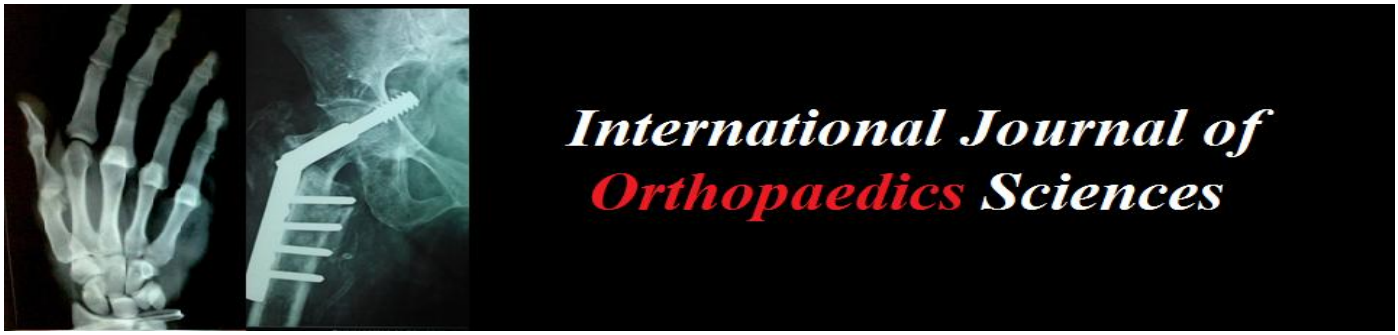

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A comparative study of two percutaneous pinning techniques (Cross K wire vs Lateral K wire) for Gartland type III pediatric supracondylar fracture of the humerus

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Abstract
Background: Supracondylar fractures of humerus are one of the most common fractures in paediatric age group. Closed reduction and percutaneous K-wire fixation is one of the most commonly used treatment modality in Gartland type 3 fractures. A prospective randomized controlled study was undertaken to compare whether parallel k wires are better in terms of the stability, functional outcome and iatrogenic ulnar nerve as compared to cross k wire (medial and lateral).
Material and methods: This is a prospective comparative randomized controlled trial. A total of 30 patients of displaced supracondylar fracture aged between 5-13 years, without any compound injury or comminution were enrolled for the study and randomly divided into two groups, each of 15 patients. One group was assigned treatment of crossed pinning and other group with lateral pinning respectively and outcome was evaluated on basis of pain, motion, stability and function according to Mayo's elbow score and follow-up was maintained for a period of 45 days and statistical significance was calculated.
Results: After assessment of 15 patients in each group we found out that mean mayo score was 98 in cross pinning group and 96.83 in lateral pinning group. This difference is statistically not significant.
Conclusion: In our study we conclude that, lateral pinning is an equally good treatment choice in these fractures and especially for grossly swollen elbows. Also, risk of ulnar nerve injury during placement of medial pin is eliminated in lateral parallel k wires. Both the methods offer consistently satisfactory functional and cosmetic results.

Keywords: Supracondylar fracture humerus, Percutaneous fixation, Iatrogenic ulnar nerve injury

Introduction
Supracondylar humerus fractures (Fig. 1) constitute 60–65 % of all the fractures around the elbow joint, peak incidence being between 4 and 7 years of age [1] Out of the common complications associated with supracondylar fractures, some complications like malunion, ischemic contracture and neurovascular damage are worrisome [2, 3]. Closed reduction and percutaneous k wire fixation is the preferred method of treatment in Gartland type 3 suprcondylar humerus fractures in children [1]. However, there has always been a difference of opinion for better method of fixation between cross medial- lateral k wiring and parallel lateral k wire fixation [4]. Hence, outcomes and complications like deformity due to loss of reduction and rate of iatrogenic ulnar nerve palsy help us define a better method of fixation [5, 6]. The advantage of medial-lateral entry pin fixation is probably increased biomechanical stability, although iatrogenic ulnar nerve injury may result from placement of the medial pin [2, 4, 7]. Conversely, the advantage of lateral entry pin fixation is avoidance of iatrogenic ulnar nerve injury, although the construct may be less stable biomechanically [2, 8-10]. The aim of this study was to compare the efficacy in terms of stability, functional outcome and iatrogenic ulnar nerve injury between lateral entry pin fixation and medial– lateral entry pin fixation of completely displaced (type-III) extension supracondylar fractures of the humerus in children.

Fig 1: Gartland type 3 Supracondylar fracture of humerus

Materials and methods

We conducted a prospective, single-blinded randomized control trial in the Department of Orthopaedics, in Krishna Institute of medical sciences, karad, for a period of one year, after obtaining ethical committee approval. Full written informed consent was taken from parents/legal guardian before participating in this study.

Inclusion criteria

Aged between 5 and 13 years, Closed Gartland type III supracondylar humeral fracture Duration of injury < 4 days, Normal neurological and vascular status of the affected limb.

Exclusion criteria

Duration of injury > 4 days, Inability to take part in postoperative rehabilitation, Compound fractures, medical contraindications to surgery, fracture requiring open reduction or neurovascular exploration, previous ipsilateral elbow fracture, and floating elbow injury.

A total of 30 patients with supracondylar fractures of humerus were included in the study from the patients that were admitted in the orthopedic wards either through the outpatient department or emergency services who fulfilled our inclusion criteria. The method of patient selection for lateral entry or medial-lateral entry was random. Our analysis included 30 patients who were followed up for at least 6 months at. 3, 6, 10, 14, and 24 weeks. All the children with suspected supracondylar fractures of the humerus were assessed for vascular and neurological status. Anteroposterior and lateral radiographs were performed. All displaced supracondylar fractures of humerus were admitted and limb immobilized in an above-elbow splint with limb elevation. Pulseless limbs were excluded from the study. Surgical techniques were standardized in terms of pin location, pin size (weight< 20 kg size 1.5 mm and weight > 20 kg size 2 mm), stability on the table and the position of the elbow for pin placement. Surgery was performed by a senior orthopedic surgeon who was well trained in this technique. General anesthesia was used for all patients with the injured upper limb on the side of the table. Closed reduction was performed and confirmed by the image intensifier. First, longitudinal traction was applied with the elbow in hyperextension and the forearm in supination. While the traction was maintained, the medial or lateral displacement was corrected by applying a valgus or varus force at the fracture site. The posterior displacement of the distal fragment was then corrected by applying a force to the posterior aspect while the elbow was gently hyperflexed and the elbow was secured in hyperflexion, and the reduction was confirmed by the image intensifier. The medial pin was placed directly through the apex of the medial epicondyle. The lateral pin was placed at the center of the lateral epicondyle. For the lateral fixation technique, two or three pins were inserted from the lateral aspect of elbow across the lateral cortex to engage the medial cortex keeping the elbow in hyperflexion. Pins were placed either in parallel or divergent configuration with adequate separation at the fracture site. For the medial-lateral fixation technique, first the lateral pin was inserted from lateral cortex to engage the medial cortex keeping the elbow in hyperflexion. The elbow was then extended to >90º and the ulnar nerve rolled back with the opposite thumb and the medial pin was inserted to engage the lateral cortex with the elbow in 90º of flexion. After the pins were placed, the elbow was extended and the carrying angle was measured and compared with that on the nonaffected side. The adequacy and stability of the reduction were checked under image intensification (Fig. 2). The pins were bent to prevent migration and cut off outside the skin to allow removal in the outpatient clinic. A single preoperative parenteral dose of cefotaxim was given at the time of induction and postoperatively, and oral cefotaxim was given for seven days at the time of discharge. Postoperatively, the extremity was placed in a wellpadded posterior splint with the elbow flexed to 90º. For all patients, immediate postoperative radiographs were taken to determine the maintenance of the reduction. The operated limb was elevated and carefully observed at regular intervals for any neurovascular deficit. During follow-up in the outpatient department, clinicalradiological evaluation was performed for maintenance of reduction (at first follow-up) and functional outcome, which included passive range of motion, measurement of carrying angle, Baumann angle, metaphyseal–diaphyseal (MD) angle, neurovascular status, superficial and deep infection, and the necessity to re-operate. Clinical evaluation was graded according to carrying angle and elbow range of motion using the criteria of Flynn *et al*. [14]. Radiographic evaluation was performed by anteroposterior and true lateral view at 1, 3, and 6 weeks and at 3 and 6 months. In the third week, the pins were removed without anesthesia. At 3 and 6 month follow-up, the children were evaluated for full function, minor limitation of function and major loss of function. The final results were graded as excellent, good, fair and poor, according to the loss of range of motion and loss of carrying angle using the criteria of Flynn *et al*. Loss of reduction was graded by the loss of Baumann angle using the classification of Gordon *et al*. [5].

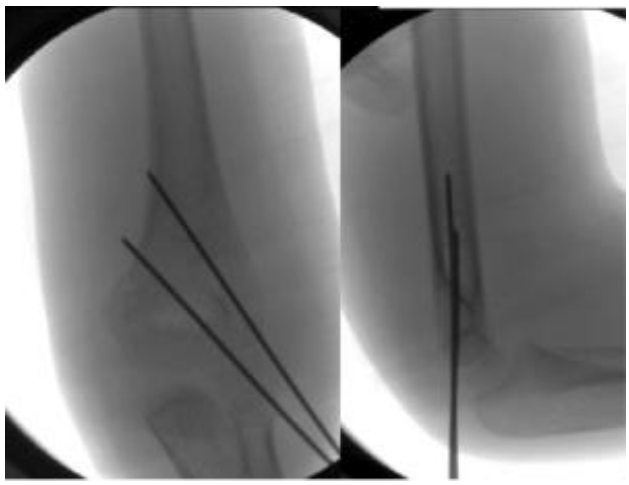

Fig 2: Reduction confirmation in A/P and Lateral view

Result

The mean age of the patients was 8 years. In the lateral entry group, out of 15, 9 were male and 6 were female, whereas in the medial–lateral entry group, out of 15, 10 were male, and 5 were female. The commonest cause of injury was fall while playing (63.3 %), followed by fall from a bicycle (30 %) and fall from a height (6.7 %). Involvement of the left side was 73.3 % and 26.7 % for the right side. At the time of presentation, the radial pulse was normal in 83.3% cases while it was weak in 16.6 % which spontaneously resolved after reduction. The average delay in reporting the injury was 1.79 ± 0.54 days. The average delay between the day of injury and day of the operation was 2.3 days. In the lateral entry group, the average delay was 2.25 days and 2.35 days in the medial-lateral entry group. The average hospital stay was 4.03 days with a minimum and maximum duration of 3 and 5 days, respectively. Postoperative complications like pin tract infection were found in three cases (one in the lateral entry group and two in the medial-lateral entry group) but all infections were superficial only (Fig. 4). There was no case of iatrogenic ulnar nerve palsymin the medial–lateral entry group but one case had paraesthesia along the ulnar nerve distribution, which subsided spontaneously within three weeks. No patient in either group had a major loss of reduction. There was a mild loss of reduction in one case in the lateral entry group. Although radiological and clinical union occurred within a similar time period without any residual deformity, the loss of both the range of motion and the carrying angle was greater in this patient as compared to those without loss of reduction. However, there were no significant differences between groups regarding change in the Baumann angle, M-D angle, carrying angle, or range of motion. According to Flynn criteria, the final result was excellent in 63.3 %and good in 36.7 % of cases with no poor results. The result for the medial-lateral entry group was excellent in 66.7 % and good in 33.3 % cases, and the result for the lateral entry group was excellent in 60 % and good in 40 %.

Results according to flynn's criteria

Result	Lateral Group	Medial Lateral Group
Excellent	63.3%	66.7%
Good	36.7%	33.3%
Poor	0%	0%

Table 1: Analysis of deformities at 24weeks follow-up

Parameters	Lateral entry group (mean)	Medial–lateral entry group (mean ± SD)
Loss of carrying angle	4.35	3.6
Loss of Metaphyseo - diaphyseal angle	2.20	2.10
Loss of Range of motion	8.0	7.84
Loss of Baumann angle	4.33	4.86

Discussion

The treatment for Gartland type III supracondylar fractures of the humerus in children is closed reduction and percutaneous pin fixation. However, there is still a discrepancy in ideas regarding the optimal technique, whether lateral or crossed medial–lateral pin fixation is better. According to earlier studies, the advantage of medial–lateral entry pin fixation is that there is increased biomechanical stability as compared to the lateral pin [7, 15], although iatrogenic ulnar nerve injury may result from placement of the medial pin [4]. On the other hand, the advantage of lateral entry pin fixation is avoidance of iatrogenic ulnar nerve injury, although the construct may be less stable biomechanically [10, 11, 16, 17]. It does not provide torsional stability. A biomechanical study by Zionts *et al.* [7] demonstrated that crossed pinning is more stable than lateral pinning as far as rotational, varus and valgus stability is concerned. However, a study by Skaggs *et al.* [10] demonstrated no clinical difference in stability between crossed and lateral pins. The average loss of the carrying angle, Baumann angle, M–D angle and range of motion in the lateral pinning cases in our study may be related to a comparatively less stable construct with two lateral pins compared to crossed medial–lateral pins. Although radiological and clinical union occurred in a similar time period without any residual deformity, the loss of both the range of motion and the carrying angle was relatively more in this patient, compared to those without loss of reduction. The risk of loss of reduction after lateral entry pin fixation can be minimized by following proper pin placement technique, with divergent pins, pins that engage both the lateral and central columns. In our study, only one case showed only paraesthesia along the ulnar nerve distribution, which subsided spontaneously within one week. The incidence of ulnar nerve injury in our study was low because of precautions such as inserting the lateral pin first, avoiding hyperflexion of the elbow during medial pin placement and by retracting the nerve more posteriorly digitally before inserting the medial pin. According to studies, iatrogenic ulnar nerve injuries associated with medial pin fixation resolve after replacement of the medial pin at a new location [21]. In our study, the difference with regard to the loss of range of movement between the two groups was statistically insignificant (P = 0.51), with both groups showing an excellent or good range of movements. The functional outcome following medial and lateral pinning was excellent in 66.7 % and good in 33.3 % of cases. There were no poor results, while cases treated with lateral pinning showed 63.3 % excellent and 36.7 % good results with no poor results. The major limitation of the study was the small number of cases in each group. A randomized controlled trial involving a large number of patients with long-term follow- up is clearly needed to clarify the differences between the two techniques.

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