



# Study To Compare Clinoradiological Outcome of Two Lateral Pinning Versus Crossed Pinning in Displaced Supracondylar Fractures of The Humerus in Children

## KEYWORDS

Supracondylar fracture, Gartland Classification, Flynn, Matthews and Benoit, Webb and Sherman and Boyd and Aronson criteria.

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**ABSTRACT BACKGROUND:** Supracondylar fracture was described by Hippocrates during the third and fourth centuries A.D. The management of a child with displaced supracondylar fracture of humerus remains one of the difficult problems in Orthopaedics. Supracondylar fracture of humerus is the most common elbow fracture in children. 32,40 comprising 55% to 75% of all elbow fracture mostly in left or nondominant side in the age group of 5 to 10 years (30). The primary objective was to study the percutaneous pinning configuration to achieve better stability in the treatment of displaced supracondylar fractures in the children.

**METHODS:** 150 patients (divided by random sample technique) of 75 cross pinning & 75 two lateral pinning with K-wires in extension type of supracondylar fracture in children of <15 years classified by Gartland classification during April 2014 to December 2015 were compared for clinical and radiological outcome. The outcome was assessed according to the criteria of Flynn, Matthews and Benoit, Webb and Sherman and Boyd and Aronson. The minimum follow-up was for 6 months.

**RESULTS:** Assessed as per the criteria of Flynn, Matthews and Benoit, Webb and Sherman and Boyd and Aronson, results were excellent in 55 cases (73.33%) and good in 13 cases (17.33%) and results were poor in 4 cases (5.33%) in Cross Pinning group and excellent in 34 cases (45.33%) and good in 27 cases (36.00%) and poor in 4 cases (5.33%) in two Lateral pinning group.

In Cross Pinning group results were excellent in 43 cases (57.33%) and good in 19 cases (25.33%) and poor in 4 cases (5.34%) and in Two Lateral Pinning group results were excellent in 32 cases (42.66%) and good in 26 cases (34.60%) and results were poor in 5 cases (6.67%) for the cosmetic factor.

**CONCLUSION:** We conclude that cross pin fixation method is better than two lateral pin fixation while considering biomechanical stability of construct, but two lateral pinning group method is safe and away from the important structure around the elbow. It avoids the medial route and does not carry risk of iatrogenic ulnar nerve injury which is a major concern while treating supracondylar fracture of humerus in children.

## Introduction

Supracondylar fracture was described by Hippocrates during the third and fourth centuries A.D. The management of a child with displaced supracondylar fracture of humerus remains one of the difficult problems in Orthopaedics. Supracondylar fracture of humerus is the most common elbow fracture in children.<sup>1,2</sup> Peak age range in which most supracondylar fracture occurs in 5 to 6 years<sup>3</sup>. The fracture occur more often in Boys (62.8%) than in girls (Wilkins KE, 1991)<sup>4</sup>. The left or Nondominant side is most frequently injured (60.8%).

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. The incidence of cubitus varus varies with a maximum of 57% and an average of around 30% in most series.

The supracondylar fracture of humerus treated with closed reduction and cast application have poorest functional and cosmetic results (Pirone et al)<sup>5</sup>. D'Ambrosia (1972) reported 24% incidence of cubitus varus, Millis et al<sup>6</sup> reported redis-

placement and loss of reduction in 86% of patients, who were immobilized in less than 120° of Flexion.

The results of open reduction and internal fixation have varied, persistent elbow stiffness after open reduction has been reported. Weiland et al<sup>7</sup> reported a varus deformity in 25% and decreased range of motion (ROM) in 10% of the patients.

Avoidance of complications and achievement of excellent functional and cosmetic results are the goals of the treatment. In this regard percutaneous pinning seems to be useful and effective technique. Different configurations of placement of the Kirschner (K)-wires have been described using one medial and one or two lateral, or two or three lateral, placed parallel or divergent. In our series we compared the crossed pinning and Two lateral pinning with K-wires fixation of displaced supracondylar fractures mostly Gartland type 2 and results were analysed clinically as well as radiologically.

## Material and Methods

This study was done prospectively on the patients having extension type fractures of Gartland type II & III in the pa-

tients of <15 years admitted in the Department of Orthopaedics, SMS Medical College & Hospital, Jaipur during the April 2014 to December 2015 with an minimum follow up 6 months. Fractures with vascular injury /Impending VIC were excluded from the study.

This study involved two types of techniques for fixation of closed supracondylar fracture humerus in children in the total of 150 patients divided into two categories by Random Sample Technique:

Close Reduction and Two lateral pinning fixation method

Close reduction and Cross pin fixation method.

In Cross pin fixation method, after closed reduction, if the fracture was posteromedial, the medial pin and if the fracture was posterolateral, the lateral pin was inserted first to push the distal fragment laterally or medially respectively towards the proximal fragment.

Lateral pinning fixation method, 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. A second lateral K-wire is passed across the fracture from distal lateral to medial proximal to prevent rotation under image intensifier. An above-elbow POP slab is applied for three or four weeks.

#### Postoperative management and follow-up:

In the both category K-wires and slab were removed around twenty first 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 finding were recorded.

The final follow up, which were not to be less than 6 months in any case, a thorough clinical and radiological assessment were done. On the basis of these examinations, the final results were graded as excellent/good/fair/poor as per criteria laid down by Flynn et al, 1974.

Flynn's<sup>8</sup> cosmetic and functional factors and the outcome as described by Webb and Sherman and Boyd and Aronson<sup>9</sup>

Grade	Cosmetic factor carrying angle loss (°)	Functional factor movement loss (°)	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

150 patients with the mean age  $6.82 \pm 2.28$  years in both groups of Crossed pinning and Two lateral pinning were analysed finally at 6 months clinically by recording range of movements at elbow and forearm ( flexion, extension & supination, pronation) and radiologically by measuring Baumann's Angle and Metaphyseal - Diaphyseal Angle in both injured and uninjured side.

The most common mechanism of injury was fall on ground while playing(80%). Males (70% ) were more more com-

monly involved than females . Left side (62%) was more commonly injured than right side. Majority of patients, 96 cases (64%) had type III fracture with posteromedial displacement.

Type III fractures constitute 66 cases (88%) in the cross pinning group and 62 cases (82.66%) in two lateral pinning group.

In 5 patients (6.66%) ulnar nerve paraesthesia developed in Cross Pinning group after pinning. The ulnar nerve paraesthesia developed 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.

The Baumann's angle on the normal side was distributed between 64-78° in Cross Pinning group and between 66-76° in Two Lateral Pinning group. Mean angle for Cross Pinning group was 74.98 and the mean for Two Lateral Pinning group was 76.41.

The angle was taken to assess the reduction. In four cases of Cross Pinning group and 6 cases of Two Lateral Pinning group the Baumann's angle could not be drawn due to rounding of the capitular epiphysis or its overlap by the distal humeral metaphysis. These data should be analyse keeping in mind the fact that unlike the carrying angle, an increase in Baumann's angle denotes varus change and tends towards unsatisfactory results.

Most patients, 45 cases (60.00%) had metaphyseal - diaphyseal angle between 86°-90° in cross pinning group. Most patients, 34 cases (45.3%) had metaphyseal - diaphyseal angle between 86-90° and 31 cases (41.3%) between 81-85° in Two Lateral Pinning group. The angle could not be drawn in 4 cases in Cross Pinning group and 6 cases in two lateral pinning group due to Callus or rounding of Distal Humeral Metaphysis.

The metaphyseal - diaphyseal angle was taken to assess cosmetic and functional position of forearm in relation to arm.

No loss of range of movement were noted in 16 cases (21.3%) in Cross Pinning group and 18 cases (24.00%) in Two Lateral Pinning group.

Maximum loss of range of movement (>15° loss) were noted in 4 cases (5.33%) in cross pinning and 6 cases (7.14%) in two lateral pinning group.

In Cross Pinning group 4 cases (5.33%) has carrying angle below 0°, which implies cubitus varus and constitute unsatisfactory results. Mean carrying angle on the injured side was 9.53° and normal side was 12.61°.

In Two Lateral Pinning group 4 cases (5.33%) has carrying angle below 0°, which implies cubitus varus and constitutes unsatisfactory results. Mean carrying angle on the injured side was 8.11° and normal side was 13.16°. In Cross Pinning group the carrying angle was distributed between -7° to 17° on the injured side and between 9-18° on the normal side. In Two Lateral Pinning group the carrying angle was distributed between -8° to 22° on the injured side and between 9-18° on the normal side.

**Complication of Pin Fixation**

Complication	Two Lateral Pinning	Cross Pinning	Grand Total
Cubitus Varus	5	3	8
Ulnar nerve paresthesia	0	5	5
Infection	3	5	8
Loss of moment	4	6	10

**FINAL RESULTS FOR COSMETIC FACTOR ACCORDING TO FLYNN'S CRITERIA.**

In Cross Pinning group results were excellent in 43 cases (57.33%) and good in 19 cases (25.33%) and poor in 4 cases (5.34%).

In Two Lateral Pinning group results were excellent in 32 cases (42.66%) and good in 26 cases (34.60%) and results were poor in 5 cases (6.67%).

**FINAL RESULTS FOR FUNCTIONAL FACTOR (MOVEMENT LOSS) ACCORDING TO FLYNN'S CRITERIA.**

In Cross Pinning group results were excellent in 55 cases (73.33%) and good in 13 cases (17.33%) and results were poor in 4 cases (5.33%).

In Two Lateral Pinning group results were excellent in 34 cases (45.33%) and good in 27 cases (36.00%) and results were poor in 4 cases (5.33%).

**Discussion**

We did a randomized clinical study of 150 children of supracondylar fractures of humerus (extension type) and divided them in two groups consisting of two lateral pin fixation group and cross pin fixation group.

The advantage of medial and lateral entry pin fixation is probably greater fracture stability, although iatrogenic ulnar nerve injury may result from placement of the medial pin. The reported incidence of iatrogenic nerve injury from a pooled data is 3.3% (Brauer, 2007). Conversely, the advantage of two lateral pin fixation is avoidance of iatrogenic ulnar nerve injury.

All the fractures were of extension type. There was no flexion type of fracture. We classified fracture according to Gartland's classification (1959)<sup>10</sup>. Commonest type of fracture was type III (85.3%). This finding is comparable to Mitchell and Adams<sup>11</sup> series where 99% of the fractures were of extension type. Only 22 cases (14.67%) were type II. None of our cases was of type I fracture.

Only 1 case (1.3%) in CPF group and in 2 cases (2.6%) in two lateral pinning fixation group were admitted with nerve injury. We observed median nerve injury in both groups, which recovered fully during the follow up period after close reduction and internal fixation with K wires. This was comparable to incidence reported by Flynn J.C. (1973)<sup>9</sup> that commonly injured nerve was median nerve. Majority of iatrogenic nerve injury can be reduced with medial incision and extension of elbow during medial pin placement. Most of the injuries resolve after wound exploration and replacement of medial pin.

Baumann's (1929)<sup>12</sup> describes on angle formed between the lateral distal humeral epiphysis and long axis of humerus. Sandegard (1944)<sup>13</sup> stated this angle helps one rapidly and definitely divide whether or not displacement towards the axis is present.

In our series of patients treated by Cross pin fixation, 62 cases (82.66%) had a **Baumann's angle** of 80° or less in post reduction skiagram. In 4 cases the angle could not be drawn either due to rounding of the capitular epiphysis or overlap of the distal humeral metaphysis making the growth plate indistinct.

In two lateral pin fixation group 59 cases (78.6%) had a Baumann's angle of 80° or less in post reduction skiagram. In 6 cases the angle could not be drawn.

In Both group all cases having post reduction Baumann's angle less than 80° had an excellent or good results. Although excellent and good results were seen when post reduction Baumann's angle was more than 80°, poor results were just as common. These findings are similar to those of Williamson et al (1993) who also recorded excellent or good results in all patients who had a Baumann's angle of 80° or less at the time of reduction, 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 the changes in Baumann's angle was less than 6° in 45 cases (60%) in CPF group and 24 cases (32%) in two lateral pinning fixation group.

In our series of patients treated by CPF, 68 cases (90.67%) had **metaphyseal diaphyseal angle** ranging between 80°-90° in the post reduction x-rays as well as in final x-rays. In 4 cases the angle could not be drawn due to callus or rounding of distal humeral metaphysis.

In two lateral pin fixation group 65 cases (86.67%) had metaphyseal diaphyseal angle ranging between 80-90° in the post reduction x-rays as well as in final x-rays. In 6 cases the angle could not be drawn.

Angle of more than 90° indicates varus angulation. In our study 3 cases (4%) in CPF group and 5 cases (6.67%) in two lateral pinning fixation group had cubitus varus and out of them, 2 cases in CPF group and 4 cases in two lateral pin fixation group had metaphyseal diaphyseal angle more than 90° and in 4 cases of CPF group and 6 case of two lateral pinning fixation group the angle could not be drawn due to callus or rounding of distal humeral metaphysis.

In CPF group 43 cases (57.33%) had **carrying angle** between 11°-15° and 68 cases (90.62%) had carrying angle of 6° or more. The carrying angle on the normal side was distributed between 9°-18° with a mean of 12.61. Whereas on the injured side the mean was 9.53 with a range from -7° to 17°. 4 cases (4.76%) had carrying angle less than 0° which implies cubitus varus and constitutes unsatisfactory results.

In two lateral pinning fixation group 22 cases (29.33%) had carrying angle between 11 to 15° and 63 cases (84%) had carrying angle of 6° or more. The carrying angle on the normal side was distributed between 9°-18°, with a mean of 13.16. Whereas on the injured side the mean was 8.11 with a range from 8° to 22°. 5 cases (5.95%) had carrying angle less than 0° which implies cubitus varus and constitutes unsatisfactory results.

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.

Thus 4 cases (4.76%) in CPF, showing a decrease in carrying angle of 16 degrees or more had cubitus varus and had poor results. 5 cases (5.95%) in two lateral pinning fixation group showing a decrease in carrying angle 16 degrees had cubitus varus and had poor results. Thus we conclude that patients, having change in carrying angle of more than 16° usually had poor prognosis.

Most of patients [28 cases (37.33%)] in CPF group had 1-5° loss of movement as compared to normal side. 17 cases (22.66%) had full range of movement (no loss of movement). 3 cases (4%) had 6 to 10° loss of movement. 13 cases (17.33%) had 11-15° loss of movement. From this group only 4 cases (5.33%) had more than 15 degree loss of movement which is said to be correlating with poor outcome by Flynn.

In two lateral pinning fixation group 9 cases (12%) had full range of movement (no loss of movement), 11 cases (14.66%) had 1-5° loss of movement, 10 cases (13.33%) had 6-10° of movement, 27 cases (36%) had 11-15° loss of movement & 4 cases (5.33%) had >15° loss of movement. Thus only 4 (5.33%) cases had sufficient loss of movement correlates with poor outcome.

The final outcome was decided according to the criteria laid down by Flynn et al (1974).

**In CPF group, results for cosmetic factor (carrying angle loss)** was, 43 cases (57.33%) had excellent results and 9 cases (12%) had good results and 19 cases (25.33%) had fair results, 4 cases (5.33%) had poor results. The cause of poor results was cubitus varus.

In two lateral pinning fixation group results for cosmetic factor was 32 cases (42.66%) had excellent results and 12 cases (16%) had good results, 26 cases (34.60%) had fair results and 5 cases (6.67%) had poor results.

The results in our series are comparable to these in other series, in which the displaced supracondylar fracture of humerus was treated by percutaneous pinning.

**Clinical results compared with those of other series in the literature**

Treatment	Author	No. of cases	Cosmetic				Functional			Remarks	
			Ex	G	F	P	Ex	G	F		P
Lateral Pining	Boyd and Aronson <sup>7</sup>	71	68	3	0	0	60	7	3	1	-
	Mazda et al <sup>14</sup>	82	76	3	0	3	77	5	0	0	-
	Foead et al <sup>15</sup>	27	22	2	1	2	16	6	1	4	Functional for extension loss
Crossed wired	Foead et al <sup>15</sup>	28	21	4	2	1	14	7	3	4	Functional for extension loss
	Flynn et al <sup>8</sup>	52	42	7	2	1	-	-	-	-	Cosmetic and functional outcome for total cases
	Mehserle and Meehan <sup>16</sup>	33	23	7	1	2	-	-	-	-	Cosmetic and functional outcome for total cases

The final outcome was decided according to criteria laid down by Flynn et al (1974). There was 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.

Lateral pinning entry easy safe and away from the important structures around the elbow. It avoid the medial route and possible injury to the ulnar nerve.

In our series 5 patients (6.67%) in the cross wire group and 3 (4%) patients in two lateral pinning fixation group had a superficial infection

**Conclusion**

We found that most of the patients 74% are in the age group of 5-10 years. Most of them are boys (70%). The left side (62%) was involved in most cases.

There were 5 cases (6%) of significant cubitus varus in two lateral pinning group and lateral pin fixation and 3 cases (4%) in cross pin fixation.

There was significant loss of range of movement at elbow in 4 cases (5.33%) in two lateral pinning group with lateral pin fixation group and 4 cases (5.33%) in cross pin fixation group.

There are 5 cases of iatrogenic nerve injury in CPF group.

In the two lateral pinning group with lateral pin fixation group the overall results were satisfactory in 93.33% cases and in the cross pin fixation group the overall results were satisfactory in 94.66% cases, for the cosmetic factor.

Final result for cosmetic factor according to Flynn's criteria 57.33% cases have excellent results in CPF group while only 49.33% cases were excellent in two lateral pinning fixation group (**p value <0.05**) **this difference is statistically significant.**

Final result for functional factor (movement loss) according to Flynn's criteria 73.33% cases have excellent result in CPF group while 45.33% were excellent result in two lateral pinning fixation group (**p value <0.05**). **This difference is statistically significant.**

We find significant change in mean value of change in Baumann's angle of abnormal side in both groups (p value was <0.05).

Finally we conclude that cross pin fixation method is better than two lateral pin fixation while considering biomechanical stability of construct, but two lateral pinning group method is safe and away from the important structure around the elbow. It avoids the medial route and does not carry risk of iatrogenic ulnar nerve injury which is a major concern while treating supracondylar fracture of humerus in children.

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