

Displaced Supracondylar Humeral Fractures In Children- Treatment Outcomes Following Closed Reduction And Percutaneous Pinning

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Citation

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Abstract

PurposeThe purpose of the study was to know the treatment outcomes following fixation of displaced supracondylar fractures by closed reduction and percutaneous pinning.
MethodsA prospective study based on 30 cases with type III Gartland fracture managed by crossed percutaneous pinning was conducted at our institute over a period of two years. 20 (67%) children were males and 10(33%) were females from an age of 2 to 13 years with a mean age of 7.06 years. The patients were followed till an average period of 24 weeks. Patients were assessed both radiologically for union and functionally using Flynn's criteria.
ResultsUsing Flynn's criterion, 97% of our cases had a satisfactory result with only one case with a poor result. Special emphasis was also given to assessment of Baumann's angle at the time of post reduction and post union and the results compared using Pearsons correlation which was found to be significant
ConclusionThe results obtained following percutaneous pinning showed that this method is safe, effective, with good functional and cosmetic results and more convenient for the patient with a shorter hospital stay. A modification of Flynn's criteria is also suggested.

INTRODUCTION

Supracondylar fractures of the humerus are amongst the commonest fractures accounting for 60% of the fractures around the elbow in children [1]. Supracondylar fractures were described in the writings of Hippocrates during the 3rd and 4th century A.D. Most of the discussion during the 1700s and 1800s was directed towards the controversy regarding the correct position of immobilization. At the beginning of the 20th century, treatment began to change from simple passive methods to more aggressive and active methods.

Classically these injuries are divided into 'extension' and 'flexion' types as observed by Wilkins while reviewing 4520 cases in 31 major series [2]. Extension types are the most common accounting for 90-98% of the fractures. The supracondylar fractures have been classified time after time by many authors. Presently most widely accepted classification is the Gartland classification [3]. Type III Gartland is a widely displaced fracture. There is no cortical contact between the fracture fragments. Generally medial displacement of the distal fragment is more common than

lateral displacement.

Closed reduction and percutaneous pinning is now the universally accepted treatment for displaced supracondylar fractures, though different methods of accomplishing the procedure have evolved over time. We used the classic technique of placing the crossed percutaneous pins to fix the fracture.

MATERIALS AND METHODS

This was a prospective study done from January 2007 to December 2008 in our institute which is a tertiary care orthopaedic hospital. The patients of 2 years to 13 years were chosen who had a closed Gartland type III extension type supracondylar fracture. All the patients who with multiple injuries, head injuries, deformed and absent opposite limbs were excluded. Besides fractures more than 1 week old and patients with a history of previous pathologies in the ipsilateral limb were also not included in the study.

After taking a written and informed consent and proper preparation of the patient for the surgery, closed reduction

was performed under general anaesthesia by applying longitudinal traction. After achieving a satisfactory reduction under image intensifier, the distal fragment was secured to the shaft by two k wires of 1 to 1.25mm diameter placed percutaneously through the medial and lateral epicondyles. The ulnar nerve was protected by milking the swelling and by giving an incision if needed. The extremity was externally rotated for the posteromedially displaced fractures and pin was passed through the medial epicondyle first followed by internal rotation and placement of lateral pin. We tried to keep pin placement at an angle of 40 degrees superiorly and 10 degrees posteriorly and the pins crossed each other 2 to 2.5cm above the fracture. The elbow was gently extended and compared to the contralateral elbow on the image intensifier. If the radiographic appearance, carrying angle (Bauman's angle), angle of inclination (Humero capitellar) and pin placement were satisfactory (in most of our cases we accepted reduction within 5 degrees of the normal limb), the pins were bent and cut off outside the skin for easy removal on outpatient basis. If the circulation was doubtful, the elbow was extended to a position where the circulation was maximum. The elbow was generously padded and posterior plaster splint applied to allow palpation of radial pulse. The patients were monitored for 48 hours in terms of distal neurovascular status.

A total of 30 patients (TABLE I- Master chart) were taken with type III Gartland extension type supracondylar fracture for the closed reduction and percutaneous pinning as mentioned above. 20 (67%) children were males and 10(33%) were females. The non dominant side was involved in 18 cases (60%) and in 12 cases (40%) right side was involved. The age distribution of the patients is shown in table II. Maximum number of patients was in the age group of 6 to 9 years (60%). Mean age of the patients was 7.06 years. The mechanism of injury in 20 cases (66.7 %) was because of fall while playing, in 7 cases (23.3%) trauma was caused because of fall from height and in 3 cases (10%) it was because of road traffic accidents. Regarding fracture displacement, 22 cases (73%) had posteromedial displacement and 8 cases (27%) had posterolateral displacement.

In our series of 30 cases, 3 patients had an associated neurological involvement out of which two had median nerve involvement (posterolateral displacement) and one patient had radial nerve involvement (posteromedial displacement). All these patients recovered within a time

period of two to three months. Out of thirty cases only 5 patients had an absence of pre reduction radial pulse. All the cases including these 5 cases had a good capillary refill with normal skin color and temperature. Majority of cases were intervened between 1 to 3 days of trauma and most of our cases took an average time of 30 to 40 minutes to operate. Average hospital stay was 4.5 days in the majority of cases. Follow up was done at 1st, 3rd, 6th, 12th and 24th weeks. During these visits assessment of carrying angle and range of motion were made and recorded. Final assessment was made as per the Flynn's criteria (table III). The overall rating in those patients who had changes both in carrying angle and in function was made on the basis of the greater clinical loss, that is, a good functional rating and a fair cosmetic rating resulted in a fair rating. Any patient with reversal of the clinical carrying angle was considered to have a poor result.

RESULTS

Earliest evidence of union with periosteal new bone formation in both anteroposterior and lateral views was seen in 26 cases (87%) as early as 3 weeks (figure 1 and 2), while the remaining 4 cases (13%) showed evidence of periosteal new bone formation at 4 weeks. All the thirty cases under our observation had a complete radiological union by the end of six weeks.

Bauman's angle was compared at immediate post reduction and post union and it was found that 25 cases (83%) had a change in their Bauman's angle of 0 to 2 degrees, 3 cases (10%) had a change of 3 to 4 degrees in the angles and two cases (07%) had ≥ 5 degrees change in the Bauman's angle at union. By applying pearson correlation , the statistical correlation of radiological measurement of Bauman's angle measured at immediate post reduction and at union showed significant relationship ($p=0.01$) indicating maintenance of reduction achieved at surgery. Similarly we observed that 27 cases (91%) had 0-5 degrees change in their clinical carrying angles, 1 case had 6-10 degrees change, another 2 showed a change of 11 to 15 degrees and 1 case had more than 15 degrees change in the clinical carrying angle.

Range of motion in the fractured elbow was compared with the contralateral side. It was observed that range of motion progressively improved over a period of time from a restricted range of motion of 20 degrees to 35 degrees at 6 weeks in majority of patients to full range of motion in 11 patients, 5 degrees restricted motion in 8 cases, 10 degrees in 3, 15 degrees in 2 cases and 20 degrees of restriction in one case at 24 weeks when final assessment was done.

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In our study, 6 patients had restriction of motion in a range of ≥ 10 degrees, 4 patients had pin track infection which resolved by giving antibiotics and premature removal of pins at 2 weeks in two cases, 3 patients had post pin insertion ulnar nerve palsy which showed complete recovery by 4 months, 1 patients had cubitus varus deformity and 1 patient had cubitus rectus deformity. Though all cases had their carrying angle altered, the change was negligible in most of the case. The case with cubitus varus deformity had only 6 degrees valgus angle on the normal sides making them susceptible to this deformity. The case with cubitus rectus deformity, we had removed the pins earlier due to severe pin tract infection and we may correlate this deformity to his premature pin removal with loss of reduction in healing period. Final results according to Flynn's criteria are shown in table IV. Majority of our cases had an excellent result and only one patient had a poor result (figure3).

Figure 1

Figure 1- Pre op Photograph

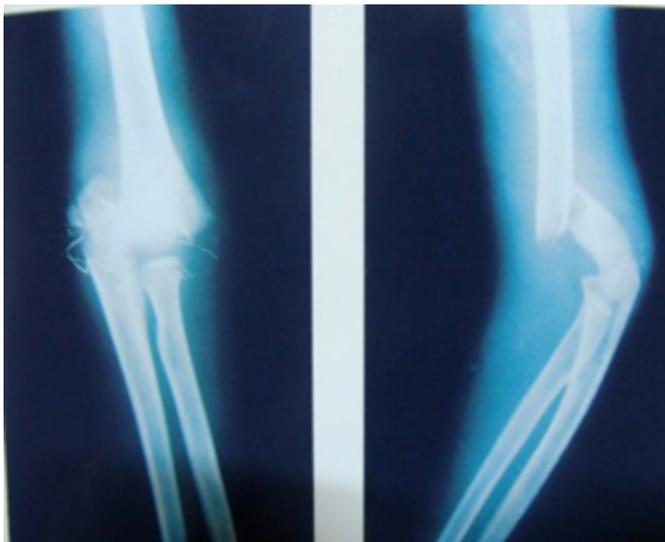


Figure 2

Figure 2- Post op Photo graph



Figure 3

Figure 3- At the time of union



Figure 4

MASTERCHART (TABLE-I)

Case No.	age	sex	side	Diagn.	Neuro	Bauman's angle			C.A. [C.A. (F,U)]	Range of motion			Hospit. Stay	Anesth. time	Complications	Results		
						BA (N)	BA (P,R)	BA (F,U)		FLX (N)	FLX (inj)	EXT (N)					EXT (inj)	
1	10	M	L	PL		15	16	15	16	8	148	135	10	12	2 Days	30 min		E
2	6	M	L	PM		8	8	10	4	6	145	145	8	8	1	30	PTI	E
3	2	F	R	PM		13	14	13	13	9	135	135	7	7	3	25	ULN Palsy	E
4	9	M	R	PL		12	17	17	6	7	148	148	8	8	2	30		E
5	5	F	R	PM	RNP	25	20	20	15	13	142	132	7	10	1	27	Stiff elbow	G
6	6	F	R	PM		29	26	26	17	15	145	5-145	9	-5	4	30	Stiff elbow	F
7	5	F	L	PM		19	19	19	11	11	140	140	10	10	2	36		E
8	11	M	R	PM		26	25	26	16	17	143	5-141	6	6	2	35	PTI	E
9	7	M	L	PM		20	15	15	12	11	145	138	10	10	2	25		E
10	8	M	R	PL	MNP	8	8	8	3	3	141	130	9	12	8	50	ULN Palsy	E
11	9	M	R	PM		12	7	6	5	2	148	138	8	10	3	35	PTI	E
12	10	M	L	PM		18	17	12	9	6	145	150	7	5	4	30		E
13	7	F	L	PM		11	6	3	6	8	138	125	6	6	5	40	Cubitus rectus	G
14	8	M	R	PL		24	25	24	15	15	135	135	9	9	6	35		E
15	4	F	R	PM		14	12	12	10	9	148	140	8	8	4	30	Stiff Elbow	E
16	9	M	R	PM		20	23	23	14	2	148	125	7	12	2	30	Stiff elbow	F
17	8	M	L	PL		15	16	18	10	12	138	138	10	10	5	38		E
18	5	F	L	PM		15	12	12	11	10	138	135	8	6	4	30		E
19	6	M	L	PM		8	2	-8	17	16	144	144	9	8	8	55		E
20	4	M	L	PL		22	23	24	12	13	148	130	8	10	5	28		G
21	6	F	L	PL		12	12	12	7	8	135	130	7	9	3	40	Stiff Elbow	E
22	7	M	R	PM		26	23	19	15	12	138	138	6	6	4	25		E
23	3	M	R	PL		13	14	7	6	5	125	127	8	8	5	40		E
24	6	M	L	PM		16	11	10	10	8	148	138	7	7	2	30		E
25	9	M	L	PM		15	10	7	7	8	135	135	9	9	4	25		E
26	5	F	R	PM		28	26	26	4	-16	145	125	5	12	6	36	Stiff Elbow, Cubitus varus	P
27	3	F	L	PM		14	14	13	11	12	148	141	8	8	2	30		E
28	9	M	L	PM		16	12	12	12	11	148	144	8	6	1	35	ULN PALSIV	E
29	8	M	L	PM		12	11	10	6	5	138	132	7	7	3	25	PTI	E
30	7	M	L	PM		20	24	24	13	12	125	130	9	7	4	30		E

BA-Baumann's angle, CA- Carrying Angle, PR-Post reduction, PU-Post Union, RNP- Radial nerve palsy, MNP-Median nerve palsy

ULN-Ulnar nerve, PTI-pin track infection, (N)-normal, (inj)-injured limb, E-Excellent, G-Good, F-Fair, P-Poor

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Figure 5

Age Distribution of patients Table II

Serial number	Age group	Number of cases	Percentage
01	02-05	09	30
02	06-09	18	60
03	10-13	03	10

Figure 6

Flynn's criteria TABLE III

Result	Rating	Cosmetic Factor Loss of carrying angle in degrees	Functional Factor Motion Loss in Degrees
Satisfactory	Excellent	0-5	0-5
	Good	6-10	6-10
	Fair	11-15	11-15
Unsatisfactory	Poor	>15	>15

Figure 7

Final result according to Flynn Criteria Table IV

Result	Rating	Number of patients	Percentage
Satisfactory	Excellent (0-5)	24	80
	Good (6-10)	03	10
	Fair (11-15)	02	07
Unsatisfactory	Poor >15	01	03

Figure 8

Final results in comparison with other studies Table V

Study	J.C.Flynn ⁴ (1974)	A.J.Webb ²⁵ (1989)	W.L. Mehserle ²⁶ (1991)	Present Study
Number of patients	52	35	33	30
Excellent	42(81%)	20(57%)	23(70%)	24(80%)
Good	07(13%)	08(23%)	07(21%)	03(10%)
Fair	02(04%)	02(6%)	01(04%)	02(07%)
Poor	01(02%)	05(14%)	02(06%)	01(03%)

Figure 9

Our modification of Flynn's Criteria Table VI

Result	Rating	Cosmetic Factor (Loss of carrying angle in Degrees)	Functional Factor (Motion Loss in Degrees)	Neurological factor (post pin insertion nerve palsy, ulnar or radial persisting beyond 6 months)
Satisfactory	Excellent	0-5	0-5	Not present
	Good	6-10	6-10	
	Fair	11-15	11-15	
Unsatisfactory	Poor	>15	>15	Present

DISCUSSION

Supracondylar fractures are the most common injuries around the elbow and usually occur in the first decade of life [1].

The management of displaced supracondylar fractures of the elbow is one of the most difficult of the many fractures seen

in children. Much concern has been expressed over the maintenance of fracture reduction and of adequate circulation to the limb. Although good functional results are reported using closed reduction with cast application [5, 6], Dunlop traction [7], overhead skeletal traction [5, 8-12] open reduction with internal fixation [5, 8, 13-15] the cosmetic deformity of cubitus varus remains the most common determinant of unsatisfactory result. The disadvantages of closed reduction with cast application are loss of reduction requiring repeated manipulation leading to elbow stiffness, high incidence of cubitus varus deformity and the danger of compartment syndrome that can remain unnoticed under the cast. Disadvantage of skeletal traction include elbow stiffness, pin tract infection, prolonged hospital stay, higher incidence of recurvatum of the elbow. The drawbacks of open reduction and internal fixation are need for extensive surgery, soft tissue damage, infection, persistent elbow stiffness and myositis ossificans. Displaced supracondylar fractures of the humerus managed by closed reduction and percutaneous pinning have demonstrated improved results since its introduction by 'Swenson' for the first time in 1948 [16] and later popularized by 'Flynn' [4] and others [17-19] and have several advantages over other methods. The main disadvantage of closed reduction and percutaneous pinning is injury to ulnar nerve with a reported incidence of 2-8% and can be avoided by judicious placement of pin and good post operative pin site care [20-23]. Arino et al. [17] recommended inserting the two wires through the lateral epicondyles to avoid ulnar nerve injury. Biomechanically this is a less secure fixation which may allow rotation of the fracture. There is another technique introduced by Dorgans in which two lateral crossed percutaneous k wires are put in to avoid ulnar nerve injury [24]. In our study, we have used the classic technique of percutaneous fixation.

Final results according to Flynn criteria in comparison with other studies are shown in table V [4, 25, 26]. As shown in the table, operative treatment of supracondylar fractures by closed reduction and percutaneous pinning has yielded excellent result in 57- 81% patients, good result in 13-23%, fair result in 03-06% and poor result in 02-14% of patients. In present study we achieved excellent result in 80% of cases, good result in 10% cases, fair result in 07%, and poor result in 3% of cases. This particular case with poor result had reported late and developed frank pin tract infection necessitating premature pin removal.

In our study, we observed an average flexion of 132 degrees

(125- 145 degrees) and extension of average -8.3 degrees with a range of (-12 to 6 degrees) at the time of final assessment. This observation of ours is similar to the findings of others like Boyd et al [27] and Mehserle [26] .

We had an average loss of reduction of 1 degree in the Baumann's angle from immediate post operative to post union time. The observation of ours as regards to the clinical carrying angle and the deformities in terms of varus and valgus is also in conformity to others like Boyd [27] and Mehserle [26].

Though Flynn's criteria [4] are time tested, but authors feel that a slight modification should be done to it to make it more universally acceptable and result oriented. As described previously, Flynn's criteria include two factors, 'cosmetic factor' (loss of carrying angle) and 'Functional factor' (motion loss in degrees). Authors propose that another factor 'Neurological factor' should be added to the criteria set by Flynn and et al as shown in table VI. The description of neurological factor is that if a patient develops post pin insertion ulnar or radial nerve palsy and which persists beyond 6 months, the result should be declared unsatisfactory or poor despite satisfactory cosmetic or functional results. This is because a patient who has persistent ulnar clawing with excellent cosmetic results at elbow and an excellent range of motion after surgical intervention cannot be called to have an excellent result for obvious reason of having a clawed hand.

CONCLUSION

The results obtained following percutaneous pinning of displaced supracondylar fracture show that this method is safe, effective, with good functional and cosmetic results and more convenient for the patient with a shorter hospital stay.

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