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Management of supracondylar fractures of the humerus in children: Conservative versus operative

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Abstract
Background and Objectives: Supracondylar fractures of the humerus are the most common fracture pattern of the elbow in children. Severely displaced supracondylar fractures of the distal humerus in children are a challenging problems. Many treatment methods have been described for the treatment of displaced supracondylar fractures of the humerus, however, it has not been reached a consensus for the choice of the treatment. The purpose of this study is to assess and compare the results of two different treatment methods, closed reduction and slab application and open reduction and internal fixation(ORIF) by K-wires for completely displaced supracondylar fractures (type-III fractures).
Methods: 40 children (type-I - 8, type-II – 12, type-III – 20) of supracondylar humerus fractures were treated. Out of 20 type-III fractures, 10 were treated by closed reduction and external immobilization and 10 by open reduction and internal fixation by K-wire. We evaluated the results of two different methods for type-III fractures according to Flynn's criteria.
Results: According to the study, the ratio of poor results of closed reduction and slab immobilization and open reduction and internal fixation by k-wires for type-III supracondylar fractures were 50% and 10% respectively.
Conclusion: The present study shows that open reduction and K-wire fixation has better results compared to closed reduction and slab application for type-III supracondylar fractures of humerus in children. It is recommended that closed reduction and external immobilization be reserved for type-I and type-II fractures.

Keywords: Dsplaced supracondylar fracture of humerus, closed reduction and slab immobilization, open reduction and internal fixation by K-wires

Introduction
Supracondylar fracture of humerus accounts for 60% of all fractures of the elbow in children and represents 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].
It is the fracture of the lower end of the humerus usually involving the thin portion of humerus through coronoid or olecranon fossae, or just above the fossae or through the metaphysis of the humerus.
Undisplaced supracondylar fracture 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 close reduction and cast immobilization, traction, ORIF and close reduction and percutaneous pinning.
Closed reduction with splint or cast immobilization has traditionally been recommended for displaced supracondylar fractures, but 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].
Surgery was generally reserved for complicated cases or performed only after failure of several attempts at closed reduction, as it was believed to produce poor results attributed to additional surgical insult.
The aims of surgical treatment are to maintain an anatomical position and to prevent varus deformity.

Hence, the study was undertaken

1. To study the age and sex incidence, mechanism of injury, fracture patterns and the associated complications of supracondylar fractures of humerus in children.
2. To study the role of conservative management in the treatment of Type-I and Type-II supracondylar fractures.
3. 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 (degree).

Methodology

This study was conducted in the Department of Orthopaedics at Khaja Banda Nawaz Institute of Medical science Hospital, Gulbarga, for a period of 2yrs from August 2011 to July 2013. The study received clearance from Ethical Clearance Committee of the institution.

Inclusion Criteria

Pediatric patients in the age group of 1 to 14 years with supracondylar fracture of humerus.

Exclusion Criteria

Supracondylar fracture of humerus in patients above age of 14 years.

Method of Collection of Data

40 pediatric patients in the age group of 1 to 14 years with supracondylar fractures of humerus seeking medical advice were taken for our study.

Out of 40 patients, 20 type-III fractures were taken for comparative study. In a random manner, two equal groups were drawn. 10 patients were treated by closed reduction and external immobilization and another 10 patients by open reduction and internal fixation (ORIF) by K-wires.

A detailed history was elicited from the patient and from parents in case of younger children. The nature of injury i.e fall on an outstretched hand, direct injury, road traffic accident and time since injury was elicited. Then a detailed examination of the patient was carried out.

The general condition of the patient assessed. Patients with associated head injury and fractures of other long bones were given priority for the emergency management. If there was none of the other injuries then the local examination of the injured elbow was carried out. The deformity, swelling around the elbow, tenderness over the distal end of the humerus and movements of the elbow noted.

The vascular status of the limb examined. The capillary filling over the fingers, radial and ulnar pulsations assessed. The dynamic status of the vascular system was assessed by passive extension of the fingers. All the three major nerves i.e., median, radial and ulnar evaluated for their motor and sensory functions. The anterior interosseous nerve was given special attention by evaluating the flexion of inter phalangeal joints of the thumb and index finger.

The x-rays were adviced. The standard anteroposterior and lateral views of the elbow were taken in the emergency radiology room. In the mean time, the patients were given analgesics and the fractured part was splinted temporarily. Before surgery, the necessary laboratory investigations were done.

The fracture pattern seen in the X-rays. was classified according to Gartland's classification [6].

Type-I Non-displaced

Type-II Minimally displaced with intact posterior cortex

Type-III Completely displaced with no cortical contact

a) Posteromedial

b) Posterolateral

Then management protocol was drawn according to the type of fracture.

Type-I Fractures

The patient's radiographs were thoroughly scrutinized and fracture pattern confirmed. The posterior displacement was ruled out by noting down the anterior humeral line. Then a posterior splint was applied to the limb with elbow at 90º flexion and forearm in neutral rotation. A cuff and collar sling was given. Then the plaster instructions were given to the patient and was advised to come for review after two days. The loosening of the splint if any was corrected and the patient was advised to come after three weeks. At the end of 3 weeks the posterior splint was removed and the X-rays were repeated to assess the healing. After seeing the X-rays the splint was discontinued and the patient was advised to start active range of motion exercises for the elbow.

Type-II Fractures

The anteroposterior X-ray was looked for the coronal displacement and angulation. After confirmation of the type, patient admitted and kept nil orally. A splint was applied and the affected extremity was elevated to minimize the swelling. Under general anesthesia carrying angle of the normal and the affected elbow assessed and noted down. Then closed reduction was carried out giving a longitudinal traction of the forearm by the surgeon and counter traction to the proximal arm by the assistant. The elbow was flexed up until resistance was felt usually just above 90º of elbow flexion. Then the distal fragment was pushed anteriorly. With that the elbow was flexed up to 120º and forearm was brought into full pronation. Then the vascular status assessed. A posterior splint was applied with the elbow in 120º flexion and forearm in full pronation. A cuff and collar sling given. The patient observed in the hospital for 24 hours. Later the patient was discharged with the instructions regarding the plaster complications and advised to come after three weeks. At the end of 3 weeks the splint was removed and x-rays repeated. The carrying angle assessed and active range of motion exercises started. Patient followed up at periodic intervals and each time the carrying angle and the functional range of movements assessed and noted.

Type-III Fractures

The type-III fractures diagnosed with the help of x-rays are taken for comparative study. Two groups were drawn. One group treated by closed reduction and maintained with external immobilization. Other group treated with open reduction and internal fixation with K-wires. Both the groups have equal type-IIIa and type-IIIb fractures. The compound injuries were treated by open method.

The results of treatment of two groups were assessed using the Flynn's criteria [7] to compare the functional range of movements and carrying angle of the injured and the uninjured elbow.

The function is graded in 5 degree interval of loss of the total arc of flexion and extension, and the cosmetic appearance of the elbow is graded in 5 degree intervals of change in the carrying angle. With any varus angulation resulting in a poor grade. The overall rating in those patients who had changes both in the carrying angle and in function was made on the

basis of the greater clinical loss, that is good functional rating and a fair cosmetic rating resulted in a fair rating. The carrying angle was measured with a goniometer and compared with that of the normal opposite extremity. This is the most rigorous grading method in the literature and is recommended to facilitate comparative studies.

Flynn's Grading System [7]

Results	Rating	Cosmetic factor: Carrying angle loss (degrees)	Functional factor: Loss of range of motion (degrees)
	Excellent	0 – 5	0 – 5
Satisfactory	Good	6 – 10	6 – 10
	Fair	11 – 15	11 – 15
Unsatisfactory	Poor	Over 15	Over 15

The following methods have been used to treat the fractures:

Manipulative Technique: 10 cases of type -III fractures were treated by this method. The patient hospitalized and advised nil by mouth. The fractured limb was splinted and elevation was done to reduce the swelling. Then the reduction was carried out under general anesthesia with full relaxation in the operating room. The carrying angle was assessed and noted down. First the longitudinal traction applied to the forearm with the elbow in extension and forearm in supination. Counter traction to the proximal arm was provided by the assistant. Then with the traction being maintained, the medial or lateral displacement was corrected by applying a valgus or varus force at the fracture site. Once length was re-established and the edges of the fragments, were joined, the displacement and angulation of the distal fragment were corrected by flexing the elbow. At the same time a posteriorly directed force was applied to the anterior portion of the arm over the proximal fragment and an anteriorly directed force was applied posteriorly over the distal fragment. The reduction was achieved, which was confirmed by full flexion of the elbow. Then the elbow was kept in 120º flexion and forearm in full pronation in a posterior splint. A cuff and collar sling was applied. The distal vascularity was checked. Patient discharged on the second day and reviewed after 2 days and then after one week to see whether reduction was stable clinically and radiologically, then after three weeks. Postoperative management as per type-II fracture was carried out. The results were noted down.

Open reduction and internal fixation (ORIF) with K-wires

10 cases of type-III fractures were subjected to ORIF with K-wires. In majority of the cases, the posterior Campbell's approach was used. In one case with brachial artery injury we have used the antero-medial approach and in two cases antero-lateral approach was used- one case had radial nerve injury and another case had compound grade-I fracture.

Posterior Approach

Under general anesthesia the patient in prone position with the elbow supported on the sand bag, extremity was prepared from axilla to wrist & draped. With a posterior Campbell's approach, ulnar nerve was isolated, an inverted tongue shaped incision done over the triceps. All the blood clots & debris removed from the fracture site. Fracture reduced & internally fixed with two or three smooth crossed Kirschner's wire of diameter 1.5 to 2.5 mm. The pins were introduced with the help of a hand drill. The lateral wire was introduced through the anterior side of lateral condyle and directed posteriorly into the posteromedial side of the opposite cortex. The medial wire was started through the posteromedial side of medial condyle and engaged into the anterolateral side of opposite cortex. While introducing the medial wire, greater care was taken to avoid the ulnar nerve. By this method, the wires were laid high above the fracture site. The pins were cut percutaneously for easy removal later. After the pins are placed, the elbow is extended and the carrying angle is measured and compared to that on the non-affected side. The stability of the fracture was checked. Then the wound was closed and a drain kept and a posterior splint was applied with the elbow in 90º flexion and forearm in neutral rotation.

Postoperative Course

- Full arm posterior slab was used, cuff and collar was given. The limb elevated.
- The preoperative antibiotics were continued parentally on the day of operation. It was continued for 3 to 5 days, keeping a watch on body temperature and the wound.
- Analgesics and anti-inflammatory drugs were given in moderate dose to improve the pain threshold.
- As patient regained consciousness, he was advised to do active finger movements.

Drain removed after 48 hours

- Dressings changed usually on 3rd, 6th and 10th day.
- Check X-ray was taken routinely.
- Sutures removed on 12th day and patient discharged.
- Advice given at the time of discharge:

a) Elevation of the limb till the edema subsides.
b) Active mobilization of fingers and shoulder joint.
c) Pain killers were given for first five days and afterwards as and when required.
d) Patients were called at third week for "K" wire removal. After the k-wires were removed the posterior slab was discarded, and active movements of elbow were started. Special mention was made to avoid oil massage and passive stretching which is advocated by unqualified medical personnel. All these cases were advised to attend the outpatient department at regular intervals of 3 weeks, 6 weeks, 3 months, 6 months and 12 months for checkup and to note down the progress of union, range of movement at elbow and onset of any deformity. Range of movements and carrying angle were measured using goniometer.

Check X-ray were taken postoperatively at the end of 3-4 weeks, 3 months and 6 months. Cases were followed from 6 to 12 months.

Results

In the present study most of the cases were in the age group of 5- 8 years (52.5%). The youngest was 2 years old and the eldest 12 years old. 60% of the cases were boys and 40% were girls. 87.5% of cases were due to indirect injury i.e., fall on an outstretched hand and 12.5% of cases were due to direct injury to the elbow joint, which mostly comprised of vehicular accidents. [Table-1]

The percentage of closed fractures were 95% and open were 5%. All open fractures were high velocity injuries due to vehicular accidents. The 2 open fractures, which included one case of grade-I and another of grade-II Gustilo and Anderson's classification of open fractures. Based on supracondylar fractures, 38 were extension type and 2 flexion type. The left elbow was involved in 25 (62.5%) cases and right side in 15

(37.5%) cases [Table-2].

50% of the cases were of type-III fractures, 30% type-II and 20% of type-I. Among the 20 (50%) cases of type-III fractures, 10 cases had posteromedial displacement and 10 cases with posterolateral displacement. [Table-3].

In the present study, 1 case of brachial artery injury, one case of radial nerve injury, 2 cases of elbow stiffness, 3 cases of cubitus varus, 1 case of cubitus valgus and 1 case of superficial pin tract infection was noted. The total percentage of associated complication was found to be 22.5% (9 patients). The most common complication in this study was cubitus varus accounting for one-third of the complications [Table-4].

At the final follow-up, 0-5º loss of range of motion of the affected extremity was noted in 3 (30%) cases and more than 15º loss of range of motion was noted in 4 (40%) cases and the mean loss of elbow motion of the cases treated by conservative method was 14.2º. Whereas the 0-5º of carrying angle loss of the affected extremity treated by conservative method was noted in 3 (30%) cases and more than 15º loss of carrying angle was noted in 5 (50%) cases and mean change in the carrying angle was 11.2º [Table-5].

In the conservative treatment of type-IIIa and type-IIIb fractures, poor results were 3 and 2 respectively. In type-IIIa fractures, the mean loss of range of motion and carrying angle loss of 16.6º and 10.0º respectively was noted. Whereas in type-IIIb fractures there was mean loss of range of motion and carrying angle loss of 11.8º and 14.6º respectively. [Table-6].

The 0-5º loss of range of motion and carrying angle loss, treated by operative method was noted in 6 (60%) cases respectively and more than 15º loss of range of motion was noted in only 1(10%) case and none of the cases had more than 15 degrees carrying angle loss. Mean loss of range of motion and change in the carrying angle was 7.3º and 5.8º respectively [Table-7].

In operative group of type-III fractures, none of the case had poor results in type-IIIa whereas 1 poor result was noted in type-IIIb fractures. In type-IIIa fractures the mean loss of range of motion and carrying angle loss was 5.8º and 4.8º respectively, and in type-IIIb fractures, the mean loss of range of motion and carrying angle loss was noted as 8.8º and 6.8º respectively [Table-8].

Out of 10 cases of type-III supracondylar fracture treated by conservative method, 5 patients (50%) had satisfactory results and 5(50%) patients had unsatisfactory results, which were rated poor.

Whereas among the 10 cases of type-III fractures treated by operative method, 9 cases (90%) had satisfactory results and only one (10%) case was rated as poor with unsatisfactory results. The ratio of poor results of conservative and operative method were 50% and 10% respectively [Table-9].

Table 1: Distribution based on Age, Sex and Mode of injury

Age Group(years)	No. of Cases (n=40)
0 - 2	2 (5%)
3 - 4	4 (10%)
5 -6	13 (32.5%)
7 - 8	8 (20%)
9 - 10	7 (17.5%)
11 - 12	6 (15%)
12 - 14	0
Sex	
Male	24 (60 %)
Female	16 (40 %)
Mode of Injury	
Fall on outstretched hand	35 (87.5%)
Direct injury	5 (12. 5%)

Table 2: Distribution based on Fracture pattern, side affected.

Type of Fracture	No. of Cases (n=40)
Closed	38 (95%)
Open	02 (5%)
Extension	38 (95%)
Flexion	02 (5%)
Side	
Right	15 (37.5%)
Left	25 (62.5%)

Table 3: Distribution based on Gartland's type of fractures and Type lll fractures

Gartland's type of fractures	No. of cases (n=40)
Type l	8 (20%)
Type ll	12 (30%)
Type lll	20 (50%)
Type lll fracture patterns	**No. of cases (n=20)**
Type llla posteromedial	10 (50%)
Type lllb posterolateral	10 (50%)

Table 4: Complications

Complications	No. of cases
Vascular injury	1 (2.5%)
Volkmann's ischemic contracture	--
Nerve injury	
a) Radial injury	1(2.5%)
b) Median nerve	--
c) Ulnar nerve	--
Myositis ossificans	--
Elbow stiffness	2 (5%)
Cubitus varus	3 (7.5%)
Cubitus valgus	1 (2.5%)
Superficial pin tract infection	1 (2.5%)
Total	9 (22.5%)

Table 5: Distribution of conservative management of Type lll fractures

Flynn's criteria		Loss of range of motion	Carrying angle loss
Rating	Degree		
Excellent	0 – 5	3 (30%)	3 (30%)
Good	6 – 10	1 (10%)	1 (10%)
Fair	11 – 15	2 (20%)	1 (10%)
Poor	≥15	4 (40%)	5 (50%)

Table 6: Distribution of conservative management of Type llla and Type lllb fractures

Flynn's criteria		Type llla (n=5)	Type lllb (n=5)
Rating	Loss of movement and Carrying angle		
Excellent	0 – 5	1 (10%)	2 (20%)
Good	6 – 10	1 (10%)	-
Fair	11 – 15	-	1 (10%)
Poor	≥15	3 (30%)	2 (20%)

Table 7: Distribution of Operative management of Type lll fractures

Flynn's criteria		Loss of range of motion	Carrying angle loss
Rating	Degree		
Excellent	0 – 5	6 (60%)	6 (60%)
Good	6 – 10	3 (30%)	3 (30%)
Fair	11 – 15	-	1 (10%)
Poor	≥15	1 (10%)	-

Table 8: Distribution of Operative management of Type llla and Type lllb fractures

Flynn's criteria		Type llla (n=5)	Type lllb (n=5)
Rating	**Loss of movement and Carrying angle (degree)**		
Excellent	0 – 5	3 (30%)	3 (30%)
Good	6 – 10	2 (20%)	1 (10%)
Fair	11 – 15	-	-
Poor	≥15	-	1 (10%)

Table 9: Comparison of treatment outcomes of conservative and operative management of type-III fractures

Treatment outcome	Flynn's criteria		Conservative management (n=10)	Operative management (n=10)
	Rating	Loss of movement and carrying angle (degree)		
Satisfactory	Excellent	0 – 5	3 (30%)	6 (60%)
	Good	6 – 10	1(10%)	3 (30%)
	Fair	11 – 15	1 (10%)	-
Unsatisfactory	Poor	>15	5 (50%)	1 (10%)

Fig 1: (A) X-ray showing supracondylar fracture, (B) post-reduction X-ray, (C&D) Photograph showing cubitus varus deformity.

Fig 2(a): X-ray showing supracondylar fracture, **(b).** X-ray after reduction, **(c)** post-reduction X-ray showing union (follow up 3wks - 6months)

Fig 3: X-ray showing supracondylar fracture at time of presentation, (b) Immediate post-operative x- ray, (c) x-ray showing union(follow up 4wks -6months), (d) photograph showing functional and cosmetic results.

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 supracondylar fractures of the humerus in children such as closed reduction and plaster of paris slab application, skin traction, overhead skeletal traction, ORIF and closed reduction and percutaneous pin fixation [8].

The aim of this clinical study is to study the epidemiology of supracondylar fractures, the mechanism of injury, the associated complications and the role of conservative and operative management of the fractures by comparing the results of closed reduction and slab application and ORIF with K-wire for the supracondylar fractures (type-III) of the humerus in children.

Majority of the patients reported to the hospital within 12 hours of injury. The average reporting time is 24 hours. Most of the children were initially taken to the bone setters in their village. After increase in pain and swelling, they reported to our hospital.

In the present study, 52.5% of the cases were of 5-8 years age group with the average age being 7.1 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]. Similarly D' Ambrosia [1] observed an incidence of 69% in males and 31% in females. The male predominance can be explained as boys are more active and are more prone for fall.

The most common mode of injury was due to fall on an outstretched hand accounting for 87.5% of the cases and 12.5% had a direct injury i.e. fall on the point of the elbow. Our observations is in concurrence with that of McDonnel DP and Wilson JC [11] i.e., when a child loses its balance he or she tries to save themselves with an outstretched hand [Table-1].

In the present study 2 cases had open fractures (5%). All of the open fractures were caused by high velocity injuries due to vehicular accidents. 38 cases (95%) were of extension type, 2 cases (5%) were of flexion type. In comparison Fowles and Kassab [10] have reported extension to flexion type of injury as 90% v/s 10%. Fracture occurred on the left side in 25 (62.5%) cases and on the right side in 15 (37.5%) cases. Similarly Fowles and Kassab [10] noted that 57% of supracondylar fractures occurred in the left side. Flynn JC *et al*. [7] reported 48 (66.7%) fractures on the left side and 24 (33.3%) on the right side in their study of 72 cases. [Table-2]

In the present study, out of 20 type-III supracondylar fractures 10 (50%) cases had posteromedial and 10 (50%) had posterolateral displacement. Whereas Aronson DD *et al*. [2] noted 15 (75%) cases of posteromedial and 5 (25%) cases of posterolateral displacement in their study of 20 cases. [Table-3]

Out of 40 cases, 1 (2.5%) had absent radial pulse on presentation. It was of type-III fracture with posterolateral displacement. Closed reduction was tried first under general anesthesia. But the radial pulse did not return. Hence, the fracture was explored and brachial artery was found to be compressed by the proximal fragment. Fracture fragment were reduced and the compression relieved and pulse returned. Fracture was stabilized with K-wires. Whereas in contrast to present study, Kassar JR [12] has reported cases in which the brachial artery flow was resumed often by simple reduction of the fracture under general anesthesia. Campbell *et al*. [13] have reported that 38% of their cases had evidence of injury to the brachial artery. The low incidence in the present study may be explained due to the smaller sample size. No cases had Volkmann's ischemic contracture. In the present study, 1 case (2.5%) presented with radial nerve injury. It was operated using anterolateral approach. The injury was of neurapraxia type and recovered completely by 8 weeks. Ippolito E [14] observed neurological complications in 12 of the 131 patients. In the present study, there were no cases of myositis ossificans.

Elbow stiffness was noted in 2(5%) cases, 1 case each in operative and conservative method. We defined elbow stiffness as loss of $\geq$ 25º of flexion or extension or both. Mean loss of flexion and extension in cases treated by operative and conservative method was 7.3º and 14.2º respectively. Coventry MB, Henderson CC [15] and Henrikson B [16] reported, fractures treated by closed and open methods the average loss of flexion was 4º and 6.5º 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 [17], French [18]). Pirone AM *et al*. [8] reported incidence of cubitus varus in 14% with closed reduction and cast immobilization and 11% in ORIF. (Figure-1)

Cubitus valgus deformity was noted in 1 (2.5%) case in this study, it was a type-III fracture with posterolateral displacement treated by closed reduction. Cubitus valgus was the result of residual displacement of distal fragment in lateral displacement. Ippolito E [14] reported an incidence of 5.6% of cubitus valgus treated by conservative method in a long term follow up study [Table-4].

1 case of superficial pin tract infection was noted, which was treated by appropriate antibiotics. The average period of immobilization in this study was 3.2 weeks. In 2 patients K-wire were removed after 5 weeks, because they did not turn up for follow-up after 4-weeks. The average period of follow-up in this study was 8.6 months.

In this study among 10 cases treated with closed reduction, the results were excellent in 3, good in 1, fair in 1 and poor in 5 cases. Whereas Shoaib M *et al*. [19] 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%). (Figure-2), [Table-5].

Among the 10 cases treated by operative method, the results were excellent in 6, good in 3, fair in none and poor in 1 patient. The results are comparable to results of various other studies. Mulhall KJ *et al*. [20] reported 13 cases had excellent results, 2 good and 1 had fair result. Whereas Reitman *et al*. [21] reported as 18 (55%) were rated excellent, 8 (24%) were good, 3 (9%) were rated fair and 4 (12%) rated poor. (Figure-3), [Table-7].

In the present study, the ratio of poor results of closed reduction and slab application and ORIF by K-wires for type-III fractures were 50% and 10% respectively. Similarly Diri B, *et al*. [22] reported the ratio of poor results of closed reduction and cast immobilization and ORIF by K-wire were 28.6% and 12.8% respectively. The final results when compared using Chi –square test significantly favor ($p<0.05$) operative method over conservative method of choice for treatment of supracondylar fracture of humerus in children. [Table-9].We attribute the high incidence of poor results in the conservative management group due to inadequate achievements of reduction and failure to maintain reduction. With open reduction, anatomical reduction was possible and fixation with K-wire were quite stable. Hence, we could achieve better results with ORIF with K-wires than closed reduction.

Conclusion

From the above study it is concluded that open reduction and internal fixation with K-wire is an effective and safe method of treatment for completely displaced (type-III) supracondylar fracture of the humerus in children compared to closed reduction and slab application. Closed reduction and external immobilization gives good result in type-I and type-II fractures.

Open reduction and internal fixation offers more advantage with fewer complications, more stable fixation and better anatomical reduction, better functional and cosmetic results for type-III supracondylar fractures of humerus in children.

References

1. D' Ambrosia RD. Supracondylar fractures of humerus – prevention of cubitus varus. J Bone and Joint Surg (Am). Jan. 1972; 54:61-66.
2. Aronson DD, Prager BI. Supracondylar fractures of humerus in children – A modified technique of closed pinning. Clin Orthop. 1987; 219:174-184.
3. Kasser JR, Beaty JH. Ed. Supracondylar fractures of the distal humerus. Chapter-14 in: Rockwood and Wilkin's Fractures in Children, 5th Edition, Philadelphia; Lippincott Williams & Wilkins: 2001; 3:577-620.
4. Haddad RJ, Saer JK and Riordan DC. Percutaneous pinning of displaced supracondylar fractures of the elbow in children. Clin Orthop. 1970; 71: 112-117.
5. Canale TS. Ed. Fractures and dislocations in children. Chapter-50 in Campbell's Operative Orthopaedics. 9th Edition, New York; Mosby. 1998; 3:2407-2422.
6. Gartland JJ. Management of supracondylar fractures of the humerus in children. Surg Gynaecol Obstet. 1959; 109:145-154.
7. Flynn JC, Mathews JG, Benoit RL. Blind pinning of displaced supracondylar fractures of the humerus in children. J Bone & Joint Surg (Am). 1974; 56A:263-272.
8. Pirone AM, Graham HK, Krajbich JI *et al*. Management of displaced extension-type supracondylar fractures of the humerus in children. J Bone & Joint Surg. 1988; 70A:641-650.
9. Minkowitz B, Busch MT. Supracondylar humerus fractures – Current trends and controversies. Orthop Clin North Am. 1994; 25:581-594.
10. Fowles JV, Kassab MT. Displaced supracondylar fractures of the elbow in children. J Bone & Joint Surg. 1974; 56-B(3):490-500.
11. Mcdonnell DP, Wilson JC. Fracture of the lower end of the humerus in children. J Bone Joint Surg. 1948; 30A:347-358.
12. Kasser JR. Percutaneous pinning of supracondylar fractures of the humerus. American Academy of Orthopaedics Surgeons Instr Course Lect. 1992; 41:385-390.
13. Campbell CC *et al*. Neurovascular injury and displacement in type III supracondylar humerus fractures. J Pediatr Orthop. 1995; 15(1):47-52.
14. Ippolito E, Caterini R, Scola E. Supracondylar fractures of the humerus in children. J Bone Joint Surg. 1986; 68A:333-344.
15. Coventry MB, Henderson CC. Supracondylar fractures of the humerus: 49 cases in children. Rocky Mount Med J. 1965; 53:458-465.
16. Henrikson B. Supracondylar fractures of the humerus in children. Acta Chir Scand. 1966, Suppl 103.
17. Dunlop J. Transcondylar fractures of the humerus in childhood. J Bone Joint Surg. 1939; 21A:59.
18. French PR. Varus deformity of the elbow following supracondylar fractures of the humerus in children. Lancet. 1959; 2:439-441.
19. Shoaib M, Hussain A, Kamran H, Ali J. Outcome of closed reduction and casting in displaced supracondylar fractures of humerus in children. J. Ayub Med Coll Abbottabad. 2003; 15(4):23-5.
20. Mulhall KJ, Abuzakuk T, Curtin W, O'Sullivan M. Displaced supracondylar fractures of the humerus in children. Int Orthop. 2000; 24(4):221-3.
21. Reitman RD, Waters P, Millis Michael. Open reduction and internal fixation for supracondylar humerus fractures in children. Journal of Pediatrics Orthop. 2001; 21(2):157-161.
22. Diri B, Tomak Y, Karaismailoglu TN. The treatment of displaced supracondylar fracture of the humerus in children (an evaluation of three different treatment methods). Ulus Travma Derg. 2003; 9(1):62-9.