Lateral Closing Wedge Supracondylar Humeral Osteotomy for Treatment of Post-Traumatic Cubitus Varus

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ABSTRACT

Objective: To evaluate the results of lateral closing wedge humeral osteotomy and K-wire fixation following isolation and protection of the ulnar nerve when used to correct cubitus varus deformity.

Methods: Forty-one cases of cubitus varus deformity following supracondylar fractures of the humerus were operated by lateral closing wedge osteotomy of the humerus during February 1999 to June 2007 at King Hussein Medical Center. The mean age of the patients at the time of corrective surgery was 7.2 years (range 4.7-12.3 years). The osteotomy was internally fixed with two crossed, smooth, K-wires. After surgery, the patients were observed closely for more than one and half year. We compared preoperative and postoperative humerus-elbow-wrist angle, range of motion, and carrying angle for all patients. The results were evaluated according to the criteria of Oppenheim *et al*.

Results: There were 36 excellent, four good and one poor result. The average amount of correction of the humerus-elbow-wrist angle was 24.3° and the carrying angle was 25.5°. Preoperatively, the range of motion averaged 4.7° of extension to 125° of flexion, to a mean postoperative range of motion of 4° of extension and 123° of flexion. The only one poor result was due to early removal of the K-wires. However, in all patients, the desired range of motion, good alignment, and complete union of the bone were achieved.

Conclusion: We report that lateral closing wedge supracodylar humeral osteotomy to correct post-traumatic cubitus varus through posterior approach with isolation and direct vision control of the ulnar nerve is relatively safe, simple and effective procedure with low rate of complications, which is important in a procedure performed purely for cosmetic indication.

Key words: Cubitus Varus, supracondylar fracture, supracondylar osteotomy.

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Introduction

Cubitus varus or "gunstock deformity" (Fig. 1) is the most common complication of supracondylar humerus fracture with an incidence varying from 9 to 57%.[1-3] Immediate and late causes of cubitus varus deformity are medial angulation, medial rotation, overgrowth of lateral condyle and osteonecrosis or delayed growth of medial condyle.[2] The medial angulation is the major determinant for the deformity while medial rotation contributes to it.[4] Cosmetic appearance is the common indication for surgery, which more authors now agree, should be performed as early as deformity becomes established.[4-6] Delayed ulnar nerve palsy and tardy posterolateral rotary instability of the elbow can accompany cubitus varus and may require treatment.[7] Various corrective osteotomy procedures have been advocated in the treatment of cubitus varus.

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Fig. 1. Cubitus varus deformity

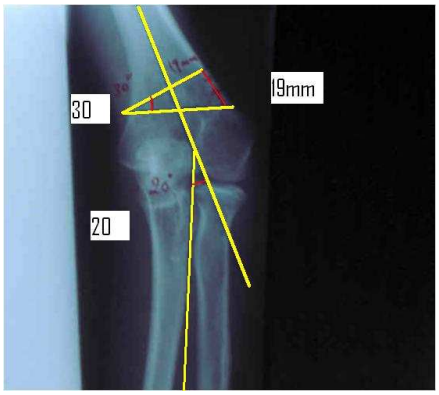


Fig. 2. Preoperative radiograph showing the HEW angle of 20° varus and the (19mm) planned width of supracondylar wedge to produce correction of the varus deformity

However, most of the osteotomies have been described, if not all are technically demanding and are being replaced for need of better stabilization, three dimensional correction and above all simplicity.[8-13] Medial open wedge osteotomy fell in to disrepute because of its inherent instability, need of bone graft and neurological complications.[5,14,15] Various newer techniques have been tried to correct the deformity in three dimensional planes but to achieve that, accurate preoperative planning, calculations and special attention to surgical details are needed,[1,12,13] and still results are no better than simple lateral closing wedge osteotomy.[4,5] Reconstructive procedures to correct cubitus varus deformity have many complications such as infection, loss of fixation, stiffness, nerve palsy and brachial aneurysm. Ulnar nerve palsy is reported in the literatures as high as 27% which is not accepted for a procedure performed for cosmetic reason.[4,15-18]

This study was conducted to evaluate lateral closing wedge humeral osteotomy to correct cubitus varus deformity, fixed with smooth, crossed K-wires after identification of the ulnar nerve and protecting it.

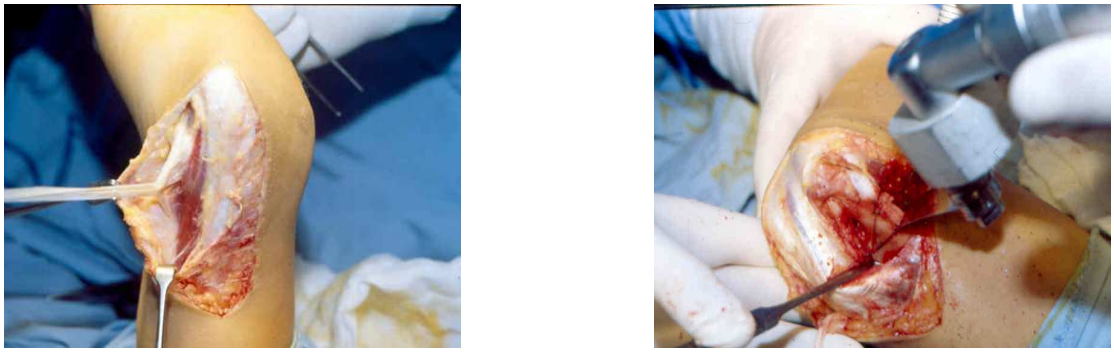
Methods

Between 1999 and 2007, 41 lateral closing wedge supracondylar osteotomies fixed with crossed smooth K-wires were performed to correct cubitus varus deformities resulting from supracondylar fractures of the humerus at King Hussein Medical Center. The deformity which was secondary to fracture malunion was not progressive in any patient. The primary indication for operation in all patients was correction of cosmetic deformity. None of the patient or family members recognized any functional deficit resulting from the cubitus varus deformity.

Among the 41 patients, 26 were males and 15 were females. The right elbow was involved in 29 patients and the left was involved in 12. The mean age at the time of injury was 3.9 years (range 15 months to 8 years), mean age at osteotomy was 7.2 years (range 4.7-12.3 years). The average follow-up was 5.9 years with a range of 1.5 years to 8.8 years (Table I).

The preoperative carrying angle was determined clinically by measuring the angle formed by the intersection of the longitudinal axis of the upper arm and the forearm, with the elbow in extension and supination. A radiographic humerus-elbow-wrist (HEW) angle was also obtained with elbow in extension and supination. Carrying angle and HEW angle were measured for both the injured and normal extremity. Preoperative range of motion (ROM) of the involved elbow was measured using a goniometer.

The wedge shape osteotomy of the distal humerus is planned by measuring the HEW of the involved extremity then compared with that of the contralateral normal arm and the difference between these radiographic angles is determined. This angle is then plotted on the preoperative radiograph to define the size of the lateral wedge to be removed from the supracondylar region of the distal humerus (Fig. 2). The base of the wedge is drawn perpendicular to the olecranon fossa. The thickness of the wedge at the lateral humeral cortex is measured and determines the amount of the bone to be resected during the operation.



A B

Fig. 3. A- Exposed ulnar nerve. B- Laterally based wedge removed after saw cuts were made

Operative Procedure

The procedure is performed under general anesthesia, full aseptic conditions, pneumatic tourniquet and supine position. Posterior longitudinal incision is made along the posterior aspect of the elbow for about 8 to 10 cm in length starting from just below elbow joint upwards. The fascia is incised in line with the skin incision, superficial dissection, the ulnar nerve is exposed, isolated and protected under direct vision during the procedure (Fig. 3A). At the lateral side of the elbow through the same incision, the interval between the Brachioradialis muscle anteriorly and the Triceps muscle posteriorly is developed. The distal humerus is then exposed by subperiosteal, without the radial nerve exposure. Two osteotomy cuts necessary to form the laterally based wedge are made with an osteotomy power saw perpendicular to the shaft of the humerus across the width of the metaphyseal bone just superior to the olecranon fossa. A second oblique cut is made proximally to form the preoperatively determined thickness of the laterally based wedge (Fig. 3B) (an existing extension deformity can also be corrected by removing additional bone anteriorly from the proximal humeral segment).

An attempt is made to preserve the medial cortex and periosteum to act as a controlling "hinge" in closing the osteotomy site. A smooth 0.062 inch K-wire is drilled through the distal fragment in retrograde fashion, so that it emerges from the lateral epicondyle. The osteotomy site is closed, and the K-wire is passed across to exit from the medial cortex of the proximal humeral segment. This provides sufficient stabilization to allow a second 0.062 inch K-wire to be driven percutaneously through the medial epicondyle (anterior to the ulnar nerve) across the osteotomy site and to exit from the lateral cortex of the proximal humeral segment. A third K-wire occasionally is passed percutaneously from the lateral condyle across the osteotomy site for additional stability.

The elbow is extended, and final intraoperative correction is assessed by comparing the clinical carrying angle of the involved extremity to the opposite normal arm and by measurement of the HEW angle on an intraoperative radiograph. The incision is closed in layers, and the K-wires are cut off beneath the surface of the skin. The extremity is placed in a long-arm posterior splint with the elbow at 90° of flexion. On postoperative day 2 or 3, this splint is changed to a snugly fitting long-arm cast. The extremity is maintained in plaster until roentgengraphic signs of healing are evident, usually in 4-6 weeks. The cast and K-wires are then removed, and active exercises are initiated. The elbow is protected in a sling or posterior splint until full motion is regained, HEW angle, and ROM are determined at final postoperative follow-up.

Results

The forty one patients had complete bone union by 12 weeks postoperatively, good alignment and the desired range of motion of the elbow.

The preoperative clinical carrying angle of the involved elbow was measured for all patients and averaged 22.8° of varus (range 14.5°-34°). Postoperatively, the involved elbow improved to a carrying angle of 3.3° of valgus (range 4° of varus to 15° of valgus); this compared to a carrying angle of the opposite normal elbow of 9.3° of valgus (range 7° to 15° of valgus). The average correction of carrying angle was 25.5° (range 15°-36°).

The average HEW of the normal extremity was 12° of valgus (range 4°-20°). The HEW of the involved elbow averaged 20.7° of varus (range10°-33°).

Table I. Results of correction of cubitus varus in the study group as per demographic characteristics

Parameter	Average	Range
Age at injury (year . month)	3.9	1.3 - 8
Age at operation (year . month)	7.2	4.7 - 12.3
Follow up (year . month)	5.9	1.5 - 8.8
Preoperative clinical carrying angle (varus)	22.8°	14.5° – 34°
Preoperative HEW angle (varus)	20.7°	10° – 33°
Postoperative clinical carrying angle (valgus)	3.3°	4° varus – 15° valgus
Postoperative HEW angle (valgus)	4.9°	8° varus – 16° valgus
Normal extremity HEW angle (valgus)	12°	4° – 20°
Correction clinical carrying angle	25.5°	15° – 36°
Correction HEW angle	24.3°	16° – 36°
ROM of injured extremity		
Preoperative	-4.7°-125°	-12° – 140°
Postoperative	-4°-123°	-10° - 135°

Fig. 4. Post-operative clinical correction for the same patient in Fig 1

Postoperatively, this improved to a HEW angle of 4.9° (range 8° of varus -16° of valgus); the average of correction was 24.3° (range 16°-36°).

Pre and postoperative range of motion were measured for all patients. Preoperatively, the arc of motion averaged 4.7° of extension (range 12°-35°) to 125° of flexion (range 110°-140°). Postoperatively, average ROM was 4° of extension (range 0-10°) and 123° of flexion (range 110°-135°). No extremity had a loss of arc of motion more than 5° (Table 1).

Results were categorized by the method of Oppenheim *et al*.[4] An excellent required correction of the HEW angle to within 5° of the opposite elbow, while maintaining ROM within 5° of preoperative arc of elbow motion. A good result included a valgus position and motion within 10° of the preoperative arc of elbow motion. A poor result included any case with a perioperative complication, a residual varus position or loss of more than 10° of motion, According to these strict criteria there were 36 excellent, four good, and one poor result.

The only one poor result exhibited residual radiographic varus postoperatively. Review of radiographs showed removal of the K-Wires without enough callus formation around the osteotomy.

No complications were related to surgical approach, type of osteotomy, use of K-Wires fixation, or postoperative protocol.

Discussion

Outward angulation of the supinated forearm at the extended elbow, the carrying angle, is present in utero and is completely developed in the newborn baby.[15] A change in the carrying angle after treatment of a supracondylar fracture 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 that the medial angulation is the major determinant for the deformity while medial rotation contributes to it.[4]

Cubitus varus deformity represents a serious and common complication of supracondylar fracture.[1-3] We recommend surgical correction anytime after fracture union and full elbow motion has been obtained. Despite the cosmetic appearance, there are other functional disturbances such as delayed ulnar nerve palsy and tardy posterolateral rotary instability of the elbow.[7]

There are several techniques of corrective osteotomy of the distal humerus. The medial

opening wedge osteotomy leads to instability and stretching of the ulnar nerve, and is difficult to fix.[15] A dome osteotomy can reorient the distal fragment in both the coronal and the horizontal plane; thus, residual prominence of the medial and lateral condyle can be avoided.[13] However, because of contracture of the surrounding soft tissue, it is often difficult to rotate the distal portion in the coronal plane and frequently some prominence of the condyle remains. The simple cut translation osteotomy has a wide soft tissue dissection regarding the tripces tendon and the joint capsule with high incidence of ulnar nerve palsy.[18] A pentagonal osteotomy corrects angular deformity, translating the distal fragment medially.[11] Protrusion of the lateral condyle can be avoided with this approach, but the technique is complicated and difficult to perform consistently. The external fixation method decreases the protrusion of the lateral condyle, translating the distal fragment medially.[19] However, there may be neurovascular injury, and the method causes discomfort to the patient. Lateral closing wedge osteotomy is the most common method reported in the literature.[4,16-18] It is the easiest, safest and inherently the most stable osteotomy; however serious complications have been reported including infection, loss of fixation, skin loss, nerve palsy and brachial aneurysm.[4,15-19] Functional disability as a result of nerve palsy following distal humeral osteotomy is not justifying a procedure performed for cosmetic reason.

In our study, we always isolated the ulnar nerve and released the cubital tunnel before we performed the osteotomy in our patients. Identification of the ulnar nerve is important to avoid nerve damage at the medial end of the wedge osteotomy and percutaneous Kirschner wire fixation of the osteotomy site from the medial condyle. None of our patients had ulnar nerve palsy or significant decrease in arc of motion. In addition to avoiding potential adhesions and contractures that could occur if the triceps is taken down posteriorly, the interval between the Brachioradialis muscle anetriorly and the triceps muscle posteriorly provides a safe exposure of the distal humerus without placing major neurovascular structures at direct risk.

The results of our study compare favorably with those previously reported in the literature. The only poor result was from overestimation of the radiographic signs of the healing process followed by removal of K-wires which resulted in partial recurrence of the deformity. The patients and the parents were satisfied from the end result of the surgery (Fig. 4).

Conclusion

We report that lateral closing wedge supracodylar humeral osteotomy to correct post-traumatic cubitus varus through posterior approach with isolation and direct vision control of the ulnar nerve is relatively safe, simple and effective procedure with low rate of complications, which is important in a procedure performed purely for cosmetic indication.

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