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ORIGINAL ARTICLE

Results of Lateral Closing Wedge Osteotomy of Humerus for Post-Traumatic Cubitus Varus in Children

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ABSTRACT

Background: Cubitus varus deformity is common to occur following supracondylar humeral fractures among children. Patients of cubitus varus complain of cosmetic problems, and functional disability and may be complicated by ulnar nerve palsy or posterolateral rotatory instability. We did this research to assess the outcomes of lateral closing wedge osteotomy of the humerus for post-traumatic cubitus varus in children at Zagazig University hospitals.

Patients and methods: This study was held on 18 cases who presented with cubitus varus, ten were males while the other eight were females, they were managed by lateral closing wedge osteotomy, all the patients were subjected to history, physical examination, and plain X-ray lateral and anteroposterior views of the elbow. Functional outcome was assessed at the end of follow-up after 6 months.

Results: There was a statistical significance between the pre-operative varus angle and post-operative carrying angle (P1 value=0.027) also there was a statistical significance between the pre-operative varus angle and carrying angle of the normal elbow (P3 value=0.031) while there was statistical non-significance between post-operative carrying angle and carrying angle of the normal elbow (P2 value=0.392). The hyperextension in 8 cases with a mean of 8.5 degrees (range 5 to 16 degrees) improved to normal postoperatively. Fifteen patients had excellent outcomes while only three cases had good results with satisfactory outcomes and no complications.

Conclusion: French osteotomy results can be compared to the other more technical methods of osteotomy with good results and fewer complications.

Key Words: Closing Wedge Osteotomy, Cubitus Varus, Humerus, Children.

INTRODUCTION

To correct the deformity of cubitus varus in children, a lateral closing-wedge osteotomy of the distal humerus is performed. When a humeral supracondylar fracture is not properly treated, malunion or malreduction can occur causing deformity[1].Cosmosis was traditionally considered a key surgical indication, even though typical arcs of motion may be modified. However, lateral condylar

fractures may happen in the cases of uncorrected cubitus varus [2], other complications include posterolateral rotatory instability of the elbow (PLRI) [3],snapping of medial triceps, and ulnar nerve instability[4].

Posterolateral rotatory instability manifests as instability in the time of rising from a chair or lateral elbow pain. Symptomatic patients have irreversible attenuation of the lateral ulnar collateral ligament (LUCL), and morphologic alterations in the ulno-humeral joint require more extensive surgery, such as humeral distal end osteotomy, reconstruction of the LUCL, and possibly transposition of the ulnar nerve[5].Different techniques of osteotomies are described such as step-cut osteotomy[6-9], simple lateral closing wedge osteotomy, dome-shaped osteotomy, 3-dimensional osteotomy[10], or distraction osteogenesis.Closing wedge osteotomies have a distal cut parallel to the joint line and may retain a troublesome lateral prominence (if the proximal humerus is not been displaced medially or the medial cortex is intact) [11, 12].Karatosun et al. used the Ilizarov technique of lateral closing wedge osteotomy among adults [13].A unilateral external fixator was used byHandelsman et al. [14] and Jain et al. [15] for stabilization of the distal fragment after wedge osteotomies.

The present prospective study is reporting cases to be treated by the French technique of lateral closing wedge osteotomy managed by two screws and a figure of “8” tension band wire.

The hypothesis of the current study was that correction of cubitus varus deformity in children by using lateral closing wedge osteotomy fixed by two screws and figure of eight tension band wire have good outcomes with fewer complications compared to other techniques.Therefore, this study aimed to correct the angular deformity around the elbow andto assess the outcomes of lateral closing wedge osteotomy of the humerus for post-traumatic cubitus varus in children among Zagazig University hospitals with better cosmoses and good range of motion.

SUBJECTS AND METHODS

We conducted this prospective interventional study on eighteen cases with cubitus varus deformity at the Orthopaedic Surgery Department, Zagazig University Hospitals during the period from June 2022 to June 2023.Written informed consent was obtained from all parents of participants, the study was approved by the research ethical committee of the Faculty of Medicine, Zagazig University. Approval was obtained from the **Institutional Review Board (IRB) (#9552/29-5-2022).**This work has been carried out following The Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans.

Inclusion criteria: Children aged more than 8 years who had cubitus varus deformity following malunion of supracondylar humeral fracture.

Exclusion criteria: Children of age less than 8 years who have Cubitus varus deformity with neurological complications.

Pre-operative preparation: In the outpatient clinic, patients were examined for the deformity and any other complaints they may have had. The three bony point relationship in both elbows was checked to determine the cause of the varus deformity (i.e., a

supracondylar fracture of the humerus or physical injury), and the lengths of the arms and forearms were measured to rule out physeal injury.To calculate the clinical carrying angle, we drew the long axis of humerus and ulna on both sides.Pre-operative evaluations, including hematological tests, chest X-rays, and assessments of pediatric and anesthetic fitness, were performed on all in-hospital patients who were deemed candidates for surgical intervention. Measures taken from radiographs, including angular measurements from anteroposterior and lateral views.

Operative procedures: After standard preparation draping and inflation of the tourniquet while the patient is in a supine position under general anesthesia. A small lateral incision was made directly above the supracondylar ridge of the humerus, which was then exposed subperiosteally. Lateral closing wedge osteotomy was performed, the proximal cut is oblique while the distal cut is transverse, the distal cut is proximal to the supracondylar fossae. The wedge was cut with an oscillating saw or using drill holes. Then weremoved the wedge gently using a bone nipper.The medial cortex was left intact to be broken and used as a hinge.Two screws were then passed through a single cortex, the proximal one is posterior and the distal one is anterior and parallel to the prepared wedge.The screws were then wired together with (8) shaped tension band wire. Then we closed the wound in layers. For three to four weeks, the operative limb was kept immobilized in a flexed 90° position with the forearm fully supinated in a back slab(Figure 1).

Post-operative stage and follow-up: Strict elevation of limb for the first five days. The dressing was first checked on the 2nd day postoperative. On the 14th daypostoperative sutures were removed and the back slab continued for 3 or 4 weeks. After 3 weeks, the slab was taken away for follow-up X-rays and clinical and radiographic assessments of the degree of deformity repair. Mobilization started after there was radiological evidence of callus, follow-up was done at 3, and 6 months later to detect any complications.

Statistical analysis:

Excel was used for the analysis of the data. Afterwards, SPSS 20.0 (Statistical Package for the Social Sciences) was used to analyze the gathered data.Numbers and percentages are used to represent qualitative data, while continuous groups are shown as means and standard deviations for quantitative data. Quantitatively independent multiple-difference ANOVA tests for differences.

RESULTS

The age of patients at the time of surgery ranged from eight to thirteen years of age. With mean value (± SD) 10 ± 2 years. The total number of cases included in the study was eighteen patients including ten males and eight females with male sex predominance in 56% of cases. The right side (61%) was affected more (Figure 2).According to Bellmore's criteria, cosmetically almost all cases were satisfied with the outcome (Table 1). There were no neurological complications, scarring, or deformity. Most of our patients were able to attain a supination-pronation angle > 170 degrees due to stable fixation. In most patients, the range of motion between flexion and extension is limited by < 5-10 degrees,

and in only two patients, it is limited by 10-20 degrees.There was a statistical significance between the pre-operative varus angle and post-operative carrying angle (P1 value=0.027) also there was a statistical significance between the pre-operative varus angle and carrying angle of the normal elbow (P3 value=0.031) while there was a statistical non-significance between post-operative carrying angle and carrying angle of the normal elbow (P2 value=: 0.392) (Table 2).The mean loss of flexion of 17 degrees preoperatively (range 0 to 30) reduced to a mean of 6 degrees (range 0 to 11 degrees) postoperatively (Figure 3).The hyperextension mean in 8 cases was 8.5 degrees (ranging from 5 to 16 degrees), which improved to normal postoperatively (Figure 4).Fifteen patients had excellent outcomes while only three cases had good results with satisfactory outcomes and no complications according to Bellmore's criteria. The average final Mayo Elbow Performance Score was 97.5 (range 95-100 points) showing excellent results.A case of a male child aged 8.5 years. The complaint was varus, hyperextension, and limitation of flexion. Pre-operative clinical examination and X-ray confirmed the presence of varus and hyperextension. Lateral closing wedge osteotomy of the humerus was performed. Post-operative X-ray showed varus correction(Figure 5).

Table (1): Showing results according to Bellmore's criteria.

Bellmore's criteria	Excellent	Good	Poor
Range of motion	16	2	-
Carrying angle	18	-	-
LCPI	17	1	-
Complications	-	-	-

Table (2): Relation between pre-operative clinical varus angle, normal carrying angle and post-operative carrying angle.

	Pre op clinical varus angle	Carrying angle of normal elbow	Post op carrying angle	Test of significance (p- Value)
Carrying angle range	**16 - 25**	**11 - 16**	**12 - 17**	
Mean ± SD	**20.4 ± 4**	**13.3 ± 2**	**14.3 ± 2**	**P1: 0.027 (S)** **P2: 0.392 (NS)** **P3: 0.031 (S)**

(S) Significant p-Value. (NS) Non-significant p-Value. Data was expressed as Mean ± SD one-way Annova test.P-Value: Level of significance: P>0.05: Non-significant (NS); P <0.05 : Significant (S).

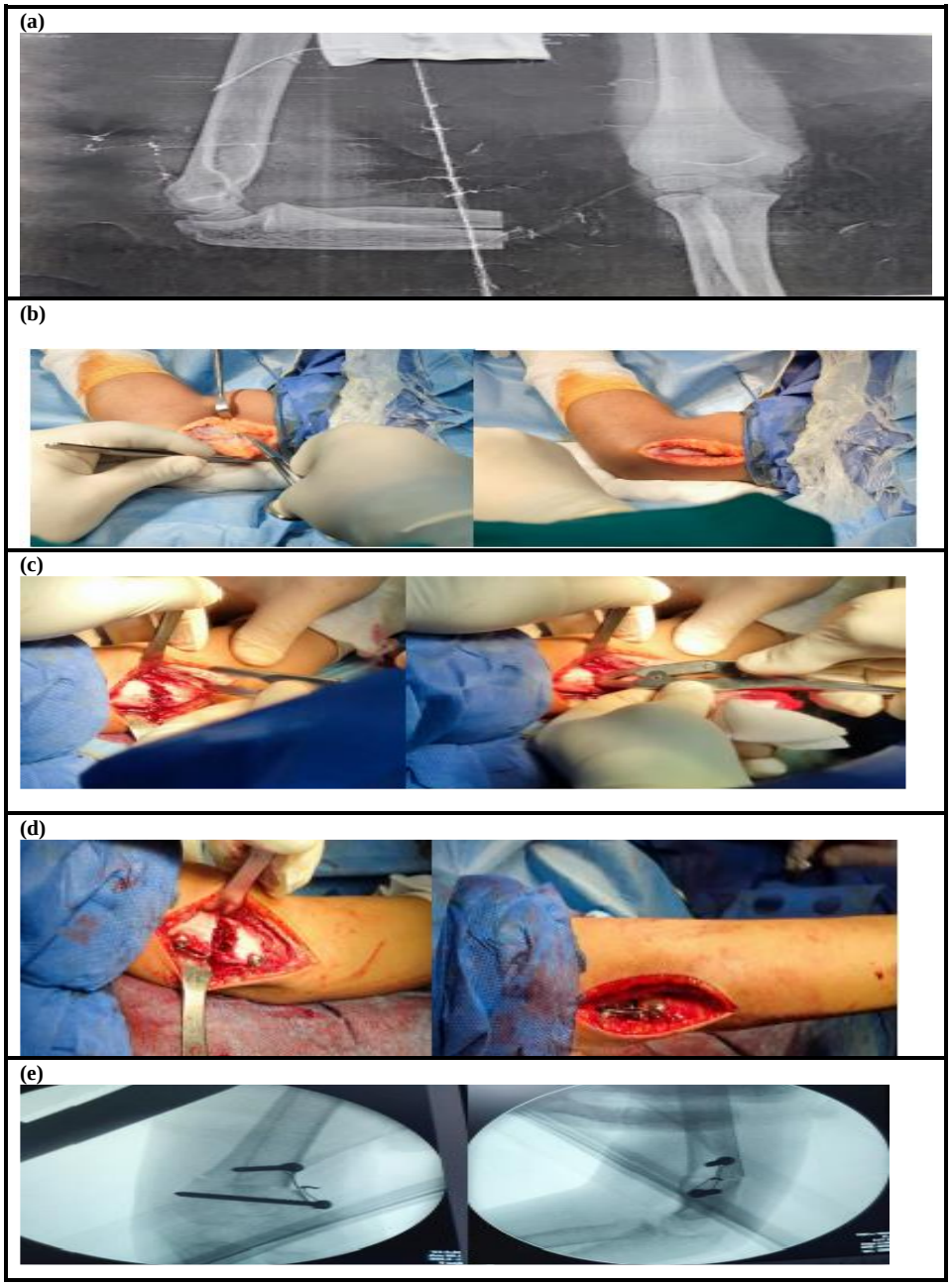

Figure (1): Operative procedures: (a): preoperative x ray (b) showing the site of incision; (c) showing removal of the wedge at the site of osteotomy; (d) showing insertion of 2 screws & 8 shaped tension band wire; and (e) showing post-operative X-ray.

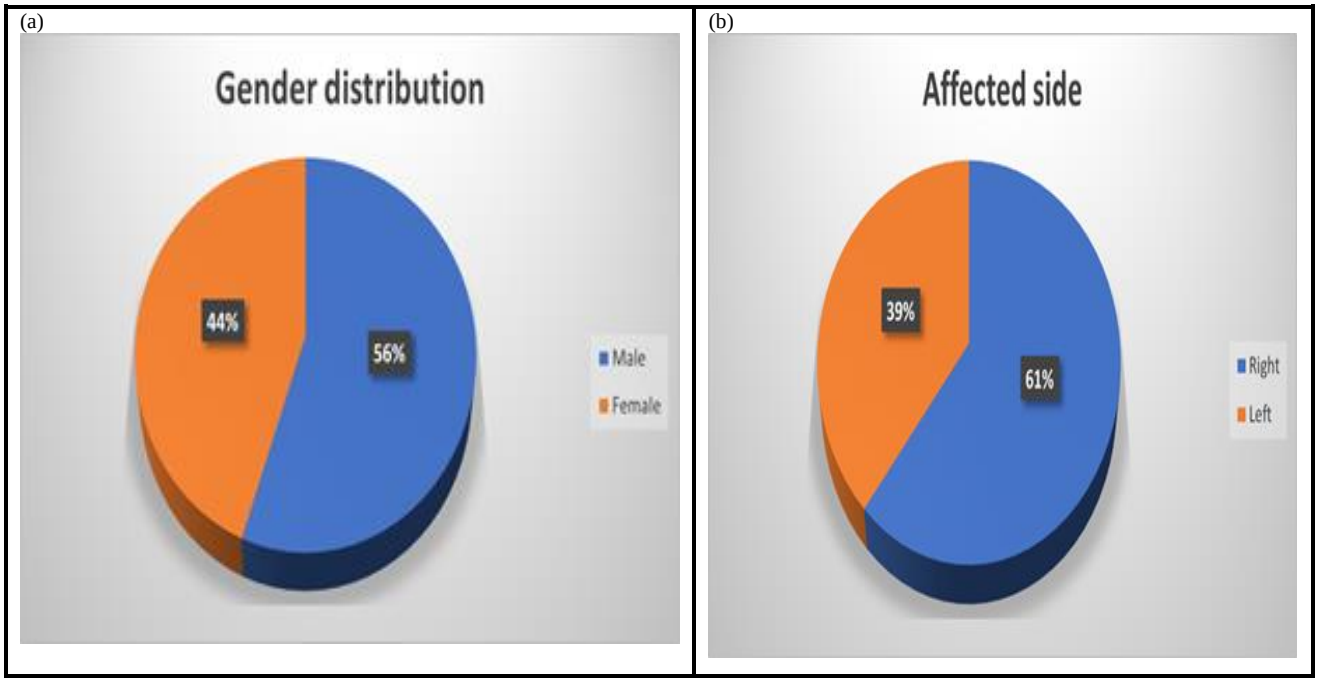

Figure (2): Gender and affected sidedistribution among the studied cases.

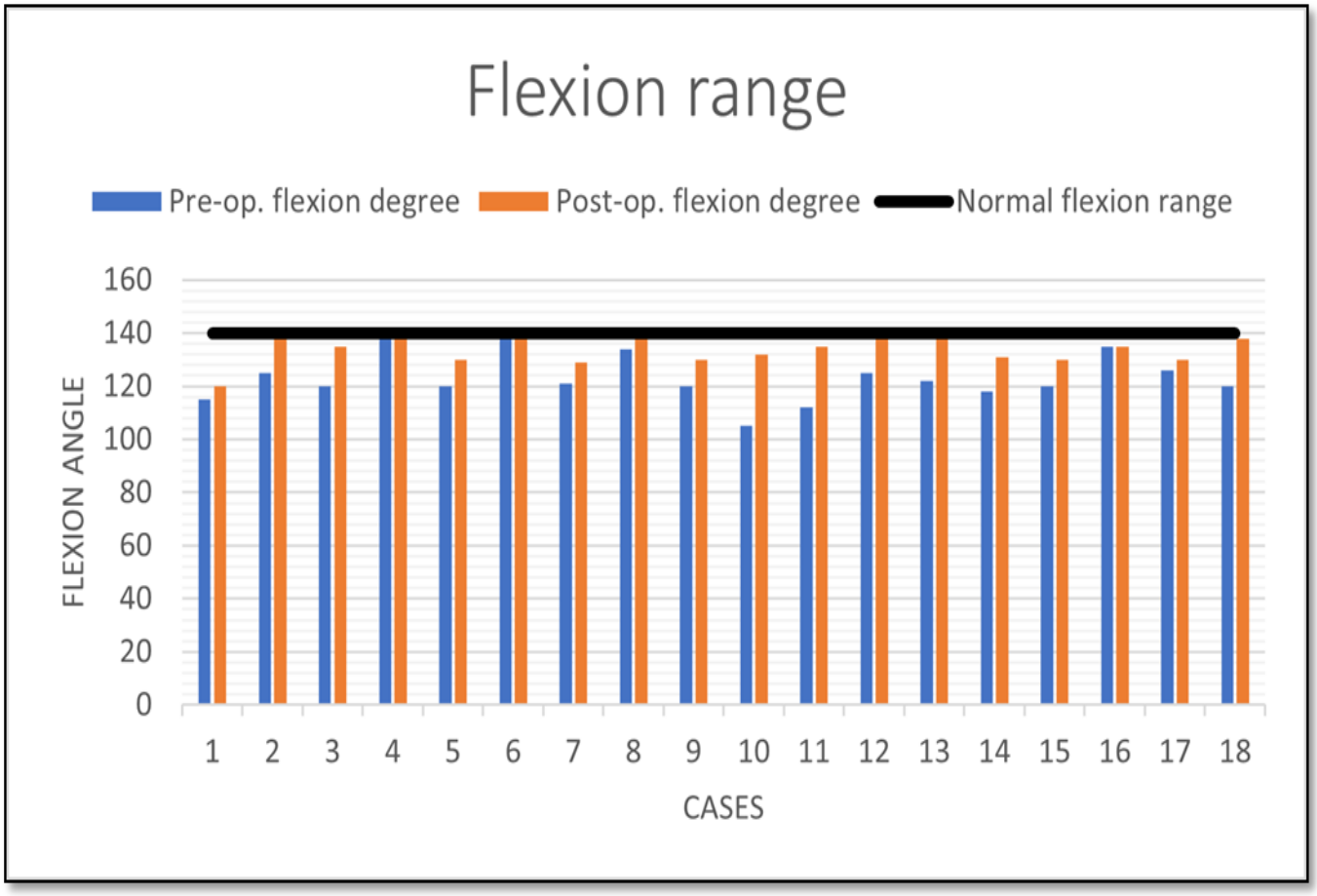

Figure (3): Preoperative and postoperative flexion degree compared to normal flexion range.

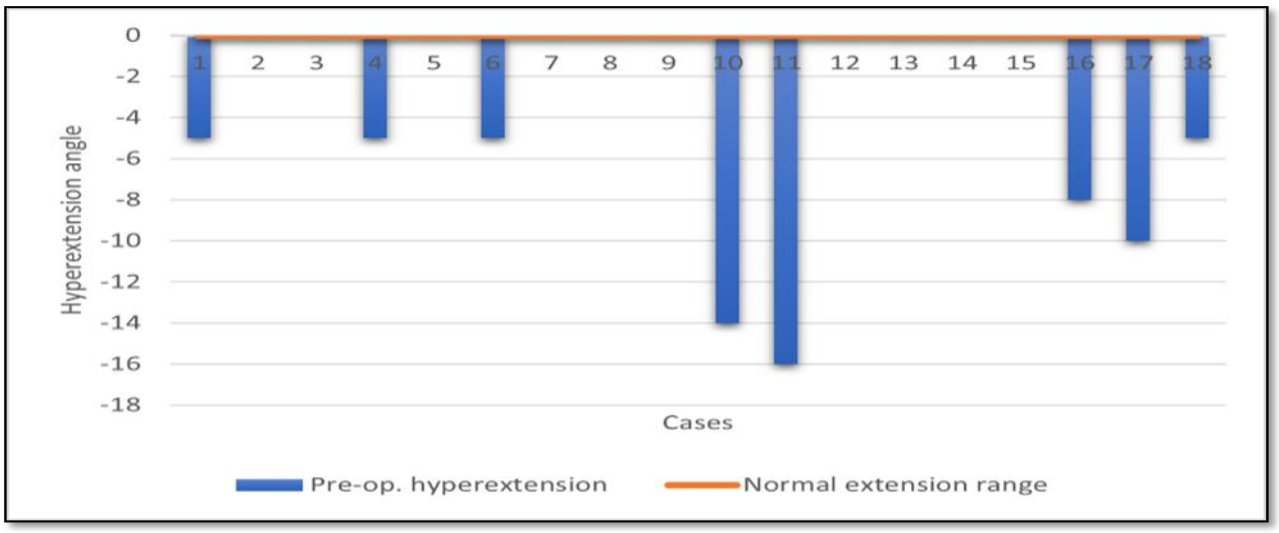

Figure (4): Showing cases with hyperextension.

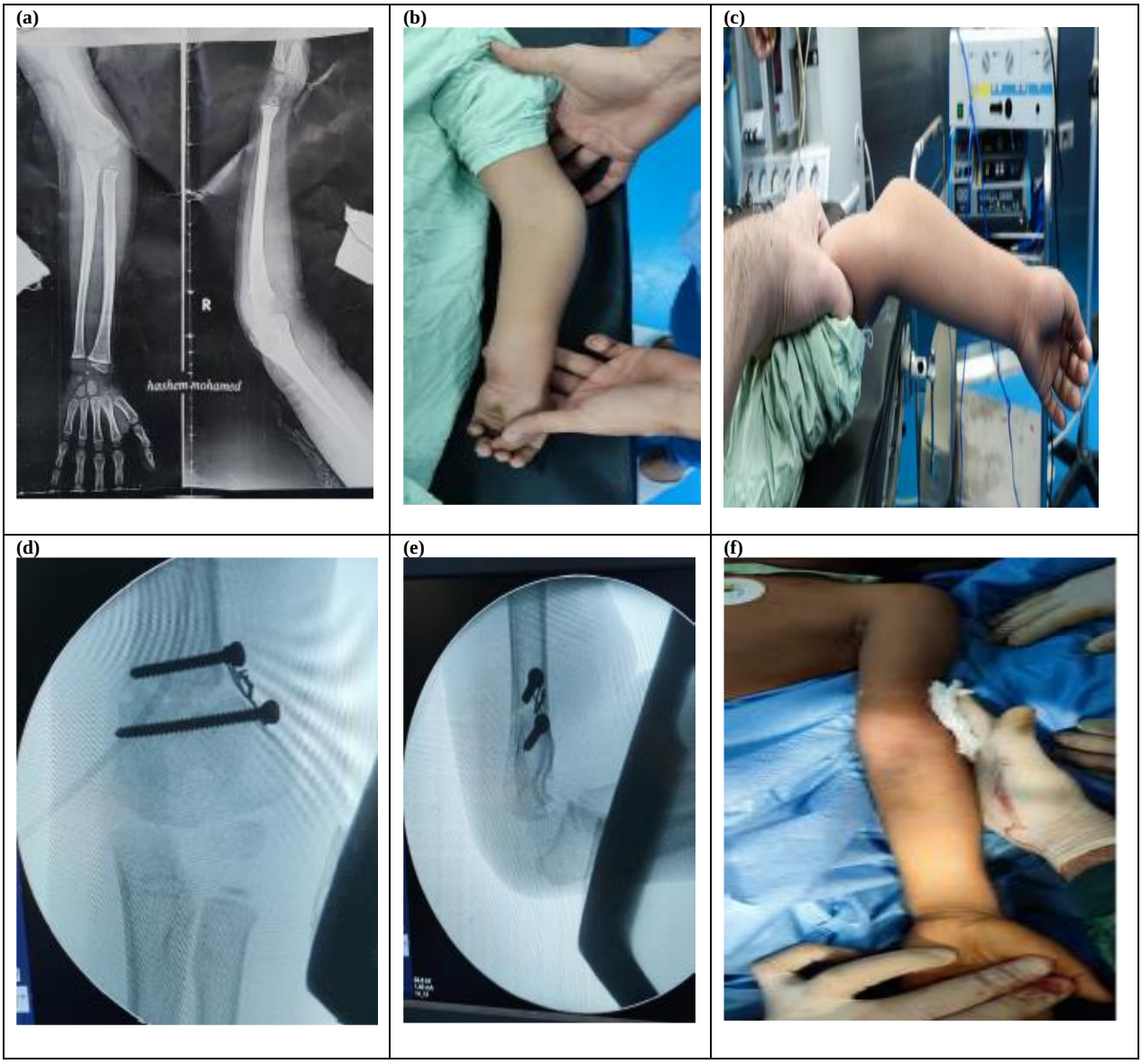

Figure (5): Male aged 8.5 years. The complaint was limitation of flexion (a-c) showing varus and hyper-extension; (d-f) Post-operative X-ray showing varus correction

DISCUSSION

Cubitus varus is known as gunstock deformity and is defined as a deformity in which the long axis of the forearm is deviated inward in relation to the long axis of the arm. Cubitus varus is a complex three-dimensional deformity that consists of Internal rotation, varus, and hyperextension deformity of the humeral distal bone fragment. It is the most common deformity after supracondylar humeral fracture, it may also occur due to physeal arrest secondary to trauma, infection, or tumors [13]

Typical motion arcs may be changed with decreased motion range, surgery was done traditionally for cosmetic causes as a primary indication. When cubitus varus is not corrected, subsequent complications could occur like posterolateral rotatory instability of the elbow (PLRI), lateral condylar fractures, ulnar nerve palsy, posterior interosseous neuritis as well as snapping of medial triceps.The deformity should be assessed radiologically and clinically [13,16]. The best method to avoid this deformity is to achieve anatomical reduction of the supracondylar fractures from the start because neither rotational nor angular deformities can be corrected by remolding [16].We can prevent cubitus varus by making certain at the time of reduction of supracondylar fractures that the Baumann's angle is intact and remains so during healing, which is best assured with pin fixation [17].Even though there are many methods for treating supracondylar fractures, cubitus varus remains a common problem and achieving and sustaining almost complete and accurate reduction of supracondylar humeral fracture is essential in its prevention. Malunion of the fracture with medial angulation of the distal humeral fragment is now generally accepted as the cause of cubitus varus after a supracondylar fracture, rather than a growth disturbance. [18-20].We concur with Oppenheim et al., who recommend correcting the deformity in early childhood as there is no evidence of deformity recurrence or interruption of growth inspite of using the screws near the epiphyseal plate [21].Many surgeons are discouraged from repairing traumatic cubitus varus because of the high risk of complications documented in some series and because the condition is addressed mostly for cosmetic reasons and rarely to improve function and consistently generate satisfying results [21-23].It would appear that these conditions are met by French osteotomy. With practice, the process only takes about 30 minutes to complete. The dissection is minor, and nerve damage is unlikely to occur [22].A medial opening wedge osteotomy with bone graft, a lateral closing wedge osteotomy, and rotation of an oblique osteotomy have all been described as treatments for cubitus varus. The simplest method of treating cubitus varus is with a lateral closing wedge [24].According to the results of our study that was conducted on 18 patients (10 males & 8 females), all cases showed excellent or good results in terms of range of motion and carrying angle with cosmetic satisfaction except for one case that showed little difference due to excessive lateral condylar prominence. There was a statistical significance between the pre-operative varus angle and post-operative carrying angle (P1 value=0.027) also there was a statistical significance between the pre-operative varus angle and carrying angle of the normal elbow (P3 value=0.031) while there was a statistical non-significance between post-operative carrying angle and carrying angle of the normal elbow (P2 value=: 0.392).In agreement with our study, North et al. [25]conducted a retrospective study on 90 patients managed by French osteotomy, eighty-four patients had excellent or good results regarding carrying angle and range of motion while only six patients had

poor outcome (residual varus, loss of >20 degrees of preoperative range of flexion or extension or a complication necessitating revision surgery) without any neurovascular complications.Deb et al. [26]compared the results of cubitus varus deformity treated by using dome osteotomy to those treated by modified French osteotomy, finding that the French osteotomy group had excellent or good results in terms of the range of motion and carrying angle for all 16 patients they managed.Rathor et al. [26]conducted a comparative study between fixation of modified French osteotomy with tension band wire and plate in cubitus varus and reported that in the 15 cases treated by tension band wiring, 11 patients had excellent and good outcomes in terms of carrying angle, range of motion and lateral condylar prominence while only 4 cases had poor outcomes. Contrary to our study, Orbach et al. [28]conducted a retrospective review of seven patients treated by French corrective osteotomy, four patients suffered from residual hyperextension with an average of 27.5 (range 15°-35°) however, it was corrected spontaneously in all patients during the follow-up and also three patients suffered from limited flexion with an average of 18.3º (range 5º-35º) compared to the healthy elbow.Singh et al.[29]reported that after using dome osteotomy for correction of cubitus varus in 18 patients, all cases regained their preoperative motion range within 6 months postoperative. One patient required early pin removal and extra splint protection due to a pin tract infection, whereas the other two cases responded to aseptic dressings and oral antibiotics.Vashisht et al. [30]reported that after using modified step cut osteotomy for correction of cubitus varus in 15 children, nine patients (60%) had an excellent functional outcome, five patients (33.3%) had a good outcome, and one patient (6.6%) had a bad outcome. No statistically significant difference was seen in the lateral condylar prominence index (LCPI) between the surgical side and the normal side.The medial technique was presented by Hui et al. as a solution to the problem of visible scarring; however, it is technically challenging due to the difficulty in isolating the ulnar nerve and the risk of ulnar nerve palsy[16].The French method utilizes a medially intact periosteal hinge, two laterally placed screws and a wire loop to stabilize the distal fragment,. None of our 18 patients experienced a loss in fixation, and they all showed either excellent or good improvement of their deformity. There are no neurological or infectious consequences. When compared to the other treatments documented for treating cubitus varus, French's method is the most effective [24-31]. In our study, advantages of French osteotomy is that it is simple technique that can be performed with experience in short time with great outcome and less complications than other osteotomy techniques. As for future studies one or two lateral K-wires can be added for more stable fixation.

Our study had several limitations including a lack of long-term follow-up, a small sample size, and stringent inclusion criteria. Another limitation is the study design, which lacked a comparative approach group to compare the procedure to the standard one.

We recommend that larger studies involving more participants and to be in 2 comparative 2 groups with 2 different techniques to elucidate which technique have more advantages and outcomes in management of post-traumatic cubitus varus in children.

CONCLUSION

The outcomes of French osteotomies are equivalent to those of other, more technically advanced osteotomies, with satisfactory results and fewer complications. We suggest

the French procedure for the treatment of cubitus varus deformity after trauma in children.

Conflict of interest

The authors declared that they have no conflicts of interest with respect to the authorship and publication of this article.

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Figure legends

Figure 1: Operative procedures: (a) showing the site of incision; (b) showing removal of the wedge at the site of osteotomy; (c) showing insertion of 2 screws & 8 shaped tension band wire; and (d) showing post-operative X-ray.

Figure 2:Gender and affected side distribution among the studied cases.

Figure 3: Preoperative and postoperative flexion degree compared to normal flexion range.

Figure 4:showing cases with hyperextension.

Figure 5: Male aged 8.5 years. The complaint was limitation of flexion (a-c) showing varus and hyper-extension; (d-f) Post-operative X-ray showing varus correction.

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