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MODERN METHODS AND PRINCIPLES FOR REDUCING COMPLICATIONS OF DIABETES MELLITUS

Ergashev Ulugbek Yusufjanovich
Zokhirov Adkhamjon Rafikovich
Istamov Maxmudali Iskandarovich
Department of General Surgery No.2, Tashkent
State Medical University (Tashkent, Uzbekistan)

Abstract. This scientific article presents a comprehensive treatment approach for 112 patients with purulent-necrotic wound complications in the lower extremities arising from diabetes mellitus. The patients were divided into groups according to Wagner's classification and treated using a locally produced medication (Reomannisol). The effectiveness of the complex treatment was assessed based on criteria such as the duration of patients' disability, the necessity for amputation, the frequency of repeat visits, and other indicators.

Keywords: diabetes mellitus; purulent-necrotic wound; Reomannisol; amputation; disability.

Introduction. The purulent-necrotic form of diabetes mellitus is one of its most common and severe complications, accounting for 15% of all patients with diabetes mellitus, resulting in more than 80,000 leg amputations annually in the USA [1,2,3]. Neuropathy, diseases of the peripheral arteries of the lower extremities, and the occurrence of infection are recognized as risk factors for the purulent-necrotic form of diabetes mellitus [4,5,6].

The reason patients seek medical attention is a surgical infection of the soft tissues [5]. In 5 European Union countries - France, Germany, Italy, Spain, and the United Kingdom - 1.3 million patients hospitalized with surgical soft tissue infections in 2004 were patients with purulent-necrotic injuries of the lower extremities due to complications of diabetes mellitus [7,8,9]. According to expert estimates, 700,000 patients with this pathology are registered annually in the Russian Federation [10,11,12].

Currently, scientists in the Russian Federation attribute the increase in surgical soft tissue infections to difficult living conditions, chronic immunodeficiency, increasing average age, and the deterioration of the environment from year to year [13,14,15]. In the Russian Federation, more than 5 million patients have reported purulent-necrotic lower limb injuries involving surgical soft tissue infections not associated with diabetes mellitus [16,17,18]. In the USA and Western Europe, up to 10% of patients with non-diabetic purulent-necrotic wounds are currently hospitalized, which causes damage to the state in the amount of $9-10 billion annually [19,20,21].

Furthermore, the average duration of inpatient treatment for ulcers, minor amputations, and major amputations alone is 13.3, 20.5, and 59.6 days. The average annual cost per patient is US$3,368 (ulcer only), US$10,468 (minor amputation), and US$30,131 (large amputation) [16]. The long duration of treatment for the purulent-necrotic form of diabetes mellitus, high disability and mortality rates, long hospitalizations, and high medical costs not only seriously affect the patient's quality of life and physical and mental health but also lead to significant economic losses for society [20,21,22].

Purpose of study: Conducting comprehensive treatment measures in patients with purulent-necrotic wounds of diabetic foot syndrome, determining the effectiveness of reducing the risk of amputation, and based on this, reducing days of disability.

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Materials and research methods. Clinical base of the 2nd Department of General Surgery of the Tashkent Medical Academy. The results of the examination and treatment of 112 patients with purulent-necrotic clinical forms of diabetes mellitus in the lower extremities were analyzed at the Purulent Surgery Department of the Yakkasaray District Medical Association between 2021 and 2024. The majority of the 112 patients with purulent-necrotic forms of diabetes mellitus in the lower extremities (78; 69.6%) were men, and the remaining 34 (30.4%) were women. The ratio of men to women was 2.3: 1, which corresponds to the statistics of Uzbekistan as a whole. The age of the patients we observed ranged from 50 to 80 years. The average age of the patients was 65.2±1.7. The duration of diabetes mellitus averaged 10.3±0.65 (see Table 1).

Table 1

Characteristics of the patients under study

Average age	65.2±1.7
Average duration of diabetes, years	10.3±0.65
Men	78 (69.6%)
Women	34 (30.4%)

Results. To determine whether to perform conservative or minor surgical operations in patients with purulent-necrotic wounds of diabetes mellitus, we used a duplex scanning method to determine the patency of the main and diastatic arteries of the lower extremities (see Table 2).

Distal polyneuropathy was found to underlie microcirculatory blood flow disorders in patients with the purulent-necrotic form of diabetic foot syndrome. In this case, the developing edema further exacerbates microcirculatory disorders and creates additional conditions for the development of secondary ischemia in the affected area. In ischemic and neuroischemic forms of diabetic foot syndrome, damage to the main arteries is the leading factor in microcirculation disorders. In patients with purulent-necrotic complications, the distal type prevailed among major arterial lesions in ischemic and neuroischemic forms of diabetic foot syndrome.

Table 2.

Distribution of results for vascular permeability of the peripheral arteries of the lower extremities

Scope of investigation	Control group (n=62)		Main group (n=50)		p
	Stenosis, %	Occlusion, %	Stenosis, %	Occlusion, %	p<0.05
Iliofemoral segment	5 (8.06)	2 (3.22);	6 (12.0)	0 (0.00)	p<0.05
Femur-subknee segment	4 (6.67)	3 (4.84)	A (8.0);	1 (2.0)	p<0.05
Femur-subknee segment stenosis and tibio-calcaneal segment occlusion	23 (37.1);		19 (38.0)		p<0.05

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Femur-subknee and tibio-calcaneal segments	6 (9.67)	3 (4.84)	A (8.0);	2 (4,0);	p<0.05
Tibiopalveolar segment	7 (11.29)	9 (14.51).	6 (12.0)	8 (16.0)	p<0.05
Total	62 (100.00)		50 (100.00)		

In the control group, the most frequently affected areas were the thigh-hip segment and the calcaneofibular segment (51.61%). In the main group, the same segments were found to be affected, accounting for 50.0%.

After detecting stenosis in 6 (9.67%) patients and occlusion in 3 (4.84%) patients of the control group, and stenosis in 4 (8.0%) patients and occlusion in 2 (4.0%) patients of the study group, MSCT angiography was performed and X-ray endovascular interventions were performed (see Table 3).

Table 3.

Distribution of X-ray endovascular interventions performed in patients with Wagner grade IV

Artery	Type of injury	Control group, n=9.				Main group, n=6;			
		BAP		BAP and stenting		BAP		BAP and stenting	
		n	%	n	%	n	%	n	%
ASF*	Stenosis	-	0.00	-	0.00	-	0.00	-	0.00
	Occlusion	-	0.00	-	0.00	-	0.00	-	0.00
ASF**+ ATA*	Stenosis	1.	11.1	-	0.00	1.	16.7	-	0.00
	Occlusion	-	0.00	-	0.00	-	0.00	-	0.00
ASF*+ ATP	Stenosis	-	0.00	-	0.00	-	0.00	-	0.00
	Occlusion	-	0.00	1.	11.1	-	0.00	1.	16.7
ASF*+ AP**	Stenosis	1.	11.1	-	0.00	-	0.00	-	0.00
	Occlusion	-	0.00	-	0.00	-	0.00	-	0.00
ASF*+ AP*+ ATA	Stenosis	-	0.00	-	0.00	-	0.00	-	0.00
	Occlusion	-	0.00	1.	11.1	-	0.00	-	0.00
ASF*+ AP*+	Stenosis	-	0.00	1.	11.1	-	0.00	1.	16.7
	Occlusion	-	0.00	-	0.00	-	0.00	-	0.00

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ATP**									
AP*+	Stenosis	-	0.00	2.	22.2	-	0.00	1.	16.7
ATA**	Occlusion	-	0.00	-	0.00	-	0.00	-	0.00
AP*+	Stenosis	-	0.00	-	0.00	-	0.00	-	0.00
ATP	Occlusion	-	0.00	1.	11.1	-	0.00	1.	16.7
ASF**+	Stenosis	1.	11.1	-	0.00	1.	16.7	-	0.00
APF*	Occlusion	-	0.00	-	0.00	-	0.00	-	0.00
Total		3.	33.3	6.	66.7	2.	33.3	4.	66.7

* - hemodynamically insignificant stenosis; ** - hemodynamically significant stenosis;

During the operation, no occlusion was detected in the superficial femoral artery (SFA) of patients in both groups, but hemodynamically insignificant stenosis was identified. In 1 (11.1%) patient of the control group, hemodynamically significant stenosis of the superficial femoral artery (SFA) (95% degree of stenosis) and hemodynamically insignificant stenosis of the anterior tibial artery (ATI) (35% degree of stenosis) was detected; balloon angioplasty (BAP) of the SFA was performed on this patient. In 1 (11.1%) patient, hemodynamically insignificant stenosis in the ACL (strength of stenosis 30%) and a 2.0 cm occlusion in the posterior tibial artery (OrTBA) were identified, to which a stent was applied to restore patency using a JR LBT (Long Bright Type) conductor with a diameter of 2 F. In 1 (11.1%) patient, hemodynamically insignificant stenosis of the ACL (30%) and hemodynamically significant stenosis of the popliteal artery (85%) were detected; this patient underwent balloon dilation with a 0.014 conductor at a pressure of 12–18 atm using a balloon catheter, after which re-angiography was performed and patency was fully restored. In 1 (11.1%) patient with hemodynamically insignificant stenosis (30% and 35%) in SCA and AP, and occlusion in ASF, stenting was performed in combination with balloon angioplasty. Hemodynamically insignificant stenosis (30% and 35%) was identified in the PAT and AP, and hemodynamically significant stenosis (95%) in the posterior tibial artery (PTA), and this patient underwent BAP and stenting. In 2 (22.2%) patients, hemodynamically insignificant stenosis (30%) was identified in the AP, hemodynamically significant stenosis (95%) in the ACBA, and patients were fitted with a SAVVY Cordis stent with a diameter of 4.0 mm, and patency was restored. Hemodynamically insignificant stenosis (25%) was detected in the AP and a complete 3.0 cm occlusion in the ATP, and stenting was performed. In 1 (11.1%) patient, hemodynamically significant stenosis (90%) was detected in the deep femoral artery (DFA) and hemodynamically insignificant stenosis (20%) in the deep femoral artery (DFA), and this patient underwent dilation with a 6 F cylindrical catheter at a pressure of 12-18 atm; vascular permeability was restored.

In 1 (16.7%) patient of the main group, 95% stenosis was detected in the UCA, and this patient underwent balloon dilation using a STRAIGHT 5F diagnostic catheter; blood flow was fully restored (see Fig. 4.6).

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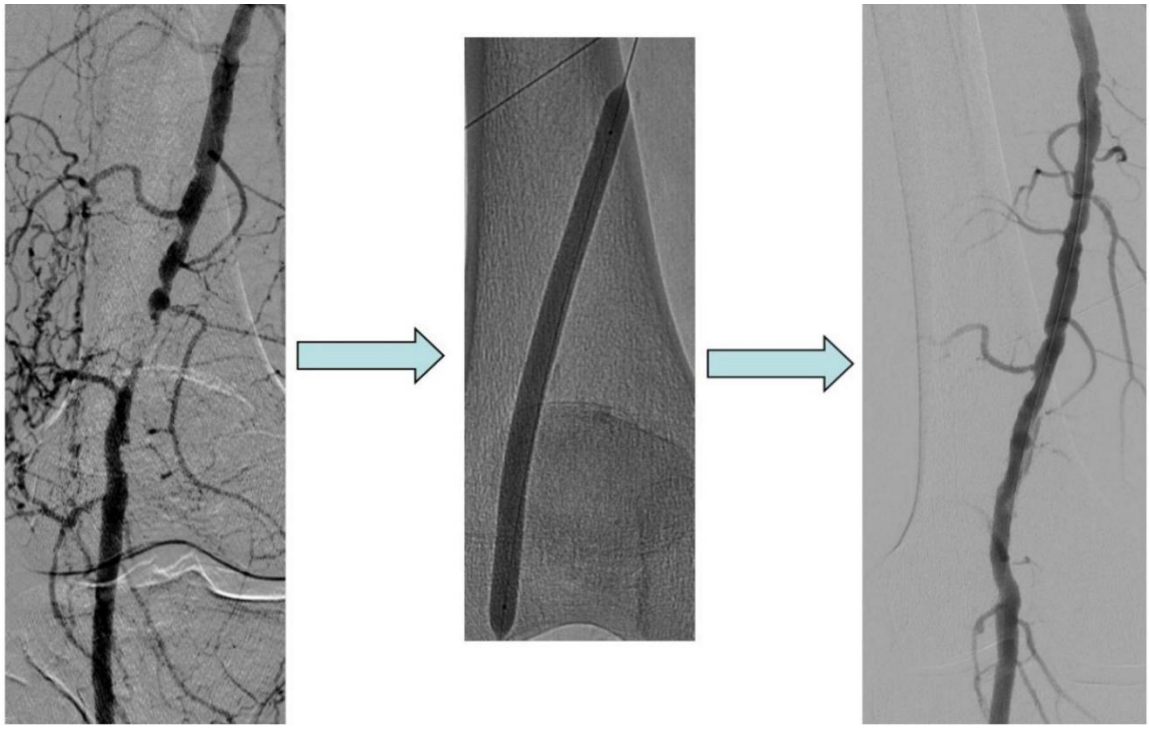

Figure 1. Restoration of blood flow after balloon angioplasty of 95% hemodynamically significant stenosis in the distal part of the superficial femoral artery.

In 1 (16.7%) patient with an occlusion of 5.0 cm in the posterior tibial artery (TBA), CAP and stenting were performed, blood flow was restored, local temperature in the soft tissues of the fingers and toes was increased, and pulse was detected in the medial subclavian region. In 1 patient (16.7%) with hemodynamically insignificant stenosis of the SCA and AP (30% and 35%) and hemodynamically significant stenosis of the ATP (89%), dilation was performed using a 0.014 mm diameter balloon catheter for 180 seconds at a pressure of 15-18 atm, but due to the possibility of restenosis, stenting was used. In 1 (16.7%) patient, hemodynamically significant stenosis (89%) was detected in the ACBA, and stetherization was performed on this patient, vascular permeability was restored, and pulse was determined. In 1 (16.7%) patient with complete permeability impairment in the posterior tibial artery (PTA), stenting with balloon angioplasty was successfully performed, soft tissues warmed up, pulse was restored, and blood flow improved.

All patients who underwent X-ray endovascular interventions continued conservative treatment. In the main group of patients, purulent-necrotic wounds of the lower extremities were treated with an ozonated physiological solution, and Reomannisol, which improves blood rheology, was administered parenterally according to the plan. At the same time, patients eliminated critical ischemia, pain disappeared, superficial wounds healed, the healing time for non-healing prolonged wounds was reduced by 10 days, small amputations were performed, the volume of large amputations decreased, and no postoperative complications were observed.

Comprehensive treatment of the purulent-necrotic form of diabetes mellitus should be based on the following principles: saving the patient's life or reducing the severity of amputation. The integrated approach used to solve these tasks serves as the basis for forming an algorithm for a pathogenetic approach to treating this complex category of patients.

Discussion. To study the correct choice of tactics and the effectiveness of the treatment method in patients receiving complex treatment, patients' injuries were studied in the

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postoperative period. A total of 112 patients were examined, including 62 (55.36%) patients in the control group and 50 (44.64%) patients in the study group.

Indicators such as mortality, a high frequency of amputations, treatment duration, and the number of repeat visits were used as criteria for treatment effectiveness. Based on these indicators, the final results of the treatment were evaluated, rather than the intermediate results.

Assessment of the effectiveness of the complex treatment was carried out according to the scheme developed in our clinic, conditionally taking into account the results of "good," "satisfactory," "unsatisfactory," "death," "re-apply" (see Table 4).

Table 4.

Evaluation of the effectiveness of surgical interventions as a result of complex treatment performed on patients

Results	Main group (n=50)		Control group (n=62)	
	abs	%	abs	%
Good	34	68.00	35	56.45
Satisfactory	10	20.00	12	19.35
Not satisfactory	3.	6.00	5.	8.06
Lethality	1.	2.00	2.	3.23
Reapply	2.	4.00	8.	12.9
Total	49	98.00	47	96.77

A good result is achieved by stopping the purulent-necrotic process in the foot area using minor surgical interventions (opening and draining of phlegmon, exarticulation of finger phalanges, metatarsal resection) while preserving the support function of the foot;

Satisfactory result - if, against the background of complex treatment, it is possible to reduce the presumed high localization of the amputation while preserving the knee joint, and patients return;

Unsatisfactory outcome – if, against the background of complex treatment, the purulent-necrotic process intensifies, a leg amputation was performed at the hip level, or it resulted in death.

The unsatisfactory state in the main group was associated with 3 (6.0%) hip amputations, which were closely linked to the complete occlusion of the tibial segment artery and the accelerated development of purulent-necrotic lesions. Repeat visits (2 (4.0%) were associated with insufficient primary surgical treatment of the wound and the failure of patients to receive the necessary medications. It was established that the mortality rate in the control and our main groups is due to the decompensation stage of diabetes mellitus, as well as the patient's history of acute myocardial infarction, chronic renal failure, amputation of the middle 1/3 of the thigh, and acute cardiovascular failure. Furthermore, the "Good" status increased from 56.45% to 68.0%, the "Satisfactory" status increased from 19.35% to 20.0%, and mortality decreased from 3.23% to 2.0%, proving that our treatment method is more effective than the treatment method in the control group.

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Conclusion. As a result of complex treatment based on Doppler and angiographic indicators in patients with purulent-necrotic wounds of diabetes mellitus, a reduction in the number of high amputations from 8.06% to 6.0% was achieved. Additionally, as a result of complex treatment of patients with purulent-necrotic complications of diabetic foot syndrome, their quality of life and lifestyle were preserved, and the disability rate due to diabetes mellitus decreased from 17.74% to 12.0%.

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