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# Comparative study of posterior intrafocal with lateral pinning versus cross pinning for extension type supracondylar fracture humerus in children

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**Abstract**
**Introduction:** Supracondylar fractures of humerus are the most common elbow fracture in children. The treatment of this fracture is very difficult because of the instability of the fragments and grave soft tissue injuries which may lead to complications. Percutaneous pinning techniques have become the treatment of choice for most supracondylar fracture of humerus.
**Objectives:** To assess and compare clinical (functional and cosmetic) and radiological results and complications of two types fixation technique [cross pin fixation (CPF) versus posterior intrafocal and lateral pin fixation (PILPF)] for extension type closed supracondylar fracture humerus.
**Methodology:** This study was done prospectively on patients having extension type supracondylar fracture of humerus in children admitted in the Department of Orthopaedic, SMS Medical College & Hospital, Jaipur during the February 2012 to November 2013. A total of 168 cases (84 in each category) were studied. Patients were divided into two groups, in first group all 84 patients were managed by CPF while in second group, by PILPF method with K-wire.
**Results:** There were 5 cases (5.95%) of significant cubitus varus in PILPF and 4 cases (4.76%) in CPF. There was significant loss of range of movement at elbow in 6 cases (7.14%) in PILPF group and 4 cases (4.76%) in CPF group. There were 5 cases of iatrogenic nerve injury in CPF group. In PILPF group, overall results were satisfactory in 94.04% and in CPF group in 95.23% cases, for the cosmetic factor. Final result for cosmetic factor according to flynn's criteria: 72.61% cases have excellent results in CPF group while only 44.04% cases were in PILPF group (p value <0.05, statistically significant). In PILPF group, overall results were satisfactory in 92.85% cases and in CPF group in 95.23% cases, for the functional factor. Final result for functional factor (movement loss) according to flynn's criteria: 57.14% cases have excellent result in CPF group while 47.61% were in PILPF group (p value >0.05, statistically not significant). We find significant change in Baumann's angle of abnormal side in both groups (p value<0.05).
**Conclusion:** CPF method is better than PILPF method while considering biomechanical stability, but PILPF method is safe. It does not carry risk of ulnar nerve injury.

**Keywords:** Supracondylar fracture, cross pin fixation (CPF), Posterior intrafocal with lateral pin fixation

## Introduction
Supracondylar fracture of humerus are the most common elbow fracture in children.[8,9] These comprise 55% to 75% of all elbow fracture. Most injuries occurring between age 5 and 10 years. Peak age range occurs in 5 to 6 years[7]. The fracture occur more often in boys (62.8%) than in girls and more often on the left side (60.8%). Supra condylar fracture of humerus can be divided into extension and flexion types. Extension Type accounts 97% to 99% of Supra condylar fracture of humerus. Posteromedial displacement is more common (approximately 75%).

Many treatment modalities have been devised for these fractures, the commonly used methods are closed reduction and immobilization in flexion, Dunlop's traction, overhead olecranon skeletal traction, closed reduction and percutaneous pinning and open reduction and internal fixation.

Displaced supracondylar fracture of humerus in children treated by any method may result in a limb threatening Volkmann's ischaemic contracture, arterial injury, nerve palsy, elbow stiffness and cubitus varus deformity which may complicate management of these fractures.

Malunion is the most common complication of this fracture.
Pin configuration

1. Cross: One medial & one lateral pin. (Lee *et al*) [16]
2. Divergent: two divergent lateral pin. (Lee *et al*) [16]
3. Parallel: Two parallel lateral pins. (Lee *et al*) [16]
4. Two lateral & one medial wires (Shim & Lee) [19]
5. Posterior Intrafocal pinning (Fahmy *et al*) [17]
6. Posterior intrafocal and lateral pinning (Fahmy *et al*) [17]

**Percutaneous pinning techniques have become the treatment of choice** for most supracondylar fracture of humeurs [6]. There are many advantages of the percutaneous pinning method. Since the fracture is stabilized the elbow can be splinted in a safe and comfortable position, maximizing circulation and minimizing risk of circulatory insufficiency. The likelihood of cubitus varus deformity is markedly reduced. The severe amount of swelling seen in these fracture is greatly reduced. Pain is less once the fracture has been internally fixed. Hospitalization time is reduced. There is less risk of infection, less chances of elbow stiffness and good union rates as there is no loss of fracture hematoma.

**Objectives**

To assess and compare clinical and radiological results and complications of two types of fixation technique for extension type closed supracondylar fracture humerus in children.

1. Closed reduction with posterior intrafocal and lateral entry percutaneous pin fixation ( PILPF)
2. Closed reduction with cross (medial and lateral) entry percutaneous pin fixation (CPF)

**Material and Methods**

This study was done prospectively on the patients having extension type supracondylar fracture of humerus admitted in the Department of Orthopaedic, SMS Medical College & Hospital, Jaipur during the February 2012 to November 2013 with a minimum follow up of 6 months.

**Inclusion Criteria**

- Extension type fracture of Gartland type II & III
- Age <15 years
- Patient willing for surgery

**Exclusion Criteria**

- Flexion type fracture, Comminuted fracture, 'T' or 'Y' fracture
- Age >15 years
- Patient not willing to participate
- Vascular injury/impending VIC

A total of 168 cases (84 in each category) were studied. Patients were divided into two groups, in first group all 84 patients were managed by CPF method while in second group all 84 patients managed by PILPF method with K-wire. After admission, detailed clinical and radiological examination was done. All cases were immobilized in forearm slab with elbow in approximately 20 to 40 degrees of flexion,, and after routine investigations, patient were taken up for surgery as soon as possible.

**Method of Randomization**

System random sample technique: all odd number of cases allotted to CPF group and all even number of patient allotted to PILPF group.

**Gartland J.J. (1959) [13] classified the fracture into 3 types**

Type-I : Undisplaced fracture
Type-II : Displaced fracture with intact posterior cortex
Type-III : Displaced fractures with no cortical contact, complete displacement (posteromedial, posterolateral)

**Radiographic Evaluation:** Angles used for assessment of reduction are:

**1. Carrying Angle**

Carrying angle is formed between the long axis of the humerus and the long axis of the ulna, on a standard AP film. In children, Smith (1960) [20] found this to be 6.1º (range 0-12º) in girls and 5.4 (range 0-11º) in boys.

**2. Baumann's Angle**

Worlock (1986) [22] observed that an increase in Baumann's angle indicates medial tilting of the distal fragment i.e. cubitus varus. The normal Baumann's angle is approximately 75º. A 5º change in Baumann's angle contributes to 2º change in carrying angle. He found this correlation to be statistically significant. Williamson *et al* (1992) [21] studied the mean Baumann's Angle was 72º (S.D. ± 4) and 95% of the normal elbows had a Baumann's Angle between 64º and 81º.

**Operative technique**

1. Technique for close reduction
2. Technique for percutaneous pin fixation

**1. Technique for close reduction**

Under general anaesthesia, patient was placed supine on the operating table, longitudinal traction with elbow in extension and forearm in supination (with counter traction). While the traction is being maintained, medial and lateral displacement is corrected by applying a valgus or a varus force at the fracture site. Once length has been re-established elbow is flexed. Once the 90 degrees of elbow flexion is achieved the forearm is pronated for posteromedially displaced fracture and supinated for posterolaterally displaced fracture. With this position maintained, the elbow is further flexed to 120 degrees to maintain the reduction. Check vascularity of limb after reduction.

**2. Technique for percutaneous pin fixation**

**(a) Medial & Lateral entry pin fixation:** If the fracture was posteromedial, the medial pin and if posterolateral, the lateral pin was inserted first under image intensifier to push the distal fragment laterally or medially respectively towards the proximal fragment. The medial pin was placed directly through the apex of medial epicondyle and was directed slightly anteriorly in the shaft due to posteriorly placed medial epicondyle. The lateral pin was placed where the anterior humeral line crosses the center of the lateral condyle and was directed slightly posteriorly in the sagittal plane. For medial and lateral entry technique, one pin was inserted from the lateral aspect of the elbow across the lateral cortex to engage the medial cortex with the elbow in hyperflexion. The elbow was then extended to less than a 90º position to avoid injury to an anteriorly subluxating ulnar nerve. The medial pin was then placed, starting in the medial epicondyle and engaging the lateral cortex, with elbow extended to below 90º and with retraction of soft

tissue from the medial epicondyle.

**(b) Posterior intrafocal and lateral pinning:** A posterior K-wire is introduced. Its point of entry is the intersection of a line between the epicondyles and a vertical line at right angles to this, dropped from the lateral border of the olecranon.

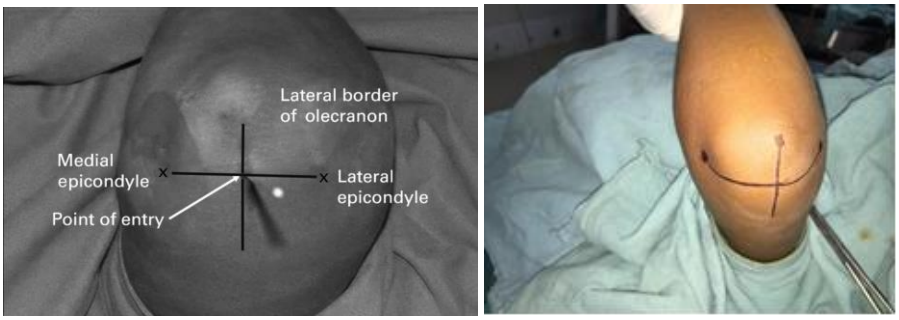



**Fig 1:** Entry point of posterior intrafocal pin

The wire should be parallel to the axis of the forearm and in line with the axis of humerus. The wire is then driven into the anterior cortex of the humerus.

The elbow is then extended to the limit allowed by the wire and the position is checked fluoroscopically. A second lateral K-wire is passed across the fracture from distal lateral to medial proximal to prevent rotation. An above-elbow POP slab is applied.

**Postoperative management and follow-up**

In both groups, check X-rays were done and a postoperative clinical examination for swelling, arterial injury, finger movements and nerve injury etc. done. In both groups, K-wires and slab were removed around 21st postoperative day and mobilization of the elbow started thereafter. Subsequent follow up were at 6 weeks, 3 months and 6 months. At every follow up clinical and radiological evaluation done.

Final Cosmetic and Functional Assessment was done according to the Criteria Laid down by Flynn *et al* (1974)

**Table 1:** Flynn's [11] cosmetic and functional factors and the outcome as described by Webb and Sherman and Boyd and Aronson5

| Grade | Cosmetic factor carrying angle loss (º) | Functional factor movement loss (º) | Outcome |
|---|---|---|---|
| Excellent | 0 to 5 | 0 to 5 | The lower of the two ratings and an elbow with a varus deformity is automatically graded as poor |
| Good | 6 to 10 | 6 to 10 | |
| Fair | 11 to 15 | 11 to 15 | |
| Poor | >15 | >15 | |

**Results**

**Table 2:** Neurovascular Injury in two groups

| Nerve Injury | | | | | | | |
|---|---|---|---|---|---|---|---|
| CPF | | | | PILPF | | | |
| Radial | Ulnar | Median | Total | Radial | Ulnar | Median | Total |
| - | 5 | 1 | 6 | - | - | 2 | 2 |

1 patient (1.19%) in CPF group and 2 patients (2.39%) in PILPF group were admitted with median nerve paraesthesia preoperatively. In all 3 cases nerve injury (in both groups) recovered completely and spontaneously during the follow up period. In 5 patients (5.95%) ulnar nerve paraesthesia developed in CPF group after pinning as we are not fully accustomed with the percutaneous pinning. Poor pin placement consequent upon severe swelling was also the cause of this complication. On the second postoperative day medial pin was removed and slab applied. All cases of nerve injuries recovered completely and spontaneously.

**Table 3:** Change in Baumann's Angle between Normal and Abnormal Side

| Change in Baumann's angle | CPR | | | PILPF | | |
|---|---|---|---|---|---|---|
| | Increase | Decrease | Total | Increase | Decrease | Total |
| Unchanged | 3 | - | 3 | 4 | - | 4 |
| <6 degree | 38 | 10 | 48 | 18 | 4 | 22 |
| 6-12 degree | 19 | 4 | 23 | 38 | 6 | 44 |
| >12 degree | 6 | - | 6 | 8 | - | 8 |
| CND | 4 | - | 4 | 6 | - | 6 |

In CPF most of patients, 51 cases (60.71%) had change in final Baumann's angle were below 6º. The mean Baumann's angle on normal side was 71.05º and injured side was 75.71º. In PILPF most of patients, 44 cases (52.38%) had change in final Baumann's angle were 6-12º. The mean Baumann's angle on normal side was 70.58º and on the injured side was 77.65º. There is an increase in Baumann's angle denotes varus change and tends towards unsatisfactory results.

**Table 4:** Distribution of Final Carrying Angle

| Carrying angle (in degrees) | No. of Cases | |
|---|---|---|
| | CPF | PILPF |
| <0 (varus) | 4 | 5 |
| 0-5 | 4 | 8 |
| 6-10 | 23 | 43 |
| 11-15 | 48 | 24 |
| >15 | 5 | 4 |

In CPF group 4 cases (4.76%) has carrying angle below 0º, which implies cubitus varus and constitute unsatisfactory results. Mean carrying angle on the injured side was 9.53º and normal side was 12.61º. In PILPF group 5 cases (5.95%) has carrying angle below 0º, which implies cubitus varus and constitutes unsatisfactory results. Mean carrying angle on the injured side was 8.11º and normal side was 13.16º.

Maximum number of cases in CPF group found in 11-15º which constitute 48 cases (57.14%). Maximum number of cases in PILPF group found in 6-10º which constitute 43 cases (51.19%).

**Table 5:** Change in Carrying Angle at Final Follow Up

| Change in final carrying angle (in degrees) | | CPF | PILPF |
|---|---|---|---|
| No change | | 7 | 5 |
| 1-5 | Varus | 42 | 23 |
| | Valgus | 12 | 9 |
| 6-10 | Varus | 15 | 32 |
| | Valgus | - | - |
| 11-15 | Varus | 4 | 10 |
| | Valgus | - | - |
| ≥16 | Varus | 4 | 5 |
| | Valgus | - | - |

Most patient, 42 cases (50%) had 1º to 5º varus changes in final carrying angle in CPF group and 32 patient (38.09%) had 6º to 10º varus changes in final carrying angle in PILPF group. In CPF group 4 cases (4.76%) and in PILPF group 5 cases (5.95%) showing a decrease in carrying angle >15º had cubitus varus constituted unsatisfactory results.

**Table 6:** Complication of Pin Fixation

| S. No. | Complication | CPF | PILPF |
|---|---|---|---|
| 1. | Superficial Pin Tract Infection | 7 | 5 |
| 2. | Significant varus deformity | 4 | 5 |
| 3. | Significant loss of range of movement | 4 | 6 |

**Table 7:** Flynn's Cosmetic & Functional Factors and Outcomes

| Grade | Cosmetic Factor (Carrying Angle Loss) | | Functional Factor (Loss of Movement) | |
|---|---|---|---|---|
| | CPF | PILPF | CPF | PILPF |
| Excellent (0-5º) | 61 (72.61%) | 37 (44.04%) | 48 (57.14%) | 40 (47.61%) |
| Good (6-10º) | 15 (17.85%) | 32 (38.09%) | 21 (25%) | 24 (28.57%) |
| Fair (11-15º) | 4 (4.76%) | 10 (11.90%) | 11 (13.09%) | 14 (16.66%) |
| Poor (>15º) | 4 (4.76%) | 5 (5.95%) | 4 (4.76%) | 6 (7.14%) |

**Final results for cosmetic factor according to flynn's criteria**

In CPF group results were excellent in 61 cases (72.61%) and good in 15 cases (17.85%) and poor in 4 cases (4.76%). In PILPF group results were excellent in 37 cases (44.04%) and good in 32 cases (38.09%) and results were poor in 5 cases (5.95%).

P value <0.05, statistically significant.

**Final results for functional factor (Movement loss) according to flynn's criteria.**

In CPF group results were excellent in 48 cases (57.14%) and good in 21 cases (25%) and results were poor in 4 cases (4.76%). In PILPF group results were excellent in 40 cases (47.61%) and good in 24 cases (28.57%) and results were poor in 6 cases (7.14%).

P value >0.05, statistically not significant.

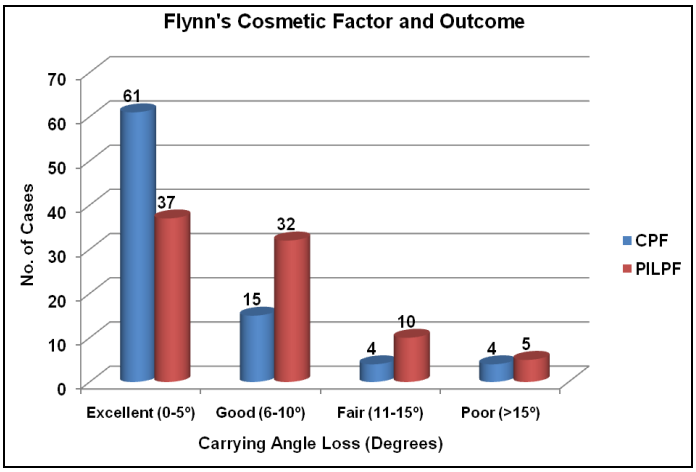



**Fig 2:** Carrying Angle loss

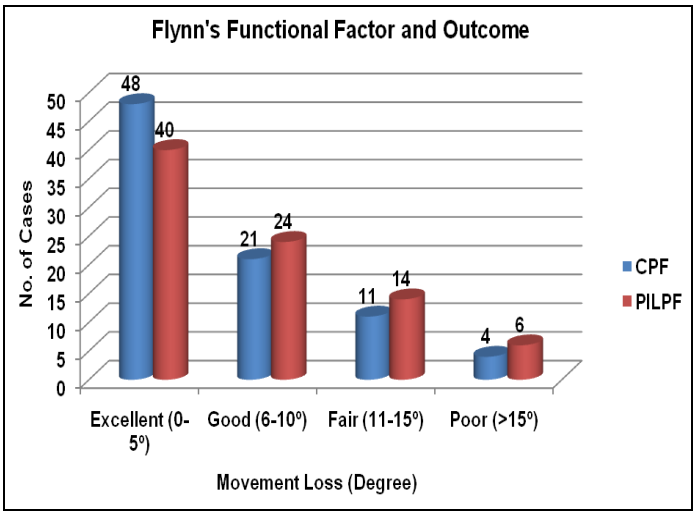
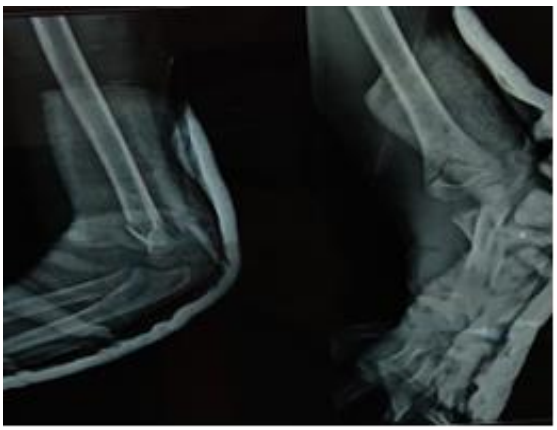



**Fig 3:** Movement Loss

**Preoperative X Ray (CPF Group)**

**Postoperative X Ray (CPF Group)**



**Preoperative X Ray (PILPF Group)**

**Postoperative X Ray (PILPF Group)**

**Discussion**

Close reduction and percutaneous pinning is the treatment of choice for displaced supracondylar fractures in children.

We found that most of the patients 131 (77.97%) were in the age group of 5-10 years. Overall mean age 6.82 ± 2.28 years, as the child is most susceptible for this fracture during this period. Males are more prone to sustain injury, 118 cases (70.23%) because they are more active than females. Majority of patients 103 cases (61.31%) had injury on left side (non dominant side). Majority of patients 135 cases (80.35%) sustain injury either due to fall from height or after falling on ground while playing. All the fractures were of extension type. Majority of patients, 110 cases (65.47%) had type III fracture with posteromedial displacement.

Patients treated by CPF, 70 cases (83.33%) and in PILPF group, 67 cases (79.76%) had a Baumann's angle of 80º or less in post reduction skiagram. In Both group all cases having post reduction Baumann's angle less than 80º had an excellent or good results. Worlock (1986) studied the relationship between the Baumann's angle and the carrying angle. He stated that as the Baumann's angle increases the carrying angle decreases, our study had similar findings. In the final follow up x-rays, 3 cases in CPF group and 4 cases in PILPF group had cubitus varus. We find significant change in mean value of change in Baumann's angle of abnormal side in both groups (p value was <0.05).

There were 5 cases (5.95%) of significant cubitus varus in PILPF and 4 cases (4.76%) in CPF. When post reduction x-rays of the cases with cubitus varus were reviewed, poor pin placement was noticed in all, because of comminution of the fracture site. No loss of range of movement were noted in 18 cases (21.42%) in CPF group and 20 cases (23.80%) in PILPF group. There was significant loss of range of movement at elbow (>15º loss) in 6 cases (7.14%) in PILPF group and 4 cases (4.76%) in CPF group. We conclude that patients, having change in carrying angle of more than 16º usually had poor prognosis.

The final outcome was decided according to criteria laid down by Flynn *et al* (1974). There was no significant difference (p value >0.05) in terms of loss of range of movement at elbow in both the groups and there was significant difference (p value <0.05) in terms of change in carrying angle at elbow in both the groups.

In our series 7 patients (8.33%) in CPF group and 5 (5.95%) patients in PILPF group had a superficial infection.

The advantage of CPF is probably greater fracture stability, although iatrogenic ulnar nerve injury (5 cases) in CPF group may result from placement of the medial pin. Conversely, the advantage of PILPF is easy, safe and avoidance of iatrogenic ulnar nerve injury. It avoid the medial route and possible injury to the ulnar nerve. The posterior wire allows three point fixation. It locks the distal fragment, converting the fracture to a type I injury.

In PILPF group the overall results were satisfactory in 94.04% cases and in CPF group the overall results were satisfactory in 95.23% cases, for the cosmetic factor. Final result for cosmetic factor according to flynn's criteria 72.61% cases have excellent results in CPF group while only 44.04% cases were excellent in PILPF group (p value <0.05) this difference is statistically significant.

In PILPF group the overall results were satisfactory in 92.85%

cases and in CPF group the overall results were satisfactory in 95.23% cases, for the functional factor. Final result for functional factor (movement loss) according to flynn's criteria 57.14% cases have excellent result in CPF group while 47.61% were excellent result in PILPF group (p value >0.05). This difference is statistically non-significant.

**Conclusion**

Cross pin fixation method is better than posterior intra focal with lateral pin fixation while considering biomechanical stability of construct, but posterior intrafocal method is safe. It avoids the risk of iatrogenic ulnar nerve injury which is a major concern while treating supracondylar fracture of humerus in children.

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