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## DEVICE FOR TRANSOSSEOUS OSTEOSYNTHESIS AT THE FRACTURES OF THE CLAVICLE

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### Abstract

The article presents a technical solution to the issues of external osteosynthesis in the treatment of clavicle fractures, which is mainly characterized by insufficient capabilities inherent in the structures to move fragments in different directions and planes. **Purpose:** to establish the distinctive features of the known external devices used in the osteosynthesis of clavicle fractures, and to develop a design taking into account the identified shortcomings. **Material and methods:** based on the identified shortcomings in various author's designs, an original device was developed for the treatment of patients with fractures of the considered localization. The use of the device involves the use of stabilizing and repositioning screw rods, which are inserted through the proximal and distal fragments of the clavicle. A feature of the introduction of these screw rods is that they are located relative to each other at an angle of 90°, which ensures stable fixation of fragments of the clavicle in all planes. The method of rod fixation developed in the clinic allows for controlled reposition using repositioning nodes, the mobility of which is possible in three planes. Stable fixation of

fragments of the clavicle is maintained until the fracture heals, while ensuring the function of the shoulder and elbow joints. **Conclusions:** evaluation of the technical results of the device showed that external osteosynthesis can be the method of choice for treatment and have practical application in trauma departments.

**Key words: fracture; clavicle; attachment; through-cyst osteosynthesis**

Introduction. In modern traumatology, since the period when transosseous osteosynthesis became widely used, there has been a shift towards the technical side of fracture treatment [1]. Until now, designs and techniques of surgical intervention are being improved, and new devices are also being offered. Attempts by various researchers are aimed at introducing transosseous osteosynthesis into clinical practice as the method of choice in the treatment of clavicle fractures. It is known that the stability of external fixation [2], which is not inferior to internal fixation, has been proven by experimental data and has led to a significant improvement in treatment results due to a reduction in the percentage of complications. Despite this, the treatment of fractures of this localization will continue to be a difficult and unresolved issue.

**The purpose** of the research is to develop a device for rod-type transosseous osteosynthesis and a technique of controlled external fixation, which will allow to restore the anatomy of the clavicle and ensure a positive clinical outcome of the treatment.

**Research material and methods.** The goal set in the work is achieved by the device we developed for transosseous osteosynthesis of clavicle fractures (patent of Ukraine No. 53182 dated September, 27, 2010), which was used in patients with clavicle fractures who were treated at the traumatology and orthopedics clinic of Odessa Medical University starting 2010. Due to the original design, the proposed device allows to achieve dosed repositioning and stable fixation of fragments due to the presence of repositioning nodes, the compactness of which, in turn, limits the patient's inconvenience during self-care.

The proposed device (Fig. 1) belongs to one-sided rod fixators, assembled on the basis of the "Osteomechanik" apparatus [3], which is a structure consisting of an external support in the form of a screw pin 1  $\text{Ø } 6 \times 120$  mm, on which there are rod holders for fixation of stabilizing screw-rods 2,3  $\text{Ø } 6 \times 80$  mm with M6 thread and repositioning screw-rods 4, 5  $\text{Ø } 5 \times 80$  mm with M5 thread, which are passed through the proximal and distal fragments of the clavicle. Screw rods are made of VT-16 titanium alloy.

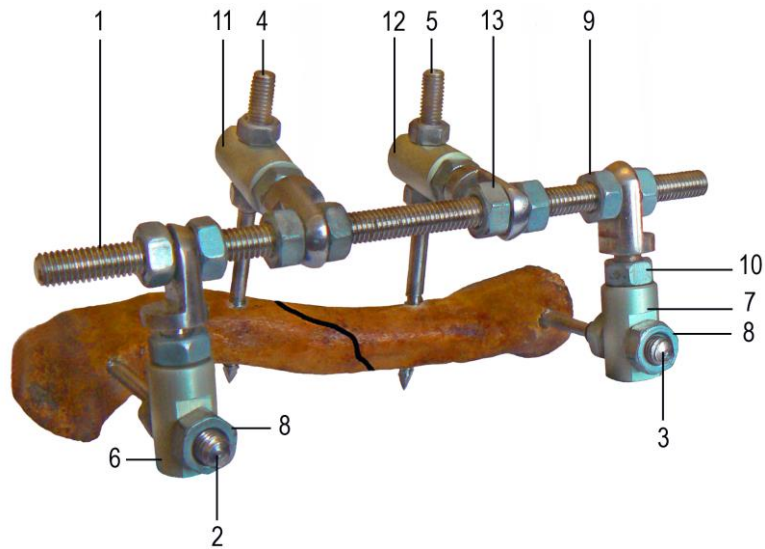


Fig. 1. Device for transosseous osteosynthesis of clavicle fractures

The controllability of the clavicle fragments is ensured by repositioning nodes (Fig. 2) in the form of rod holders, which consist of a sleeve 1 and a semi-hinged bracket 2, connected to each other by a nut 3. The possibility of movements in different planes and directions in the repositioning node is indicated by arrows.

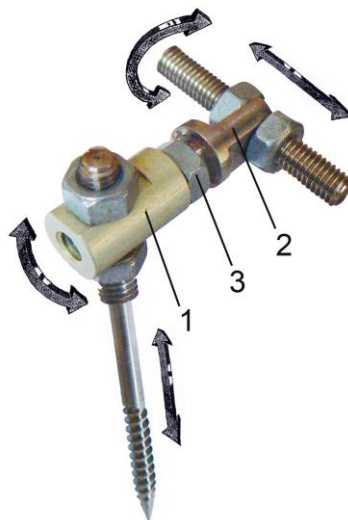


Fig. 2. Repositioning unit (rod holder) in working condition

The minimally traumatic technique of surgical intervention is implemented as follows (Fig. 1). Position of the patient on his back with a roller placed between the shoulder blades. After general anesthesia and treatment of the operative field, first, in the area of the sternal and acromial ends of the clavicle, skin to bone incisions of 5 mm in size are made with a scalpel in the longitudinal direction. Through the incisions, holes are formed in the fragments

with a drill at an angle of  $45^\circ$  to the surface of the skin, into which stabilizing screw-rods 2, 3 are screwed with the help of a hammer.

With the help of one-moment manual repositioning, the displacement of the clavicle fragments is eliminated by lifting the damaged upper arm and moving it outward and backward, bringing the peripheral fragment to the central one. The achieved displacement of the fragments is fixed, and in this position the device is put on the stabilizing screw-rods 2, 3 through the holes of the bushings of the rod holders 6, 7, which must be in a relaxed state. Holding the device parallel to the surface of the upper arm, its stabilization is carried out by successive tightening: first, nuts 8 on the stabilizing screw-rods 2, 3, then 9, located on the screw pin 1, and finally, nuts 10.

According to the control X-rays taken on the operating table, the places of insertion of repositioning screw rods 4, 5 are determined at a distance of at least 1 cm from the fracture line of the proximal and distal ends of the clavicle fragments. Depending on the level of the fracture, by moving the rod holders 11, 12 along the screw pin 1, the distance to the specified place of conducting and fixing the screw-rods in the fragments of the clavicle is adjusted. Through the holes of the bushings of rod holders 11, 12, which are in a relaxed state, repositioning screw-rods 4, 5 are passed, then the rod holders are turned until the screw-rods come into contact with the skin. In this place, appropriate incisions are made in the skin to the bone, holes are formed with a drill at an angle of  $45^\circ$  to the surface of the skin, through which the repositioning screw-rods 4, 5 are successively screwed in using a drill bit. Their stabilization in the device is carried out by tightening the nuts, as described above. Thus, the repositioning screw-rods 4, 5 are located relative to the stabilizing screw-rods 2, 3 at an angle of  $90^\circ$ , which ensures stable fixation of the clavicle fragments in all planes.

Displacement of clavicle fragments remaining after manual repositioning is eliminated as follows:

- displacement along the length is eliminated by distraction, which occurs under the conditions of outward movement of the nuts 9, 13 along the screw pin 1 to the required distance. In the reverse order, compression occurs between fragments;

- displacement in the vertical plane along the width is eliminated by simultaneously deepening or removing in opposite directions the repositioning screw-rods 4, 5, while the stabilizing screw-rods 2, 3 must be relaxed;

- the displacement in the frontal plane in width is eliminated, depending on the situation, by moving the stabilizing screw-rods 2 or 3 in the rod holders 6 or 7 relative to the

device to the required distance with nuts 8, while the repositioning screw-rods 4, 5 must be relaxed.

**Research results and their discussion.** Retrospective analysis of radiological research methods showed that intraoperative repositioning in all cases of application of the proposed device was recognized as satisfactory even with significant displacement of fragments. Therefore, we consider it advisable to continue research in this direction, so the next publications will be devoted to comparative clinical results of operative treatment of clavicle fractures.

Based on the results of technical capabilities, we came to the conclusion that the presented device differs from already known ones. The apparatus of Kolesnikov Yu. P. and Sviridova A.I. (1974), consists of two rod holders connected to each other by means of a smooth and a screw pin. However, this device allows repositioning of clavicle fragments only in one plane, and the use of only one rod in each of the fragments does not ensure their stable fixation.

The design of V.G. Klymovytskyi et al. (2006) is based on the apparatus of G.A. Ilizarov in the form of a support beam, to which four screw-rods are attached through the holes with the help of cantilever attachments and fasteners. But this device also has several drawbacks - the design, where the rods are fixed on one side of the support beam, has limited opportunities for dosed repositioning and does not allow to perform dosed compression (or distraction) between the fragments of the clavicle.

The closest to the proposed technical solution is the device of O.V. Beydyka et al. (2003), which contains an external support in the form of two slats connected to each other through holes with screw pins, at the ends of which cantilever spokes are fixed with the help of fasteners. This device also has disadvantages, namely:

- allows to perform only distraction (compression) of clavicle fragments;
- the absence of the possibility of controlled fixation (dosed reposition) of clavicle fragments in the device, since the locking spokes do not have degrees of mobility;
- the lack of degrees of mobility in the fasteners limits the use of cantilever rods, which makes it impossible to insert them at the required angle;
- the diameter of the cantilever spokes does not allow to prevent their migration or plastic deformation under conditions of repositioning efforts in the device along its length;
- the bulkiness of the external structure causes inconvenience to the patient at the moment of self-care in everyday life.

**Conclusions.** The presented device for controlled rod fixation allows repositioning of clavicle fragments due to the created original design consisting of rod holders that provide the possibility of movements in different planes and directions, as well as to carry out functional minimally invasive osteosynthesis of clavicle fractures based on closed repositioning and stable fixation of fragments for the term, required for consolidation.

The proposed device is compact and simple, preserves the function of the shoulder and elbow joints under the conditions of use, regardless of the side of the injury (right or left clavicle), so it can be the method of choice for current treatment and have wide practical use in trauma departments of different levels, as it consists of available component parts of the "Osteomechanik" apparatus, compatible with the Ilizarov apparatus.

**Conflict of interest.** The authors declare no conflict of interest and no financial interest during the preparation of this article.

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