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ABSTRACT

of the dissertation for the degree of Doctor of Philosophy

CHOICE OF MINIMALLY INVASIVE TREATMENT METHODS OF SUPRACONDYLAR AND TRANSCONDYLAR FRACTURES OF THE HUMERUS IN CHILDREN

Speciality: 3227.01 – Traumatology and orthopedics

Field of science: Medicine

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Baku-2025

The dissertation work was conducted at the Scientific Research Institute of Traumatology and Orthopedics of the Ministry of Health of the Republic of Azerbaijan and at the Sumgait Emergency and Urgent Care Hospital.

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GENERAL CHARACTERISTICS OF THE WORK

Relevance and approbation of the topic. Transcondylar (TC) and supracondylar (SC) fractures of the distal meta-epiphysis zone of the humerus in children are the most common fractures among household injuries, accounting for 57.3-64.6% of fractures of the elbow joint[1]. Displacement of fragments is observed in 90% of cases of TC and SC fractures of the humerus[2]. In most cases, the passage of the fracture line through cartilaginous tissue, the absence of ossification on the fragments, small areas of contact of the fragments to each other, in addition to having a negative effect on fusion, leads to the formation of secondary displacement, and the mobility of the distal fragment, complicating the fracture, leads to difficulty in proper fusion[3]. Since these fractures are intra-articular, restoration of joint function largely depends on the anatomical structure of the bone and the complete restoration of the configuration of the articular surfaces[4]. Non-removal of displacement in TC and SC fractures of the humerus leads to its improper fusion, as well as disrupting the configuration of the articular surface of the distal end of the humerus and the biomechanics of the elbow joint leads to limitation of movements and the formation of secondary deformations in the joint[5]. Taking into account the complex anatomical structure of the elbow joint and the location of the fracture, the reposition of these fractures is technically very difficult. Improper treatment leads to

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neurological complications, circulatory disorders, complete dysfunction of the elbow joint and disability [6]. The frequent occurrence of fractures in children is due to the fact that the growing bone at a certain age is rich in blood vessels, large losses occur in the skeletal system during these years and it does not recover and does not evolve to mature bone. The fact that the distal end of the humerus is more developed than the condyle makes this area very weak and prone to fracture. Some scientists attribute TC and SC fractures of the humerus to children and call them "fractures of the typical location of the humerus"[8]. TC fracture line of the humerus passes through the growth zones, which leads to damage to the joint pocket and in 95% of cases the joint capsule and ligaments [7]. Humeral condylar fractures are classified into two groups: extension (opening) and flexion (bending) fractures. In case of extension fractures, the distal fragment is displaced backward, and in case of flexion fractures, it is shifted forward. In addition to clinical symptoms, which are of great diagnostic importance, the use of examination techniques is one of the important criteria for establishing and clarifying the diagnosis. Sometimes a two projection X-ray is sufficient. In connection with repeated displacement of the fracture, deformation of the elbow joint, loss of joint function, damage to the neurovascular bundle in the elbow joint, and the occurrence of future complications injuries of the elbow joint in children are among the priority issues that await their solution in modern traumatological science.

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Object of research. The objects of the study were 155 patients undergone medical treatment and surgically operated on for SC and TC fractures of the humerus at the Scientific Research Institute of.Traumatology and Orthopedics and in the orthopedic department of pediatric traumatology of the Sumgait Emergency and Urgent Care Hospital in 2017-2021.

The purpose and objectives of the research. The purpose of the study is to improve outcomes for SC and TC humerus fractures in children by improving treatment methods.

Research objectives are:

1. studying of the clinical and roentgenological condition before the treatment of SC and TC fractures of the humerus in children;
2. creation a table-algorithm for the joint use of minimally traumatic methods of surgical treatment for SC and TC fractures of the humerus in children;
3. elimination of complications by studying long-term results by improving methods of surgical treatment of minimally traumatic osteosynthesis;
4. prevention of future complications by improving treatment tactics with minimally traumatic osteosynthesis used to improve the results of conservative and surgical methods of treating fractures of the distal end of the humerus in children.

Research methods. The study utilized clinical-anamnestic, instrumental and laboratory data, X-ray imaging, computed tomography, and electron-optical apparatus (EOP) (ultrasound methods were not employed for examining fractures, as they are considered uninformative for this purpose).

Basic provisions for defense:

1. The developed algorithm allows for the creation of stable osteosynthesis by applying minimally traumatic surgical operations in practice;
2. In displaced fractures it is more appropriate to apply skeletal traction under anesthesia, reposition under the control of radiography and an electron-optical apparatus (EOP), fix with metal rods, and perform osteosynthesis through the skin without making an incision;

3. The development and implementation of a long-term outcome assessment table has helped to select the correct treatment method, achieve more effective results, and shorten the treatment period.

Scientific novelty of the research:

1. Minimally traumatic osteosynthesis was performed after repositioning under the control of X-ray or an electro-optical apparatus (EOP) for a fracture of the condyle of the humerus with skeletal traction of fractured and displaced bone fragments in one plane in three directions under general anesthesia, used at Kharkiv Institute of Traumatology and Orthopedics;
2. An algorithm has been created for the treatment methods of supracondylar and transcondylar fractures of the humerus in children;
3. A table for assessing long-term results of treatment of humeral condyle fractures has been developed.

Practical significance of the research. Practical significance of the research is to achieve stable fixation of fragments by developing non-traumatic methods of osteosynthesis treatment using conservative and surgical methods for TC and SC fractures of the humerus in children, to achieve a reduction in the recovery period by preventing complications. These methods will prevent secondary complications, while restoring the anatomical structure of the articular surface and the congruence of the elbow joint.

Approbation of research. The initial fragments of the dissertation were discussed at the Scientific Council of the Scientific Research Institute of Traumatology and Orthopedics of the Ministry of Health of the Republic of Azerbaijan (13.04.2017, protocol No.3). The main results of the dissertation were reported and discussed at the following international scientific conferences: All-Ukrainian Scientific and Practical Conference of Young Scientists "Medical Science in Health Care Practice" (Poltava, 2017), International scientific and practical conference "International scientific review of the problems and prospects of modern science and education" (Бостон, 2018), XI International scientific conference “Scientific achievements of the third millennium” (Washington, 2019),

International Scientific Forum "Science and Innovation - Modern Concepts" (Moscow, 2022), LXXIX international scientific-practical conference “Modern medicine: new approaches and relevant studies” (Moscow, 2023), Scientific and practical conference dedicated to the 80th anniversary of Professor Bahram Ashurov (Baku, 2023). The dissertation were reported in the Scientific Council of Scientific Research Institute of Traumatology and Orthopedics of the Ministry of Health of the Republic of Azerbaijan (11.01.2022.100-00274). It was discussed at the Scientific Seminar of the ED 2.06 Dissertation Council operating under the Azerbaijan Medical University (30.04.2024, Protocol No. 3).

Application of the research results. The results of treatment were studied in 155 patients who were treated for TC and SC fractures of the humerus at the Scientific Research Institute of Traumatology and Orthopedics and Sumgait Emergency and Urgent Care Hospital.

The name of the institution where the dissertation work was completed. The dissertation work was carried out at the Scientific Research Institute of Traumatology and Orthopedics and at the Sumgait Emergency and Urgent Care Hospital.

Publications on dissertation material. 13 articles, 4 conference proceedings and theses have been published on the topic of the dissertation. Received 2 certificates (certificate No.14, No.15/12-2018) for osteosynthesis treatment methods with cannulated self-absorbable and non-absorbable screws in the treatment of supracondylar and transcondylar fractures of the humerus in children. A utility model patent (F2021 0009) has been received from the Intellectual Property Agency of the Republic of Azerbaijan for a device for dynamic osteosynthesis of fractures of long tubular bones. The articles were published in scientific periodicals included in the international abstracting and indexing systems (bases).

The volume and structure of the dissertation. The dissertation was printed on a computer in Windows 2003 version with Times New Roman font size 14. Dissertation consists of 140 pages (31483 characters), introduction (4 pages, 1412 characters), conclusion (2 pages, 390 characters), practical recommendations (1 page, 150 characters) and list of literature (15 pages). The main content of the

dissertation is divided into 5 chapters: Chapter I -"Literature Review" (13 pages, 4182 characters), Chapter II- "Materials and Methods" (26 pages, 5493 characters),Chapter III-"Examination Methods"(20 pages, 3617 characters), Chapter IV-"Treatment Methods" (27 pages, 6923characters),ChapterV-"Complications"(11pages,2424 characters).Conclusion(12pages,3229characters)Thelist of references contains 141 sources, of which 3 are in the native language, 60 in Russian and 78 in other foreign languages. The main text is illustrated with 20 pictures, 5 diagrams and 26 tables on 124 pages.

MATERIALS AND METHODS OF RESEARCH

From 2010 to 2015, 155 patients with TC fractures of the humerus were treated. Of these, 107 (69%) patients were treated in Scientific Research Institute of Traumatology and Orthopedics, and 48 (31%) patients were treated in Sumgait Emergency and Urgent Care Hospital. 70 (36.1%) patients presented within 33 hours, and 85 (63.9%) patients presented within 1-28 days. These patients presented with complaints of bullation, deformity, swelling, and pain in the elbow joint after injury. Of these, 100 (60%) patients were treated with new traumas, and 55 (40%) patients with old traumas. Most of the injured children were boys. Thus, 103 (66.5%) of these patients were boys, and 52 (33.5%) were girls. These fractures occur 2.2 times more often in boys than in girls.

This is explained by the fact that boys are more active. By fracture type, 110 (71%) patients had TC humerus fractures, and 45 (29%) patients had SC fractures of the humerus. According to the nature of displacement, 50 (32.3%) patients were presented with forward displacement, 32 (20.6%) with backward displacement, 47 (30.3%) with external displacement, and 26 (16.8%) with internal displacement. TC fractures of the humerus are divided into 3 types according to soft tissue injuries: there were 85 (54.8%) patients with edema in the elbow joint in type I fractures, 50 (32.3%) patients with large bleeding in the peri-articular soft tissues in type II fractures, 20 (12.9%) patients with swelling and deformity in the elbow joint in type III. According to the severity of the fracture and the nature of the injury, TC (SC) is divided into the following types: type I mild

fractures – in 40 (25.8%) patients with displacement of the distal fragment below an angle of 20°, type II moderate fractures – in 64 (41.3%) patients with displacement of the distal fragment by more than an angle of >20° and type III severe fractures – in 51 (32.9%) patients.

The following were treated along the fracture line: type 1 – 43 (27.7%) patients with the fracture line passing from above, type 2 – 64 (41.3%) patients with the fracture line passing through the middle, type 3 – 48 (31%) patients with passing the fracture line from below. By type of injury, street injuries predominate – 51.1% - 79 patients, followed by household injuries – 22% - 34 patients, school injuries – 11.6% - 18 patients, sports injuries – 10.2% - 16 patients, road traffic injuries – 5.2% - 8 patients. TC fractures of the humerus occur most often at the age of 6-11 years in 62 (40%) patients, and in 19 (12.3%) patients aged 0-3 years, in 33 (21.3%) patients aged 8-10 years, in 41 (26.5%) patients aged 11-15 years. There were 1.5 times more fractures in the left upper extremity, and in the extremities – 100 (64.5%) patients with TC fracture of the humerus in the left elbow joint, 55 (35.5%) patients with a (table 1) TC fracture of the humerus in the right elbow joint. For statistical analysis, Pearson's $\chi 2$ goodness-of-fit criterion was used.

Table 1. Localization and distribution of fractures in the upper extremities

	Joint	**Transcondylar**	**Supracondylar**	**Number**	**%**
according to extremity	Right elbow	50 (32.3%)	5(3.2%)	55	35.5
	Left elbow	70 (45.2%)	30(19.4%)	100	64.5

RESULTS OF PERSONAL RESEARCH

An anamnestic study of injuries sustained in 155 patients showed that humeral condyle fractures are caused primarily by improper mechanical action. In our material, in 67 (43.2%) of 155 patients, the fracture occurred in the position of flexion of the elbow joint, and in 88 (56.8%) patients in the position of extension of the elbow joint. In TC fractures of the humerus, the force of injury is primarily distributed along the axis of the bone during a fall when the arm is extended or flexed at the elbow. When a patient in a state of pronation of the forearm falls onto the arm as a fulcrum from the elbow joint in an open or bent position, TC fracture of the humerus is formed due to the action of an upward force along the axis of the humerus and stretching of the ligamentous and muscular apparatus around the joint causes displacement of the broken fragment. If the force exerted on the condyle of the humerus continues during a fall onto the hand while the forearm is in supination, the condyle is displaced posteriorly.

When a patient falls on the elbow joint in a bent position, the displacement of the broken fragment occurs as a result of the mechanical action of the hump of the articular surface of the ulna on the block of the humerus. In our material, forward displacement was recorded in 76 (49.1%) patients, and backward displacement in 60 (38.7%) patients. 103 (66.4%) patients had an abduction fracture, 52 (33.5%) had an adduction fracture with displacement of the peripheral fragment relative to the body during the fracture. The clinical course of TC fractures of the humerus largely depends on the degree of displacement of the fragment, the type and nature of the injury. With epiphyseal fractures without displacement in tender-age infants, the clinical symptoms are not very pronounced, but the movements of opening and flexing the joints (supination and pronation) are painful. With large displacements in the joint, swelling, deformation, pain, and limited movement are noted. 80 (58.8±54.8%) patients had swelling of the soft tissues, 50 (36.8±32.3%) patients had major hemorrhage in the soft tissues of the joints, and 25 (22±19.3%) patients as a result of reflex

accumulation of muscles, limitation of movements in the elbow joint was recorded. Rotation of the broken bone fragment forward, backward, inward, outward, around its own axis was reflected in the patients included in our material, so that in case of fractures of the condyle of the humerus, the distal fragment was radiologically examined and moved forward at an angle of 20-120° in 24% of patients, in 75 % of patients recorded displacement of the distal fragment back at an angle of 15-125°, in 28% of patients displacement of the distal fragment inward at an angle of 40-110° and in 43% of patients displacement of the distal fragment outward at an angle of 30-145° was recorded.

There is no active movement in the joint; the joint is deformed due to the presence of pathological mobility. It was recorded that the limb was forced to stand in a bent or extended position due to the displacement of a fragment in the elbow joint. These clinical signs are more clearly manifested in epiphysiolysis of the humeral condyle and epi-metaphyseal fractures. X-ray (CT, EOP electron-optical device) studies play a major role in establishing the diagnosis. Diagnostic difficulty is noted with epiphyseal fractures that have not changed their location. The relationship of the epiphysis of the humerus to the metaphysis is determined based on the roentgenogram. To determine the epiphyseal-diaphyseal angle, a longitudinal line is drawn through the middle of the humerus from top to bottom through the head of the humerus; the angle between these lines is normally 30-40°. As you can see from the (table 2), a decrease in this angle means that the broken fragment is moving forward, and an increase in the angle means that the fragment is moving backward.

As can be seen from the table for assessing t-criteria for radiological displacement of fragments, below the angle < 15° excellent results were obtained in 13 (8.4%) patients; at 15°-25° good results were obtained in 42 (27.1%) patients; at 25°-50° satisfactory results were obtained in 85 (54.8%); above 50° unsatisfactory results were obtained in 15 (9.7%) patients. To determine the type of these displacements, it is important to determine the Bauman line; the angle of intersection of the longitudinal line passing through the

diaphysis with the transverse line passing through the growth zone is considered equal to 100-105°. For displaced fractures, this angle decreases to 90°.

Table 2. Clinical and radiological parameters of angular displacement of the peripheral axis of the fractured fragments before and after reposition in fractures of the humeral condyle

X-ray displacement of fracture fragments							
Results	**Displacement angles**	**Forward**	**Backward**	**Inward**	**Outward**	**Total number of patients**	**t-criteria of calculated parameters**
excellent	$<15^0$	3(1.9%)	2(1.3%)	2(1.3%)	1(0.6%)	8(5.2%)	P<0.05
good	$15^0>25^0$	15(10%)	13(8.4%)	12(7.7%)	2(1.33%)	42(27.1%)	P<0.03
satisfactory	$25^0>50^0$	27(17.4%)	24(15.5%)	22(14.2%)	12(7.7%)	85(54.5%)	P<0.004
unsatisfactory	$50^0>$	13(8.4%)	2(1.3%)	2(1.3%)	3(1.9%)	20(12.9%)	P<0.04

There is a decrease in the Marx angle in opening displacement fractures and an increase in flexing fractures (normally it is 20-45°). If it is difficult to determine the angle of the fragment, in this case X-rays of the healthy elbow joint are taken in a symmetrical position and compared with an X-ray of the damaged joint. An anterior view alone may not be sufficient to assess rotational displacement because both fragments may be rotated to different degrees and their lateral dimensions may appear similar in anterior view. In addition to X-ray of the elbow joint in two (anterior, posterior and lateral; R - anterior, posterior and lateral) projections in patients admitted to the clinic with fractures of the elbow joint, also performing X-ray of a healthy elbow joint is considered one of the important factors for assessing the course of treatment.

For elbow fractures, anterior and lateral radiographs should be taken in the Jones position (pronation back and forth with elbow flexion) when the joint is severely swollen. Despite the fact that the reposition in the joint is visually straight, X-ray is considered one of the important conditions for verifying the correct restoration of the anatomical structure. Anterior X-ray can provide more accurate information about the angular abduction (varus) and adduction (valgus) displacements of the fracture. Of the 155 patients in our control group, valgus deformity of the elbow joint was recorded in 9 (5.8%) and varus deformity in 6 (3.9%) patients. Sagittal rotation of the peripheral fragment is noted by 50-60° in lateral view and complete frontal rotation of the central fragment. With less rotation (up to 30°), the peripheral fragment can be seen in the sagittal plane, and the central fragment in the middle position.

A special type of stereography, tomography or radiography is performed in a tangential projection to determine the location of fragments between frontal and sagittal rotation and in which plane the fracture is located. The difficulty of X-ray diagnosis is associated with the presence of a growth plate in children. In children, the distal end of the humerus consists of cartilaginous tissue and appears transparent on X-ray images.

Table 3. Classification of fractures by injury types

Injury types	Supracondylar	Transcondylar	Number	%
Household	19 (12.5%)	15 (9.7%)	34	22
Street	62 (40%)	17 (11.5%)	79	51.1
Sport	10 (6.5%)	6 (3.9%)	16	10.2
School	16 (10.4%)	2 (1.2%)	18	11.6
Automobile	4 (2.6%)	4 (2.6%)	8	5.2

According to the nature of the injury(table 3), street injuries takes the first place with 51.1% (79 patients). It is noted that the second place is occupied by domestic injury – 22% (34 patients). It is noted that school injuries occupy third place – 11.6% (18 patients).

As can be seen, of the 19 patients who were treated with closed reduction, 4 (2.6%) received injuries at household, 9 (5.8%) – on the street, 4 (2.6%) – at school, 1 (0.6%) %) – during a traffic accident, which is 12.3% of the total number of patients. Normally, the ossification nuclei of the humeral condyle end at different ages.

The humerus block is located in physiological forward flexion of 30-40°. In some cases, the shadow of bone bone plasticity during osteoepiphysiolysis is mistakenly perceived on the X-ray image as a fracture of the condyle that has been torn off from the metaphysis. Therefore, the traumatologist needs to know the age-related characteristics of X-rays in children, i.e., the time of formation of ossification nuclei, the degree of development and time of fusion of the synostosis of the metaphyses of the humerus.

TC fractures of the humerus are divided into several groups depending on the size and type of displacement, but existing classifications do not allow determining the treatment tactics of TC fractures of the humerus. For fractures of the humeral condyle, the main focus should be on maintaining proportionality and incongruence of the bones of the elbow joint and on proper restoration of the articular surfaces.

In the conservative treatment of SC and TC fractures of the humerus, despite closed reduction and fixation with a splint plaster cast and correct installation of the fragment fragment in its place, in 90% of cases, due to its secondary displacement, incorrect treatment leads to neurological complications; in our material, 3 (1.9%) patients had damage to the radial nerve, 1 (0.6%) patient had damage to the median nerve, 3 (1.9%) patients had damage to the ulnar nerve, 1 (0.6%) patient had vascular compression syndrome, in 154 (99.1%) patients, palpation of the pulse on the fusiform artery, in 78 (14.2%) patients it was registered when checking the sensitivity of the fingers, which causes circulatory disorders and secondary deformation of the elbow joint, contracture, complete dysfunction of the joints and ultimately leads to disability.

In conservative treatment of supracondylar and transcondylar fractures of the humerus, despite closed reposition and fixation with a plaster tongue bandage and correct placement of the fragment, in

90% of cases, due to its secondary reposition, improper treatment can lead to neurological complications, circulatory disorders and secondary deformation of the elbow joint, contracture, complete dysfunction of the joint and ultimately disability. Based on this, we compiled an algorithms (table 4) and chose treatment tactics.

According to our proposed classification, TC and SC fractures of the humerus are divided into 4 groups according to treatment tactics:

I. There were 19 patients with non-displaced fractures, of which 16 patients (10.3%) with TC and 3 patients (1.9%) with SC humerus fracture; of these, 7 patients (4.5%) had extension fractures, 3 patients (1.9%) had flexion fractures. 9 patients (5.8%) were observed intra-articular fractures and 10 patients (6.45%) extra-articular fractures.
II. There were 33 (21.3%) patients with a slightly displaced (~3-5 mm) humeral condyle fracture; of these, 13 (8.4%) patients had TC fracture of the humerus, and 20 (12.9%) patients had SC fracture of the humerus. There were 18 (11.6%) patients with extension fractures , 15 (9.7%) patients with flexion fractures , 16 (10.3%) patients with intra-articular fractures, and 17 (11%) patients with extra-articular fractures.
III. There were 41 (26.5%) patients with fragmental slight displacement of humeral condyle fracture, of which 21(13.5%) patients with TC humerus fracture, 20 (12.9%) patients with SC humerus fracture, 15 (9.7%) patients with extension fracture, 26 (16.8%) patients with flexion fracture was observed. 21 (13.5%) of 41 patients were observed intra-articular fractures and 20 (12.9%) extra-articular fractures.

Table 4. Algorithm for minimally traumatic treatment of supracondylar and transcondylar fractures of the humerus in children

N/N	Fracture types	Classification of fractures according to the displacementmechanism	Classification of the fracture according to its relation to the joint	I Conservative treatment	II Surgery treatment
I 19 patients with nondisplaced fractures	**1.** transcondylar fracture 16 (10.3%) pat. **2.** Supracondylar non-displaced fracture 3 (1.9%) pat.	**1.** open fracture 7(4.5%) pat. **2.** flexion fracture 3(1.9%) pat.	**1.** intra-articular (epiphysiolysis, osteoepiphysio-lysis) fracture 9(5.8%) pat. **2.** extra-articular fracture 10(6.45%) pat.	plaster cast 18 (11.6%) pat.	minimally invasive osteosynthesis with metal wires in cases at risk of secondary dis-placement 1 (0.6%) pat.
II 33 patients with fractures with slight displacement of 3-5 mm	**1.** transcondylar fracture 13 (8.4%) pat. **2.** supracondylar fracture with slight displace-ment 20(12.9%) pat.	**1.** open fractur18 (11.6%)pat. **2.** flexion fracture 15(9.7%) pat.	**1.** intra-articular fracture 16 (10.3%) pat. **2.** extra-articular fracture 17(11%) pat.	simultaneous closed reposition, plaster cast 32 (20.6%) pat.	minimally invasive closed osteo-synthesis with cannula screw 1 (0.6%) pat.
III 41 patients with comminuted fractures with displacement of 5>mm	**1.** transcondylar fracture 21 (13.5%) pat. **2.** comminuted supracondylar fractures with displacement 20(12.9%) pat.	**1.** open fracture 15 (9.7%) pat. **2.** flexion fracture 26 (16.8%)pat.	**1.** intra-articular fracture 21 (13.15%) pat. **2.** extra-articular fracture 20(12.9%) pat.	closed reposition in bone traction, osteosynthesis with cross wires after removal of displacement 20 (12.9%) pat.	open osteosynthesis in cases where displacement cannot be eliminated 21 (13.5%)pat.
IV 62 patients with comminuted non-displaced fractures	**1.** transcondylar fracture 21 (13.5%) pat. **2.** comminuted supracondylar fractures with displacement 41 (26.5%) pat.	**1.** open fracture 29 (18.7%) patients **2.** flexion fracture 33 (21.3%) patients	**1.** intra-articular fracture 31 (20%) pat. **2.** extra-articular fracture 31 (20%) pat.	simultaneous closed reposition, plaster cast 30 (19.4%) pat.	minimally invasive closed osteo-synthesis 32 (20.6%) pat.
%	**Total**				**100%**

VI.There were 62 (40%) patients with fragmental displacement of humeral condyle fracture; of these, 21 (13.5%) patients had TC fracture of the humerus, 41 (26.5%) patients had SC fracture of the humerus, 29 (18.7%) had an extension fracture, 33 patients (21.3%) had a flexion fracture. 31 (20%) of 62 patients were observed intra-articular fractures and 31 (20%) extra-articular fractures. There were 19 (12.2%) patients in the first type, 33 (21.3%) patients in the second type, 41 (26.5%) patients with third type fractures, and 62 (40%) patients in the fourth group. Clinical signs are less noticeable in patients belonging to the first type. In the treatment of non-displaced fractures in patients belonging to the first type, 18 (11.6%) patients were treated with splint type plaster cast, due to the risk of secondary displacement, osteosynthesis with metal Kirschner wires was used in 1 (0.6%) patient under general anesthesia. In 33 (21.3%) patients belonging to the second type, after removing the reactive edema under the cast, so as not to cause restriction of movement in the joint due to secondary displacement and disruption of the congruence and biomechanics of the articular surfaces of the distal end of the humerus by instantaneous reposition in the closed position in 32 (20.6%) patients were applied Kirschner wire plaster cast; in 1 (0.6%) patient a screw-cannula was applied closed without an incision. Angled (transverse) wires were placed in 31 (20%) patients; due to the fact that the edema had subsided, 2 (1.2%) patients were repositioned in a closed manner using a minimally invasive method and cannula screws were applied under general anesthesia, plaster cast was applied using minimally invasive osteosynthesis. Of the 41 (26.5%) patients included in the third type, 20 (12.9%) had comminuted fractures without displacement and taking into account the presence of large edema in the joint with the use of bone traction on the elbow joint after reducing the edema under general anesthesia closed reposition was performed by applying a plaster cast with a transverse wire, and in 21 (13.5%) patients due to the non-disappearance of swelling, edema and displacement, open osteosynthesis was performed, a plaster cast was applied fixing with parallel wires. In the fourth type of fractures in 62 (40%) patients, in 30 (19.4%) of them, since there was a comminuted fracture,

osteosynthesis was performed with transosseous metal wires after eliminating the displacement by performing a one-step reposition during bone traction. 32 (20.6%) patients underwent minimally invasive divergent plaster casting with osteosynthesis with metal wires. Clinical symptoms are more pronounced in cases of disruption of contact with the head of the radial bone during TC fracture of the humerus, which depends on damage to the ligamentous-capsular apparatus of the elbow joint and connecting muscles. In our control group, 9 of 155 (5.8%) patients had secondary valgus deformity and 6 (3.9%) patients varus deformity of the elbow joint, which were corrected by open surgery, accounting for 9.7% of the total fractures. In patients who underwent open correction or osteotomy, movement in the joint was not completely restored after long-term rehabilitation measures. Taking into account the secondary displacement, in 64.6% of the above cases, osteosynthesis of fragments was performed using a closed method in cases of complete or partial disruption of the articulation after conservative treatment. Depending on the type of fracture and the nature of the displacement, different treatment tactics for TC (SC) fractures of the humerus are selected. In fractures of the humeral condyle, there is no doubt about the choice of surgical treatment in case of partial or complete disruption of articulation with radial head. But in TC fractures of the humerus, where articulation with radial head is not impaired, surgical treatment is controversial. In cases where there is no displacement of the fragment during TC fractures of the humerus, depending on the nature of the fracture, in cases where the articulation with the head of the spindle of the bone is not broken and in cases where there is no danger of secondary displacement, traumatologists carry out conservative treatment and fix extremity within 3-4 weeks giving it a physiological state by applying a posterior plaster cast. After removing the splint plaster cast, local restorative treatment is started. However, despite long-term recovery treatment, along with secondary complications in the joint, joint movement limitation and deformation are noted. In our control group, 9 (5.8%) patients had valgus and 6 (3.9%) patients had varus deformity of the elbow joint, which were corrected by open surgery, accounting for 9.7% of the

total number of fractures. After sucking out the reactive edema under the round plaster cast, which causes restriction of movements and deformation of the joint, the plaster becomes loosened due to the formation of secondary fibrous tissues in the periarticular tissues, relaxation of the muscles around the joint causes secondary displacement of the broken bone fragment, these signs are also observed in our control group and recorded in 15 (9.7%) patients. The articulation in the joint is disrupted as a result of improper healing of the TC fracture of the humerus. Due to a violation of the incongruity and biomechanics of the articular surfaces, in 25 (22±19.3%) patients secondary deformation and limitation of movements in the joint, as well as the formation of limitation of movements in the elbow joint due to reflex muscle contraction were noted. In order to prevent in the future secondary complications and restrictions on movement in the joint, even with non-displaced fractures, by minimally invasively cruciformly, parallel, and divergent (at an angle) introducing metal Kishner wires (1-1.2 mm) into the condyle through the skin under general anesthesia, performing osteosynthesis, can be kept it in a cast for 2-3 weeks; after removing the cast, can be begun premature movement of the joint. Of the 155 patients in our control group, 81 (52.2%) patients received a transverse wire, 2 (13.5%) patients parallel wire, 32 (20.6%) patients divergent wire, and 2 (1.2%) patients cannula screw. If appeal in the first hours or first day of injury with large displacements of the fragment, with large swelling of the joint, with impaired articulation of the joint (over 6-7 years), can be applied bone traction to the joint. In 80 (58.8±54.8%) patients with edema in soft tissues, osteosynthesis with wires was performed under general anesthesia after the edema was removed. In order to improve the treatment of humeral condyle fractures, the above conditions should be taken into account. For implementing this, for all types of the humeral condyle fractures, minimally invasive, atraumatic surgical intervention, osteosynthesis with cannulated screws, which can be performed in a closed or open manner, depending on the type of fracture, has been proposed. For this purpose, according to the efficient offer (No. 14 and No. 15 14.12. 2018), certificates were

obtained. Reposition is carried out under X-ray or electro-optical (EOP) control, the broken bone fragment is fixed with metal wires, cannulated screws are placed over the wire, fixing the broken fragments, a control x-ray is taken, and then a plaster cast is applied. After 2-3 weeks, the plaster cast should be removed and the joint should be moved slowly under control. However, repeated reposition can cause damage to periarticular tissues, ligaments and the muscular-capsular apparatus, malnutrition in the joint, large swelling and hemoarthrosis in the joint, and in 1.7% of cases secondary ossification of the joint. Therefore, in patients who have partially or completely impaired articulation in the joint, depending on the nature of the fracture, the ineffectiveness of closed reposition of fresh fractures is an indication for surgical treatment. The following indicators are considered to be important conditions that are the basis for surgical treatment:1)if the displacement of the peripheral or distal fragment TC fracture of the humerus is large along with rotation;2)if the displacement of fragments is large in case of TC fractures of the humerus;3)if in case of TC fractures of the humerus, in addition to disturbances in the peripheral circulation, there is a danger of damage to the brachial artery or nerve and two attempts at reposition were unsuccessful.The fragment should be fixed under X-ray or an electron-optical device (EOP) control using Kirschner wires by repositioning the fragment in an open manner. In case of TC fracture or dislocation of the humerus, open repositioning is a direct indication. In this type of fracture, the displacement of the fracture depends on the degree of damage to the ligamentous-capsular and muscular apparatus surrounding the joint. With large displacements of the fragment, extensive damage to the aponeurosis of the muscle surrounding the joint should be eliminated during surgery, with open reposition of the fragment, as this helps prevent secondary displacement of the fragment and deformation of the joint. For old TC fractures of the humerus, surgery should be as protective as possible and care should be taken not to disrupt the connection of the fractured fragment to the musculotendinous junction. Immobilization of the humeral condyle fracture is of fundamental nature, the opening of non-adherent plaster cast and the premature initiation of

rehabilitation treatment lead to loosening of the fractured and adjoined bone fragment, delayed adhesion, and the formation of a false joint. Our observations show that reducing the duration of immobilization without periodic examination, radiography and information about bone adhesion is unacceptable. Observations show that, unlike other injuries of the elbow joint, immobilization for TC (SC) fractures of the humerus should not be less than 3-4 weeks even in the absence of displacement or in the presence of slight displacement, since the assembly of the musculo-ligamentous apparatus attached to the condyles is not creates physiological compression, since in metadiaphyseal fractures sometimes premature movement of the joint along with delayed fusion of the broken fragment leads to the formation of a false joint and, secondly, to deformation of the joint, tearing the fragment away from the maternal bed. The reason for the limitation of movements in the elbow joint is not long-term immobilization of the joint, but mechanical obstacles in the joint, which include, along with a large fibrosing callus around the joint and periarticular ossification, incorrect reposition. When studying the short-term and long-term results of treatment of the humeral condyle fractures, these criteria were taken into account, dividing them into four groups: 1. Complications due to damage to nerves and blood vessels during injury 2. Worsening during reposition. 3. Complication with plaster cast, hematoma, compression of vascular-nerve bundle. 4. Complications with damage to the capsule-ligament apparatus. SC and TC fractures of the humerus are the most common household injury in children and are more common in children 6-11 years old, which may be due to the active lifestyle of children at this age. According to our observations, TC fractures of the humerus account for 57.3-64.6% of elbow joint fractures, and in boys these fractures occur 2.2 times more often than in girls. One-moment closed reposition can be used as one of the main treatment methods if it is performed correctly in time: closed reposition was performed in 19 (12.3%) patients, of which 4 (2.6%) patients had a good result, 11 (7.1%) sufficient, 4 (2.6%) insufficient. Closed reposition and fixation of fragments with Kirschner wires are more effective when

performed in the first hours of trauma. In our observations, this method was used in 33 (21.3%) patients. Of these, the results were good in 4 (2.6%) patients, sufficient in 20 (12.9%) and insufficient in 9 (5.8%). When there was a large swelling in the joint and in the cases referred 2-3 days after the fracture, skeletal traction was first applied, after the swelling was removed, closed reposition was performed and Kirschner wire were fixed. This method was used in 62 patients (40%), good results were obtained in 50 (32.2%) patients, sufficient results in 10 (6.5%) patients, and insufficient results in 2 (1.3%) patients. Open reposition is indicated in the following cases: open fractures, fragments piercing the skin, danger of damage to blood vessels and nerves, cases with impaired blood circulation in the surrounding area, failure to perform closed reduction, dangerous displacement of the fracture, in cases of hospitalization within a day. According to our observations, open reposition was performed in 41 (26.4%) patients: 40 (25.8%) patients had a good result, 1 (0.6%) patient had a satisfactory result. Finally, a good result was achieved in 98 (63.2%) patients. The anatomical structure of the distal epimetaphysis of the humerus is completely restored, the angle of flexion is 10°, opening is 180°. In 42 (27.1%) patients, with sufficient results, transverse displacement of the articular fragment was recorded, contracture in the joint at an angle of 170-175° was determined, and conservative treatment was required. Insufficient results were obtained in 15 (9.7%) patients. Treatment of the patient was continued, despite the fact that the anatomical structure of the TC fracture of the humerus was not completely restored, contracture in the elbow joint and limitation of movements remained. In patients with insufficient results in the postoperative period, complications were eliminated, which amounted to 9.7% of elbow joint fractures. To achieve successful stable fixation, it is necessary to restore the anatomical structure of the joint, as well as create the basis for early functional results and the absence of secondary displacement. In patients in whom another method, that is, closed reposition of those subjected to osteosynthesis with Kirschner wires, limb function was restored after 1.5-2 months. However, with old fractures, both the period of limb immobilization and rehabilitation time are somewhat

longer. For delayed fractures, the open method is more often used. The immediate results of treatment were studied in 155 patients, conservative treatment was performed in(tabe 5) 19 (12.3%) patients, surgical treatment was performed in 136 (87.7%) patients.

Table 5. Proximate results of conservatively treated patients

Treatment method	Number of patients	Result			
		Excellent	Good	Sufficient	Insufficient
Conservative treatment (with a plaster cast)	19	-	4 2.6±1.27%	11 7.1±2.06%	4 2.6±1.27%

A good result was obtained in 4 (2.6±1.27%) patients immobilized using a conservative method, that is, a plaster cast, and in 11 (7.1±2.06%) patients the reason for obtaining a sufficient result was the formation of secondary displacement under the plaster cast, and in 4 (2.6±1.27%) patients the reason for the insufficient result is that the patients came after three days and were first examined by a mid-level doctor, called a bonesetter. Open surgery was performed in these admitted patients. Analysis of the immediate results of conservative treatment shows that in osteoepiphysiosis with slight displacement of the humeral condyle, closed reduction and immobilization with a plaster cast can be used to obtain a good result if these patients are under constant medical supervision. Thus, as the reactive hematoma is sucked out, the plaster cast loosens, and as a result of contraction of the muscles that compress the fingers, diastasis and secondary displacement of various sizes are created, causing various exacerbations. Reposition of the elbow joint using an open or closed method, osteosynthesis using various methods was (tabe 6) performed in 136 (87.7%) patients. 100 (64.5%) of these patients had a new fracture, and 55 (33.5%) had an old fracture. Of these, 110 (80%) had SC fractures, and 45 (20%) had TC fractures.

Table 6. Results of surgical treatment of humeral condyle

Treatment method	Number of patients	Result (SC-TC fractures of the humerus)			
		Excellent	Good	Sufficient	Insufficient
Skeletal traction and fixation by Kirschner wires	62	----	50 32.2±3.75%	10 6.5±1.97%	2 1.3±0.91%
Closed reposition + osteosynthesis	33	----	4 2.6±1.27 %	20 2.9±2.69%	9 5.8±1.88%
Open reposition + osteosynthesis	41	----	40 25.8±3.51%	1 0.65±0.64%	-----
Total	136	----	94 60.6±3.92%	31 20.0±3.21%	11 7.1±2.06%

As can be seen from this table, 94 (60.6±3.92%) patients achieved a good result thanks to timely assistance, 31 (20.0±3.21%) patients had a sufficient result, and 11 (7.1± 2.06%) patients received insufficient results due to joint contracture and secondary ossification after surgery, which is 7.1% of the total number of patients. Regeneration of humerus epimetaphyseal fractures is bone-cartilage, chondroosteogenesis type. The formation of callus of the cartilaginous type occurs in the epiphysis, and of the osteoid type in the metaphysis. This also shows that the reparative regeneration process was not at the same intensity, it was slow on the epiphyseal side and fast on the metaphyseal side. When negative factors appear, this process slows down.

RESULTS

1. In case of TC injury of the humerus, the choice of treatment method should be based on clinical and radiological classification. Based on this classification, we divided the 155 patients in the control group into the following groups: a) SC fracture in 45 (29%) patients, TC fracture in 110 (71%) patients; b) flexor fracture in 67 (43.2%) patients, open fracture in 88 (56.8%) patients; c) radiographically, fracture with anterior displacement

in 55 (35.4%) patients, fracture with posterior displacement in 41 (26.5%) patients, fracture with internal displacement in 41 (26.5%) patients, fracture with outward displacement in 18 (11.6%) patients [2, 5, 10].

2. According to the treatment algorithm, in 19 patients, a plaster cast was applied for non-displaced fractures in 18 (11.3%) patients, and fixation with a metal wires in 1 (0.6%) patient due to the risk of displacement. 4 (2.6%) good, 11 (7.1%) sufficient, 4 (2.6%) insufficient results were obtained. Household injury accounts for 22% of TC fractures of the humerus in children. These injuries are more common in children aged 6-11 years. According to our observations, TC fractures of the humerus account for 57.3-64.6% of fractures of the elbow joint, with 66.5% of these patients being boys and 33.5% girls, and in boys these injuries occur in 2 ,2 times more often than in girls, and the left limb is injured 1.5 times more often than the right: left – 64.5%, right – 35.5% [1, 3, 7, 11].
3. Closed reposition – fixation of fragments with Kirschner wires is more effective when performed in the first hours of trauma. In our observations, this method was used in 33 (21.3%) patients, of which 4 (2.6%) patients had good, 20 (12.9%) patients had sufficient, and 9 (5.8%) patients had insufficient results. Skeletal traction was applied to the patients who apply 2-3 days later; after the swelling was removed, reposition was performed and fixed with Kirschner wires. This method was used in 62 (40%) patients, good results were obtained in 50 (32.2%), sufficient in 10 (6.5%), insufficient in 2 (1.3%) patients [9, 4, 2, 15].
4. For open fractures with significant displacement, open reduction was performed when the neurovascular bundle was compressed. Reposition using this method was performed in 41(26.4%) patients, good results were obtained in 40 patients (25.8%), satisfactory results were obtained in 1 (0.6%). 9 out of 23 (5.8%) patients had valgus deformity of the elbow joint, 6 (3.9%) patients varus deformity, 1 (0.6%) patient vascular compression syndrome, 3 (1.9%) %) patients damage to the radial nerve, 1 (0.6%) patient damage to the median nerve, 3 (1.9%) patients damage to the

ulnar nerve, which were restored by open surgery, which is 14.7% of the total number of patients. During the long-term results of treatment, 29.7% excellent, 37.4% good, 23.2% sufficient, 9.7% insufficient results were obtained. Complications in the postoperative period were eliminated in patients with insufficient results [4, 1, 8, 13, 14].

PRACTICAL RECOMMENDATIONS

1. Since the diagnosis of TC fractures of the humerus in children is very difficult, the injured elbow joint and the healthy elbow joint should be X-rayed in the same position in two projections. This examination allows you to measure and compare the epiphyseal-diaphyseal angle in the lateral projection, allowing you to determine the degree of articulation impairment, and creates conditions for clarifying treatment tactics.
2. All TC fractures of the humerus must be accurately and stably fixed, regardless of the degree of displacement. All fractures of the humeral condyle with displacement in children are indications for osteosynthesis with atraumatic metal wires and surgical intervention to prevent secondary complications.
3. Even if the articulation is not partially impaired, it is recommended to fix the fragment using Kirschner wires in a closed way through the skin.
4. In TC fractures of the humerus the congruence of the articular surfaces should be restored by urgent open repositioning, and the fragment should be fixed with two intersecting, parallel, divergent Kirschner wires, which will allow to prevent secondary displacement during the resorption of bone fragments during the treatment process and complications that may occur in the future.

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EFFICIENT OFFER

1. Osteosynthesis of fragments in transcondylar and supracondylar fractures of the humerus with a biodegraded self-resorbable polymer implant screw (containing L-lactide glycolide). Efficient offer. Certificate № 14, "14"12. 2018.
2. Stable fixation of fragments with a closed, minimally invasive cannulated (under angle beeing cruciate, parallel or divergent) screw in children with transcondylar and supracondylar fractures of the humerus. Efficient offer. Certificate № 15,"14"12. 2018.

PATENT

Device for dynamic osteosynthesis of fractures of long tubular bones. Intellectual Property Agency of the Republic of Azerbaijan "Industrial Property" Inventions Useful models magazine No. 11/Baku-2020 published an article about the invention on page 8, received a diploma in June 2021.

LIST OF ABBREVIATIONS

HB - humerus bone
EJ - elbow joint
HC - humeral condyle
HCF - humeral condyle fracture
SCFH - supracondylar fracture of the humerus
FTHC - fracture through the humeral condyle
FF - flexion fracture
EF - extension fracture
IC - internal condyle
EC - external condyle
M - median nerve
U - ulnar nerve
R - fusiform nerve
CF - cubital fossa
KITO - Kharkiv Institute of Traumatology and Orthopedics
SRITO - Scientific Research Institute of Traumatology and Orthopedics
EUCH - Emergency and Urgent Care Hospital
CT - computed tomography
EOP - electron optical device
USM - ultrasound examination
X-ray - radiographic examination
MRT - magnetic resonance tomography
AO-association osteosynthesis
Abduction- approach
Adduct-dissociation

The defense will be held on "6" March 2025 at 14⁰⁰ at the meeting of the Dissertation council ED 2.06 of Supreme Attestation Commission under the President of the Republic of Azerbaijan operating at the Azerbaijan Medical University.

Address: AZ1022, Baku, A. Gasimzade street, 14 (conference hall)

Dissertation is accessible at the Azerbaijan Medical University Library.

Electronic versions of dissertation and its abstract are available on the official website of the Azerbaijan Medical University (https://amu.edu.az/).

Abstract was sent to the required addresses on "20" January 2025

Signed for print:
Paper format: 60×84 1/16
Volume: 6717 characters
Order: 100
Number of hard copies: 50
Publishing house "TABIB"