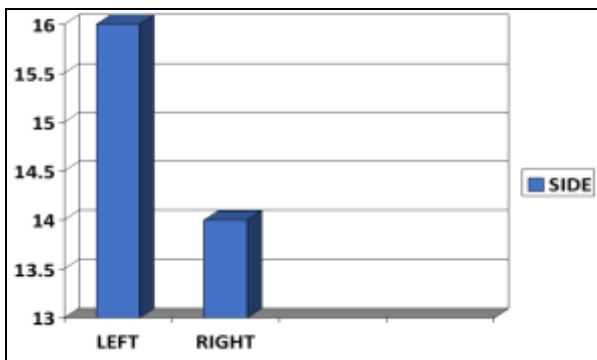


**Fig 5:** Mode of Injury

In side distribution, 16(53.33%) children had left sided and 14(46.66%) children had right sided fractures.

**Table 6:** Side Distribution

Side	Cross Pinning
Left	16
Right	14

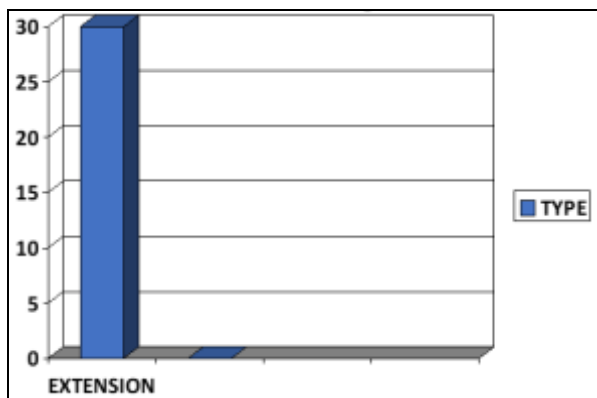


**Fig 6:** Side Distribution

All patients had extension type of fracture.

**Table 7:** Type of Fracture

Type	Cross Pinning
Extension	30
Flexion	0

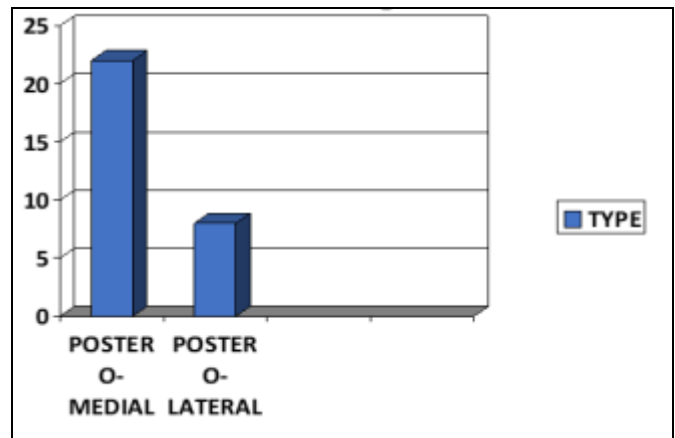


**Fig 7:** Type of Fracture

In type of displacement, 22(73.33%) children had postero-medial and 8 (26.66%) children postero-lateral displacement.

**Table 8:** Type of Displacement

Type	Cross Pinning
Postero-Medial	22
Postero-Lateral	8

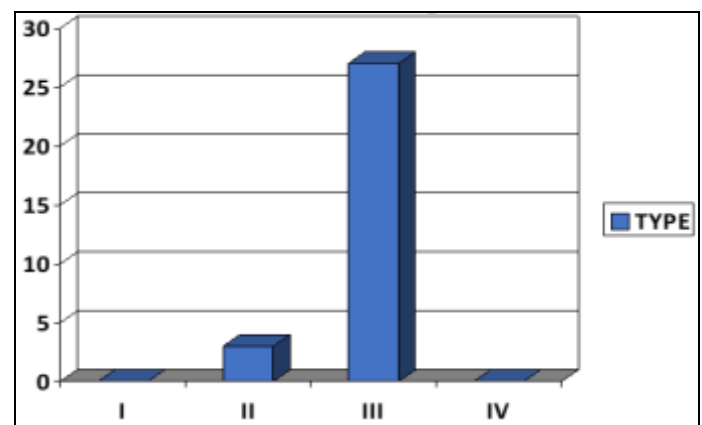


**Fig 8:** Type of Displacement

In modified gartland type, 3(10%) patients were Type 2 and 27(90%) patients were type 3 by gartland classification.

**Table 9:** Modified Gartland Type Injury And Surgery

TYPE	Cross Pinning
I	0
II	3
III	27
IV	0



**Fig 9:** Modified Gartland Type Injury and Surgery

In loss of terminal flexion, 25 (83.33%) patients had limitation of terminal flexion between 0 to 5 degree, 5 (16.66%) patients had limitation of terminal flexion between 5 to 10 degrees compared with normal contralateral side.

**Table 10:** Loss of Terminal Flexion Flexion

	Cross Pinning
00 To 05	25
05 To 10	5
10 To 15	0
>15	0



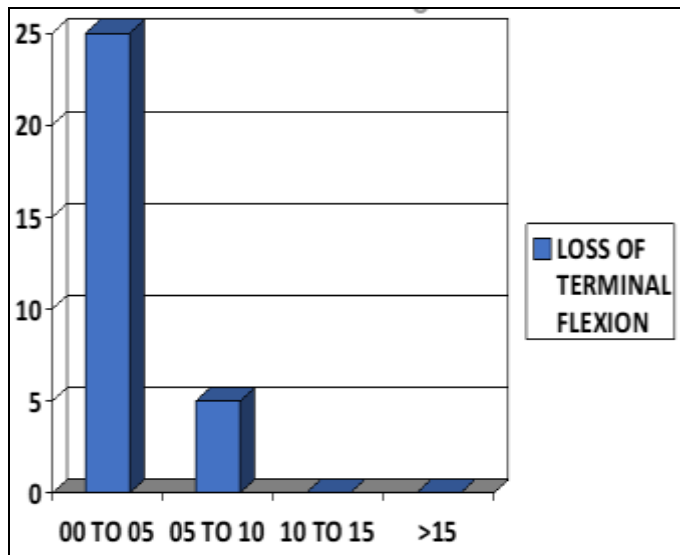


Fig 10: Loss of Terminal

In loss of carrying angle, 30 (100%) patients had loss of carrying angle between 0 to 5 degree compared with normal contralateral side. the loss of carrying angle was due to inadequate initial reduction achieved at the time of surgery. There was no loss of reduction in both immediate postoperative radiograph and in the radiograph taken at time of kirschner wire removal.

Table 11: Loss of Carrying Angle

	Cross Pinning
00 TO 05	30
05 TO 10	0
10 TO 15	0
>15	0

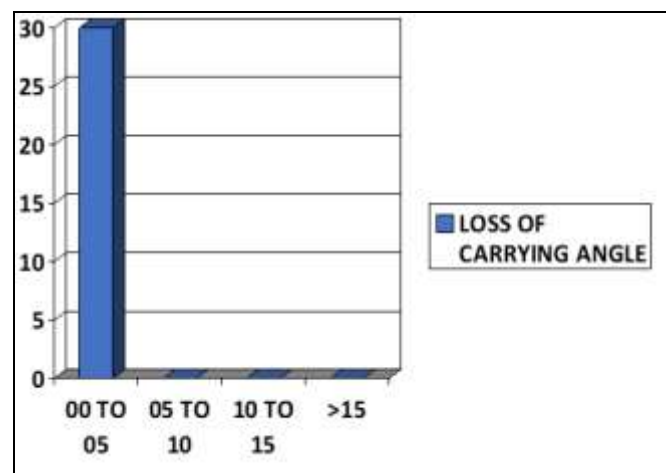


Fig 11: Loss of Carrying Angle

In modified flynn’s grading, all 30 cross pinned patients had satisfactory results, 18 had excellent and 10 cases had good results and 2 cases had fair.

Table 12: Modified Flynn’s Grading

Grading	Cross Pinning
Excellent	18
Good	10
Fair	2
Poor	0

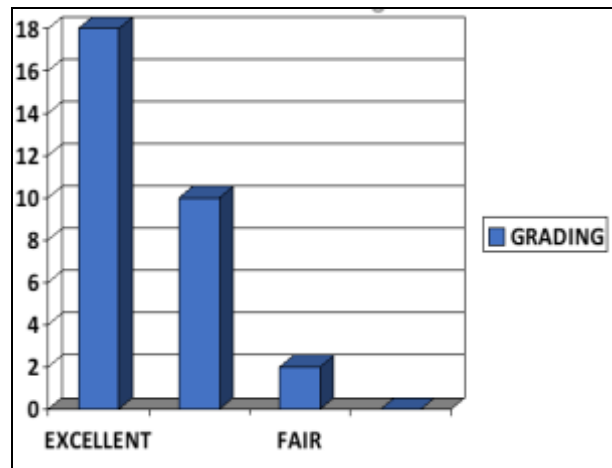


Fig 13: Modified Flynn’s

All fractures united by 3 to 4 weeks duration. The mean duration of fracture union was 3.4 weeks. No patient in cross pinning had any loss of reduction. One patient in cross pinning developed postoperative partial ulnar nerve injury which resolved completely in 3 weeks after Kirschner wire removal. 1 patient in cross pinning developed pin site infection which resolved with oral antibiotics.

Discussion

The management of displaced supracondylar fracture humerus in children is closed reduction and maintenance of the reduction with Kirschner wires. The success of surgical treatment depends upon initial anatomical reduction and maintenance of reduction till union.

Although closed reduction and percutaneous pinning stabilization is the current gold standard in managing displaced supracondylar fractures of the humerus in children, there is controversy on the configuration of K-wires based on stability, biomechanics and ulnar nerve safety. The most commonly used configurations are cross pinning and lateral pinning. The data collected in this study is assessed, analysed, compared with other studies and results were evaluated.

In our study, the average age of patients with supracondylar fractures of humerus was 7.26 years ranging from 2 years to 12 years. Age incidence in our study is comparable with other studies. The average age incidence in other studies are as follows:

Table 13: Average age incidence

Study	Average Age (Years)
Ippolito <i>et al</i> [12]	7.3
Wilkins <i>et al</i> [8]	6.7
Our Study	7.26

In our study, 18 patients (60%) were males and 12 patients (40%) were females. This male predominance may be explained as boys are more active and are more prone for falls. Sex incidence in our study is comparable with other studies. The average sex incidences in other studies were as follows:

Table 14: Sex incidence

Study	No Of Males (%)	No Of Females (%)
Fowles <i>et al</i> [13]	89 (81%)	21 (19%)
Pirone <i>et al</i> [14]	119 (52%)	111 (48%)
Our Study	18 (60%)	12 (40%)

In our study left side was involved in 66.67% of patients and right side in 33.33% patients. Right handed persons have weaker muscles in the left arm and improper balancing during fall. Therefore, the left arm is more prone in this type of injuries.

Side Involvement in our study is comparable with other studies. Side involvement in other studies are as follows:

**Table 15:** Side involvement

Study	Right Side (%)	Left Side (%)
Fowles <i>et al</i> <sup>[13]</sup>	63 (43%)	97 (57%)
Pirone <i>et al</i> <sup>[14]</sup>	85 (37%)	145 (83%)
Our Study	14 (46.66%)	16 (53.33%)

In our study, all thirty patients had extension type of supracondylar fracture of humerus. Traditionally, extension type of supracondylar fractures account for 95% to 98% of supracondylar fractures. Incidence of extension and flexion type of supracondylar fractures in various studies are as follows.

**Table 16:** Type of Fracture

Study	Extension Type (%)	Flexion Type (%)
Fowles <i>et al</i> <sup>13</sup>	158(90.29%)	17 (9.71%)
Pirone <i>et al</i> <sup>14</sup>	321 (98.77%)	4 (1.23%)
Wilkins <i>et al</i> <sup>8</sup>	98%	2.0%
Our Study	30 (100%)	0 (0%)

In our study, twenty patients had posteromedial displacement and ten patients had posterolateral displacement. Type of displacement documented in other studies are as follows:

**Table 18:** Type of Displacement

Study	Postero-Medial (%)	Postero-Lateral(%)
Pirone <i>et al</i> <sup>[14]</sup>	94 (81%)	22 (19%)
Wilkins <i>et al</i> <sup>[8]</sup>	75%	25%
Our Study	22 (73.33%)	8 (26.66%)

In our study, one (3.3%) patient in cross pinning group developed partial ulnar nerve palsy. Skaggs *et al.*<sup>[15]</sup> study had 8% and Lyons JP *et al.*<sup>[16]</sup> study had 6% of ulnar injury in cross pinning group. We followed flexion extension method to avoid ulnar nerve injury. In our study ulnar nerve injury recovered completely after 3 weeks duration.

In our study, one (3.3%) patient had pin track infection. Dorgan *et al.*<sup>[17]</sup> study had 4.4% of pin track infection.

At the final follow up, the results were analysed according to Modified Flynn's criteria. In our study, 30 out of 30 patients had satisfactory results which is comparable with Palange *et al.*<sup>[18]</sup> study.

There was no loss of reduction in both cross pinning and in lateral pinning group. This was comparable to Skaggs *et al* study<sup>[19]</sup>.

Out of 30 patients, 25 (83.33%) patients had limitation of terminal flexion between 0 to 5 degree, 5 (16.66%) patients had limitation of terminal flexion between 5 to 10 degrees compared with normal contralateral side.

In our study, there was no significant difference in functional outcome cross pinning. This is comparable to the Kocher *et al.*<sup>[20]</sup> and Reynolds *et al.*<sup>[21]</sup> studies.

30 (100%) patients had loss of carrying angle between 0 to 5 degree compared with normal contralateral side. A loss of carrying angle was due to inadequate initial reduction achieved at the time of surgery. There was no loss of

reduction in both immediate postoperative radiograph and in the radiograph taken at time of kirschner wire removal. The difference in the loss of carrying angle was not found statistically significant between the two groups. These results were comparable with the study by Foad *et al.*<sup>[22]</sup>

## Conclusion

No significant difference exists with respect to fracture characteristics, loss of reduction on follow-up, pin tract infection except for iatrogenic ulnar nerve injury in cross pinning. There were no major complications apart from ulnar nerve injury in cross pinning group.

Cross pinning was good in term of functional and cosmetic outcome. Cross pinning provides most stable fixation in maintaining the reduction of supracondylar fractures of humerus in children.

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