J Orthop Spine Trauma. 2023 December; 9(4): 180-4. DOI: 10.18502/jost.v9i4.13935

Case Series

Modified French Osteotomy for Cubitus Varus Correction: Our Experience

Puttamaregowda Madhuchandra[1,*], Keelara Mahadevappa Pawankumar[2], Galla Sunil Santhosh[3]

[1] Professor, Department of Orthopedics, BGS Global Institute of Medical Sciences, Bengaluru, Karnataka, India
[2] Associate Professor, Department of Orthopedics, BGS Global Institute of Medical Sciences, Bengaluru, Karnataka, India
[3] Assistant Professor, Department of Orthopedics, BGS Global Institute of Medical Sciences, Bengaluru, Karnataka, India

[*] Corresponding author: Puttamaregowda Madhuchandra; Department of Orthopedics, BGS Global Institute of Medical Sciences, Bengaluru, Karnataka, India. Tel: +91-9845304422
Email: drmadhuchandrap@gmail.com

Received: 20 March 2023; **Revised:** 19 May 2023; **Accepted:** 03 July 2023

Abstract

Background: Various fixation techniques have been described for osteotomy for correction of cubitus varus. Kirschner-wiring (K-wiring) was used in the past for fixation; however, rates of fixation failure and pin-track infection were high. Fixation with two screws and a figure-of-eight wiring provides a stable fixation in children younger than 15 years. Herein, we used a modified lateral approach and a figure-of-eight construct with two screws and evaluated the outcome.
Methods: A case series comprising 35 patients out of the total of 54 patients who underwent modified French osteotomy between January 2013 to December 2021 was conducted retrospectively. Functional outcomes were assessed using the modified Mayo Elbow Performance Scoring (MEPS) system.
Results: There were 22 male and 13 female subjects in the study group. We had excellent results in 16 cases, good outcomes in 13 cases, and fair outcomes in 6 cases. Superficial infection was seen in three patients and four patients had occasional negligible pain. In addition, there was no loss of correction or fixation failures in our study.
Conclusion: Modified French osteotomy using two screws and figure-of-eight wiring is a simple and safe procedure that yields satisfactory outcomes. A careful preoperative planning, sufficient surgical technique, and stable fixation are key to achieving satisfactory functional outcomes.

Keywords: Osteotomy; Humeral Fractures; Elbow Injuries; Fracture Malunion; Fracture Fixation

Citation: Madhuchandra P, Pawankumar KM, Santhosh GS. **Modified French Osteotomy for Cubitus Varus Correction: Our Experience.** *J Orthop Spine Trauma* 2023; 9(4): 180-4.

Background

Elbow injuries are very common among children because of the high physical activity, while supracondylar fractures alone account for nearly 50% to 60% of these injuries. Supracondylar fractures are considered one of the emergencies in orthopedics, since delay in diagnosis and treatment can result in missing the vascular injuries and difficulty in obtaining reduction secondary to increased edema. In some countries such as India, Nepal, and Sri Lanka, tendency of the people to go to native bone setters is high, especially in the rural population (probably due to ignorance and financial conditions of the parents) (1-3).

As a result, the chances of developing complications in supracondylar fractures of the humerus are quite high. The most common complication of supracondylar fractures is malunion, also termed "cubitus varus" or "gun stock deformity". Surgically treated fractures are also no exception for the development of malunion. The reason for malunion is severe comminution on the medial aspect, in addition to the internal rotation of the distal fragment at the time of reduction. The incidence of cubitus varus in supracondylar humerus fractures ranges from 4% to 58% (4, 5).

Hyper extension associated with cubitus varus is in the plane of movement and gets remodeled to a certain extent over time. However, cubitus varus has no tendency to spontaneous remodeling and has to be corrected surgically.

Corrective osteotomy is the available surgical option for cubitus varus deformity. Different types of osteotomies like a lateral closing wedge, medial opening wedge, dome and step-cut osteotomy can be performed. Fixation methods are also plenty including staples, Kirschner wires (K-wires), plate and screws, and screws with stainless steel wires.

French osteotomy with two 3.5 mm screws and figure-of-eight stainless wiring has been the routinely used fixation method over the years and gives adequate stability at the osteotomy site. In the current study, we describe our experience with modified French osteotomy using screws and stainless steel wires (6, 7).

Methods

The case series was conducted retrospectively and all patients who underwent modified French osteotomy for post-traumatic cubitus varus deformity at BGS Global Institute of Medical Sciences, Bengaluru, India, were included in the study. All of the cases were performed between January 2013 and December 2021. Patients between the age group of 3-15 years were included, while patients above the age of 15 years and those with elbow instability were excluded from the study. Patient data were obtained from the case records and the records of the radiology department. All of the patients were clinically assessed for functional outcomes, and their carrying angles (CA) and range of motion (ROM) were obtained from radiographic data. Additionally, all patients were evaluated using the modified Mayo Elbow Performance Score (MEPS) (8) (Table 1). Informed consent was taken from all the patients included in the study. Institutional ethics committee approval was taken before the initiation of the study. The study was conducted by the principles laid down by the Declaration of Helsinki.

Surgical Technique: Surgeries were performed under either general anesthesia or regional block under tourniquet control. A lateral incision measuring approximately 5 to 6 cm centering over the supracondylar area was made.

Table 1. Modified Mayo Elbow Performance Score (MEPS)

Function	Scores
Loss of flexion extension (maximum: 15 points)	Arm length (maximum: 15 points)
Full (15 points)	< 0.5 cm (15 points)
0 to 10 degrees (10 points)	0.5 to 1 cm (10 points)
11 to 20 degrees (5 points)	1 to 1.5 cm (5 points)
> 21 degrees (0 points)	> 1.5 cm (0 points)
Pain (maximum: 10 points)	Arm wasting (maximum: 15 points)
No pain (10 points)	0 cm (15 points)
Mild (5 points)	0 to 0.5 cm (10 points)
Severe (0 points)	0.5 to 1 cm (5 points)
	> 1 cm (0 points)
Stability (maximum: 10 points)	Ulno-humeral angle correction (maximum: 15 points)
Stable (10 points)	-5 to 0 degrees (15 points)
Moderately unstable (5 points)	1-5 degrees (10 points)
Grossly unstable (0 points)	6-10 degrees (5 points)
	> 10 degrees (0 points)
Function (maximum: 10 points)	
Normal (10 points)	
Difficulty in doing hard work (lifting heavy weight) (5 points)	
Difficulty in doing routine activities (0 points)	
Cosmesis (maximum: 10 points)	Mean total (maximum: 100 points)
Good and acceptable (10 points)	
Prominent but acceptable (5 points)	
Unsightly (0 points)	

Deep dissection was done in the plane between the triceps and brachioradialis muscles. The lateral aspect of the humerus was exposed subperiosteally, keeping the medial periosteum intact. The amount of wedge to be removed was measured using preoperative radiographs. Two cortical screws were inserted proximally and distally to the planned osteotomy and wedge site. In patients having rotational deformity, the distal screw was positioned slightly anterior to the sagittal plane.

Osteotomy was performed using the osteotome, keeping the medial cortex intact. Lateral-based closed wedge was taken according to the preoperatively calculated amount. The wedge was closed by doing the osteoclasis of the medial cortex keeping the periosteal hinge intact. The distal fragment was derotated in patients with rotational deformity and aligned with the superior screw. Wire loop using the stainless steel wire in a figure-of-eight fashion was tightened around the screw heads to oppose the cut surfaces firmly. Finally, the wound was closed in layers (Figure 1).

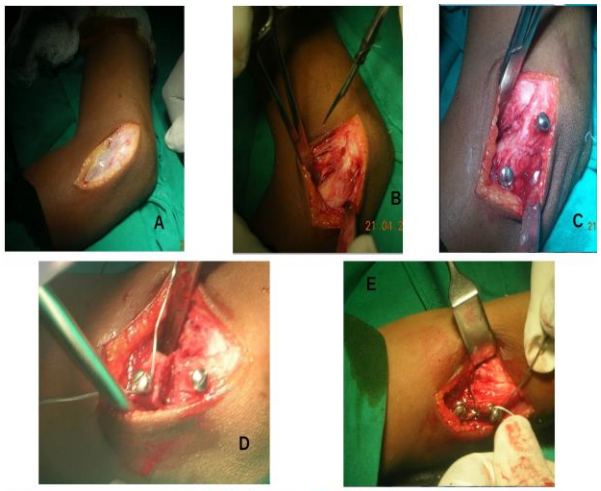

Figure 1. A) Lateral incision; B) Subperiosteal exposure; C) Insertion of cortical screws leaving behind the wedge site; D) Lateral based wedge osteotomy; E) Correcting varus and closing the wedge

Post-operative Protocol: Above elbow posterior slab was applied in extension of the elbow with the forearm in supination. On the 12th day, the suture removal was done, and the above elbow slab was changed to elbow in 90 degrees of flexion and supination for three weeks. At the end of three weeks, the slab was removed and ROM exercises were started. Patients were followed up at the sixth and twelfth weeks and six months. Clinical and radiological evaluations were assessed and recorded during each follow-up. Physical examination included measurements of the CA and ROM (Figure 2).

Figure 2. A) Clinical picture showing cubitus varus; B) Limitation of external rotation

X-rays of the elbow in anteroposterior (AP) and lateral views were taken and the CA was measured (Figure 3A). Functional evaluation of the patients was done using the modified MEPS.

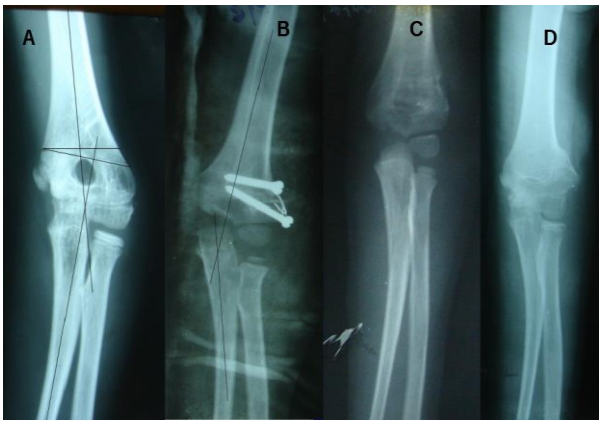

Figure 3. A) Preoperative X-ray; B) Immediate post-operative X-ray showing correction of varus; C) One-year post-operative X-ray following implant removal; D) 7-year post-operative X-ray showing complete varus correction

Results

Out of the 54 cases that underwent surgery during this period, 35 patients were available for follow-up and were included in the present study.

There were 22 male and 13 female subjects in the study. The left side was involved in 20, while the right side in the remaining 15 patients. The average age of the patients was 9.2 years (range: 4.5 to 14 years).

The mean follow-up period was 2.8 years ranging from 9 months to 4 years. The mean duration from trauma to presentation was 3.9 years (range: 2.5 to 5 years). The average preoperative CA was 20.2 degrees (range: 16-25 degrees) on the affected side, while the average CA on the normal side was 11.08 degrees (range: 8-15 degrees). Preoperative mean loss of flexion was 15 degrees ranging from 0 to 20 degrees. Besides, hyperextension was noted in four cases (Table 2).

Table 2. Clinical characteristics of the patients

Number	Age (year)	Sex	Pre-operative CA affected side	Pre-operative CA normal side	CA at union	Pre-operative flexion	Post-operative flexion	Union time (week)
1	14	Male	22	9	9	0-110	0-130	7
2	8.5	Male	20	10	9	5-120	0-130	5.5
3	13	Female	24	13	12	-5, 120	0-135	6
4	12.5	Male	19	8	7	0-115	0-130	6.5
5	11	Female	16	14	12	0-125	0-135	7.5
6	10.5	Male	21	9	9	8-120	5-130	8
7	4.5	Male	18	9	9	-10, 125	0-130	6
8	6.5	Female	23	13	12	0-115	0-135	6.5
9	7	Male	21	10	9	10-125	0-135	6
10	9	Female	17	12	11	5-125	0-140	7
11	5.5	Male	19	9	8	-8, 125	0-135	7.5
12	10	Male	20	9	9	0-130	0-140	6.5
13	11	Male	22	11	10	0-110	0-135	7
14	10.5	Female	25	15	13	7-125	0-135	6
15	9.5	Male	23	10	8	5-120	0-140	6.5
16	12	Female	23	14	11	0-110	0-135	5.5
17	7.5	Male	21	10	9	5-130	0-140	6
18	13	Male	16	9	8	0-115	0-135	7
19	8.5	Male	18	9	9	-5, 125	0-135	8.5
20	10	Female	19	13	11	5-135	0-135	7
21	9	Female	17	14	12	0-120	0-140	6
22	7.5	Male	20	10	9	5-115	5-140	6.5
23	6	Female	22	14	12	0-125	0-135	7
24	8	Male	21	10	10	5-130	0-140	6.5
25	9.5	Male	20	11	9	7-120	0-135	6.5
26	11	Female	19	14	11	0-110	0-135	6
27	10	Male	17	10	9	5-130	0-140	6
28	6	Male	22	9	7	0-126	0-137	6
29	8	Female	21	15	11	0-110	0-135	8
30	8.5	Male	21	10	8	5-130	0-140	7
31	11	Female	19	14	10	0-110	0-135	7.5
32	10	Male	18	9	8	10-115	0-135	6
33	7.5	Male	19	9	8	5-125	0-140	6
34	5	Male	23	8	7	0-115	0-135	6.5
35	12	Female	21	15	11	0-120	0-145	7

CA: Carrying angle

Activities of daily living were resumed in all of the cases by the end of three months. Time to union, as evidenced radiologically, was 6.6 weeks on average (range: 5.5-8.5 weeks).

The post-operative CA was measured once the radiological union was achieved (Figures 3B and 3D). The mean post-operative CA was 9.62 degrees (range: 7-13 degrees), while the mean variation between the CA measured radiologically on the operated and normal side was ± 1.62 degrees. Notably, preoperative mean loss of flexion was reduced to 3 degrees from 15 degrees. The hyperextension in all four cases was corrected postoperatively. Moreover, there was no supination or pronation either preoperatively or postoperatively.

Out of 35 patients, 30 patients gained a full ROM after a mean period of 6.9 weeks (range: 6 to 8.5 weeks). The remaining five patients regained the complete ROM by the end of the 10^{th} week. There was no coronal plane instability in any of the patients post-operatively. A total of 33 patients (94%) had satisfaction with the cosmetic outcome. Two patients had prominent lateral condyles, and thus had slight complaints about cosmetic appearance.

As assessed by modified MEPS, 16 patients (46%) had excellent outcomes (76-100), 13 (37%) patients had good outcomes (51-75), and 6 patients (17%) had fair outcomes (26-50). Importantly, none of the patients achieved poor outcomes (< 25) (Figures 3 and 4).

There was a superficial wound infection in three patients, which healed with regular wound dressings and oral antibiotics. Four patients had occasional pain, although it did not affect the activities of daily living. In addition, there were no post-operative neurovascular injuries, loss of fixation, or loss of correction of the deformity in any of our cases. The majority of the patients regained the preinjury functional status by the end of the post-operative 9^{th} week.

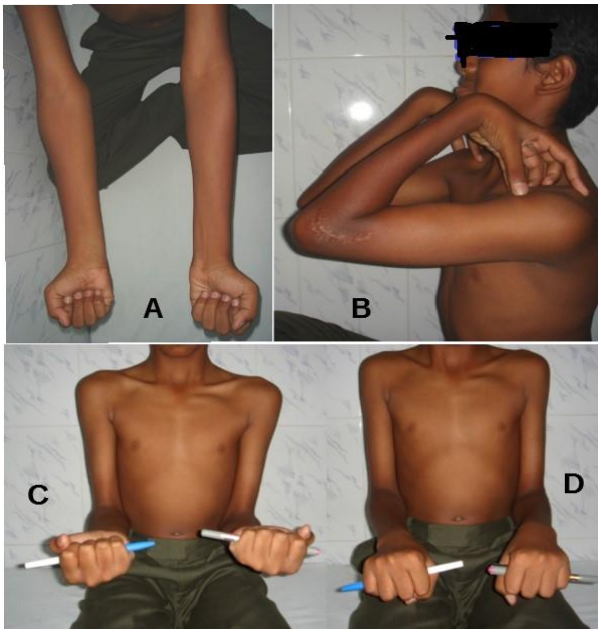

Figure 4. A) Post-operative follow-up picture showing complete varus correction; B) Post-operative picture showing complete flexion; C) Post-operative picture showing complete external rotation; D) Post-operative picture showing complete internal rotation

Discussion

In the current study, we evaluated the outcomes of modified French osteotomy on 35 patients and demonstrated satisfactory results. We achieved 16 excellent, 13 good, and 6 fair outcomes, which are comparable with other studies (Figures 3B, 3C, and 4A-4D). Piggot et al. in their study included 20 cases with good results concerning CA and ROM (9).

Kumar et al. compared dome osteotomy and French osteotomy, and showed no significant difference in CA correction, even though the internal rotation correction was significantly higher in dome osteotomy. However, the incidence of complications was higher with dome osteotomy such as infection, loss of correction, nerve palsy, and stiffness (10). Thus, although technically simpler, modified French osteotomy acquires fewer complications than dome osteotomy.

When we compared the complications of our study with studies where lateral closing wedge osteotomy was done, the results were also comparable. There were three cases of superficial infection which healed with regular wound dressings and oral antibiotics. In addition, four patients had mild pain which did not interfere with activities of daily living. Rang in a series of 20 patients had varus in 6 patients and stiffness in 2 patients (11). Srivastava et al. had 2 cases of pin track infection in their study (12). Oppenheim et al. in their series of 45 patients had 12 cases of varus, 5 cases of nerve palsy, and 3 cases of infection (13). However, we had no nerve palsies in our study (Table 3).

Table 3. Comparison of complications in different studies of lateral closed wedge osteotomy

Study	Complications
Present study (35 cases)	Superficial infection (3)
Rang (11) (20 cases)	Varus (6), Stiffness (2)
Piggot et al. (9) (20 cases)	Varus (2), neutral (4), stiffness (2)
Oppenheim et al. (13) (45 cases)	Varus (12), nerve palsy (5), infection (3)
Srivastava et al. (12)	Pin track infection (2)

It is important to start an early ROM to achieve good functional results according to Song et al. (14). We had a stable fixation with two screws and a figure-of-eight wiring technique. Moreover, by retaining the medial periosteal hinge, additional stability was achieved. Hence, we could initiate the ROM early and were able to gain significant functional results. However, we avoided this fixation technique in children older than 15 years who required more stable fixation to prevent fixation failures.

Fixation techniques by K-wires do not provide a stable fixation in older children. Loss of correction, implant failure, pin-track infections, and K-wire backouts are common problems associated with K-wire techniques. Raney et al. treated 30 cases in which two patients had loss of fixation (15). In a study done by Sweeney, 14 patients had a loss of fixation (16). Therefore, we used the modified technique of two screws and figure-of-eight wiring which provided adequate stable fixation, while there was no risk of fixation failure or pin track infections. Dissection was done subperiosteally and the periosteal hinge on the medial aspect was retained, thereby preserving the biology for the osteotomy site to heal and stressing the fact that biological factors are equally important (17).

Limitations: The current study was a retrospective study. Sample size in our study was small. A long-term prospective observational study will provide a better knowledge about the benefits of the modified French osteotomy. Besides, there is no comparison with the other types of osteotomies and other types of fixation method. Comparative studies with different types of osteotomies and different fixation methods are needed to come to a conclusive decision.

Conclusion

Modified French osteotomy is a simple and safe procedure that yielded excellent to good outcomes in 83% of cases. We used lateral incision as a modification to lessen the chances of nerve injuries. None of our patients had any progression or recurrence of deformity at the recent follow-up. There were no neuro-vascular complications or fixation failures in this technique despite early mobilization. Furthermore, the chances of epiphyseal injury and shortening are meager as it is an extra-articular procedure away from the physeal plate. Careful preoperative planning using standard radiographs, minding the humeroulnar angle, planning the amount of wedge to be taken, careful surgical technique, and stable fixation are key to achieving satisfactory functional outcomes.

Conflict of Interest

The authors declare no conflict of interest in this study.

Acknowledgements

We thank the patients for their informed consent to publish this study along with clinical pictures.

References

1. Abzug JM, Herman MJ. Management of supracondylar humerus fractures in children: Current concepts. *J Am Acad Orthop Surg*. 2012;20(2):69-77. doi: 10.5435/JAAOS-20-02-069. [PubMed: 22302444].
2. Wong HK, Lee EH, Balasubramaniam P. The lateral condylar prominence. A complication of supracondylar osteotomy for cubitus varus. *J Bone Joint Surg Br*. 1990;72(5):859-61. doi: 10.1302/0301-620X.72B5.2211772. [PubMed: 2211772].
3. Hedayat E, Nicolas A, Mohammadi MA, Nabian MH. Step by step approach to interpretation of pediatric elbow radiography. *J Orthop Spine Trauma*. 2020;5(1):7-11. doi: 10.18502/jost.v5i1.3352.
4. Ippolito E, Moneta MR, D'Arrigo C. Post-traumatic cubitus varus. Long-term follow-up of corrective supracondylar humeral osteotomy in children. *J Bone Joint Surg Am*. 1990;72(5):757-65. [PubMed: 2355039].
5. Orbach H, Rozen N, Rubin G, Dujovny E, Bor N. Outcomes of French's corrective osteotomy of the humerus for cubitus varus deformity in children. *Isr Med Assoc J*. 2018;20(7):442-5. [PubMed: 30109795].
6. 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;96-B(5):691-700. doi: 10.1302/0301-620X.96B5.32296. [PubMed: 24788507].
7. Uchida Y, Ogata K, Sugioka Y. A new three-dimensional osteotomy for cubitus varus deformity after supracondylar fracture of the humerus in children. *J Pediatr Orthop*. 1991;11(3):327-31. [PubMed: 2056080].
8. Morrey B, An K, Chao E. Functional evaluation of the elbow. In: Morrey BF, Sanchez Sotelo J, Morrey ME, editors. The elbow and its disorders. 2nd ed. Philadelphia, PA: Saunders; 1993. p. 95.
9. Piggot J, Graham HK, McCoy GF. Supracondylar fractures of the humerus in children. Treatment by straight lateral traction. *J Bone Joint Surg Br*. 1986;68(4):577-83. doi: 10.1302/0301-620X.68B4.3733834. [PubMed: 3733834].
10. Kumar K, Sharma VK, Sharma R, Maffulli N. Correction of cubitus varus by French or dome osteotomy: A comparative study. *J Trauma*. 2000;49(4):717-21. doi: 10.1097/00005373-200010000-00021. [PubMed: 11038091].
11. Rang M. Children's fractures. Philadelphia, PA: Lippincott Williams and Wilkins; 1974.
12. Srivastava AK, Srivastava D, Gaur S. Lateral closed wedge osteotomy for cubitus varus deformity. *Indian J Orthop*. 2008;42(4):466-70. doi: 10.4103/0019-5413.43397. [PubMed: 19753237]. [PubMed Central: PMC2740347].
13. Oppenheim WL, Clader TJ, Smith C, Bayer M. Supracondylar humeral osteotomy for traumatic childhood cubitus varus deformity. *Clin Orthop Relat Res*. 1984;(188):34-9. [PubMed: 6467726].

14. Song HR, Cho SH, Jeong ST, Park YJ, Koo KH. Supracondylar osteotomy with Ilizarov fixation for elbow deformities in adults. *J Bone Joint Surg Br*. 1997;79(5):748-52. doi: 10.1302/0301-620x.79b5.7615. [PubMed: 9331029].
15. Raney EM, Thielen Z, Gregory S, Sobralske M. Complications of supracondylar osteotomies for cubitus varus. *J Pediatr Orthop*. 2012;32(3):232-40. doi: 10.1097/BPO.0b013e3182471d3f. [PubMed: 22411326].
16. Sweeney JG. Osteotomy of the humerus for malunion of supracondylar fractures. *J Bone Joint Surg Br*. 1975;57:117.
17. Muller ME, Allgower M, Schneider R, Willenegger H. Manual of internal fixation: Techniques Recommended by the Ao-Asif Group. 3rd ed. Berlin, Germany: Springer Berlin, Heidelberg; 1991.