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Original Research Article

Comparative study of crossed pinning v/s lateral pinning in paediatric supracondylar humerus fractures

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ABSTRACT

Background: Closed reduction and percutaneous pinning are the preferred management of supracondylar humerus fractures in children, but the preference of pinning pattern needs more research. A prospective comparative interventional study was undertaken to compare the stability of fixation, functional outcome and neurovascular complications between crossed pinning and lateral pinning in Gartland type 2 and type 3 fractures.
Methods: 60 patients of age group 2 to 12 years with Gartland's type 2 and 3 fracture were randomized into 2 groups- lateral pinning (n=30) and crossed pin fixation (n=30). Intraoperative parameters were compared, post operative ulnar nerve palsy and serial range of motion were assessed. At 3 month follow up, outcome was assessed using Flynn criteria. The results were compared and analysed.
Results: There were 2 cases (3.3%) of iatrogenic ulnar nerve injury in crossed pinning group and none in lateral pinning group. Lateral group had more cases with excellent Flynn rating. The mean loss of range of motion and the mean loss of carrying angle was significantly lower for lateral method.
Conclusions: Lateral pinning provides, better functional outcome along with comparable stability without the risk of iatrogenic ulnar nerve injury.

Keywords: Supracondylar humerus fractures, Iatrogenic ulnar nerve injury, Pinning

INTRODUCTION

Supracondylar fractures of the humerus are the most common elbow injuries in children and adolescents, accounting for approximately 60% of all elbow injuries.[1,2] These injuries can be difficult to treat due to immediate complications like compartment syndrome, neurovascular damage, and late complications like Volkman's ischaemic contracture and malunion.[3-5]

Supracondylar fractures of the humerus are common in children aged 5-10, causing high rates of neurovascular injury due to falls on non-dominant limbs, often resulting from falls during play or stairs.[6,7] These fractures are broadly classified as extension and flexion types depending on the position of the distal fragment. Extension type fractures constitute 96%, whereas the flexion type are rare.[6] Gartland's classification holds the test of time for these injuries, with extensions being classified as displaced fractures (type I), partially displaced fractures with intact posterior hinge (type II), and completely displaced fractures with no contact between bone fragments (type III).[8,9]

Wilkins further classified type III fractures based on coronal displacement as Gartland IIIA- posteromedial and IIIB- posterolateral type respectively.[10] Leich et al, added type 4 fractures with multidirectional instability. Posteromedial fractures are more stable once reduced. In posterolateral fractures the proximal fragment lies

anteromedially, impinging on the brachialis muscle and potentially injuring the median nerve and brachial artery. Various treatment modalities have been advocated for these fractures, including closed reduction posterior slab support, pin traction till reduction of swelling, closed reduction and percutaneous pining under fluoroscopic guidance, and open reduction. Percutaneous k-wire fixation is recommended for closed reduction and open reduction, but cross k wire fixation provides best stabilization.[6]

Conservative treatment is associated with complications such as loss of reduction, compartment syndrome, and malunion.[11] The most common choice of pinning in children is either a medial or lateral pin in a cross manner or two lateral pins. Cross pinning has proven to be superior to two lateral pinning with more stability, excellent results, and less morbidity.[5,10]

So, Lateral pinning and crossed pinning are 2 standard fixation techniques for supracondylar humerus fractures in children. As per previous studies, crossed pinning has better stability but has more incidence of ulnar nerve injury which can cause long term morbidity whereas lateral pinning provides comparable stability with minimal risk of ulnar nerve injury.

The aim of the present study was to compare the functional outcomes of lateral and cross pinning technique using Flynn criteria in supracondylar humerus fractures in children.

METHODS

After approval from institutional ethical committee, the present prospective comparative type of interventional study was conducted in Department of Orthopedics and Traumatology, M.G.M Medical College & M.Y Hospital, Indore (M.P) on 60 patients of supracondylar fractures of the humerus of age group from 2 years to 12 years of age who visited the emergency OPD of M.Y Hospital, Indore and qualified the inclusion criterion were enrolled for the study.

A written informed consent as per Indian Council of Medical Research (ICMR) guidelines for children was obtained from parent after explaining the study protocol in their vernacular language.

Inclusion criteria

All patients of fracture supracondylar humerus of age group from 2 years to 12 years of age. Gartland's classification type 2 and 3. Duration of injury less than 7 days

Exclusion criteria

Compound fractures, pathological fractures, history of massage, abnormal skin conditions, compromised neurovascular status, ipsilateral and contralateral upper limb fractures

Sampling method

Sequential method of sampling was used and first 60 patients coming to OPD/Casualty who fulfilled the inclusion criteria were included in this study. Primary ATLS protocol was followed and patient was hemodynamically stabilized. X-ray elbow–antero-posterior and lateral view were done and above elbow slab support was given.

Operative procedure

All the surgeries were done with the patients in supine position and under suitable anaesthesia (GA/regional). Patients were randomly allocated to the two methods of pinning in an odd even manner i.e., crossed pinning (n=30) and lateral pinning (n=30).

Surgical technique

Crossed pinning

Smooth 2.0 mm K-wire used for children (6-12 years). 1.6 mm K-wires can be used for smaller children (2-6 years). Two pins inserted through lateral epicondyle and one pin through medial epicondyle such that they cross proximal to the fracture line.

Two lateral pins were inserted sequentially in diverging manner and engaged to opposite cortex. While inserting medial pin the ulnar nerve was palpated and retracted posteriorly. Avoid making entry through the posterior aspect of medial epicondyle, to avoid the chances of ulnar nerve injury.

Lateral pinning

3 pins inserted through lateral condyle sequentially. First pin was inserted adjacent to olecrenon process and engaged in opposite cortex, then the rotational and mechanical stability were assessed.

Second pin was inserted through centre of lateral column diverging away from the first pin and fixed to opposite cortex and the third pin was inserted lateral to the second pin in lateral condyle and engaged in the opposite cortex taking a longer span. Pin separation at fracture site =/>2 mm for better stability.

Evaluation

Intraoperatively, all patients were evaluated for duration of surgery, number of C-arm shoots and loss of reduction. Immediate post operatively, above elbow slab given and assessed for iatrogenic ulnar nerve injury, compartment syndrome and other complications.

Post operative follow up

Done at 2 weeks, 4 weeks, 8weeks and 12 weeks. At 4th week X rays were done and radiological union assessed before slab and pin removal. Active elbow exercises started. Final follow up was done at 12th week and patient was evaluated for functional outcome using Flynn criteria.

Statistical analysis

The data was collected and entered in standard software and analyzed. All the descriptive data were presented as mean, standard deviation, frequency and percentages represented as the pie charts and bar diagrams. The continuous data were analysed using student t test for mean difference and the strength of association between the variable using the Pearson's correlation was calculated. A p value of <0.05 was considered statistically significant.

RESULTS

Out of 60 patients, maximum 38.3% of patients belonged to 6-8 years of age group. A higher number of patients were males 39 (65%) as compared to females 21 (35%). Fall [fall on outstretched hand] was the most commonly reported mode of injury with 90% patients. Majority of the patients 32(53.3%) had gartland type 3 fracture and 28 (46.7%) patients had gartland type 2 fracture. Highest proportion 54.5% for excellent outcome was in those who presented on day first of injury. None of the patient in the lateral group and only 2(3.3%) patients belonging to crossed method reported ulnar nerve injury. Immediate removal of medial K wire was done for recovery of the nerve. None of the patients reported any infection or pin tract infection.

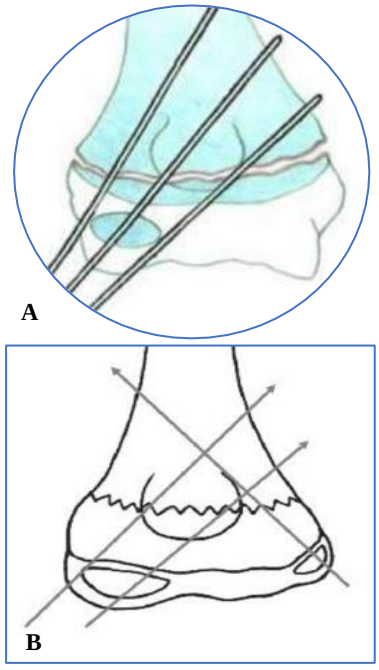

Figure 1: Lateral and crossed methods.

Figure 2: (A) Crossed pinning left side- loss of carrying angle-1 degree; (B) loss of range of motion-3 degree & (C) Flynn criteria-excellent.

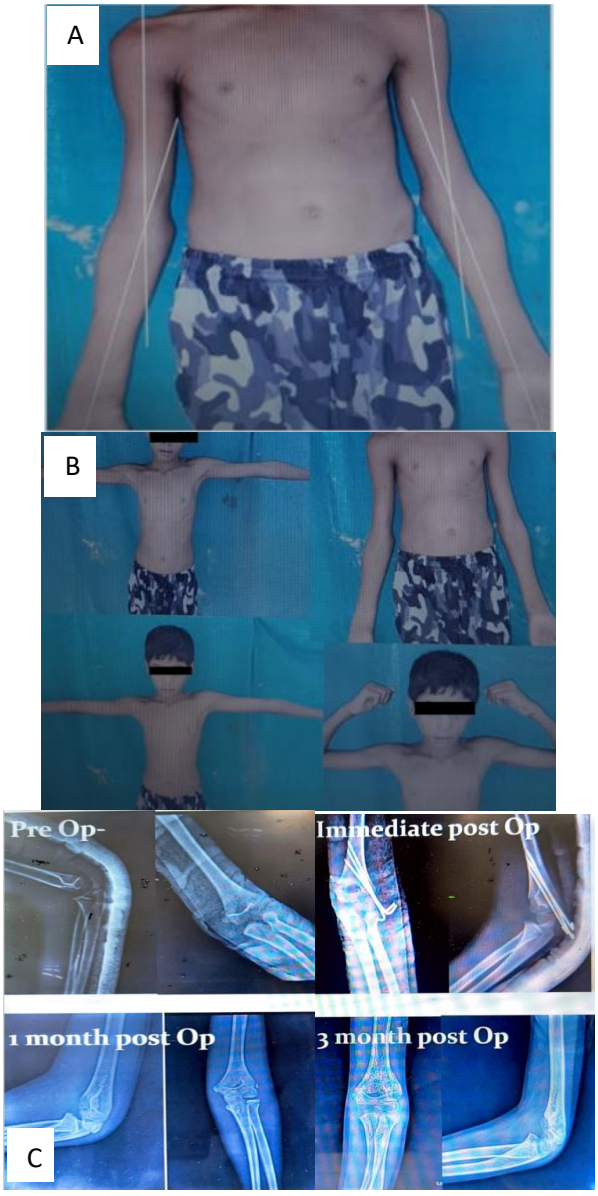

Figure 3: (A) Lateral pinning left side- loss of carrying angle-2-degree, (B) loss of range of motion- 4 degree & (C) Flynn criteria-excellent.

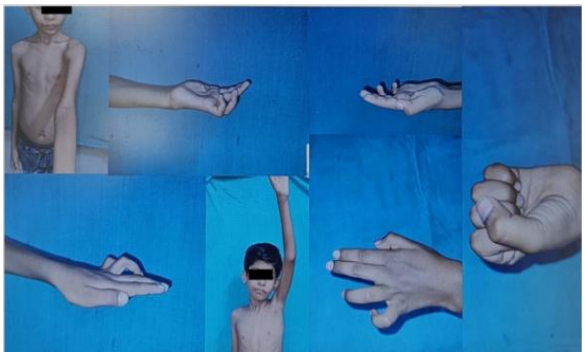

Figure 4: Complication--iatrogenic ulnar nerve palsy in crossed pinning.

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

Figure 5: Flynn criteria.

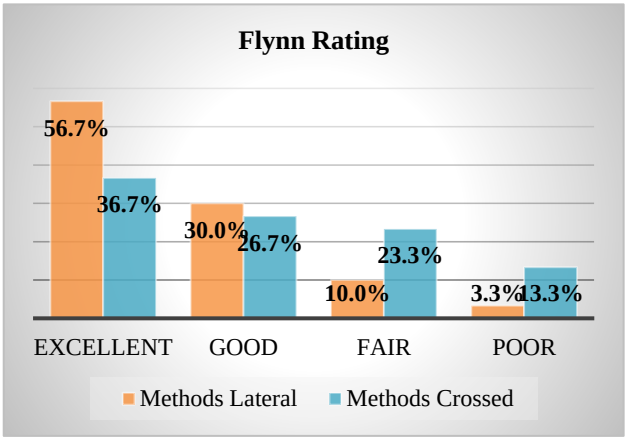

Figure 6: Association between Flynn rating and two study methods.

Table 1: Comparison between lateral and crossed pinning.

	Lateral pinning method	Crossed pinning method	P value
Mean age (in years)	6.30+1.822	6.27+2.559	0.954
Mean surgical time (min)	39.57+3.350	41.33+4.205	0.077
Number of C arm exposure	17.23+3.441	16.47+3.431	0.391

Table 2: Comparison of mean loss of elbow range of motion and loss of carrying angle at 12 weeks among two methods.

Variable	Methods	Sample	Mean	Standard deviation	T Test	P Value	Result
Loss of elbow Range of motion in degree at 12 weeks	Lateral	30	6.17	3.514	-2.511	0.015	Significant
	Crossed	30	8.87	4.725			
Loss of carrying angle at 12 weeks	Lateral	30	2.47	1.008	-2.437	0.018	Significant
	Crossed	30	3.3	1.579			

A higher number of patients in lateral method group 17 (56.7%) had excellent Flynn rating as compared to crossed pin method with 11 (36.7%) patients. 5 (8.3%) patients had poor Flynn rating with 4 patients belonging to crossed pin surgical method while only 1 patient belonging to lateral method. A statistically significant correlation was observed between the Flynn rating of outcome and delay in presentation for first visit ($p<0.05$). Mean union time for lateral method was lesser (4.1 weeks vs 4.2 weeks).

The mean carrying angle for lateral method was significantly lower compared to crossed method (14.47+1.0080 vs 15.30+1.5790; $p<0.05$). The mean loss of carrying angle (measured with respect to the contralateral normal limb) was significantly lower for lateral method (2.470 vs 3.300; $p=0.018$). The mean loss of elbow range of motion measured with respect to the contralateral normal limb was significantly lower for lateral method (6.170 vs 8.870; $p=0.015$).

DISCUSSION

Supracondylar fractures are common and challenging in children, with the main goal being anatomical reduction and stable internal fixation. Closed reduction with K-wires fixation is the gold standard in managing these injuries. The success of surgical treatment depends on initial accurate reduction and maintenance of reduction till union. There is ongoing debate on the best pin fixation modality for displaced supracondylar humerus fractures in children. Common treatment methods include crossed pinning and lateral only pinning. Cross pinning provides more fracture stability but can cause iatrogenic ulnar injury. Biomechanical studies by Larson et al found cross pinning provides greater rotational stability than lateral pinning.[12]

The present study aimed to compare the efficacy of lateral pin fixation and crossed pin fixation for Gartland type 2 and 3 supracondylar humerus fractures in 60 patients. In our study the mean age was in 6 to 8 years group with lateral method being non significantly more than crossed method. Prashant et al, reported that the men age was 8.4 years in their study.[13] This was in concurrence with results of our study Khwaja MK et al, reported that the mean age was 6.1 years.[15] These were with concurrence with our study. A higher no. of patients were males 39 (65%) as compared to females 21 (35%). Similar study done by Barr et al, also reported a higher male gender predominance in their series of 159 patients and Naik GL et al, in reported a predominance of male gender with 21 (36.8%) females and 36 (63.2%) males.[1,14] Fall on outstretched hands was the most commonly reported mode of injury with 54 (90%) patients. Prashant et al, reported that the commonest cause of injury was falling while playing (64.51 %), followed by fall from a tree (27.41 %) and fall from a bicycle (8.06 %).

Naik et al, reported that among the 57 patients enrolled in their study, 46 (80.7%) had a fall while playing. These was in agreement with our study. Only 2 (3.3%) patients belonging to crossed method reported ulnar nerve injury. Lyons et al, they observed that 6% of the patients had an iatrogenic ulnar nerve palsy.[16] Naik et al reported that there were 6.8% cases in crossed group, who had ulnar nerve neuropraxia postoperatively and who recovered completely within three weeks of surgery. Skaggs et al also reported that 8% of ulnar injury in cross pinning group.[17] Na Y et al in 2018 also reported that iatrogenic ulnar nerve injury occurred in 50 (4.9%) of 1020 patients treated with crossed pins.[18] Zhao et al, in 2013 incidence was higher with medial/lateral entry pins than with lateral entry pins (3.33 times).[19] None of the patients reported any infection Similar results were reported by Na Y et al, reported that no significant difference between the two groups was observed in terms of superficial infection.[18] A statistically non-significant association was observed between the range of motion loss at 12 weeks and the surgical method. Most of the patients in lateral method group had excellent Flynn rating 17 (56.7%) followed by good 9 (30%), fair 3 (10%) and only 1 (3.3%) patient had poor Flynn rating. Similarly, in crossed pin method 11(36.7%) patients had excellent Flynn rating and 8 (26.7%) had good Flynn rating; which was less as compared to lateral group. Similar study by Naik et al, reported that as per the Flynn scoring system, 22(78.6%) patients had excellent, Vito P et al. in 2016 [20] also observed that more than 90% patients had excellent results.[1] Prashant et al, reported that according to Flynn criteria, the final result was excellent in 79.03 % and good in 20.97 % of cases.[13]

The mean surgical time taken was non-significantly lower for lateral method as compared to crossed method. Naik et al reported that the average surgical time was longer for crossed method. The mean number of C arm exposure was non-significantly higher for lateral method as compared to crossed method.[1] The mean union time was non-significantly lower for lateral method as compared to crossed method. The mean loss of carrying angle for lateral method was significantly lower than the mean carrying angle for crossed method. Zhao et al who suggested that better functional consequence of elbow, including carrying angle, occurred more commonly in lateral entry.[19] Kwok et al, reported that there was no statistically significant difference in loss of carrying angle.[21] This was in contrast to results of our study. The mean loss of elbow range of motion was significantly lower for lateral method as compared to crossed method. The sample size was only 60 and the follow up duration was only a minimum of 3 months. Larger studies with longer follow up are required to confirm the findings were the limitations of the study.

CONCLUSION

So, in conclusion, in the present study those patients who were treated with Crossed entry pin technique suffered from higher risk of iatrogenic ulnar nerve injury as compared to lateral entry pin technique. Therefore, the recommended strategy for treatment is the lateral entry technique with introducing divergent three pins which can provide a stable configuration and better functional

outcome as well as negate the chances of ulnar nerve injury.

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