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Impression metadiaphyseal fractures of the proximal end of the leg bones and our experience

Abstract

Introduction: Impression fractures of the proximal end of the tibia occupy the main place in the appearance of defor-mation of the articular surfaces. The goal is to improve the results of treatment of impression fractures of the proximal end of the shin bones, based on clarifying the volume of impression defects and filling the residual cavities.

Materials and methods: The study analyzed the data of 32 patients with impression fractures of the proximal end of the tibia. The volume of the formed cavities was determined according to the program for the MSCT study (per cubic centimeter measurements). V = length *thickness *width *0.52 = cubic cm, the method by which radiation diagnostics doctors work and display the volume of the cavity in cubic centimeters. V cavity volume \ u003d cavity length *cavity thickness *cavity width *0.52 \u003d cc / cm (0.52 is the accepted average value, standard).

Results: The results were also studied according to the accepted methodology compiled by the crite-ria for evaluating the results, and they turned out to be the following in terms of the totality of the treatment performed: in 25 patients it was from 62 to 76 points, i.e. good, in 7 patients they were satis-factory, i.e. averaged 58 points, there were no unsatisfactory result.

Discussion: The combined use of PRP-therapy, bone grafting or bone impregnated with platelet mass proved to be compatible in osteosynthesis of bone fragments using the Ilizarov apparatus.

Conclusion: The use of modern visualization diagnostic tools determines the volume and calculations for filling bone defects.

Keywords: fractures of the proximal end of the leg bones, bone grafting, PRP therapy with platelet-rich and erythrocyte mass

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Diagnosis and treatment of impression metaphysical and metadiaphyseal frac-tures of the proximal end of the shin bones and our experience in their treatment

Outcomes

Distribution of patients according to the defects obtained: - 6 patients had small defects, 18 patients had medium defects and 5 patients had 3 cm fistula defects. Four patients with hem arthrosis of the knee joints were punctured and subsequent PRP-therapy, enriched with platelets in the amount of 10 ml up to 6 times according to the articular scheme. The results were also studied according to the adopted methodology compiled by the criteria for assessing the results of the above described examination, and they turned out to be the following in the totality of the treatment performed: in 25 patients it was from 62 to 76 points, i.e. good, in 7 patients they were satisfactory, i.e. on average they amounted to 58 points, there were no unsatisfactory results, so there was a complete fusion of fractures in a short time. The average time of temporary disability of patients with fractures of the proximal bone of the lower leg was 132.8±3.42 days, and in the comparison group - 189.4 were satisfactory, i.e. averaged 58 points, there were no unsatisfactory results, so there was a complete fusion of fractures in a short time. The average time of temporary disability of patients with fractures of the proximal bone of the lower leg was 132.8±3.42 days, and in the comparison group - 189.4.

Patients who received a road tra c injury amounted to 22 (68.75%), sports injuries were observed in 6 (18.75%) patients and the remaining 4 patients were injured at home. Patients were admitted in different time periods, most patients (16-50.0%) were admitted on an emergency basis, in the rst hours after injury, after 12 hours 5 (15.625%) patients, after a day 5 (15.625%) patients, after 3 days 4 (12.5%) and after 5 days 2 (6.25%) patients. Comminuted fractures were registered in the majority of patients - 24 (75%) patients, oblique fracture lines were observed in 8 (25%) patients. In 9 (28.125%) patients, metaphyseal fractures had extensions of the fracture line into the diaphyseal part, in the remaining 23 patients (71.875%), the fractures were associated with articular surfaces.

Table 1 Distribution of patients by cause of fractures.

			Car accident	Sports	Household
1	men	25	18	4	3
2	women	7	3	2	1
			22	6	4

The study design included patients aged 18 to 78 years with metaphyseal and metadiaphyseal fractures of the proximal end of the tibia. Included digital designation of X-ray and CT examina-tions with 3D examination of cavities and all required clinical and biochemical examinations. Immediate and long-term results were studied in all 32 patients in terms of three and six months after surgery (to study the immediate results) and after one year (for long-term results). To compare the results obtained, the study included patients treated in the same hospital in the period 2015-2016 in the amount of 15 patients.

For patients with a clear X-ray picture of the formed impression defect, CT provides 3D images of the post-traumatic cavity, its shape with a mathematical de nition of volume (all 32 operated patients).

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Basically, the volume was determined in the preoperative period, but sometimes when trying to correct these impressions, i.e. during open reposition, they slightly increase, this can be about 5% of the total volume. According to the obtained impression defects, the patients were divided into three groups. The rst group consisted of 9 patients (28.125%) with small impression defects up to 0.5-0.7 cm in diameter, who underwent PRP therapy. The second group included 18 (56.25%) patients with medium impression defects up to 3 cm in diameter, the volume of which ranged from 2.34 cm/cube to 6.24 cm/cube, who underwent autologous grafting and the third group with large impressions in 5 (15.625%) patients who had defects of more than 3 cm in diameter, where bone grafting with a cortical plate impregnated with platelet-rich plasma was used. When determining defects, their occupied volume and, of course, the shape of the cavity were studied. With residual defects after bone grafting, platelet-rich PRP therapy was performed with erythrocyte mass in 3/2 or 4/2 ratio (after 4 or 6 single PRP-therapy, enriched with platelets, 2 more times the erythrocyte mass is added to the indicated former localizations). To comply with the statistical signi cance of the study, the homogeneity of the groups was assessed by the following indicators: age, fracture type, fracture location, and the volume of the impression defect.

Table 2 Distribution of patients according to the size of defects and the treatment per-formed.

No	Cavity volume of patients	PRP therapy	Bone plastic	PRP-therapy +Bone plastic
1	Small cavities up to 0.5-0.7 cm	9	-	-
2	Medium cavities up to 3 cm in diameter		18	
3	Large cavities over 3 cm in diameter			5
		9	18	5
			32	

Table 3 Volumes of impression defects

No	Small	Medium	Large
1	0.3-0.5 cm - in 6 patients	2.34 cm/cc in 3 patients	12.48 cm/cu in 4 patients
2	0.5-0.7 cm - in 3 patients	4.68 cm/cu in 5 patients	14.97 cm / cu in 1 patient
3		6.24 cm/cu in 10 patients	
	9	18	5

Results of surgical treatment of patients with impression fractures. The follow-up period ranged from 3 months to 4 years. The results were evaluated on the basis of subjective and objective clinical examination data, and radiological diagnostic methods. During the subjective clinical examination, attention was paid to pain, the ability to load the limb, activity, attitude to sports, walking up the stairs for the lower limb. An objective clinical examination took into account the deformation of the fracture area, the presence or absence of edema, atrophy of the leg muscles, range of motion in the adjacent joints, the presence of synovitis and local hyperthermia, violation of local blood circulation and innervation of the limb. When evaluating the long-term results of surgical treatment of patients with impression fractures, the phenomena of arthrosis of the joints (arthrosis of the knee joint in one patient) were noted, deformity and atrophy of the muscles of the leg were less common. Patients often complained of pain in the operated joint, lameness in three patients on the knee joint, limitation of the load during sports (in 6 patients).

Based on the indicated subjective and objective clinical and radiological data and the results of the study of the functional capabilities of the segments and the study of the terms of disability, a scoring system for studying long-term results was developed.

Good and excellent results of surgical treatment of patients with impression fractures of the above limb segments included those who had from 61 to 80 points. To satisfactory results - the sum of points from 41 to 60 points. Unsatisfactory results were considered those when the nal result was 40 or less points.

Distribution of patients according to the resulting defects: - in 6 patients with minor defects who were treated with PRP-therapy in an amount of 10 ml. up to 8 (6 + 2) times, with the appli-cation of the Ilizarov apparatus according to the adopted technology at the Center. acad. Ilizarov, 3 patients with LSP plates. In 18 patients with average defects up to 3 cm, the cavity was filled with an autologous fragment from the iliac wing, with fixation with the Ilizarov apparatus in 6 patients, LSP plates in 8 patients, hybrid osteosynthesis was used in 4 patients (cancellous screws in combination with the Ilizarov apparatus in 2 patients and a plate with additional screws also in two patients). 5 patients with 3 cm fistula defects underwent plasty with one metaphyseal-cortical form of a fragment from the iliac wing impregnated with platelets enriched with platelets. Fragment fixation in 4 patients was carried out with overhead LSP plates, in one patient the Ilizarov apparatus was applied, and only in one case additional fixation was performed with a wire and a screw. These patients had difficulties with complete filling of bone defects, and therefore, PRP therapy was performed in the amount of 5-7 ml for residual marginal defects between the graft and the bone up to 8 (6+2) times.

Table 4 Distribution of patients according to treatment methods

	Defects	Number of pain	Treatment method	Ilizarov apparatus	Fixation with plates	Hybrid osteosynthesis
1	Small	9	PRP therapy	6	3	
2	Medium	18	bone plastic	6	8	3
3	Large	5	PRP-therapy + bone plastic	1	4	1
		32		13	15	4

Four patients with hemarthrosis of the knee joints underwent joint puncture and subsequent PRP therapy enriched with platelets in the amount of 10 ml. up to 6 times according to the artic-ular scheme. Who had a good recovery of the kinematics of the joints. Conducting methods of intra-articular management and maintaining them to fill the defects in the fracture area was carried out simultaneously.

The results were also studied according to the accepted methodology compiled by the criteria for evaluating the results, and they turned out to be the following in terms of the totality of the treatment performed: in 25 patients it was from 62 to 76 points, i.e. good, in 7 patients they were satisfactory, i.e. averaged 58 points, there were no unsatisfactory results, so there was a complete union of fractures in a short time.

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The average period of temporary disability in patients with fractures of the proxi-mal leg bones was 132.8±3.42 days, and in the comparison group - 189.4

		Average periods of temporary disability	Timing of fusion
1	Main group	132.8 days	86.3 days
2	Control group	189.4 days	98.5 days

Discussion

To select the optimal treatment tactics and prevent the development of postoperative complications, it is necessary to detail the nature of the fracture, determine the number and size of bone fragments, their displacement, and identify the degree of impression and damage to soft tissue structures. Treatment in impression fractures of the tibia is always a difficult task. Since this is a multi-stage therapy and each stage requires the fulfillment of separate requirements in order to receive positive effect in the aggregate treatment. With regards to the clamps used; Over the past decades, various methods, designs and devices have been developed that create a certain compression and stability in the fracture zone for a long time.[1–4] At the same time, the use of the above methods and devices for fracture stabilization does not completely eliminate non-union or delayed consolidation. Each segment has its own characteristics in the treatment of impressions, and each segment requires its own specification when determining defects, performing plasty and fixing bone fragments.[5–7]

The most common localization of an impression fracture is an impression of the proximal tibia. All types of defects were encountered and he performed all types of bone osteosynthesis of this localization. Used PRP-therapy in the amount of 10 ml. up to 8 (6+2) times, bone grafting and grafting with impregnated metaphyseal-cortical bone with the imposition of the Ilizarov appa-ratus, LSP plates or cancellous screws. The average time of union was 86.3 days, in the comparison group - 98.5 days, the function of the knee joint was restored by 2 months. The results in the majority of patients were good in 25 patients (78.1%) and satisfactory results were observed in 7 patients (22.9%) patients.[8,9]

The combined use of PRP-therapy, bone grafting or platelet-impregnated bone proved to be compatible in osteosynthesis of bone fragments using the Ilizarov apparatus, LSR plates, cancellous screws. Since in the selection of the technique, all asepsis precautions and individual features of the fracture localization and the shape and volume of the defect were observed. Despite repeated injections in the area of the bone fracture (up to 8 times), no infectious phenomena were observed.

The most difficult to treat are comminuted impression fractures with a large destruction of the articular surface and bone substance of spongy bones. As a rule, such fractures are combined with damage to the ligamentous apparatus. With such injuries, it is necessary to promptly restore the congruence of the articular surfaces with bone auto-alloplasty and restore the integrity of the ligamentous apparatus.[10,11] In all the patients we observed, intra-articular fractures were without displacement of the articular surfaces; therefore, we did not perform intra-articular manipulations. And when studying the long-term results, there were no patients with articular instability either.

If there are no contraindications on the part of the skin, early, adequate osteosynthesis is indi-cated, which is advisable to be carried out simultaneously with bone grafting.[12,13] We used the method of early osteosynthesis with bone grafting (on the rst day of injury) in 7 patients. In connection with a pronounced edematous-inflammatory process, these operations are fraught with complications. In addition, we did not find a significant difference in the results of treatment in the study of long-term results. Therefore, the main category of patients were operated on within 3 days, after explaining to patients about osteoplastic surgery.

The autograft has the best properties in bone grafting. To fill impression defects, many authors prefer an autograft, the "gold standard of orthopedics", taken from the iliac wing or from the femoral condyle. It is the autograft that has not only osteoinductive and osteoconductive prop-erties, but also osteogenic properties, i.e. contains living cells that can differentiate into osteo-blasts, release biologically active substances that promote cell differentiation into osteoblasts in a short time.[11–13] At the same time, the use of bone autoplasty is safe due to the absence of the risk of disease transmission and antigenic reactions. But in the practical implementation of bone grafting, there are some points that are not always feasible. This is the determination of the exact location and shape of the defect, the volume of the cavity, the complete filling of this cavity and the decision to further remove the filling material. Therefore, there is a problem of filling small and large cavities, which is not always feasible in practical traumatology. Small cavities up to 0.5-0.7 cm in diameter, in various shapes, do not need to be filled with a bone fragment. But the presence of even small cavities lead to a break in the transmission of metaphyseal bone tissue regeneration. Usually we hope that these cavities are filled with out owing blood, but in practice this has not always turned out to be the case. In addition, the zones of the marginal surfaces along the depth of the crater are covered with necrotic tissues, which also prevent the smooth ow of fusion processes. Therefore, small cavities also need to be filled, in order for them to quickly join the processes of adhesion. There are literature data on filling these cavities with bone powder, liquid bone or bone masses in the form of ointments or gel forms, metaphyseal mass and biologically active granules absorbed with antibiotics.[4,5] The introduction of liquid bone or blood cells into spongy bone under pressure fills residual defects, drains and opens empty reserve bone vessels, thereby creating conditions for normalizing intraosseous blood flow and improving regeneration. The method of intraosseous administration of drugs into spongy bone tissue is well known and is a type of intravenous administration.[13] To fill small cavities, we have undertaken the PRP-therapy method using a whole red blood cell mass. The technique is as follows: 10-20 ml of whole blood is taken from the patient's vein into a vacuum container, 2-3 drops of heparin are added and centrifuged at 2000 rpm for up to 7 minutes. Then separated plasma with about 5 or 10 ml of platelets is withdrawn from the container and injected into a predetermined location of the fracture. After the 3rd or 4th session, a whole erythrocyte mass is administered 2 times in an amount of about 2-3 ml. (therefore, when describing clinical cases, (4 + 2) value is used). The erythrocyte mass is also taken from the same container, only it is taken from the deep layers of centrifuged blood. The sam-pling and management technique is quite simple and has the function of sharing with any methods of osteosynthesis and under aseptic conditions without infectious complications. The technique is carried out mainly in stationary conditions or the last injections can be performed on an outpatient basis.

The filling of the middle cavities with a diameter of up to 3.0 cm was filled with a solid bone taken from the wing of the ilium, bula, anterior surface of the tibia with a cortical plate or bone of nearby localizations. Large cavities 3 cm or more are filled with bone substitutes or metal-containing implants with various coatings

(titanium nickelide) or arti cial materials of various origins. We used autologous bone - metaphyseal, metaphyseal-cortical, one- and two-cortical types of bone fragment shape in accordance with the shape and volume of the defect.

Metadiaphyseal fractures differ significantly in the course and timing of union. In connection with this, it is necessary to more correctly treat the stability of fragments during osteosynthesis. The choice of fixation method should be well assimilated with the established bone fragment. Installing them in the transitional space, according to our observation, gave many positive results. The fusion of bone fragments began precisely from these areas, despite the fact that this did not have a signi cant impact on the reduction in the total terms of fusion of bone fragments of the damaged segment.

One of the requirements of bone grafting is full volume filling of cavities. This is not always feasible in practice. Leaving residual defects after the performed osteoplastic surgery leads to low results, sometimes even complications in the form of instability of the plastic material or its suppuration. Therefore, many authors use a combination of the above methods of filling, trying to cover the weight of the volume of the post-traumatic cavity. The main volume is filled with a bone fragment, the remaining marginal parts are filled with liquid bone with shaped elements or one of the bone masses in the form of ointments or helium forms. When filling large cavities or when there is a technical lack of bone fragments, we also used the PRP-therapy method using a whole red blood cell mass in a ratio of 4 + 2, or 6 + 2 sessions at a predetermined localization during the operation.

Conclusion

1. Digital x-rays are a fairly informative diagnostic study for impression fractures of metaphyseal localizations. To determine the volume and shape of impression cavities or to determine residu-al defects after bone grafting, it is better to use MSCT studies. MRI studies are indispensable for impressions associated with damage to intraarticular structures. Determining the volume of bone impression defects with MSCT in a 3D image and converting it mathematically into a centimeter square value makes it possible to accurately determine the conduct of bone grafting.
2. One of the fundamental therapeutic tactics in the treatment of impression fractures is to identify and fill the resulting cavities (with a bone fragment or PRP-therapy enriched with platelets together with the use of a whole erythrocyte mass) restores the interrupted connection between the fragments, reducing the time of the reparative process.
3. Autoosseous grafting, being the gold standard for filling bone cavities, is practically applicable for defects (medium) of more than 1 cm. With residual small defects in the metaphyseal zone, it is better to use a combination of the method with platelet-rich PRP therapy together with the use of whole erythrocyte mass.
4. Plasty of larger defects (fistula 3 cm) has always been a problem for practitioners and the use of the technique of plasty with platelet rich one or two metaphyseal-cortical form of a fragment from the iliiac wing impregnated with platelets, followed by PRP therapy in an amount of 10 ml. up to 8 (6+2) times give better results than filling these cavities with porous metal structures.
5. Planning the timing, volume and selection of the appropriate universal type of metal structures for compatible bone grafting significantly improves the long-term results of these joint interventions.
6. The results obtained show the feasibility of using the developed techniques in the treatment of impression fractures of metaphyseal localization. Which reduced the average terms of fracture union by 1.2-2.7 days, restoration of joint function by 10.7-15.5 days, and terms of disability by 7.4-10.2 days.
7. Residual defects after osteoplastic operations create conditions for the development of complications. For this purpose, the use of platelet-enriched PRP therapy in conjunction with the use of whole erythrocyte mass fills in residual defects and allows the smooth continuation of the smearing process.
8. It is not advisable to carry out osteoplastic operations on an emergency basis, since the proposed osteosynthesis requires careful preparation: the choice of the most optimal technique, the selection of metal structures, implant blanks, etc.

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None.

Conflicts of interest

The authors disclose that they do not have any competing interests.

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