

COMPARATIVE FUNCTIONAL EVALUATION OF VARIOUS OPTIONS FOR EXTERNAL FIXATION OF DIAPHYSEAL FRACTURES OF THE HUMERUS.

<https://doi.org/10.5281/zenodo.7838852>

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Treatment of diaphyseal fractures of long tubular bones remains to this day a far from solved problem. At the same time, no one doubts the priority of surgical methods of treatment. Taking into account the criteria of the "ideal" fixator at the present stage of the development of traumatology, the best is external transosseous osteosynthesis using various devices 1, 2. Nevertheless, there are a number of factors constraining the wider use of this method in the treatment of fractures of long tubular bones. We have analyzed these factors in relation to the use of various options for external fixation. As an example, we will focus on the treatment of diaphyseal fractures of the shoulder.

A study of the literature has shown that transosseous osteosynthesis is limited in use in fractures of the humerus. This is primarily due to the complexity of the anatomical structure of the shoulder, the risk of damage to neurovascular formations, the complexity of applying the device, its relative bulkiness, which creates inconvenience for the patient. In addition, the cross-insertion of two spokes at each level creates an obstacle to the normal functioning of the shoulder muscles. Therefore, for a complete it takes from 1 to 1.5 months to restore the function of the upper limb after removing the external fixation device.

In order to reduce injury and improve the functioning conditions of the shoulder muscles, a number of authors use only one Kirschner spoke or a spoke with a thrust pad at each level of fixation. However, this leads to a significant decrease in the stability of fixation due to the low resistance to stretching the Kirschner spokes into the bone and the unilateral action of the thrust pads. Therefore, the use of such a technique of osteosynthesis is possible only if the shifting forces on bone fragments are minimal (in children, elderly and weakened patients).

Material and methods. The rigidity and stability of fixation were studied on 30 samples of fresh unmaserated humerus bones, which were fixed by three methods developed by us – using spiral spokes, rods and a combined method. The deformation of the free end of the bone was created by the selected load and was recorded by the indicator with an error of 0.001 mm, stiffness was estimated by the amount of deformation. Stability was determined by the magnitude of the load causing plastic deformation. The results of the experiments were processed by methods of variational statistics, the significance of the results was checked by comparison of averages.

Comparative clinical studies were conducted on the experience of surgical treatment of 132 patients with diaphyseal fractures of the shoulder. In accordance with the schematic diagrams of external fixation, which were used in patients under our supervision, the latter were divided into 4 groups. The first group consisted of 39 patients who underwent transosseous osteosynthesis according to the method of G.A. Ilizarov. In the remaining groups, the external fixation schemes proposed by us were used. The spoke variant was performed in patients of the second group (40 people). Sick the third group (34 people) carried out a spoke-rod version of external fixation. Patients of the fourth group (19 people) underwent rod external fixation.

To assess the functional state the amplitude of movements of the shoulder and elbow joints, the static strength of the shoulder muscles, the elastic properties of the soft tissues of the shoulder were measured. The amplitude of the movements of the shoulder and elbow joints was estimated using a standard universal goniometer. The measurement of the strength of the shoulder muscles in the isometric mode was performed using flat-spring silomers DR-25 and DR-50. The elastic-elastic properties of the soft tissues of the shoulder were evaluated using a device developed at the Department of Instrumentation of the Saratov State Technical University. The principle of operation of the device is based on determining the specific degree of deformability of soft tissues when creating local pressure. The sensor indicators were recorded digitally (N/m) and graphically. The studies were carried out 1-3 days and a month after the operation, before removing the device and a month after the termination of external fixation. Assessment the immediate and long-term results of treatment were carried out according to the Luboshitz-Mattisashvartzberg method, modified by V.I. Shevtsov et al.

Results and their analysis. A comparative study of the rigidity of fixation of bone fragments showed that a two-rod structure resists the action of force in the plane of the fixed section and the action of bending moment much better than a two-spoke structure. According to the results obtained, linear and angular displacements for rods are 2.5-5 times less than for spokes. The spoke-rod fixation system occupies an intermediate position between two-spoke and two-rod structures. The least stability was observed with the spoke version of osteosynthesis. Nevertheless, the minimum destabilizing force (165 6N) was almost twice the value of the maximum displacing forces acting on the fragments of the humerus (85 3N) from the shoulder muscles and gravity. The latter value was determined by experimental and computational methods. Analysis of the data obtained allowed us to conclude that the options we have proposed for external fixation of diaphyseal fractures of the shoulder provide at least a twofold margin of reliability and can be applied quite reasonably.

When analyzing the immediate and long-term results of treatment, there were no statistically significant differences between the groups. Good results were achieved in 90.3-92.5% of cases. Satisfactory results were observed in 7.5-9.7% of patients. There

were no unsatisfactory results of treatment. The average terms of fusion of fractures and false joints and fixation by the apparatus in the groups had no significant differences compared to the data of other authors. Thus, a reduction in the number of osteofixers in the schemes of transosseous osteosynthesis proposed by us it did not have a negative impact on the conditions of fracture consolidation. At the same time, the rehabilitation period after the completion of hardware fixation in patients in these groups was statistically significantly reduced by 1.7-2.3 times in comparison with the first group of patients. The shortest average period of rehabilitation treatment after removal of the compression-distraction apparatus was observed in patients of group 4 who underwent external rod fixation (13.2+- 2.3 days). In this group, there was the best positive dynamics of indicators characterizing the functional state of the upper limb. At the same time, the most dynamic indicator was the elastic elasticity of the soft tissues of the damaged limb segment.

Comparative analysis showed that the elastic elasticity of the soft tissues of the shoulder in the immediate postoperative period in all groups of patients was higher than the normal level by 17-24%. At the same time, after a month in groups 2, 3, 4, this indicator was significantly closer to normal in comparison with the 1st group of patients. By the time of termination of external fixation in patients of group 4, the elastic elasticity of the soft tissues of the shoulder had almost normal indicators. In cases where this indicator did not tend to normalize during fixation by the device, as a rule, it was necessary to conduct courses of restorative treatment to eliminate contractures of the shoulder and elbow joints after the termination of external fixation.

Thus, the use of our proposed options for external fixation of diaphyseal fractures of the shoulder allowed us to improve the functionality of the damaged upper limb already at the stage of fixation by the device, as well as to reduce the duration of rehabilitation treatment and temporary disability. We believe that this is primarily due to the reduction in the number of fixing elements (spokes) and external supports (rings and arcs) by half compared to the standard method of transosseous spoke fixation, which allowed choose the optimal directions for their implementation, so that they pass through the minimum number of muscle beds and do not interfere with movements in the joints. The use of frame external supports and rod clamps, from our point of view, is more rational compared to circular supports and spokes. They greatly facilitate the social rehabilitation of patients. At the same time, it remains possible to influence reparative osteogenesis by compression and distraction.

Conclusions.

1. The use of transosseous osteosynthesis schemes with a minimum number of osteofixers in the treatment of diaphyseal fractures of the shoulder makes it possible to avoid limiting the function of the shoulder muscles during the fixation of the fracture with a compression-distraction apparatus. At the same time, the period of recovery of

working capacity practically corresponds to the period of treatment with an external fixation device.

2. The rod scheme of external fixation of diaphyseal fractures of the shoulder using frame external supports greatly simplifies the technique of osteosynthesis and is the most functional. Its application allows to achieve maximum social rehabilitation and preservation of the quality of life in the treatment of this category of patients.

3. The value of elasticity of the soft tissues of the shoulder is the most dynamic indicator in the treatment of a fracture of the humerus by external transosseous osteosynthesis and can serve with a high degree of reliability as a prognostic sign of restoration of the function of the damaged upper limb.

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