Original Research Article

https://doi.org/10.53339/aimdr.2026.12.2.2
E-ISSN: 2395-2822 | P-ISSN: 2395-2814

Functional Recovery and Elbow Alignment After Modified French Osteotomy with Reconstruction Plate Fixation for Cubitus Varus Deformity

Md. Kamruzzaman[1,*], Jahangir Alam[1], Shahidul Islam[1], Younus Hossain[2]

[1]Department of Orthopaedic Surgery, National Institute of Traumatology & Orthopaedic Rehabilitation (NITOR), Dhaka, Bangladesh.
[2]Department of Orthopaedic Surgery, Jashore Medical College, Jashore, Bangladesh.

***Address for correspondence:** Dr. Md. Kamruzzaman, Department of Orthopaedic Surgery, National Institute of Traumatology & Orthopaedic Rehabilitation (NITOR), Dhaka, Bangladesh. **E-mail:** zamandmc.6@gmail.com

Abstract

Background: Cubitus varus is a common post-traumatic deformity of the elbow, typically resulting from malunited supracondylar fractures in children. Despite its frequent occurrence, consensus on the optimal surgical technique remains limited. This study aimed to evaluate the functional recovery and elbow alignment after modified French osteotomy with reconstruction plate fixation for cubitus varus deformity.

Methods: This prospective observational study was conducted at the National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR), Dhaka, from January 2018 to December 2019 on 22 patients. All patients underwent modified French osteotomy with reconstruction plate fixation. Preoperative and postoperative carrying angle, internal rotation, lateral capitello-physeal index (LCPI), and elbow range of motion were recorded. Data were entered and analyzed using SPSS version 26.

Results: The cohort comprised 22 patients (most patients fell within a 10–15-year range; 59.1% male). Malunited supracondylar fracture was the leading cause (81.8%). The mean carrying angle improved from −25.14 ± 8.28° preoperatively to 4.81 ± 5.48° postoperatively ($P < 0.001$). Internal rotation decreased from 27.73 ± 13.07° to 8.86 ± 3.76° ($P < 0.001$). The functional arc of motion improved from 119.00 ± 5.10° to 132.68 ± 5.20° ($P < 0.001$). Union was achieved in all patients: 86.4% within 12 weeks and 13.6% within 16 weeks. The complication rate was low, with superficial infection in 9.1% and transient nerve irritation in 4.5% of cases.

Conclusion: Modified French osteotomy with reconstruction plate fixation is a reliable and effective surgical technique for correcting cubitus varus deformity, yielding significant improvements in both elbow alignment and functional range of motion with an acceptable complication profile.

Keywords: Cubitus varus, modified french osteotomy, reconstruction plate fixation, elbow deformity, supracondylar fracture malunion

Introduction

Cubitus varus is also called gunstock deformity, and is one of the most common post-traumatic sequelae after elbow injuries in the paediatric population.[1] It usually develops as a result of malunited supracondylar humeral fractures, the most frequent fracture of the elbow in children (50–70% of all elbow fractures in children).[2] Although not always functionally impaired in the early stages, untreated cubitus varus can cause progressive instability of the elbow, lateral condyle stress fractures, tardy ulnar nerve palsy, and significant cosmetic disfigurement.[3] The

deformity is characterized by a medial angulation of the distal humerus, reduced/reversed carrying angle, and internal rotation of the distal fragment, which together compromise the aesthetics and biomechanics of the elbow joint.[4] Radiological indices such as the lateral capitello-physeal index (LCPI) and the Baumann angle have been used to quantify the degree of coronal and rotational malalignment that allows for objective preoperative planning and postoperative evaluation.[5] A variety of surgical osteotomy techniques have been proposed for the correction of cubitus varus, including the lateral closing wedge osteotomy, dome osteotomy, step-cut osteotomy, and the French or modified French osteotomy.[6] Each of these techniques set out to correct the parts of the deformity - namely, varus angulation, internal rotation, and sometimes flexion or extension malalignment - whilst minimizing complications - namely, neurovascular injury, recurrence, and unacceptable scarring.[7] The French osteotomy, which is a three-dimensional correction technique, has attracted more and more attention because of its ability to simultaneously correct coronal, sagittal, and rotational deformities through a single surgical approach.[8] The use of internal fixation using a reconstruction plate provides biomechanical stability in the postoperative period with reduced risk of fixation failure, earlier mobilization, and possibly improved rate and quality of bony union.[9] Despite these advantages, comparative data on outcomes of plate fixation vs other fixation methods (e.g., K-wires), in the context of modified French osteotomy, are limited, especially from low to middle-income country settings where delayed presentation and resource constraints present additional challenges.[10] Patient demographics are important to understand the burden of cubitus varus in various healthcare settings. Studies from South Asia and sub-Saharan Africa confirm a delay in presentation, with many patients offering injury to surgery times of greater than 2 years.[9] This delay is often due to dependence on traditional bone-setting practices, inadequate orthopaedic infrastructure, and low health literacy. As a result, surgeons in these settings are often faced with complex deformities with fixed contractures, muscle imbalance, as well as altered physeal growth - all of which raise the complexity of surgery and the risk of suboptimal correction.[10] Therefore, this study aimed to assess the functional recovery, radiological alignment, and complications in a group of patients (paediatric and adolescent) undergoing the modified French osteotomy with reconstruction plate fixation procedure for the treatment of cubitus varus deformity, at a tertiary orthopaedic centre in Bangladesh.

Methods

This prospective observational study was conducted at the National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR), Dhaka, from January 2018 to December 2019 on 22 patients. A total of 22 patients who were diagnosed with cubitus varus deformity were included in the study. All patients had corrective surgery by the modified French osteotomy technique with reconstruction plate fixation. The non-probability consecutive sampling method was used to recruit the participants. Patients of all ages with radiologically confirmed cubitus varus deformity, defined as a negative carrying angle, with a proven history of past elbow trauma, were eligible for inclusion. In addition, patients had to consent to follow-up postoperatively for at least 12 weeks. Patients were excluded if they had open physes with continued skeletal growth, active infection at the surgical site, neurovascular compromise in need of emergency surgical intervention, skeletal dysplasia's or metabolic bone disorders affecting the bone structure, or incomplete medical records that could interfere with accurate data collection and analysis. All surgical operations were done under general anaesthesia using the modified French osteotomy technique. A lateral approach to the distal humerus was used to expose the operative area. The osteotomy permitted correction of the deformity in three dimensions, including varus angulation, internal rotational deformity and hyperextension. Stabilization of the osteotomy site was accomplished

by the use of a reconstruction plate in all 22 patients. In selected cases where further structural support was required, bone grafting was carried out; this was required in 3 patients, 13.6% of the study population. Outcome variables were determined radiologically and clinically. The main radiological parameters considered were the carrying angle in degrees, internal rotation angle in degrees, and the lateral condylar prominence index (LCPI) as a percentage. Such measurements were taken from standardized anteroposterior radiographs before surgery and at the time of postoperative evaluation. Secondary outcome variables included elbow flexion, hyperextension, and overall functional arc of elbow motion, all in degrees of elbow flexion at the time of the last follow-up visit. In addition, postoperative complications and radiological evidence of bone union were recorded in order to assess the safety and efficacy of the procedure. All the collected data were entered and analyzed using Statistical Package for the Social Sciences (SPSS) version 26. Descriptive statistics were used to summarize the findings, wherein the categorical variables were summarized as frequencies and percentages, and the continuous variables were summarized as means with standard deviations. To assess the efficacy of the surgical intervention, the paired *t*-test was used to compare preoperative and postoperative measurements. Statistical significance was calculated at a P-value < 0.05.

Results

Table 1 represents the demographic profile of the 22 study participants. The majority were of the 10–15-year age category (45.5%), owing to the paediatric predominance of supracondylar fracture-related deformities. Males were more often affected (59.1%) than females. More frequently, the right elbow was involved (54.5%). A significant number of patients (63.6%) were living in rural areas, indicating poor access to early orthopaedic care, and delayed presentation is likely [Table 1].

The aetiological and clinical features of the cohort are represented in Table 2. Malunited supracondylar fracture was the leading cause of cubitus

Table 1: Demographic characteristics of the study population ($N = 22$)

Variable	Category	Frequency	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

Table 2: Etiology and clinical presentation of cubitus varus deformity ($N = 22$)

Variable	Category	Frequency	Percentage (%)
Cause of deformity	Malunited supracondylar fracture	18	81.8
	Lateral condyle fracture malunion	3	13.6
	Post-traumatic physeal arrest	1	4.6
Time since injury	<2 years	5	22.7
	2–5 years	9	40.9
	>5 years	8	36.4
Primary complaint	Cosmetic deformity	15	68.2
	Reduced elbow motion	4	18.2
	Pain during activity	3	13.6

varus (81.8%). The majority of patients (77.3%) had sustained the original injury more than 2 years before presentation, indicating delayed referral patterns. Cosmetic deformity was the most common primary complaint (68.2%), and a smaller number of subset was presenting with motion restriction or activity-related pain, confirming the predominantly cosmetic burden of this condition [Table 2].

Operative details of the cohort are summarized in Table 3. All 22 patients underwent the modified French osteotomy with reconstruction plate fixation, which confirmed a uniformity of technical application in the entire series. Bone grafting was only necessary in 3 patients (13.6%), indicating sufficient local bone stock in most cases. The mean operative time was 78 ± 15 min, and the mean hospital stay was 4.2 ± 1.3 days, both consistent with a manageable surgical procedure in a tertiary care setting [Table 3].

Table 4 shows the highly significant improvements in radiological alignment after surgery. There was a significant improvement in the carrying angle from a mean of −25.14 ± 8.28° to 4.81 ± 5.48° postoperatively ($P < 0.001$), confirming effective varus correction. Internal rotation decreased from 27.73 ± 13.07° to 8.86 ± 3.76° ($P < 0.001$), indicating successful correction of rotation. The LCPI normalized from −12.73 ± 10.51 to 1.34 ± 12.49% ($P < 0.001$) with a collective affirmative autonomic three-dimensional corrective capacity of the modified French osteotomy [Table 4].

Table 5 shows the results of the function at final follow-up. Elbow flexion improved significantly from 132.36 ± 3.74° to 139.09 ± 3.78° ($P = 0.007$). Hyperextension deformity showed significant reduction from −13.36 ± 3.67° to −6.41 ± 3.90° ($P = 0.001$). Most notably, the functional arc of motion increased from 119.00 ± 5.10° to 132.68 ± 5.20° ($P < 0.001$), which demonstrated a clinically relevant and statistically significant improvement in the overall elbow mobility following the modified French osteotomy with plate fixation [Table 5].

Table 6 shows the postoperative complication profile and the union results. The majority of patients (81.8%) had an uneventful recovery. Superficial surgical site infection occurred in 2 patients (9.1%) and was treated conservatively. Transient nerve irritation was recorded with one patient (4.5%) and resolved without intervention.

Table 3: Operative characteristics of modified French osteotomy

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	–	–

Table 4: Correction of elbow alignment after surgery

Parameter	Preoperative Mean ± SD	Postoperative Mean ± SD	*P*-value
Carrying angle (°)	−25.14 ± 8.28	4.81 ± 5.48	<0.001
Internal rotation (°)	27.73 ± 13.07	8.86 ± 3.76	<0.001
LCPI (%)	−12.73 ± 10.51	1.34 ± 12.49	<0.001

Table 5: Functional recovery of elbow range of motion

Parameter	Preoperative Mean ± SD	Final follow-up Mean ± SD	*P*-value
Flexion (°)	132.36 ± 3.74	139.09 ± 3.78	0.007
Hyperextension (°)	−13.36 ± 3.67	−6.41 ± 3.90	0.001
Functional arc of motion (°)	119.00 ± 5.10	132.68 ± 5.20	<0.001

Table 6: Postoperative complications and union rate

Variable	*n*	%
Uneventful recovery	18	81.8
Superficial infection	2	9.1
Transient nerve irritation	1	4.5
Delayed union	1	4.5
Union status:		
Union outcome	***n***	**%**
Union within 12 weeks	19	86.4
Union within 16 weeks	3	13.6
Nonunion	0	0

Delayed union occurred in one patient (4.5%), who went on to experience union at 16 weeks. Crucially, no case of nonunion was recorded, and all patients achieved bony union 86.4% within 12 weeks, underscoring the reliability of reconstruction plate fixation in this context [Table 6].

Discussion

This study demonstrates the clinical efficacy of modified French osteotomy with reconstruction plate fixation approach in the correction of cubitus varus deformity. Our results showed statistically significant improvements for all radiological and functional outcome parameters, with an acceptable safety profile, in line with the report by Persiani et al. in support of three-dimensional corrective osteotomies for this condition.[11] The predominance of malunited supracondylar fractures as the underlying aetiology (81.8%) is consistent with data from other areas of the world, confirming the inadequate reduction or loss of reduction after paediatric supracondylar fractures as a major determinant of cubitus varus deformity.[12] The high proportion of rural patients (63.6%) with delayed presentation (>2 years in 77.3%) is typical for resource-limited settings and reinforces the need for early access to specialists in paediatric orthopaedic trauma care.[9] The correction of the carrying angle from a mean of −25.14° to 4.81° postoperatively ($P < 0.001$) is a substantial clinical improvement. This level of correction is comparable to results reported by Omori et al. and others using three-dimensional osteotomy techniques, which are superior to traditional uniplanar lateral closing wedge osteotomies, particularly in cases with concomitant rotational deformity.[7] The ability to simultaneously correct internal rotation (from 27.73 to 8.86°, $P < 0.001$) and normalise LCPI (−12.73 to 1.34, $P < 0.001$), the rotational corrective capacity of the modified French osteotomy, further confirms the ability of this technique to address the issue; uniplanar techniques fail to adequately address this problem.[13] Functional recovery as reflected by improvement in functional arc of motion from 119° to 132.68° ($P < 0.001$) is a particularly meaningful outcome from a patient perspective. Sardelli et al. have documented that the functional arc required for activities of daily living is about 100°, which suggests that our cohort achieved not only normal but supranormal functional capacity following surgery.[14] The great improvement of elbow flexion ($P = 0.007$) and reduction of hyperextension deformity ($P = 0.001$) further support the biomechanical benefit conferred by the procedure. The utilization of reconstruction plate fixation in our study must be stressed, unlike Kirschner wire fixation, which carries the risk of external immobilization and

risk of pin-site infection, migration, and less stable fixation. Plate fixation allows for rigid internal stabilisation, allowing earlier postoperative mobilisation.[15] This is likely to have contributed to the better range of motion results noted, as immobilisation time is a known determinant of elbow stiffness post-osteotomy.[16] The 100% union rate, with 86.4% of patients achieving union within 12 weeks, provides evidence of the biomechanical adequacy of plate fixation in this anatomical location. The overall complication rate of our study was low (18.2%) with no cases of neurovascular injury, nonunion, or recurrence of deformity. The superficial infection rate of 9.1% was treated conservatively with no sequelae. The one case of transient nerve irritation cleared up without treatment. These outcomes compare favourably with reported complication rates of 10–25% for osteotomy series published, especially those with external fixation or K-wire technique.[17] The low incidence of delayed union (4.5%) and the lack of nonunion are representative of both the inherent osteogenic capacity of the growing paediatric skeleton as well as the stability provided by rigid internal fixation.[18] The demographic profile of our cohort is one for which the words merit comment. The predominance of male patients (59.1%) and the 10–15 year old age group (45.5%) is consistent with the known epidemiology of supracondylar fractures, which predominantly affect school-aged boys engaged in physical activity.[19] More striking, however, is the percentage of the patients from rural areas (63.6%) with injury-to-surgery intervals of more than 2 years (77.3%). This pattern reflects systemic barriers to early orthopaedic consultation - including reliance on traditional bone-setters and limited referral pathways as well as geographic inaccessibility of tertiary care - which are collectively contributing to late-stage deformity requiring corrective surgery, which is complex.[9] Our results suggest that in even such challenging late presentation scenarios, the modified French osteotomy combined with plate fixation can reliably result in near-normal alignment and a functional recovery. It is also noteworthy that cosmetic deformity was the main complaint in 68.2% of the patients, highlighting the psychosocial aspect of the cubitus varus apart from its biomechanical aspect. Children with visible gunstock deformity often suffer social stigma, decreased participation in physical activities, and decreased self-esteem, especially in adolescence.[13] Surgical correction that restores normal carrying angle has therefore significant quality of life benefits in addition to functional improvement. Future studies that include validated patient-reported outcome measures such as the Oxford Elbow Score or DASH questionnaire would give a more comprehensive notion of the holistic impact of the corrective osteotomy in this population.[20] Taken together, these results are supportive of the modified French osteotomy with reconstruction plate fixation as a reliable, reproducible, and effective option for surgeons managing cubitus varus deformity, especially in settings where delayed presentations and complex three-dimensional deformity are commonly encountered.

Limitations of the Study

This study is limited because it is a single-centre study with a small sample size (n = 22), which may limit the generalisability of the study results. The lack of a control group or long-term follow-up study beyond the union period further limits the ability to conclude a comparison.

Conclusion

Modified French osteotomy with reconstruction plate fixation offers good three-dimensional correction of cubitus varus deformity and statistically significant improvement in carrying angle, internal rotation, and lateral capitello-physeal index. Functional outcomes were excellent, and there were marked improvements in elbow flexion and total arc of motion. The procedure has a good safety profile with a low complication rate and a hundred percent union rate, which proves that it is a reliable surgical option. These results

are especially encouraging in the context of late presentations in resource-limited settings, where complex correction of deformity with stable fixation is imperative. Modified French osteotomy with plate fixation should be considered the approach of choice in paediatric and adolescent patients with cubitus varus, particularly in those patients with concomitant rotational deformity and varus angulation.

Recommendations

Future prospective multicenter studies with larger sample sizes and longer follow-up times are recommended for validation of these outcomes and comparison of modified French osteotomy with other three-dimensional correction techniques, especially in delayed presentation cohorts from low-resource settings.

References

1. 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 May 1;96(5):691–700.
2. Abzug JM, Herman MJ. Management of supracondylar humerus fractures in children: current concepts. J Am Acad Orthop Surg 2012 Feb 1;20(2):69–77.
3. Acar MA, Yildirim S, Elmadag NM, Senaran H, Ogun TC. Treatment of posttraumatic cubitus varus with corrective supracondylar humeral osteotomies using the methyl methacrylate external fixator. J Pediatr Orthop 2014 Apr 1;34(3):253–9.
4. Hannonen J, Pokka T, Serlo W, Sinikumpu JJ. Lateral-only kirschner-wire fixation of type-3 supracondylar humerus fractures in children with a special attention to technical issues. Scand J Surg 2021 Jun;110(2): 258–64.
5. Su Y, Xie Y, Nan G. A novel method of lateral closing wedge osteotomy for cubitus varus deformity in children. BMC Surg 2022 Nov 24;22(1):408.
6. Verka PS, Kejariwal U, Singh B. Management of cubitus varus deformity in children by closed dome osteotomy. J Clin Diagn Res 2017 Mar 1;11(3):RC08–RC12.
7. Omori S, Murase T, Oka K, Kawanishi Y, Oura K, Tanaka H, et al. Postoperative accuracy analysis of three-dimensional corrective osteotomy for cubitus varus deformity with a custom-made surgical guide based on computer simulation. J Shoulder Elbow Surg 2015 Feb 1;24(2):242–9.
8. Moradi A, Vahedi E, Ebrahimzadeh MH. Surgical technique: spike translation: a new modification in step-cut osteotomy for cubitus varus deformity. Clin Orthop Relat Res 2013 May;471(5):1564–71.
9. Challa S, Agarwal-Harding KJ, Levy P, Barr-Walker J, Sabatini CS. Supracondylar humerus fractures in low- and lower middle-income countries: a scoping review of the current epidemiology, treatment modalities, and outcomes. Int Orthop 2020 Nov;44(11):2443–8.
10. Bali K, Sudesh P, Krishnan V, Sharma A, Manoharan SR, Mootha AK. Modified step-cut osteotomy for post-traumatic cubitus varus: our experience with 14 children. Orthop Traumatol Surg Res 2011 Nov 1; 97(7):741–9.
11. Persiani P, Noia G, de Cristo C, Graci J, Gurzì MD, Villani C. Lateral wedge osteotomy for pediatric post-traumatic cubitus varus: Kirschner-wires or locking angular plate?. J Pediatr Orthop B 2017 Sep 1;26(5):405–11.
12. Garg S, Weller A, Larson AN, Fletcher ND, Kwon M, Schiller J, et al. Clinical characteristics of severe supracondylar humerus fractures in children. J Pediatr Orthop 2014 Jan 1;34(1):34–9.
13. Oka K, Miyamura S, Shiode R, Kazui A, Iwahashi T, Tanaka H, et al. Three-dimensional corrective osteotomy for cubitus varus deformity using patient-matched instruments. JSES Int 2024 May 1;8(3):646–53.
14. Sardelli M, Tashjian RZ, MacWilliams BA. Functional elbow range of motion for contemporary tasks. J Bone Joint Surg Am 2011 Mar 2;93(5):471–7.
15. Piskin A, Tomak Y, Sen C, Tomak L. The management of cubitus varus and valgus using the Ilizarov method. J Bone Joint Surg Br 2007 Dec 1;89(12):1615–9.
16. Takeyasu Y, Murase T, Miyake J, Oka K, Arimitsu S, Moritomo H, et al. Three-dimensional analysis of cubitus varus deformity after supracondylar fractures of the humerus. J Shoulder Elbow Surg 2011 Apr 1; 20(3):440–8.
17. Tang X, Wang J, Slongo T, Wang S, Ze R, Zhou R, et al. Comparison of internal fixation vs. external fixation after corrective osteotomy in children with cubitus varus. J Shoulder Elbow Surg 2020 Apr 1; 29(4):845–52.
18. Carrazzone OL, Mansur NS, Matsunaga FT, Matsumoto MH, Faloppa F, Belloti JC, et al. Crossed versus lateral K-wire fixation of supracondylar fractures of the humerus in children: a meta-analysis of randomized controlled trials. J Shoulder Elbow Surg 2021 Feb 1; 30(2):439–48.

19. Tanwar YS, Habib M, Jaiswal A, Singh S, Arya RK, Sinha S. Triple modified French osteotomy: a possible answer to cubitus varus deformity. A technical note. J Shoulder Elbow Surg 2014 Nov 1;23(11):1612–7.

20. Macken AA, Prkic A, Koenraadt-van Oost I, Buijze GA, The B, Eygendaal D. Can a single question replace patient-reported outcomes in the follow-up of elbow arthroplasty? A validation study. J Orthop Traumatol 2024 Oct 22;25(1):49.

How to cite this article: Kamruzzaman M, Alam J, Islam S, Hossain Y. Functional Recovery and Elbow Alignment After Modified French Osteotomy with Reconstruction Plate Fixation for Cubitus Varus Deformity. Ann. Int. Med. Den. Res. 2026;12(2):8–15.

Source of Support: Nil, **Conflict of Interest:** None declared.

Received: 05-Feb-26; **Revised:** 05-Mar-26;
Acceptance: 19-Mar-26; **Published:** 30-Apr-26