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Original article

Reverse V osteotomy and treatment of cubitus varus deformity – Results and experience

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ABSTRACT

Introduction: Cubitus varus is a most common repercussion of malunited supracondylar fracture of humerus in paediatric age group. Initially, valgus osteotomies were in trend, but due to higher rate of complications, these procedures are not in trends today, as they were earlier. Here, we are sharing our experience and results of reverse V osteotomy done for cubitus varus.
Material and method: Reverse V osteotomy was done on 20 patients of cubitus varus (due to malunited supracondylar fracture of humerus). After correcting the deformity, cross K-wires and wiring (from lateral side) or Y-shaped plate was used for internal fixation. Y-shaped plate was used in older (in 20% cases) and K-wire was used for internal fixation in younger patients.

All the patients underwent follow-up by clinical–radiological means and the analysis of functional outcome was done by the criteria of Oppenheim et al.
Results: Based on the Oppenheim's criteria, our results were 90% excellent and 10% good, among the 20 cases.
Conclusion: We concluded in this study that reverse V osteotomy provides inherent stability and its stable behaviour further strengthened by internal fixation. It is a safe technique for correcting cubitus varus with aesthetic satisfaction.

1. Introduction

Cubitus varus rarely leads to malfunction due to its misalignment and its cosmetic point of view, which makes the most common indication of surgery.[1] Until recently, the traditional valgus osteotomies have been in trend, but due to higher rate of complications like fixation failure, stiff elbow and myositis ossificans, these procedures are rarely performed now.[2,3] This article constitutes 20 patients of cubitus varus corrected with reverse V osteotomy and fixation with K-wire or Y-plate and discusses its clinico-radiological and aesthetic considerations.

2. Material and method

This prospective study was done for the management of cubitus varus by reverse V osteotomy and it was carried out from January 2010 to March 2012. Twenty patients were enrolled under this study and the follow-up of all the patients was done. Mean age of presentation was 11.1 years (range, 8–15 years). All the patients gave the prior history of significant trauma over the elbow and all of them were managed by the conservative method at that time of trauma. All the patients had the extension type of supracondylar fracture of humerus.

At the time of presentation, the parents solely complained for the unsightly deformity over the elbow. And the parents wanted for the correction of it, so the deformity correction was the indication of the surgery. Average trauma-surgery interval was 4 years (range 2–6.5 years) and among the 20 patients, the male-to-female ratio was 1:3. All the patients visiting the outpatient department of the Hospital were included in the study.

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All patients underwent history taking and physical and radiological examinations. We advised the X-ray of bilateral elbow, including the arm and forearm (with full supination at wrist and full extension at elbow) and lateral view in 90 degrees of flexion. We measured the preoperative humerus–elbow–wrist (HEW) angle, lateral prominence index (LPI) and arc of motion of both the elbows in each case.

The HEW angle was measured (over the X-ray film) on the antero-posterior view. A line was passed through the mid longitudinal axis of the lower 1/3rd part of the humerus, and then the second line drawn along the mid-longitudinal axis of the upper 1/3rd part of the forearm, between the radius and ulna. The two lines now extended and they cut each other at the mid of trans-epicondylar distance. Now, the subtended angle is HEW angle (Fig. 1). The LPI was measured (on X-ray film) by drawing the longitudinal humeral axis to the transepicondylar line, which divided the transepicondylar line into lateral and medial parts (Fig. 2). Then the ratio of the difference of lateral and medial distance and total transepicondylar distance was calculated and called as LPI.[4] Using goniometer, we measured the range of motion of the elbow and the status of the affected limb, i.e. any complications (valgus–varus instability, aesthetic issue, power and neurovascular status) documented.

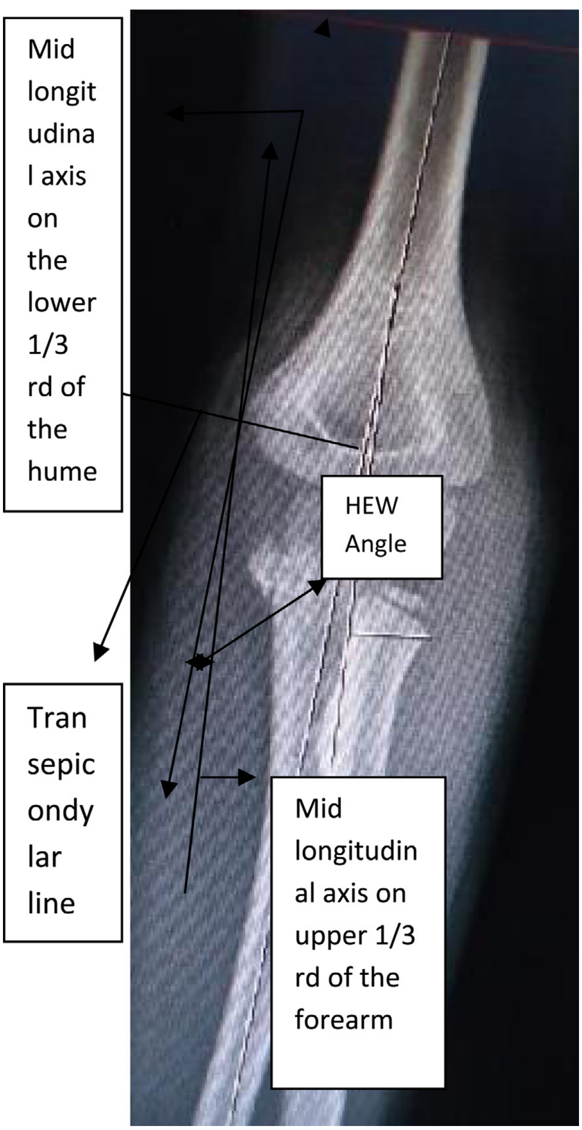

Fig. 1. HEW angle is formed at intersecting point of longitudinal axis of humerus and both bone of forearm.

Fig. 2. Usually LPI is negative. It is measured by – lateral distance − medial distance/transepicondylar distance. Calculated as $ab - bc/ac = 2.6 - 3/5.6 = -0.07$.

3. Preoperative templating and osteotomy

After completing all the preliminaries and investigations, we recommended the patient for surgery. The total correction of angle was measured by calculating the HEW angle difference (varus angle) of both the limbs and then we added 5° more for overcorrecting the deformity. For the templating, we used the X-ray film showing the antero-posterior view of the concerned elbow. We drew a horizontal line (line AB) about 0.5–1.0 cm above to the olecranon fossa and perpendicular to the long axis of the humeral shaft over the. This line AB is the first osteotomy cut. Then, we drew the second line from point B towards the proximal humerus at an angle of correction which had been measured previously. Then, we put a third perpendicular line on the second line from point A. Intersecting point of the second and third line is designated as point C. Now, the triangular template (with angle ABC) is ready and by superimposing over this triangle, we made a template and autoclaved it (Figs. 3 and 4). Angle of correction (angle ABC) was kept towards the ulnar (medial) end during osteotomy because in varus deformity, distal humerus has to be translated medially.

The operation was done on the lateral position of patients with a flexed elbow over the pillow by posterior approach. A longitudinal incision (about 7–9 cm) was done vertically over the posterior aspect. Then, the ulnar nerve was exposed and triceps splitting approach was used for further osteotomy. The triangular template was turned to face downwards (because of posterior approach) and its outline was marked with surgical ink. Then, the osteotomy was done over the distal humerus accordingly and the lateral edge of the distal part of osteotomized humerus was moved

Fig. 3. Preparation of outline of template.

Fig. 4. Marked outline imprinted over transparent paper and now the template is ready.

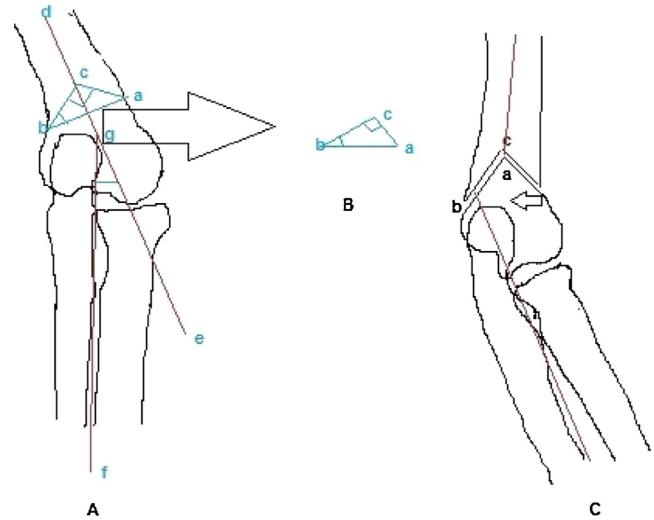

Fig. 5. (A) Showing the calculation of HEW angle (<*fge*) by intersecting line *de* and *gf*. Now the angle of correction = HEW angle + angle of cubitus valgus of opposite side + 5° overcorrection. And the template (<*abc*) of valuing the angle of correction (made by outline of the deformed elbow on to the tracing paper) kept over the supracondylar area about 0.5–1 cm above to the olecranon fossa. Angle abc kept towards unlar side because the approach is from posterior side. (B) Showing the removed wedge. After removing the wedge the distal part of the humerus rotated medially to correct the cubitus varus.

towards the apex of proximally osteotomized humerus. In Fig. 5, the line diagram is depicted to illustrate the osteotomy.

After correcting the deformity, either the cross K-wires and wiring (from lateral side) or Y-shaped plate was used for the internal fixation. Y-shaped plate was used in the older (20% cases, whose were near to epiphyseal fusion of elbow) age group and K-wires (with wiring from lateral side) used for internal fixation in younger patients. In only one case (Case no 3) both Y-plate and cross K-wires were used, because we were not satisfied with the stability of the Y-plate fixation alone. Ulnar nerve transposed anteriorly and the wound was closed under drain. Post-operatively, limb was kept in above elbow removable slab in 90° flexion and neutral rotation. Active-assisted range of motion exercise was initiated in the third post-operative day.

This study was conducted at a single institute and surgery was done and assisted by a fixed group of surgeons and follow-up was also done by the same group. For keeping authenticity, the templating and carrying angle measurement were done by single surgeon and counter checked by second surgeon.

All the patients underwent follow-up by clinical–radiological means (in the term of arc of motion, HEW angle correction, union, implant fixation, LPI, cosmetic issue, instability and neurovascular examination) at each time of 2, 6, 12, 24 weeks and then at every 6 months for an average of 2 years (range, 1.5–4 years). Gradation of functional outcome was done by criteria of Oppenheim et al. as poor, good and excellent results.[5]

4. Results

All the patients underwent follow-up, so the result is based on total 20 patients. In this literature, the radiological alignments improved and the aesthetic issues became satisfactory. Preoperative details and post-operative outcomes are depicted in Table 1. Correction of the cubitus varus by K-wires and Y-plates is depicted in Figs. 6–9.

Among all patients right side involvement of the elbow was in nine patients (7 female and 2 male) and eleven patients (8 female and 3 male) presented with left side involvement. Based on the Oppenheim's criteria out of the 20 patients, 18 excellent and 2 good results were obtained. We did not encounter the nerve palsy, infection and implant failure. Average time taken for the union at the osteotomy site was 9.5 weeks (range, 8–12 weeks). Post-operatively, the supination and pronation movements of the wrist remained the same. In the post-operative rehabilitation period (average 2 months), almost all the patients regained their pre-operative arc of motion.

Mean preoperative and post-operative arc of motion (at the end of last follow-up) were 126° and 121° respectively and it showed the statistical difference. Paired *T*-test was applied and was found that *t*-stat value was 5.2 and two tailed critical value was 2.09, which means that observed *t*-value is more than the critical *t* value giving rise to a *P* value <0.05 (i.e. range of motion significantly reduced). Among the seven patients, there was the decrease of arc of motion between 5° and 10°, while a decrease of ≤5° of arc of motion was present in five patients, and the remaining 8 cases achieved their pre-operative arc of motion. Sixteen patients were fully satisfied with their outcome, but remaining four patients were partially satisfied with their results. Partially satisfied patients (three fixed by K-wire and one managed by Y-plate)

Table 1
Table depicting patients profile, pre- and post-op values, results and internal fixation methods.

No	Age/sex	Pre-operative arc of motion (extension–flexion)	Post-operative arc of motion (extension–flexion)	Pre-operative HEW angle difference	Post-operative HEW angle difference	Pre-operative LPI in percentage	Post-operative LPI in percentage	Results	Internal fixation by
1	8/M	130 (0 to 130)	130 (0 to 130)	28	4	−4.1	−5	Excellent	K-wire
2	11/M	130 (−10 to 120)	120 (−5 to 115)	25	4	3.7	2.5	Excellent	K-wire
3	15/M	130 (−5 to 125)	125 (−5 to 120)	27	−4	5.1	4.8	Excellent	Y-plate and K-wire
4	15/F	125 (0 to125)	115 (0 to 115)	30	−4	2.6	2	Good	Y-plate
5	10/M	120 (−5 to 115)	110 (0 to 110)	35	2	−3.4	−3.9	Good	K-wire
6	15/M	125 (−5 to 120)	125 (−5 to 120)	25	6	−4	−4.6	Excellent	Y-plate
7	10.5/F	125 (0 to 125)	115 (0 to 115)	22	5	2.7	2.4	Excellent	K-wire
8	9/F	125 (−5 to 120)	115 (0 to 115)	28	4	−3.9	−5.1	Excellent	K-wire
9	8/F	120 (0 to 120)	120 (0 to 120)	26	6	4.3	2.8	Excellent	K-wire
10	10/F	125 (−5 to 120)	125 (−5 to 120)	30	4	3	2.5	Excellent	K-wire
11	12/F	120 (0 to 120)	110 (0 to 110)	35	−3	−4.3	−6.1	Excellent	K-wire
12	8/F	125 (0 to 125)	125 (0 to 125)	28	5	−3.1	−3.8	Excellent	K-wire
13	9/F	130 (−5 to 125)	125 (0 to 125)	30	3	2.7	2.2	Excellent	K-wire
14	8.5/F	130 (−10 to 120)	125 (−10 to 115)	25	5	2.9	2	Excellent	K-wire
15	15/F	125 (0 to 125)	120 (0 to 120)	24	7	4.1	3.3	Excellent	Y-plate
16	15/F	130 (−5 to 125)	125 (0 to 125)	28	4	−3.2	−3.9	Excellent	Y-plate
17	12/F	120 (−5 to 115)	120 (−5 to 115)	26	6	4	2.8	Excellent	K-wire
18	9/F	135 (−10 to 120)	130 (−5 to 1250	30	5	3.7	2.9	Excellent	K-wire
19	10/F	125 (0 to 125)	125 (0 to 125)	32	5	3.3	2.5	Excellent	K-wire
20	12/F	130 (−5 to 125)	120 (0 to 125)	36	6	−2.4	−3.2	Excellent	K-wire
	Ave 11.1 years	Ave 126.25	Ave 121.25	Ave 28.5	Ave 3.5	Ave 0.68	Ave −0.145		

were disappointed for their unsightly posterior scar and decreased arc of motion.

Positive (+) and negative (−) signs are used here to depict the valgus and varus angulations respectively. So the average HEW angle improved from −24° to +10°. The mean pre-operative HEW angle difference between limbs was 28.5° (range 22–36°) and post-operatively it became 3.5° (range, −4° to +6°). Statistical analysis of paired *T*-test of HEW showed significant improvement in varus

Fig. 6. Pre-op X-ray of 15-year-old girl of right-sided cubitus varus.

Fig. 7. Same patients treated by reverse V osteotomy and fixation by Y-shaped plate and K-wires.

Fig. 8. Pre-op X-ray of 8-year-old boy of left-sided cubitus varus.

Fig. 9. Same patients treated by reverse V osteotomy and fixation by K-wires and Y-shaped plate.

correction (t stat value = 19.17, two tailed critical value = 2.09, P value <0.05). All the patients had a corrected HEW angle within 6° of the opposite limb (Figs. 10 and 11, depicting correction of cubitus varus).

The mean of the pre-operative LPI was 0.68 (range, −4.3 to +5.1) and average post-operative LPI was – 0.145 (range, −6.1 to +4.8). Since the negative LPI implies the more medial prominence at the elbow, so in comparison to pre-operative value, the LPI decreased in all of the cases or in other words the aesthetic issue improved. Paired T test for LPI was applied (t stat value = 9.59, two tailed critical value = 2.09) and it was significantly improved, $P < 0.05$.

5. Discussion

Cubitus varus is a most common complication of displaced supracondylar fracture humerus, and it is blamed for its awkward look, while without significantly compromising the range of motion at elbow. Incidence of cubitus varus is up to 50% in paediatric age group, as a complication of supracondylar fracture of humerus.[6] Aesthetic issue and good appearance have been considered as a main purpose of the treatment of cubitus varus. However, corrective osteotomies have acted as a double edge sword because of the multitude of aesthetic drawbacks.[7] Siris was the first who formulated the idea of lateral close wedge osteotomy in 1939 for correcting cubitus varus.[8] Then, many other modalities of correction developed. In various literatures, different types of osteotomy and fixation methods have been discussed with their pros and cons.

Protruded lateral condyle (Lazy S deformity) is a drawback of lateral close wedge and step-cut osteotomy. Step-cut osteotomy is based on precise cutting and the wedge of distal segment, which act as an intact periosteal hinge, allows control over osteotomy. Its configuration gives some stability but is prone to the fracture of its cortical narrow wedge and cut through of screw. De Rosa and Graziano in their study (step-cut osteotomy) found that atrophy of musculature around elbow enhances the lateral prominence.[4,9] Wong et al. found in his study that in 64% cases, lazy S deformity is present and they suggested that it remodels, but on the contrary in another study by Ippolito et al., they found that it does not remodel and even it persisted at final follow-up.[4,7]

In dome osteotomy, condylar prominence can be minimized by repositioning of distal fragment in coronal and horizontal plane, but it is more often difficult to obtain, due to scarring of tissue. But no bone loss and preservation of arm length are its advantages at the cost of some condylar prominence.[10] Pentagonal osteotomy and external fixation method are available in the literature for addressing the lazy S deformity, but they are technically demanding and associated with neurovascular and psychosocial issue respectively.[11,12]

Reverse V osteotomy (fixed by cross-pinning and wiring) was described by Yun and Shin for treating cubitus varus. This technique shows advantage over step-cut osteotomy because it provides more available space for fixation over distal segment. Since it is performed at little higher level, more available space at distal part may engage screws of plates, if it is being performed in adults. Its inherent stability appears due to proper fitting of its firm wedge on both medial and lateral columns. Configuration of reverse V osteotomy itself provides restraint to valgus and varus forces. Cross K-wire and wiring (from lateral side) or Y-plating further multitudes its stability of construct.[13] Based on this

Fig. 10. Pre-op photo of a 15-year-old boy with cubitus varus of right side.

Fig. 11. Post-op photo of same patients after correction by reverse V osteotomy.

osteotomy, Yun and Shin in their study found excellent outcome in 91% and good results in 9% cases. In another study of Oner et al., they also showed 78% excellent and 22% good results by using reverse V osteotomy for correcting childhood cubitus varus.[14]

In this literature, the proposed osteotomy is reverse V osteotomy and here we are sharing our results and experience with it. Comparison between the method and various methods and their results have been depicted in Table 2.

In spite of promising result, our literature has its own limitations like a small sample size and absence of a control group. Since all the patients were of the paediatric age group, the procedure's outcome also cannot be predicted as same in adults, as it was in paediatric age group. Probably, bigger sample size and wide age group variation might have given better and more precise outcome.

6. Conclusion

We concluded in this study that reverse V osteotomy provides inherent stability. Its stable behaviour is further strengthened by the K-wire or Y-plate, which allow us to the earliest mobilization in the early post-op day or even the first post-op day. In this small study, we experienced that it is a safe technique for correcting cubitus varus with aesthetic satisfaction. Excellent results, reliable

Table 2
Table showing the comparison between different techniques by the authors.

Studies	Osteotomy and method of fixation	Results and complications
Yun et al. (22 cases)[13]	Reverse V osteotomy and fixation by K-wires and lateral wiring	Excellent (91%), good (9%). Transient ulnar nerve palsy.
Oner et al. (9 cases)[14]	Reverse V osteotomy and fixation by K-wires	Excellent (78%), good (22%). Transient radial nerve palsy.
Srivastava et al. (21 cases)[15]	Lateral closed wedge osteotomy and K-wire	Excellent (86%), good (14%). Superficial pin tracts infection.
Bali et al. (14 cases)[16]	Modified step-cut osteotomy and reconstruction plate	Excellent (57%), good (36%), poor (7%). Residual varus deformity in one patients.
Moradi et al. (13 cases)[17]	Spike translational osteotomy and fixation by lag screw or reconstruction plate	Excellent (85%), good (15%). Hypertrophic scar.
Our study (20 cases)	Reverse V osteotomy and fixation by K-wires and lateral wiring or Y-plate	Excellent (90%), good (10%). Hypertrophic scar.

healing and very less complications make it as a reasonable procedure for treating bow elbow along with the one repercussion that it will need the second session of surgery for the implant removal.

Conflicts of interest

The authors have none to declare.

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