

HYPEREXTENSION MALUNION OF THE DISTAL HUMERUS - CHEVRON OSTEOTOMY: A CASE REPORT

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Abstract: *Treatment of hyperextension malunions of the distal humerus is done by osteotomy, several types being described in the literature. The aim of the paper is to highlight the possibility of using Chevron-type osteotomy in sagittal malunions of the distal humerus shaft. The patient presented in this case report has suffered multiple interventions after a 13C1 AO/OTA fracture of her right arm. When the malunion was identified her range of motion (ROM) was 40-90 degrees flexion. We have performed a supracondylar sagittal Chevron osteotomy at a 30 degrees angle open anteriorly. After the surgery, her ROM improved to 40-135 degrees flexion.*

The authors chose the Chevron osteotomy because it created an increased area (by 30%) of the interface between the two fragments and offers a good rotational stability. Unfortunately, information in the literature is limited and future studies must be done to endorse the usage of Chevron osteotomy in hyperextension malunion of the distal humerus.

Key words: *Chevron osteotomy; Humerus hyperextension malunion; Supracondylar osteotomy*

1. Introduction

Distal humerus fractures are not commonly met during the everyday practice and necessitate a high level of skill and equipment in order to perform the best treatment. Only 23.2% of the

humerus fractures are located distally, compared to more than 50% for proximal humerus [7], [11]. The distribution of cases is bimodal, the first peak incidence being recorded during the end of puberty – young adults groups, while the second peak cluster is represented by the elderly,

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especially women [2]. The mechanism of production is correlated with age, younger patients are victims of high energy traumatic events (e.g. motorcycle accidents), while low energy injuries/osteoporosis lead to distal humerus fractures in population over 65 years old [19]. Even though some cases may be treated nonoperative, regardless of the group they are assigned to, the majority of the distal humerus fractures require surgery – most of them open reduction internal fixation (ORIF).

The aftermath of the treatment is decisive because the elbow is prone to stiffness. Although the arm is immobilized after surgery, for early rehabilitation it is recommended to use a removable splint. Furthermore, the shoulder abduction must be avoided in order to prevent the varus stress of the elbow. Early mobilization is promoted, only if the fixation is adequate and the patients respect the indications for ROM [1], [13], [18].

These types of fracture are susceptible to have a problematic evolution. The most frequent complication is the malunion, the incidence being over 30% of the overall complications (ulnar neuropathy, nonunion, infection etc.) [12],[20]. Factors such as blood supply of the metaphysis, quality of reduction, the lack of patient surveillance immediately post operator can influence the development of malunion.[6] The localization can be intraarticular or supracondylar. The first one is more painful for the patient, may be disabling and the treatment can be challenging compared to the supracondylar one [12], [15]. The latter implies congruent joint space associated with the angulation of the metaphysis – varus, valgus, extension etc. Patients who suffer from extraarticular malunions

complain about reduced ROM and peculiar aspect of the elbow – cosmetic reason of presentation [10]. Pain is not present in all cases with cubitus varus or hyperextended elbow, but when the movement is additionally painful the operation must be considered.

In order to treat extension-type malunions of the distal humerus, after thoroughly planning, the orthopaedic surgeon has to correct the deformity by supracondylar osteotomy. The sagittal realignment osteotomy can be ventral closing edge, step-cut, complex multiplanar cut, dome cut, Chevron-type. The latter is not commonly used in this situation, but the biomechanics of the procedure motivated the senior author to choose the Chevron osteotomy for treating the patient presented in this paper.

2. Case Report

An 18-year-old female patient presented in the emergency room of the Clinical Emergency County Hospital of Brasov after a high energy motorcycle accident, polytraumatic patient. Regarding the limb traumatism, she had multiple injuries at the level of both lower limbs and right arm: Open tibial fracture; knee instability and a fracture of the distal humerus type 13C1 (AO classification). The patient needed emergency intervention: external fixation of tibia; splinting of the knee; ORIF of the humerus. She also suffered a moderate traumatic brain injury (TBI) which led to 2 weeks of coma, experiencing moments of psychomotor agitation. Unfortunately, several events (agitation which progressively deteriorate the splint; late rehabilitation) lead to secondary displacement and elbow stiffness. Because the elbow fracture

healed early (often observed in patients with TBI) the first author considered that the corrective intervention at the level of elbow could be postponed so that the patient would start walking using crutches. At that moment, another intervention at the level of the elbow would have needed arm immobilization and delayed rehabilitation of the lower

limbs. The patient was followed up in the ambulatory observing severe reduced ROM (articulation mobility ranged between 80-90 degrees flexion). After arthrolysis and several kinesiotherapy sessions her range of motion improved only the extension up to 40-45 degrees, but the flexion impairment persisted (90 degrees flexion).

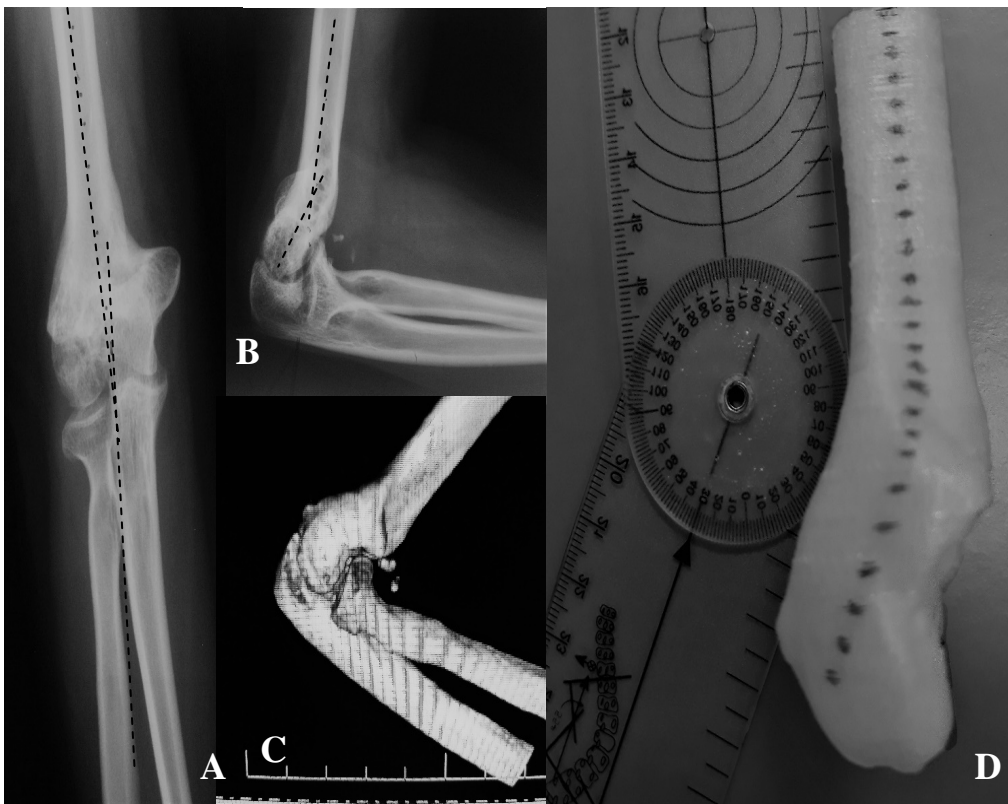


Fig.1. A. Anterior-posterior X-Ray of the elbow – no varus/valgus deviation; B. Lateral elbow X-Ray shows posterior deviation of the distal epiphysis of humerus; C. 3D CT proves the hyperextension malunion; D. 3D printed model – measurement shows 30 degrees of posterior angulation

After thoroughly examination, a 3D CT of the elbow has been performed and it has revealed an extension malunion of the distal shaft of the humerus (Figure 1). The patient has been evaluated using Liverpool elbow score (score: 3.66/ poor; Range: 0/severe-10/normal) and American

Shoulder and Elbow Surgeons - Elbow. ASSES-E score showed that the patient measured her pain around 5-6 (Range 1-10; 0= no pain/ 10= worst pain ever) and her subjective function of her right elbow has been graded between 0-1 (unable to do/very difficult to do the activities listed

in the questionnaire). The choice of using these two surveys has been taken because there is no score considered gold

standard, ASES-E is organ specific and has multiple criteria, and LES is fast to do and has good reproducibility [14], [22].

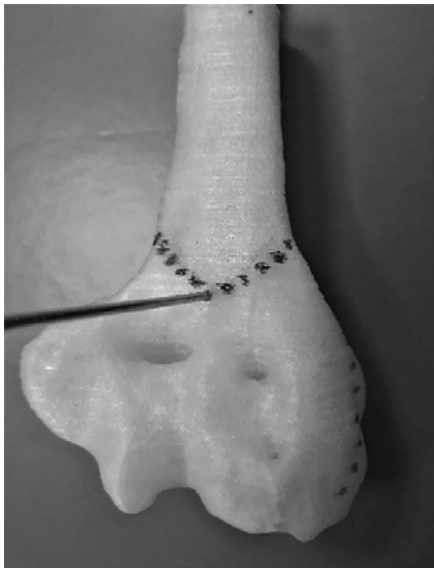


Fig.2. Kirschner wire inserted perpendicularly at the level of the "V"'s apex – posterior aspect of the 3D model

The first step was identifying and isolating of the ulnar nerve on the medial border of the triceps, followed by the osteotomy. Then, the site of the malunion was isolated and a Chevron osteotomy of the humerus was performed as follows: using K-wires the apex of the osteotomy was marked; the angle between the 2 limbs of the V being 90 degrees; the apex was centred on the diaphysis pointing distally (Figure 2). For the next step, the limbs of the "V" of the distal fragment was cut as at 30 degrees angle opened anterior-inferiorly, so that when matched with the proximal segment, the distal epiphysis will be rotated anteriorly (Figure 3). The angle was correlated to the hyperextension degree of the epiphysis (Figure 1 - D). After the cut was performed, the distal segment was elevated posteriorly, the debridement of the anterior adhesions has been performed afterwards the

fragment being repositioned (Figure 4). Following the osteotomy, internal fixation of the fragment was carried out with plate fixation on the lateral crest (Figure 5).

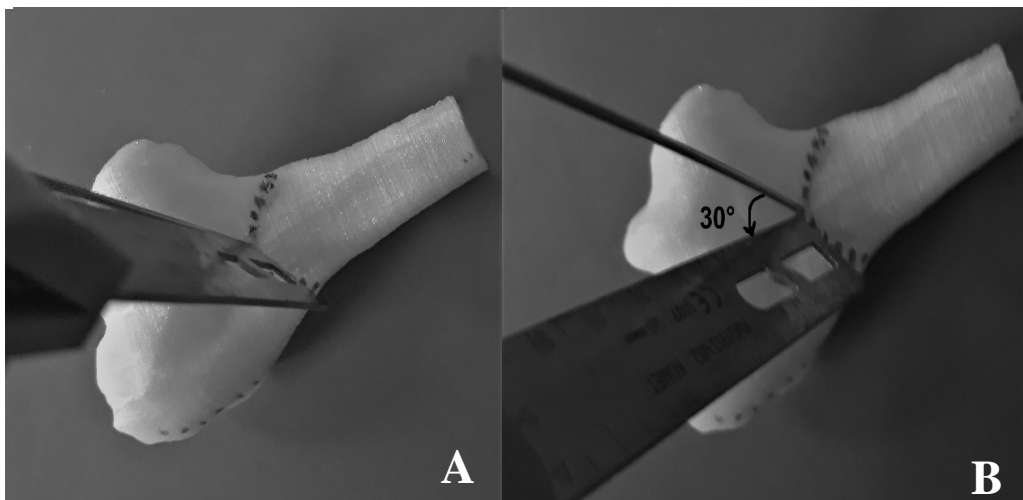


Fig. 3

A. Placing the saw perpendicularly on the bone;

B. The saw rotated 30 degrees distally

Subsequent to the surgery, the patient has had to wear a ROM elbow brace for 3 weeks and, 1 week after surgery, she started the assisted movement rehabilitation. Early recuperation was good and present evaluation shows the LES score has improved to 10 (Normal function) and ASES-E: pain 1-3 and function 3. She regained the normal mobility: flexion 40 degrees - 135 degrees.

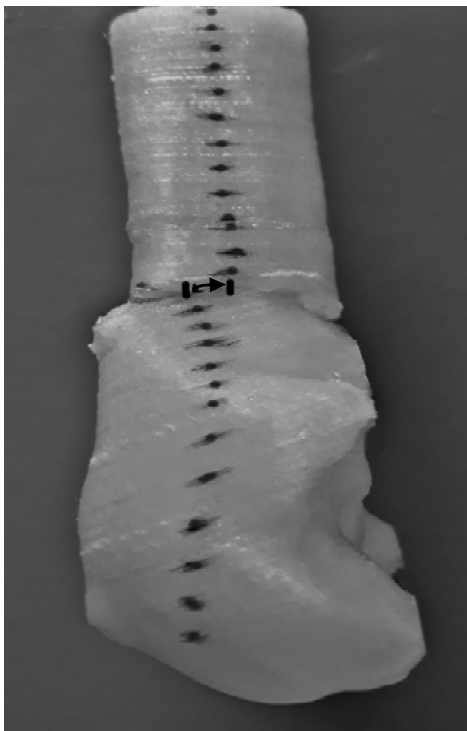


Fig. 4 . *Axial reposition of the distal fragment after osteotomy*

The biomechanics evaluation and surface calculation were done on a 3D printed model. We have compared the area of the chevron osteotomy to the one of the transverse cut. Moreover, we reproduced the technique on a 3D model based on the CT scan provided by the

patient on CD. The 3D reconstruction was made using RadiAnt DICOM viewer 64-bit and exported as “.stl” file to Autodesk Meshmixer 3.5.474 in order to generate printable surfaces. The “.gcode” file was generated using Cura 4.7 and the model was printed in transparent PLA (polylactic acid -1.75mm Gembird3 PLA) at 0.1mm layer height with 0.4mm nozzle. The final processing of the model was made mechanically with a blade. The surfaces have been smoothed out with hot air (Gordak 952-A) machine on a single facet of the page, and also in electronic format, identical with the printed copies.

3. Discussion

The arm mobility is crucial for our daily life, any impairment of its function is significantly affecting the patient, the patient’s life and working place etc. Normal ROM of the elbow is between 0-140 degrees of flexion, while most of the actions are performed within 30 to 130 degrees [5], [16]. Furthermore, the rotational ROM ranges from 180 degrees pronation to 80 degrees of supination [5]. If the bone structures suffer deformities – intra-/extraarticular – the ROM is reduced because of mechanical obstacles. The cause of reduced function in this case was because of bone deformity, and not because of other soft tissue pathology. Because of this complex movement possibility, the elbow must be stable and the articular surfaces must be congruent as any damage of the “loose hinge” will reduce the ROM and the patient’s quality of life. Another aspect of the elbow biomechanics is the screw displacement axis (SDA) which refers to the variation of the arm axis compared to the forearm axis during elbow flexion. SDA may vary

between 2.6-5.7 degrees during flexion [4]. This fact explains why modification of the axis (varus/valgus) will impair the flexion.

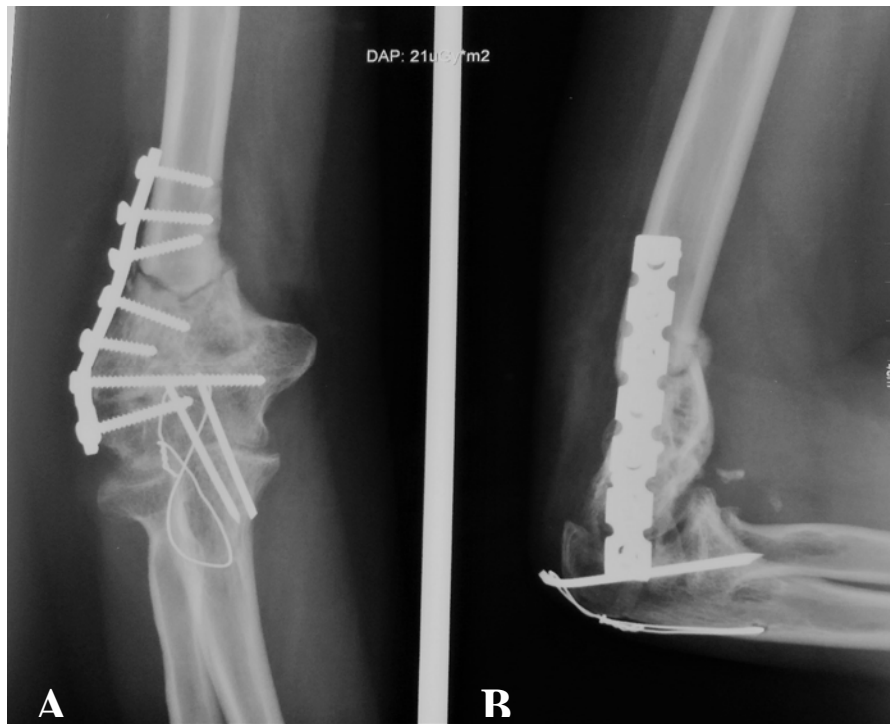


Fig. 5. X-Ray after surgery:

A. Antero-posterior;

B. Lateral view

During the elbow ROM shear and compressive forces are applied at the level of the articulation which may lead to damage the stability. This fact is important not only in ligamentous pathology, but also after fractures – attention must be paid when choosing the optimal ORIF technique [5], [23].

Hyperextension malunion is the most common complication of supracondylar fractures in paediatric patients, but it is also present in adults [9]. Corrective osteotomy is the best option for the cases that complain about decreased function (with/without pain), and cosmetic aspect. The success rate is satisfactory, a great percentage of patients recover their ROM and normal aspect after the procedure [9], [17].

Step-cut and wedge osteotomies are the most used treatment options for uniplanar malunions of the distal humerus, the information about Chevron osteotomy in these cases being scarce. The first author has chosen to perform this technique of osteotomy because it creates an increased area (by 30%) of the interface between the two fragments [8]. The direct outcome of larger surface is greater rotational stability and faster bone healing. The stability has been proven to be higher with 55% when Chevron osteotomy was used, compared to step-cut [8]. The contact surface between the fragments is highly important at this level as the bone is narrow and the intensity of the forces acting around the elbow is elevated.

We found only one paper concerning Chevron osteotomy in humerus [21]. Nithid Sri-utenchai et. al. has performed a biplanar osteotomy with great results.

Posterior approach has been chosen because it is known to have less negative impact [21]. The olecranon osteotomy has been proven to offer better visualization of the distal humerus area compared to triceps lifting, although the latter one has a lower percentage of complication at 1 year [3].

Regarding the patient, improvement of flexion is great for the patient as well as for the orthopaedic team, although, the extension impairment persisted (just 40 degrees of extension). The first author believes that the suitable moment to correct this is during the next intervention for material extraction.

4. Conclusion

Articles about Chevron osteotomies in humerus malunion are insufficient, with low evidence level, which means further research must be done to confirm the clinical utility of this technique in this particular case. We have tried the technique on a 3D printed model in order to observe the outcome of the operation and to understand the benefits. Using a 3D printed guide for osteotomy is a great idea, as Nithid Sri-utenchai *et al.* have presented, because it will increase the quality of the cuts and the matching of the fragments will be improved.

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