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Prospective observational study of pediatric supracondylar humerus fractures operated with closed reduction and k wire fixation

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Abstract

Aim: To evaluate the cases of pediatric supracondylar humerus fractures operated with closed reduction and k wire fixation.

Methods: A prospective study was conducted in the Department of Orthopaedics, Netaji Subhas Medical College and Hospital, Patna, Bihar, India, June 2018 to July 2019. Total 32 children's with displaced supracondylar fracture of Humerus in aged between 2-14yrs. Type II and III fractures were included in this study. These patients were treated by closed reduction of fracture and percutaneous fixation with K-wire under C-arm guidance. The outcome was assessed clinically by Flynn's criteria and radiologically by Skaggs's criteria.

Result: among 32 patients, 24 were male and 8 were female. The fracture was extension type in all 32 patients. Left side was involved in 23 patients and right side in 9 cases. The average age was 9.1 yrs. 23 patients presented within 24 hrs and 9 patients between 2 to 5 days. Based on Gartland classification 7 patients had type-II and 25 patients had type III pattern. The mode of violence was fall during play in the ground 28 patients and fall from height or bicycle in 4 patients. Complications were noted in 5 patients, 3 with radial nerve injury, 2 with median nerve injury. As per Flynn Criteria 23 were excellent, 6 Good, 2 were fair and 1 remained poor. 2 Patients developed myositis ossificans and both had restriction of elbow flexion and extension and graded fair. 5 patients reported pin tract infection.

Conclusion: Closed reduction and percutaneous K-wire fixation is an effective treatment for displaced supracondylar fractures of Humerus in pediatric age group.

Keywords: Closed reduction, percutaneous fixation, supracondylar fracture of humerus

Introduction

Supracondylar humerus fracture is the most common elbow fracture in children. They account for 55% to 70% of all elbow fractures and are seen most frequently in children between the ages of 3 and 10 years^[1]. The chances of residual deformity and that for rare but devastating neurovascular complications make supracondylar humerus fractures a dreaded injury. Over time, we have advanced from the conservative approach to an operative approach with closed reduction percutaneous pinning as the acceptable mode of treatment. The current standard treatment for displaced supracondylar humerus fracture is closed reduction and percutaneous pinning. This method has consistently given excellent results reported by various authors. However, controversy still exists regarding which pin fixation is the best in terms of stability and iatrogenic ulnar nerve injury. Medial and lateral pin fixation has been presumed to be more stable, however it has the risk of iatrogenic ulnar nerve injury. Lateral only pinning is riddled with issue of lesser torsional stability but avoiding neurological complications. Recently 'trans-olecranon fossa-four cortex purchase (TOF-FCP)' pin fixation technique has reports of having better torsional stability than conventional LOP and retaining its fewer complications^[2]. The Gartland type 3 displaced and many of the type 2 supracondylar fractures are stabilized with Kirschner (K) wire fixation after reduction^[3,4]. The stability after fracture fixation has been the subject of much debate in the past^[5]. The quality of reduction, configuration of wire fixation, i.e. crossed or parallel, timing of surgery, medial or lateral entry

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for placement of pin, number of pins, and more recently fracture configuration and the inherent instability of the fracture pattern have all been considered as important factors contributing to the stability of fixation [5-9]. The technical errors play an important role in the final outcome [8, 9]. Some centers have guidelines on how to pin these injuries, and very often the fracture pattern is not taken into account even though some patterns are considered more unstable than others and deemed to require specific methods of fixation [5]. While there are many articles dealing with various aspects of supracondylar fracture stability after fixation, there is very little written about the role of the fracture pattern and its effect on the stability of reduction [6]. This prospective study was undertaken to evaluate the causes of loss of reduction in cases of pediatric supracondylar humerus fractures operated with closed reduction and k wire fixation.

Material and methods

A prospective study was conducted in the Department of Orthopaedics, Netaji Subhas Medical College and Hospital, Patna, Bihar, India, June 2018 to July 2019, after taking the approval of the protocol review committee and institutional ethics committee. After taking informed consent detailed history was taken from the patient or the relatives if the patient was not in good condition. The technique, risks, benefits, results and associated complications of the procedure were discussed with all patients.

Total 32 children's with displaced supracondylar fracture of Humerus in aged between 2-14yrs. Any associated neurovascular injuries, fractures, compartment syndrome were noted. Radiograph of the elbow was taken in Antero-posterior and lateral views. The diagnosis was confirmed by radiological examination. The fractures were classified according to Gartland's classification. All patients were taken up for surgery as soon as possible after necessary routine preoperative hematological investigation.

Gartland's classification

- Type-I Non-displaced
 - Type-II Minimally displaced with intact posterior cortex
 - Type-III Completely displaced with no cortical contact
1. Postero-medial
 2. Postero-lateral

Inclusion criteria

- Type II and III fractures

Exclusion criteria

- Type I fractures
- Compound fractures
- Associated fractures of ipsilateral upper extremity

The patients were laid supine on the operating table. The C-Arm image intensifier was placed at the head end of the table. Under general anesthesia, the part was prepared with antiseptic lotion and draped properly. The fracture reduction

was done by applying traction and counter traction for 2-3 minutes, with the elbow held in 20° flexion and forearm in supination. Once the fragments were disengaged, medio-lateral displacement and tilting are corrected. Then posterior displacement and tilt was corrected by controlled flexion at elbow with fingers controlling the lower part of Humerus and thumb pushing the distal fragment anteriorly. Radial pulsation and nail bed capillary filling after blanching was verified. Reduction was confirmed by AP, lateral and oblique views by rotating the C-Arm but not the limb. After satisfactory reduction, the fracture was stabilized with two 1mm to 2 mm K-wires depending on the age and bulk of arm of each patient. These pins were introduced from lateral to medial direction. In parallel or divergent configuration getting hold in both medial and lateral metaphysis of the proximal fragment. After satisfactory fixation, the K-wires were bend and cut, protruding through the skin. Antiseptic dressing was done and posterior long arm Slab support was applied with the elbow in 90° flexion and forearm in supination or pronation depending upon the initial displacement, usually supination. Patients were discharged from hospital on second postoperative day. Regular follow up was done at 1 week, 3 week and 5 week postoperatively. Posterior plaster slab was removed at 3 weeks and range of motion exercises started. K-wires were removed at 5 weeks. There after patients were followed at 8th week, 12th week and then after every 3 month. Radiological evaluation were done immediately after surgery and at 3, 5, 8 and 12th week. Clinical assessment was done according to Flynn criteria. Radiological assessment was made by assessing the Baumann's angle in the first and final X-rays. Displacement of 12° was graded as major, 6 to 12° as mild and less than 6° as no displacement as described by Skaggs.

Result

In this study 32 patients were taken up. 24 were male and 8 were female. The fracture was extension type in 32 patients. Left side was involved in 23 patients and right side in 9 cases. The age distribution was from 2 to 14 years with maximum patients in the 2 to 7 years of age group, the average age was 9.1 yrs. The presentation varied from few hours to 5.3 days post injury. 23 patients presented within 24 hrs and 9 patients between 2 to 5 days. Based on Gartland classification 7 patients had type-II and 25 patients had type III pattern. The mode of violence was fall during play in the ground 28 patients and fall from height or bicycle in 4 patients. Complications were noted in 5 patients, 3 with radial nerve injury, 2 with median nerve injury. As per Flynn Criteria 23 were excellent, 6 Good, 2 were fair and 1 remained poor. Results in our study were excellent in terms of carrying angle and functional outcome with attainment of full range of motion. 2 Patients developed myositis ossificans and both had restriction of elbow flexion and extension and graded fair. 5 patients reported pin tract infection. None had post-operative neurovascular compromise. Union was achieved without any serious complication. Patients with pre-manipulation nerve deficit recovered fully.

Table 1: Flynn Criteria

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

Table 2: Demographic profile of the patients

Gender	Number of patients	Percentage
Male	24	75
Female	8	25
Age in years		
Below 7 years	23	71.87
8-14 years	9	28.13
Side involvements		
Left side	23	71.87
Right side	9	28.13
Mode of injury		
Fall during play	28	87.5
Fall from height or bicycle	4	12.5

Table 3: Distribution of fractures

Fractures	Number of patients	Percentage
Type II	7	21.87
Type III	25	78.13

Table 4: Pre-operative complications

Pre-operative complications	Number of patients	Percentage
Radial nerve palsy	3	9.37
Median nerve palsy	2	6.25

Table 5: Post-op complications

Post-op complications	Number of patients	Percentage
Pin tract infection	5	15.63
Myositis ossificans	2	6.25

Table 6: Functional Outcome

Functional Outcome	Number of patients	Percentage
Excellent	23	71.87
Good	6	18.75
Fair	2	6.25
Poor	1	3.13

Table 7: Variables Associated With Loss of Reduction among All Patients Treated for Supracondylar Humerus Fractures (N = 32)

Variable	Loss of Reduction (n = 5)	No Loss of Reduction (n = 27)	P
Age	6.2 ± 2.6	5.8 ± 2.2	0.39
Sex			0.74
Male	3 (60)	21 (77.78)	
Female	2 (40)	6 (22.22)	
Fracture type			0.77
Type II	2 (40)	5 (18.52)	
Type III	3 (60)	22 (81.48)	
Injury type			0.99
Flexion	0	1 (3.70)	
Extension	5 (100)	26 (96.30)	
Relation to fossa			0.76
At	4 (80)	25 (92.59)	
Above	1 (20)	2 (7.41)	
No. pins used			0.88
2	3 (60)	12 (44.44)	
3	1 (20)	14 (51.85)	
4	1 (20)	1 (3.71)	
Pin placement			0.92
Divergent	3 (60)	10 (37.04)	
Convergent	0	1 (3.71)	
Parallel	0	2 (7.41)	
NA	2 (40)	14 (51.85)	
Comminution	0	2 (7.41)	0.91
Bicortical	5 (100)	27 (100)	0.93
Medial pin	1 (20)	5 (18.52)	0.37
AP view pin spread (mm)	9.1 ± 3.87	12.9 ± 4.33	0.01
AP view pin spread (% of humerus size)	27 ± 8	36 ± 11	0.05
AP view pin height (mm)	38.3 ± 11.7	35.3 ± 11.3	0.49

Discussion

The treatment of supracondylar fracture of Humerus in children is quiet challenging. These fractures are very common in children between 5 to 10 years of age as reported in studies by Ziontes LE *et al.* [10]. In the present study, the average age was 9.1 years similar to other studies. The incidence of this type of fracture is reported to be more in boys than girls. In the present study, 24(75%) were male patients and 8 (25%) were female. Supracondylar fractures result from a fall on an outstretched hand in up to 70% of patients [11]. 4(12.5%) patients had fall from height and 28(87.5%) had fall while playing. The non-dominant extremity was most commonly affected. In the present study, 23 (71.87 %) had left sided injury and 9 (28.13%) of them had right sided injury. Based on Gartland's classification, 7 (21.87%) patients had Type II fracture and 25(78.13%) had Type III fracture. The average time for maximum recovery of

movement was 14.06 weeks for type II fracture and 18.2 weeks for type III fractures. 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 was safe and effective for both Gartland type II and type III fractures, moreover it prevented iatrogenic injury to ulnar nerve. They did not recommend routine use of crossed pins and if at all medial pin was used, the elbow should not be hyper flexed during its insertion [12]. Boyd *et al.* preferred crossed medial and lateral pins and reported that out of 71 patients, 70 cases had satisfactory result and only 1 case had ulnar nerve palsy. [11] 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. Ring D *et al.* [10] found two cases with compartment syndrome following closed reduction

and cast immobilization [13]. In this study no cases of compartment syndrome was detected. In our study the complications were noted in 5 patients, 3 with radial nerve injury, 2 with median nerve injury. As per Flynn Criteria 23 were excellent, 6 Good, 2 were fair and 1 remained poor. Our results match with Williamson DM *et al.* who managed the supracondylar fracture by traction, manipulation, reduction and percutaneous pinning (PCP) [14] and with Harrington P *et al.* who observed 83% good to excellent results [15]. The incidence of deep infection and osteomyelitis was very low as reported by Mostafavi HR *et al.* and Gupta N *et al.* [16, 17] In our study 5 patients had superficial Pin tract infection which resolved with oral antibiotics and removal of the pins. This infection may be attributed to personal hygiene as all patients with pin site infection were from poor socioeconomic status. Supracondylar humerus fractures are the most common elbow fracture in a pediatric population [18, 19]. Several complications have been associated with the management of these injuries. LOR may occur and has ranged in the literature from 0.7% to 15% [20, 21]. A recent meta-analysis of at least 10 studies had an overall rate of 4% for lateral entry-pin constructs and 2% for cross-pin constructs. Although these numbers may vary in the literature in part due to how LOR is defined, they are in line with our reported rate of 15.63%.

Conclusion

Closed reduction and percutaneous K-wire fixation is an effective treatment for displaced supracondylar fractures of Humerus in pediatric age group.

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