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Improvement of Surgical Treatment of Valgus Deformity of the Elbow Joint

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Abstract: Valgus deformity of the elbow joint is a complex orthopedic pathology requiring a comprehensive approach in diagnosis and treatment. This article examines modern methods of evaluating this pathology taking into account age-related characteristics of patients, as well as analyzes various surgical techniques for deformity correction. Special attention is paid to the effectiveness of surgical interventions depending on patient age and the degree of deformity development.

Keywords: valgus deformity, elbow joint, surgical intervention, age groups.

Introduction. Valgus deformity of the elbow joint represents a deformity in which the forearm deviates from the torso at an angle when the arm is fully extended, with the angle of arm inclination or the degree to which it is abducted from the body exceeding 10 degrees; however, diagnosis is possible even at flexion angles from 3 to 29 degrees, which is more common in women [1]. This pathological condition can occur both in young and mature age [2]. Valgus deformity of the elbow joint is also one of the most common complications of condylar and lateral condylar fractures [12]. The main cause is non-union of lateral condyles, which leads to valgus deformity. Ulnar nerve deformity is often observed in late stages. The main cause is often underestimation of treatment methods for acute lateral condylar fractures. Acute fracture has a large cartilaginous component and extends to the radiocarpal or ulnar joint. Any damage to epiphyseal cartilage increases the probability of displacement and allows synovial fluid to penetrate the fracture site. Osteoblasts cannot overcome the fluid barrier, leading to insufficient healing of the lateral condylar fragment and distal humerus [17, 18]. Subsequently, progressive valgus deformity develops, which over time leads to fragment displacement and bone deformity. Due to continued stretching of the ulnar nerve, late ulnar nerve palsy may develop [8]. Treatment of valgus deformity of the elbow joint depends on several factors, including patient age and degree of deformity. This disease does not always require treatment, but due to high risks of nerve compression, timely diagnosis and treatment are recommended. The most widespread and effective type of treatment is surgical. According to our hypothesis, with age, surgical correction of valgus deformities of the elbow joint becomes more complex, requiring more invasive interventions compared to young patients. This hypothesis is based on greater regenerative potential at an early age. This study is aimed at analyzing age-related features of diagnosis and treatment of valgus deformity of the elbow joint.

Materials and Methods. We conducted a study involving 83 patients meeting inclusion and exclusion criteria. Participants were divided into 3 groups: Group 1 (up to 6 years) - which included 18 patients, Group 2 (from 6 to 14 years) - which included 32 patients, and Group 3 (over 14 years) with 33 patients. The study involved 45 men and 38 women. In Group 1, the average age was 4.8 years, in Group 2 - 10.2 years, and in Group 3 - 26.7 years. Inclusion criteria included patient age, presence of valgus deformity of the elbow joint (more than 10 degrees deviation from normal; considering mild, moderate, and severe stages of deformity), confirmed by clinical examination and radiological methods. No previous surgical treatment of the affected joint should have been performed. Exclusion

criteria included traumatic deformities (i.e., patients with acute elbow joint trauma or fracture consequences requiring specific treatment not related to valgus deformity), systemic diseases (patients with rheumatoid arthritis, systemic lupus erythematosus, and other autoimmune disorders affecting joint condition), and inability to follow treatment (patients who cannot undergo full conservative treatment or rehabilitation after surgery due to comorbidities or medical contraindications), osteoporosis (as osteoporosis leads to pronounced bone tissue changes, especially among older age group patients).

The study included clinical examination, radiography, and assessment of various deformity stages, as well as analysis of various surgical treatment methods. Patients were divided into 3 age groups: Group 1 (up to 6 years), Group 2 (6-14 years), and Group 3 (over 14 years). Treatment of each group depended on deformity stage and patient's general condition. None of the participants had traumatic deformities, rheumatological or autoimmune diseases, pronounced osteoporosis, or other factors that could compromise study results. All patients signed informed consent to participate in the study.

Diagnosis of patients in both groups began with clinical examination, including physical examination and assessment of elbow joint functionality. When measuring the deformity angle using a goniometer, outward deviation of the elbow joint and limited joint mobility were recorded in all patients. In all patients, the deviation magnitude was greater than 10 degrees, confirming stable valgus deformity. Based on angular measurement, deformity was classified into 3 stages.

After clinical examination, each patient underwent radiographic examination in two projections: anteroposterior and lateral. This examination, along with precise measurement of deformity angle, allowed identification of additional changes in bone tissue (for example, signs of osteoarthritis, subchondral bone damage, or articular cartilage damage [1]), which could influence treatment method selection. Magnetic resonance imaging (MRI) was used in patients with severe deformity forms for precise assessment of soft tissue, ligament, and tendon condition [4]. Electromyography allowed assessment of muscle condition around the elbow joint [5, 6]. All study participants underwent biochemical blood tests to exclude systemic diseases (arthritis and other autoimmune pathologies).

Treatment of patients from all age groups depended on deformity stage and patient condition. In Group 1, 18 patients received surgical treatment in the form of two-stage surgery - resection of the humeral head at the first stage followed by osteosynthesis with Ilizarov apparatus. In Group 2, 32 patients received surgical treatment in the form of single-stage surgery - resection of false joint of the humeral head and corrective osteotomy with osteosynthesis using Ilizarov apparatus [2, 7]. In Group 3, 33 patients received surgical treatment in the form of combined resection of false joint, corrective osteotomy of the humerus, and fixation with screws together with Ilizarov apparatus.

Clinical Case 1: Patient J., 18 years old (medical record № 8426). From anamnesis: 7 years before admission to our clinic in 2016, he sustained trauma and was initially treated with plaster cast application at a local hospital. Examination revealed valgus deformity of the elbow joint and ligament weakness. Examination established that the valgus deformity angle of the elbow joint was -38°, flexion - 40°, extension - 180°, range of motion in the elbow joint - 140°. Marx line and Günter triangle were significantly changed. Finger mobility and sensitivity were preserved. No peripheral neurotrophic changes were detected. Based on clinical-instrumental examination, the diagnosis was established: false joint of the condylar head of the right humerus and post-traumatic valgus deformity of the elbow joint.

In September 2023, the patient underwent "Resection of false joint and corrective supracondylar osteotomy of the humerus and osteosynthesis with Ilizarov apparatus and screws."

The postoperative period was satisfactory, without early postoperative complications. The patient received appropriate medication and physiotherapeutic treatment. The postoperative wound was primarily closed. The patient was discharged on the 9th day in satisfactory condition. Analysis of immediate and long-term postoperative results showed consolidation in the head of the humeral joint surface and distal humerus, with anatomical formation of the humeral joint surface.

Clinical Case 2: Patient T., 14 years old (medical record № 2459). From anamnesis: 5 years before admission to our clinic in 2015, he sustained trauma and was initially treated with plaster cast at a local hospital. Examination revealed valgus deformity of the elbow joint and medial ligament weakness. Examination established that the valgus deformity angle was 35°, flexion - 33°, extension - 180°, range of motion in the elbow joint - 147°. Marx line and Günter triangle were significantly changed. Finger mobility and sensitivity were preserved. Based on clinical-instrumental examination, the diagnosis was established: false joint of the condylar head of the left humerus and post-traumatic valgus deformity of the elbow joint.

In June 2021, the patient underwent "Resection of false joint and osteosynthesis with Ilizarov apparatus."

The postoperative period was satisfactory, without early postoperative complications. The patient received appropriate medication and physiotherapeutic treatment. The postoperative wound was primarily closed. The patient was discharged on the 9th day in satisfactory condition. Analysis of immediate and long-term postoperative results showed consolidation in the head of the humeral joint surface and distal humerus, with anatomical formation of the humeral joint surface. After 1.5 years, the range of motion in the elbow joint was fully restored.

It should be noted that treatment of humeral condylar head fractures and their complications is one of the complex and insufficiently resolved problems; many of its issues remain open, especially rational treatment methods for complicated humeral condylar head fractures, which determines the necessity of conducting research work devoted to diagnosis, improvement of treatment methods, and prevention of difficult-to-eliminate complications in pediatric traumatology and orthopedics practice.

Long-term postoperative outcomes up to 6 years were studied. For objective assessment of surgical results and standardization of clinical-radiological basis study determining pathology, it is necessary to compare treatment results with literature data. Yu.P. Soldatov and V.D. Makushin (1997) determined indicators of anatomical-functional disease signs and assessment of each sign: 14-21 points - good result, 8-13 points - satisfactory, 0-7 points - unsatisfactory. Accordingly, of 46 patients, 40 (86.9%) had good results, 6 (13.1%) had satisfactory results.

Data show that significantly better results were achieved in patients who underwent modified surgical technique. This type of surgery is traumatic, but due to prolonged joint deformity and significant dislocation of joint elements, it was necessary to apply such a method as reconstruction of the distal humerus in "T" shape and fixation with external fixator. The optimal method of surgical intervention was considered osteosynthesis using Ilizarov apparatus and screws.

In all patients, depending on the severity of elbow joint deformity, trauma duration, and patient age, both types of surgical technique should be selected.

Development of severe and irreversible complications caused by false joint and aseptic necrosis of the humeral condylar head can be treated only surgically (progressive valgus deformity of the elbow joint, late-period radiocarpal nerve neuritis). Surgical intervention should be performed using maximally economical and differentiated approaches. To separate false joint fragments from soft tissues, efforts should be made to preserve fragment connection with muscle-tendon innervation. Bone fragment fixation should be performed with external fixation devices while preserving elbow joint function; external immobilization is necessary for complete consolidation (6-8 weeks).

Results. In Group 1, 18 patients (21.7%) under 6 years of age underwent two-stage surgery. In Group 2, 32 patients (38.6%) aged 6 to 14 years were operated on in one stage. In Group 3, 33 patients (39.8%) over 14 years old underwent combined surgical approach using screws and Ilizarov apparatus.

Gender distribution by groups was relatively uniform: 45 men (54.2%) and 38 women (45.8%). Average age of patients in Group 1 was 4.8 years, in Group 2 - 10.2 years, and in Group 3 - 26.7 years.

All patients underwent successful surgical interventions. The following primary outcomes were assessed [13, 14]:

- **Bone fragment stability after osteosynthesis:** In all groups, stable fixation was achieved in 100% of patients, confirmed by postoperative radiography. Bone fragments remained stable throughout the postoperative period in each case.
- **Mobilization time:** Early mobilization, defined as beginning physiotherapy procedures on the third postoperative day, was achieved in 77 patients (92.7%). The remaining six patients had mobilization delays due to minor complications, but all were mobilized within 7 days after surgery.

Radiological examination results: In Group 1, 18 patients (100%) demonstrated complete anatomical reconstruction of the elbow joint on radiological examination by the 6th month of observation. Significant improvement in joint position was observed, and none of the patients showed signs of residual deformity.

In Group 2, 31 of 32 patients (96.9%) achieved complete anatomical reconstruction by the 6th month. One patient showed signs of delayed healing, but improvement was noted during long-term observation.

In Group 3, 31 patients (93.9%) achieved complete anatomical correction by the 6th month, while two patients (6.1%) showed incomplete bone fragment fusion, requiring additional observation and minor corrective procedures.

Functional results were assessed based on range of motion and joint strength evaluation conducted 3 and 6 months after surgery.

In Group 1, after 3 months, 13 of 18 patients (72.2%) restored more than 80% of normal range of motion. By 6 months, all 18 patients (100%) had joint mobility restored by more than 90%, allowing them to perform daily activities without restrictions.

In Group 2, after 3 months, 25 of 32 patients (78.1%) achieved more than 80% of normal range of motion. After 6 months, 31 patients (96.9%) had joint function restored by more than 90%, with only one patient showing minor mobility limitations due to delayed healing.

In Group 3, after 3 months, 28 of 33 patients (84.8%) had range of motion exceeding 80% of normal. After 6 months, 30 patients (90.9%) had joint mobility restored by more than 90%. Three patients with residual stiffness were elderly individuals with post-traumatic deformities.

Complications: Overall complication rate was low, with a total of 11 patients (13.3%) experiencing minor complications. In Group 1, no serious complications were observed. One patient developed superficial infection at the Ilizarov apparatus insertion site, which was successfully treated with antibiotics.

In Group 2, three patients (9.4%) had superficial infections at pin sites. These infections were eliminated with local wound care and antibiotics, without any long-term consequences.

In Group 3, seven patients (21.2%) developed complications, including two cases of delayed bone union and five cases of superficial infections at pin attachment sites. These problems were managed conservatively, with two patients with delayed union requiring additional bone grafting.

Comparative Analysis:

- **Bone stability:** No significant differences were observed between groups in terms of achieving postoperative bone fragment stability ($p>0.05$).
- **Mobilization time:** In Groups 1 and 2, early mobilization time was comparable: 100% and 96.9% of patients, respectively, began physiotherapy procedures on the third day. In Group 3, 9.1% of cases showed minor mobilization delay, probably due to more complex surgical interventions ($p<0.05$).
- **Radiological results:** Complete anatomical reconstruction was achieved in most patients in all groups, without significant differences between groups in terms of radiological correction ($p>0.05$).

- **Functional results:** After 6 months, the degree of movement recovery in Groups 1 and 2 was similar, while Group 3 had somewhat lower functional results due to case complexity involving elderly patients and more severe deformities ($p<0.05$).

The results of our study confirm the hypothesis

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