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Original Research Article

FUNCTIONAL AND RADIOLOGICAL OUTCOME FOLLOWING TRANSLATIONAL STEP CUT OSTEOTOMY FOR CUBITUS VARUS DEFORMITY IN CHILDREN: A QUASI-EXPERIMENTAL STUDY

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ABSTRACT

Background: Cubitus Varus also known as a "gunstock deformity" is the most common complication following a malunion of a supracondylar humerus fracture which leads to increased elbow extension and decreased elbow flexion. Cubitus varus deformity is a triplanar deformity consisting of varus angulation in the coronal plane, hyperextension in the sagittal plane and internal rotation in the axial plane. Although it is frequently regarded as a purely cosmetic problem in children, it occasionally causes late-onset lateral elbow pain, symptomatic elbow posterolateral rotatory instability, triceps snapping, progressive ulnar and elbow joint varus, ulnar neuropathy or rarely, predisposed to lateral humeral condyle fractures. For this reason, it may be appropriate to offer surgical treatment in the vast majority of patients with this complaint. Various treatment options proposed include observation, hemi epiphysiodesis and growth alteration, and corrective osteotomy. **Objectives:** The objectives of the present study were to assess the functional and radiological outcome of the translational step cut osteotomy of Cubitus Varus deformity in children, to assess the patient's/parent's/guardian's satisfaction after surgery and to determine the association between selected variables of interest and the outcome. **Materials and Methods:** A hospital-based, quasi experimental study was done in JNIMS, Imphal Manipur during the period from Jan 2024 to Feb 2026. All patients of the age-group 5-18 years having Cubitus Varus Deformity admitted in the Orthopaedics Department of the same institute, were the study participants. A sample size of 26 was systematically derived at and they were recruited consecutively. A pre-tested proforma which had sections on patient's particulars, pre-operative findings, all routine investigations including X-ray elbow (AP and lateral views), intra-operative details and post-operative outcomes including patient satisfaction was used to collect data. The outcome of the intervention was assessed by four parameters viz. HEW angle, LCPI, Oppenheim's criteria and Patient satisfaction score. Patients were followed up-to one year. **Results:** The mean (SD) of the normal HEW angle was 11.27° (3.05°) (range, 7° - 18°) and for the deformed elbow the pre-operative value was -24.88° (3.659°) (range, -30°- -18°) and with corrective osteotomy it was 11.77° (2.658°) (range, 8° - 17°) at the final follow-up. There was a significant mean difference in the HEW angle between pre-operative and post-operative period {t (25) =-38.34, p=<0.001}. Similarly, the mean (SD) of the pre-operative LCPI was 0.165% (3.943%) (range, -8.4% - 5.6%) and with corrective osteotomy it was -1.073% (3.904%) (range, -9.2% - 4.8%) at the final follow up. And there was a significant mean difference in the LCPI between pre-operative and post-operative {t (25) =10.66, p=<0.001}. Further, the mean (SD) of the pre-operative ROM was 123.96 ± 7.571 (range, 110 – 135) and with corrective osteotomy it was 128.96 (5.272) (range, 115- 138) at the final follow up and there was a significant mean difference in the ROM between {t (25) =-6.19, p=<0.001}. A total of 17 (65.4%) patients had excellent outcome and the remaining 9 (36.8%) patients had good outcome. There was no statistically significant difference between the age of the patients and outcome of the

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intervention (p=0.382). However, statistical significance was seen when the test was applied to compare mean duration of injury and osteotomy between the excellent and good outcome of the Oppenheim criteria (p=0.002). In this study almost all patient 25 (96.2%) were satisfied with the post-operative appearance of the arm, only 1 (3.8%) was partly satisfied and none of the patients were dissatisfied. In the satisfaction scale regarding improvement in function of arm postoperatively, majority 23 (88.5%) were satisfied, 3 (11.5%) were partly satisfied and none of the patient were dissatisfied. **Conclusion:** Functional and clinical outcome of translational step cut osteotomy was good to excellent, and is effective in correction for the cubitus varus deformity

INTRODUCTION

Supracondylar fractures of the distal humerus are the most common elbow fractures seen in children and are usually caused by a fall onto the outstretched hand with the elbow in full extension. There are many complications associated with supracondylar fractures which include vascular injury, neurological injury, compartment syndrome, deformities, elbow stiffness and myositis ossificans.[1] Cubitus Varus also known as a "gunstock deformity" is the most common complication following a malunion of a supracondylar humerus fracture which leads to increased elbow extension and decreased elbow flexion. Cubitus varus deformity is a triplanar deformity consisting of varus angulation in the coronal plane, hyperextension in the sagittal plane and internal rotation in the axial plane.[2] Although it is frequently regarded as a purely cosmetic problem in children, it occasionally causes late-onset lateral elbow pain, symptomatic elbow posterolateral rotatory instability (PLRI), triceps snapping, progressive ulnar and elbow joint varus, ulnar neuropathy or rarely, predisposed to lateral humeral condyle fractures.[3] For this reason, it may be appropriate to offer surgical treatment in the vast majority of patients with this complaint. Various treatment options proposed include observation, hemi epiphysiodesis and growth alteration, and corrective osteotomy.[4] Corrective osteotomy is the preferred method, as it yields the highest probability for success.[5]

Over the years, numerous steps cut osteotomy techniques were proposed and implemented, each with its own variations and nuances. These techniques differ in terms of the site of osteotomy, type of osteotomy, the orientation and magnitude of correction, the fixation methods used. Currently there is no standardized technique that offers both maximum deformity correction and satisfactory cosmetic appearance while minimizing complications to meet the expectations of patients and their caregivers.[6]

There are numerous techniques in the literature that address the correction of posttraumatic cubitus varus deformity. Lateral closing wedge osteotomies, medial opening wedge osteotomies, dome osteotomies, step-cut osteotomies, Ilizarov technique, hemiepiphysiodesis of the distal humerus and multiplanar osteotomies have all been described, each possessing their own advantages and disadvantages. Lateral closing wedge osteotomies have historically been the most popular technique due to the relative ease of the procedure. Complications associated with these procedures are common (range: 14% to 53%), and may include overcorrection or under correction, persistent prominence of the lateral condyle, delayed union, and neurological injury.[7]

Lateral protrusion of a distal fragment after a corrective osteotomy might cause a lazy S shaped deformity causing many patients to be dissatisfied in terms of cosmesis despite measured angular correction. Translational step cut osteotomy is a simple osteotomy that enables three- dimensional correction of coronal, sagittal, and rotational deformities. A triangular wedge- shaped surface created by osteotomy can provide stability.[8]

After evaluating results, advantages and disadvantages of different osteotomies, it was decided to use translational step-cut osteotomies with little modification in procedure which was initially described by DeRosa and Graziano,[9] that correct varus, extension and lateral condyle prominence, to assess the functional and radiological outcome of cubitus varus among children. As the main concern of the patients are for the cosmetic reasons, patient satisfaction was also assessed.

Objectives

The objectives of the present study were to assess the functional and radiological outcome of the translational step cut osteotomy of Cubitus Varus deformity in children, to assess the patient's/parent's/guardian's satisfaction after surgery and to determine the association between selected variables of interest and the outcome.

MATERIALS AND METHODS

A hospital-based, quasi experimental study was done in JN Institute of Medical Sciences, Imphal Manipur during the period from Jan 2024 to Feb 2026. All patients of the age-group 5-18 years having Cubitus Varus Deformity admitted in the Orthopaedics Department of the same institute, were the study participants. Patients who were medically unfit to undergo surgery and those who refused to give consent were excluded.

A sample size of 26 was derived at considering the standard deviation =of 5.2 from an earlier study by Kim et al,[4] an accuracy of estimate of 02 and a

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normal deviates at 95% confidence interval. All eligible patients were recruited consecutively.

A pre-tested proforma which had sections on patient's particulars, pre-operative findings, all routine investigations including X-ray elbow (AP and lateral views), intra-operative details and post-operative outcomes including patient satisfaction was used to collect data. The operational definitions used were (i) Humero-elbow-wrist (HEW) angle as described in Fig. 1

(ii) Lateral condylar prominence index (LCPI) and (iii) Oppenheim's criteria for assessing fracture complications. [Table 1]

Figure 1: The humero-elbow-wrist, (HEW) angle is calculated from the angle of intersection of the forearm and the humeral axis. The forearm and humeral axis are drawn by connecting the midpoints of 2 transverse lines drawn across the proximal and distal parts of the humerus and the forearm

Table 1: Oppenheim's criteria

Criteria	Excellent	Good	Poor
Humerus- elbow wrist angle correction	Within 5^0 of normal	Within 10^0 of normal	Residual Deformity > 10^0
Loss of ROM at elbow	Up-to 5^0	6– 10^0	>10^0
Complications	Nil	Scarring/Lazy S deformity	Other Complications (Infection, myositis ossificans and neurovascular injury)

RESULTS

A total of 26 patients with cubitus varus deformity were enrolled in the study and translational step cut osteotomy was performed for its correction. The mean (SD) age of the participants was 8.58 (1.793) years. The age ranged from 6 to 13 years. A majority (16; 61.5%) were from younger age-group of 6-8 years. Boys (18; 69.2%) outnumbered the girls.

In more than half of them (14; 53.8%), the right arm was affected. Fall from height was the most common mode of injury (17; 65.4%) while for the remaining nine cases, it was Road-traffic accident. The mean (SD) duration of injury to time of osteotomy was 24.42 (5.651) months ranging from minimum of 12-32 months.

Table 2: Comparison of findings at pre-operative and post-operative at 1 year

Variables	Pre-operative	Post -operative	t value	P value
Mean (SD) HEW	-24.88 (3.659)	11.77 (2.658)	38.34	<0.001
Mean (SD) LCPI	0.165 (3.943)	-1.073 (3.904)	10.66	<0.001
Mean (SD) ROM	123.96 (7.571)	128.96 (5.272)	6.19	<0.001

The mean (SD) of the normal HEW angle was 11.27° (3.05°) (range, 7° - 18°) and for the deformed elbow the pre-operative value was -24.88° (3.659°) (range, -30°- -18°) and with corrective osteotomy it was 11.77° (2.658°) (range, 8° - 17°) at the final follow-up. There was a significant mean difference in the HEW angle between pre-operative and post-operative period {t (25) =-38.34, p=<0.001}. Similarly, the mean (SD) of the pre-operative LCPI was 0.165% (3.943%) (range, -8.4% - 5.6%) and with corrective osteotomy it was -1.073% (3.904%) (range, -9.2% - 4.8%) at the final follow up. And there was a significant mean difference in the LCPI between pre-operative and post-operative {t (25) =10.66, p=<0.001}. Further, the mean (SD) of the pre-operative ROM was 123.96 ± 7.571 (range, 110 – 135) and with corrective osteotomy it was 128.96 (5.272) (range, 115- 138) at the final follow up and there was a significant mean difference in the ROM between {t (25) =-6.19, p=<0.001}. [Table 2]

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Table 3: Evaluation of patients based on Oppenheim's Criteria

Criteria	Frequency	Percentage
Excellent	17	65.4
Good	9	36.8
Poor	0	0

In the study, functional outcome was assessed by Oppenheim's criteria at the end of one-year follow up. A total of 17 (65.4%) patients had excellent outcome and 9 (36.8%) patients had good outcome. None of the patient had poor outcome.

Table 4: Comparison of mean of selected variables between the Oppenheim criteria outcome

	Excellent	Good	t	df	p value
Mean age (SD) in years	8.35 (1.835)	9.00 (1.732)	- 8.71	24	0.382
Mean duration of injury & osteotomy	20.06 (4.322)	26.89 (5.302)	-3.546	24	0.002

There was no statistically significant difference between the age of the patients and outcome of the intervention (p=0.382). However, statistical significance was seen when the test was applied to compare mean duration of injury and osteotomy between the excellent and good outcome of the Oppenheim criteria (p=0.002).

Table 5: Showing patient satisfaction scale

	Dissatisfied	Neutral	Partly satisfied	Fully satisfied
Feeling about the correction of the deformity	-	-	1 (3.8%)	25 (96.2%)
Satisfaction level with the post-operative appearance of the arm	-	-	1 (3.8%)	25 (96.2%)
Rating the improvement in functionality of the arm post operatively	-	-	3 (11.5%)	23 (88.5%)

In this study almost all patient 25 (96.2%) were satisfied with the post-operative appearance of the arm, only 1 (3.8%) was partly satisfied and none of the patients were dissatisfied. In the satisfaction scale regarding improvement in function of arm postoperatively, majority 23 (88.5%) were satisfied, 3 (11.5%) were partly satisfied and none of the patient were dissatisfied. [Table 5]

Figure 2: Shows the same patient at the pre-operative period and post-operative follow-up at one year

DISCUSSION

The present study was conducted to assess the functional outcome of translational step cut osteotomy for cubitus varus among children in 26 patients

In the present study, the mean (SD) age of the participation was 8.58 (1.793) ranging from 6 to 13 years. Similar finding were found in study done among children with mean of 8.9 years by Davids JR et al.[7] In some studies, done by De Rosa et al and Takagi T et al and the mean age was 7.4 years and 7.5 years respectively.[9,10] The findings indicate the need for early recognition and early decision for corrective surgery to achieve optimal functional outcome and also the deformity being a sequela of common fracture of childhood.

In our study, there was male preponderance comprising of 69.2% and female with 30.8%. The results were comparable with the study finding of Liu X et al with 72.7% male and 27.3% female.[11] Vashist et al and Bali et al also reported 73% and 78.5 % of male respectively.[12,13]

This finding may be attributed to a higher incidence of supracondylar fractures in boys due to increased outdoor and risk prone activities.

There was a significant mean difference in the HEW angle between pre-operative (-24.88°± 3.659°) and post-operative (11.77° ± 2.658°); t(25) =-38.34, p=<0.001. Similarly significant improvement was found in the study done by Liu et al where the pre operative HEW angle improve from -18.23° to 8.45°.[11] The significant improvement in the HEW angle observed from the pre-operative to post-operative period indicates effective correction of the varus deformity and restoration of near normal coronal alignment of the elbow. Similar improvements in HEW angle following corrective osteotomy have also been reported in previous studies conducted by Davids et al, Kim et al, Vashist

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et al, Moradi et al, and Abed Y.[7,8,12,14,15] The improvement is also cosmetically significant and may contribute to better functional outcome.

In this study, the mean (SD) of the pre operative LCPI was 0.165% ± 3.943% (range, -8.4% - 5.6%) and with corrective osteotomy it was -1.073% ± 3.904% (range, -9.2% - 4.8%) at the final follow up. This difference was found to be statistically significant (p=0.001). The findings were similar to studies conducted by Liu et al where the pre-operative LCPI improve from 3.52% to -3.28% post-operative and David et al where significant improvement was found. [7,11] Improvement in LCPI indicates effective reduction of lateral condylar prominence, an important cosmetic concern in cubitus varus deformity.

The mean (SD) of the pre-operative ROM was 129.81 ± 7.54 (range, 110 - 145) and with corrective osteotomy it was 125.77 ± 8.910 (range, 110 – 140) at the final follow-up in our study. Again, this improvement was found to be statistically significant (p=<0.001). This finding was consistent with the findings in previous studies done by David et al, Liu et al, Vashist et al where the range of movement of elbow was maintained.[7,11,12]

In the study, functional outcome was assessed by Oppenheim's criteria which provides a composite evaluation of functional and cosmetic results following corrective osteotomy for cubitus varus deformity. At the end of one-year follow up majority of the patients had excellent result in 65.4% of the patients to good outcome in 34.6% of the patients. This reflects effective correction of deformity, preservation of elbow range of movement and satisfactory cosmetic appearance. Similar distribution of excellent and good outcomes has been reported in earlier studies by Takagi et al and Moradi et al.[10,14]

CONCLUSION

Translational step cut osteotomy is a simple and effective treatment for the correction of cubitus varus deformity. The functional outcome measured by the Oppenheim criteria shows good to excellent outcome in all the cases which assessed the HEW angle correction, loss of ROM at elbow and complication. 65.4% had excellent outcome and 34.6% had good outcome and none had poor outcome. Almost all the patients were satisfied with the overall outcome of the osteotomy in correcting the deformity as there were significant improvement in the HEW angle. Shorter duration of injury and the time of osteotomy has shown significant improvement in the outcome. Thus, it is recommended that the corrective osteotomy is done at the earliest to get excellent results.

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