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Nikhil D Palange
Assistant Professor, Grant Govt
Medical College & Sir JJ Group
of Hospitals, Mumbai,
Maharashtra, India

Dr. Prasannakumar GS
Junior Resident, Grant
Government Medical College &
Sir JJ Group of Hospitals,
Mumbai, Maharashtra, India

Dr. Akash Mane
Junior Resident, Grant
Government Medical College &
Sir JJ Group of Hospitals,
Mumbai, Maharashtra, India

Dr. Eknath Pawar
Professor, Grant Govt Medical
College & Sir JJ Group of
Hospitals, Mumbai,
Maharashtra, India

A comparison between percutaneous cross k wire and lateral k wires fixation in management of Type III Gartland paediatric supracondylar fractures

Nikhil D Palange, Dr. Prasannakumar GS, Dr. Akash Mane and Dr. Eknath Pawar

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Abstract

Introduction: Supracondylar humerus fractures are one of the commonest fractures in the paediatric age group. Displaced fractures of these kind, that is, Gartland type III are treated by closed or open reduction and k wire fixation. Cross k wire and lateral wires are the commonest configurations used for fixation. The present study aims to evaluate the difference between the two configurations in terms of surgical technique, functional outcome and complications.

Materials and methods: A prospective study of 30 paediatric patients with displaced Supracondylar humerus fractures was carried out between September 2016 to September 2017. 15 patients were treated with cross k wire fixation (Group A) while the rest with 2 lateral k wires (Group B). The functional outcome of the 2 groups was measured by Flynn's criteria. Also, the intra operative difficulties and iatrogenic ulnar nerve palsy were noted. Statistical analysis between the two groups was done by Student's t-test to find any statistical significant difference.

Results: As per Flynn's criteria, 66.67 % patients treated with cross k wire fixation and 60.00 % patients treated with lateral k wires had excellent functional outcome. This difference was not statistically significant. 3 patients in group A had ulnar nerve palsy which resolved within 3 weeks after surgery. No incidence of ulnar nerve palsy was found in patients of group B.

Conclusions: There is no statistical difference between the two techniques with respect to functional outcome indicating that both methods are equally efficient. However, there is a risk of ulnar nerve palsy during insertion of the medial wire of the cross k wire fixation.

Keywords: Supracondylar, humerus, fracture, k-wire, cross, lateral.

Introduction

Supra-condylar humerus fractures (SCHF) are one of the most common injuries in childhood, with an incidence of 65 percent of all fractures around elbow joint [1, 2]. Children aged 4 to 7 years are most commonly affected [1]. The most common mode of injury resulting in these fractures is fall on an outstretched arm. Supracondylar fractures have traditionally been the orthopaedic surgeon's nightmare because of the serious unforgiving complications like neurovascular injury, Compartment syndrome (Volkmann's ischaemia) and Volkmann's Ischaemic Contracture (VIC). Also, these fractures if malunited may cause cubitus valgus deformity [3, 4, 5]. Gartland classified these fractures into flexion and extension types, depending on the displacement and angulation of the distal fragment. Of these, the extension type is more common. The extension type is further classified as undisplaced (type I), partially displaced with intact posterior hinge (type II) and completely displaced fractures (Type III) [6]. Wilkins further classified type III fractures, based on coronal displacement as IIIA (posteromedial displacement) and IIIB (posterolateral displacement) [7]. Type I fractures are treated with cast. Type II fractures can be treated with close reduction (by flexing the distal fragment) and cast application or by Dunlop's skeletal traction. Some surgeons advocate close reduction and percutaneous pin fixation in type II fractures to prevent the risk of displacement of fracture [8]. Type III fractures need to be reduced by either close or open method and fixed by percutaneous pins as these types of fractures definitely have chance of malunion due to displacement.

Correspondence

Dr. Prasannakumar GS
Junior Resident, Grant
Government Medical College &
Sir JJ Group of Hospitals,
Mumbai, Maharashtra, India

Conservative treatment in type III fractures has led to complications of loss of reduction, malunion and compartment syndrome [8].

Hence, the general consensus worldwide regarding the treatment of Type III supracondylar fractures has been operative, that is reduction and percutaneous pin fixation. Of these, the two most time tested configurations of pin insertion are cross fixation and 2 lateral wire fixation (figure 1). While many authors suggest that the cross k wire fixation affords more fixation stability than the lateral k wires construct, supporters of the latter technique claim that cross k wire technique is associated with the risk of iatrogenic injury to ulnar nerve while inserting the medial k-wire [4, 6, 9, 10, 11, 12].

The present study aims to compare the functional and radiological outcome of lateral and cross pinning of displaced supracondylar humerus fractures of children.

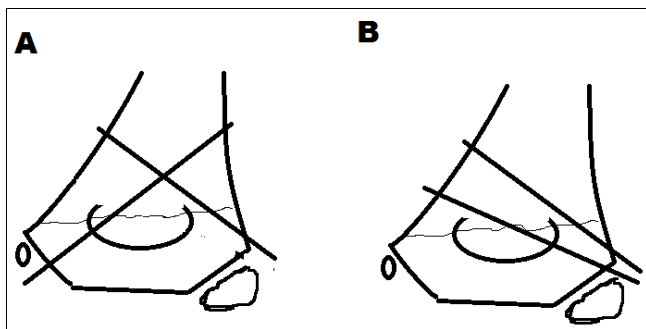


Fig 1: The two pin configurations for fixation of supra condylar humerus fractures: cross k wires (fig A) and lateral divergent wires (fig B)

Materials and methods

30 consecutive patients with displaced (type III) extension type supracondylar humerus fractures were studied prospectively from September 2016 to September 2017. All paediatric patients aged less than 13 years with closed, extension type III SCH fractures were included in the study after obtaining clearance from the institutional ethical committee. Patients with flexion type injuries, type I and type II injuries, open injuries, those with associated injuries to ipsilateral elbow and children aged above 13 years were excluded from the study. A written valid informed consent was taken from the parents/guardians of each child before being included in the study.

The patients were randomly divided into two groups. The randomization was done by the chit-pulling system, where a staff nurse in the operating room, who was completely un-associated with the study had to draw a chit from a bowl of concealed chits which were marked either "A" or "B". Patients were then accordingly divided in group A (planned to be fixed with cross pin method) or group B (planned for lateral pin fixation). Each group had 15 patients. The operating surgeon was not shown the pre-operative x rays of the patients before this randomization procedure to avoid bias.

All patients presenting with history of trauma and swelling of the elbow were assessed clinically. Neuro-vascular function was assessed in each patient. Compartment syndrome was ruled out by noting any tense swelling of forearm, pain out of proportion to injury, passive stretch pain and pulse of the limb. Plain radiograph of the elbow with distal humerus in antero-posterior and lateral views was taken to confirm supracondylar fracture, to know the type and displacement of fracture. After giving temporary POP splint, patient was

posted for surgery within 24 hours of presentation to the emergency ward. The plan for surgery was decided after randomization. All surgeries were carried out by a single senior surgeon (Dr. SMK) who is an experienced surgeon in this field.

Surgical technique

Patients were given general anesthesia and placed in prone position with arm placed on a radiolucent arm support so that the elbow is visualized under C arm. All fractures were first reduced by close method. First, traction on the affected forearm is given, supplemented by countertraction in the opposite site by an assistant. This corrects the proximal shift of fracture and helps in regaining length. After this, the surgeon corrected the deformity in coronal plane (i.e. posteromedial or posterolateral displacement) by giving forces in opposite direction. Finally, the extension component was corrected by simultaneously hyper pronating and flexing the elbow, while at the same time pushing the olecranon tip in volar direction with the thumb. While maintaining this position of hyper pronation and hyper flexion with the thumb still on the olecranon, and checking the radial and ulnar pulses, a fluoroscopic image is taken in AP and lateral views to confirm the reduction. The Baumann's angle was used to assess adequacy of reduction in AP view and in lateral view, the continuity of anterior and posterior cortices was confirmed. Once, achieving acceptable reduction, the elbow was fixed in this position by the assistant. In group A patients, the lateral wire was inserted first and the elbow was slightly extended before inserting the medial wire to avoid injury to ulnar nerve. Also, for inserting the medial wire, a small incision was taken and the nerve protected from the wire by placing a small artery forceps in between. The entry point for the medial wire was taken in a slightly anterior plane to further avoid injury to ulnar nerve. The wires were inserted in such manner that the two wires crossed proximal to the fracture site. In group B, two k wires were inserted from the lateral condyle in either parallel or divergent manner so as to cross the fracture site and engage the proximal fragment on the medial side. After confirming pin placement and reduction on AP and lateral C arm views, the pins were bent. The radial and ulnar pulses were checked once again and patients were given above – elbow splint in 90 degrees flexion and full supination. Patients were advised to keep the limb elevated and give anti-inflammatory medications to prevent excessive swelling.

Post-operative care

Patients were discharged 2 to 3 days after surgery and followed up at 1 week, 4 weeks, 3 months and 6 months. Splint was removed after 4 weeks and active elbow range of motion assessed. Final outcome was measured at 6 months follow up.

Outcome measurement

Functional outcome was measured by the Flynn's criteria [13] (Table 1) which includes functional and cosmetic component. These are further sub divided into excellent, good, fair and poor. The functional component is measured by range of flexion and extension at elbow whereas the cosmetic component is measured by carrying angle at the elbow. Radiological outcome was measured based on the Baumann's angle and time for radiological union of fracture.

Table 1: Flynn criteria

Results	Rating	Carrying Angle (Degrees)	Loss of Motion (Degrees)
Satisfactory	Excellent	0-5	0-5
	Good	5-10	5-10
	Fair	10-15	10-15
Unsatisfactory	Poor	>15	>15

Outcome analysis

All data was collected and compiled in MS Excel 2016 and analysed in the Epi info 7 software (version 7). Independent Student's t- test was used to analyse the parameters. The results were expressed as mean with standard deviation (SD) and p- value of <0.05 was considered to be statistically significant.

Results

The mean age of patients in group A was 6.52 ± 2.3 years and in group B was 7.41 ± 3.1 years. The difference was not found to be statistically significant. The study group comprised of 19 males and 11 females. The most common mode of trauma was found to be fall on an outstretched hand in 21 patients (70 %) followed by road traffic accident in 6 patients (20 %) and fall from height in 3 patients (10 %). The left side was involved in 18 patients while in the rest the right side was involved. The average follow-up period for patients in group A was 11.43 ± 2.4 months while that for patients in group B was 10.36 ± 3.1 months. This difference was not found to be statistically significant. As per the Flynn criteria, 10 patients (66.67 %) in group A had excellent results, 4 patients (26.67 %) had good results and 1 patient (6.67 %) had fair result. In group B, 8 patients (60.0 %) had excellent results, 4 patients (26.66) had good results and 3 patients (20.0 %) had fair results. No patients in either group had a poor result. These differences were not statistically significant. At final follow up, the mean loss of carrying angle in group A was 4.3 degrees and that in group B was 3.8 degrees. Also, the mean loss of Baumann's angle was 3.52 degrees in group A and 4.10 in group B. These differences were also not found to be statistically significant. No patients in our study had pre operative ulnar nerve palsy, but 3 patients in group A had post operative ulnar nerve palsy. No such incidents were noted in group B. The difference was found to be statistically significant (p value < 0.05). The mean time for complete radiological union was 6.56 weeks in group A and 6.12 weeks in group B which was not significant.

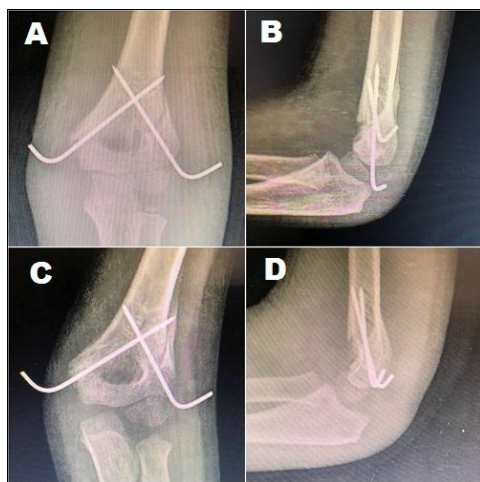


Fig 2: 4 year old female patient with type III SCH fracture operated with CRIF with cross k wire fixation : A, B (immediate post-operative fixation) & C, D: at 6 weeks follow-up)

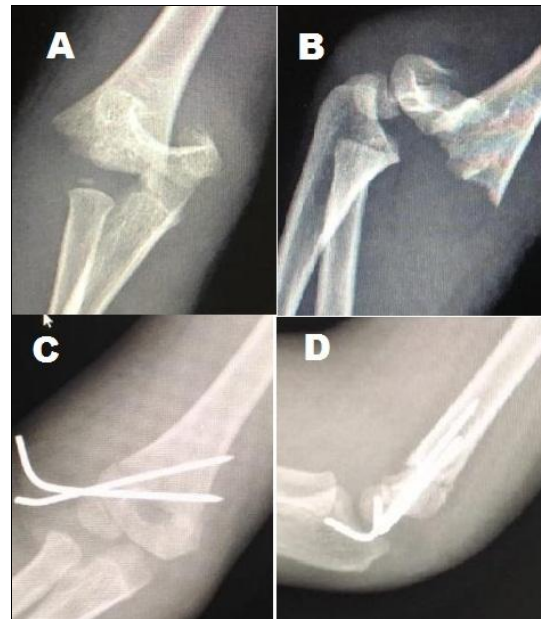


Fig 3: Pre-operative(A, B) and immediate post-operative (C, D) radiographs of a 5 year old male patient with type III SCH fracture operated with close reduction and lateral k -wires fixation.

Discussion

Considering the possibility of serious complications of supracondylar humerus fractures, special care and attention has to be given to these fractures with regard to treatment. Grade III fractures are notoriously known to cause complications like injury to neurovascular structures, compartment syndrome and VIC [4, 5]. Hence, immediate management of these fractures is essential to prevent these complications. Type III fractures are treated by close reduction and k wire fixation. Currently, the two popular methods of k-wire fixation are cross wire pattern and 2 lateral wire pattern. The cross k wire fixation although stable biomechanically, has risk of ulnar nerve palsy whereas the lateral k wire fixation has no risk of nerve palsy. However, the lateral wire configuration is less stable than the cross k wire configuration, especially to torsional forces [14, 15, 16, 17].

In our study, the mean age of patients was 6.52 ± 2.3 years in group A (cross pin group) and 7.41 ± 3.1 years in group B (2 lateral k wires). This is comparable to other studies [18, 19]. Supracondylar fractures are commonly seen in 4- 10 years age group. Also, higher incidence in males and greater involvement on left side were seen, which is consistent with a study of 57 patients conducted by Naik *et al.* [20]

No significant difference in functional outcome was noted between either of the techniques in our study. This finding is comparable to the studies by Naik *et al.* [20] Patil *et al.* [21] Kocher *et al.* [5] and Reynolds *et al.* [22] This shows that the surgeon may choose any of the two techniques to fix the fracture as per his convenience, fracture pattern and surgical skill. Lateral k wire fixation has as good outcome as cross k-wire fixation. Also, the difference in the loss of carrying angle and Baumann angle was not found statistically significant between the two groups. These findings are similar to the study of 30 patients by Naik *et al.* [20] in their study, 15

patients were operated with cross k wires and 15 with lateral k wires fixation. The authors concluded that there is no difference between the two methods with respect to functional outcome as well as loss of carrying angle and Baumann's angle.

There was also no significant difference in the time for radiological union in the two groups, which signifies equal efficiency of both the techniques in fixing these fractures and enabling early mobilization and return to function.

No patient in our study had ulnar nerve palsy pre-operatively, although 3 patients in group A had post-operative palsy. No patient in group B had nerve palsy. The risk of ulnar nerve palsy in cross k wire fixation is known, while inserting the medial k wire. The risk is reduced by taking precautions like inserting the lateral wire first, extending the elbow while inserting the medial wire and taking small incision and protecting the nerve while passing the wire. These nerve palsies were found to be neurapraxias and recovered spontaneously after 4 to 6 weeks.

Our study was limited due to the smaller size of the sample. Large, multicentric trials will be more efficient for better study of both methods of fixation.

Conclusion

Cross k wire and lateral k wire fixation are both equally efficient methods of fixation of supracondylar humerus fractures with similar functional, radiological and cosmetic outcomes. The risk of ulnar nerve palsy in cross k wire fixation can be reduced by preventing hyperflexion and retracting the nerve carefully during insertion of medial wire.

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