



The equal limbs lateral closing wedge osteotomy for correction of cubitus varus in children

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Many methods have been described for correction of cubitus varus ; the lateral closing-wedge osteotomy of French is the most popular. Although many authors reported successful correction, some authors since then have been critical of that osteotomy, alluding to problems with a lateral bulge or the scar. The aim of the present study is to evaluate a technique of correction of posttraumatic cubitus varus in children with an equal limbs laterally closing-wedge osteotomy of the distal humerus. From 2003 to 2006, twelve patients underwent supracondylar osteotomies for correction of cubitus varus in the Mansoura University Hospital. The average age was 8.7 years. The average follow-up was 20 months. The average preoperative carrying angle was 25° varus, and this was corrected to an average of 5° valgus. There was no noticeable prominence of the lateral condyle or an unsightly scar. This study shows that the equal limbs laterally closing-wedge osteotomy is simple, safe, and associated with an excellent cosmetic outcome and a low complication rate.

Keywords : cubitus varus ; lateral closing wedge osteotomy ; lateral condylar prominence ; children.

Although cubitus varus does not cause functional disability, surgery is often required for cosmetic reasons.

Many methods of cubitus varus correction have been described, but the lateral closing-wedge osteotomy of French has been one of the most popular. By design, this method is primarily a uni-planar osteotomy. Although many authors reported successful correction of the varus alignment (1,3,4,6,7,8,17,20,21), the overall cosmetic appearance of the elbow has received little attention. The cosmetic outcome, however, is of paramount importance because the osteotomy is performed for cosmetic reasons and rarely to improve function (20). Some authors since have been critical of closing-wedge osteotomies, alluding to problems with a lateral condylar prominence (lazy-S deformity) or an unsightly scar (12,16,30).

Some believe that the cause of the lazy-S deformity is inherent to the design of the osteotomy.

INTRODUCTION

Cubitus varus (gunstock deformity) is the most common long-term complication of supracondylar fractures of the humerus in children. Reported in up to 58% of patients, its occurrence is higher in fractures originally managed conservatively (11,23).

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Excision of the wedge leaves two bone fragments of unequal width. During closure of the osteotomy, hinging on the medial cortex effectively shifts the distal fragment laterally (30). The tendency to form an unsightly scar is reported to be due to direct crossing of the Langer skin lines by the standard longitudinal incision. Furthermore, the anterior location of the scar on the hanging arm at rest and the upward location of the scar on the pronated arm resting on a desk causes the scar to be obvious and unacceptable (12).

The present study evaluates a technique of correction of posttraumatic cubitus varus in children with an equal limbs laterally closing-wedge osteotomy of the distal humerus through a posterolateral approach and fixation with Kirschner wires.

PATIENTS AND METHODS

During the period 2003-2006, 12 children were entered into a prospective study on correction of posttraumatic cubitus varus using a supracondylar equal limbs laterally closing-wedge osteotomy at the Mansoura University Hospital. There were seven boys and five girls. Their ages at operation ranged from 5 to 12 years (mean, 8.7 years). The average interval between the injury and the corrective osteotomy was 4.1 years (range, 2-7 years). Right-elbow injuries occurred in eight cases, the remaining four cases injured the left elbow. All patients enrolled in this study had cubitus varus after a supracondylar fracture of the humerus. The indication for osteotomy was cubitus varus that was cosmetically unacceptable to either the child or the parents.

The carrying angle and the range of motion of both elbows were measured with a goniometer. The carrying angle of both elbows was clinically determined in full extension, and the difference between elbows was calculated. The sagittal-plane deformity of the elbow was evaluated by comparing the range of motion of the injured side with that of the contralateral uninjured side. The difference in extension between the injured side and the uninjured side was the amount of extension at the fracture site. Internal rotation deformity was measured by the method described by Yamamoto *et al* (31) with the patient bending slightly forward. The patient's arm is held at the side with the elbow flexed at 90° and the shoulder held in maximum extension. In this position, maximum internal rotation strain is applied to the

patient's arm. The angle formed between the horizontal plane of the back and the midline of the forearm represents the internal rotation deformity.

Preoperative planning

The purpose of the corrective osteotomy is to produce an elbow joint with a final appearance closely similar to that of the unaffected side. Before planning, radiographs of both upper extremities are taken in the same position with the elbow joints fully extended and the forearms fully supinated. The radiograph of the affected side is then traced (fig 1 A). The traced forearm is superimposed on top of the reversed radiograph of the unaffected forearm, and the unaffected humerus is traced. The angle between the central axes of both the affected and the unaffected side is the angle of correction (fig 1 B&C). The angle of correction is copied onto a card in form of a triangle with two equal limbs and with several marks in both limbs at equal distances. The planned triangle is cut out and sterilized (fig 2).

The lateral prominence index (LPI) was calculated on the affected side as the difference between the measured medial and lateral widths of the bone from the longitudinal midhumeral axis and was expressed as a percentage of the total width of the distal humerus to minimize errors from magnification (fig 3). The lateral prominence index (LPI) = $(AC - BC) \times 100/AB$. There is usually a slight medial prominence, making the LPI predominantly negative (22).

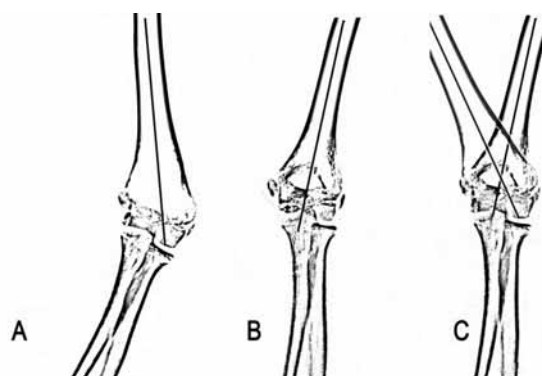


Fig. 1. — (A) The radiograph of the affected side is first traced. (B) The reversed radiograph of the unaffected forearm. (C) The affected side is superimposed over the unaffected side, and the angle between the central axes of both the affected and the unaffected side is the angle of correction.

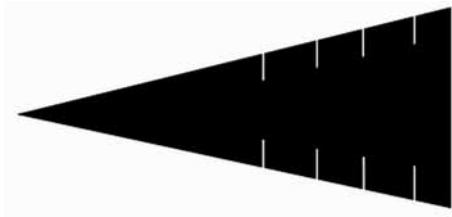


Fig. 2. — The angle of correction is drawn onto a card in form of a triangle with two equal limbs and with several marks in both limbs at equal distances.

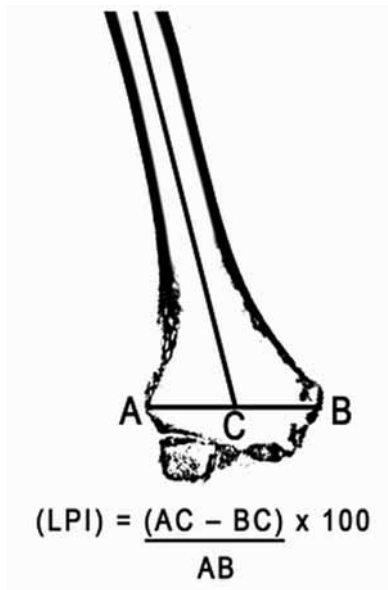


Fig. 3. — The lateral prominence index (LPI) = $(AC - BC) \times 100 / AB$.

Surgical Technique

The lower humerus was exposed through a posterolateral approach because it gives adequate exposure and makes it easier to remove a lateral based wedge without much retraction of the lateral soft tissues. Also, the osteotomy is easy to handle if the medial cortical hinge is intact. The planned equal limbs lateral-based wedge was marked in the supracondylar area (fig 4 A), ending short of the medial cortex, and considering the amount of extension deformity at the malunited fracture site. The wedge was then excised, leaving the medial cortex intact (fig 4 B) which was weakened by two or three drill holes, and the osteotomy was closed slowly and carefully to avoid fracture of the medial cortex (fig 4 C). During

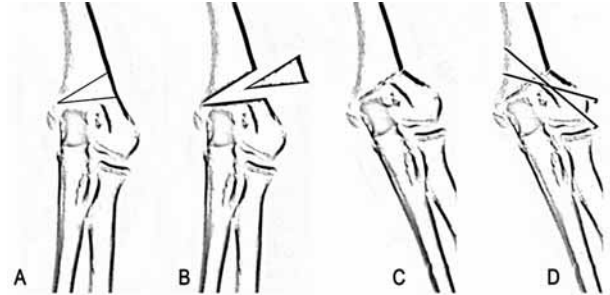


Fig. 4. — (A) The planned angle of correction is marked in the supracondylar area. (B) The wedge is then excised, leaving the medial cortex intact. (C) The osteotomy is closed slowly and carefully to avoid fracture of the medial cortex. (D) The osteotomy is fixed by two crossing Kirschner wires.

closure of the osteotomy, the posterior cortex of the distal fragment could be hinged over that of the proximal fragment to correct some of the internal rotation deformity and what remains will be compensated by the shoulder movement. The osteotomy was fixed by two crossing Kirschner wires and the wound was closed in layers (fig 4 D).

Children were immobilized in a cast and were reviewed at 2-week intervals for 2 months postoperatively, and then every month or every other month for one year. The Kirschner wires were removed after three weeks postoperatively and the cast after five weeks, followed by active range of motion (ROM) exercises. At each follow-up visit, the children were assessed for range of motion, carrying angle, and the presence of a bony prominence over the lateral condylar region ("lazy S" deformity) or an unsightly scar at the site of surgery. Radiographs were performed in the immediate postoperative period, at 3 weeks, and when the patient regained full range of motion.

Results were evaluated by the criteria described by Oppenheim *et al* (21). Results were considered excellent if there was correction of the varus deformity to within 5° of the carrying angle of the contralateral elbow; range of motion to within 5° of preoperative flexion and rotation arcs, and no perioperative complication. Results were considered good if there was a valgus position and range of motion to within at least 10° of the preoperative arcs. Results were considered poor if there was any complication or residual varus or loss of more than 10° in any plane of motion compared with the preoperative examination.

Table I. — Carrying angle (in degrees)

	Preoperative Carrying Angle	Postoperative Carrying Angle	Contralateral side carrying angle	The difference between right and left
Minimum	15	2	4	0
Maximum	33	7	7	4
Mean	25.1	5.2	5.6	1.6
Standard Deviation	6.1	1.8	1.2	1.1

Table II. — Range of flexion and extension

	Extension		Flexion	
	Preoperative	Postoperative	Preoperative	Postoperative
Minimum	0	0	125	124
Maximum	5	3	133	135
Mean	2.6	1.3	128.7	129.4
Standard Deviation	1.7	1	2.5	2.8

RESULTS

The mean length of follow-up was 20.6 months, with a range of 6 to 36 months. The average preoperative carrying angle was 25° varus, with a range of 15° to 33° varus, and this was corrected to an average of 5° valgus, with a range of 2° to 7° valgus, and with an average difference between the right and left side of 1.6°, with a range of 0° to 4° (table I).

There were little or no differences in the range of motion (ROM) of the elbow except in one child who had slight limitation in elbow flexion of about 6°. The average range of motion of the elbow joint was from 2.6° extension (range, 0-5°) to 128° flexion (range, 125-133°) preoperatively and from 1.3° extension (range, 0-3°) to 129° flexion (range, 124-135°) postoperatively (table II).

In all patients, the final radiographs showed little or no difference between the right and the left side. The visual appearance of the treated arm with no prominence of the lateral condyle was nearly similar to that of the unaffected side.

The preoperative lateral prominence index (LPI) averaged 2.4% (range -2.9% to 6.4%). The negative value indicates the medial prominence. During the follow-up, it was noticed that the LPI slightly decreased in large deformities due to rotation of the

Table III. — Complications

	Number	Percent
No complications	10	83.3
Wire infection	1	8.3
Prominent lateral condyle	1	8.3
Total	12	100

distal humerus along a large arc especially in older children with less power of remodeling. However, at the end of follow-up, the postoperative LPI averaged -2.3% (range -4.8% to 2.1%). Compared with the preoperative values, the LPI actually decreased in all children except in one child aged 12 years who had an LPI of about 2.1% ; however, this did not cause any clinically significant prominence of the lateral condyle.

No complications, such as ulnar neuropathies, nonunion, loosening of fixation or recurrence of the deformity, were observed. Pin tract infection was detected only in one child (8.3%) and responded well to repeat dressing (table III).

The final results according to Oppenheim *et al*(21), showed 11 children (91.7%) with excellent results and one child with a good result (table IV). In all cases, the parents and their children were satisfied with the appearance of the elbows and

Table IV. — Overall results according to Oppenheim *et al* (21) criteria

	Number	Percent
Excellent	11	91.7
Good	1	8.3
Poor	0	0
Total	12	100



Fig. 5. — (A) 8-year-old girl with 33° post-traumatic cubitus varus deformity of left elbow. (B) Postoperative radiograph after 3 weeks. (C) Follow-up after 18 months with 4° valgus carrying angle and no lateral prominence. (D) Full range of flexion and extension.

none of them noticed any difference from the unaffected side or complained about the operative scar. Representative cases are shown in figure 5 (A-D) and figure 6 (A-D).

DISCUSSION

Cubitus varus is one of the most common complications of supracondylar fractures of the



Fig. 6. — (A) 9-year-old girl with 25° post-traumatic cubitus varus deformity of right elbow. (B) Postoperative radiograph after 3 weeks. (C) Follow-up after 30 months with 3° valgus carrying angle and no lateral prominence. (D) Full range of flexion and extension.

humerus in children treated with nonoperative management without reduction and fixation. Its reported incidence varies from 4% to 58% (11,23). It may result from inadequate reduction, from loss of reduction with consequent malunion, or from disturbance of growth at the lower end of the humerus. Most authors consider the deformity to result from inadequate reduction that leaves a residual rotatory deformity that can collapse into a medial tilt resulting therefore in a varus deformity (7,25,29,31).

Multiple osteotomies have been described for correction of the cubitus varus deformity. King and Secor (14) described a medial opening-wedge osteotomy, which has the advantage of maintaining

the length of the humerus, but the disadvantage of lengthening the medial structures, which can result in an ulnar neuroparaxia. The lateral closing-wedge osteotomy and the oblique osteotomy of the distal humerus and their variants are now used to correct the cubitus varus deformity (24). Although these osteotomies correct the deformity, reports on results of surgery indicate significant difficulty in maintaining postoperative correction (1,5,8,12,13,21).

French (7) described a lateral wedge osteotomy, which corrected both the angular and the rotational component simultaneously by variable positioning of the screws in the anteroposterior plane. Although the lateral closing wedge osteotomy is the simplest

method, it has many technical pitfalls (9). First, the osteotomy site is usually more proximal than the malunited metaphysis ; therefore, it is often difficult to cross the fixation pins at the osteotomy site for rigid fixation. Second, the tightness of the medial soft tissue after the closing wedge osteotomy tends to produce a strong varus moment that can lead to recurrent deformity if the osteotomy site is not rigidly fixed. To solve the problem, a two-hole lateral plate and a medial percutaneous pin are recommended to enhance the stability of the internal fixation (10). The third pitfall is the tendency to produce a prominent lateral condyle after the angulation is corrected. This secondary deformity often compromises the cosmetic outcome.

Barrett *et al* (2) found that a lateral closing-wedge osteotomy can achieve a good correction of cubitus varus without a significant lateral bony prominence or unsightly scar in the majority of patients. They therefore report that a supracondylar osteotomy, performed by the French technique (7) on children young enough to allow remodeling, produces excellent results. Ippolito *et al* (12) reported that 60% of patients complained of an unsightly postoperative scar. In addition, Wong *et al* (30) reported a poor cosmetic appearance of the elbow in many patients because of bulging of the lateral epicondyle, which was more prominent if there was atrophy of the flexor muscles of the forearm (lazy-S deformity). More recently, Voss *et al* (28) claimed that no patients in their series were disturbed by the cosmetic appearance of the lateral step-off, although many were aware of its presence.

A dome osteotomy, as used by Tachdjian (26) cannot reduce the incidence of a protrusion by the lateral condyle. Also, Kumar *et al* (15) observed that the rotation reduced the area of contact between the bone ends, making the osteotomy unstable and difficult to fix and excessive derotation led to the formation of an anterior bulge with restriction of flexion. Moreover, rotation of the fragment in the coronal plane is difficult in patients with marked deformities. Wilkins (29) made similar observations and hypothesized that this was because of the tight medial structures. He recommended a combination of a wedge and dome osteotomy by making two semicircular cuts. We believe that this would

additionally complicate the procedure. Adequate correction can be achieved with both the French and the dome osteotomy, but the latter is technically difficult and associated with a higher incidence of complications. The French osteotomy gave better results and produced fewer complications. An arc osteotomy was introduced to correct the cubitus varus deformity (19) ; this is a refinement of the technique of the dome-shaped osteotomy. The line for the arc osteotomy is drawn on the humerus tracing the trimmed and sterilized card in accordance with a preoperative diagram. However, the transcribed two-dimensional cards are difficult to match to the three-dimensional structures of the distal humerus. Although a 3-dimensional osteotomy (18,27) can correct flexion, extension, varus, valgus, and rotational deformity simultaneously, it cannot avoid lateral shift.

CONCLUSION

In this study, twelve children with posttraumatic cubitus varus were treated with equal limbs laterally closing-wedge osteotomy of the distal humerus through a posterolateral approach and fixation by Kirschner wires. Excellent results were seen in 91.7%, and good results in 8.3%. The average preoperative carrying angle was 25° varus ; this was corrected to an average of 5° valgus, with an average difference between the right and left side of 1.6°. The lateral prominence index (LPI) decreased from an average of 2.4% to -2.3%. The improvement in the LPI is much more in younger children due to the higher remodeling power. In all patients, the final radiographs showed little or no difference between the right and left side. The visual appearance of the treated arm with no prominence of the lateral condyle was nearly similar to that of the unaffected side. This study shows that the equal limbs laterally closing-wedge osteotomy is simple, safe, and associated with an excellent cosmetic outcome and low complication rate.

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