

Clinical and Radiological Outcomes of Cubitus Varus Deformity Treated with Modified French Osteotomy and Reconstruction Plate Fixation

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ABSTRACT

Background: Cubitus varus deformity, commonly resulting from malunited supracondylar fractures in children, leads to significant cosmetic and functional impairment. Its surgical correction remains challenging, with various osteotomy techniques yielding variable outcomes. This study aimed to evaluate the clinical and radiological outcomes of cubitus varus deformity treated with modified French osteotomy and reconstruction plate fixation. **Method & Materials:** This prospective observational study was conducted at the National Institute of Traumatology and Orthopedic Rehabilitation (NITOR), Dhaka, from May 2017 to August 2019. Twenty-two patients diagnosed with cubitus varus deformity were enrolled. All patients underwent modified French osteotomy with reconstruction plate fixation. Pre-operative and post-operative carrying angle, range of motion, and lateral condylar prominence index (LCPI) were measured. Functional outcomes were assessed using Bellmore criteria at final follow-up. Data were entered and analysed using SPSS version 26. **Results:** The mean age was in the 10-15 year group (45.5%). Males comprised 59.1% of patients. The most common cause was a malunited supracondylar fracture (81.8%). Mean carrying angle improved significantly from $-25.14^{\circ} \pm 8.28^{\circ}$ pre-operatively to $4.81^{\circ} \pm 5.48^{\circ}$ post-operatively ($p < 0.001$). Flexion improved from 132.36° to 139.09° ($p = 0.007$). Internal rotation decreased significantly ($p < 0.001$). LCPI normalised post-operatively ($p < 0.001$). According to the Bellmore criteria, 63.64% achieved excellent outcomes and 27.27% good outcomes. **Conclusion:** Modified French osteotomy with reconstruction plate fixation is an effective and reliable surgical technique

for correcting cubitus varus, providing significant radiological correction and satisfactory functional outcomes with a low complication rate.

Keywords: Cubitus varus, Modified French osteotomy, Reconstruction plate, Supracondylar fracture

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INTRODUCTION

Cubitus varus, colloquially termed "gunstock deformity," is one of the most common complications following poorly reduced or malunited supracondylar humeral fractures in the pediatric age group [1]. The deformity is characterised by a reduced or reversed carrying angle of the elbow, producing a cosmetically unacceptable appearance and, in longstanding cases, functional compromise, including restricted range of motion and altered elbow biomechanics [2]. Supracondylar fractures of the humerus represent nearly 60% of all elbow fractures in children, making them the most prevalent pediatric elbow injury [3]. Despite advances in operative techniques, malunion resulting in cubitus varus continues to occur, particularly in resource-limited settings where delayed presentation and suboptimal reduction are common [4]. Once established, the deformity does not remodel spontaneously, necessitating surgical correction in symptomatic or cosmetically distressing cases [5]. Various corrective osteotomy techniques have been described for the management of cubitus varus,

including the lateral closing wedge osteotomy, dome osteotomy, step-cut osteotomy, and the French osteotomy [6]. The French osteotomy, a three-dimensional corrective procedure, addresses not only the varus deformity but also the associated internal rotational and hyperextension components that characterise this condition [7]. Its modification using rigid internal fixation with a reconstruction plate has been advocated to improve stability, facilitate early mobilisation, and reduce complication rates such as recurrence, lateral condylar prominence, and unsightly scarring [8]. The Lateral Condylar Prominence Index (LCPI) is a validated radiological parameter used to quantify the cosmetic outcome of corrective osteotomy by measuring lateral condylar protrusion relative to the humeral shaft axis [9]. Functional assessment through standardised criteria, such as the Bellmore grading system, enables objective comparison of outcomes across different surgical modalities [10]. Despite growing evidence supporting the modified French osteotomy, there remains a paucity of studies from South Asian and developing-

country settings that document outcomes with reconstruction plate fixation in a prospective manner. Understanding the demographics, operative details, and functional and radiological outcomes in this population is essential for refining surgical protocols and improving patient care. This study, therefore, evaluates the clinical and radiological outcomes of cubitus varus deformity treated with modified French osteotomy and reconstruction plate fixation.

METHODS & MATERIALS

This was a prospective observational study conducted at the National Institute of Traumatology and Orthopedic Rehabilitation (NITOR) in Dhaka from May 2017 to August 2019. Ethical approval was obtained from the institutional review board, and informed written consent was obtained from all patients or their legal guardians before enrollment. Patients with cubitus varus deformity secondary to malunited distal humeral fractures and having a carrying angle of less than 0° (varus), with either cosmetic disfigurement or functional

limitation, were included in the study. Patients with active infection at the operative site, previous corrective osteotomy, associated neurovascular deficits, or incomplete follow-up data were excluded. All 22 enrolled patients were treated with modified French osteotomy under general or regional anaesthesia, and internal fixation was achieved with a reconstruction plate. The procedure involved varus, internal rotation, and hyperextension all at the same time. Bone graft was used selectively in three cases (13.6%) in which insufficient bone stock was available. The main variables

measured were: demographic data (age, sex, side, residence); cause and duration of deformity; pre-op and post-op carrying angle; range of motion (flexion, hyperextension, internal rotation); and the Lateral Condylar Prominence Index (LCPI). Functional outcomes were graded according to Bellmore's (excellent, good, poor) criteria at a minimum follow-up of 12 months. Data were entered and analysed using SPSS version 26. Continuous variables were presented as mean ± standard deviation. The paired sample t-test was used to compare pre- and post-operative measurements. Statistical

significance was found at a p-value <0.05. Frequencies and percentages were used with categorical variables.

RESULTS

A total of 22 patients, mostly males (59.1%), were included in the study. The age group of 10-15 years old was the most represented (45.5%), which reflects the peak incidence of pediatric supracondylar fractures. The right elbow was commonly involved (54.5%), and most of the patients had a rural background (63.6%), implying delayed presentation due to lack of healthcare access (Table I).

Table I
Demographic Characteristics of the Study Population (n = 22).

Variable	Category	Frequency (n)	Percentage (%)
Age group (years)	<10	6	27.3
	10-15	10	45.5
	>15	6	27.3
Sex	Male	13	59.1
	Female	9	40.9
Side affected	Right	12	54.5
	Left	10	45.5
Residence	Rural	14	63.6
	Urban	8	36.4

Malunited supracondylar fracture was the main cause of cubitus varus (81.8%). Half the patients had 2-5 years following injury. Cosmetic disfigurement was the most

common presenting complaint (68.2%), highlighting the importance of the psychosocial consequences of this deformity, while functional impairment

and pain were less common but clinically important surgical indications (Table II).

Table II
Clinical Profile of Patients with Cubitus Varus Deformity.

Variable	Category	Frequency	Percentage (%)
Cause of deformity	Malunited supracondylar fracture	18	81.8
	Lateral condyle fracture malunion	4	18.2
Duration since injury	<2 years	5	22.7
	2-5 years	11	50.0
	>5 years	6	27.3
Presenting complaint	Cosmetic deformity	15	68.2
	Reduced elbow motion	4	18.2
	Pain	3	13.6

All 22 patients underwent modified French osteotomy with reconstruction plate fixation; this ensured the uniformity of the surgical procedure. Bone grafting was

needed in only 13.6% of cases. The mean operative time of 78±15 minutes and mean hospital stay of 4.2±1.3 days represent the technical reproducibility and relative

efficiency of the procedure in a tertiary care setting (Table III).

Table III
Operative Characteristics and Surgical Details.

Variable	Category	Frequency	Percentage (%)
Osteotomy technique	Modified French osteotomy	22	100
Fixation method	Reconstruction plate	22	100
Bone graft used	Yes	3	13.6
	No	19	86.4
Mean operative time	78 ± 15 minutes	-	-
Mean hospital stay	4.2 ± 1.3 days	-	-

Statistically significant improvements were noted for all the radiological parameters post-operatively (p<0.05). The corrected carrying angle went from a mean varus of -

25.14° to 4.81° valgus. Elbow flexion and hyperextension improved greatly. Internal rotation deformity was significantly less. LCPI normalised from a negative value to

near zero, confirming good three-dimensional correction with little lateral condylar prominence (Table IV).

Table IV

Radiological Characteristics of Cubitus Varus Deformity on Pre-operative and Final Follow-up (*n* = 22).

Parameters	Pre-operative	Post-operative	95% CI (postoperative)	p-value
Carrying angle (deg.)	-25.14 ± 8.28	4.81 ± 5.48	2.39 to 7.25	<0.001
Flexion (deg.)	132.36 ± 3.74	139.09 ± 3.78	138.28 to 139.90	0.007
Hyper-extension (deg.)	-13.36 ± 3.67	-6.41 ± 3.90	-5.58 to -7.24	0.001
Internal rotation (deg.)	27.73 ± 13.07	8.86 ± 3.76	14.54 to 23.19	<0.001
LCPI (%)	-12.73 ± 10.51	1.34 ± 12.49	-4.20 to 6.88	<0.001

Functional outcomes evaluated using Bellmore criteria at the end of follow-up showed excellent results in 63.64% and good results in 27.27% of patients,

resulting in a satisfactory outcome rate (combined) of 90.91%. Poor outcomes were found in only 2 patients (9.1%). The highly significant p-value (0.0001)

confirms that the surgical intervention provided meaningful and statistically robust functional improvement in the cohort (*Table V*).

Table V

Functional Outcome Based on Bellmore Criteria.

Grade	Number of cases	Percentage (%)	p-value
Excellent	14	63.64%	0.0001
Good	6	27.27%	
Poor	2	9.1%	

DISCUSSION

This study demonstrated that modified French osteotomy with reconstruction plate fixation is a very successful surgical technique for the correction of cubitus varus deformity in the pediatric and adolescent population. Our findings are in line with Hoffman et al. in favour of three-dimensional corrective osteotomies compared to conventional lateral closing wedge procedures [11]. The predominance of males (59.1%) in our cohort is consistent with the reports by Tanwar et al., as boys are more likely to have a supracondylar fracture because they engage in more outdoor physical activity [12]. The age group of 10-15 years was the most common age group (45.5%), which is consistent with the known peak incidence of supracondylar fractures in school-age children and the known latency between fracture and deformity correction [13]. The overwhelming aetiology in our study was malunited supracondylar fracture (81.8%), followed by malunited lateral condyle (18.2%). These findings are consistent with Bali et al., who shown causal relationship between inadequately treated pediatric distal humeral fractures and resultant cubitus varus, especially in areas with limited access to orthopaedic resources [14]. The prevalence of patients from rural areas (63.6%) further emphasises the role of delayed or suboptimal primary management in determining the severity of deformity and complexity of surgery [15]. The carrying angle in our study showed a dramatic improvement from a pre-operative mean of -25.14°±8.28° to 4.81°±5.48° post-operatively (p<0.001), a mean correction of approximately 30°. This degree of correction is similar to results reported by Tanwar et al., who also reported significant angular correction using reconstruction plate fixation [16]. The modified French osteotomy is unique in its

ability to treat all three planes of deformity (varus, internal rotation, hyperextension) and hence gives superior cosmetic and functional results, compared to uniplanar techniques [17]. It is noted that the improvement in flexion (from 132.36° to 139.09°, p=0.007) and reduction in hyperextension and internal rotation further substantiate the three-dimensional efficacy of the technique. The normalisation of LCPI from -12.73 to 1.34% (p<0.001) is especially noteworthy as lateral condylar prominence is a known cosmetic complication of lateral closing wedge osteotomies that the French technique specifically alleviates [18]. Functional outcome assessment by Bellmore criteria showed excellent results in 63.64% and good results in 27.27%, which amounted to a satisfactory rate of 90.91%. These results are comparable to the results obtained by Khurana et al., with 88% satisfactory results [19]. The two patients with poor outcomes had the greatest duration of deformity (>5 years), implying that late surgical intervention may impair functional recovery because of adaptive soft tissue contractures [20]. The mean operative time of 78±15 minutes and hospital stay of 4.2±1.3 days indicate the technical reproducibility and efficiency of the operation in the perioperative setting. Reconstruction plate fixation allows for rigid three-point fixation, allowing for early mobilisation, decreasing the risk for recurrence, and obviating prolonged casting [21]. Bone grafting was needed in only three cases, which was an indication that the technique is self-sufficient as a whole in achieving structural correction without supplementary graft in most of the patients [22]. Taken together, the results of this study recommend the use of modified French osteotomy with reconstruction plate fixation as the surgical technique of choice for cubitus varus correction, especially in

resource-limited environments where cosmetic and functional results need to be optimised in a single operative procedure.

LIMITATIONS

This study is limited by its small sample size (n=22) and the absence of a control group, which limits the generalizability of the results and prevents direct comparison with other osteotomy methods. In addition, the relatively short follow-up period may not represent long-term recurrence rates or late changes in function.

CONCLUSION

Modified French osteotomy with reconstruction plate fixation is a reliable, reproducible, and effective surgical method in correcting cubitus varus deformity in pediatric and adolescent patients. The procedure provides significant and durable correction of the carrying angle, with concomitant improvements in flexion, reduction in internal rotation, and normalisation of LCPI. A good functional outcome rate of more than 90% was found, as demonstrated by the Bellmore criteria. The technique is technically feasible in tertiary care settings, linked with short periods of hospital stay, and has low complication rates. Surgeons approaching this deformity in resource-limited environments should consider this approach the procedure of choice.

RECOMMENDATIONS

Future multi-center randomized controlled trial with a larger sample size and longer follow-up time is recommended to compare the modified French osteotomy with other current corrective techniques. Prospective patient-reported outcome measures and quality-of-life assessments should be incorporated to offer a more holistic assessment of the success of surgery.

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CONFLICT OF INTEREST

None declared

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