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Study of Results of Closed Reduction and Percutaneous Pinning In Supracondylar Fractures of Humerus in Children

KEYWORDS: Percutaneous pinning, supracondylar fracture humerus, cross k wire and, lateral pinning

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ABSTRACT *Supracondylar fractures are important due to its various vascular and neurological complications and late sequelae like volkmans ischemic contracture, cubitus varus and myositis ossificans. So it is mandatory to have proper reduction and maintenance of reduction to achieve reasonable long term results and avoid above mentioned complications. There are different modalities of treatment like cross pinning and two lateral pinning. The aim of this study was to assess the efficacy of treatment of this fracture using cross pinning or two lateral pins. Our study has analyzed the results and complications of supracondylar fractures.*

Background: Supracondylar fractures are important due to its various vascular and neurological complications and late sequelae like volkmans ischemic contracture, cubitus varus and myositis ossificans. So it is mandatory to have proper reduction and maintenance of reduction to achieve reasonable long term results and avoid above mentioned complications. There are different modalities of treatment like cross pinning and two lateral pinning. The aim of this study was to assess the efficacy of treatment of this fracture using cross pinning or two lateral pins. Our study has analyzed the results and complications of supracondylar fractures.

Materials and Methods: 50 cases of displaced supracondylar humerus fractures were included in the study. The mean age of the patients was 6.7 years (range 3-12 years). The male/female ratio was 5:1 and left side was involved in 70% whereas 30% had right sided injuries. The most common mode of trauma was fall from height with elbow in extension. All the 50 consecutively admitted patients had extension type injury with 73.3% fractures being Gartland type III and 26.7% were type II. Posteromedial displacement was noted in 70% whereas 30% fractures were posterolaterally displaced. In 30 cases, two lateral entry pinning technique whereas, in 20 cases, cross K-wire technique was used. K-wires were removed 3 weeks postoperatively and follow up was done at 6 weeks and 12 weeks when they were evaluated according to the criteria described by Flynn. Chi-square test was used as a statistical test of significance to compare results among different variables.

Results: Results were graded according to Flynn's criteria. Excellent results were achieved in 7 (13.3%), good in 30(60%), fair 8 (16.7%) while in five patients (10%) poor results were obtained.

Conclusions: Both lateral entry K-wires and cross k wire fixation techniques provide stable fixation and results are equivalent in both groups except ulnar nerve involvement in cross pinning.

Introduction: Supracondylar fracture of the humerus is almost exclusively a fracture of the immature skeleton, seen in children and young teenagers. Displaced supracondylar fractures are notorious for difficulty in reduction, maintenance of reduction and frequent involvement of neurovascular structures.

No general agreement on the treatment of this fracture is evident. In displaced extension type supracondylar fractures, controversy exists regarding ideal timing of surgery, method of maintenance of reduction and configuration of the pin fixation. Mechanical stability is believed to be more with cross k wires than the lateral pins alone. However, the ulnar nerve can be injured with the use of a medial pin. It has not been proved that added stability of a medial pin is clinically necessary since, in children, pin fixation is always augmented with immobilization in a splint or cast. Lateral pins alone impart less rotational stability to the fracture although it has been attributed mainly to technical errors of pin placement.

OBJECTIVE: Percutaneous pinning in supracondylar humerus fractures in children

The objective of this study was to assess the efficacy of treatment of this type of fractures using two cross K wire or two lateral entry K-wires alone.

MATERIALS AND METHODS

A prospective interventional study which included 50 consecutively admitted cases of supracondylar fractures of the humerus in children (Gartland grade II and III).

Inclusion criteria:

1. Children aged between 2 and $2^{1/2}$ years
2. Presenting within 3 days of injury
3. Open fractures with Gustilo-Anderson grade I

Criteria for exclusion:

1. Open supracondylar fractures of humerus with Gustilo-Anderson grade II and III
2. Irreducible fracture or fracture with vascularity compromised having pulse less arm with poor perfusion.

All patients were taken for elective surgical procedures as soon as possible after adequate blood investigations and one dose of intravenous cefotaxime was given two hours before and on induction appropriate for weight . General anesthesia or regional block was used in all cases. Patient was positioned supine with

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ipsilateral shoulder at the edge of the table on a radiolucent side support. Affected elbow, arm and forearm were scrubbed, painted and draped leaving the elbow, lower third of arm and upper third of the forearm exposed. The C-arm image intensifier was positioned adjacent and parallel to the table and covered with a sterile drape. Longitudinal traction was given with elbow in less than full extension and forearm in supination. At the same time, counter-traction was given by an assistant by holding proximal portion of the arm. Continuing traction and counter-traction, medial or lateral displacement was corrected by lateral or medial force respectively at fracture site. A varus angulation was reduced by pronation of the forearm. After that, posterior displacement and angulations were corrected by flexing the elbow and simultaneously applying anteriorly directed force from the posterior aspect of the distal fragment and posteriorly directed force from the anterior aspect of the proximal fragment. Reduction was checked with anteroposterior (AP) view through the fully flexed elbow, and lateral view was taken by rotating the shoulder or by rotating the C-arm in very unstable fractures. A reduction was considered acceptable when Baumann angle was restored on the AP view; medial and lateral columns were observed to be intact, anterior humeral line passed through the capitulum on the lateral view and rotation was minimal. 1.6 mm or 1.8 mm smooth K-wires were used for maintenance of reduction. In 30 cases, lateral entry wires alone were used whereas in 20 cases, cross K-wires were used .Among the study cases in most of the patient primary reduction was achieved and maintained by inserting single k wire from lateral side. Later on, both lateral wires alone and Cross k wires techniques were utilized randomly in rest of the patients. In the latter technique, after achieving reduction and keeping the elbow in full flexion, a K-wire was inserted through the lateral column, passed across the fracture site and fixed into the medial cortex and another k wire passed through the medial column across the fracture site and fixed in the lateral column. A true AP view in maximum possible extension and lateral view of the distal humerus were taken for lateral pinning. K-wires were bent and kept at least 1 cm outside the skin. Sterile dressing was applied, and an above elbow posterior plaster of Paris (POP splint in 90^0 elbow flexion and supine position of the forearm was given. On second post operative day patients were discharged after check x ray with oral antibiotics and analgesics and asked for follow up after 3 weeks to look for signs of union of fracture on check X ray. In nine patients, the K-wire had to be retained till 4 weeks postoperatively due to lack of clinical union at 3 weeks. In no patient were the wires retained for more than 4 weeks and all patients were advised to do gentle intermittent active elbow extension and flexion exercise. At 6 weeks, radiological examination was again done to assess union. Patients were advised the exercises of the elbow till final follow up in outpatient department at 12 weeks when they were evaluated -results graded according to toe criteria described by Flynn .[0] (loss of movements and change in carrying angle). The obtained results were further categorized according to variables like method of fixation, grade of fracture relapsed between injury and surgery and age of the patient and statistical analysis of these results was done using Chi-square test as a test of significance.

Figure 1: 1 week follow-up of lateral k wire

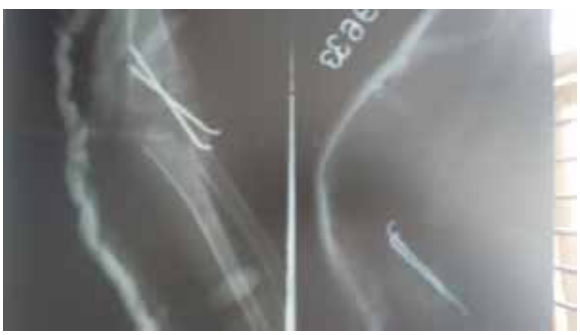

Figure 2: check x-ray at 1 week follow up

Figure 3: 1 week follow up of lateral cross k wire

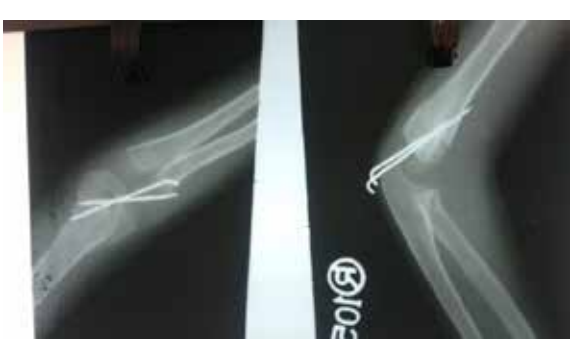

Figure 4: post operative check film of supracondylar fracture

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Figure 5: 3 Weeks follow up showing full extension

Figure 6: 3 Weeks follow up showing full flexion

RESULTS

Out of the 50 children in the study (mean age 6. 7 years range 3-12 years), 42 (82%) were boys and 8 (18%) were girls. The left side was involved in 15 (30%) and rest had right sided injuries. All the consecutive admitted patients were of extension type. 37(73.3%) fractures were of Gartland type 3 and 13(26.7%) was type 2 with posteromedial displacement in 35 and 15(30%) fractures being posterolaterally displaced. We noted 2(4%) distal radial metaphyseal fractures and 2(4%) fractures both bones forearm in association with the supracondylar fracture. These patients were also included in the final analysis.

Preoperative complications included radial nerve palsy in 2(4%) cases, feeble radial pulse, but adequate distal perfusion in two (4%) and grade I open fracture in two (4%) patients. four (8%) patients were operated within 12 h of injury; 18 (36%) in 12-24 ; 22 (44%) in 24-48 hand 6 (12%) were operated within 48-72 h of injury (due to late presentation or massive swelling at the elbow. Maximum percentage of excellent cases was noted in the group operated within 12 h of injury (50%) and highest percentage of poor cases (25%) was observed in the group operated within 48-72 h after injury. The results were analyzed statistically using Chi-square test for significance and it was noted that there is no statistically significant difference in results in patients operated at various durations after injury (X^2 = 11.841; df = 12; P> 0.05). Early postoperative complications included pin tract infection in 1 (2%) and loss of reduction in 5 (10%) cases. Out of these five cases with postoperative loss of reduction, one fracture was significantly displaced, and rests four were mildly displaced. Although in all these cases satisfactory reduction had been achieved intra operatively, loss of reduction was seen in X-rays on first postoperative day probably due to technical errors of pin placement. In the three cases with significant loss of reduction, wires were removed and open reduction and stabilization with K-wires was done under GA. In the other four cases, since the displacement was mild and more than 24 h had already elapsed after pinning, we continued with the POP splint fearing the risk of complications from multiple attempts at reduction. At final follow up at 12 weeks, 3 (6.0%) patients developed elbow stiffness and 3 (6.0%) cases of cubitus varus deformity were noted. Results were evaluated according to Flynn. Criteria. Excellent result was achieved in 7 (13.3%) patients, good in 30 (60%), fair in 8 (16.67%) and poor in 5 (10%) patients. Thus, satisfactory result was obtained in 90% cases and the rest 10% had unsatisfactory results according to Flynn criteria. Poor results were obtained in the cases in which loss of reduction was noted in the immediate postoperative period.

The ratio of satisfactory cases in grade II fractures (100%) were more than those in grade III fracture (86.3%). But after applying statistical test of significance (chi-square test), it was observed that the difference in results of grade II and III were not statistically significant (X^2 = 4.290; df = 3; P> 0.05) [Table 2]. Maximum percentage of satisfactory results (100%) was achieved in age group 2-4 years whereas least satisfactory results (84.6%) were noted in age group 9-12 years. However, after applying a statistical test of significance, it was observed that there is no statistically significant difference in results among patients of different age groups (x^2 = 4.570162; df = 6; P > 0.05) [Table 3].

DISCUSSION

The mean age and sex incidence observed in our study was comparable to the studies of Nacht, Wilkins, Fowles and Kassab and Aronson and Prager. Out of the various complications reported, we observed an incidence of 4% of nerve injuries (all radial nerve) whereas Fowles and Kassab[12] reported an incidence of 6.36%, Wilkins 7.7% and Aronson and Prager observed it to be 5 % in their study. The incidence of the brachial artery injury reported by Pirone *in* 10%, Fowles and Kassab in 7.27% and Aronson and Prager observed no case of the same-in their study of 30 cases. In our study, 2 cases (4% incidence) had preoperative vascular complications in the form of feeble radial pulse but adequate distal perfusion and after fixation of fracture capillary filling was sufficient, immediately after surgery and the pulse returned to its normal volume within 8 h of surgery in all cases.

Early postoperative complications included loss of reduction in 5 (10%) cases. Musa in their study observed 10% incidence of iatrogenic ulnar nerve injury with crossed percutaneous pinning, whereas Balakumar and Madhurio noted an incidence of iatrogenic nerve injuries of 1.1 %, 2.2% and 1.1 % for ulnar, median radial nerves respectively using various techniques of percutaneous pinning. We observed two cases (4% incidence) of iatrogenic ulnar nerve injury which recovered completely after 6 to 8 weeks of pins removal. In their study, Devkota noted loss of reduction postoperatively in 1. 96 % cases; Lee observed the same i.e. in 7% cases, whereas Balakumar and Madhurio in their study observed postoperative loss of reduction in 18.2% cases.

Table 1: Results according to time relapsed between injury and surgery

Time between-injury and surgery	Result%				Total
	excellent	Good	Fair	Poor	
<12	1(50)	2(50)	0	0	3
12 – 24	6(18.2)	10(54.5)	5(27.3)	0	21
24-48	0	15(69.2)	2(7.7)	3(15.4)	20
48-72	0	3(50)	1(25)	2(25)	6
Total	7	30	8	5	50

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Table 2: Results according to grade of fracture

Gartland grade	Results				Total
	Excellent	Good	Fair	Poor	
2	1(12.5)	9(87.5)	0	0	10(100)
3	6(13.7)	21(50)	8(22.6)	5(13.7)	40(100)
Total	7	30	8	5	50

Table 3: Results according to age group

Age (in years)	Results (%)				Total
	Excellent	good	Fair	Poor	
2 to 4	3(30)	6(60)	1(10)	0(0)	10
5 to 8	7(25.9)	14(51.9)	5(18.5)	1(3.7)	27
9 to 12	4(30.8)	4(30.8)	3(23.0)	2(15.4)	13
Total	14	24	9	3	50

In our study, loss of reduction was noted at the time of first postoperative X-ray (satisfactory reduction was achieved under C-arm in all these cases).four out of these five cases belonged to the lateral entry K-wires group and one occurred Cross K-wires group. The incidence of cubitus varus after pinning of supracondylar fracture of the humerus was observed as 6% by Lee & 8.6% by Wael whereas Aronson and Prager observed no case of cubitus varus. The incidence of pin tract infections noted by Wael was 8.6%, 7.84% by Devkota whereas Aronson and Prager reported no case in their series. In our study, two (4%) cases of pin tract infection were noted, which were superficial and were treated effectively with oral antibiotics and with pin removal at 3 weeks and did not lead to any sequelae.

Majority of patients regained almost full range of motion at 12 weeks. Five (10%) patients had loss of movements at the elbow more than 150°.Mean loss of flexion was 7.3° and ranged from 0 to 25°. Mean loss of extension was 2.6° and varied from 0° to 18°. In their studies, Maity Musa and Foead observed the mean loss of movements at final follow-up to be 3.86°, 4° and 18.3° respectively. A slightly more loss of movements at final follow up was observed in our study which may be attributed to a shorter period of follow up. In our study, most of the patients (30 i.e. 60%) had a decrease in carrying angle only up to 50°. Loss of carrying angle ranged from 0° to 18° with mean decrease of 5° to 10°. No case of cubitus valgus was observed. Musa observed 2.6° and Foead noted 3.7° mean change in carrying angle in their studies respectively.

No statistical difference was found in terms of mean loss of extension, mean loss of flexion and mean change in carrying angle between the two groups and analysis indicated that there was no significant difference in these parameters between patients who had cross k wire fixation and those who had lateral pin fixation [Table 4].

We achieved 7 (13.3%) excellent, 30 (60%) good, 15 (16.67%) fair and 5 (10%) poor results. Thus, satisfactory results were obtained in 90% cases and the rest 10% had unsatisfactory results according to the criteria described by Flynn et Fowles and Kassab[12] achieved 87.5% satisfactory results; Davis 80% and Aronson and Prager obtained 100% satisfactory results in their studies. Hence, the results in our study were similar to the results noted in most other studies '[Table 5].

Results were also compared between the two methods of fixation. In both groups, satisfactory results were obtained in 90% cases and unsatisfactory in 10% cases. After statistical analysis, it was found that there was no statistically significant difference in results if either lateral wires or lateral with cross k wires were used as a method of fixation ($X^2 =$ 0.775; df = 3; $P > 0.05$) [Table 5].

A probable limitation in our study was a shorter period of follow-up as compared to most of the other studies. Though, we did follow-up some of our patients as long as till I-year, this was not incorporated in the study. It was observed that at follow-up at I-year, the findings in elder children did not vary much from those at 12 weeks, whereas in younger children, slight changes in the final clinical appearance of the elbow were present, although functional outcome remained more or less the same.

Though many studies have been done so far to analyze the outcome of various treatment modalities for fixation of pediatric supracondylar fractures humerus, none of them has been done to evaluate the outcome of cross k wire pinning technique. Thus, our study provides a comparison between the already established lateral entry pinning technique and the cross k wire pinning technique.

Table 4: Analysis of loss of extension, flexion and carrying angle between two methods of flexion

clinical parameter (in degrees)	2 lateral pins	Cross pinning	P (using student's t-test)
Mean loss of extension	2.1+-4.35	3.70+-4.19	0.11
Mean loss of flexion	7.5+-5.25	6.90+-6.26	0.63
Mean change in carrying angle	5.5+-4.72	4.90+-2.85	0.52

Table 5 : Results according to method of fixation

Gartland grade	Result				Total
	Excellent	good	Fair	poor	
2 lateral pins (%)	5(15)	21(55)	6(20)	4(10)	36(100)
Cross pinning (%)	2(10)	9(70)	2(10)	1(10)	14(100)
Total	7	30	8	5	50

CONCLUSION

Both lateral entry K-wires and cross k wire techniques provide stable fixation when observing the guidelines for wire placement. With both the techniques, consistently satisfactory results can be obtained both cosmetically and functionally.

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