

SUPRACONDYLAR HUMERAL OSTEOTOMY IN CHILDREN WITH SEVERE POSTTRAUMATIC CUBITUS VARUS DEFORMITY

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The authors report the results of corrective osteotomy of the humerus in 11 children with severe posttraumatic cubitus varus deformity. The average carrying angle on the affected side was -24.4° , and there was an average internal rotation deformity of the distal humerus of 22° . Flexion and extension of the injured elbow were severely limited. A supracondylar lateral wedge osteotomy of the humerus was performed keeping the medial cortex intact. Two K-wires served as levers to correct the angular and rotational deformity of the elbow and then as fixation material to hold the osteotomy fragments. Postoperatively we immobilized the elbows in 90° flexion for 3 to 4 weeks. There was no loss of the postoperative osteotomy alignment in most cases. Recurrence of mild varus deformity (-5° and -7°) occurred in only two patients. At the end of the follow-up we observed excellent results in 9 patients with an average carrying angle of 7.2° (range $5-10^\circ$).

Keywords: supracondylar osteotomy; cubitus varus deformity.

Mots-clés: ostéotomie sus-condylienne; humérus; cubitus varus.

INTRODUCTION

Supracondylar fractures of the elbow in children, as well as fractures involving the distal part of the humerus may lead to residual elbow deformity (4, 2, 3, 16). Cubitus varus deformity represents the most common complication of those fractures in children. Although functional impairment is rare, the cosmetic deformity of the elbow is significant. A number of children with severe posttraumatic cubitus varus deformity also have an internal rotation deformity of the distal humerus accompanied with severe limitation of elbow movements. Disability may occur because

of the severity of elbow deformity and because of the decrease in normal range of motion of the elbow. Davids *et al.* (5) presented six cases of lateral condylar fractures in children with preexisting cubitus varus deformity due to prior supracondylar fractures. They believed that posttraumatic cubitus varus deformity may predispose a child to subsequent elbow injuries as biomechanical analysis showed that both torsional moment and the shear force generated across the capitellar physis by a routine fall are increased by varus malalignment. Moreover, Abe *et al.* (1) presented 15 patients with late-onset ulnar nerve palsy caused by cubitus varus deformity. We believe that severe posttraumatic cubitus varus deformity should be treated not only as a cosmetic deformity, but as a potential future disability in a growing child. The purpose of this study is to show the effectiveness of the use of minimal metal implant in the correction and fixation of the osteotomy fragments when followed by a short period of postoperative immobilization of the elbow in 90° flexion.

MATERIALS AND METHODS

From January 1985 to June 1995, 11 corrective osteotomies for post-traumatic cubitus varus deformity (figs. 1, 2) were performed on 7 boys and 4 girls. The average age of patients was 5.2 years (range 3-7 years) at the time of injury, and 9.1 years (range 6-14 years) at the time of operation. The time interval between

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Fig. 1a, b. — Anteroposterior and lateral x rays of a post-traumatic cubitus varus deformity. Note the malunion of the lateral humeral condyle.

injury and the corrective osteotomy averaged four years (range 2-8 years). The right elbow was involved in 7 cases, the left in 4. The average carrying angle on the normal side was $+13.2^\circ$ as against -24.4° (range -20 to -35°) on the affected side (Table I, II). According to McCoy & Piggot (14) all deformities presented in this study were considered as grade IV severe cubitus varus deformities (fig. 2). The internal rotation defor-

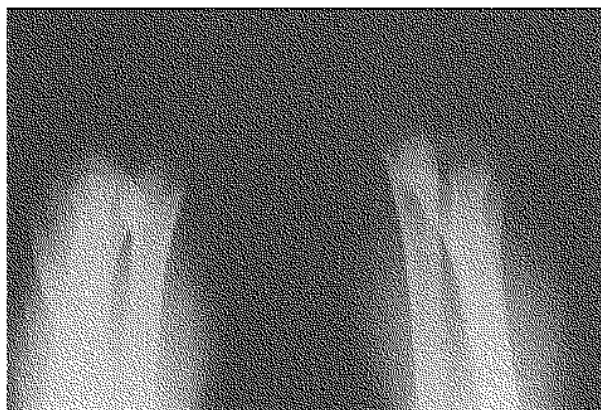


Fig. 2. — A comparative axial view of both elbows in a patient with a left posttraumatic cubitus varus. Note the loss of alignment of the olecranon and the condyles on the left injured side.

mity of the distal humerus averaged 22° (range 20 - 31°). There was limitation of flexion, as compared to the uninjured side, averaging 18° (range 15 - 25°) and of extension averaging 11° (range 5 - 15°), (table I). The carrying angle of both elbows was measured clinically and radiologically with the elbows in full extension and supination. The degree of internal rotation deformity of the distal humerus was evaluated based on the restriction of the external rotation of the shoulder on the affected side (18).

OPERATIVE TECHNIQUE

Campbell's posterolateral approach to the elbow was used for all osteotomies. The tongue of the triceps aponeurosis was freed and reflected distally. Careful subperiosteal stripping on both lateral and medial aspects of the distal humerus allowed a wide exposure of the deformity. The ulnar nerve was always identified and protected. Through this approach the axial and rotational deformity were well demonstrated. Two K-wires were used to identify the level of the osteotomy and the degree of deformity. The distal K-wire was placed across the lateral and medial condyles, parallel to the articular surface of the distal humerus. The proximal K-wire was placed just above the lateral epicondyle and perpendicular to the lateral cortex of the distal humerus (fig. 3). A lateral wedge osteotomy of the distal humerus was then per-

Table I. — Preoperative clinical assessment of the elbows

Case N°	Gender	Age at injury (years)	Age at operation (years)	Carrying angle (degrees)	Limitation of flexion (degrees)	Limitation of extension (degrees)	Internal rotation of distal humerus (degrees)
1	M	4	7	-20	15	5	22
2	M	5	9	-21	15	10	20
3	M	7	10	-20	20	10	25
4	F	6	9	-35	15	10	28
5	F	5	7	-30	15	15	30
6	M	6	10	-25	20	10	24
7	M	4	6	-30	20	15	31
8	F	7	14	-24	15	10	28
9	F	4	7	-22	15	10	20
10	M	3	11	-20	20	15	23
11	M	6	11	-22	25	15	26

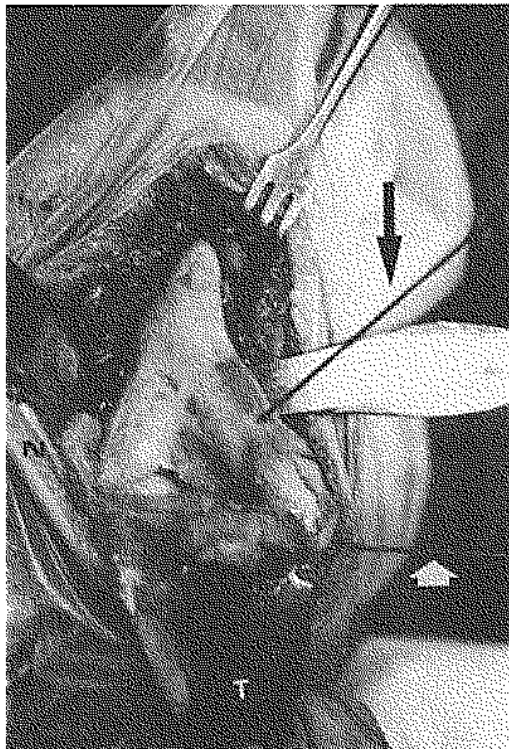


Fig. 3. — Campbell's posterolateral approach. Note the proximal K-wire (black arrow) and the distal K-wire (white arrow) inserted in different planes. Also note the tongue-shaped flap of the triceps aponeurosis (T), and the ulnar nerve isolated as it is seen next to letter (N).

formed. The distal part of the wedge was cut parallel to the distal K-wire, proximal to the olecranon fossa. The proximal part of the wedge was cut parallel and distal to the proximal K-wire. In all cases the medial cortex of the wedge was left intact (figs. 4, 5). The two K-wires served as levers as they were made parallel with each other and carefully joined together. The angular and rotational deformity of the elbow was corrected under direct vision (fig. 6). Two patients had a preoperative ulnar neuropathy and anterior subcutaneous transposition of the ulnar nerve was performed during osteotomy. Postoperatively, a long-arm plaster splint was applied for 3 to 4 weeks with the elbow in 90° flexion. The K-wires were removed 4 to 6 months postoperatively.

RESULTS

All patients were followed to clinical and radiological union. The follow-up period averaged 5.7 years (range 2-10 years). The postoperative carrying angle, the range of motion, and the degree of internal rotation of the affected elbow were measured. Our results were evaluated on the basis of three criteria used by Graham *et al.* (9). At the final follow-up we had excellent results in 9 patients with a carrying angle averaging 7.2° (range 5-10°). The range of motion of those elbows was almost normal. The limitation of flexion averaged 2.2° (range 0-5°), and the limi-



Fig. 4. — Lateral wedge osteotomy. Note the intact medial cortex.

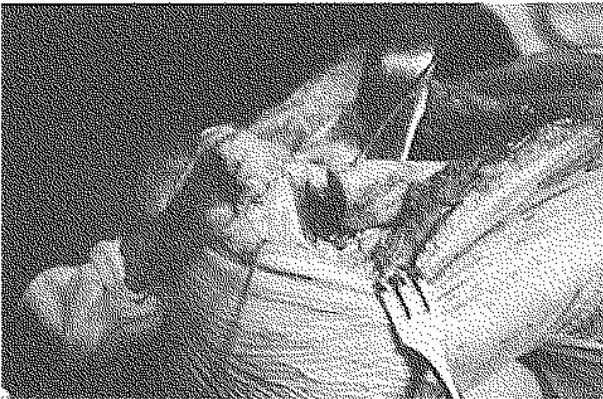


Fig. 5. — A side view of the osteotomy. The lateral wedge has been removed. Note the intact medial cortex and the position of the 2 K-wires in different planes.



Fig. 6. — A side view of the osteotomy. Note the locking of the two osteotomy fragments and the tightening of the 2 K-wires. Angular and rotational deformity were corrected under direct vision.

tation of extension averaged 3.6° (range $0-10^\circ$). Two patients had a persistent varus deformity of -5° and -7° respectively, but surprisingly they had quite a good range of motion with minimal limitation of flexion and extension. Restriction of motion of the affected shoulder also improved (table II, III). The average internal rotation of the distal humerus was 4.4° (range 0 to 10°). All patients and parents were satisfied with the outcome of the surgery. There were no perioperative or postoperative complications. All surgical scars healed in an acceptable manner.

DISCUSSION

The allegedly high rate of complications following corrective osteotomy for posttraumatic cubitus varus deformities has deterred many surgeons from performing that operation (15, 17). Many of the corrective procedures lately described in the literature require accurate preoperative planning and include surgical details which are technically difficult to perform (6, 11, 13, 18). In all our cases we used Campbell's posterolateral approach to the elbow because through this approach we had a wide and unrestricted view of the axial and rotational deformity of the distal humerus. We were able to perform the supracondylar osteotomy and to correct the existing elbow deformities under direct vision. The decision on the size and shape of the wedge to be removed was mainly made during surgery. Preoperative radiological and clinical assessment of the degree of elbow deformity is necessary for the documentation of the results.

Various methods have been used for stable and rigid fixation of the osteotomy fragments. King and Scor (12) in 1951 reported the use of tibial cortical bone grafts with Steinmann pins inserted into both osteotomy fragments and held by an external fixator. French (8) in 1959 used a tightening wire around the screwheads, whereas Hernandez and Roach (10) in 1994 used plates, wires, Steinmann pins and screws. Because of the high rate of postoperative complications reported in the literature with the use of various massive metal implants, we preferred to use two K-wires for the

Table II. — Postoperative clinical assessment of the elbows

Case N°	Gender	Follow-up time (years)	Carrying angle (degrees) Injured side	Carrying angle (degrees) Non-injured side	Limitation of flexion (degrees)	Limitation of extension (degrees)	Internal rotation of distal humerus (degrees)
1	M	5	-5	+10	0	5	4
2	M	6	-5	+10	5	5	6
3	M	8	+5	+15	5	10	0
4	F	9	+5	+15	5	0	0
5	F	2	+10	+15	0	5	0
6	M	3	+5	+10	0	5	0
7	M	4	+10	+10	5	5	5
8	F	7	+10	+15	0	0	10
9	F	2	+5	+15	5	5	6
10	M	7	+10	+15	0	0	5
11	M	10	+5	+10	0	0	0

Table III. — Average results of preoperative and postoperative clinical assessment of the elbows

	Average carrying angle (degrees)	Average limitation of flexion (degrees)	Average limitation of extension (degrees)	Average internal rotation of distal humerus (degrees)
Preoperative	-24.4 (range 20-35)	18 (range 15-25)	11 (range 5-15)	22 (range 20-31)
Postoperative	In 9 patients : 7.2 (range 5-10) In 2 patients : -5 and -7	2.2 (range 0-5)	3.6 (range 0-10)	4.4 (range 0-10)

stabilization of the osteotomy fragments. No obvious injury to the growth plate occurred with this method. The K-wires were used as levers to approximate and firmly lock the osteotomy fragments together in the position required to correct the deformity (figs. 7a, b). We also tried to keep the medial cortex intact during the osteotomy because it provided additional stability.

In our opinion a posttraumatic cubitus varus should be considered more than a cosmetic deformity, and the primary indication for surgery should not only be cosmesis. All deformities treated in this study were considered as grade IV severe cubitus varus deformities (14). The average carrying angle of the affected elbow was -24° , and the average internal rotation of the distal humerus was 22° . There was also limitation in both flexion (average 17.7°) and extension (average 11.3°) of

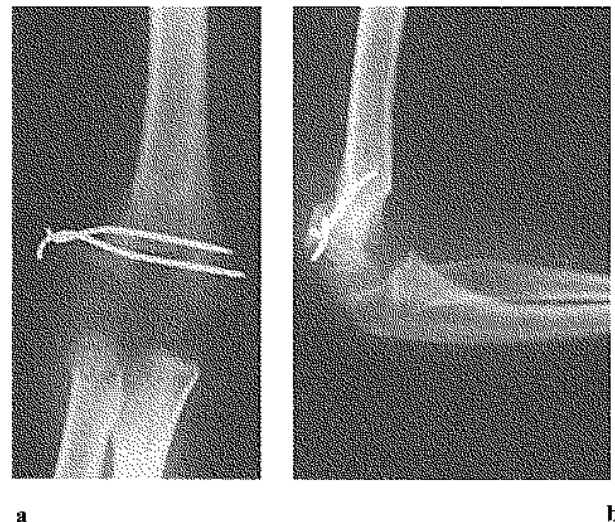


Fig. 7a, b. — Anteroposterior and lateral x ray of the elbow three months postosteotomy. Note the stable fixation of the osteotomy fragments.

the elbow. We also agree with Abe *et al.* (1) that a traumatic cubitus deformity may cause a delayed ulnar palsy, and such an elbow deformity should be recognized as a possible cause of cubital tunnel syndrome. Two of our patients had a concurrent posttraumatic cubital tunnel syndrome for which release and anterior subcutaneous transposition of the ulnar nerve were performed during the corrective osteotomy. Moreover, authors like Davids *et al.* (5) also believed that a posttraumatic cubitus varus deformity should not be considered only as a cosmetic deformity because the varus malalignment of the elbow in such injuries might easily predispose the child to subsequent lateral condylar fractures.

We do not feel that postoperative immobilization of the elbow in full extension is necessary. McCoy and Piggot (14) in 1988 as well as Grahams *et al.* in 1990 suggested that immobilization of the elbow in full extension is essential in order to avoid possible postosteotomy malalignment. We recommend postoperative immobilization of the elbow in 90° flexion for 4 weeks after corrective osteotomy held firmly with 2 K-wires. We did not have any loss of the postoperative osteotomy alignment (figs. 8a, b), and according to the postoperative assessment criteria used by Grahams *et al.* (9) we had excellent results in nine patients and satisfactory results in two. We did not have any unsatisfactory results.

We could therefore conclude that :

1. Supracondylar corrective osteotomy of the elbow should definitely be considered in severe posttraumatic cubitus varus deformity.
2. The use of a posterolateral surgical approach of the elbow allows a direct and clear view of the distal humeral deformity, which is essential for correction.
3. The use of minimal metal implants is advised in order to avoid postoperative complications. K-wires can be used as levers to correct the existing deformity and as fixators to hold firmly the osteotomy fragments.
4. Postoperative immobilization of the elbow in 90° flexion, when accompanied with firm K-wire fixation of the osteotomy fragments, does not lead to postoperative malalignment problems.

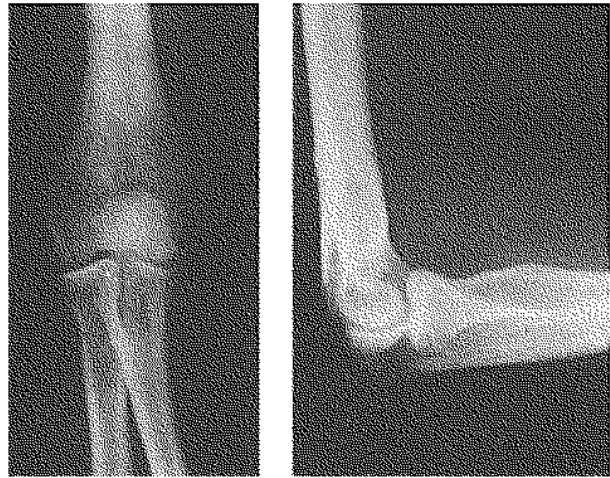


Fig. 8a, b. — Anteroposterior and lateral x ray of the elbow 10 years postosteotomy. Note the normal appearance of the elbow.

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SAMENVATTING

T. A. BESLIKAS, J. M. KIRKOS, F. E. SAYEGH, V. A. PAPAVALIIOU. Supracondylaire osteotomie van de humerus bij kinderen met ernstige posttraumatische cubitus varus.

Wij rapporteren de resultaten van een correctieve osteotomie bij 11 kinderen met ernstige posttraumatische cubitus varus. De gemiddelde hoek bedroeg $-24,4^\circ$ en de gemiddelde interne rotatiedeformatie van distale humerus was 22° . Flexie en extensie van de getroffen elleboog waren eveneens sterk beperkt. De supracondylaire laterale wigosteotomie van de humerus

werd uitgevoerd met behoud van een mediale cortex. 2 K-draden werden als hefboom gebruikt om de angulaire en rotatoire deformatie van de elleboog te corrigeren en ook gebruikt als fixatie van de osteotomiefragmenten. Postoperatief werden de ellebogen gedurende 3 à 4 weken geïmmobiliseerd in 90° flexie. Bij geen enkele patiënt werd een postoperatief verlies van de osteotomie vastgesteld. Er was wel een licht varusrecidief bij 2 patiënten (respectievelijk -5° en -7°). Op het einde van de follow-up periode waren er uitstekende resultaten bij 9 patiënten met een gemiddelde hoek van $7,2^\circ$ (spreiding 5 tot 10°).

RÉSUMÉ

T. A. BESLIKAS, J. M. KIRKOS, F. E. SAYEGH, V. A. PAPAVALIIOU. Ostéotomie sus-condylienne de l'humérus chez l'enfant pour cubitus varus post-traumatique.

Les auteurs rapportent les résultats obtenus après ostéotomie sus-condylienne de l'humérus réalisée chez 11 enfants en raison d'une déformation post-traumatique importante en cubitus varus.

L'angle de charge du côté affecté était en moyenne de $-24,4^\circ$, et il existait un trouble rotatoire, avec une rotation interne de l'humérus distal, de 22° en moyenne. Il existait une limitation importante de la flexion du coude, du côté affecté. Le cal vicieux a été corrigé par une ostéotomie sus-condylienne avec soustraction d'un coin osseux externe, en laissant intact le cortex interne. Deux broches de Kirschner ont été utilisées comme leviers pour corriger les deux composantes de la déformation, puis pour fixer la correction. Une immobilisation plâtrée de 3 à 4 semaines, en flexion à 90° , a fait suite à l'opération. Le plupart des cas n'ont présenté aucune perte de correction; un cubitus varus discret a persisté chez 2 patients (angulations de -5° et -7°). Les 9 autres ont eu un excellent résultat, avec un angle de charge de 5 à 10° (moyenne: $7,2^\circ$).