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A prospective study of crossed versus lateral only pinning in the treatment of displaced supracondylar fractures of the humerus in children

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Abstract

Supracondylar fracture of humerus in children is the most common fracture of the upper limb. There is a lot of controversy regarding optimal method of treatment. Some others prefer lateral only pinning and others prefer crossed medio lateral pinning. We conducted a study at Mc Gann teaching district hospital Shivamogga to compare the results of lateral only pinning and crossed medio lateral pinning in supracondylar fracture humerus in children. There were 20 patients in each group. The results were assessed by as per criteria of Mitchell and Adams (1961) and Flynn's criteria. There was no statistically significant difference in the outcome of both the groups when assessed by above criteria

Keywords: Supracondylar fracture humerus, Lateral pinning, Crossed pinning, Medio lateral pinning

Introduction

Supracondylar fracture of the humerus is one of the most common paediatric fractures encountered by orthopaedicians in their day to day practice. It is also the most common fracture around the elbow in paediatric age group [1, 2]. These fractures account for 65.4% of upper extremity fractures in children [3]. The fracture occurs at the distal end of humerus where the tubular bone becomes flat bone and the fracture lies just above the articular surface. Because of local anatomy, it is difficult to reduce the fracture and also to maintain it. The majority of these fractures (96-98 %) are extension-type fractures [4-7]. Hippocrates in his works has mentioned about this fracture long ago but its treatment methods are traceable in literature only after 17th century AD.

Gartland in 1959, classified extension-type supracondylar fractures in children into three types [8]. Type I fractures are non-displaced, type II are displaced with an intact posterior cortex and type III are completely displaced without cortical contact. Further, type IIIa fractures have posteromedial displacement of distal fragment and type IIIb have posterolateral displacement. Supracondylar fractures may be associated with a number of complications such as neurovascular injuries, malunion, compartment syndrome, iatrogenic neurovascular injury and elbow stiffness [1, 2, 9]. Cubitus varus due to malunion is the most common angular deformity and the incidence is around 5% according to Flynn *et al.* [10]. Incidence of iatrogenic ulnar nerve injuries after percutaneous fixation with medial and lateral entry pinning was about 15% according to Chai [11].

In 1908 Ingerbrightson used overhead skin traction for treating these fractures. In 1920 Bauman, Bohler and Heygroves, introduced olecranon pin traction. In 1924 Cotton advised closed reduction of the fracture and immobilisation in plaster strapping around the chest. Flynn *et al.* in 1974, concluded that closed reduction and percutaneous pinning provided stability [10]. Zions *et al.* in 1994, studied the torsional strength of pin configurations used to fix the supracondylar fracture of the humerus in children and concluded that because two crossed pins placed from medial and lateral condyles provided the greatest resistance to gross rotational displacement, this method may be preferable in most fractures [12].

Topping *et al.* in 1995 in their clinical evaluation of crossed pin versus lateral pin fixation in displaced supracondylar fractures, concluded that cross pin fixation offers no clinically significant advantages over two laterally placed pins [13].

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Though crossed medio lateral pin fixation provides increased biomechanical stability, it carries the risk of iatrogenic ulnar nerve injury from placement of the medial pin [14, 15, 16]. Two lateral pin fixation avoids the danger of iatrogenic ulnar nerve injury, but it provides less biomechanical stability [12, 17, 18, 19]. The aim of our study was to compare the outcome of medial and lateral entry pinning with lateral only pinning for percutaneous fixation of displaced supracondylar humerus fractures in children (Gartland type II and type III extension type).

Materials and methods

Between May 2016 and Jan 2017, 46 children with displaced unstable type II and type III supracondylar humeral fractures were managed with the lateral only pinning or crossed medio lateral pinning technique in the department of orthopaedics, SIMS, Shivamogga. There were 29boys (63%) and 17 girls (37%). Their age ranged from 3 to 13 years with a mean of 7.5 years. Both right and left sides were nearly equally affected. There were 32 patients with postero medial (69.56%) and 14 patients with postero lateral (30.43%) displacement. Most of the injuries were due to fall from height (55%).

On arrival, patients were assessed both clinically and radiologically. Each patient was assessed carefully for any peripheral neurovascular deficits. None of the patients were having neurological deficits at presentation. Among 46 patients, 2 patients who were lost to follow up(1 male from each group), 2 patients with open fractures(1male and 1female)and 2 patients in whom closed reduction could not be achieved and had to be open reduced were excluded from the study. Radial pulse was absent on presentation in 2 patients and it was feeble in 4 patients. The average time lapse between injury and surgery was 23 hours. The average time taken for surgery was 14 min. Finally total of 42 patients were included in our study after taking well informed consent from the parents or guardians as the patients were minors and divided them in to two groups. Group I, lateral only pinning group and group II crossed medio lateral pinning group. Lateral only pinning or crossed medio lateral pinning group was done according to the random assignment scheme. Institutional ethical clearance was taken to conduct this study.

Inclusion Criteria

1. Only type II and type III supracondylar humerus fractures.
2. Age between 3 to 13 years.
3. Only extension type of fractures was included.

Exclusion Criteria

1. Open fractures.
2. Fractures associated with neurological injuries.

Source of fund

No source of external funding in support of this study was taken.

Procedure

Under general anaesthesia, the patient was put on supine position with injured limb on a radiolucent side table with the shoulder in 90 degrees of abduction and elbow in 15 to 25 degrees of flexion. Traction was given by the surgeon holding the forearm and the Counter traction was given by the assistant with both his hands in the axilla of the child holding the lateral side of the chest. Traction was continued around a

minute and distal fragment is milked gently and mediolateral displacement was corrected in AP view with fluoroscopic assistance. Now keeping thumb over patients olecranon, the elbow was flexed gently and fracture was reduced by manipulation and confirmed by lateral view. We do not rotate the limb for lateral view, instead move the C-arm. Reduction was confirmed in both AP and lateral views, Two or three 1.5mm or 2mm K wires were passed from lateral condyle, directed in parallel or divergent configuration in a retrograde fashion till they cross the medial cortex. Stability of reduction was checked by extension of the elbow. K-wires were left percutaneous and bent and cut just proud of the skin which helps to remove without anesthesia. For mediolateral cross pinning, first lateral K-wire was passed as explained above and elbow was extended gently ulnar nerve was pushed backwards by thumb and K-wire was passed from medial epicondyle upwards towards the lateral cortex till it just pierces the lateral cortex.

The limb was immobilised in an above elbow POP slab for 4 to 6 weeks. Patient was discharged after 24 to 48 hours with oral antibiotics and appropriate analgesics.

Follow up

Weekly pin site dressing was done. K- wires were removed at 3 to 4 weeks and mobilization of elbow was encouraged. X rays were taken immediately in the post-operative period and subsequently at 3 wks, 6 wks, 9 wks, 3 months and 6 months. During follow up, patients were assessed for cosmetic appearance passive range of elbow motion, Carrying angle. Minimum of six months of follow up was done before assessment. Each patient was assessed by the same doctor throughout the study.

Results were assessed as per criteria of Mitchell and Adams (1961) as shown in table 1 and Flynn's criteria [10] as in table 2. Statistical analysis was done by student t test and Chi-square test.

Table 1: Criteria of Mitchell and Adams (1961)

Results	Criteria
Excellent	Normal shape & movements apart from 5 ⁰ changes in carrying angle and 10 ⁰ limitation of flexion.
Good	Reduction of the carrying angle from 5 ⁰ to 10 ⁰ but not beyond Cubitus rectus and restriction of flexion by 10 ⁰ to 20 ⁰ .
Unsatisfactory	Alteration of carrying angle by more than 10 ⁰ with obvious varus deformity and restriction of flexion more than 20 ⁰ .

Table 2: Flynn's criteria for grading

Results	Rating	Carrying angle loss (Degrees)	Total range of elbow motion loss (Degrees)
Satisfactory	Excellent	0-5	0-5
	Good	5-10	5-10
Unsatisfactory	Fair	10-15	10-15
	Poor	Over 15	Over 15

Results

Between May 2016 and May 2017, total of 42 children with displaced unstable type II and type III supracondylar humeral fractures were treated by percutaneous pinning. Among them 1 male child from each group lost to final follow up leaving 40 children for final assessment. There were no statistically significant differences between the groups regarding characteristics such as age, sex, laterality, type of fracture

displacement, duration between injury and surgery, duration of surgery and also there was no significant difference between two groups regarding neurovascular injuries on presentation (Table 3). There was no significant difference in withdrawal in both the groups. Each patient's X rays were taken before the final follow up examination was done. The results were compared at minimum follow up of 6 months. Results were assessed after careful assessment of cosmetic appearance, carrying angle, range of motion

Table 3

Baseline characteristics	Lateral only pinning group(n=20)	crossed medio lateral pinning(n=20)	p value
Age (years)	7.62±2.5	7.37±2.7	0.76
Males (% of children)	13(65%)	12(60%)	0.74
Laterality (% of patients)			
Left	11(55%)	12(60%)	0.75
Right	9(45%)	8(40%)	
Type of displacement (% of patients)			
Postero medial	14(70%)	15(75%)	0.72
Postero lateral	6(30%)	5(25%)	
Gartland type (% of patients)			
Type II	7(35%)	8(40%)	0.74
Type III	13(65%)	12(60%)	
Duration from injury to surgery (hrs)	23±6	22±8	0.66
Average time taken for surgery (min)	16±6	15±8	0.66

Table 4: Criteria of Mitchell and Adams (1961)

Results	Criteria
Excellent	31
Good	9
Unsatisfactory	-

Table 5: Flynn's criteria for grading

Results	Lateral only	Medio lateral	Total
Excellent	15	16	31
Good	4	3	7
Fair	1	1	2
Unsatisfactory	-	-	-
	20	20	40

Radiographs



Pre op lateral view

Pre op AP view



Post op lateral

Post op AP

Case 1: Lateral only pinning



Pre op lateral

Pre op AP



Post op Lateral

Post op AP

Case 2: Medio lateral pinning

Complications

There were 3 cases of pin track infections, 2 in lateral only pinning cases (among them in one case, a K-wire came out at 2 weeks because of infection) and 1 in mediolateral cross pinning cases. In 1 case of medio lateral cross pinning post-operative ulnar nerve injury was noticed, in which medial pin was removed at 3 weeks. At 9 weeks the ulnar injury recovered completely. For pin track infections regular dressing with saline soaked gauze was done to remove any crust or debris and K- wire tips were covered with povidone iodine soaked gauze.

There was no statically significant differences between the two groups with respect to the outcome measures such as carrying angle, elbow range of motion, change in the Baumann angle and loss of reduction, Flynn's grading.

Discussion

Previously, type II and type III supracondylar humerus fracture in children were managed by open reduction. But the most accepted method of treating type II and type III supracondylar fracture humerus in children now a days is

closed reduction under image intensifier and percutaneous K-wire fixation. This minimally invasive method of treating supracondylar fracture humerus in children is the accepted modality of intervention. There is a lot of controversy regarding K-wire placement in terms of stability, retention of fixation and ulnar nerve injury. Convincing evidence of the ideal method of percutaneous K-wires fixation is lacking. Arino *et al.* [20] used two lateral only K-wires. Swenson [21], Casiano [22] and Flynn *et al.* [10] used two crossed medio lateral K-wires. Though medio lateral k-wires fixation provides relatively a strong construct, it carries the risk of iatrogenic ulnar nerve injury [14, 15, 16].

We conducted a prospective randomized study to analyse to compare the efficiency of lateral only pinning with medio lateral cross pinning for the fixation of displaced extension type supracondylar humerus fractures in children. In our study out of 46 children, 2 had open fractures and were excluded from our study. Among these 44 children we could achieve closed reduction in 42 children and 2 children were considered for open reduction (95.45%). These figures compare favorably to the 60% rate of closed reduction achieved by Millis *et al.* [23] and 78% by Mazda *et al.* [24] In the Boston series, they achieved a rate of 92% of closed reduction. [25] In our study we can say that around 90 to 95 percent of the type II and type III supracondylar humerus fractures in children can be treated by closed reduction and percutaneous pinning. Ulnar nerve was iatrogenically injured in one case (neuropraxia), which was treated by medio lateral crossed K-wires. [15, 16, 18, 26] In our study there were no late displacement of fractures after percutaneous K-wire fixation. Pin track infections are described in literature in up to 18% of cases. [24] In our study we had one case of iatrogenic ulnar nerve injury (2.5%) in which medial K-wire was removed at 3 weeks and the ulnar nerve recovered completely at 6weeks. Pin track infection was 7.5% which is comparable to other series.

According to Flynn's criteria, in our series there were 15(75%) cases in lateral only pinning group and 16(80%) cases in medio lateral pinning group had excellent results, 4(20%) cases in group I and 3(15%) cases in group II had good results and 1(5%) in each group had fair result. none of the cases were having unsatisfactory results and these results are comparable to other studies [19, 24] According to criteria of Mitchell and Adams (1961), 31(77.5%) patients were having excellent results and 9(22.5%) patients were having good results. In the 1980s in Kallio's series [19] 48% needed an open reduction. However, more recently in the 1990s, only 23% in the French series [24] required an open reduction. In our series out of 44 patients only 2 (4.54%) patients required open reduction. In Brauer *et al.* series, there were no significant difference between the two groups in terms of iatrogenic nerve injury and loss of reduction [27] Our results are comparable to Brauer *et al.* series.

Conclusion

In our study we could conclude that there is no significant difference in the outcome between the lateral only pinning and crossed medio lateral pinning in terms of the stability, secondary displacement and union rate. Regarding ulnar nerve injury, we conclude that if the operating surgeon follows the technique of extension of elbow and retraction of the ulnar nerve by the thumb before pin placement, ulnar nerve injury can be avoided. We also conclude that, fixation of the medial K-wire is technically not so difficult. In view of comparable results in our study we are of the opinion that both

percutaneous lateral only pinning and crossed medio lateral pinning yields similar results and both the techniques are equally acceptable.

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