A Study of Management of Supracondylar Fracture of Humerus in Paediatric Age Group by Open and Closed Reduction with Internal Fixation

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ABSTRACT

BACKGROUND

Supracondylar humerus fracture is the most serious paediatric skeletal injury of elbow in children. Supracondylar fracture of humerus leads to many complications due to the intrinsic fracture instability, close proximity of the brachial artery, three main upper extremity nerves, poor radiographs, contradictory perception of reduction and reduction management modalities and, lastly, patient compliance with care. The aim of this research is to determine the short-term outcomes of closed and open reduction and Kirschner wire fixation in childhood Gartland type III supracondylar humerus fracture.

METHODS

It is a comparative case series of 2 years duration conducted among 30 patients with supracondylar humerus fracture who were admitted and treated at the Department of Orthopaedics. Closed reduction was handled in 15 out of 30 patients, with the remaining 15 patients being treated by open reduction. The outcomes are calculated on the basis of the Flynn scale, which is based on change in the carrying angle and loss of motion after treatment.

RESULTS

Males (56.66 %) were more affected than females; left side (66.67 %) was more affected than the right side; fractures of type III were more common. 26 patients stayed in a sufficient range of motion, 4 patients had insufficient motion with a loss of more than 100, of which 3 were treated with a closed reduction and 1 with an open reduction. Twenty-six (86.66 %) of the 30 patients showed good to excellent results and four (13.33 %) showed mediocre to poor results. Of the four cases, one was handled with a closed reduction and three were handled with an open reduction.

CONCLUSIONS

We conclude that open reduction and K-wire fastening without triceps is a treatment option for displaced supracondylar humerus fractures.

KEYWORDS

Supracondylar Fracture, Humerus Fracture

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BACKGROUND

Supracondylar fracture of the humerus in children is the most common paediatric skeletal injury around the elbow.[1] Peak incidence is observed in the 6 - 9 year age range due to different causes, mainly ligamentous laxity, violent remodelling and structure of the humerus, i.e. flat transition tube at the lower end of the humerus.[2,3] Supracondylar humerus fractures are described in the early writings of hippocrates[4]. Even though it is so common and so early known to mankind, it has invited many debates, some resolved in due course of time and some are still continuing. To quote, in the past some diagnosed it as an abscess with chances of gangrenous complications and some considered it as elbow dislocation. Regarding the position of immobilisation some adopt hyper flexion, some ninety-degree flexion and some extension. Regarding the type of fixation some advocate lateral pinning and some cross pinning, and, in the past, even transverse pins were used to hold the reduction. Regarding the reason for cubitus varus deformity, some say it is due to melanin and some say growth arrest of medial candle and some say medial communication is the reason. Many treatment modalities are available in the management of supracondylar humerus fractures, such as closed reduction and immobilisation with elbow cast / slab above, overhead olecranon wing traction, closed reduction and percutaneous pinning under image intensification control, open reduction and pinning (lateral pinning, cross pinning constructs), lateral external fixator[5] and straight arm skeleton.[6] Supracondylar fracture of the humerus is noted for its complications due to the inherent instability of the fracture, close proximity of the brachial artery, three major upper extremity nerves and poor radiographs, and inconsistent understanding of the reduction and mode of management and, lastly, patient compliance with care. Supracondylar fracture of humerus is one of the few fractures that, if treated properly, might not give the surgeon a reputation, but if treated poorly, it would undoubtedly give notoriety to a well-known surgeon.

METHODS

Thirty patients with supracondylar humerus fracture were admitted to the Department of Orthopaedics, Gandhi Hospital, Secunderabad during the period from August 2015 to August 2017. Out of the 30 patients, 15 were treated with a closed reduction and the remaining 15 were treated with an open reduction (after a failed attempt at a closed reduction) followed by a K-wire fixation.

Inclusion Criteria

- Age group between 5 - 15 years.
- Early presentation.
- No associated fractures in the same limb.
- Not treated elsewhere.

Exclusion Criteria

- Age < 5 years, > 15 years.
- Open fractures.
- Associated neurovascular injury.

Initially, radiological assessment consisted of anteroposterior and lateral films, Jones' view is evaluated after manipulation with or without pinning. In anteroposterior films – Baumann's angle was measured. In lateral films – anterior humeral line, crescent sign and the fish tail sign were noted. In Jones' view assessment of the coronal alignment of the distal fragments was done. For classification, we used Gartland classification with Wilkins adjustment extension form and flexion forms, depending on the sagittal tilt of the distal fragment.

Both types are further classified into
Type i - Undisplaced.
Type ii - Displaced with intact posterior cortex / anterior cortex.
Type iii - Displaced with no bone contact.
Type iv - Further classified into two types (Wilkins modification) depending upon the displacement type.

a) posteromedial
b) posterolateral

For type III (completely displaced): Sort III (completely displaced): Initially closed reduction was attempted. If not minimised by closed approaches, open reduction by posterior approach and K-wire fastening. After fixation, the elbow is protected by the pop slab or cuff and collar. Open reduction indications and K-wire fastening were

1) 2 to 3 attempts of failed closed reduction manoeuvring
2) An open fracture

Open Reduction Technique

We did posterior (triceps reflecting) approach to lower end humerus to minimise open fracture. In this technique, patients are placed in the opposite side of the lateral decubitus position and the elbow is kept in the flexion position on one side. The skin incision and the subcutaneous tissue are made from 7 cm upper to 2 cm lower than the olecranon by a posterior midline method. Subcutaneous arteries were coagulated; subcutaneous tissues were dissected off the muscle and fascia of triceps without separating the muscle. The ulnar nerve is examined and maintained safely during surgery. Then the muscle of triceps is dissected from both sides of laughter and along the intermuscular septum, so the distal humerus rear surface is deperiosted. Therefore, all the regions of medial and lateral epicondyle, condyle and supracondylar ridge and joint surface are exposed, and the proximal part is exposed as much as the surgeon needs. In this approach, we do not need to cut the triceps mechanism. After an open fracture reduction, the pins are positioned either medially or laterally or two pins are positioned laterally, depending on the size of the distal fragment and the intraoperative stability. Pins can be left in place slightly longer after an open reduction than after a closed reduction. When the pin is removed, a healthy

callus can be identified at fracture, usually 3 to 4 weeks after injury. Results were graded as excellent, good, fair and poor according to the Flynn's criteria.

Excellent
- Loss of movement 0 - 5 (Functional)
- Loss of carrying angle 0 - 5^0 (Cosmetic)

Good
- Loss of movement 5 - 100 (Functional)
- Loss of carrying angle 5 - 10^0 (Cosmetic)

Fair
- Loss of movement 10 - 150 (Functional)
- Loss of carrying angle 10 - 15^0 (Cosmetic)

Poor
- Loss of movement more than 150 (Functional)
- Loss of carrying angle more than 15^0 (Cosmetic)

RESULTS

Age in Years	No. of Patients	Percentage (%)
5 – 8 years	14	46.67 %
9 – 12 years	12	40 %
13 – 15 years	4	13.33 %
Gender		
Male	17	56.66 %
Female	13	43.33 %
Side		
Right	10	33.33 %
Left	20	66.67 %

Table 1. Demographic Distribution

In the present sample, 56.66 % were male and 43.33 % were female. 46.67 % were in the 5 – 8 years age group, 40 % in the 9 - 12 years age group, 13.33 % in the 13 - 15 years age group. 66.67 % had left side fracture and 33.33 % had right side fracture.

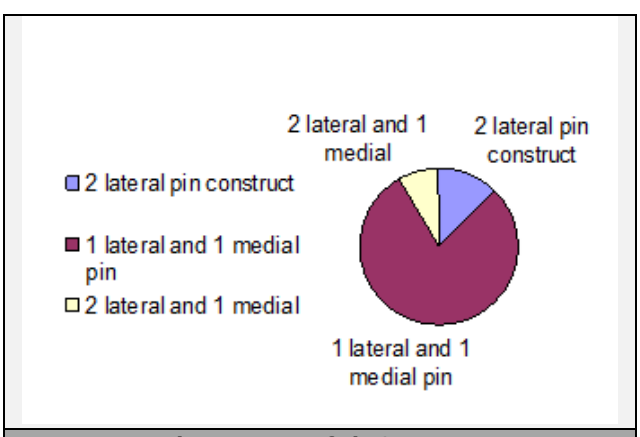

Figure 1. Type of Pin Constructs

In a total of 30 supracondylar fractures of humerus, our favoured method was cross pinning. We used 1 lateral and 1 medial pin in 20 cases, and 2 lateral pins in 3 cases and 2 lateral pins and 1 medial pin in 1 case.

Complications	No. of Cases	Percentage (%)
Cubitus varus deformity	2	6.66 %
Pin tract infection	1	3.33 %
Restriction of movement	1	3.33 %

Table 2. Post-Operative Complications in the Present Study

Post operatively, one patient had a pin tract infection, 2 patients developed cubitus varus deformity and one patient had restriction of movements.

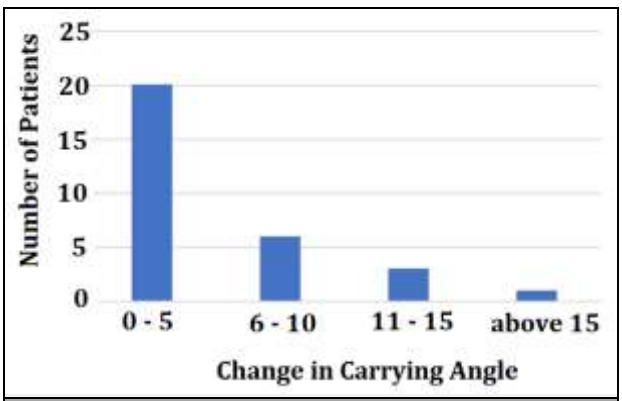

Figure 2. Change in Carrying Angle

In 86.67 % of the cases, the change in the carrying angle was less than 10 degrees.

Outcome	Loss of Range of Motion		Loss of Carrying Angle		Average Percentage
	No. of Patient	%	No. of Patient	%	
Excellent	20	66.66 %	20	66.66 %	66.66 %
Good	6	20 %	6	20 %	20 %
Fair	3	10 %	3	10 %	10 %
Poor	1	3.33 %	1	3.33 %	3.33 %

Table 3. Final Results in the Present Study after Surgery

According to Flynn's criteria[7] results of our study are analysed. In our sample, 86.66 % of 30 patients were good to excellent and 13.33 % showed average and bad outcomes.

Results	Functional Factor (Loss of Motion in Degrees)	Cosmetic Factor (Loss of Carrying Angle in Degrees)
Excellent	$0 - 5^0$	$0 - 5^0$
Good	$6 - 10^0$	$6 - 10^0$
Fair	$11 - 15^0$	$11 - 15^0$
Poor	$> 15^0$	$> 15^0$

Table 4. Final Results by Flynn's Criteria

Twenty-six patients had an acceptable range of motion only with a loss of $0 - 10^0$, four patients had inadequate motion with a loss of more than 10^0, of whom three were treated with closed reduction and one patient with an open reduction. 6.66 % of cases had a carrying angle loss in excess of 10^0. 10 % of cases had more than 10^0 loss of motion spectrum. 26 Cases (86.6 %) had outstanding and decent (satisfactory) results, 4 cases (13.3 %) had average and bad results.

DISCUSSION

In our study, one case had limitations on the mobility of the elbow after an open reduction and internal fixation, and a sufficient range of motion was achieved with physiotherapy. In 2 instances, a small degree of cubitus varus was observed due to the unsatisfactory reduction and fixation of the

fragment in a poor place. Of the two, one was dealt with by a closed reduction, and the other by an open reduction. In the case of a closed reduction, the degree of Cubitus varus was higher.

Musa et al.[6] observed in 30 cases of type III Gartland fracture handled by crossed percutaneous pinning over a duration of 2 years. The age range was between 2 and 13 years with an average age of 7.06 years.

C Charles A Rockwood[7] found that the peak occurrence of supracondylar humerus fracture in children occurred in the latter part of the first decade of life. In this report, the average age is 10 years (range 5 – 15 years) and the most common age group affected was between 5 – 8 years (46.67 %). In their research, 230 patients had a fracture of the supracondylar humerus.

Pirone A M et al.[8] have found that boys (119) are more affected than girls (111). Robert D Ambrosia[9] found that the incidence of supracondylar humerus fracture was 63 per cent in males and 37 per cent in females. In our study, the prevalence of supracondylar humerus fracture is 56.66 per cent in males and 43.33 per cent in females.

Robert D Ambrosia[9] found that the left elbow involvement was 64 percent, and that the right-side involvement was 36 per cent of his cases of supracondylar humerus fracture in babies. In the present study, 33 % of the cases were influenced by the left and 67 % by the right. The frequency of fractures in our study was found to be higher on the left (66.67 %).

Pirone A H et al.[8] analysed 230 cases of Humerus displaced by supracondylar fracture and found that 137 (62 %) cases were Type III fractures and 83 (36 %) were Type III fractures. Form III fractures 94 were posteromedially displaced, 22 were posterolaterally displaced and 21 were directly displaced.

Mehlman et al.[10] during their review of surgical treatment of supracondylar humerus fracture in children found that, according to Gartland's classification, 77.4 per cent were type III fractures and 18.3 per cent were type II fractures. In the present study of 30 patients, all cases included were Gartland type III fractures.

The incidence of pin tract infections reported by Wael et al.[11] was 8.6 %, 7.84 % by Devkota et al.[12], while in their series Aronson and Prager did not mention any case Cramer. K E et al.[13] in its retrospective examination of 29 children with supracondylar humerus fracture in children treated with closed reduction and percutaneous pinning and open reduction and percutaneous pinning 1 patient with closed reduction and percutaneous pinning in 15 cases reported superficial pin tract infection.

The incidence of cubitus varus after pinning of supracondylar humerus fracture was recorded as 6 per cent by Lee et al.[14] 8.6 per cent by Wael et al.[11] While Aronson and Prager did not find any cubitus varus cases. Topping et al demonstrated the occurrence of cubitus varus in one patient (4.3 %) out of 43 patients treated with closed reduction and percutaneous pinning. In this study, two patients (6.67 %) developed cubitus varus. This deformity can be seen in the closed reduction group with one patient in the open reduction and percutaneous pinning group and the other patient.

Pirone A M et al.[8] recorded migration of one side pin out of 96 cases treated with closed reduction and percutaneous pinning. In our research, we never saw this problem because in all pinning cases, after application, we bent k-wires outside the skin.

Musa et al.[6] found a 10 % occurrence of iatrogenic ulnar nerve injury with percutaneous pinning crossed in their report. Balakumar and Madhuri[15] observed an occurrence of 1.1 % iatrogenic nerve injury, 2.2 % and 1.1 % ulnar, median and radial nerve injury using separate percutaneous pinning techniques, respectively. Iatrogenic nerve injuries occurred in 6 % of patients with a supracondylar fracture of the humerus and consisted mainly of percutaneous pinning damage to the ulnar nerve, recorded in 11 % of subjects. Gurkan et al.[16] recorded 4.5 % of cases of ulnar nerve injury following a medial approach reduction. The trigger may have been nerve stretching during reduction manoeuvres. In contrast, no cases of iatrogenic ulnar nerve injury were detected after an open reduction.

In their study, Devkota et al.[12] noted loss of reduction postoperatively in 1.96 % cases. Lee et al.[14] observed the same to be 7 %, while Balakumar and Madhuri[15] observed postoperative reduction loss in 18.2 % of cases in their study. In our research, loss of reduction was noted at the time of the first postoperative X-ray (in all these situations, a sufficient reduction under C- arm was achieved).

In our study, the findings are evaluated according to Flynn's parameters based on the change of the carrying angle and the lack of movement of the drug. In a study of 106 patients with displaced supracondylar humerus fracture treated with closed reduction and percutaneous pinning. Franke et al.[17] showed good to excellent results with 10.7 % satisfactory results and 4.6 % unsatisfactory results. In this study of 135 subjects with a displaced fracture of the supracondyle of the humerus.

Ababneh et al.[18] had outstanding and decent results in 87 % of patients and 8 per cent of subjects had poor results. Anmol Sharma et al.[19] reviewed 54 cases of supracondylar humerus fracture and found excellent results in 12 (13.3 %), nice in 54 (60 %), decent in 15 (16.7 %) while bad results were obtained in nine patients (10 %). 26 (86.66 %) of the 30 patients in our sample showed good to outstanding results and 4 (13.33 %) showed average to bad results of the four cases, one was handled with a closed reduction and three were handled with an open decrease.

CONCLUSIONS

Humerus supracondylar fracture is one of the most common injuries of elbows in infants. The most common cause for injury is fall on the extended hand. In view of the role of the affected extremity, supracondylar fractures should be considered essential and should be handled as such without delay. The treatment is based on complete anatomical reduction of the fracture fragments. There is a lack of reduction and a need for repeated manipulation in the closed reduction of splint or cast immobilisation. This will lead to

elbow stiffness and epiphyseal injury, the latter resulting in arm shortening.

In particular, cast therapy is prescribed for undisplaced fractures. When used for displaced fractures, there is a risk of re-displacement after the swelling subsides. The use of lateral and medial pin fasteners offers more protection than lateral pins on their own. In order to have rigid fixation, the pins must proceed into the opposite cortex. A smooth pin is preferable to threaded pin. Open reduction and K-wire fastening without triceps is an option of treatment for displaced supracondylar humerus fracture in children, as reduced postoperative stiffness, prolonged function recovery and effective period of hospitalisation is 1 to 2 days.

In our study, there were no significant differences in postoperative reliability, functional outcomes and complications between percutaneous pinning and open cross-wiring reduction. It is assumed that these findings support the use of percutaneous pinning in the first section, which is easier and less violent than the open reduction.

Data sharing statement provided by the authors is available with the full text of this article at jebmh.com.
Financial or other competing interests: None.
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