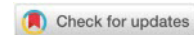


TREATMENT OF FRACTURES OF THE DISTAL END OF THE HUMERUS IN CHILDREN USING THE METHOD OF PERCUTANEOUS OSTEOSYNTHESIS - OUR FINDINGS

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Abstract: Introduction: Fractures of the distal end (capitulum and trochlea) of the humerus are more common in children than adults. The mechanism of injury demonstrates that the fracture occurs when falling on an outstretched arm, where the protective mechanisms cannot prevent the transfer of energy to the bone, leading to breaking the continuity of the bone, i.e. fracture. Our paper aims to present our experience in percutaneous osteosynthesis of the distal end of the humerus, where we have excellent functional results and 100% healing of the fracture.

Methods: Percutaneous osteosynthesis has been applied to 17 patients. The patients were divided into groups depending on the type of fracture, namely: one group of patients with supracondylar and another group of patients with a condylar fracture of the distal end of the humerus.

Results: It has been proven that percutaneous osteosynthesis of the distal end of the child's humerus led to fracture union in 100% of cases, which is a consequence of the marked stability of the osteosynthetic material. Functional results obtained after 5-6 weeks of rehabilitation are excellent in 99% of cases, except for one patient with a supracondylar fracture where we have a delay of flexion movement by -10 degrees. It should be noted that we had only one complication with a single patient suffering from a dislocation of bone fragments.

Conclusion: If it is possible to perform this method, percutaneous osteosynthesis is the preferred method in treating fractures of the distal end of the humerus among the paediatric population.

Keywords: fracture, distal humerus, percutaneous osteosynthesis.

Field: Medical Sciences and Health

Introduction

Fractures of the distal end of the humerus are more common in children than adults. The mechanism of injury demonstrates that the fracture occurs when falling on an outstretched arm, where the protective mechanisms cannot prevent the transfer of energy to the bone, leading to a break in the continuity of the bone, i.e. fracture. Fractures of the distal end of the humerus were divided into supracondylar, condylar, and transcondylar. The supracondylar fracture of the humerus is the most common of all fractures and accounts for 18% of all fractures in paediatrics or 60% of all elbow fractures. The most frequent is the extension type, very often associated with dislocation of the elbow joint(1,2).

Classification of the supracondylar fractures:

Modern literature uses a modified Gartland classification of supracondylar fractures of the distal end of the humerus.

Modified Gartland Classification of Supracondylar Fractures

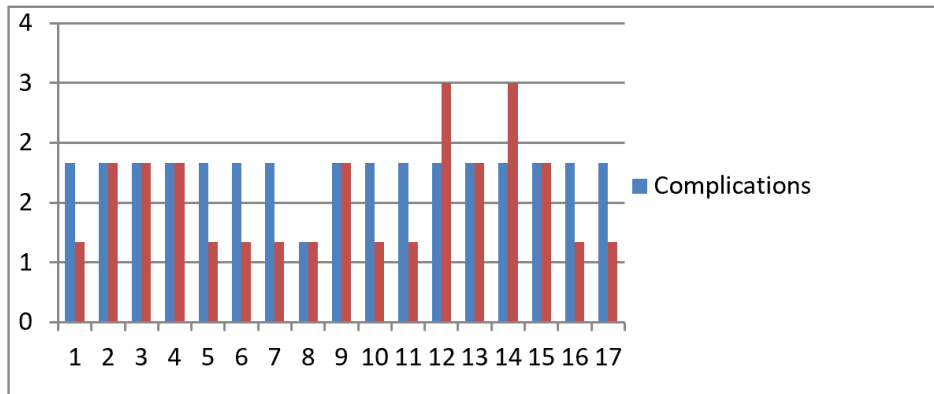
Comments

Type I	Undisplaced	Fat pad present acutely
Type II	Hinged posteriorly	Anterior humeral line anterior to capitellum
Type III	Displaced	No meaningful cortical continuity
Type IV	Displaces into extension and flexion	Usually diagnosed with manipulation under fluoroscopic imaging
Medial comminution	Collapse of medial column	Loss of Baumann's angle

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(not truly a separate type)



Picture 1. Classification of the fracture

Transcondylar fractures:

Unlike supracondylar fractures, transcondylar fractures of the distal end of the humerus are less common. The fracture line in this type of fracture passes through both condyles (medial and lateral), with the lower fragment acting as an independent part. Repeatedly this type of fracture is associated with dislocation of the radius and ulna (3,4)

Classification of transcondylar fractures:

Toniolo and Wilkins propose a simple classification of T — transcondylar fractures of the distal end of the humerus based on the degree of dislocation and comminution of the fragments, namely:

- Type I fractures are minimally displaced (Fig. 17-3A, B, C).
- Type II fractures are displaced but do not have comminution of the metaphyseal fragments (Fig. 17-4AB).
- Type III fractures are displaced fractures with comminution of the metaphyseal fragments (Fig. 17-5A-F).

Condylar fractures:

For condylar fractures of the distal end of the humerus, we use the Milch classification based on the presence or absence of a fracture line through (Type 1) or around (Type 2) the ossification center of the capitulum.

THE AIM OF THE PAPER

The paper aims to present our experience in treating fractures of the distal humerus with percutaneous osteosynthesis.

METHODOLOGY

At the Surgery Clinic's Department for Orthopaedic Surgery and Traumatology, Medical Center of KosovskaMitrovica, 27 patients with fractures of the distal end of the humerus were treated. Seven patients were treated non-operatively, and 3 patients were subjected to surgery. In our work, we analyzed 17 patients with a fracture of the distal end of the humerus who were treated with percutaneous osteosynthesis as a definitive treatment method. Indications for percutaneous osteosynthesis are: compromised elbow neurocirculatory report, unsuccessful reduction of Gartland type I fractures, as well as Gartland type II fractures, and unstable and dislocated condylar fractures of the distal end of the humerus. After hospitalization, a clinical and radiological examination was used to assess the stability of the fracture, as well as the need for operative treatment.

Surgical techniques of percutaneous osteosynthesis of the distal humerus

Closed reduction

We start implementing the closed reduction with longitudinal traction and 'milking' of the surrounding soft tissue. The elbow is in slight flexion. This position provides us access to the physiological length of the arm. After that, we approach the correction of varus/valgus angulation and mediolateral translation of the distal fragment of the humerus. If there is also deformation in how the fragments are rotated, we

apply pronation or supination with a varus/valgus component. With pronation, we achieve the correction of internal rotation, while supination helps us correct external rotation. Observing the position of the fragments in the sagittal plane, we apply hyperflexion of the elbow in the extension type of fracture, while in the flexion type, we apply for an extension. We use the "joystick" technique as a reduction option for very unstable fractures (5,6).

Percutaneous osteosynthesis technique

The mobile X-ray machine with an inverted arch is used in percutaneous osteosynthesis of the children's elbow. This technique was first introduced by Charnley in 1954. For osteosynthesis, we use Kirschner needles, which are applied percutaneously, most often from the lateral side, where the medial cortex must also be covered. Using this technique avoids iatrogenic injuries of the ulnar nerve. We apply two or three Kirschner needles, parallel or divergent. With the lateral application of Kirschner needles, the entry point at the level of the capitulum gives us a more stable fixation of the fracture and the stability of the osteosynthetic material compared to the entry point that is directly on the lateral side. (7). If the fracture is very unstable, we can also use the technique of transolecranon application of the needle, in which 4 cortices are included. The Kirschner needles we use for percutaneous osteosynthesis of the distal humerus are 2 mm in diameter. They show much better functional results compared to needles with a diameter of 1mm (8).

Convergent application of needles improves the stability of the fracture and osteosynthetic material but increases the possibility of iatrogenic injuries to the ulnar nerve. It is also possible to use the medial application of needles, but then an incision should first be made on the medial side of the distal humerus in order to protect the ulnar nerve (9,10). Medial application of needles is accompanied by a high risk of nerve injury and requires considerable surgical experience. Therefore, during the application, it is necessary to bend the elbow in the extension position, which moves the nerve to the posterior position.

Open reduction and percutaneous osteosynthesis

Open reduction is applied when the anatomical position of bone fragments cannot be obtained by closed reduction. The soft tissue and vascular structures of the elbow are trapped in the fracture gap between the fragments, making it difficult or impossible to return the fragments to their anatomical position. We also use the open method for all types of open fractures of the distal end of the humerus. Due to the absence of a radial pulse or reduced perfusion of the arm after reduction and fixation, recommendations in literature suggest that the dissection of the brachial artery should be performed to detect if there is an interruption of blood flow. However, this method is controversial. For open reduction, we use an anterior approach to the elbow, and as an alternative, a medial, lateral, or posterior approach (11,12).

RESULTS

In our study, there were 9 male patients (53%) and 8 female patients (47%). By age structure, 4 patients (22%) were under 5 years old, 11 patients (64%) were between 5-10 years old, and 3 patients (14%) were over 10 years old. Nine patients (53%) had a supracondylar fracture of the distal humerus (2 boys and 7 girls), 6 patients (35%) with a transcondylar fracture (5 boys and 1 girl), and 2 patients (12%) with a condylar fracture (2 boys). (Diagram 1)

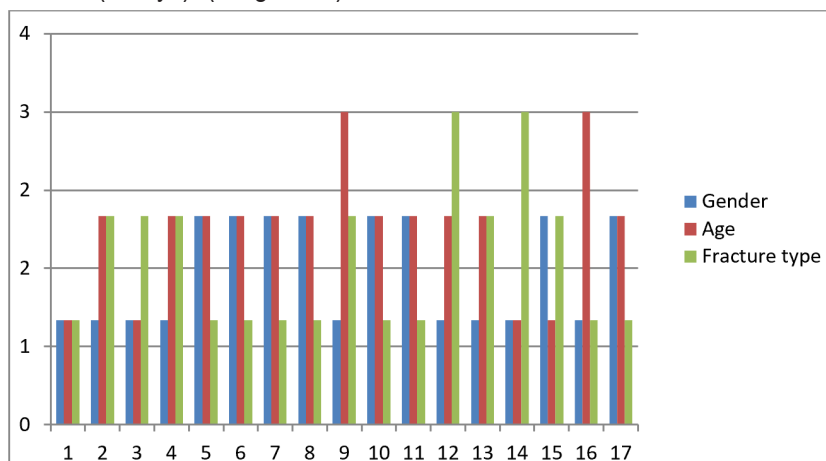


Diagram 1. Gender and age structure of patients and type of fracture.

In diagram 2, we have shown the connection between complications and the type of fracture. Out of 17 patients, we had one complication in a female patient with a supracondylar fracture of the distal end of the humerus. Namely, on the third day after the operation, the osteosynthetic material loosened, after which a revision was performed. (Diagram 2)

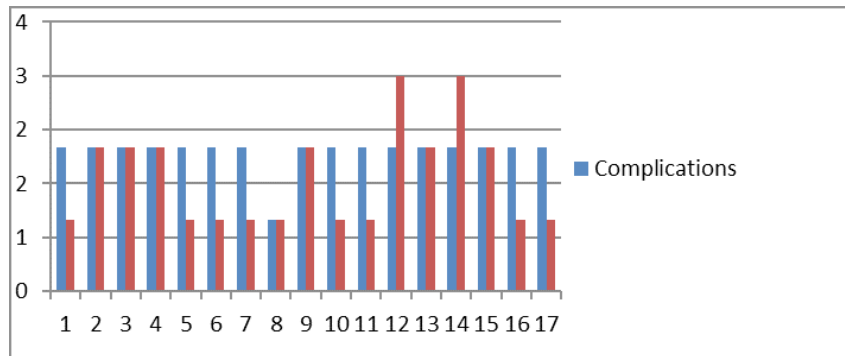


Diagram 2. Fracture type and complications

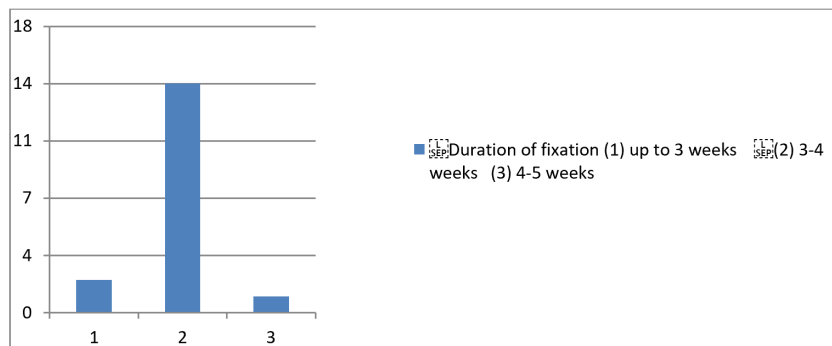


Diagram 3. The duration of the fixation.

In 2 patients (10%), the duration of fixation lasted up to 3 weeks, in 14 patients (85%), the duration lasted between 3 and 4 weeks and in one patient (5%), the duration lasted between 4 and 5 weeks. (Diagram 3)

Movement of the elbow	Supracondylar type of fracture	Transcondylar type of fracture
Extension (N)	Full	Full
Flexion (N)	-10 °	Full
Internal Rotation (pronation)	Full	Full
External Rotation (supination)	Full	Full

Table 1 Movements in the elbow joint after completion of orthopaedic and physical treatment

After completing the operative treatment of the fracture of the distal end of the humerus, excellent functional results have been obtained in 99% of cases. Complete movements of extension, pronation, and supination were present in all patients treated with percutaneous osteosynthesis. In one patient with a supracondylar fracture of the distal end of the humerus, we have a delay of the flexion movement in the elbow joint by -10 degrees. In that same patient, we had a complication earlier in the form of the dislocation of bone fragments. (Table 1)

The average length of rehabilitation for patients with a fracture of the distal humerus is 5-6 weeks.

DISCUSSION

The central outcome of operative treatment of supracondylar and transcondylar fractures is the anatomical reduction and stable fixation without Bowman's angle deformity. It is performed by the method of closed reduction and percutaneous fracture osteosynthesis. Inadequate osteosynthesis and procedural errors are correlated with distal humerus defects. In the literature, several studies are listed, that prove that convergent fixation provides greater stability than divergent fracture fixation, but as a result, has a higher risk of iatrogenic injuries on nervusulnaris. Bloom et al. proved that three divergent Kirschner needles provide the same stability as two convergent ones. Kocher et al. proved that there is no significant difference between the divergent and convergent osteosynthesis techniques in terms of radiographic and clinical outcomes. In a randomized study, Blanco et al. found no significant radiological differences comparing these two surgical techniques (13). In our work, we described the operative treatment of the distal humerus (supracondylar and transcondylar fractures) by the method of percutaneous osteosynthesis, in which we applied the Kirschner needles convergently and covered the second cortex during the process. The clinical results of all 17 patients showed that the osteosynthesis was stable with one complication (fragment dislocation after three days), which is in line with the existing literature. The functional results showed us a 99% success rate of treatment with one contracture in the elbow joint in terms of reducing the degree of flexion.

CONCLUSION

If it is possible to perform this method, percutaneous osteosynthesis is the preferred method in treating fractures of the distal end of the humerus among the paediatric population.

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