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Short Communication

Blood Speed by Arteries Bone Regeneration of the Shoulder and Tibia

*Schurov VA**

Ilizarov Research Center for Rehabilitation Traumatology and Orthopedics, Russia

Abstract

A total of 41 patients with closed diaphyseal fractures of the humerus and 57 patients aged from 21 to 66 years with closed diaphyseal fractures of the bones of the tibia in the conditions of Ilizarov treatment were examined. In the bone regenerate, the Blood Flow Velocity (BFV) was studied by Doppler. In patients of the 1st group, an increase in BFV was observed with a functional load on the shoulder of 10, and in patients of the 2nd group- 30 kgf. A total of 41 patients with closed diaphyseal fractures of the humerus and 57 patients aged from 21 to 66 years with closed diaphyseal fractures of the bones of the tibia in the conditions of Ilizarov treatment were examined. In the bone regenerate, the BFV was studied by Doppler. In patients of the 1st group, an increase in BFV was observed with a functional load on the shoulder of 10, and in patients of the 2nd group- 30 kgf. In the process of treating BFV in the arteries of the tibia, it decreased more with orthostatic test and increased less with functional load. A increase in the duration of the fixation period and a reduction in the period of functional rehabilitation.

Keywords: Bone fractures; Doppler ultrasound; Functional load; Ilizarov method

Introduction

The intensity of the blood supply to the limbs determines the growth and development of the musculoskeletal system [1-3]. With an age-related decrease in the intensity of blood supply, the growth rate slows down and the weight of the bones of the limbs decreases [4-6]. In older people, the blood flow rate in the arteries of the extremities is relatively lower by 30% [7]. With the age-related decrease in the rate of regional blood flow, tissue regeneration is slowed down [8], the duration of bone fracture healing increases [9,10].

Of greatest interest to us is the question of changing the blood flow velocity along the arteries of the regenerate tibial bones when patients move from a prone position to a standing position, when the intravascular pressure increases on average by 70 Hg, as well as the formation of the protection system of the vascular bed of the bone regenerate upon application to the upper and lower extremities of the external dosed axially directed functional load in the treatment of patients in inpatient and outpatient settings.

Material and Methods

Surveyed 2 groups of patients. The first included 41 patients with closed diaphyseal fractures of the humerus. The age of patients from 24 to 66 years (43 ± 3), the period of bone fixation by the Ilizarov apparatus at the time of the examination is from 3 to 94 days (22 ± 6). The second group consisted of 57 patients aged 21 to 64 years (43 ± 4) with closed diaphyseal fractures of the bones of the leg in the conditions of treatment according to the Ilizarov method.

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***Corresponding author:** Vladimir A Schurov, Ilizarov Research Center for Rehabilitation Traumatology and Orthopedics, Kurgan, Russia, E-mail: shchurovland@mail.ru

Using a sensor with a carrier frequency of 8 MHz of the Angiodin-2 KM computerized diagnostic complex of the production association BIOSS (Russia), the blood flow velocity was recorded in the bone regeneration zone along the anterior inner surface of the tibia or stepwise axially directed functional loading of the segment limbs [4]. The blood flow in the soft tissues above the bone was excluded, since the indication stopped at the slightest pressure by the sensor on the tissue.

Additionally, the arteries were visualized using the sonography method (Logic P5 device). Using a 2 MHz sensor through the transtemporal acoustic window, we estimated the blood flow velocity in the middle cerebral arteries at rest [7].

In processing the research materials, standard statistical programs were used, allowing the use of parametric research methods with the analysis of indicators of the reliability of differences in independent Student's samples, incorporated in the "Microsoft Office Excel 2010" package. Average values are given in combination with standard deviation. The graphs show the values of the reliability of the results (when approximation, the coefficient of determination R^2 is given).

Results

The linear blood flow velocity in the arteries of the shoulder regenerate at physical rest at 7, 14 and 60 days after surgery was 36 ± 4, 29 ± 3 and 28 ± 5 cm/s, respectively, 32 ± 3, 35 ± 3 and 30 ± 2 cm/s. The blood flow rate during the treatment was increased in the first 2 weeks of treatment, relatively higher on the shoulder. During the month of fixation, the indices decreased, but then increased again, which is associated with an increase in the load on the limbs after switching from 3 weeks to an outpatient treatment regimen (Figure 1).

When performing a functional test with an increase in the load on the shoulder up to 10 kgf, an increase in the linear velocity of the blood flow occurred due to an increase in extramural pressure on the arterial walls and a decrease in their lumen. This reaction, most pronounced at 2 to 4 weeks of the fixation period, was practically absent at the end of the treatment period (Figure 2), which is associated with 2 compaction of the bone regenerate and increased protection of the vascular bed under the influence of external mechanical factors.

Blood flow velocity in the arteries of the regenerate tibia decreased significantly when patients moved from the "lying" to the "standing" position (Figure 3). The longer the fixation period, the more pronounced the reduction in speed. This decrease is associated with the reaction of the walls of the arteries and precapillaries to a 3 increase in intravascular pressure, which prevents the transmission of high pressure to the microcirculatory bed, known as the Ostroumov-Beilis effect.

If the blood flows velocity at the load on the shoulders reaches a maximum at 10 kG, then on the legs- at 30 kg (Figure 4). This increase in the first weeks of the fixation period reached 30%, and at the end of the period it decreased to 4%.

Moreover, the longer the fixation period was, the less pronounced was the effect of external functional load on the blood flow velocity in the regenerate arteries (Figure 5). Four Consequently, a system of protection of the circulatory bed of the bone regenerate was gradually formed in patients.

A close functional relationship was found between the blood flow rate of the injured limb and the contralateral side of the brain, which is supplied by the Middle Cerebral Artery (MCA). At the same time, as the fracture heals, the blood flow rate in the contralateral SMA becomes relatively higher [11,12]. This blood flow rate increased in patients of both groups after a period of decline associated with the transfer of patients to the outpatient treatment regimen (Figure 6).

Hus, in Ilizarov treatment in patients with humeral fractures, an increase in the blood flow velocity in the regenerate arteries is observed with a load of 10, and of the tibia- 30 kgf. This reaction determines the great functionality of the bone regenerate of the lower extremities. In the process of treatment, the severity of this reaction is reduced to a minimum. At the same time, the arteries of the bony regenerate of the tibia become more sensitive to the orthostatic increase in the intravascular blood pressure.

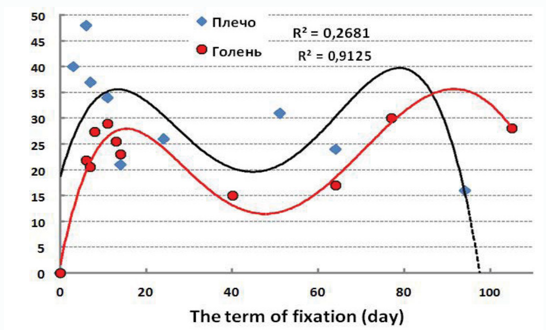

Figure 1: Dynamics of blood flow velocity in the bone regenerate of the shoulder and lower leg.

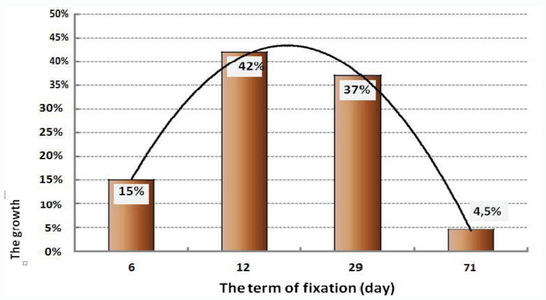

Figure 2: Increase of the IC in the arteries of the shoulder regenerate with increasing load from 5 kgf to 10 kgf during the treatment period of patients.

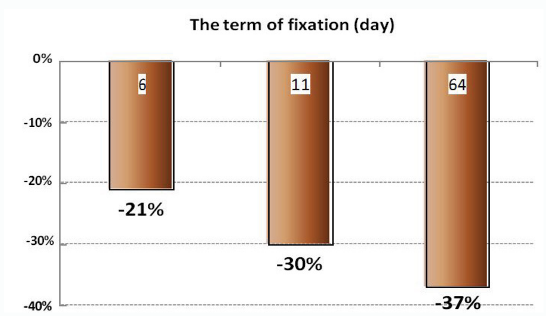

Figure 3: Reduction of Blood flow velocity in the arteries of the regenerate tibia during an orthostatic test.

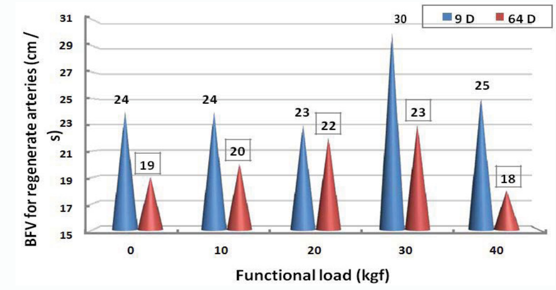

Figure 4: Blood flow velocity in the arteries of the regenerate tibia with increasing load on the limb in the first and last weeks of treatment.

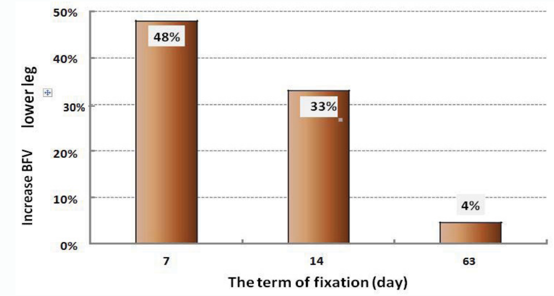

Figure 5: The increase in blood flow velocity in the vessels of the regenerate tibia during the period of fixation.

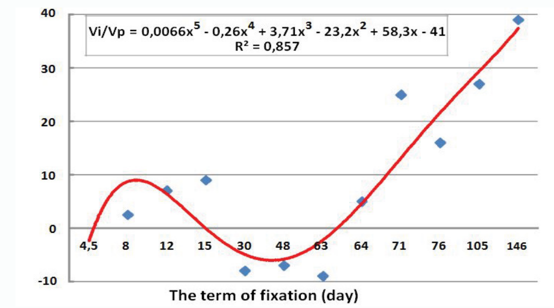

Figure 6: Dynamics of relative blood flow velocity in the contralateral SMA in the treatment of patients in both groups.

The early transfer of patients to the outpatient treatment regimen allowed increasing the operational activity of the trauma surgeons, to provide a higher number of patients with highly skilled surgical care, allowing the patient to be in the family circle during the treatment period. However, an increased load on the limbs leads to an increase in the micromotion of bone fragments [13], an increase of 1.5 times the length of the fixation period, but at the same time the period of subsequent functional rehabilitation is reduced. Estimation of cerebral blood flow rate makes it possible to assess its redistribution between centers on the contralateral and ipsilateral sides of the brain.

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