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Clinical and Radiological Outcome following Kim's Step cut Translation Osteotomy for Cubitus Varus and Valgus in Children

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Abstract

Several osteotomies are available to correct cubitus varus and valgus deformities in children. The purpose of this study was to evaluate clinical and radiological outcome following Kim's step cut translation osteotomy for such deformities.

Materials and Methods: We have instituted Kim's step cut translational osteotomy in seven children having deformities of elbow (cubitus varus - 4 and cubitus valgus - 3). Patients were followed up for a period of 8 to 14 months during the period of August 2014 to October 2015. Clinically and radiologically, preoperative and postoperative Humerus-Elbow-Wrist angle, Range of motion of elbow, Lateral/Medial Prominence Index and neurological examination for ulnar nerve were determined. Results were evaluated according to modified Oppenheim et al criteria.

Results: The mean postoperative Humerus-Elbow-Wrist angle in patients with cubitus varus was 8.5±2.06 ^{0} (range, 5^0 to 10^0). The mean improvement in Lateral Prominence Index was 7.4 ±1.28% (from –13.15% to -5.75%). In cubitus valgus patients, mean postoperative Humerus-Elbow-Wrist angle was 12.33±3.51^0(range, 8^0 to 15^0) . The mean improvement in MPI was 8.7±0.83% (from -15.5% to -6.8%) . In all patients range of motion was comparable with normal side elbow. Bone union was achieved in all patients. According to Oppenheim's criteria, six patients had excellent results and one patient had good result. .None of them had any complications.

Conclusion: Even though multiple procedures are available for correcting deformities of elbow, Kim's step cut translational osteotomy provides good correction angle, lesser prominence of the condyle, better stability and three dimensional correction.

Key Words: Cubitus varus, Cubitus valgus, Kim's osteotomy, Lateral/ Medial prominence Index.

Introduction

Cubitus varus and valgus deformities are complications of elbow fractures in children[1]. Cubitus varus has multiple components that include varus malalignment, hyperextension and internal malrotation[2,3]. The most important indication for osteotomy is to achieve a good cosmesis[2,4]. Many surgical techniques have been described to correct these deformities including closing wedge, opening wedge, dome and step cut osteotomies[5-12]. The closing wedge osteotomy has a tendency to produce prominent condyles after correction,often compromising the cosmetic outcome[2,13-16]. The inclusion of translation in the osteotomy improves cosmetic appearance by minimizing the persistent prominence of the medial or lateral condyle. This can be achieved by Kim's osteotomy. The aim of our study was to evaluate clinically and radiologically, the preoperative and postoperative Humerus-Elbow-Wrist(HEW) angle, Lateral/Medial Prominence Index(LPI/MPI), Range of Motion(ROM), in children undergoing Kim's step cut translation osteotomy for cubitus varus and valgus.

Materials and Methods

This is a retrospective study, from August 2014 to October 2015, involving seven paediatric patients in the age group 8 – 14 years with male:female ratio of 4:3. Those with cubitus varus deformity had sustained supracondylar humerus fracture and those with valgus deformity had fracture lateral condyle. All the patients had undergone native treatment immediately after injury, and presented to our department after a period of 14 months to 34 months after injury.

We have instituted step cut translational osteotomy of Hui Taek Kim [1] in all the seven patients. Preoperatively, radiological and clinical planning includes measurement of HEW angle, lateral/medial prominence index (using the method described by Wong et al [2,16]),range of motion of elbow, neurological examination for ulnar nerve and internal rotation malalignment (using the method described by Yamamoto[17,18]). Same radiological and clinical parameters were evaluated postoperatively.

HEW angle was measured by drawing two lines, one line along the anatomical axis of humerus ,and another line joining

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Figure 1: Humerus-Elbow-Wrist (HEW) Angle

LPI (%)=(AB-BC)/AC×100 LPI (%)=(AB-BC)/AC×100

Figure 2: Lateral/Medial Prominence Index % (LPI/MPI)

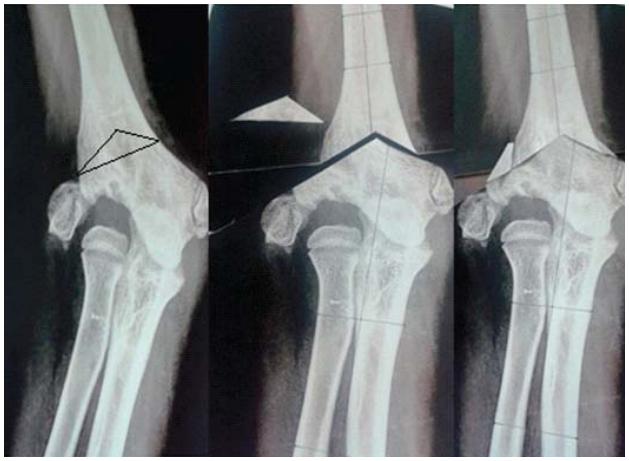

Figure 3: Preop Templating

midpoints of two transverse lines(one proximal and one distal) across the forearm that connected the medial cortex of ulna and lateral cortex of radius (Fig-1). The Lateral/Medial Prominence Index was measured by using the formula shown in (Fig-2).

We determined the Correction Angle (CA) for patients with cubitus varus by adding varus HEW angle with normal side HEW angle, and for patients with cubitus valgus by subtracting normal side HEW angle from affected side valgus HEW angle. A template using X-ray film, was prepared preoperatively, to mark the site and size of osteotomy, using following technique(Fig-3).

The outline of the bone was drawn on a trace paper. A horizontal line was drawn perpendicular to anatomical axis of humerus at a level 0.5 to 1 cm proximal to the olecranon fossa. Now the trace paper was cut along the horizontal line and the distal fragment was rotated laterally and translated medially(in case of cubitus varus) so as to achieve HEW angle of normal side. Vice versa was done for cubitus valgus deformity. An inverted V was marked on the trace paper. We then cut out the triangular overlapping area from the paper and prepared X-ray film of same size and shape. This triangular X-ray film was sterilised for use during osteotomy.

Method of Osteotomy

With the patient in lateral decubitus position,through posterior approach ,ulnar nerve was isolated and protected. The triceps aponeurosis was split. The triangular X-ray template (turned face downward because of posterior approach) was placed over the bone 1cm proximal to olecranon fossa and necessary osteotomy was done to remove an identical piece of bone. The distal fragment was rotated laterally for cubitus varus(and medially for cubitus valgus) and inserted into the inverted V shaped defect. The deformity correction was assessed clinically and then the fixation was done with distal radius T-Plate and 3.5mm cortical screws. The ulnar nerve was transposed anteriorly in patients who had tardy ulnar nerve palsy due to cubitus valgus deformity. Patient was immobilised in long arm slab for 2 weeks following which active and assisted mobilisation was done intermittently retaining the splint until radiological union was achieved.

Results

The HEW angle, LPI/MPI, ROM were measured and analysed (Table -1).

In cubitus varus patients, mean postoperative HEW angle was 8.5^0(range, $5^0$to 10^0),with mean correction of 21.5^0(range,19^0 to 25^0). The mean improvement in LPI was 7.4% (from -13.15% to -5.75%) .In cubitus valgus patients(Fig-5), mean postoperative HEW

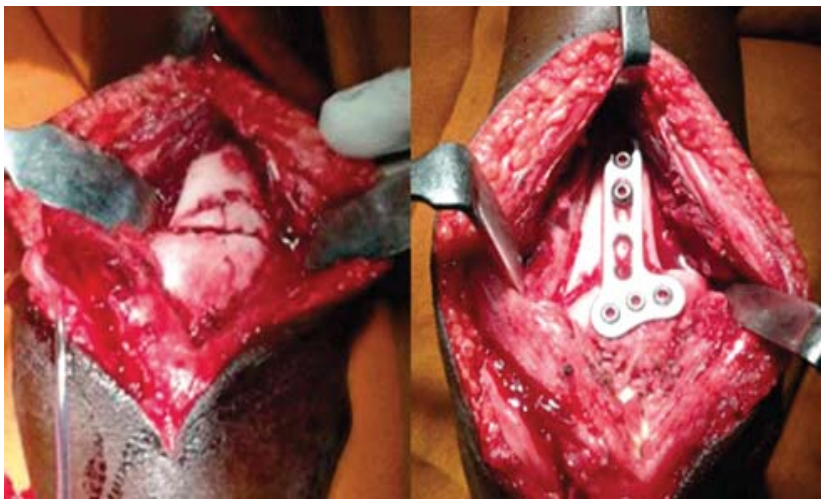

Figure 4: Osteotomy and Fixation

Figure 5: X-ray(Preop and Postop)

Figure 6: Lateral/Medial Prominence Index % (LPI/MPI)

S.no.	Age/ sex	HEW Angle			ROM		LPI/MPI			Oppenheim 's Criteria
		Preop	Postop	CA	Preop	Postop	Preop	Postp	Correction	
1.	14/M	35^0	15^0	20^0	$0\text{-}135^0$	$0\text{-}130^0$	-16.6	-8.1	8.5	Excellent
2.	13/F	30^0	8^0	22^0	$0\text{-}130^0$	$0\text{-}125^0$	-14.2	-6.1	8.1	Excellent
3.	12/F	35^0	12^0	23^0	$0\text{-}130^0$	$10\text{-}120^0$	-15.8	-6.2	9.6	Good
4.	10/F	-15^0	10^0	25^0	$0\text{-}130^0$	$0\text{-}130^0$	-13.6	-5.6	8.0	Excellent
5.	8/F	-10^0	9^0	19^0	$0\text{-}130^0$	$0\text{-}130^0$	-12.8	-6.8	6.0	Excellent
6.	12/M	-15^0	5^0	20^0	$0\text{-}125^0$	$0\text{-}125^0$	-11.6	-5.2	6.4	Excellent
7.	9/M	-12^0	10^0	22^0	$0\text{-}130^0$	$0\text{-}125^0$	-14.6	-5.4	9.2	Excellent
Mean	11.14	33.33^0/- 12.33^0	12.33^0 /8.5^0	21.66^0/2 1.5^0			-15.5/ -13.15	-6.8/ -5.75	8.7/7.4	
SD	2.19	2.88/2.12	3.51/2.06	1.52/2.29			1.22/1.09	1.12/0.62	.83/1.28	

Table-1: Preoperative and Postoperative Measurements.

HEW- Humerus-Elbow-Wrist angle, LPI /MPI - Lateral/Medial Prominence Index, CA- Correction Angle

angle was 12.33^0(range, 8^0 to 15^0),with mean correction of 21.66^0(range,20^0 to 23^0). The mean improvement in MPI was 8.7% (from -15.5% to -6.8%).In all patients, range of motion was comparable with normal side elbow (Table 1). Pronation and supination movements were normal in all our cases. Bone union was achieved in all patients. According to Oppenheim's criteria [7], excellent result (Fig-6) was achieved in 6 patients and good result in one patient, and no patient had poor result.

Discussion

In patients with cubitus varus/valgus, the following problems need to be addressed deformity correction in coronal plane(valgus/varus), sagittal plane(fixed flexion/hyperextension),horizontal plane(internal/external rotation deformity); ulnar nerve palsy, if any.

The deformity is better corrected during childhood. Correction, particularly in cubitus varus, in adult is challenging due to mature skeleton, inherent instability at osteotomy site, risk of delayed union/non union, implant failure, infection, stiffness and neurovascular complications [19]. A rough estimate will be around a year after original injury. Again patient demands, growth potential and status of physis should be taken into account while planning surgery[20].

Major types of osteotomies are - simple closing wedge [17,21,22],step cut translation [1,17,23], dome rotational osteotomy[13,14,17,24] and spike translation osteotomy[17]. Many of these osteotomies have got their own disadvantages, like lateral scar, medial and lateral condylar prominence and difficulty in correcting rotational deformities(due to contractures)[1,24,25,26].

Various method of fixation include use of K-wires, screws, plates and external fixators (Ilizarov technique) [5,13,25,27-29]. We have used Kim's method of step cut translation Osteotomy, and fixed with distal radius T-plate.

This method has got multiple advantages. Adequate Correction Angle (CA) is achieved by moving the apex more medially (in cubitus varus) or laterally (in cubitus valgus). The stability of fixation is enhanced because the distal fragment is inserted into the inverted V shaped proximal fragment and fixation was done with plates. The prominence of condyles (lateral condyle in cubitus varus and medial condyle in cubitus valgus) is less with Kim's osteotomy (when compared to other methods) because distal fragment is translated. With Kim's osteotomy, three dimensional correction is possible. The correction of internal rotation is recommended when the difference in rotational alignment in both sides is greater than 10^0 [1,17,18]. In our study ,we did not encounter patient with hyperextension, or internal rotation more than 10^0, when compared to normal side. Hence we have not attempted correction in sagittal/horizontal planes.

The limitations of our study is smaller sample size and follow up of only 14 months duration.

Conclusion

This simple step cut translation osteotomy(Kim's) results in good cosmetic deformity correction,very firm fixation,earlier elbow movement and also avoids problems of condylar prominence and non union. Deformities in sagittal/horizontal plane can also be corrected.

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