American Journal of Medicine and Medical Sciences 2025, 15(1): 9-14
DOI: 10.5923/j.ajmms.20251501.02

A Strategy for the Treatment of Patients with Diabetic Foot Gangrene Against the Background of Scheduling Hemodialysis

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Abstract The results of the study and inpatient treatment of 147 patients with diabetic feet gangrene against the background of scheduling hemodialysis were analyzed, in which various surgical operations were carried out on the feet. Patients were in stationary treatment in the department of purulent surgery of the multidisciplinary clinic of the Tashkent Medical Academy in 2016-2023. Depending on the surgical tactics of the surgical method of treatment, patients are divided into 2 groups. Group 1 (comparison) was made up of 79 patients (53.8%) admitted to inpatient treatment in 2016-2018. In these patients, endovascular revascularization practices and small operations were performed in the traditional way without taking into account the damage nature of the foot and toe peripheral arteries. Group 2, which was considered the main, included 68 patients (46.2%) who were admitted to inpatient treatment in the same unit in 2019-2023.

Keywords Diabetes, Diabetic foot syndrome, Gangrene, Amputation

1. Introduction

Diabetes mellitus is the most common endocrine disease in the world. According to the IDF Diabetes Atlas for 2023, 630 million diabetes patients are registered in the world, and according to predictions, 1 billion people suffer from diabetes by 2045 [1]. According to 2021 statistics, 3,582,865 patients in our country were diagnosed with DM [2,3]. Experts have been regularly studying the problem of diabetes and its complications for the past 20-30 years. During these years, various theories of DM etiopathogenesis have been proposed and the main factors in the development of the disease have been identified. By the end of the 20th century, most scientists had come to a general consensus that a number of tissues, organs and systems would be involved in the pathological process in diabetes at the same time. One of the most severe and dangerous complications of DM is foot damage [4,5,7]. It is known that at the expense of atherosclerotic lesions in the arteries of the feet, 27-43% of patients show distal flow disorders of the arterial system, which in turn indicates that joint stenosis or occlusion of small and medium-sized arteries may occur in the areas below the knee [8]. In this case, atherosclerosis of the calf arteries can occur between them for a long time without clinical symptoms due to the developed collateral network. There may be no ischemic symptoms if at least one of the tibial arteries is unchanged i.e. performs its function fully [9,10]. Over the past decades, "evolution" of atherosclerosis has been observed and treatment strategies have changed to some extent. The number of patients with multiple occlusions and damage to the knee arteries is increasing, which reduces the chances of conventional vascular surgery. For this reason, more than 30% of patients do not have the opportunity to perform standard reconstructive surgery [11]. As a result of this, the implementation of primary high amputations of the legs is observed along with an increase in mortality and reaches 21-44% [12].

Critical limb ischemia (CLI) is constant pain for two weeks (rare exacerbation), characterized by the presence of trophic injuries on the toes, which in turn corresponds to stages 3-4 under the Fontaine-Pokrovsky grade and 4-6 under the Rutherford classification. It was mentioned that the frequency of morbidity with CLI on the Earth is 50-100 cases per 100,000 people per year [13]. In patients of this contingent, critical ischemia to the tibial arteries (in most cases, each artery below the knee) is indicated as the cause of critical ischemia observed in the feet in 25-30% of cases [14]. Only 23-80% of patients in this condition manage to carry out the restoration of arterial circulation only in cases, and in the general case 16% of patients are forced to carry out a primary above the knee amputation [15].

The purpose of the study was to improve the results of the treatment of patients with diabetic gangrene of the feet

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Received: Dec. 6, 2024; Accepted: Dec. 28, 2024; Published: Jan. 11, 2025
Published online at http://journal.sapub.org/ajmms

against the background of scheduling hemodialysis.

2. Material and Methods

In this research work, the results of the surgical treatment of 147 patients with diabetic feet gangrene against the background of scheduling hemodialysis were analyzed, in which various surgical operations were carried out on the feet. Patients were in stationary treatment in the department of purulent surgery of the multidisciplinary clinic of the Tashkent Medical Academy in 2016-2023. Depending on the surgical tactics of the surgical method of treatment, patients are divided into 2 groups. Group 1 (comparison) was made up of 79 patients (53.8%) admitted to inpatient treatment in 2016-2018. In these patients, endovascular revascularization practices and small operations were performed in the traditional way without taking into account the damage nature of the foot and toe peripheral arteries. Group 2, which was considered the main, included 68 patients (46.2%) who were admitted to inpatient treatment in the same unit in 2019-2023. In them, endovascular revascularization practices in the peripheral arteries of the feet were carried out according to the combined method improved taking into account the damage nature of the tibial arteries. In addition to surgery, against the background of the hemodialysis program, all patients with diabetic foot gangrene received an intensive complex of systemic antibacterial, double antiagregant, therapy and treatment measures for vasoconstriction. It should also be noted that all patients are in scheduling hemodialysis, which complicated our surgical treatment tactics in terms of conducting adequate infusion therapy and catheter therapy, since there is no possibility of hemodialysis in our medical complex, and every 3 days patients were forced to go to another medical institution. When choosing a strategy for surgical procedure in patients in the comparison group, the degree of damage to peripheral arterial flow, the nature of the pathological process and the effectiveness of bacterial flora on antibacterial drugs were taken into account. Endovascular Surgery in patients in the main group was carried out according to our improved methodology, taking into account the damage nature of the tibial arteries, which are described in detail in this dissertation. In principle, the patients examined were assessed as having a severe course of DM, with clinical signs of complications against the background of organic changes in target organs and systems.

3. Results and Discussion

Despite adjustments to treatment tactics aimed at improving affected limbs, these patients were required to receive appropriate preoperative training and conduct in a special manner during the postoperative period. There were 4 (3.8%) of patients who were not diagnosed with deviations in members other than affected toes. Thanks to long-term full-complex treatment, much more positive results were achieved in them. Patients undergoing endovascular revascularizing surgery against the background of scheduling hemodialysis were diagnosed with ischemic and neuroishemic forms of DFS (Table 1).

Occlusive-stenosis lesions of arterial blood flow and the appearance of PNLT (purulent necrotic lesions of the toe) associated with signs of damage to peripheral nerve nodes, i.e. neuroishemic form of DFS, were found in 139 of the patients examined (94.6%), neuropathic form - 8 (5.4%). All patients with a neuroishemic form of DFS underwent endovascular revascularization (balloon angioplasty). In the neuropathic form, there was no need for endovascular practices, and only intra-arterial catheter therapy (IACT) was performed in patients in the main group at high risk of postoperative complications.

Table 1. Distribution of patients according to the DFS form

DPS forms	Main group, (n=68)		Comparison group, (n=79)		χ^2	p
	abs.	%	abs.	%		
Neuropathic	3	4,4	5	6,3	0,000	<0,05
Neuroishemic	65	95,6	74	93,7	2,803	<0,05
Total	68	100	79	100	32,968	<0,001

Table 2. Distribution of patients according to the localization of the purulent-necrotic process in the toe

№	Damage volume (area)	Comparisiongroup, (n=79)		Main group, (n=68)		χ2	p
		абс.	%	абс.	%		
1.	Toe finger gangrene	26	32,9	21	30,9	0,145	<0,05
2.	Toe distal gangrene	10	12,6	8	11,7	0,023	<0,05
3.	Heel spur gangrene	14	17,7	17	25,0	0,162	<0,05
4.	Deep phlegmon of the toe	11	13,9	9	13,2	0,119	<0,05
5.	Total gangrene of toe	18	22,8	13	19,1	0,128	<0,05
	Total	79	100	68	100	32,968	<0,001

Companion diseases were diagnosed in 66.1% of patients in the comparison group and 67.9% of those in the main group. Of the concamitant diseases, ischemic heart disease (IHD) - in 46.1%, hypertension and diabetic enteropathy (DEP) were most common. Diseases of other organs and systems (diabetic retinopathy, arterial hypertension) are less common. Thus, delayed hospitalization of a large number of patients, the presence of severe levels of intoxication, the large number of elderly people with concamitant diseases is an unpleasant condition that contributes to the development of complications in the postoperative period, which made it difficult for patients with DFS to choose surgical treatment and care them. The pathological process in the toe was often localized in the area of the fingers: in the main group, such patients were 21 (30.9%), in the comparison group - 26 (32.9%). Gangrene of the distal part of the toe was rarely observed - in 11.7 and 12.6% of those examined, respectively. This group included patients with a purulent-necrotic process up to the toe bone (Table 2). In terms of prognosis and treatment, end-stage (most critical) heel area gangrene was observed in 31 patients (21.1%).

One of the difficult to diagnose toe nosology in patients with scheduling hemodialysis is deep foot phlegmon, with 20 cases (13.6%) reported. 31 (21.1%) patients have been diagnosed with massive toe necrosis (total gangrene). 97.2% of patients with scheduling hemodialysis who were admitted to our clinic with leg gangrene had type 2 diabetes, with insulin-dependent Type DM reported in only 4 (2.8%).

Analysis of the results of peripheral endovascular revascularizing surgeries in patients in the comparison group showed that existing traditional techniques or implementation approaches are not sufficiently effective in terms of maintaining the toe and reducing the number of postoperative complications.

Clinical observation.

Patient B.I., DOB 1964, k/h No. 651/172. Was admitted on January 12, 2024, the left toe was laid on the medial surface with complaints of pain, redness, purulent-necrotic wound and darkening. From Anamnesis: has been suffering with diabetes for 15 years, constantly taking drugs (insulin) that reduce sugar levels (hypoglycemic). Operated on left toe gangrene 3 months ago, it has been in scheduling hemodialysis for 2 years. In dynamics, treatment did not work, the patient's condition was aggravated, he was admitted to our clinic for treatment in stationary conditions. The patient's condition is stable, severe at the time of arrival. The skin coating and visible mucous membranes have a tonal color. Blood pressure 100/70 mm Hg. Pulse - 80 beats / min. Weakened vesicular breathing in the lungs. The abdomen is soft and painless. The liver and spleen are not enlarged. Fecal and urine excretion is regular.

Local: the limbs are asymmetrical due to swelling of the left toe. The toe is cold and painful in the area of the wound when it is touched. In the area of the medial surface of the left foot there is a neuroischemic wound measuring 3.0 x 2.5 cm, as well as swelling and deformity of the toe (Fig. 1).

Figure 1. The initial appeal is the appearance of the foot toe

Figure 2. Subintimal angioplasty via sub knee access

In the shin area on the left, the territorial lymph nodes are not enlarged, they are painless. The heart rate (HR) is determined in the arteries of the toe. With ultrasound, the blood flow in the vessels of the lower leg is collateral. The patient has a purulent necrotic ulcer of the medial surface of the left foot. MRI revealed occlusion of the femoral arteries (FA and popliteal artery), and it was decided to perform a Subintimal balloon angioplasty via knee access (Fig. 2).

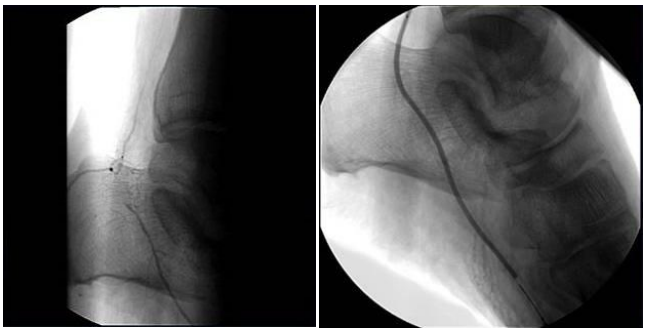

Figure 3. Angiography before and during the implementation subintimal angioplasty

In angiography, occlusion was recorded in the femoral arteries basin and Subintimal angioplasty was performed on the patient on January 13, 2024.

A good arterial flow was achieved using the first endovascular treatment method, and the intraducer was installed on the

skin for 2 days after the IAT (Figure 3).

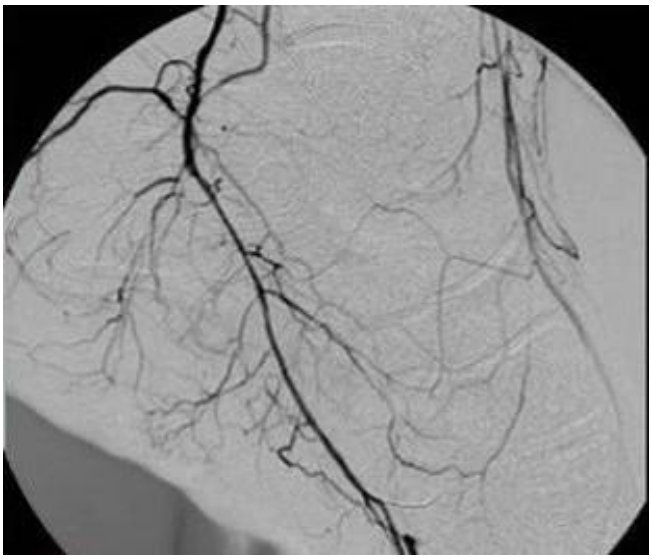

Figure 4. Vascular appearance after SBAP implementation

The patient was given a second SBAP session with a satisfactory result on January 15, 2022 (Figure 4).

The patient was discharged from the clinic for outpatient treatment at the place of residence in a satisfactory condition on January 17, 2024.

Figure 5. Toe view 1.5 months after SBAP implementation

Against the background of surgical treatment carried out in the control examination, it was observed that the scar defect in the toe was completely healed in dynamics (Figure 5).

The result of surgical tactics of treatment, of course, depends on the localization of the purulent-necrotic lesion in the toe, the condition of the local tissues and the compensation of ischemia in the toe area. Based on the study of unsatisfactory results of endovascular practices in patients in the comparison group and the assessment of the results according to the effect on the localization of the purulent-necrotic process in the toe and its postoperative course, we proposed a new improved method of combined endovascular practices.

Unlike the comparison group, it was observed that patients in the main group had a 58.2 to 73.5% increase in good performance rates in the postoperative period. The frequency of a satisfactory result in groups did not differ significantly: in the comparison group, their number was 20.2%, in the main group - 17.2% (Figure 6). A certain difference in the results of surgical treatment was noted in patients with above-the-knee amputations. In the comparison group, this figure was 21.5% (17 out of 79 patients), thanks to the use of an improved method of endovascular revascularizing surgeries in the main group, a reduction of 8.8% was achieved (in 6 out of 68 patients). For patients, performing repeated surgeries is always considered an additional physical and psychological trauma. In some cases, repeated surgeries are sometimes required, regardless of the technique of performing small surgeries on the foot and the medical procedures performed. All repeated practices carried out on the toe were associated with purring of the wound after surgery or the rapid development of ischemic manifestations.

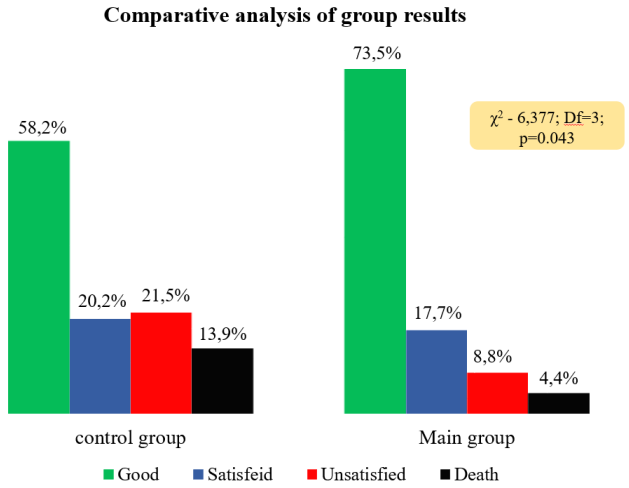

Figure 6. Efficacy indicators of combined endovascular treatment in diabetic gangrene of the toes

In the comparison group, 11 patients (13.9%) were required to perform repeated surgeries, while the need for secondary surgery in the primary group only appeared in 4 patients (5.8%). In the main group, a gradual necrectomy was not performed several times, in the comparison group it was performed in 2 patients (2.5%). From this data, it is possible to adequately assess the effectiveness of the improved method of endovascular revascularization, since repeated operations were rarely required in patients of the main group, in most cases, positive results were obtained after combined minimally invasive interventions.

4. Discussion

In most cases, it is necessary to carry out a above-the-knee amputations of the legs as a result of improperly performed operationalization or a selective tactic that is not suitable for the treatment of patients with purulent-necrotic processes of the toe against the background of DFS. After above-the-knee amputations, most patients lose their social status and experience mental emotional stress, with a very high probability of losing even the second leg in the next 2 years. Therefore, this study is relevant in terms of the social status of patients and

the prevention of severe complications in patients with ulcerative defects against the background of DFS.

Thus, we have improved the technique of performing a combined endovascular operation. In this case, the localization of the purulent-necrotic lesion or the nature of damage to the peripheral arteries is strictly taken into account. In patients with a severe purulent process (wet gangrene) on the toe, second stage operation was carried out: the first stage - surgical dating of the pathological hearth with maximum preservation of suspicious tissue around the wound, the second stage-examination of peripheral arteries with endovascular revascularization, followed by reconstructive plastic surgery, taking into account local tissues in the toe part and localization of lesion. The time for the implementation of the second stage was determined individually and averaged 3-10 days. In the case of critical ischemia (such patients in the studied groups 96.3%), we first tried to carry out revascularization of the peripheral arteries of the legs (balloon angioplasty) (in the main group, only subintimal balloon angioplasty), dating of the postiniratory-necrotic lesion, and then reconstructive surgery.

In almost half of patients with amputated legs, a state of depression is observed: in 52% - mild, in 8% - severe (on the Hamilton Depression Rating Scale). This once again emphasizes how important it is for the patient to maintain the support activity of his legs and the possibility of returning to normal social life.

Summarizing these cited data, it should be noted that according to the affected part of the toe and the nature of the arterial basin lesions of the legs, the results of treatment were significantly improved in terms of maintaining the functional and musculoskeletal functions of the foot using an improved method developed to perform combined endovascular operations. The main effect of the improved method was achieved by reducing the number of patients with whom above-the-knee amputations were performed, which ensured the preservation of the optimal base function of the paw. Properly selected surgical strategy and technically based on the affected parts of the toe contributed to the smooth course of the post-revascularization operation, which made it possible to achieve positive treatment results.

5. Findings

1. In terms of the volume of arterial nutrition of the toe and the possibility of compensating for circulatory disorders in the etiopathogenesis of the occurrence and development of gangrene of the ankle in DFS, the posterior large tibial artery plays a key role, since the probability of the occurrence of a purulent-necrotic process in the toe in isolating damage to the posterior tibial arterial basin is 59.9% ($p>0.05$).
2. An improved surgical strategy for the execution of combinatorial ьштшьфд штмфқшму operations (main group (n=68)) resulted in good results in 73.5% of cases $p>0.05$), which is significantly higher in comparison group patients (58.2%). As a result of these surgical tactics, a low rate of mortality was recorded in the post - operative period - 4.4% (n=3) (in the comparison group-13.9% (n=11)) ($r>0.05$).
3. In patients with toe gangrene with DFS against the background of chronic renal failure, the implementation of combined endovascular operations reduces the preservation of functional activity of the toe from 59.4 to 72.3% ($r>0.05$), improves musculoskeletal activity from 78.3 to 90.7% ($p>0.05$), and in turn reduces the frequency of above-the-knee amputations of the legs from 21.5 (n=17) to 8.8% (n=6) ($p>0.05$).

Consent

It is not applicable.

Ethical Approval

It is not applicable.

Competing Interests

Authors have declared that no competing interests exist.

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