Original Article

CANNULATED SCREW FIXATION FOR DISPLACED LATERAL CONDYLE HUMERAL FRACTURES IN CHILDREN

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Abstract

Background: *lateral condyle humeral fracture is one of the commonest elbow fractures in children. open reduction and Smooth Kirschner wires (K-wires) are the most commonly used method for fixation of lateral condyle humeral fracture in children. Few Authors suggest the use of cannulated cancellous (CC) screws for fracture fixation as it provides compression at the fracture site and provides more stability. The aim of this study was to evaluate the clinical outcome of displaced lateral condyle fracture of humerus in children treated with open reduction and cannulated cancellous screws fixation.* **Methods:** *This study was conducted on 20 patients with a closed lateral condylar fracture with more than 2 mm of displacement in a child less than 14 years of age, injured for less than two weeks. The patients were treated with open reduction and CC screws.* **Results:** *The 3 months follow up mayo score, time of union, and Hard et al criteria at 3 months showed excellent results. There were no statistically complications.* **Conclusions:** *Orthopaedic surgeons often use K-wires or screws for fixation of fractures of the lateral condyle. In this study, we used screw fixation and found excellent results in terms of functional outcome, time to union, or post-operative complications. Considerations for long-term monitoring and screw removal to evaluate growth outcomes are also important.*

Keywords: *Kirschner wires, cannulated screws, lateral condyle, humeral fracture*

1. Introduction

Lateral condyle humeral fracture is the second most common fracture around the elbow and represents 20% of all the elbow fractures in children after supra condylar humeral fracture. The most common age group for this fracture between 4 and 10 [1]. Milch classified lateral condyle fracture into Milch type I injury in which the fracture line extends through the ossification center of the lateral condyle and exits at the radio-capitellar groove and Milch type II fracture line exits medial to the capitello-trochlear groove. Both angulation and lateral translation of the olecranon and upper segment of radius are present in type II fractures [2]. Different management options were described for the lateral condyle fractures including conservative management with plaster cast immobilization was described for undisplaced or minimally displaced fractures, but the displaced fractures more than 2 mm need operative management. The aim of treatment in the displaced fracture is to restore and maintain the articular congruity and preserving the elbow function [3,4]. Many classification systems described the

lateral condyle fracture of humerus. The operative management includes open or closed reduction methods. It is a must that the displaced fractures should be treated with open reduction so as to achieve the anatomical alignment and joint congruity [5]. Smooth K-wire are the most commonly used metallic implants for fixation of the fracture. But this fixation requires an additional immobilization with a plaster splint or a cast for four to six weeks. Few recently published reports suggest the use of cannulated cancellous (CC) screws for fracture fixation as it provides compression at the fracture site and is a more stable construct. It also allows early range of motion, shortens time to union and without any significant complication [6]. The aim of this study was to evaluate the clinical outcome of displaced lateral condyle fracture of humerus in children treated with CC screws. The primary outcome was to evaluate the range of motion, time of union, and complications as regard alteration in carrying angle, stiffness, lateral spur, non-union, and infection.

2. Patients and Methods

This trial was conducted on 20 patients with a closed lateral condylar fracture with more than 2 mm of displacement in a child less than 14 years of age, injured for less than two weeks at Sohag university hospitals. The hospital officials granted treatment between February 2022 and January 2023 after receiving approval from the hospital's ethics committee. Informed consents were signed by patient guardians. Patients were excluded if they had open fractures, neurovascular injury, previous injuries to the same elbow, or an anatomical abnormality.

2.1. Preoperative evaluation

Clinical evaluation: Extensive questioning on the circumstances surrounding the accident, most often a fall from a great height. Routine lab investigations: Complete blood picture and coagulation profile. Radiological evaluation initial

radiographic evaluation were including both anterior-posterior and lateral views to diagnose as well as classification of subtype.

2.2. Postoperative follow up

Follow up radiographs were requested at immediate postoperative, 2, 4, 6, and 12 weeks postoperative to assess healing (union) & deformity. After fracture union was apparent in the follow up radiographs, splint is removed at 2 weeks postoperative and elbow range of motion exercises are started. Screws were removed once the fracture union is seen on radiographs after 12 weeks under general anesthesia in the operating room. The treatment's efficacy on functional outcomes were measured according to the criteria suggested by Hardacre et al, and Mayo Elbow Performance score (MEPS). Pain (out of a possible 45), stability (10), range of motion (20), and daily functional activities make up the MEPS's four areas of elbow function measurement (25 points). Grades range from exceptional (100) through good (75), decent (60-74), fair (50-59), and bad (0-49).

Table (1) Hardacre et al criteria

Excellent Result	No loss of motion, no alteration in the carrying angle, no symptoms
Good Result	Functional range of motion, lacking no more than 15⁰ of complete extension, inconspicuous alteration in the carrying angle, no arthritic or neurological symptoms
Poor Result	Disabling loss of motion, conspicuous alteration of carrying angle, arthritic symptoms, ulnar neuritis or radiological findings of non-union or avascular necrosis

Mayo Elbow Performance score (MEPS)

Table (2) Mayo Elbow Performance score (MEPS)

Variable	Definition	No. of points
Pain (max. 45 points)	None	45
	Mild	30
	Moderate	15
	Severe	0
Range of motion (max. 20 points)	Arc >100°	20
	Arc 50−100°	15
	Arc <50°	5
Stability (max. 10 points)	Stable	10
	Moderately unstable	5
	Grossly unstable	0
Function (max. 25 points)	Able to comb hair	5
	Able to feed oneself	5
	Able to perform personal hygiene tasks	5
	Able to put on shirt	5
	Able to put on shoes	5

2.3. Operative technique

Patient positioning: the patient was resting supine with the afflicted arm

draped over the shoulder and a clean tourniquet nearby. *Anesthesia:* general anesthesia was used for all patients in this study. *Prophylactic antibiotics:* prophylactic broad spectrum parenteral antibiotics were administered with induction of anesthesia, before applying of tourniquet, and continued for 3day postoperative. Then oral broad spectrum antibiotic continued for 7 days. *Surgical approach:* a direct lateral approach: The lateral supracondylar ridge may be incised curvedly or straightly. An incision is made above the lateral supracondylar ridge, starting a few centimeters (3-5 mm) proximal to the elbow joint, depending on the child's age and size. From the ulnar side of the proximal forearm, it moves laterally to the posterior aspect of the radial head. Cut the deep fascia in a direction parallel to the incision in the skin. Locate the plane that connects the brachioradialis muscle to the triceps muscle. Follow the posterior border of the extensor muscles as you make a cut between these two muscles Extensor Carpi radialis longus and Brevis all the way to the capitellum. Invert the triceps to face backward, and the brachioradialis to face forward. The common extensor origin may be disengaged from the lateral humerus by raising the triceps. The cut capsulotomy is shown by the red line. By making an anterior incision in the joint capsule, the radial head and lateral epicondyle may be accessed. If improved joint exposure is necessary, the anterior attachment of the capsule to the humerus may be broken. Keep the dissection anterior because the blood supply of the lateral condyle is posterior. *Fracture Reduction*: Can place a K-wire into the distal fragment to use as a joystick to control the reduction. Reduce the fracture. The fracture can in many cases be maintained in a reduced position with a pointed towel clip on the lateral aspect of the fracture fragment and metaphysis of the distal humerus. Visually

evaluate the reduction (intraarticular surface, metaphysis anteriorly, metaphysis laterally). It is also often possible (and beneficial) to feel the articular surface and have tactile confirmation that this is smooth without any step off. *Fracture fixation:* using a screw this is placed in the met-aphysical spike (avoiding the physis), across the fracture site and up the lateral column. Check screw placement with fluoroscopy. *Posterolateral approach*: Mohan, Hunter, and Colton all agreed that this method offered the best possible visibility with the least amount of tissue damage. They found that this method allowed them to see the fracture clearly and reduce it precisely with very little in the way of dissection. The initial incision was an approximately 4-cm-long incision on the posterolateral aspect of the humerus or an approximately 7-cm-long, longitudinal incision on the posterior aspect of the humerus. The posterolateral approach to the distal part of the hum-erus was made through the space between the anconeus muscle and the ECRB ant-eriorly, and between these same structures and the triceps posteriorly. After the subcutaneous tissue was dissected with blunt scissors, the attachments between the anconeus muscle and the ECRB and the distal part of the humerus were identified and released, which exposed the posterior aspect of the humerus.

3. Results

Table (3) Demographic and baseline characteristics of the study participants.

			P value
Age (years)	*Mean ± SD*	5.7 ± 2.83	0.498
	Range	3 - 12	
Sex	*Male*	14 (70%)	1.00
	Female	6 (30%)	
Right side		8 (40%)	0.653
Left side		12 (60%)	
Type 2		14 (70%)	0.639
Type 3		6 (30%)	

The 3 months follow up mayo score, time of union, and Hard et al criteria at 3 months, tab. (4)

Table (4) Follow up mayo score, time of union, and Hard et al criteria at 3 months

			P value
3 months follow up mayo score	Mean ± SD	84.5 ± 4.38	0.773
	Range	80 – 90	
Time of union (Weeks)	Mean ± SD	4.5 ± 0.71	0.567
	Range	4 – 6	
Hard et al criteria at 3 months	Excellent	12 (60%)	0.639
	Good	8 (40%)	

Table (5) Complications of the studied group

			P value
Complications	No	16 (80%)	0.386
	Pin tract infection	0 (0%)	
	Delayed union	2 (10%)	
	Lateral spur	0 (0%)	
	Superficial infection	2 (10%)	
	Affected range of motion	0 (0%)	
	Change in carrying angle	0 (0%)	

Case 1

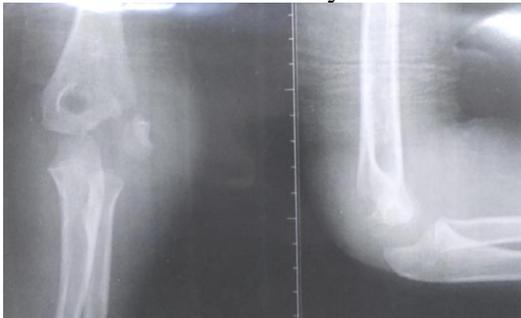9 Years old male pt, falling on out str-etched hand Lateral condyle humerus fr.

Figure (1) preoperative x-ray of 9 Years old male child with Lateral condyle humerus fr AP view and lateral view

Figure (2) 1-week postoperative x-ray of 9 Years old male child with Lateral condyle humerus fr. AP view and lateral view

Figure (3) 1-month postoperative x-ray of 9 Years old male child with Lateral condyle humerus fr. AP view and lateral view

Figure (4) 3 months postoperative x-ray of 9 Years old male child with Lateral condyle humerus fr AP view and lateral view

Figure (5) postoperative x-ray of 9 Years old male child with Lateral condyle hum-erus fr before screw removal AP view and lateral view

Figure (6) clinical photos of the patient 4 months postoperative

4. Discussion

Lateral condyle fractures are the second most common kind of elbow fractures in children after supracondyle humeral fracture [7]. Although anybody may suffer this form of injury, children under the age of 10 are more at risk [8,9]. In the event of a fall and axial load through a fully

extended elbow, the radial head may impact the humeral condyle directly, and a varus force on a supinated forearm can cause the extensor muscle to pull on the condyle, both of which result in a fracture [4]. While immobilisation may be sufficient for treatment of nondisplaced or minimally displaced fracture patterns, surgical reduction and fixation with K-wires or screws may be necessary for displaced fractures [4]. Although not universally agreed upon, it is generally accepted that a displacement more than 2, or 3 mm need reduction and stabilisation to assist union and prevent deformity and articular incongruity [10]. Treatment options for a fractured lateral condyle in a child are controversial. For displaced fractures of the lateral condyle, in this study, we compared the results and functional outcomes of open reduction and internal fixation of lateral condyle in children by K-wires and CC screws [10]. When doing pin fixation, it is important to consider whether the pins should be buried beneath the skin (to prevent pin-site infection from spreading to deeper tissues) or left exposed (resulting in the need for a secondary procedure for pin removal), so we left the pins exposed in all cases to be easily removed in outpatient clinc and avoid another procedure for removal [10]. All patients who were given screws as part of their fixation have been advised to have them removed. Using a screw fixation technique would add more expense to health system due to the need for implants and subsequent operations to remove the screws [11]. On the other side, compression may be administered over the fracture site and range of motion can be introduced while the fixation remains in place with a screw fixation [11]. However, there was little to no difference in the incidence of clinically significant range of motion loss. The aim of this study is to seek if the screw fixation is best regarding time of union, clinical outcomes, range of motion, complications (infection, malunion, delayed union, lateral spuring,

alteration of carrying angle) and cost. Time of union in patient fixed by screw was 4.5 ± 0.71 weeks (Range 4-6 weeks) with no cases of non-union and no statistically significant difference in the time of union. In a study by Li WC et al., [12] the effectiveness of screw fixation (32 patients) was compared to that of K-wire fixation (30 patients), he found the same lack of difference in clinical result and absence of nonunion. In a study by Thomas DP et al., [13] 104 patients underwent a 3-week period of K-wire fixation, with one instance of nonunion. Of 16 fractures treated with K-wire fixation by Jenyo and Mirdad [14], malunion was observed in one case, resulting from loosening of a K-wire, and nonunion was observed in one case, requiring subsequent bone grafting and screw fixation. In a study by Weiss et al., [10] observed no nonunion, among the 73 patients who had displacement requiring open reduction, nine had malunion, loss of reduction, or nonunion. These results go with ours regarding the incidence of union but with higher incidence of malunion. In another large series of 105 patients done by Leonidou A et al., [15] with K-wire fixation following open reduction for displaced fracture, reported 96% excellent results with no non-unions which also go with our results regarding the non-union incendence. With regard to screw fixation, Loke et al., [16] examined 34 patients with an average follow-up of 24.5 months and found the average time to radiographic union to be 6.9 weeks. In our study, the follow up time was limited to 6 months, with no significant statistical difference regarding the time needed for union. Sharma et al. [17] monitored 37 kids for an average of 4.8 years after inserting 4.0 mm cancellous screws. one patient who did not fit the norm because to a delayed union. After 6 months follow up, we found one case with affected range of motion about 15 degrees in elbow extention this case was 4 years old male child with lateral condyle humerus fracture fixed by screw. Sharma et al. [17] monitored 37

kids for an average of 4.8 years after inserting 4.0 mm cancellous screws. Elbow range of motion was reduced by 10 degrees in one patient. After 6 months follow-up we found one case with lateral spuring, this case was 9 Years old male child with Lateral condyle humerus fracture fixed by screw. In a study by Li WC et al., [12] the effectiveness of screw fixation (32 patients) was compared to that of K-wire fixation (30 patients), Lateral expansion was clinically visible in 37% of patients treated with K-wires and in 12% treated with screws. With a mean follow-up of 39 months, Boz et al., [18] who studied the results of K-wire fixation, discovered that 71.3% of 69 patients had satisfactory functional outcomes. such a long duration of follow up was not suitable which may reflect a statistical difference in the range of motion and functional outcome in comparison to our study with follow up duration up to 6 months. Of the patients, 47% were observed to have lateral condylar overgrowth. Thomas DP et al. [13] looked at 104 patients 3 weeks following K-wire fixation and identified 44% of abnormal elbow shape (which included lateral condylar overgrowth and excessive bone formation over the outer surface of the condyle). Although we had a large sample size (104 instances), we only discovered one incident of abnormal elbow morphology (such as a lareral spur). In a study of 34 patients with a mean follow-up of 24.5 months by Loke et al. [16] This study indicated an increased incidence of issues despite the prolonged follow-up period; for example, lateral overgrowth occurred in 2 patients, lateral condylar avascular necrosis resulted in a valgus deformity in 2 patients, and a fishtail deformity occurred in 3 patients. In our study, we had no cases with significant change in carrying angle. In a study by Li WC et al., [12] the effectiveness of screw fixation (32 patients) was compared to that of K-wire fixation (30 patients). Variations in the carrying angle were seen in 23% of patients treated with K-wires (six of seven seemed to

have cubitus varus), while 19% of patients treated with screws showed apparent cubitus valgus. A study of 34 patients with a mean follow-up of 24.5 months by Loke et al. [16] found lateral condylar avascular necrosis resulted in a valgus deformity in 2 patients. One person in our research also had a minor pin tract infection. The patient received 3rd generation Cephalosporin antibiotic injection form for 3 days and daily dressing was done untill infection resolved. Limitations of our study include the short follow-up period. The short duration of follow-up limits interpretation of the range of motion data and Hardacre outcome. There hasn't been enough time for follow-up to see whether growth disruption is an issue. When deciding whether or not to use screw fixation, it's also necessary to think about how much money you'll have to spend on a second operation to get the screws out. but this issue was covered by our health insurance.

5. Conclusions

Orthopaedic surgeons often use K-wires or screws for fixation of fractures of the lateral condyle. In this study, we used screw fixation to and found good results in terms of functional outcome, time to union, or post-operative complications. Considerations for long-term monitoring and screw removal to evaluate growth outcomes are also important.

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