ROD UNIT FOR THE TREATMENT OF MULTIPLE AND ISOLATED DIAPHYSEAL FRACTURES OF THE TIBIA

The paper discusses improving of treatment in multiple and isolated fractures of the shin bone. The study is based on an analysis of treatment of 24 patients with multiple fractures in isolated tibial diaphysis in age from 19 to 57 years. In all patients we used the constructed rod apparatus for osteosynthesis of tibia. The proposed rod fixation, which can improve treatment results and shorten the time of disability. Application of developed external fixation devices significantly complements the classic Ilizarov method, contributes to the early functional rehabilitation, and also it reduces the number of inflammatory complications in the catches by 2.5 times compared to traditional layouts.

Keywords: Transosseous, rod fixation, multiple, isolated, broken bones, shin

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Introduction

Associated injuries and multiple fractures account for 60-70% of all injuries (Nikitin and Gryaznuhin, 1983). According to some authors' multiple fractures of the lower limbs ranged from 6.6 to 29.8% of all fractures, and there is a stable tendency for increase of this percentage. Fractures of the lower extremities occur 2 times more often than fractures of the upper extremities. On average, they are recorded at every third patient, in 48% of cases they are combined (Karasev, 2005).

The lower extremity injuries dominate in the disability structure in patients with fractures. The duration of temporary disability varies widely, from 3-4 to 9-10 months (Redko, Kornilov, and Zakutnev, 2004). The frequency of primary disability as a result of diaphyseal fractures of the shin bone and thigh ranges from 5.1 to 39.9%. (Klimovizhky, Pasternak, Chernish, Lobko, and Pricolota, 2004).

Osteosynthesis of diaphyseal fractures with the rod apparatus for external fixation is an alternative method for the primary fixation of fractures in patients with multiple and isolated injuries, as this operation is not long and not accompanied by traumatization of the soft tissues (Haliman and Vinogradov, 2008).

Rod fixation has several advantages: small size of one-sided vehicles, light weight, comfortable for patients, minimal risk of damage to neurovascular structures during the rods, a small amount of suppurative complications due to the high stability of rods (Korzh, Talus, and Ryndenko, 1987; Ryndenko and Bets, 1990; Furdyuk, 1992).

This study examine ways of improving the treatment results in patients with multiple and combined injuries of the bones of the lower limbs through upgrading apparatus and surgical techniques.

Materials and methods

The study is based on an analysis of treatment of 24 patients with multiple fractures in isolated tibial diaphysis in age from 19 to 57 years. In all patients we used the constructed rod apparatus for osteosynthesis of tibia.
Rod unit for the treatment of long bone fractures (No.FAP 20110033) contains a bone rods 1, screws 2, threaded rods 3 parallel to each other and connected by half-braces 4. The threaded rods are with mounted plates 5 and the half-braces with the holes 4, which are fixed to the threaded bars with clamping screws 2. Further, the plates 5 and half-braces are equipped with clamps for bone rods 6.

Males of working age dominated among observed patients with tibia fractures. The proposed technology for rod fixation osteosynthesis of tibia by us executed in unstable (oblique, comminuted, and helical) tibial diaphyseal fractures in 38 cases. From them 14 patients had multiple nature of injuries and 10 patients had isolated damage. For bone fixation we used a set of compression-distraction apparatus of Ilizarov. External fixation bracket was used to fix the clamps to the rod and plates with half-braces holes. Threaded rods 1 were injected transosseous screwed into the channel formed by a drill through both the cortical layer of the tibia, corresponding to the diameter of the rod without cutting thread. The length of the threaded portion of the rod corresponded to the width of the bone at the injection site.

**Technique of rod fixation in diaphyseal damage.** External fixation of long bone with rod apparatus, according to this technology does not require special orthopedic operating table. Without removing the system of skeletal traction, the place is treated with antiseptic. One rod in the frontal plane is entered to the every metaphysis of tibia. If the fracture is close to the knee joint (at the level of proximal metaphysis or metadiaphysis), it is better to enter the rod to the distal femoral metaphysis, and through the talus block if it’s close to the ankle. Conducted in the frontal plane rods allow the operator to manipulate with the bone fragments both in the frontal (due to the movement of fragments along the rod) and sagittal (due to rotation of fragments around the rod) planes. All transfers are conducted in the same plane, in which radiography is performed, which greatly simplifies to a surgeon the orientation using the radiograph.

If the bone fragments do not have an equal length, the rod (conducted through a longer fragment) should form an angle of 95-100 degrees to provide correction of existing angular displacement. When using a short fragment, as well as in cases of fractures in the middle third of the diaphysis with equal length of fragments, the rod should be conducted perpendicular to their axes. Then, the rod is fixed and pulled in external support, consisting of four bars and clamps, connected by two threaded rods. Initially, proximal rod is fixed and tightened. After that, by manipulating the distal part of tibia, the operator can remove rotating shift, if it is determined clinically or radiographically. The operator
then holds the distal tibia, and the assistant secures and tightens the distal rod. Distraction until a small overdistention (0.5 cm) is conducted for threaded rods. In case of correct entering of the rod, the correct removal of angular displacement occurs both in frontal and sagittal planes. The forward displacement of the distal end of the central fragment of the tibia (caused by traction of the quadriceps femoris) is eliminated by full extension of knee joint, which is achieved by rising of distal support by the 4-5 cm from the table surface. Radiography is performed after removal of coarse displacement. If angular deformity remains in the frontal plane, then asymmetric distraction of threaded rods should be delivered (more on the side where the angle is open to). A small (5-7 degrees) angular deformation can be eliminated by moving the rod fragments towards the top corner of deformation. The same technique can be used to eliminate displacement in width. If rotational displacement is detected, it must be eliminated in this stage. To fulfill this, one should reduce the distraction, then release the threaded rods in one external support, rearrange the rods in a circle bearing the corresponding number of holes (moving by the one hole in the ring of 240 mm diameter corresponds to 5 degrees), then fasten the rods and restore distraction. After that one should repeat radiography to make sure that the rotating displacement is eliminated. The remaining small displacements at an angle or the width can be eliminated in subsequent stages of applying apparatus.

The next step starts with entering rods in the tibia, two in each fragment. The rods are entered at 2-3 cm from the ends of the fragments. In the anteromedial part of tibia the 0.5 cm skin puncture is made with a scalpel; the defender (trocar) is introduced through all the way to the bone. The channel of 5 mm in diameter through both cortical layers and in perpendicular to the diaphysis is created by drill. Rod with self-tapping screw-thread is inserted to the channel; the screw-thread can be also first cut before entering the rod. The rod must pass through both the cortical layers. Rods are conducted in projection planum tibiae, that is, in the anterior-medial quadrant of the cross-sectional segment. With this conduction muscles remain intact; also in this method there are no significant soft tissue arrays conditioning a high likelihood of inflammation.

**Results**

Clinical and radiologic densitometric analyses in the treatment of 24 patients with multiple and isolated tibia fractures found that the load on limb was increasing up to complete by the end of third month after fixation. Inflammation in the rod exit places at basic pillars was observed in 17% and at intermediate pillars - in 9% cases. Duration of fracture healing made 153 days. Mixed contractures in the ankle joint made 18% and in the knee joint - 9%. Disability term was 196 days. To design the optimal layout of the apparatus, along with increased stiffness, it was necessary to improve the system of the final reposition of bone fragments at the level of the intermediate plate and the half-bracers with the holes. Therefore, changing the rod conduction angle was carried out.

The following clinical example provides a confirmation on opportunities of exact repositioning, increasing the degree of bone fragments fixation stiffness, lowering rate of inflammatory complications around the rods.

**Patient: 32 years old (clinical card No.6577)**

**Diagnosis:** Multiple injuries, closed a double fracture of diaphysis of the right femur, open fracture of middle bones in the lower third of the right tibia, open fracture of the upper third in the left shin bone with a mix of bone fragments, the I-II degree traumatic shock.

The patient was discharged in a satisfactory condition to outpatient treatment after 6 days. On arrival to control examination: soft tissue around exit sites of transosseous elements were without signs of inflammation; vascular, motor, sensory disturbances in the toes were not revealed. The patient walked on crutches with measured load on the leg (40 kg), a moderate swelling of the legs (1 cm). Movement of the knee is full, ankle - 30/0/10°.
The term of using the apparatus of external fixation made 78 days. Disability period made 105 days.

**FIGURE 2. RADIOGRAPHS OF THE PATIENT BEFORE OPERATION**

![Figure 2. Radiographs of the patient before operation](image1)

**FIGURE 3. RADIOGRAPHS OF THE PATIENT AFTER OPERATION**

![Figure 3. Radiographs of the patient after operation](image2)

**Discussion.** Our clinical observation of treatment of patients with multiple and isolated fractures of tibial diaphysis and analysis that used different layouts of external fixation apparatus (providing similar type of introducing the system of transosseous elements, but with a different stiffness of bone fixation) found 97.3 to 100% positive outcomes.

At the same time noted complications such as inflammation around the rods ranged from 6.9 to 26.4%; they occurred more frequently with a longer period of bone fixation (in patients with comminuted fractures and in cases of using fixation apparatus with spoke layouts). Fixation time was directly dependent on the rigidity of fixation bone fragments (the smallest fixation time was in the spoke-rode layout -102 days) and on the type of injury (92 days in fracture at the transverse line of the bone). In all cases when comparing between the first group (the spoke-apparatus) and second (spokes-rod), the Ilizarov method produced the longer fixation periods (143 vs. 108 days and 102 days) and the increased period of rehabilitation of patients (up to 196 days vs. 138 days in the second group).
Conclusion

Application of developed external fixation devices significantly complements the classic Ilizarov method, contributes to the early functional rehabilitation, and also it reduces the number of inflammatory complications in the catches by 2.5 times compared to traditional layouts. More compact support provides better overview of the segment, and a greater patient comfort. In case of combined and multiple injuries when focusing on the dominant damage it is required to minimize the time and trauma stabilization of fractures. In this situation, one should not waste time to achieve an accurate reduction, which can be performed after the normalization of a patient. To stabilize the bone segments in such cases one should use the simplest construction - rod unit with unilateral support in the form of beams and brackets from the set for transosseous osteosynthesis by Ilizarov. After stabilizing a patient's condition, procedures such as rods removal from the support, conducting reposition, rods re-fixation must be made.

The core units described in this paper are quite accessible to specialized trauma departments. For their application there is no need to purchase additional equipment as a set of components used for osteosynthesis by Ilizarov is available almost everywhere.

References


Karasev, A., 2005. “Percutaneous osteosynthesis treatment by Ilizarov in patients with femur and two tibias fractures,” Traumatology and Orthopaedics in Russia [Travmatologiya i ortopediya Rossii], in Russian, No2, pp.8-12


Nikitin, G., Gryaznuhin, E., 1983. A. Multiple fractures and combined injury [Mnozhestvennye perelomy i sochetannye povrezhdeniya], in Russian, the second edition. L: Medisina
