



Optimization of Osteoregeneration in the Surgical Treatment of Diaphyseal Fractures of the Lower Leg

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Abstract: According to the World Health Organization, diaphyseal fractures of the lower leg bones "... account for up to 41% of all bone fractures and up to 61% of long tubular bone fractures ." Unsatisfactory treatment results are observed in up to 25%, despite optimization of surgical treatment for fractures of long tubular bones, and disability in up to 30%, despite the use of various surgical methods and stimulation of reparative regeneration in fractures of the lower leg bones. The causes of these complications are circulatory disorders at the site of the fracture and malnutrition as a result of incomplete nerve impulses in diaphyseal fractures of the lower leg bones.

Keywords: optimization, diaphyseal, bone fracture, tibi.

A number of studies are being conducted in the world on the development of minimally invasive surgical interventions for diaphyseal fractures of the lower leg, analysis of bone biochemistry, and optimization of reparative regeneration. The principles of surgical treatment and methods of operative fixation for bone fractures are being improved, including blocking intramedullary osteosynthesis is, Ilizarov apparatus technologies. The tactics of step-by-step implementation of surgical interventions and methods for predicting complications have been improved. Details of the surgical technique of minimally invasive osteosynthesis is were revealed. Recommendations and contraindications to internal and external osteosynthesis are developed. It has been shown that in the area of bone fractures, heat, low-frequency electric current and vacuum enhance local blood circulation and, as a result, successfully consolidate fractures. Despite the fact that intramedullary osteosynthesis (BIOS) and Ilizarov apparatus osteosynthesis are effective methods of treating diaphyseal femoral fractures, their share of complications is high. Therefore, it is advisable to develop methods to stimulate osteogenesis, use biologically active substances to compensate for the deficiency of bone tissue and normalize blood circulation in bone fragments, using methods that stimulate bone cells to complete recovery in individual defects remaining between fragments after fractures.

In our country, measures are being taken to improve the quality of medical services to world standards, introduce modern methods, including in the field of traumatology and orthopedics. Particular attention is paid to improving the healthcare system, including " ... improving the level and quality of medical and social care, including raising the level of medical services to a new level...". At the same time, the use of platelet-rich plasma and optimization of the osteoreparation process are important for diaphyseal fractures of the lower leg bones.

Research material and methods describes the clinical material and methods used. Patients operated on for diaphyseal fractures of the lower leg bones were observed for 1 to 5 years. We divided the patients into two groups: the main group and the control group. The main group included 40 patients operated on using BIOS with plasmolifting (PRP), and 20 patients operated on with the Ilizarovdevice. The control group included 60 patients who underwent surgery with BIOS (40 patients) and c annaparom Ilizarov apparatus (20 patients) without plasmolifting. The total number

of patients was 120, aged from 18 to 70 years, including 96 men (78.3%), 24 women (21.6%) (Table 1).

Table 1. Classification of patients by age

Gender	Under				Total
	25 years	26-35 years	36-49 years	Over 50	
Women	1	6	11	6	24
Men	20	20	36	20	96
Total	21	26	47	26	120

From the presented data, it can be seen that among our patients, patients aged from 36 to 49 years prevailed. This suggests that diaphyseal fractures of the lower leg bones occur mainly in young and able-bodied patients. The majority of our patients were men, 96 of them (80%).

The following special methods were used to make a clinical diagnosis for patients:

X-ray methods of research. The most important research methods of diagnosis were radiological methods. We analyzed the dynamics of foot radiographs in the anterior and lateral projections: during hospitalization, after surgery, during outpatient treatment after 1, 6 months and a year to study the immediate results, and after 3 and 5 years to study the long-term results. X-ray images were used to assess the nature of the fracture, the type and degree of displacement of the fracture, the localization of the fracture after surgery, and the degree of fracture consolidation. In 3 cases, computed tomography was performed to more accurately determine the location of the fracture in small fragments of the fracture, which was necessary for planning the operation. X-ray control was performed intraoperatively using an electron-optical converter (EOP). With its help, the necessary reposition was achieved, the conductivity of blocking screws during intramedullary osteosynthesis was monitored, and the condition of broken fragments was evaluated. Using the X-ray method, we identified the following feature of diaphyseal fractures of the lower leg bones, depending on the nature of the diaphyseal fracture of the lower leg bones, we gave the following results (Table 2)

Table 2. Character of diaphyseal fractures of the lower leg bones

Groups	Oblique	Transverse	Comminuted	Total
Main	14 (11,7%)	6 (5%)	40(33,3%)	60(50%)
Control	panel 27 (22,5%)	8(6,7%)	25(20,8%)	60(50%)
Total	41 (34,2%)	14(11,7%)	65 (54,1%)	120(100%)

Methods of biochemical research. Biochemical markers helped to observe reparative regeneration in bone fractures, and the qualitative characteristics of tissues during bone regeneration.

Osteomarkers were identified to clarify the level of bone regeneration, including: 1) a decrease in the level of Ca and vitamin D in the blood; 2) an increase in the amount of alkaline phosphatase, thioalcin enzymes that are involved in the formation of new bone tissue.

Experimental research method. On the basis of the pharmacotoxicological, biological and immunological research departments of the Interdepartmental Research Laboratory of the Tashkent Medical Academy, experimental modeling of diaphyseal injuries to the lower leg bones of male rabbits of 11-12 months, weighing 2.5-3.5 kg, was performed. In the postoperative process, the results of OTP therapy, the state of local stimulation, and morphofunctional osteogenesis were studied.

Animals of the experimental group were injected with 0.2 mg of platelet-rich plasma (serum) at 5 points of the wound surface perimeter zone after osteotomy for 3 days and 1 ml of OTP per 1 session. Plasmolifting was performed every two days. In the control group, OTP was not administered to rabbits, and the wound was cleaned daily with a betadine solution. The general condition of the animals, their biochemical, radiological and densitometric results were studied after

7, 14, 30, 60, and 90 days. The course of the regenerative process in the area of experimental trauma and its activity as a result of postoperative osteotomy and *данный* histomorphological analysis at the level of callus in the area of trauma were studied. Using lytic doses of isofuran, animals inhaled under inhalation anesthesia until complete cardiac and respiratory arrest were excluded from the experiment 7, 14, 30, 60, and 90 days after surgery.

Results of experimental studies and experiments on tibial diaphyseal fractures The results of hematological, biochemical, radiological, densitometric and histomorphological studies conducted on rabbits are presented.

The effectiveness of treatment of diaphyseal fractures of tubular bones using plasmolifting in an experiment was evaluated. Studies were conducted on experimental models of diaphyseal fractures of the lower leg bones of 60 male rabbits aged 11-12 months, belonging to the genus *Chinshilla*, weighing 2.5–3.5 kg. Morphofunctional local stimulation of osteogenesis in the postoperative period was studied on rabbits receiving plasmolifting with platelet-rich autologous blood plasma.

Results of histomorphological studies on the reparative regeneration of bone tissue in experimental rabbits. The course of the regenerative process in the experimental fracture zone was evaluated by biochemical, X-ray, and densitometric signs on days 7, 14, 30, 60, and 90 after osteotomy, and histomorphological analysis of bone marrow tissues in the fracture zone was performed. Recovery process in the experimental fracture zone, which was excluded from the experiment 7, 14, 30, 60 and 90 days after surgery, isofuran was administered to animals that slept until complete cardiac and respiratory arrest by inhalation anesthesia using a lytic dose. Histomorphological data of bone marrow tissue analysis from the fracture zone were evaluated on days 7, 14, 30, 60, and 90. Morphological analysis of the diaphyseal tissue of the lower leg bones allowed us to study the processes of neoplasms after intramuscular administration of 1 ml of OTP and assess its effect on the process of reparative regeneration. Thus, the results of histomorphological studies after 3 months show a positive effect of OTP on the regeneration of bone fractures in animals. Lamellar tissue formations, mature bone plates, and numerous osteons were revealed. Histological studies confirmed intensive osteogenesis with OTP injections starting from day 30.

X-ray (densitometric) studies. X-ческиерау (densitometric) studies were performed on 60 rabbits 7, 14, 21, 30, 60, and 90 days after modeling a diaphyseal fracture of the posterior part of the lower leg bones. The animals were divided into 2 groups. Rabbits of the 1st experimental group did not receive specific therapy after modeling the fracture. Postoperative wounds were cleaned daily with a betadine solution. Animals of the second experimental group were injected intramuscularly with 1 ml of platelet-rich plasma along the wound perimeter for one week. Thus, according to the results of X-ray examination and densitometry, it is possible to state a positive dynamics of osteointegration processes using platelet-rich plasma. To determine the dynamics of the bone tissue regeneration process, an X-ray study was performed with computer analysis of X-ray images.

Histological studies and control X-rays confirmed intensive osteogenesis during OTP injections. Restoration of bone tissue defects occurred on the 60th day of the experiments, depending on the type of complex treatment. The results of X-ray and densitometric studies confirmed signs of osseointegration.

Surgical treatment of diaphyseal fractures of the lower leg the results of surgical treatment of fractures of the lower leg bones in patients are described. Plasmolifting (OTP) was used for diaphyseal fractures of the lower leg bones in the main group, and the Ilizarov hardware method Илизарова and BIOS were used in 60 patients. The control group included 60 patients who were treated with BIOS and Ilizarov apparatus without plasmolifting (Figure 1a, b).



Figure 1. X-ray picture after the BIOS operation: a - with the use of OTP; b-without the use of OTP

During the operation, different operations were used for fractures of the diaphyseal part of the lower leg bones, depending on the degree and type of fracture according to the indications. The majority of patients who underwent plasmolifting after surgery with BIOS and Ilizarov apparatus did not have pain retention, deformities were not noted, and lower leg movements were fully restored compared to the control group and other methods of surgery. The main group of patients showed a reduction in pain, rapid recovery of active joint mobility, and improved quality of life.

Study of the results of treatment of patients with aphyseal fractures of the lower leg
 приведенные результаты лечения пациентов после различных хирургических вмешательств представлены и результаты исследования. Мы изучили результаты лечения 120 пациентов. Долгосрочные результаты лечения были изучены у 10 пациентов с диафизальными переломами из 120 пациентов по 10 основным показателям: боль, ходьба, деформация, подъем по лестнице, эмоциональное благополучие, физическая активность, жизнеспособность, общее состояние, заживление переломов костей, коленного и голеностопного суставов. Средний срок наблюдения с долгосрочными результатами составил от 1 до 5 лет, а метод оценки результатов лечения был основан на наших измерениях. Эти показатели разделены на 3 категории, каждая из которых оценивается в 10 баллов. В послеоперационный период функциональное состояние нижней конечности было определено (Таблица 3).

Table 3. Long-term evaluation of treatment outcomes based on the scale developed by us

Rating (point)	Main group	Control group	The number of patients
is good (higher 10)	50 (83,5%)	46 (76,6%)	96 (80%)
Satisfactory (8-10)	6 (10%)	8 (13,4%)	14 (11,5%)
Unsatisfactory (7 and below)	4 (6,5%)	6 (10%)	10 (8,5%)

Total	60 (100%)	60 (100%)	120 (100%)
Average values (1-10 points)	78.01± p0.001	71.7± p0.001	74.6± p0.001

Table 3 shows that in the main group of 60 people, good results were achieved in 50 (85.5%) patients, satisfactory - in 6 (10%), unsatisfactory - in 4 (6.5%) patients. The average score was between 85 and 71.

In the control group of 60 patients: 46 (76.6%) patients had very good results, 8 (13.4%) patients had satisfactory results, and 6 (10%) patients had unsatisfactory results. The average score for a long time after a fracture of the diaphyseal part of the calf bones ranged from 70 to 55. Pain before surgery was 55 points, after surgery-85 points. The state of walking before surgery after 55 operations was 88 points. After the preoperative ladder climb is 52 points, the surgical ladder itself can pass 86 points. Emotional well-being - 53 points before surgery and 89 points after surgery. physical activity before surgery was 54 points, after surgery-87 points. The survival rate before surgery was 52 points, and after surgery - 86 points. General health status before surgery 53 points, after surgery 88 points. Healing of broken bone fragments before surgery is 0 points and 89 points after surgery. The height of the joint gap of the knee and ankle joints before surgery averaged 55 points, after surgery-88 points. Thus, different surgical methods were used during the operation, depending on the degree and type of fracture, depending on the condition of the fracture line диафизарныхof diaphyseal fractures of the lower leg bones.

Conclusions

1. A retrospective analysis of the results of surgical treatment of 30 (100%) patients with diaphyseal fractures of the lower leg bones showed slow fusion of bone fragments in 3.3% (1 patient) cases, and the results of surgical treatment of 30 (100%) patients with multi-comminuted diaphyseal fractures showed slow fusion of fragments in 10% (3 patients) and the formation of post-traumatic false joints in 6.7% (2 patients) cases.
2. The results of the study of immunological activity in rabbits showed that in rabbits in the group without plasmolifting показатель, the IgA index reached 0.132 ± 0.0104 mg / l 7 days after bone fracture, 0.206 ± 0.0145 mg / l on day 90; in plasmolifted rabbits, it was 0.179 ± 0.0150 mg / l after 7 days, increasing to 0.270 ± 0.0237 mg / l on day 90 and reaching normal values. It has been experimentally shown that the use of plasmolifting in animals with diaphyseal fractures of the lower leg bones has a positive effect on the level of IgA in their immune system.
3. The results of a 60-day histomorphological study of experimental rabbits showed that in the control group there was a predominance of porous bone tissue and a low occurrence of osteons and osteoblasts; in rabbits of the main group, the appearance of lamellar bone tissues in the bone tissue, the predominance of porous bone, the presence of a large number of osteons, osteoblasts, and osteocytes. In plasmolifted rabbits, the normal course of the osteoreparation process is ensured.
4. The results of biochemical parameters when using platelet-rich plasma in patients for the treatment of diaphyseal fractures of the lower leg bones were as follows: in both groups, the amount of total calcium and vitamin D on the first day of treatment was generally lower than normal, and the amount of alkaline phosphatase was high ($p < 0.1$), but on average 1 month after. At the beginning of treatment, patients in the main group showed a greater tendency to return to normal than in the control group, and in the control group there was a decrease from the norm ($p < 0.1$), a preventive slowdown in the processes of reparative bone regeneration ($p < 0.001$).
5. Surgical treatment and use of OTP in patients with diaphyseal fractures of the lower leg bones showed the following long-term results: in the main group, 50 (83.5%) patients achieved good results without pain, complete healing of fractures without deformity, and complete recovery of physical activity; in the control group, the same result was observed in 46 (76.6%) patients. Unsatisfactory results were observed in 4 (6.5%) patients of the main group and in 6 (10%) patients of the control group.

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