

## Research Article

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# Experience of extended transtriceps approach in osteosynthesis of complex fractures of the distal metaepiphysis of the humerus

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**BACKGROUND :** Open reduction and internal fixation is the method of choice for operative treatment of intraarticular distal humerus fractures. Many operative approaches and their modifications have been developed for better fracture site visualization.

The aim of the study is to determinate indications for extended transtriceptal approach and to evaluate functional results after distal humerus fracture fixation utilizing mentioned approach

**MATERIAL AND METHODS** Among 186 patients with distal intraarticular humerus fractures in 112 (the main group), the surgical treatment was performed with extended transtriceptal approach. The comparison group consisted of 74 patients with the same fracture type. Olecranon chevron osteotomy was performed in that group during surgery. Both patient groups were comparable in age, sex, mechanism of injury and fracture type. Long-terms results were evaluated in all 186 patients with 12 months follow-up period.

**RESULTS .** Comparative analysis showed. a mean surgery time reduction by 20 minutes ( $p=0.03$ ) in the main group. Short and middle-term results were evaluated during physical examinations, by interpreting radiographs, by improvements in the elbow range of motion dynamics. Obtained results were comparable between the groups. Fixators migration was observed in 5.5% of patients in the main group and in 16% of patients in the comparison group. In the comparison group, there were following additional complications: olecranon non-union after osteotomy, K-wires migration with skin perforation, reactive bursitis.

**CONCLUSION** Extended transtriceptal approach provides adequate visualization for distal humerus fractures fixation. Utilizing that approach provides shorter surgery time, reduced complication rate and intraoperative soft tissue trauma. After operations with the transtriceptal approach patients can efficiently rehabilitate achieving good functional results.

**Key words:** extended transtriceps access, chevron osteotomy of the olecranon, fractures of the distal humerus, osteosynthesis

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**Conflict of interest** Authors declare lack of the conflicts of interests

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ETTA, extended transtricepital access  
RTA, road traffic accident

## INTRODUCTION

Distal humerus fractures in adults account for about 2% in the structure of all fractures and for about one third in the structure of shoulder fractures. Most of these fractures are low-energy, resulting from a simple fall with an axial load on the arm (when falling on a straightened arm). In the younger population, these injuries are more likely to occur as a result of a road traffic accident (RTA) and sports trauma [2, 5, 11, 12].

Open reposition and internal fixation are the preferred treatment options for intra-articular dislocated fractures [1, 4, 13, 19, 20].

Adequate visualization of the articular surface of the distal shoulder and elbow joint is necessary to stabilize two-column fractures using the necessary implants.

The need to get a better visualization of the fracture geometry has given rise to a large number of new accesses and their modifications.

Surgical approaches to the ulnar process with cutting off the triceps from the ulnar process have pronounced disadvantages in the form of wider access, weakness of the triceps, and delayed activation in the postoperative period [3, 6].

There is a strong opinion that posterior surgical access with chevron osteotomy of the ulnar process provides optimal visualization of the condyle fracture and facilitates intraoperative manipulation with fragments [15, 21].

Our research and practical experience confirm that this is true for type B3 fractures according to the AO/ASIF classification (Figure 1). However, the occurring complications (delayed fusion or non-fusion, migration of fixators, etc.) led to the need to search for new solutions and accesses for type C fractures according to the AO/ASIF classification (Fig.2).

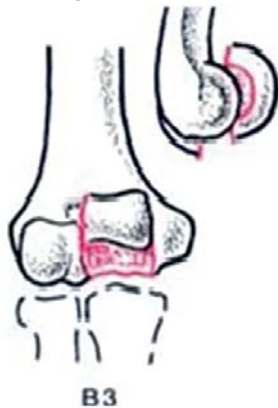


Fig. 1. Fracture AO 13 B3  
(The AO/OTA classification). Scheme

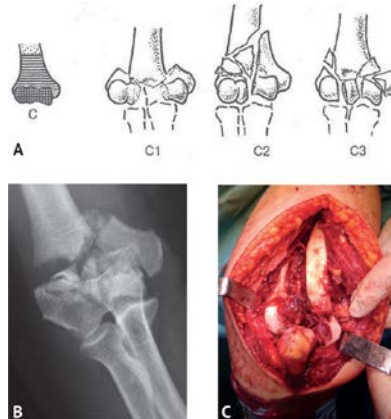


Fig. 2. Fracture AO 13 C (The AO/OTA classification):  
A — diagram; B — X-ray; C — intraoperative photo

Several authors noted various complications associated with osteosynthesis of the ulnar process with pins and wire. Macko et al. noted the symptoms associated with the migration of pins were noted in 15 cases (75%) and skin perforation in 4 cases.

In a study of 88 ulnar process fractures, J.G. Horne et al noted that 66 patients (75%) required fixator removal within a year, and 7% did not achieved the union [23].

Ring et al. noted a 30% non-fusion rate in transverse ulnar osteotomy. B.J. Gainor et al. noted that 27% of patients needed to remove metal fixators due to the development of septic bursitis [22].

The revealed shortcomings of routine well-known approaches led to the search for alternative options for creating conditions for adequate visualization of the proximal humerus metaepiphysis and the convenience of manipulations during osteosynthesis. This led to accesses either with triceps retraction or directly through it [8, 17, 18].

For this type of fracture, we consider the use of extended transtricepital access (ETTA) through the posterior median incision to be promising. With this access, it is possible to do without osteotomy of the ulnar process, mobilizing m. triceps brachii and ulnar muscle from the posterior surface of the humerus and the

intermuscular septum, which provides an adequate visualization, so necessary for open reposition and internal fixation.

Also, this access preserves the blood supply to the ulnar muscle that is a dynamic stabilizer of the elbow joint.

**The study objective** was to develop indications for ETTA and to assess the functional results in fixation of distal fractures using this approach.

#### MATERIAL AND METHODS

The study was based on the analysis of the treatment of 186 patients with intra-articular fracture of the distal humerus of C type, according to the AO/ASIF classification, who underwent osteosynthesis with plates according to the standard method. The patients were divided into two groups.

The main group included 112 patients who underwent ETTA surgery without ulnar process osteotomy. The comparison group included 74 patients with a similar type of fracture, who were operated on by using chevron osteotomy of the ulnar process and subsequent osteosynthesis with pins and a wire loop. The groups were comparable in age, gender, trauma mechanism, and fracture pattern. Exclusion criteria were the patients with ipsi- or contralateral injury of the upper limb or with any previous musculoskeletal pathology. Long-term results were evaluated in 186 patients (minimum follow-up period was 12 months) (Table 1).

Table 1

**Comparative characteristics of the studied groups**

Criteria	Groups		P
	Main	Comparisons	
Total	112 (100%)	74 (100%)	
Gender	Male	44 (39%)	27 (36.5%)
	Female	68 (61%)	47 (63.5%)
Mean age (years)	57 (18–78)	55 (22–80)	0.511
Mechanism of injury	Fall	79 (70.5%)	53 (71.6%)
	Sport	12 (10.7%)	8 (10.8%)

Notes: p is the confidence level of group differences

#### SURGICAL TECHNIQUES

All operations were performed under nerve block anesthesia with patient positioned on a healthy side. In all patients, we performed an extended posteromedial access in the lower third of the shoulder with a transition to the ulnar process without osteotomy. Surgical access was performed by a longitudinal median skin incision along the posterior surface from the border of the middle and lower third of the shoulder to the upper third of the forearm along the proximal epiphysis of the ulna (Fig. 3).

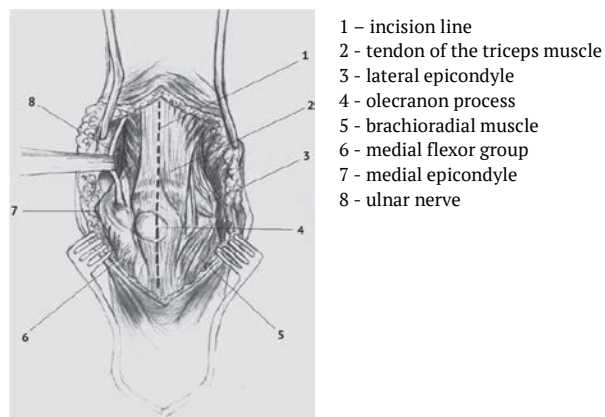


Fig. 3. Standard posterior midline incision. Intraoperative photo

To expose the humerus distal metaepiphysis and its formations, a longitudinal incision was made along the center of the triceps muscle from the upper third of the tendon to the ulnar process (Fig. 4). If necessary, the ulnar process was mobilized from the lateral and medial sides. For this purpose, the upper segments of the attachment of the ulnar flexor muscle of the hand (m. flexor carpi ulnaris) and the deep flexor muscle of the fingers (m. flexor digitorum profundus) were separated from the medial side subcostally, and the upper segment of the ulnar muscle attachment site (m. anconeus) on the lateral side. Thus, we provided sufficient mobility of the proximal epiphysis of the ulna (Fig. 5). This type of mobilization allowed, if necessary, moving the ulnar process posteriorly, which improved the view of condylar structures (Fig. 6).



Fig. 4. Anatomical diagram of the posterior surface of the elbow joint



Fig. 5. Visualization of the fracture of the condyle of the humerus: A — diagram; B — intraoperative photo

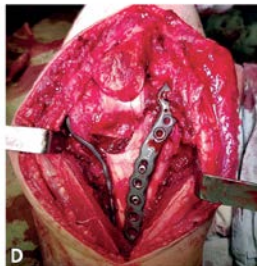
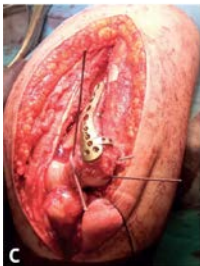


Fig. 6. Stages of osteosynthesis: A — scheme; B, C, D — intraoperative photos

The intra-articular part -- block and condyle head were repositioned first and synthesized using various retainers. Further, the condyle with the distal end of the humerus were anatomically modeled and the lateral and medial columns were provisionally fixed with 1.6 mm and 2.0 mm pins.

In all cases, we used pre-modeled interlock plates in two planes (Fig. 7).



Fig. 7. The result of osteosynthesis of a fracture of the condyle of the humerus: A — X-ray before surgery; B — X-ray after surgery

Allografts were used in 24 patients to replace a bone defect.

The ulnar nerve was isolated and revised or transposed anteriorly in patients with neuropathy in the preoperative period.

After the fracture stabilization with fixators, the range of motion was checked to assess stability. The triceps was sutured separately with 2/0 polyesther through the drilled holes in the ulnar process.

Drainage of the anterior and posterior parts of the elbow joint was mandatory for at least 24 hours. In the postoperative period, they were fixed for 2 weeks with a soft bandage with 90-degree flexion and the possibility of passive movements in the elbow joint in the absence of pain.

An active exercise therapy - the development of joint movements - was started 2 weeks after surgery.

The results of the study were recorded in Microsoft Excel spread sheets stored on a remote server for their safety. We used Microsoft Excel 2007 and STATISTICA 10.0 programs for statistical information processing. When determining statistical significance, Pearson's  $\chi^2$  test and Student's t-test were used (the sample corresponded to the normal distribution). The value of  $p < 0.05$  was taken as the level of statistical significance.

## RESULTS

Comparative analysis revealed that the time of surgical intervention was reduced by mean of 20 minutes ( $p=0.03$ ). The immediate and medium-term results were evaluated according to the results of physical examinations, control radiography, and dynamics of the increase in the amplitude of movement in the elbow joint. The intact arm was used as a control. In the main group, the flexion-extension angle was  $125 \pm 8^\circ$ , the amplitude loss was  $9 \pm 2^\circ$ , and the rotation was  $168 \pm 9^\circ$ . In the control group, respectively, the flexion-extension angle was  $120 \pm 10^\circ$ , the amplitude loss was  $11 \pm 3^\circ$ , and the rotation was  $170 \pm 6^\circ$ . Functional results were comparable.

All patients were followed-up monthly for 3 months, then at 6 and 12 months after surgery.

Each patient completed a form with an assessment of functional abilities, remaining symptoms, and existing limitations. The strength and volume of movements in the elbow joint were measured. At the same time, X-ray study was performed in anteroposterior and lateral projections.

During the follow-up period, no patients in the main group were found to have a triceps tear. Fourty six patients from this group underwent removal of fixation devices. Indications for removal in 38 cases were complaints of patients with a feeling of discomfort in the elbow joint due to the subcutaneous location of the fixators. All patients in the comparison group had their fixators removed after consolidation of the ulnar process.

**Power.** The strength of flexion and extension of the forearm was evaluated manually, comparing with the intact limb. Eighty six patients had good extension strength, 28 patients had satisfactory extension strength.

**Range of movement.** All patients had a deficit of extension/flexion and none had a deficit of the forearm rotation. The volume of movements increased in the first 6 months. As for recovery dynamics, we noted that

94 patients had recovered the range of motion with a limited range of motion to 30° in 6 months; 20 patients had an amplitude deficit of more than 30° C after 6 months of rehabilitation.

**Stability.** There were no signs of anteroposterior instability during manual examination. Valgus-varus load tests showed no signs of instability.

**X-ray analysis.** The mean time of the onset of consolidation of distal shoulder fractures was 4.5 months (Table 2).

Table 2

**Comparative analysis of groups in the postoperative period**

Criteria	Groups		P
	Main	Comparison	
Flexion-extension amplitude	125 ± 8 °	120 ± 10 °	0.452
Pronation-supination amplitude	168 ± 9 °	170 ± 6 °	0.532
Lack of movement	9 ± 2 °	11 ± 3 °	0.621
Fracture consolidation (weeks)	18 ± 2	19 ± 2	0.558
Removing the fixators	46 (41%)	74 (100%)	0.02

Note: p, the confidence level of group differences

## ОСЛОЖНЕНИЯ

When assessing existing complications in the treatment of AO/ASIF type C distal shoulder fractures, we noted in the main group the following: ulnar nerve neuropathy in 4.5%, migration of fixators in 5.5%, early postoperative superficial suppuration in 2.7%, formation of para-articular osteophytes that disrupt joint function in 9.8%. In the comparison group, we noted: ulnar nerve neuropathy in 4%, migration of fixators in 16%, early postoperative superficial suppuration in 2.7%, formation of paraarticular osteophytes that impaired the joint function 10.8%. In the comparison group, non-fusion of the ulnar process after osteotomy, migration of pins with skin perforation, and reactive bursitis were added to the general complications (Table 3).

Table 3

**Postoperative complications statistic**

Complications	Main group	Comparison group	P
Ulnar nerve neuropathy	5 (4.5%)	3 (4%)	0.34
Fixator migration	6 (5.5%)	12 (16%)	0.02
Superficial suppuration	3 (2.7%)	2 (2.7%)	0.84
Osteophyte formation	11 (9.8%)	8 (10.8%)	0.63

Note: p, the confidence level of group differences

## DISCUSSION

Access with ulnar osteotomy and mobilization of the distal triceps is considered classic in the osteosynthesis of fractures of the distal humerus. However, it has undesirable consequences in the form of a decrease in muscle strength due to the development of fibrosis on the lateral and medial sides of the triceps in the areas of surgical intervention for mobile abduction of the musculoskeletal flap [7, 10, 16].

When using ETTA, longitudinal dissection of the muscle fibers of the triceps and its tendon avoids the formation of fibrosis on the lateral and medial sides of the muscle, but creates a central fibrous scar, which also leads to a decrease in muscle strength, although to a lesser extent [9, 14].

Extreme flexion at the elbow joint and abduction of the proximal end of the ulna allows for sufficient visualization of the anterior part of the articular surface. We did not notice any technical difficulties during the operation, even in cases of type C3 fractures.

ETTA allows an access to the shoulder throughout, including the supracondylar region. Both reconstruction and fixation can be freely performed through this access. However, according to our observation, the stability of bone and soft tissue fixation is insufficient to initiate an early activation after



surgery and requires at least 2 weeks of soft immobilization. Subsequently, based on the evaluation of the results, after using ETTA, we did not notice any significant decrease in triceps strength.

## CONCLUSION

Extended transtricepital access provides good visualization for fixing type C fractures of the distal humerus according to the AO/ASIF classification.

The assessment of the treatment results in patients with complex fractures of the distal humerus confirms that osteosynthesis using extended transtricepital access can shorten surgery time and minimize the surgical trauma, avoid complications associated with ulnar osteotomy, while not accompanied by postoperative instability in the joint, does not affect the strength of the triceps and allows successful postoperative rehabilitation, achieving good functional results.

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