

Original Research Article

Prospective review of open reduction and internal fixation with Kirschner wires (K-wires left exposed) fixation in displaced and rotated (Song V) lateral humerus condyle fractures in children

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Received: 03 October 2023

Revised: 07 October 2023

Accepted: 08 October 2023

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ABSTRACT

Background: Fractures of the lateral condyle of the humerus account for 10-15% of all elbow fractures in children. These include Salter Harris type 2 and type 4 growth plate injuries in which the fracture crosses the distal humeral growth plate and enter the elbow joint. Open reduction and internal fixation with K wire is treatment of choice for the displaced as well as minimally displaced lateral condyle fractures of children to prevent malunion, nonunion and further displacement.

Methods: This was prospective analytical study conducted in Rajendra Institute of Medical Sciences, Ranchi from December 2020 to December 2022 which consisted of 30 patients (of whom only 27 were present for follow ups) who were treated by ORIF with K-wires fixation. We followed the classification pattern given by Song et al. Results were evaluated according to the criteria given by the Hardacre et al.

Results: Major culprit for injuries was fall from height (44.4%), followed by playing indoor games (25.9%). RTA and sports each constituted of (14.8%). Functional outcomes based on Hardacre criteria are excellent (85.1%), good in 11.1% cases and fair in 3.7% cases.

Conclusions: Our findings demonstrate that open reduction and internal fixation with 2 or 3 K-wires (which were left exposed) and immobilization with casting for 3-4 weeks is sufficient for most of displaced and rotated fractures of the lateral condyle of the humerus.

Keywords: Hardacre criteria, Song classification, Fishtail deformity, Stanley's classification, Jacob classification, Lateral condyle of humerus

INTRODUCTION

Fractures of the lateral condyle of the humerus account for 10-15% of all elbow fractures in children.^{1,2} These include Salter Harris type 2 and type 4 growth plate injuries in which the fracture crosses the distal humeral growth plate and enter the elbow joint.³ It is a fracture of necessity.

Open reduction and internal fixation with K-wire is treatment of choice for the displaced as well as minimally displaced lateral condyle fractures of children to prevent

malunion, nonunion and further displacement.^{4,5} We prospectively evaluated functional outcomes, complications, fracture union for displaced lateral condylar fractures of distal humerus (stage II, III, IV and V of Song et al classification) in children. Song Stage I fractures can be well managed with long arm cast. In case of stage II fractures, directly percutaneous K wires were applied for the fracture fixation without further manipulation. In stage III or IV fractures, longitudinal traction was applied in elbow joint with slight varus force while fracture fragment was compressed simultaneously in

antero-medial direction with surgeon's thumb. Once fracture fragment was reduced within 2 mm in all the views under fluoroscopy, a slight valgus force was applied on elbow joint with forearm supinated and elbow slightly extended to maintain the fracture in position. Usually two parallel K wires were applied from lateral side to fix the fracture. For the children upto 5 years of age, K-wire of 1.5 mm was used for fixation while those with more than 5 years K-wires of 1.8 mm was used. Nonunion is a common problem in fractures of the lateral humeral condyle.⁶ Fractures can be classified using the Milch classification: type I in which the fracture line traversed the ossific nucleus of the lateral condyle or type II where fractures exited through the trochlea.⁷

Fractures can also be classified according to the degree of displacement based on Stanley's classification, a modification of the classification developed by Jacob et al stage I displacement (CRACK) is one in which the injury is a stable fracture that can be treated with a cast alone (less than 2 mm displacement).⁸ Stage II displacement (GAP) is a fracture with a significant lateral gap indicating the fragment has undergone some rotation and is unstable.

Stage III displacement (FLIP) is a fracture with complete rotation of the condylar fragment.

While internal fixation is usually achieved with K-wires in young children, compression screws can be used in older children.^{9,10}

Objective of study is to assess the outcomes of ORIF with K wires fixation of lateral epicondyle of humerus fractures (which are displaced and rotated) according to Hardacre criteria and also compare the incidence of complications. Postoperative range of motion were also noted.

METHODS

This was prospective analytical study conducted in Rajendra Institute of Medical Sciences, Ranchi from December 2020 to December 2022 which consisted of 30 patients (of whom only 27 were present for follow ups) who were treated by ORIF with K-wires fixation. Informed consent was taken from the parents of all patients.

Inclusion criteria

Patients with age younger than 14 years and presence of displaced and rotated lateral humeral condyle fracture treated by OR/IF and K- wires, and fracture less than 1-week old were included.

Exclusion criteria

Patients with undisplaced fractures, open fractures, other ipsilateral upper-limb fractures, pathological fractures, or fractures treated later than 14 days after injury were excluded.

A lateral approach to the distal humerus using the interval between the brachioradialis and the extensor carpi radialis longus anteriorly and the triceps posteriorly was performed under general anesthesia and tourniquet. Considering the blood supply to this area, minimal posterior dissection of the soft tissue from the distal fragment was used to reduce the risk of avascular necrosis of the capitellum. The joint surface was accurately reduced under direct vision and 2 convergent Kirschner wires were inserted. After wound closure, the elbow was supported in plaster backslab.

We followed the classification pattern given by song et al as shown in Table 1.

Table 1: Classifications given by Song et al.⁴

Stage	Degree of displacement (mm)	Fracture pattern	Stability
I	≤2	Fracture limited to metaphysis	Stable
II	≤2	Lateral gap	Indefinable
III	≤2	Gap as wide laterally as medially	Unstable
IV	>2	Without rotation of fragment	Unstable
V	>2	With rotation of fragment	Unstable

Classification pattern is more accurately described by additional internal oblique and external oblique views besides routine antero-posterior and lateral views of injured elbow joint. Displacement of fracture fragment was measured from the distal end of lateral metaphyseal cortex of distal humerus to lateral cortex of fractured fragment in AP, internal oblique and external oblique views. In lateral view posterior cortex was used to measure the displacement. Stage V fractures are difficult to managed by closed method alone and was better managed with open reduction and fixation. All the cases were performed under general anesthesia. Pre-op i.v. antibiotics was given, then patient was given 3-days oral antibiotic only. Posterior slab was applied at the time of fixation of fracture. At 3-4 weeks both posterior slab and K-wires were removed once the union was confirmed in check X-ray. Radiographic criteria for a healed fracture consisted of callus across the fracture site in antero-posterior and lateral radiographic views of the elbow. If callus formation was visible radiographically, K-wires were removed and active mobilization of the elbow without a cast was allowed. If the fracture did not show radiographic union at 3-weeks then K-wires were continued for another 3 weeks and removed by 6 weeks.^{9,10}

Degree of fracture displacement, elbow range of movement, radiographic changes, varus-valgus deformities, carrying angle and any other related complications were noted at each follow-up and results

were evaluated according to the criteria given by the Hardacre et al.¹¹

Table 2: Evaluation of treatment outcomes (Hardacre et al criteria).

Criteria	Outcomes
Excellent	Full range of motion
	Normal carrying angle and appearance
	No symptoms
Good	Complete healing of fracture
	Good efficient range of motion
	Loss of extension less than 15 degrees
	Mild and subtle deformity
	No arthritic or neurological symptoms
Fair	Complete healing of fracture
	Loss of motion to the extent of disability
	Alterations in carrying angle and prominent deformity
	Presence of arthritic or neurological symptoms
	Presence of nonunion or avascular necrosis

Statistical tool

Excel software and Microsoft words were used to analyse the data. Percentage was calculated for qualitative data.

RESULTS

Initially 30 patients were included in our study however only 27 patients were available during the final follow-up. So total number of patients included in our study were only 27.

Table 3: Sex incidence.

Sex	Frequency (%)
Male	17 (62.9)
Female	10 (37.1)

Table 4: Side determination.

Side	Frequency (%)
Right	12 (44.4)
Left	15 (55.55)

Table 5: Mechanism of injury.

Mechanism of injury	Frequency (%)
Fall from height	12 (44.4)
Playing indoor games	7 (25.9)
RTA	4 (14.8)
Sports	4 (14.8)

In our study, male constituted of 62.9% while female children were 37.1%. Male dominance is because they are

more involved in outdoor activities. Also, left elbows were more commonly injured (55.55%) as compared to right (44.4%). Major culprit for injuries was fall from height (44.4%), followed by playing indoor games (25.9%). RTA and sports each constituted of (14.8%). Functional outcomes based on Hardacre criteria are excellent (85.1%), good in 11.1% cases and fair in 3.7% cases.

Table 6: Functional outcomes based on Hardacre et al criteria.

Criteria	Frequency (%)
Excellent	23 (85.1)
Good	3 (11.1)
Fair	1 (3.7)

Table 7: Various characteristics.

Characteristics	Mean±SD
Baumann’s angle at 3rd month	74±10.21 degree
Time to union	5.1±06.2 weeks
Elbow flexion	135.67±04 degree
Extensor lag elbow	4.11±08.12 degree
Carrying angle	7.1±05.5 degree

Table 8: Complications.

Complications	Frequency
Nonunion	0
Pin tract infection	1
Pseudovarus deformity	1
FFD less than 10 degree	0
AVN of capitellum	0
Cubitus varus/valgus deformity	0

In our study we had 1 patient each for pin tract infection and pseudovarus deformity. We didn’t get any patient complaining of non-union, avascular necrosis of capitellum and cubitus varus or valgus deformity.



Figure 1: Case 1- fracture lateral condyle of humerus fragment was displaced and rotated.

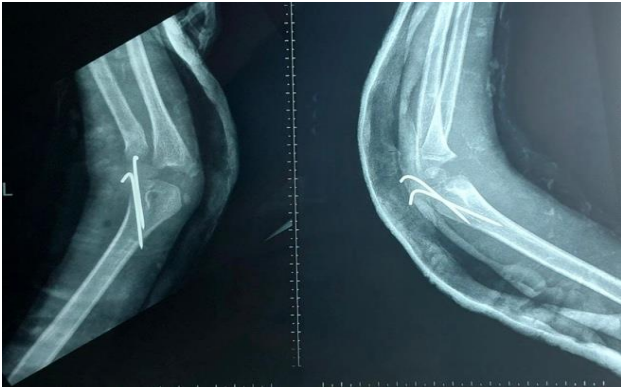


Figure 2: Post op X-ray of case 1 (fixed by 2 K-wires).

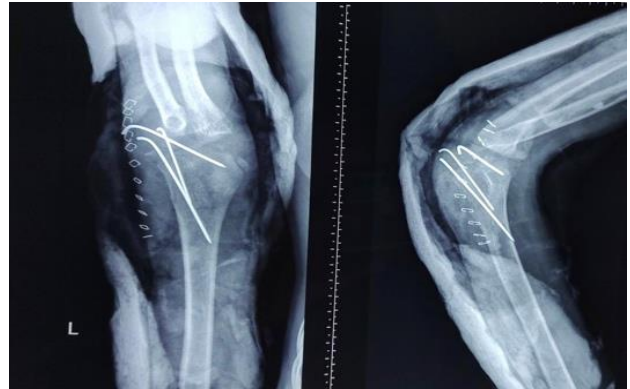


Figure 6: Case 3.

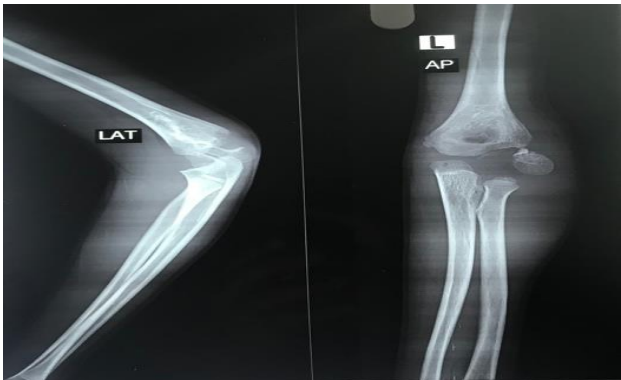


Figure 3: Case 2 fractured LCH is displaced and rotated.



Figure 7: Case 4.



Figure 4: Case 2 ORIF with IF done by 3 K-wires.



Figure 8: Case 4.

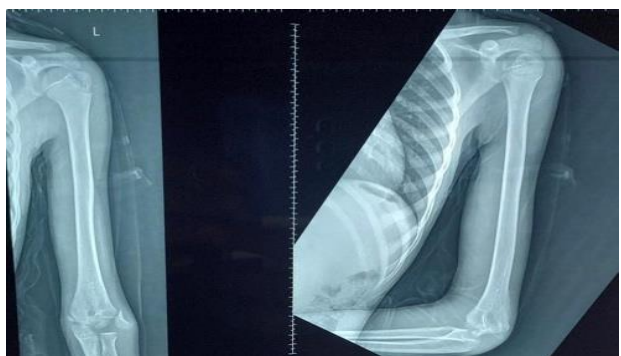


Figure 5: Case 3.

DISCUSSION

The necessity of reduction and stabilisation of displaced and/or rotated lateral condyle fractures has been well established in the literature.¹²⁻¹⁴ There are some controversies in the surgical management of these patients. The first controversy is as to whether displaced and rotated lateral condyle fractures should be managed with ORIF or with CRIF.¹³ Advocates of close reduction hypothesise that ORIF might be unnecessary in many cases and that it might even lead to avascular necrosis as a result of extensive soft tissue dissection.¹³ Song et al prospectively looked at 63 patients with lateral condyle fractures of the humerus.¹ They attempted closed reduction internal

fixation using K-wires in all of them, but in 13 cases ORIF was required. Their success rate for fixation was 73% with no cases of non-union or malunion. A second controversy exists as to when the K-wires should be removed. Thomas et al managed 104 cases of displaced lateral condyle fractures of the humerus with ORIF and K-wire fixation.¹⁵ They advocated that 3 weeks of K-wire stabilisation is sufficient for the fracture to heal and therefore removed all the wires and began elbow mobilisation. In the present study, we removed the K-wire only after radiological union was evident. In agreement to our suggestion is the recent paper by Song and Waters and they mentioned that displaced fractures should be stabilized until they are healed radiographically.¹³

In our study, all the K-wires were left exposed. It has been stipulated that leaving the wires exposed could increase the risk of infection with reported incidences varying from 1 to 28%.¹⁶ In this study we believed that leaving the wires exposed, carries the advantage of wire removal in the outpatient department instead of administering any kind of anaesthesia to the patient. In agreement to our practice is the study by Das De et al which advocates for leaving the wires exposed following ORIF of a lateral condyle fracture.¹⁶ According to Choudhary et al buried wire group have shown better union rate than exposed group, wires could be removed under local anaesthesia thereby avoiding any major procedure and also the risk of infection is low making this a better option than the exposed cohort.¹⁷

In displaced fractures of the lateral humeral condylar physis, improper reduction can result in both cosmetic deformities and functional loss of motion. Hence, open reduction has become the standard treatment.^{8,18,19} Maintenance of reduction by 2 K-wires is standard practise for most clinicians.^{18,19}

Numerous studies have reported that extended use of a plaster splint or cast was required after internal fixation with K-wires.^{18,20} Foster et al reported that 6-8 weeks of elbow joint immobilization was required after open reduction with K-wire fixation.¹⁸ Lau-nay et al reported that patients required a long-arm cast or splint for 4-10 weeks after internal fixation with K-wires.²⁰ In our study, we used an upper-arm cast or splint for an average of 6 weeks after surgery. Although patients were encouraged to perform active ROM exercises before bone union, many reported elbow pain that prevented such exercises. Indeed, many patients were unable to perform active ROM exercises for several weeks after cast/splint removal.

According to Tomori et al the safety and effectiveness of fixation with TBW and buried K-wires after OR/IF for lateral condyle fracture is more.²¹ Fixation with only 2 K-wires may be inadequate for patients requiring early active ROM exercises, which help prevent elbow joint contracture. TBW with K-wires thus appears to be the optimal method for fixation of lateral humeral condyle fracture.

After pediatric humerus lateral humerus condyle fixation, complications such as lateral spur formation, nonunion, avascular necrosis of the capitellum, cessation of physis growth or excessive stimulation of physis can be observed.²²

Bony overgrowth (lateral spurring) over the lateral condyle is a distinct radiological finding commonly seen in children following a fracture of the lateral condyle of the humerus.²⁶

Pribaz et al found that the initial fracture displacement degree was related to the degree of the spur, which did not affect the range of motion of the elbow joint. In our study no lateral spurring we're seen.²³

Gaur et al reported that in a study of 15 patients in which they performed open reduction and internal fixation, a more appropriate reduction was achieved with the Z-plasty they performed in the origin of the extensor communis muscle, and that these patients had almost complete union without AVN.²⁴ Here, in our study also no AVN were reported.

Cubitus varus angulation has been a documented complication of lateral condyle fractures but in this study no case was noted.²⁵⁻²⁷

Growth disturbance can occur after a lateral humeral condyle fracture in the form of a partial lateral growth plate closure or partial closure of the centre of the physis. In the latter case, a persistent gap between the lateral condylar physis and the trochlea could lead to a sharp angle wedge deformity also known as "fishtail deformity". Fishtail deformity can lead to cubitus varus and usually does not cause any functional problems or requires surgical intervention.¹² No fishtail deformity was noted in this study.

In a large-scale review in the literature, it was reported that nonunion is a rare complication in pediatric humeral LCFs and this rate is 1.4%. The absence of callus in the fracture fragment for 8 weeks can be considered nonunion. It has been reported that the most important risk factor for nonunion is type 3 fractures, and this complication has been overcome by fixing the fracture fragment with a threaded screw.¹⁸

Bloom et al proposed that 2 K-wires sent divergently at an angle of 60 degrees constitute the most effective method of fixation. In addition, in this biomechanical study, they reported loss of reduction in the fracture line because of the valgus test in fractures treated with 2 parallel K-wires.²⁸ Blasier declined the potential for reduction loss in the fracture line of parallel 2 K-wire application.²⁹ In our hospital, there is a tendency towards performing divergent two K-wires, at about 60 degrees to each other. However, in some cases 3 K-wires were also introduced.

Limitations

Limitation of study are small number of patients, a short follow-up period and a failure to measure inter-observer errors in radiographic interpretation or functional evaluation.

CONCLUSION

Our findings demonstrate that open reduction and internal fixation with 2 or 3 K-wires (which were left exposed) and immobilization with casting for 3-4 weeks is sufficient for most of displaced and rotated fractures of the lateral condyle of the humerus. However, radiological evaluation is still necessary because in some cases the fracture may not have united in this time period. In some cases, K-wires are left until 6-7 weeks. Physiotherapy is done after removing K-wires. Excessive stripping of soft tissue attachment from the fragment is avoided to prevent AVN of fragment. In most of the cases we used K-wires in divergent fashion.

On the basis of the good outcomes and no significant complications in cases of Song V fractures, we advocate for open reduction of these injuries as opposed to the proposed closed reduction by some studies.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Prakash V, Gupta GK, Singh N, Prabhat V. Prospective review of open reduction and internal fixation with Kirschner wires (K-wires left exposed) fixation in displaced and rotated (Song V) lateral humerus condyle fractures in children. *Int J Res Orthop* 2023;9:1160-6.