Results of lateral closed wedge osteotomy and k-wire fixation for correction of cubitus varus: A prospective study

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Abstract

Background: Cubitus varus is the most frequent post-traumatic late consequence of paediatric displaced supracondylar humeral fractures. Malunion is the most common cause of these deformities. Commonly present as cosmetic deformity but it may also cause increased chances of lateral humeral condyle fractures, posterolateral instability of the elbow, and tardy ulnar nerve palsy. Different types of corrective osteotomies have been described from simple wedge osteotomy to complex three-dimentional osteotomy but none with consensus. We conducted this study to evaluate the results of a simple lateral closed wedge osteotomy fixed with K-wires in these patients.
Aim and Objectives: To study the functional and radiological outcomes of a lateral closed wedge osteotomy fixed with K-wires to correct cubitus varus.
Materials and Methods: Twenty children with malunited supracondylar fracture humerus leading to cubitus varus deformity underwent lateral closed wedge osteotomy, which was fixed with K- wires. Patients were evaluated for elbow range of motion, carrying angle, radiological correction of humeroulnar angle and complications if any.
Results: The mean follow-up period was 2.3 years (range 1 to 6 years). The results were assessed as per Morrey criteria. Eighteen (90%) patients showed excellent results, two (10%) good while none showed fair or poor results in the follow-up. Average preoperative varus was 17.05 degrees (range 10-30), improved to postoperative valgus angle measured 10.1 degrees (range 7-14 degrees). One case had superficial pin tract infection.
Conclusion: With proper planning and execution, good results can be achieved with a simple lateral closed wedge osteotomy fixed with K-wires for correction of cubitus varus deformity. Complex osteotomies are not always necessary.

Keywords: Cubitus varus deformity, lateral closed wedge osteotomy, K-wires, malunited supracondylar fracture humerus

Introduction

Supracondylar fractures of the humerus are the most common pediatric elbow injuries[1- 3]

with a peak incidence around 5-7 years of age. At this stage remodelling of bones occur constantly and rapidly and there is decreased antero-posterior diameter in the supracondylar region of humerus. Thus cross section is flattened which reduces its structural strength. Ligament laxity in this age increases the risk of "hyperextension" elbow injuries. Anterior capsule is thicker and stronger than posterior capsule. In extension, the taut anterior capsule acts like fulcrum, due to which, the olecranon gets firmly engaged in the olecranon fossa, and with hyperextension, the olecranon may strike against the thin supracondylar region, thus fracturing it. More common in boys than girls. More common in the non-dominant side(majority-Left). Associated vascular injuries in 1% of the cases and nerve injuries involving median and radial nerve in at least 7% of the cases adds to the concern.

Cubitus varus or gunstock deformity or bow elbow is the most common late complication of displaced supracondylar fractures in children with reported incidence from 3% to 57%[4]. The most common cause of cubitus varus in patients with supracondylar fracture of the humerus is malunion, though very rarely growth disturbances in trochlea or avascular necrosis of trochlea may cause progressive deformity[5]. The causative factors for malunion are: Impacted/comminuted type I supracondylar fractures, Rotationally unstable type II fractures treated in a cast with subsequent loss of reduction, Poorly reduced or fixed type III fractures or neglected fractures.

The deformity involves not only loss of coronal alignment, but also has recurvatum deformation in the sagittal plane and internal rotation deformity in the axial plane. Recurvatum deformity is in the plane of motion of the joint and it can remodel to some extent in younger children <10 years and hence, its correction may not be necessary [6]. The internal rotation deformity is compensated by shoulder movements and is tolerated well[6]. Both these deformities may not require corrections and most of the times correction is focussed on coronal plane deformity. The clinical presentation of a child with cubitus varus is usually an unsightly deformity with a reasonably good ROM at the elbow. Although some studies have reported asymmetrical flexion arc with limitation of elbow flexion range on affected side but functional arc was maintained. This led most authors to believe that the deformity has no functional implications. However studies have shown that long term follow up of children with cubitus varus may result in a problems such as increased chances of lateral condyle fractures or other secondary fractures [7,8], posterolateral elbow pain and instability[9], tardy ulnar nerve palsy[10,11] Cosmetic appearance still is the most common cause why the parents bring their child to clinician. The above mentioned complications along with cosmetic concerns justify surgical management, although many times this deformity is neglected and patients are asymptomatic.

Various types of osteotomies have been reported in literature with no consensus on the ideal modality. Complex three dimensional osteotomies have been described advocating correction of all three components of the deformity. However, these osteotomies are technically difficult to perform. We conducted this study to evaluate whether a simple lateral closed wedge osteotomy can give predictably good results. In the present prospective study, we are presenting results of 20 cases of posttraumatic cubitus varus deformity treated with this technique.

Aim and Objectives

1. To treat cubitus varus with a simple lateral closed wedge osteotomy fixed with K-wires.
2. To evaluate the functional and radiological outcomes of patients treated with this method.
3. To arrive at consensus whether fixation of osteotomy with K–wires construct is strong enough to maintain correction till osteotomy unites.

Materials and Methods

A prospective interventional study was done in the Department of Orthopedics in GMERS medical college and civil hospital, Valsad, Gujarat between 26/12/2017 to 25/12/2021, twenty cases of post traumatic cubitus varus deformity (following malunion of supracondylar fracture humerus in children) who underwent corrective osteotomy were included in this study after obtaining informed, written consent. All patients were operated at least 1 year post trauma to rule out growth disturbances as a cause for the deformity. Clearance from the institutional ethics committee was obtained before starting of the study.

Methodology

All patients were clinically evaluated before surgery. The carrying angle and motion range of the unaffected and affected sides were recorded. Prior to surgery, the degree of deformity was estimated using the humeroulnar angle seen on X-rays as the point where the long axes of the humerus and ulna connect. To determine the amount of the wedge that needed to be removed in order to achieve rectification, the carrying angle of the opposite normal side was added to this. All patients were operated in supine position under general anaesthesia or regional block. The distal humerus was accessed utilising a lateral approach after the tourniquet was inflated. Under C-arm guidance, the osteotomy site was marked with K- wires passed as per templating done on preoperative X- rays. To stabilize the osteotomy, two percutaneous K- wires, one each from lateral and medial side of the distal humerus were passed with the medial K-wire while being careful not to injure the ulnar nerve at the distal osteotomy site. Numerous drill holes were made along the guide wires to begin the osteotomy, and it was completed with osteotomes. After removing the required portion of bone, closing the osteotomy gap, and advancing the predrilled stabilising K-wires so that they crossed over the osteotomy site and engaged the opposing cortex. After the wound had been closed in layers, a plaster slab was put above the elbow. Patients were checked in on at 2, 4, 6, 8 and 12 weeks, and then every three months for at least a year after that.[Figure 1,2,3] Once the osteotomy had healed, the K- wires were removed in OPD without need of any anaesthesia.
The assessment of the outcome of the cases was done on the basis of Morrey criteria [Table 1].

Table 1: Morrey's system of functional assessment of outcome

	None	Mild	Moderate	Severe
Pain		If patient had occasional pain during use of the elbow but took no medication.	If patient had pain at night occasionally took medication for pain but elbowdid not limit the activity of daily living.	If the patient took medication for pain regularly and activitiesof daily living were impaired.
Stability		If varus valgus laxity was estimated to be less than 5 degrees and was not associated with any symptoms.	If varus valgus laxity was estimated to be less than 5-10 degrees and was associated with mild symptoms.	If varus valgus laxity was estimated to be more than 10 degrees and was associated difficulty in activity of daily living.
Motion	Flexion and extension of the elbow were measured with a hand goniometer held along the lateral aspect of the brachium and forearm. Pronation and supination were measured at the extremes of active motion, with one arm of the goniometer held along or parallel to the brachium and the second arm placed parallel to the dorsum or the volar aspect of the wrist.			
Strength	Strength of flexion and extension was measured isometrically in all patients.			

Results

The 20 cases were followed up to a mean period of 2 years 3 months (range 1 to 6 years). Nineteen cases were fully satisfied with cosmetic results, with one case had inadequate correction.After surgery, all cases returned to their regular activities within 3 to 6 months. The radiological union at the osteotomy site took place in a mean period of 5.6 weeks (range 4 to 8 weeks). Preoperative mean loss of flexion of 11 degrees (range 0 to 20) was decreased to a mean of 3 degrees (range 0 to 5 degrees). The hyperextension in two cases by 14 and 5 degrees improved to normal postoperatively. Pre-and postoperative forearm pronation and supination were identical. There was no pain in 16, mild pain in two, moderate pain in two cases and none had severe pain. A total of 19 patients (95%) were satisfied with the cosmetic appearance while one (5%) noticed little difference due to excessive lateral condylar prominence. Of the 20 patients, 18 were able to have full range of motion after a mean of 6.8 weeks (range 5.5 to 8.4 weeks), while two patients regained at 9 and 10 weeks respectively. Coronal plane instability was absent in all cases. Eighteen (90%) patients showed excellent results, two (10%) good while none showed fair or poor results in the follow-up. Given the small study group, there was no statistical analysis performed. None of our patients experienced neurovascular dysfunction following surgery. There was superficial pin tract infection in one case but it responded to local wound care and antibiotics. No one experienced any pin loosening, severe fixation loss, or correction loss. Average preoperative varus was 17.05 degrees (range 10-30), immediate postoperative and 12th week postoperative valgus angle measured 10.1 degrees (range 7-14 degrees).

The radiological valgus achieved on the operated side was near equal to valgus of normal side with a mean variation of ±1.89 degrees (range-2 to + 3 degrees at 12-week follow-up [Table 2]). Cosmetically all were satisfied with the outcome. There had been no residual deformity, unattractive scar, or neurovascular complications. In the majority of the patients, stable fixation had allowed us to accomplish >170 degrees of supination-pronation and 5-10 degrees of limitation of flexion-extension.[Figure 2]. Most of our patients were able to regain their pre-injury functional status in the ninth week postoperatively with excellent cosmetic correction.

Table 2: The clinical details of patients

Case	Age (year)	Sex	Carrying angle (degree)		Carrying angle (degree)		Flexion (degree)		Duration of union (wks)	Carrying angle at the time of union (degree)	Results
			Pre op clinical varus angle	Pre op carrying angle of normal elbow	Immediate postop	At 12 week (follow-up)	Pre op	Post op (12weeks)			
1	10	M	25	12	13	13	0-118	0-131	6	13	Excellent
2	14	F	16	10	11	11	0-122	0-138	4	11	Excellent
3	08	M	13	06	07	07	0-125	0-140	8	7	Excellent
4	13	M	14	08	09	09	16-112	0-135	4	9	Excellent
5	11	F	12	08	07	07	-14-105	0-132	6	7	Excellent
6	12	M	14	09	10	10	-5-120	0-138	6	10	Excellent
7	09	F	25	08	11	07	0-120	0-130	4	7	Excellent
8	06	M	15	11	12	12	0-134	0-140	6	12	Excellent
9	6.5	F	13	10	11	11	0-121	0-129	6	11	Excellent
10	10	F	10	08	07	07	08-135	0-135	4	7	Excellent
11	08	M	16	12	13	13	5-140	0-140	4	13	Good
12	12	F	20	13	14	14	10-126	0-130	6	14	Excellent
13	12.5	F	30	07	09	09	0-135	0-138	8	9	Excellent
14	09	M	14	09	11	11	5-145	0-145	4	11	Excellent
15	7.5	M	14	10	09	09	0-120	0-135	8	9	Excellent
16	8.5	M	30	07	08	08	0-125	0-138	6	8	Excellent
17	12	F	15	08	09	09	5-115	0-120	4	9	Good
18	10	F	12	09	08	08	0-120	0-140	4	8	Excellent

19	1.3	M	20	12	14	14	0-110	0-130	6	14	Excellent
20	8.5	M	13	08	09	09	0-118	0-140	8	9	Excellent

Pre op-Pre operative, Post op-Post operative, M-Male, F-Female

Pre Op X-ray **Immediate Post Op X-ray** **15 Days Follow up X-ray**

6 Weeks Follow up X-ray **1 Year Follow up X-ray**

Fig 1: Pre and Post op follow up X-rays

Pre op Supination **Pre op Pronation** **Pre op Flexion** **Pre op extension**

Fig 2: Clinical Pics of Pre op ROM

Fig 3: Clinical pics of Post op ROM at 1 Yr follow up

Post op Supination

Post op Pronation

Post op flexion

Post op extension

Discussion

Cubitus varus is one of the most common complication of supracondylar fracture of humerus in children treated with non-operative management without reduction and fixation, incidence of which varies from 3% to 57%[4]. According to the majority of surgeons, the deformity is caused by insufficient reduction, which leaves a residual rotatory deformity that might collapse into medial tilt and cause a varus deformity. Instead of a licenced orthopaedist, similar injuries are still frequently treated in India by neighbourhood bone setters. This practise was primarily responsible for the majority of the patients in this series. There was no history of any accompanying injuries in any of the instances, and all were handled conservatively. When a youngster has cubitus varus, they frequently want treatment to correct the unattractive deformity even though the limb is still largely functioning. Although cubitus varus was once only thought of as a cosmetic deformity, numerous publications have reported a variety of issues after following these patients over an extended period of time. Six cases of lateral condylar fractures of the humerus caused by malunited extension-type supracondylar fractures of the humerus were originally documented by Davids *et al*.[7] in children with pre-existing cubitus varus. Distal humeral fractures following varus deformity were reported in nine cases by Takahara *et al*.[8]. 24 patients with cubitus varus deformity who acquired delayed posterolateral instability of the elbow 2-3 decades later were described by O'Driscoll *et al*.[9] in their study. These patients first complained of recurring instability and lateral

elbow pain. The olecranon, mechanical axis, and triceps line of pull are all medially shifted in cubitus varus. These abnormalities can stretch the lateral collateral ligament complex and cause posterolateral rotatory instability due to the recurrent external rotation torque on the ulna that is made possible[9]. Cubitus varus has also been linked to tardy ulnar nerve palsy, and Ogino *et al*.[10] were the first to describe cubital tunnel syndrome as a result of cubitus varus deformity in 1986. The cubitus varus deformity causes the triceps to shift slightly ulnarwards and the olecranon fossa to relocate to the ulnar side of the distal humerus.According to one theory, this ulnar shift could cause the cubital tunnel to become smaller and develop chronic neuropathy by pressing the ulnar nerve up against the medial epicondyle. The average time between the accident and the development of symptoms, according to Abe *et al*.[11], was 15 years. Due to cubitus varus deformity, these patients had developed delayed ulnar nerve palsy.The ulnar nerve was believed to be compressed by a fibrous band that runs between the flexor carpi ulnaris heads. The evidence mentioned above makes it evident that cubitus varus is not as benign a condition as was originally thought and that patients should be offered corrective surgery. Numerous osteotomies have been described in the literature including lateral closing wedge[5,12], French osteotomy[13], modified French osteotomy[14], medial opening wedge[15], step cut[16], oblique [17], dome[18] and pentalateral[19], but Statistics show that no method is either safer or more effective than any other [20].
We selected lateral closed wedge osteotomy because it is a straightforward technique with consistently positive outcomes. A problem with lateral closed wedge osteotomy is lateral condylar prominence, yet even this prominence remodels in younger children[21,22]. K-wires, screws, screws with tension bands, plates and external fixators are only a few of the approaches that different authors have recommended for stabilising the osteotomy. Although plates have been found to give the best stability and are preferred modality of fixation in older children, K‐ wire construct used in our series gave sufficient stability without any of our patients experiencing a loss of fixation. A big advantage with K‐ wires was that they could be removed easily once the osteotomy healed and it saved the child from undergoing another surgery and anaesthesia for implant removal.

Conclusion

With proper planning and execution, good results have been achieved with a simple lateral closed wedge osteotomy fixed with K-wires for correction of cubitus varus deformity in our series of patients. Complex three‐ dimensional osteotomies are not always necessary. This particular technique is technically easy to perform and yields an inherently stable osteotomy site, making implant removal extremely easy after osteotomy healing.

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Conflicts of Interest: Nil.

References

1. Siris IE. Supracondylar fractures of the humerus. Surg Gynecol Obstet 1939;68:201‐ 22.
2. Mitchell WJ, Adams JP. Supracondylar fractures of the humerus in children: A ten‐ yearreview. JAMA 1961;175:573‐ 7.
3. Griffin PP. Supracondylar fractures of the humerus. Treatment and complications. Pediatr Clin North Am 1975;22:477‐ 86.
4. Tellisi N, Abusetta G, Day M, Hamid A, Ashammakhi N, Wahab KH. Management of Gartland's type III supracondylar fractures of the humerus in children: The role audit and practice guidelines. Injury. 2004;35:1167‐ 71.

5. Voss FR, Kasser JR, Trepman E, Simmons E Jr., Hall JE. Uniplanar supracondylar humeral osteotomy with preset Kirschner wires for posttraumatic cubitus varus. J Pediatr Orthop. 1994;14:471‐ 8.
6. Takagi T, Takayama S, Nakamura T, Horiuchi Y, Toyama Y, Ikegami H. Supracondylar osteotomy of the humerus to correct cubitus varus: Do both internal rotation and extension deformities need to be corrected? J Bone Joint Surg Am. 2010;92:1619‐ 26.
7. Davids JR, Maguire MF, Mubarak SJ, Wenger DR. Lateral condylar fracture of the humerus following posttraumatic cubitus varus. J Pediatr Orthop. 1994;14:466‐ 70.
8. Takahara M, Sasaki I, Kimura T, Kato H, Minami A, Ogino T. Second fracture of the distal humerus after varus malunion of a supracondylar fracture in children. J Bone Joint Surg Br. 1998;80:791‐ 7.
9. O'Driscoll SW, Spinner RJ, McKee MD, Kibler WB, Hastings H 2nd, Morrey BF, *et al*. Tardy posterolateral rotatory instability of the elbow due to cubitus varus. J Bone Joint Surg Am. 2001;83:1358‐ 69.
10. Ogino T, Ooshio I, Minami A, Fukuda K, Nakasato T, Sakuma T, *et al*. Tardy ulnar nerve palsy due to cubitus varus deformity. J Jpn Soc Surg Hand. 1986;2:922‐ 7.
11. Abe M, Ishizu T, Shirai H, Okamoto M, Onomura T. Tardy ulnar nerve palsy caused by cubitus varus deformity. J Hand Surg Am. 1995;20:5‐ 9.
12. Carlson CS Jr., Rosman MA. Cubitus varus: A new and simple technique for correction. J Pediatr Orthop. 1982;2:199‐ 201.
13. French PR. Varus deformity of the elbow following supracondylar fractures of the humerus in children. Lancet. 1959;2:439‐ 41.
14. Bellemore MC, Barrett IR, Middleton RW, Scougall JS, Whiteway DW.Supracondylar osteotomy of the humerus for correction of cubitus varus. J Bone Joint Surg Br. 1984;66:566‐ 72.
15. King D, Secor C. Bow elbow (cubitus varus). J Bone Joint Surg Am. 1951;33‐ A:572‐ 6.
16. DeRosa GP, Graziano GP. A new osteotomy for cubitus varus. Clin Orthop Relat Res. 1988;236:160-5.
17. Amspacher JC, Messenbaugh JE. Supracondylar osteotomy of the humerus for correction of rotational and angulational deformity of elbow. South Med J. 1964;57:845.
18. Higaki T, Ikuta Y. The new operation method of the domed osteotomy for 4 children with varus deformity of the elbow joint. J Jpn Orthop. 1982;31:300‐ 35.
19. Sharma S, Modi U, Sangwan SS, Mudgal KC. Pentalateral osteotomy for correction of cubitus varus. Indian J Orthop. 1995;29:52.
20. Solfelt DA, Hill BW, Anderson CP, Cole PA. Supracondylar osteotomy for the treatment of cubitus varus in children: A systematic review. Bone Joint J. 2014;96‐ B:691‐ 700.
21. Cho CH, Song KS, Min BW, Bae KC, Lee KJ. Long‐ term results of remodeling of lateral condylar prominence after lateral closed‐ wedge osteotomy for cubitus varus. J Shoulder Elbow Surg. 2009;18:478‐ 83.
22. Lee SC, Shim JS, Sul EJ, Seo SW. Remodeling after lateral closing‐ wedgeosteotomy in children with cubitus varus. Orthopedics. 2012;35:e823‐ 8.