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Problem of High Amputation in Patients with Diabetic Foot Syndrome

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Abstract This study is based on an analysis of the results of amputations of the lower extremities at the lower leg level, performed in 159 patients with gangrene of the lower extremities due to diabetes mellitus, who were undergoing inpatient treatment in the department of purulent surgery of the multidisciplinary clinic of the Tashkent Medical Academy in 2014-2023. The patients were divided into 2 groups depending on the nature of the treatment technique performed. Group 1 (comparisons) comprised 86 (54.1%) patients hospitalized in 2014-2018. Amputation of the lower leg was performed using an improved new differentiated method, taking into account the affected anatomical part of the foot and removing individual muscles or muscle sheath.

Keywords Diabetes, Diabetic foot syndrome, Gangrene, Amputation

1. Introduction

Nowadays despite the detailed development of a technique for amputation at the lower leg level the lower extremities against the background of diabetic gangrene of the lower extremities, the risk of developing postoperative complications in the early period after the intervention remains high, which forces us to look for new ways of performing this surgical intervention [2,11]. This circumstance served as an incentive for a special scientific study to create an effective method of performing this procedure to prevent the development of an unfavourable course of the postoperative period in patients with diabetic gangrene of the lower extremities who have undergone amputation of the lower leg [8,14].

The rehabilitation period of patients after amputation of the lower leg is not included in the stages of the operation, but this is an important condition for a person's return to social life. The level of amputation of the lower limb is determined individually, in this case, the volume of healthy tissue is taken into account, in this way it is possible to preserve the function of the limb as much as possible, create a stump suitable for prosthetics, and prevent the development of phantom pain and other complications. Depending on how and when each of the listed stages will be implemented, in surgical practice there are types and techniques for performing amputation [1,7,13].

For a surgeon who performs an operation, it is important to solve complex clinical situations: indications for reamputation and features of wound management depending on the prevalence of the purulent-necrotic process on the stump of the lower leg. Addressing such problems in a timely manner with the development of a new differentiated method of surgical intervention depending on the localization of the pathological process on the foot can lead to an improvement in the quality of life of patients of this category [4,6,9].

If we consider the anatomy of the lower leg, there are 3 divisions in the c/3 region, separated from each other by fascia, each division has its own muscle sheath (fig. 1).

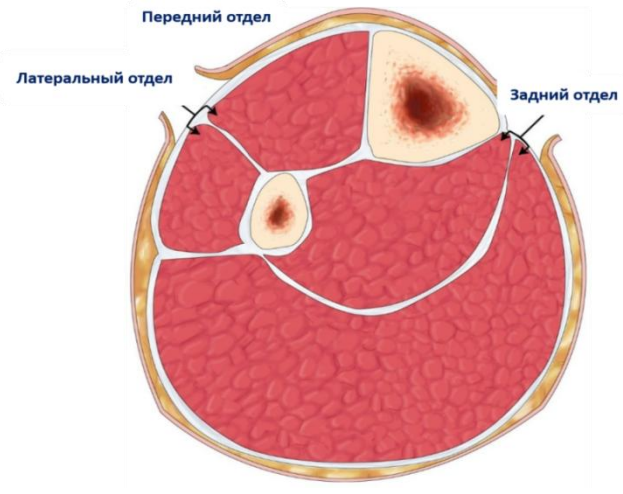

Figure 1. Anatomical structure of the c/3 lower legs and sections depending on the muscle sheath

In this case, each muscle group has its own feeding artery directly connected to the angiosome of the foot. Based on this, it should be assumed that ischemia in a certain anatomical part of the foot associated with the feeding artery,

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in turn, leads to disruption of the arterial circulation of a certain muscle sheath(or a specific muscle in a muscle sheath in a given section of the lower leg) (fig. 2.).

The key element in the formation of the stump of the lower leg during amputation is the posterior group of muscle sheath. If necessary or if the posterior tibial artery is damaged, in most cases the deep muscle layer of the posterior group is removed. It should be noted that it is advisable to leave the superficial layer of the posterior group of leg muscles to close the stump wound since this layer of the muscle sheath and the skin-subcutaneous area of this area takes arterial blood from the thigh and is very rarely affected by occlusion of the tibial arteries [5,10].

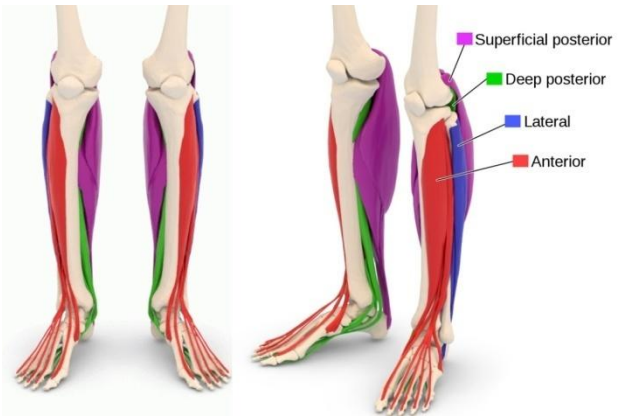

Figure 2. Topographic-anatomical structure of the lower leg muscles

As one can see from Table 1, the anterior section of the leg (i.e. muscles) is directly connected with the 1st and 7th angiosomes of the foot, since the arterial blood supply to the muscles of this section (m. tibialis anterior, m. extensor hallucis longus, m. flexor hallucis longus) occurs mainly due to the a.tibialis anterior basin, the distal branch of which is the a.dorsalispedis.

In cases of purulent-necrotic lesions of the heel area (2nd and 3rd angiosomes)and the plantar surface of the foot on the medial side (5th angiosome), the blood flow in the arterial basin a. tibialis posterior is disrupted, the distal branches of which are the medial and lateral plantar arteries of the foot.

In the lateral part of the lower leg there are m. peroneus longus et brevis, m. extensor hallucis longus, they receive nutrition from a fibularis and are directly connected to the areas of the lateral malleolus and the lateral part of the plantar surface of the foot.

The presence of occlusion-stenotic signs in the area of a certain arterial basin leads to tissue ischemia of the angiosomal structure, and accordingly there are signs of ischemia of the muscles belonging to this area.

Compensatorily, the muscle will be dominated by anaerobic glycolysis, which is characterized by edema of muscle tissue with the appearance of synovial fluid in the muscle sheath. Increased pressure in the muscle case will further impair the arterial supply to the muscle fibers, and clinical signs of ischemia will increase [6,8,12].

2. Material and Methods

This study is based on an analysis of the results of amputations of the lower extremities at the lower leg level, performed in 159 patients with gangrene of the lower extremities due to diabetes mellitus, who were undergoing inpatient treatment in the department of purulent surgery of the multidisciplinary clinic of the Tashkent Medical Academy in 2014-2023. The patients were divided into 2 groups depending on the nature of the treatment technique performed. Group 1 (comparisons) comprised 86 (54.1%) patients hospitalized in 2014-2018. For these patients, amputation of the limb at the lower leg level was performed using the traditional method without taking into account the angioarchitecture of the lower leg and damage to the anatomical areas of the foot.

Table 1. The relationship between the muscles of the lower leg and the angiosomes of the foot depending on the feeding artery

№	Angiosome	Feedingartery	Muscular sheath belonging to certain angiosomes
1	Dorsum of the foot	a.dorsalis pedis	**anterior section** (m. tibialis anterior)
2	Heelarea (lat. surface)	r.calcaneus a.fibularis	**rear section** (m. soleus + m. fibularis longus)
3	Heelarea (medicalsurface)	r. calcaneus a. tibialis posterior	**anterior section** (m. soleus + m. tibialis posterior)
4	Plantararea (lat.side)	a.plantaris lateralis	**lateral section** (m. peroneus longus et brevis + m. extensor hallucis longus)
5	Plantararea (medicalside)	a.plantaris medialis	**posterior and anterior section** (m. soleus + m. flexor hallucis longus)
6	Externalanklearea	a.fibularis (r.perforans)	**lateral section** (m. fibularis brevis ± m. soleus)
7	I finger	a. dorsalispedis, a.a. plantares (lat et med)	**anterior and lateral section** (m. extensor digitorum longus + m. extensor hallucis longus)

Group 2, the main one, included 73 (45.9%) patients hospitalized in 2019-2023. Amputation of the lower leg was performed using an improved new differentiated method, taking into account the affected anatomical part of the foot and removing individual muscles or muscle sheath.

Clinical case.

Patient T.I., born in 1947, case history № 7651/672. He was admitted to the hospital on March 12, 2020, with complaints of pain, redness, a purulent-necrotic wound and blackening of the right foot, increased body temperature and loss of appetite. From the anamnesis: he has been suffering from diabetes for 23 years, constantly taking glucose-lowering medications (insulin). During 6 days he received outpatient treatment at his place of residence. In the dynamics of treatment without effect, the patient's condition worsened, and he turned to our clinic for inpatient treatment.

The patient's condition on admission is stable, of average severity. The skin and visible mucous membranes are pale in color. Blood pressure 120/70 mm Hg. Art. Pulse – 80 beats. per minute. Weakened vesicular breathing in the lungs. The abdomen is soft and painless. The liver and spleen are not enlarged. Stool and urination are regular.

Blood tests: Hb – 123 g/l, red blood cells – 3.71012, white blood cells – 12x109, ESR – 19, blood sugar – 11.5 mmol/l. Urea – 7.5 μmol/l, creatinine – 88.7 μmol/l. Fibrinogen – 588. Blood clotting time: start 4-50, end 5-50.

Locally: the lower extremities are asymmetrical due to swelling of the left foot and lower leg. The foot feels cold and painful when touched. In the area of the lateral surface of the right foot and first toe, there is a purulent-necrotic wound measuring 10x5.0 cm, there is also blackening and a pronounced necrotic process (fig. 3).

Regional lymph nodes in the groin area on the right are enlarged and painful. Pulsation in the foot arteries (ATS) is not detected. There is no blood flow on ultrasound Doppler ultrasonography on the lower leg arteries. The patient has gangrene of the right foot. The patient was consulted by a vascular surgeon about the possibility of reconstructive surgery on arterial vessels; amputation of the lower limb was recommended due to the absence of a peripheral arterial bed.

Figure 3. Local foot status

It was decided for the patient to undergo amputation of the right leg according to the developed method.

After preoperative preparation, on March 15, 2020, the right lower leg was amputated at the level of the upper medial part with the removal of the soleus and anterior tibial muscles and the formation of the stump of the lower leg using myoplasty (Fig. 4-5).

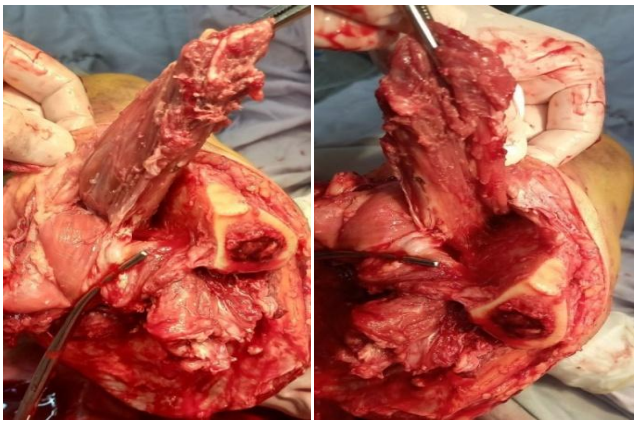

Figure 4. Removal of the anterior tibial muscle (m. tibialis anterior)

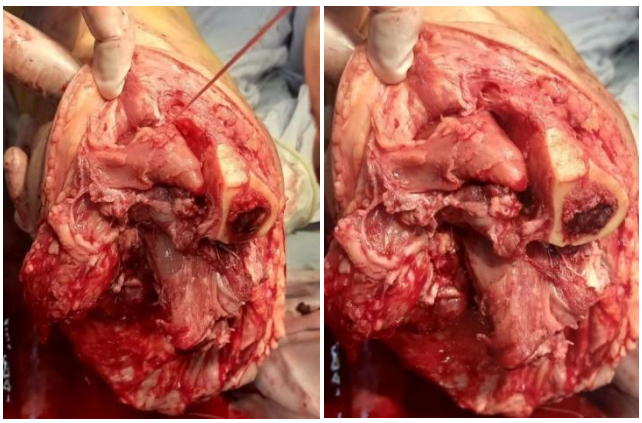

Figure 5. Myoplasty of the leg stump

Since the purulent-necrotic process is located mainly in the area of the 1st and 4th angiosomes, there is ischemia of the muscles of the anterior part of the lower leg; anterior ischemia was already predicted before the operation, which was confirmed during surgery. As with the standard procedure, we performed partial resection (extirpation) of the soleus muscle to form the stump of the lower leg. While opening the muscle sheath, swelling of the anterior leg muscle is noted with a slight accumulation of ischemic fluid. After removal of the ischemic muscle, myoplasty was performed using the muscles of the lateral leg.

In order to prevent phantom pain during the operation, the tibial nerve was catheterized using a microcatheter for continuous administration of painkillers (longocaine 1% 3.0 x 4.0 ml every 4-5 hours). Thanks to this approach, we achieved an absolutely painless postoperative period without the use of any narcotic analgesics (Fig. 6).

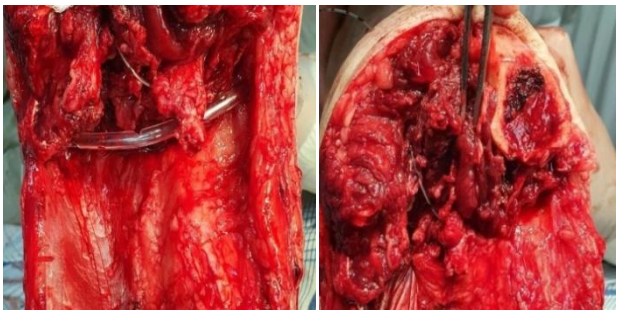

Figure 6. Drainage of the stump and catheterization of the tibial nerve

The postoperative course was smooth, the stump drainage was removed on the 2nd day after surgery, a catheter installed on the nerve – on the day the patient is discharged.

Figure 7. Postoperative stump of the lower leg

Postoperative wound of the leg stump with primary healing, the patient was discharged in satisfactory condition for outpatient treatment (fig. 7).

Removed lower leg muscles were sent for histological examination in three parts. At the same time, our predictive actions once again found their confirmation.

Focal disintegration of muscle fibers having a convoluted shape. There are small calcinates on the periphery of the sections. Small caliber arteries with wall fibrosis, stenosis, and small lumen blood loss. There are lymphoid clusters around the small vessels. Large artery with wall thickening, focus of calcinosis closer to the outer surface, and narrowing of the lumen.

Conclusion: Focal atherocalcinosis of the wall, stenosis of the lumen of arterial vessels. There are expressed contractural changes, unfibering, necrobiosis of myocytes, foci of calcinosis. There are accumulations of lymphocytes around small vessels.

The results of treatment of patients with ischemic phenomena of the lower leg stump were more evident. In the main group, only 1 patient had trophic changes of the stump on the background of ischemia. In the distant period, re-repulsion was avoided in this patient.

Different picture was observed in patients in the comparison group with arterial circulation disorders of the stump. In 8 (72.7%) of 11 patients, ischemia could not be stopped, and due to massive necrosis of muscles and fascial structures, 3 (27.3%) patients had to undergo reamputation at the hip level (Table 2).

Thus, wound infection and stump ischemia also have a significant impact on the long-term results of treatment of patients. Chronic disruption of arterial blood flow in the area of the leg stump and progression of purulent-necrotic lesions of the foot as a result of infectionmakes it impossible to preserve the knee joint, as a result, the quality and life expectancy of patients in the long-term decreases.

Table 2. Results of treatment of postoperative complications in patients of the comparison group and the main group

Final result	Comparison group, n=86				Maingroup, n=73			
	stump suppuration, n=7		stump ischemia, n=11		stump suppuration, n=1		stump ischemia, n=1	
	abs.	%	abs.	%	abs.	%	abs.	%
Preservation of the knee joint	6	85,7	8	72,7	1	1,3	1	1,3
Reamputation at the hip level	1	14,3	3	27,3	0	0	0	0

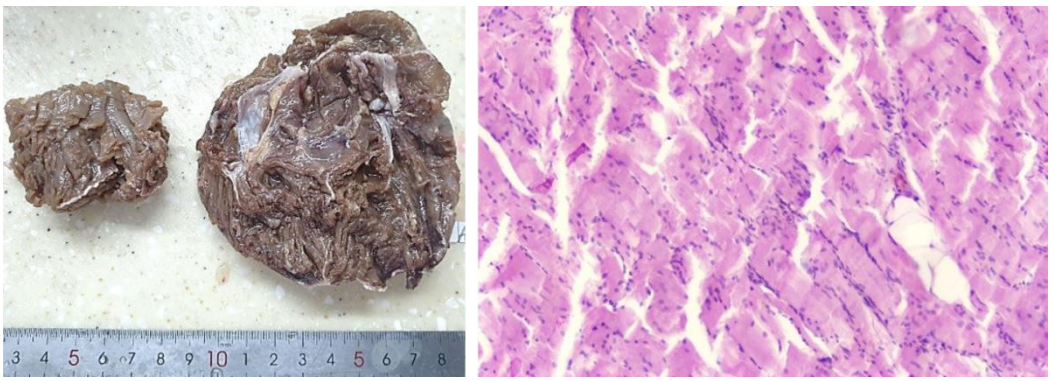

Figure 8. Morphological study of macropreparation

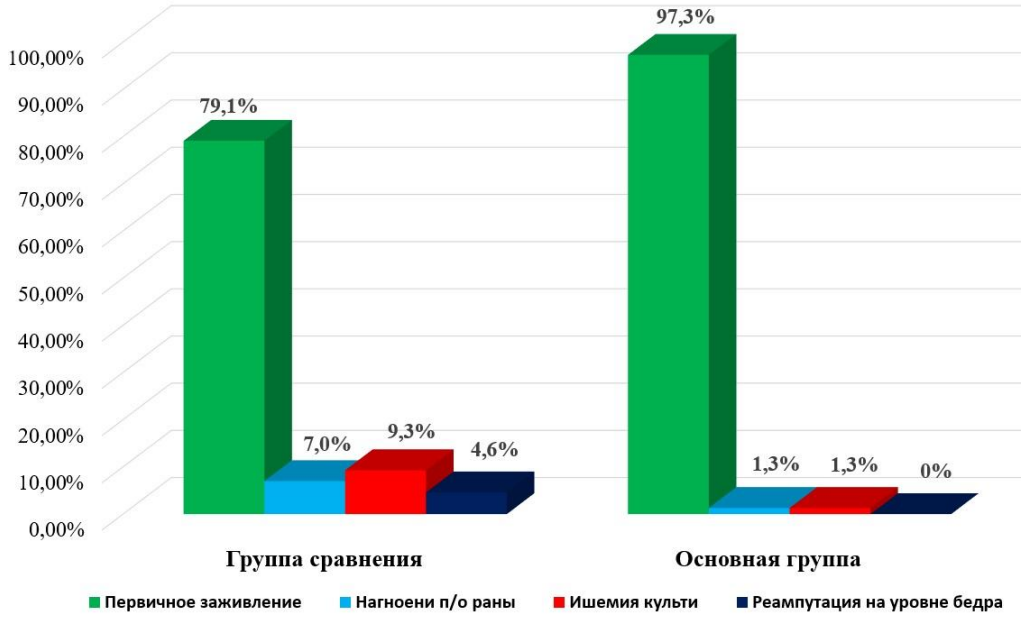

Figure 9. Efficiency indicators of an improved differentiated method of leg amputation for diabetic gangrene of the lower extremities

3. Result and Discussion

Retrospective analysis of angioarchitecture of the lower extremities after lower leg amputation (based on the results of MSCT and duplex scanning) showed that the main role in ensuring arterial blood flow is played by the lateral femoral pathway, created by the deep femoral arteries.

Occlusion of the superficial femoral artery with preservation of the mouth of the deep femoral artery makes it possible to compensate for the arterial circulation in the stump due to the arterial network of the knee joint. At the same time, the relationship between the arterial arch and the nutrient artery of the tibia is improved by increasing blood pressure in this pool which leads to the remodeling of arterial blood flow in this area, improving blood circulation in both bone and surrounding tissues. However, the main task in a differentiated approach to leg amputation is to remove muscle mass depending on the affected arterial basin, in most cases, it is not possible to clearly assess muscle ischemia on visual examination.

When performing lower leg amputation in patients of the control group, the state of the lateral circulation pathway, angiosomal structure of the foot related to the arterial basins of the lower leg, along with the role of the feeding artery of the tibial artery, were not taken into account, which in our opinion resulted in a high incidence of postoperative complications and reamputations at the thigh level.

If the amputation technique is chosen correctly, an adequate level of limb truncation is determined, and secondary infection is prevented, serious complications should not arise. Using a newly developed differentiated technique for performing leg amputation for diabetic gangrene of the lower extremities in the main group, it was possible to preserve a functioning knee joint in all patients (100%). Using traditional methods of leg amputation, the knee joint was preserved in 82 (95.4%) of 86 patients. These data indicate the high effectiveness of the developed differentiated method with a significant predominance of favourable results in the postoperative period in relation to postoperative complications than with amputation using traditional methods.

Analysis of the results of lower leg amputation of patients in the comparison group showed the following: the existing traditional techniques are not effective enough in terms of preserving the knee joint and reducing the number of postoperative complications from the stump of the lower leg. The outcome of surgical treatment certainly depends on the localization of the purulent-necrotic lesion and the compensation of ischemia in the area of the lower leg stump.

Based on the study of the angioarchitecture of the lower leg and assessment of the results of resection of the lower leg bones, depending on the preservation of the nutrient artery and the influence of the localization of the purulent-necrotic process on the course of the postoperative period, we proposed a new differentiated method of leg amputation for diabetic gangrene of the lower extremities.

In contrast to the comparison group, the rates of primary healing of the lower leg stump in the main group increased from 79.1 to 97.3%. Suppuration of a postoperative wound in the comparison group was observed in 7.0%, in the main group their number was 5 times less - 1.3%.

4. Discussion

Certainly, in modern surgery with high equipment and technology, it seems that all operations or manipulations should be without complications, but even in highly developed countries, there are high rates of postoperative complications. Today, in modern purulent surgery, the

operating surgeon faces many problems: use of modern antibacterial drugs – antibiotic resistance of bacteria; peculiar course of purulent-inflammatory diseases; the presence of concomitant pathologies, etc.

Despite the fact of development of vascular surgery and endovascular surgical interventions in patients with diabetes, the frequency of amputations is still high. In daily surgical practice with the use of theoretical knowledge, there are many ways that give the practical surgeon his direction in the treatment of gangrene of the lower extremities. High amputation is a disaster for the patient. In this case, the patient can lose the psychological nature of motivation for further actions. This work is devoted to improving the surgical results of leg amputation since the preservation of the knee joint has an important strategic role in terms of rehabilitation and survival in the postoperative period.

5. Conclusions

Using an improved method and operation algorithm, we achieved good results in the postoperative period. In patients of the main group, compared to the control group, the frequency of purulent complications and reamputations at the hip level decreased. If there is no possibility of saving the foot, the knee joint should be considered, which according to our data in 9 out of 10 people can be saved with the correct choice of surgical tactics.

With this, we will directly improve the quality of life of patients, returning them to social life and, accordingly, the mortality rate from concomitant diseases that progress with a sedentary lifestyle (with hip amputation) is reduced.

Consent

It is not applicable.

Ethical Approval

It is not applicable.

Competing Interests

The authors have declared that no competing interests exist.

REFERENCES

[1] Alieva A.V., Akbarov Z.S. Membrane lipids and some aspects of the effect of insulin on glucose transport in diabetes mellitus // Medical Journal of Uzbekistan. – 2017. – №5. – P. 95-98.

[2] Babajanov B.D., Matmurotov K.J., Sapaeva Sh.B., Atazhanov T.Sh., Babajanova M.J. Critical ischemic attack in type 2 diabetes mellitus // Bulletin of the Tashkent Medical Academy. – 2016. – №2. – P. 15-19.

[3] Babadzhanov B.D., Matmurotov K.J., Sattarov I.S., Atazhanov T.Sh. The effectiveness of anatomical resections of the leg bones for diabetic gangrene of the lower extremities // Medical Journal of Uzbekistan. – 2018. – №6. – P. 38-42.

[4] Babadzhanov B.D., Okhunov A.O., Matmurotov K.J., Mominov A.T., Atazhanov T.Sh. Features of resection of the leg bones and its impact on the outcome of the operation for gangrene of the lower extremities against the background of diabetes mellitus // Surgery of Uzbekistan. – 2019. – №1. – P. 64-72.

[5] Matmurotov K.J., Otazhonov J.Kh., Atazhanov T.Sh. Amputation of the lower leg for diabetic gangrene of the lower extremities // Introduction of high technologies in vascular surgery: Collection of abstracts of the 35th conference–SPb, 2019. – P. 135-136.

[6] Udovichenko O.V., Grekova N.M. Diabetic foot: Guide for doctors. – M.: Practical medicine, 2010. – 272 p.

[7] A. Piaggesi, C. Goretti, E. Iacopi [et al.] Comparison of Removable and Irremovable Walking Boot to Total Contact Casting in Offloading the Neuropathic Diabetic Foot Ulceration // Foot Ankle Int. – 2016. – Apr. 15.

[8] Dunning T. Integrating palliative care with usual care of diabetic foot wounds // Diab. Metab. Res. Rev. – 2016. – Suppl 1. – P. 303-310.

[9] M.L. Brown, W. Tang, A. Patel [et al.] Partial foot amputation in patients with diabetic foot ulcers // Foot Ankle Int. – 2012. – Vol. 33, №9. – P. 707-716.

[10] Matmurotov K.J., Atakov S.S., Sattarov I.S., Otajonov J.H., Atajanov T.Sh. Bone Resection Features in Leg Amputation in Patients with Gangrene of Lower Extremities on the Background of Diabetes Mellitus // Amer. J. Med. Med. Sci. – 2019. – Vol. 9, №7. – P. 249-254.

[11] Santema T.K., Poyck P.P., Ubbink D.T. Systematic review and meta-analysis of skin substitutes in the treatment of diabetic foot ulcers: Highlights of a Cochrane Systematic review // Wound Repair Regen. – 2016. – Vol. 6.

[12] Waycaster C.R., Gilligan A.M., Motley T.A. Cost-effectiveness of Becaplermin Gel on Diabetic Foot Ulcer Healing: Changes in Wound Surface Area // J. Amer. Podiatr. Med. Assoc. – 2016. – Vol. 6.

[13] Xu S.M., Liang T. Clinical observation of the application of autologous peripheral blood stem cell transplantation for the treatment of diabetic foot gangrene // Exp. Ther. Med. – 2016. – Vol. 11, №1. – P. 283-288.

[14] Xu Z., Ran X. Diabetic foot care in China: challenges and strategy // Lancet Diabetes Endocrinol. – 2016. – Vol. 4, №4. – P. 297-298.