

ORIGINAL RESEARCH

Comparative study between Fixation of Modified French Osteotomy with Tension Bend Wire and Plate in Cubitus Varus

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ABSTRACT

Background: Cubitus varus is the most common delayed complication that results following supracondylar fracture of humerus in children with reported incidence 9%–58% in various series, with an average of 30%. Many types of corrective osteotomies with several fixation techniques proposed to correct this deformity. The dispute lies in the type of fixations which are most stable with minimum complications. Present study was designed to compare between fixation of modified French osteotomy for cubitus varus deformity with Tension bend wire and plate.

Methods: A randomized comparative study (prospective) was conducted on 30 patients (5 to 15 years) with cubitus varus deformity (>10 degrees). In 15 cases the osteotomy was fixed with a figure-of-8 wire loop tightened over the screw heads (TBW Group) and in the other 15 cases the osteotomy was fixed with plate (PLATE Group) in the Department of Orthopaedics and followed up for 24 weeks. Patients' functional outcome were assessed with help of Bellmore's criteria post-operatively.

Results: Excellent outcome was observed postoperatively after 24 weeks with respect to difference of ROM-53.33 %, carrying angle - 66.66 %, LCPI- 46.66 % and post operative complications- 93.33 % in PLATE group as compared to TBW group in whom ROM-26.66 %, carrying angle 46.66 %, LCPI- 33.33 % & post operative complications- 73.33 %, respectively. Only 6.66 % cases had poor outcome with respect to ROM and carrying angle in PLATE group as compared to 26.66 % cases in TBW group.

Conclusion: The osteotomy fixed with plate had better outcome and provides more stability and early mobilization as compared to TBW.

Keywords: Cubitus Varus Deformity, Modified French Osteotomy, Plate fixation, Tension bend wire

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INTRODUCTION

Cubitus varus is the most common delayed complication that results following supracondylar fracture of humerus in children with reported incidence 9%–58% in various series, with an average of 30%.¹ This varus deformity occurs either, due to incomplete correction of medial rotation and tilt of distal fragment of supracondylar fracture, or due to osteonecrosis or decreased growth of medial epiphysis or stimulated overgrowth of lateral epiphysis of distal humerus.² This differential growth occurs as a result of injury to growth plate. The medial angulation is the major determinant for the deformity while medial rotation contributes to it.³ Many types of corrective osteotomies with several fixation techniques proposed

to correct this deformity including lateral closing wedge osteotomy, medial open wedge osteotomy, dome osteotomy, French osteotomy, modified French osteotomy, Kims step-cut osteotomy. The disagreement is over which types of fixations are the most stable with the fewest complications. Now modified French Osteotomy is the most widely accepted standard procedure for correcting a varus deformity. Considering the benefits, we adapted the modified French method by Bellmore by performing an anterior closing wedge osteotomy with intact posterior cortex apex for easier reduction, and fixed it with Tension bend wire (TBW) or plate. The present study was designed to compare between fixation of modified French osteotomy for cubitus varus

deformity with TBW and plate.

MATERIALS AND METHODS

A randomized comparative study (prospective) was conducted on 30 patients (5 to 15 years) with cubitus varus deformity (>10 degrees) attending OPD of Department of Orthopaedics of the Mahatma Gandhi Hospital, Jaipur after obtaining Institute Ethics Committee approval and written informed consent from the patients. Randomization was done with 'chit box method' for TBW (Tension band Wire) and Plate fixation. Given the benefits, we used Bellmore's modified French method by performing an anterior closing wedge osteotomy with intact posterior cortex apex for easier reduction, and fixing it either with TBW or PLATE.⁴ Patients were excluded from the study having gross elbow stiffness, myositis

ossificans due to massaging, failed surgery and evidence of osteomyelitis, neurological deficits, ischemic muscle contractures, with insufficient records and loss due to follow-up. Deformities with less than 10 degrees of varus were also not included in the study. 30 patients divided into 2 groups (15 in each group) of cubitus varus were operated by Modified French osteotomy and osteotomy stabilized by two screws and bound by figure of eight Stain less steel wire in 15 patients, this group was referred as TBW group and with compression plate in other 15 patients were called as PLATE group. Patient functional outcome, Range of motion, carrying angle, lateral prominence index, any complications were assessed at 6, 12 & 24 weeks with the help of Bellmore's criteria post-operatively.⁴

Bellmore's Criteria³

Outcome	ROM	Carrying <	LCPI	Complication
Excellent	Difference < 10°	< 6°	No increase	None
Good	Difference 10-20°	6-10°	Increase <25%	Minor
Poor	Difference > 20°	> 10°	Increase >25%	With residual defect or review surgery

Lateral Condyle Prominence Index (LCPI)

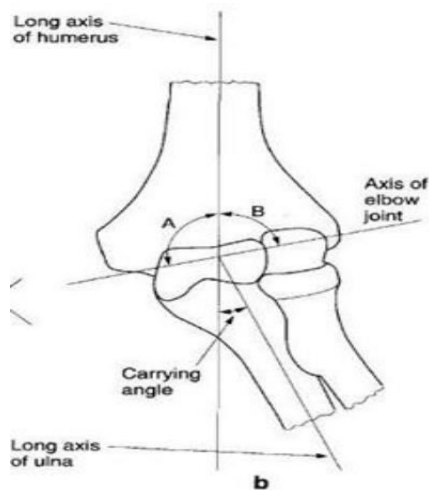
It is calculated as the difference between the measured medial and lateral widths of the bone from the longitudinal mid-humeral axis and was expressed as a percentage of the total width of the distal humerus (Figure 4). The normal is slightly negative.⁵

$LCPI = (BC - AB) 100/AC$

Carrying Angle

The carrying angle is the angle between long axis of

humerus and a line along the medial border of ulna. Clinically the carrying angle is determined with a goniometer while the elbow is full extension and supination. The goniometer was placed in the centre of antecubital fossa. Its proximal arm was aligned with the humeral shaft and distal arm lying on a line from the center of antecubital fossa to the center of the wrist. Radio logically the carrying angle is measured after anteroposterior skiagrams taken with the patient supine and elbow is extended and forearm fully supinated as shown in below diagram.⁶



Antero posterior radiograph of the right elbow

Statistical analysis

Data was entered in a Microsoft Excel spreadsheet. The data was analysed by Chi-square test to find the

significance level in various groups with the help of primer version-7. The P-value<0.05 was considered significant.

RESULT

In the present study, the TBW group mean age was 9.87 years (SD ±2.08) and in PLATE group was 10.47 years (SD ±2.72), respectively. Out of the total 30 children, 14 were male and the 16 were female. Among them 5 male and 10 female patients were in TBW group while 9 male and 6 female were in PLATE group. The left side was involved in 11 cases (4 TBW and 7 PLATE Group) and the right side in 19

cases (11TBW group and 8 PLATE group). The mean pre-operative range of motion (ROM) was 10.33±13.95 in TBW group and 8.67±10.08 in PLATE Group. The mean total deformity was 29.27±4.42 degree in TBW group and 29.80±4.90 degree in PLATE group. The mean pre-operative lateral condylar prominence index (LCPI) was 0.62±2.59 and 0.21±3.96 in TBW and PLATE group, respectively.

Table 1: Comparison of Bellmore’s criteria ROM Post-operatively in TBW and PLATE Group Patients.

Bellmore’s criteria	ROM Post-operatively after 24 weeks		Chi square	df	P value
	TBW (n)	PLATE (n)			
Excellent	4	8	3.210	2	0.201
Good	7	6			
Poor	4	1			

n= number of patients, df= degree of freedom

A non-significant difference was observed in ROM post-operatively in both groups with P value 0.201, respectively though 8 patients had excellent outcome in PLATE Group as compared to 4 patients in TBW group as per the Bellmore’s criteria.



Figure 1. Comparison of Bellmore’s criteria ROM Post-operatively in TBW and PLATE Group

Table 2: Comparison of Bellmore’s criteria Carrying angle Post-operatively in TBW and PLATE Group Patients.

Bellmore’s criteria	Carrying Angle Post-operatively after 24 weeks		Chi square	D f	P value
	TBW (n)	PLATE (n)			
Excellent	7	10	2.329	2	0.312
Good	4	4			
Poor	4	1			

n= number of patients, df= degree of freedom

Excellent outcome of carrying angle post-operatively was reported in 10 patients in PLATE group and 7 patients in TBW group but only 1 cases of PLATE group showed poor outcome while TBW group patients showed 4 poor outcome. A non-significant difference was observed in both groups with P value 0.312.

Table 3: Comparison of Bellmore's criteria LCPI Post-operatively in TBW and PLATE Group Patients.

Bellmore's criteria	LCPI Post-operatively after 24 weeks		Chi square	P value
	TBW (n)	PLATE (n)		
Excellent	5	7	.7333	.693
Good	6	4		
Poor	4	4		

n= number of patients

7 cases in PLATE group and 5 cases in TBW group showed Excellent outcome with respect to LCPI post-operatively after 24 weeks though difference in both groups was non-significant (P value 0.693). In our study, 14 cases in PLATE group and 11 cases in TBW group showed excellent outcome with no complications. 1 and 4 cases showed good outcome in PLATE and TBW group with minor complication., No cases reported with any residual defect or major complications in both groups. A non-significant difference was observed in both groups with P value 0.141 (Figure2)

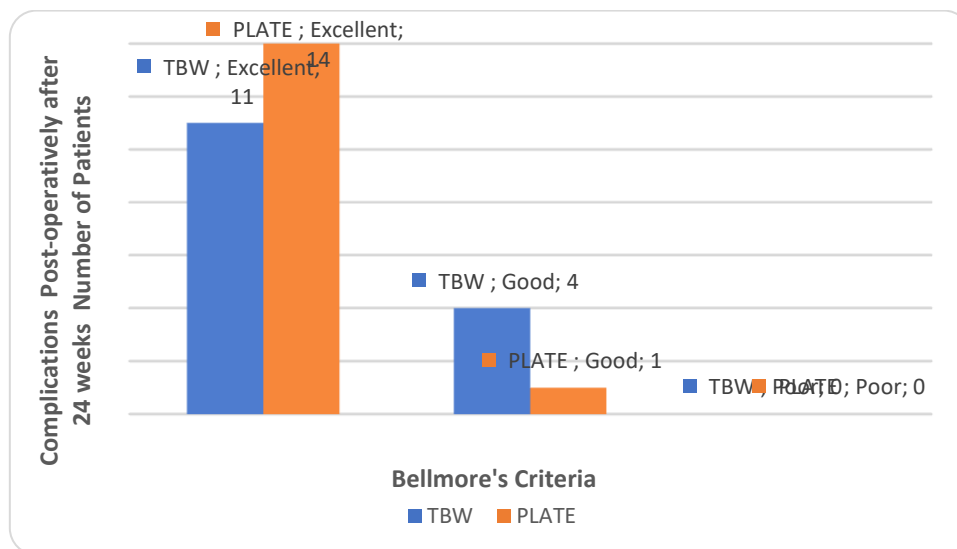


Figure2. Comparison of Bellmore's criteria Post-operatively Complications in TBW and PLATE Group Patients.

DISCUSSION

In the present study, excellent outcome was observed postoperatively after 24 weeks with respect to difference of ROM-53.33 %, carrying angle - 66.66 %, LCPI- 46.66 % and post operative complications-93.33 % in PLATE group as compared to TBW group in whom ROM-26.66 %, carrying angle 46.66 %, LCPI- 33.33 % & post operative complications- 73.33 %, respectively. Only 6.66 % cases had poor outcome with respect to ROM and carrying angle in PLATE group as compared to 26.66 % cases in TBW group. Ippolito et al. reported 4 cases of under correction out of 24 (16.6%) and 25% had over correction. Ippolito et al. reported 29% good (7 of 24), 25% fair (6 of 24) and 45.8% poor (11 of 24) result in their study of 24 patients. In 12 cases no comparison from opposite normal side was done.⁷ In study conducted by Hernandez and Roach, they have noted 20% inadequate intraoperative correction.⁸ Raney et al noticed only 2 of 68 patients (3%) complained of lateral prominence, the LCPI was abnormal in 62 % of cases. They concluded that there was no correlation between the radiographic findings and the patient's complaint of a "bump".⁹ Bellemore et al

similarly found only 2 of 17 patients(12%) disturbed by the appearance of a "bump".⁴ They ascribe this, like Wong et al, to remodelling in the skeletally immature (≤ 12 years).¹⁰ Cho et al evaluated the long-term results of remodelling after the French osteotomy. At a mean follow-up of 10 years (range 4.7 yrs to 14.2 yrs) the mean LCPI had remodeled from +0.36 postoperatively to +0.11. The patients who were prepubertal at osteotomy remodeled from +0.42 to +0.05, while the post pubertal patients only remodeled from + 0.27 to + 0.21.¹¹ However, Bellemore et al. reported 76% excellent (10 out of 13), good (3 of 13) and no poor result with MFO where as in LCWO with K-wire 45% excellent (5 of 11) and 27/0 good and poor each.¹¹ In study conducted by Song et al. & Karatosun et al. they reported 100% excellent result with Ilizarov technique for correction of varus deformity.^{12,13} Ippolito et al. reported 17 out of 19 (89%) cases of loss of correction that obtained at the time of operation. Of these 17, in 7 cases physeal injury was the etiology of varus deformity while in other 12 cases deformity was due to malunion of supracondylar fracture. However, they have longer duration of follow up than ours (average

23 years compared to 2.5 years). Also in their study average age at surgery was 7.9 years as compared to present study 12.6 years, so that potential of growth and remodeling was significantly higher in their cases than ours.^{7, 14}

In present study, we have not noted any shortening or lengthening in arm length as compared to opposite limb in both TBW and PLATE group. This is contrast to study conducted by Ippolito et al. who noted shortening of operated limb by average of 1.5 cm (1.0 to 2.5 cm). However, in their study, average corrected angle was significantly higher (33.70) as compared to ours (29.27 for TBW and 29.8 for PLATE), so the wedge removed by them for correction was wider than ours and hence may be the shortening.⁷ In the present study, the TBW group had minor post-operative complications (26.66%), 4 cases out of 15, which include one tourniquet palsy and three superficial infections treated by oral antibiotic and dressing. While in PLATE group only one case had minor post-operative complications. There was no neuro-vascular complications or unsightly scars, and no loss of correction was observed despite early mobilization of the elbow. All osteotomies united within the expected time period. Solfelt et al performed a meta-analysis of 40 studies (894 patients). Techniques compared were lateral closing wedge, dome, complex (including step-cut translation and multiplanar) osteotomies and distraction osteogenesis. The overall rate of excellent to good results was 87.8%. No technique was found to significantly affect the outcome or to be statistically safer. The complication rate was 14.5% (nerve injuries 2.5%).¹⁵ In the only randomized control study the French osteotomy was technically less demanding, had better results and fewer complications than the dome osteotomy.¹⁵ In a long-term comparative study of 50 years by Raney et al., the incidence of nerve injuries (ulnar and radial) with the posterolateral approach was 14%, whereas with the lateral approach there were no nerve injuries. The incidence of unsightly scars was low, but equal for both incisions. None of patients complained of an unsightly scar and there were no nerve injuries. The lateral incision extended from the epicondyle proximally for not more than the patient's hand breadth to avoid injury to the radial nerve.⁹ Ippolito et al. observed six patients with complication out of 24 (25%), two had ulnar nerve palsy, recovered fully after 4 months, 2 had local wound hematoma and two had circulatory disturbance recovered with splinting.⁷ Labelle et al. reported 25% complication rate (4 of 15), one radial nerve palsy, one ulnar nerve palsy and in one both radial and ulnar nerve palsy. All recovered with conservative treatment.¹⁴

Song et al. reported temporary radial nerve palsy in one and pin track infection in 3 out of 8 patients (50%) operated with Ilizarov ring fixator. And had slightly higher incidence of pin track infection with JESS fixator, 2 out of 3 patients.¹² Karatosun et al. also

reported 2 pin track infection in 7 patients (28%) operated with Ilizarov technique of distraction osteogenesis.¹³ The greenstick fracture of the medial cortex and the intact periosteum provide medial stability in the French technique. Screws and wire serve as a tension band. K-wire fixation has an incidence of nerve injury ranging from 7% to 17%. Plate fixation has a 10% incidence of nerve injury. Patients approaching skeletal maturity may have residual instability if the medial cortex fracture is complete instead of a greenstick fracture. The French osteotomy corrects mainly the varus deformity, although in the original description French placed the distal screw anteriorly to correct internal rotation. As a result, more complex multiplanar osteotomies were developed to correct the deformities of internal rotation and hyperextension. In a landmark article in 1960, Lyman Smith showed that the varus deformity was due to varus tilt, and internal rotation did not contribute to the varus.¹⁶ Kasirajan S et al. (2021) performed modified French osteotomy fixed with recon-locking plate in older children (above 8 years) and reported that reconstruction locking plate fixation of a modified French osteotomy in older children provided excellent results.¹⁷

In present study the fixation of osteotomy with plate had better outcome as compare to fixation with tension band wire and had less complications. Thus, the osteotomy fixed with plate provides more stability, early mobilisation and less complications as compared to TBW.

Strength of the Study

Our technique slightly differs from the French technique and the modified French technique. It was done in a supine position avoiding the cumbersome prone and lateral decubitus positions which were convenient to anaesthesiologist also. It helps in the correction of the carrying angle and the rotation deformity under direct vision as we can compare the alignment with the normal opposite limb. Our approach also avoids the cutting of the triceps that's described in the French procedure. This helps in early rehabilitation of the patient post operatively.

Future recommendation

Further research should consist of randomised controlled studies comparing different surgical techniques. There should also be long-term follow up of these patients to assess the outcomes of the correction of the deformity following skeletal maturity. The relative rarity of this condition makes this difficult as most referral centres don't get many cases.

Conclusion

In present study the fixation of osteotomy with plate had better outcome as compare to fixation with tension band wire and had less complications. Thus, the osteotomy fixed with plate provides more

stability, early mobilisation and less complications as compared to TBW.

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