International Research Journal of Multidisciplinary Scope (IRJMS), 2024; 5(2): 52-58

IRJMS

Original Article | ISSN (O): 2582-631X DOI: 10.47857/irjms.2024.v05i02.0209

Comparing Lateral Versus Both Medial and Lateral Percutaneous K-Wire Fixation of Displaced Supracondylar Humerus Fracture in Paediatric Patients

Santosh Kumar Sahu[1*], Chinmay Sahu[2], Dattatreya Kar[3]

[1]Department of Orthopaedics, IMS & SUM Hospital, Siksha O Anusandhan (Deemed to be University), Bhubaneswar-751003, Odisha, India. [2]Department of Orthopaedics, SNL Medical College and Hospital, Pujariput, Janiguda, Koraput-764020, Odisha, India. [3]Department of Medical Research, IMS & SUM Hospital, Siksha O Anusandhan (Deemed to be University), Bhubaneswar-751003, Odisha, India. *Corresponding Author's Email: drsksims@gmail.com

Abstract

Supracondylar humerus fractures are the most common injuries in paediatric age group. For displaced fractures [III and IV], closed reduction and internal fixation with K-wires is the most preferred option. The current study aims to compare the outcomes of the management of Gartland type III and IV supracondylar humerus fractures with crossed and lateral pinning. We included 40 patients in our study between the age of 2-12 years with Gartland Type III and IV fractures, Weight < 40 kg, less than 10 days old, closed fractures. Randomization was done where the Odd numbered patients were put in Group 1 and even number in Group 2. Group 1 participants were managed by lateral K-wire fixation and Group 2 by crossed K-wire fixation. All the patients were assessed for any loss of reduction and iatrogenic neurovascular injuries, alignment, Flynn's criteria, Mayo elbow score. The flexion-extension range in Group 1 was about 110.27° ± 14.39° as compared to 103° ± 12.05° in Group 2. Supination to pronation was about 87.7° ± 1.62° in Group 1 as compared to 87° ± 2.42° in Group 2. Functionally ($p>0.05$) and radiographically both groups did not show any significant difference. Thus, we concluded that lateral pinning in good hands is as stable as crossed pinning with lower chances of nerve injury and is relatively safe.

Keywords: Supracondylar humerus fracture, Gartland classification, Flynn's criteria, Mayo elbow performance score

Introduction

Supracondylar humerus fractures are among the most common injuries in paediatric age groups, representing nearly 60% of all elbow injuries (1, 2). Modified Gartland's Classification system is commonly used to classify these fractures (3). There are many controversies involved as far as the management of displaced fractures is concerned , because of the intrinsically unstable nature of the fracture and the complications associated with it, like Volkmann's ischaemic contracture, myositis ossification, stiffness, permanent nerve injuries and malunion (4, 5).Various treatment modalities are applicable for type III and IV supracondylar fractures ,like closed reduction and above elbow slab or cast, traction by Dunlop method, etc. but the complication rate with these methods was significantly large (6, 7). For displaced fractures [III and IV], closed reduction and internal fixation with K-wires is the most preferred treatment modality, except those fractures associated with neurovascular injuries (1, 8). However, it is unclear whether crossed or lateral pinning fixation is better, as far as functional, radiological outcomes and complications are concerned (9). Crossed wire construct is considered more stable than the lateral pin construct but there is a chance that the former can cause neural injury (10, 11). We compared the functional and radiological outcomes in a 2 year follow up period in cases of displaced supracondylar humerus fractures which were managed by crossed vs lateral pin fixation (uncrossed).

Methodology

This prospective study was conducted in the

(Received 02nd November 2023; Accepted 09th January 2024; Published 30th April 2024)

Orthopaedics Department of tertiary care hospital at Bhubaneswar (India), between October 2017 to October 2020, after the approval of IRB and IEC of the Institute (Ref.No/DMR/IMS.SH/SOA/170203). The study consent was obtained in a written format from the parent or the guardian; we included 40 children in our study with Gartland Type III and IV fractures, age 2 to 12 years, Weight < 40 kg, fractures less than 10 days old, closed fractures. All patients with Gartland type I and II fractures, age >12 years, weight > 40 kg, fractures with a neurovascular deficit, fractures with intra-articular extension and compound cases were excluded from our study. Randomization was done where the Odd numbered patients were put in Group 1 and even number in Group 2. Group 1 participants were managed by lateral K-wire fixation and Group 2 by crossed K-wire fixation.

All the patients were assessed for any loss of reduction and iatrogenic neurovascular injuries, alignment, Flynn's criteria, Mayo elbow score. Out of 40 children, 24 were boys and 16 were girls with 22 having a left-sided injury. All the children were given a resting splint. Antero-Posterior (AP)/ Lateral radiographs and required blood investigations were done (Figure 1a- 1c).

Figure 1a: Pre-op X-ray of the child treated with lateral-only construct

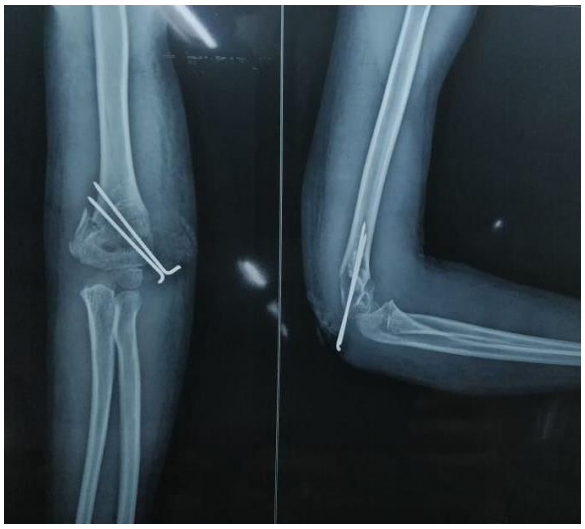


Figure 1b: Post-op X-ray of the child treated with lateral-only construct

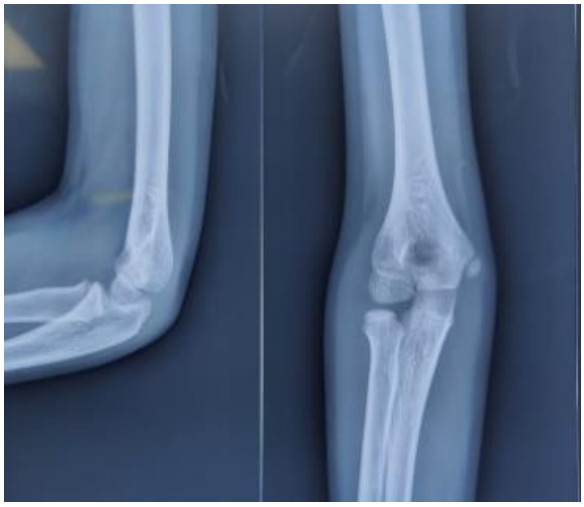


Figure 1c: Follow-up X-ray of the child treated with lateral-only construct

All participants were given general anaesthesia for surgery, within the initial 24 hours of presentation in most of the cases except 3 cases which were delayed till the swelling subsided. Patients were operated in supine position. Traction along the longitudinal axis with elbow in extension and supination were given with counter traction by an assistant holding the proximal portion of the arm. The elbow was then flexed into more than 90° while maintaining the longitudinal traction; the surgeon's thumb pushed the tip of the olecranon anteriorly at the same time. Fracture fragments were checked under an image intensifier and reduction was confirmed. Keeping the elbow in flexion and forearm in pronation, k-wires (1.5 mm), engaging the opposite cortex were then inserted from lateral side in Group 1 and from medial and lateral side in Group 2. Pins were placed in divergent configuration in Group 1 and cross wire configuration in Group 2, where we first put the pin from the medial side by palpating the ulnar nerve and medial epicondyle. The ulnar nerve was pushed posteriorly with plain forceps after giving a small incision slightly anterior to medial epicondyle.

Figure 2a: Pre-op X-ray of the child planned for crossed-pin construct

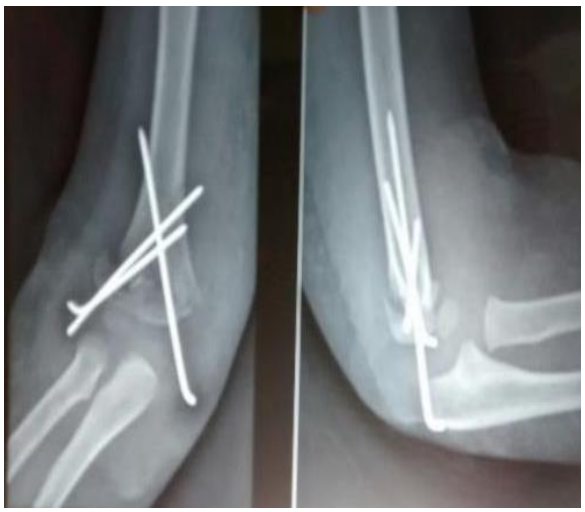


Figure 2b: Post-op X-ray of the child treated with crossed pin construct

Figure 2c: Follow-up X-ray of the Patient treated with crossed-pin construct

The arm was immobilized using an above-elbow splint posteriorly, with the limb in an elevated position over a pillow. Clinical evaluation was done post-weaning off anaesthesia effect, to rule out any distal neurovascular deficit. Active finger movements and sensations were checked and compared with the contralateral limb. Ice compression was given post-op to reduce the swelling, if any present. Patients were discharged on the 2nd postoperative day with above elbow POP slab after a change of 1st dressing. At four weeks following surgery, the slab and pins were removed and patients were evaluated radiologically, clinically and checked for any complications (figure 2a-2c). They were advised to do active and assisted elbow range of motion exercises. All cases were further followed up clinically and radiographically at 3, 6, 12, and 24 months.

They were evaluated according to Flynn's criteria as well as Mayo Elbow Performance Score at the end of 24 months follow up (3, 12-14). All data were analysed by SPSS Version 20 software (USA). While conducting the study, the ethical principles were followed mentioned in the Helsinki Declaration.

Results

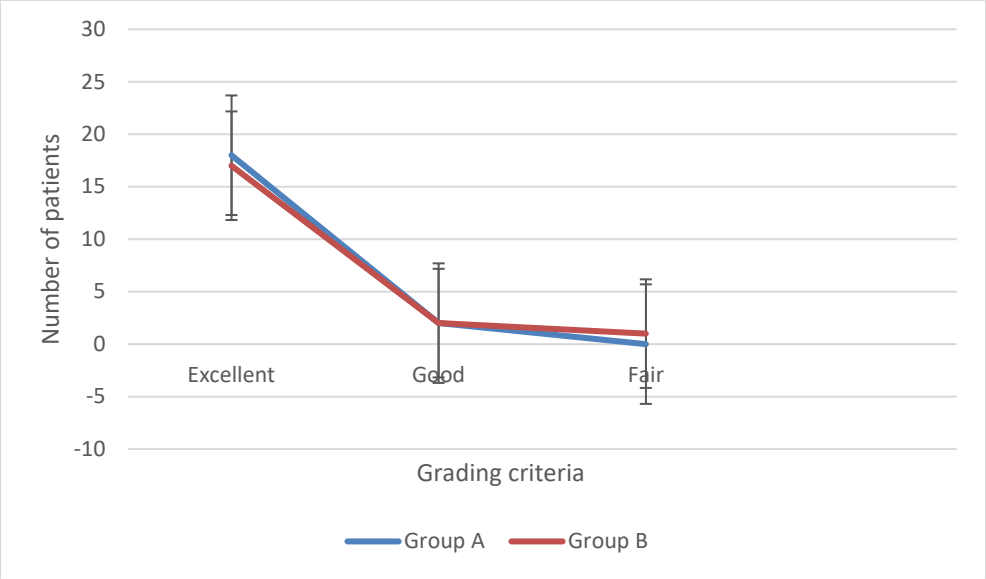
In our study, 20 patients were included in each group. 17 patients in Group 1 had posteromedial displacement and 18 in Group 2 while 3 in Group 1 and 2 in Group 2 had posterolateral displacement. We had 2 patients with post-operative nerve injury in Group 2 and none in Group 1. The flexion-extension range in Group 1 was about $110.27^0 \pm 14.39^0$ (range 92^0–135^0) as compared to $103^0 \pm 12.05^0$ (range 90^0–130^0) in Group 2. Supination to pronation was about $87.7^0 \pm 1.62^0$ (range 85^0–90^0) in Group 1 as compared to $87^0 \pm 2.42^0$(range 82^0–90^0) in Group 2. The Mean range of motion was 128^0(range -3^0 to 132^0) in Group 1 as compared to 126^0(range -4^0 to 130^0) in Group 2. The mean Baumann angle loss and humero-capitellar angle loss in Group 1 and Group 2 respectively are given in the Table 1, which was insignificant statistically.

Group 1 had one case (5%) of mild hyperextension, 1 case of extension lag of 8^0 and 1 case (5%) with superficial pin tract infection whereas Group 2 had, 1 case (5%) of 6^0varus angulation with extension lag of 7.5^0 and 2 cases of ulnar nerve paraesthesia (10%), which resolved spontaneously in 3-4 months after surgery. In our study, Flynn's grade showed excellent results in 18 patients and good in 2 patients in Group 1 as compared to Group 2, which showed excellent results in 17 patients, good in 2, and fair in 1 patient (Figure 3).

Both the groups were compared according to the parameters given in table 2. There were no significant differences ($p > 0.05$) between the groups with regard to any of these variables. However, 2 cases had postoperative nerve palsy in Group 2, although function returned to normal in about another 4 weeks and full recovery was obtained in about 3 months (Table 2)

Table 1: Participant's Demography

Parameters	Group 1 (Lateral K-wire)	Group 2 (Crossed K-wires)
Number of Participants	20	20
Age (in years)	6.2 ± 3.0	6.1 ± 2.3
Sex		
Male	11	13
Female	9	7
Modes of injury		
Fall from height	10	11
Sports Injury	7	5
RTA	2	4
Others	1	0
Side of Injury		
Right	7	11
Left	13	9



X-axis – grading criteria; Y-axis – number of patients

Figure 3: Graph showing the comparison of Flynn's grading in both the groups

Table 2: Final post-op evaluation of the participants

Parameters	Group 1 (Lateral Pinning)	Group 2 (Crossed Pinning)	P-Value
Nerve injury	0	2	
Bauman angle loss	5.20 ± 4.0	5.86 ± 4.6	0.6310
Humerocapitellar angle loss	6.0 ± 5.0	6.2 ± 5.3	0.9029
Range of motion (Degree)			
Extension	-3	-4	
Flexion	132	130	
Total motion	128	126	
Flynn Grade			
Excellent	18	17	
Good	2	2	
Fair	0	1	
Poor	0	0	
Mayo Elbow Performance Score	98/100	96/100	
Superficial infection	1	0	

Discussion

Conservative management by cast application have a limited role in the treatment of Gartland Type III and IV supracondylar fracture of humerus. Whereas Open reduction and internal fixation have their own limitations such as extensive soft tissue injury, increased surgical time, hospital stay, and increased elbow stiffness postoperatively (5,15,16). Management with closed reduction and internal fixation provides superior results when compared to other treatment modalities (6). This method was first described by Casiano *et al.,* (17). However, it is unclear whether crossed or lateral pinning fixation is better, as far as functional, radiological outcomes and complications are concerned (9). Studies conducted by Bauer *et al.,* and Larson *et al*., have demonstrated cross-wired construct as a more

stable construct when compared with lateral wire construct (11,18). A study by Sibinski *et al.,* showed better rotational stability in cross-wired construct (19). But studies by Lee *et al.,* El-Adl *et al.,* and Sankar *et al.,* have demonstrated that using two lateral wires provides adequate stability, if proper technique is followed (20-22).

Sibinski *et al.,* and Zamzam *et al.,* suggested to increase the stability, a third K-wire should be given medially in addition to 2 lateral k wires (19, 23). A study conducted on cadavers by Lee *et al.,* and Zionts *et al.,* showed that crossed wire construct provides greater torsional rigidity when compared to lateral only construct (20, 24). A study conducted by Yen and Kocher showed that when the two techniques were compared in terms of changes in pronation and supination, flexion-extension, loss of Baumann's angle and humero-capitellar angle, ability to perform daily activities or the complications associated, there was no significant difference, and these findings were consistent and were comparable to our study (25).

Our study comprised of 40 patients, 20 patients treated with the lateral-wire construct and 20 by crosswire construct. Both groups attained good functional outcome without the added complications. Mostafaviet *et al.,* demonstrated 2.8% pin tract infections in their study which was comparable to our study - 1 (2.5%) case with lateral only construct (26). Thus, Gaston *et al.,* suggested oral antibiotic therapy to reduce the risk of such complications (27). Skaggs *et al.,* reported 7.7% intraoperative nerve injuries in the study conducted by them (28). Slobogean *et al.,* showed that there was intraoperative nerve injury for every 28 patients managed with the crossed-wire construct as compared to lateral-only construct and Zhao *et al.,* showed in their study that iatrogenic injury in 12 (4.5%) cases with crossed construct while only two (0.78%) in lateral-only construct (8,29). El-Adl *et al.,* and Rasool *et al.,* showed a rate of iatrogenic ulnar nerve injury associated with crossed K-wire technique in the range of 0% to 6% (21, 30). A meta-analysis by Brauer *et al.,* comparing the two-pin fixation techniques showed that the iatrogenic injury to ulnar nerve happened in 40 (3.4%) of 1171 cases of crossed K-wire group (11). Even though care was taken not to injure the nerve directly, placement of K-wire in the vicinity of ulnar nerve may lead to reduction of effective volume of the cubital tunnel (30). In our study, we had 2 cases (5%) of iatrogenic ulnar nerve injury in children treated with crossed-wire construct, which completely recovered by the end of 3 months.

Conclusion

From our study, we came to the conclusion that when the lateral only construct was compared with crossed wire construct, both had good outcomes, without any significant difference between the use of the two methods. Both the methods were comparable clinically, functionally, and radiographically, though with an added risk of iatrogenic ulnar nerve injury, that remains in the crossed-pin construct.

Abbreviations

Nil

Acknowledgement

The authors are highly grateful to the Chairman (Prof M.R. Nayak) and the Dean (Prof. (Dr.) Sanghamitra Mishra), IMS & SUM Hospital, Siksha O Anusandhan (Deemed to be University) for providing the necessary facility during the period of study.

Author Contributions

Equal contribution.

Conflict of Interest

The authors declare that they have no conflict of interest among them.

Ethics Approval

The study was approved by IEC and IRB (Ref.No/DMR/IMS.SH/SOA/170203).

Funding

Nil

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