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Management of displaced supracondylar fractures of humerus in children: Closed reduction with external immobilization versus open reduction with k-wire fixation

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Abstract

Introduction: Supracondylar fractures of humerus are the most common fracture pattern of elbow in children. Severely displaced supracondylar fractures of the distal humerus in children are a challenging problem. Many treatment methods have been described for treatment of displaced supracondylar fractures of humerus, however there is no clear consensus as regards choice of treatment. The purpose of this study is to assess and compare the results of closed reduction and cast application versus open reduction and internal fixation [ORIF] by K-wires for completely displaced supracondylar fractures [Gartland Type-III fractures].

Materials and Methods: This prospective non-randomized comparative study was carried out over a period of 12 months in a sample size of 40 children at Rajendra Institute of Medical Sciences [RIMS], Ranchi. 20 children were treated by closed reduction and external immobilization and 20 by open reduction and internal fixation by K-wire. Patients were followed up for 6 months and functional outcome of the 2 groups were evaluated and compared using Flynn's criteria.

Result: Most cases were in the age group of 5 to 8 years [67.5%]. In conservative group 8 patients [40%] had satisfactory results whereas in operative group 18 patients [90%] had satisfactory results.

Conclusion: The present study shows that open reduction and K-wire fixation has better results compared to closed reduction and external immobilization for Type-III Supracondylar Fractures of humerus.

Keywords: Supracondylar humerus fracture, closed reduction, ORIF with k-wire

Introduction

Supracondylar fractures of humerus account for 60% of all fractures of the elbow in children and represent approximately 3% of all fractures in children. The rate of occurrence increases steadily in the first five years of life to peak at 5-7 years of age [1-3]. Undisplaced supracondylar fractures of humerus usually require no more than simple immobilization for comfort and further protection [3]. The management of displaced supracondylar fracture of the humerus is one of the most difficult of the many fractures seen in children [4]. Various treatment modalities available are closed reduction and cast immobilization, closed reduction and percutaneous pinning, open reduction and K-wire fixation. Closed reduction with splint or cast immobilization has traditionally been recommended for displaced supracondylar fractures, but because of loss of reduction and necessity of repeated manipulation is likely to go for malunion producing varus or valgus deformity of elbow and elbow stiffness [5].

Aims and Objectives

To compare the outcome of closed reduction and cast application with that of open reduction and K-wire fixation in the treatment of type-III supracondylar fracture of humerus in view of loss of carrying angle and loss of range of motion.

Materials and Methods

This was a prospective non randomized comparative study conducted in the Department of Orthopaedics at Rajendra Institute of Medical Sciences [RIMS], Ranchi from October 2017 to September 2018.

Pediatric patients in the age group of 1 to 10 years with isolated Gartland Type III [6] supracondylar fracture of humerus were included in the study after taking written, informed and understood consent from the parents/guardians. Supracondylar fractures of humerus in patients above age of 10 years, fractures associated with neurovascular injury and fractures in previous deformity of associated upper limb were excluded.

The study included 40 consecutive patients divided into Groups A and B. Group A included 20 patients treated by closed reduction and external immobilization and Group B included 20 patients treated by open reduction and internal fixation [ORIF] with K-wires.

A detailed history was elicited from the patient and parents/guardians. The nature of injury i.e. fall on an outstretched hand, direct injury, road traffic accident and time since injury was noted following which a thorough examination of the patient was carried out and neurovascular injury ruled out.

Standard anteroposterior and lateral view X-rays of the elbow were taken. In the meantime, the patients were given analgesics and the fractured part was splinted temporarily. Patients were taken up for closed reduction or ORIF after carrying out necessary laboratory investigations.

Manipulative Technique for closed reduction: Reduction was carried out under general anesthesia with full relaxation in the operating room. Pre-reduction carrying angle was assessed and noted down. First longitudinal traction was applied to the forearm with the elbow in extension and forearm in supination. Counter traction to the proximal arm was provided by the assistant and milking of the distal fragment was done. Then with traction being maintained, the medial or lateral displacement was corrected by applying a valgus or varus force at the fracture site. The elbow was then gradually flexed and posterior tilt and shift corrected by thumb manipulation of distal fragment. The forearm was pronated while flexing the elbow in posteromedial displaced fractures and supinated in

posterolateral displaced fractures. Elbow was flexed upto 120* and distal vascularity was checked by seeing capillary refill time [CRT]. If vascularity was found to be compromised, the elbow was slightly extended.

Reduction was checked on C-Arm by looking at carrying angle on AP view and Anterior Humeral Line on lateral view. Above elbow POP cast was applied when reduction was found satisfactory. Patient was discharged on the second day after collecting post-reduction X-ray.

Open reduction and internal fixation (ORIF) with K-wires: 20 cases of type-III fractures were subjected to ORIF with K-wires. In majority of the cases, the anterolateral approach was used. In one case antero-medial approach and in two cases posterior approach was used. Cross K-wires were used for fixation in all cases. Full arm posterior slab was applied post-operatively and limb was kept elevated.

The preoperative antibiotics were continued parentally upto 3rd post-op day. Analgesics and anti-inflammatory drugs were given and active finger movements were encouraged. Immediate post-op X-ray was done. Dressing was done on 3rd post-op day before discharging the patient. Patients were followed up after 2 weeks for suture removal. Slab was removed at 3 weeks and active elbow mobilization was encouraged.

All patients were advised limb elevation till edema subsided and active mobilization of fingers and shoulder joint at time of discharge. Patients were then followed up at 6 weeks to note down the progress of union, range of movement [ROM] at elbow and onset of any deformity. At 6 weeks follow-up cast was removed and check X-ray obtained in Group A and K-wires were removed and check X-ray obtained in Group B. Range of movements and carrying angle were measured using goniometer. Check X-ray were taken postoperatively and at the end of 6 weeks, 3 months and 6 months. Patients were finally evaluated at 6 month follow-up according to Flynn's Criteria [7]. [Table 1]

Table 1: Flynn's Grading System

Result	Rating	Cosmetic factor: Carrying angle loss(degrees)	Functional Factor: Loss of range o motion (degrees)
Satisfactory	Excellent	0-5	0-5
	Good	6-10	6-10
Unsatisfactory	Fair	11-15	11-15
	Poor	over 15	Over15

Results

In the present study most of the cases were in the age group of 5- 8 years (67.5%). 60% of the cases were boys and 40% were girls.

In conservative group, at the final follow-up, 0-5° loss of range of motion of the affected extremity was noted in 6 (30%) cases and more than 15° loss of range of motion was noted in 8 (40%) cases and the mean loss of elbow motion was 14.2°. Whereas the 0-5° loss of carrying angle of the affected extremity was noted in 6 (30%) cases and more than 15° loss of carrying angle was noted in 10(50%) cases and mean change in the carrying angle was 11.2° [Table 3].

In operative group, 0-5° loss of range of motion was noted in

12 (60%) cases and more than 15° loss of range of motion was noted in only 2 cases (10%). Only two cases had more than 15 degrees carrying angle loss. Mean loss of range of motion and change in the carrying angle was 7.3° and 5.8° respectively [Table 4].

Out of 20 cases of type-III supracondylar fracture treated by conservative method, 8 patients (40%) had satisfactory results and 12 (60%) patients had unsatisfactory results. Whereas among the 20 cases of type-III fractures treated by operative method, 18 cases (90%) had satisfactory results and 2 cases (10%) had unsatisfactory results. Ratio of poor results of conservative and operative method were 50% and 10% respectively [Table 5].

Table 2: Distribution based on Age, Sex, and Side Affected

Age Distribution	
0-4 yrs	6 (15%)
5-8 yrs	27 (67.5%)
9-10 yrs	7 (17.5%)
Sex Distribution	

Male	24 (60%)
Female	16 (40%)
Side Distribution	
Right	15 (37.5%)
Left	25 (62.5%)

Table 3: Results of Conservative Group

	Flynn's Criteria	Loss of range of motion	Carrying angle loss
Rating	Degree		
Excellent	0-5	6(30%)	6(30%)
Good	6-10	2(10%)	2(10%)
Fair	11-15	4(20%)	2(10%)
Poor	Above15	8(40%)	10(50%)

Table 4: Results of Operative Group.

	Flynn's Criteria	Loss of range of motion	Carrying angle loss
Rating	Degree		
Excellent	0-5	12(60%)	12(60%)
Good	6-10	6(30%)	6(30%)
Fair	11-15	-	-
Poor	Above15	2(10%)	2(10%)

Table 5: Comparison of treatment outcome of conservative and operative group

Treatment outcome	Flynn's criteria		Conservative Management (n=20)	Operative management (n=20)
	Rating	Loss of movements and carrying angle (Degrees)		
Satisfactory	Excellent	0-5	6(30%)	12(60%)
	Good	6-10	2(10%)	6(30%)
Unsatisfactory	Fair	11-15	2(10%)	-
	Poor	Above15	10(50%)	2(10%)

Discussion

Supracondylar fracture of humerus is a common injury in children. There is no controversy about the management of the non-displaced fractures, but many methods have been proposed for the treatment of displaced (Gartland Type III) supracondylar fractures such as closed reduction and plaster of paris cast application, closed reduction and percutaneous pin fixation, and ORIF with K-wires [8]. The aim of this clinical study is to evaluate the epidemiology of supracondylar fractures, the associated complications and the role of conservative and operative management by comparing the results of closed reduction and cast application and ORIF with K-wire

The average reporting time was 24 hours. In the present study, 67.5% of the cases were of 5-8 years age group with the average age being 6.1 years. Minkowitz B and Busch MT [9] has found the peak incidence between 5-7 years of age. 60% of the cases were males and 40% females. The same has been observed by Fowles and Kassab [10]. The male predominance can be explained as boys are more active and are more prone for fall.

In this study, 25 patients (62.5%) sustained fracture of left side whereas 15 patients (37.5%) sustained fracture of right side. The study is comparable to that of Flynn JC *et al.* [7], who reported 48 (66.7%) fractures on the left side and 24 (33.3%) on the right side in their study of 72 cases.

Elbow stiffness was noted in 3 (7.5%) cases, 2 cases in operative and 1 case in conservative group. We defined elbow stiffness as loss of 25° of flexion or extension or both. Mean loss of flexion and extension in cases treated by operative and conservative method was 7.3° and 14.2° respectively. According to Henrikson B [11], in fractures treated by closed and open methods the average loss of flexion was 4° and 6.5° respectively. The greater loss of elbow motion in this study

may be attributed to the shorter follow-up period.

3 (7.5%) cases had cubitus varus deformity. All the 3 cases were seen in cases treated by closed reduction. The varus deformity was the result of residual displacement of distal fragment in a medial direction and also incomplete correction of internal rotation. This concept is widely accepted by various authors (Dunlop J, French) [12, 13]. Pirone AM *et al.* [8] reported incidence of cubitus varus to be 14% with closed reduction and cast immobilization and 11% in ORIF.

In this study among 20 cases treated with closed reduction, the results were excellent in 6, good in 2, fair in 2 and poor in 10 cases. Whereas Shoaib M *et al.* [14] treated 25 displaced supracondylar fracture with closed reduction, their results were excellent in 4 patients (16%), good in 11 (44%), fair in 3 (12%) and poor in 7 patients (28%). Among the 20 cases treated by operative method, the results were excellent in 12, good in 6, fair in none and poor in 2 patient. The results are comparable to results of various other studies. Mulhall KJ *et al.* [15] reported 13 cases had excellent results, 2 good and 1 had fair result. Whereas Reitman *et al.* [16] reported as 18 (55%) were rated excellent, 8 (24%) were good, 3 (9%) were rated fair and 4 (12%) rated poor. In the present study, the ratio of poor results of closed reduction and cast application and ORIF by K-wires for type III fractures were 50% and 10% respectively. Similarly Diri B, *et al.* [17] reported the ratio of poor results of closed reduction and cast immobilization and ORIF with K-wire were 28.6% and 12.8% respectively.

Conclusion

From the above study it is concluded that open reduction and internal fixation with K-wires is an effective and safe method of treatment for completely displaced (type-III) supracondylar fracture of humerus in children compared to closed reduction and cast application, as it offers the advantage of anatomical

reduction, more stable fixation, early mobilization, better functional and cosmetic results with fewer complications.

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