

Optimal Timing for Minor Foot Surgery After Peripheral Artery Revascularization in Patients with Diabetic Foot Syndrome

Matmurotov K. J.^{1,*}, Narmetov A. B.², Sapayev B.³

¹Tashkent State Medical University, Uzbekistan

²Khorezm Branch of the Republican Specialized Scientific-Practical Medical Center of Endocrinology, Uzbekistan

³Alfraganus University, Uzbekistan

Abstract This research paper analyzed the results of treatment of 157 patients with purulent-necrotic lesions of the foot in patients with diabetic foot syndrome against a background of severe tissue ischemia, who underwent various types of foot surgery. Depending on the surgical treatment strategy, patients were divided into two groups. The first group (comparison) consisted of 82 (52.2%) patients who received inpatient treatment in 2020-2022. These patients underwent surgical interventions using the traditional method, without taking into account the nature of ischemia and clear criteria for the timing of the operation. The second group, which was considered the main one, included 75 (47.8%) patients who were treated in 2023-2025. The surgical treatment tactics in this group differed sharply from those in the comparison group, with the optimal choice of the timing of surgical treatment and the specifics of reconstructive and plastic surgery on the foot.

Keywords Diabetes mellitus, Gangrene, Amputation, Endovascular revascularisation

1. Introduction

Diabetes mellitus is the most common endocrine disease in the world. According to IDF Diabetes, in 2024 there were 589 million people with diabetes among the population aged 20-79 worldwide, and it is predicted that by 2050, 853 million people will suffer from diabetes mellitus [1,10,14]. According to statistics for 2023, 3,845,176 patients in our country were diagnosed with type 2 diabetes [2,11,13,20].

Specialists have been regularly studying diabetes mellitus and its complications for the last 20-30 years. During this time, various theories of the etiopathogenesis of DM have been proposed, and the main factors in the development of the disease have been identified. Towards the end of the 20th century, most scientists reached a consensus that diabetes mellitus involves a number of tissues, organs, and systems in the pathological process. One of the most serious and dangerous complications of diabetes is damage to the lower extremities [3,7,18,21].

Multifocal damage to target organs is directly related to a reduction in the diameter of the artery lumen, up to its complete closure, which causes a significant disruption in the blood supply to the main vessels, leading to impaired

blood circulation in the microcirculatory vessels and causing tissue hypoxia and tissue metabolism disorders. The situation is exacerbated by the opening of shunting arteriolar-venular anastomoses. This effect is relevant in the development of skin and muscle ischemia. As a result of a complex imbalance in the coagulation system, disseminated intravascular coagulation develops, which subsequently leads to the development of destructive changes in tissues under conditions of hypoxia [4,9,12,17].

The main cause of peripheral arterial disease is atherosclerosis, but in the context of diabetes mellitus, the pathophysiological process aimed at changing the vascular bed is also of considerable importance. At the same time, a number of other nosologies associated with gradual obliteration of the arteries can cause chronic limb ischemia syndrome. The following are among the main risk factors [1,5,18].

The prevalence of occlusive-stenotic peripheral artery disease, whether symptomatic or asymptomatic, is slightly higher among men than women, particularly in younger age groups. Among patients with intermittent claudication, the ratio of men to women ranges from 1:1 to 2:1. As discussed in the previous section on epidemiology, the incidence and prevalence of diseases related to arteries increase sharply with age [6,8,11,15,19]. It is one of the main risk factors for the development of peripheral arterial disease. It contributes to the development of this disease 2-3 times more often than cardiovascular disease. Large randomised epidemiological

* Corresponding author:

mj_80@mail.ru (Matmurotov K. J.)

Received: Mar. 6, 2026; Accepted: Mar. 27, 2026; Published: Apr. 1, 2026

Published online at <http://journal.sapub.org/ajmms>

studies have revealed that smoking increases the risk of developing PAD by 2-6 times and IC by 3-10 times [7,10,16,21].

Considering the above-mentioned literature data and despite the development of surgical technologies in this area, the frequency of high amputations and mortality rates has not decreased. One important factor in the treatment of patients with gangrene is the optimal timing of debridement surgery after adequate revascularization. In this regard, we decided to study this issue and offer our assessment of how to solve this problem.

The aim of this study was to improve the results of surgical treatment of purulent-necrotic lesions against a background of severe ischemia in patients with diabetic foot syndrome.

2. Materials and Methods

This research paper analyzed the results of treatment of 157 patients with purulent-necrotic lesions of the foot in patients with diabetic foot syndrome against a background of severe tissue ischemia, who underwent various types of foot surgery. The patients under study were hospitalized in the purulent surgery department of the Tashkent Medical Academy's multidisciplinary clinic and the Twins Medical Center private clinic in 2020-2025. Depending on the surgical treatment strategy, patients were divided into two groups. The first group (comparison) consisted of 82 (52.2%) patients who received inpatient treatment in 2020-2022. These patients underwent surgical interventions using the traditional method, without taking into account the nature of ischemia and clear criteria for the timing of the operation.

The second group, which was considered the main one, included 75 (47.8%) patients who were treated in 2023-2025. The surgical treatment tactics in this group differed sharply from those in the comparison group, with the optimal choice of the timing of surgical treatment and the specifics of reconstructive and plastic surgery on the foot.

The data obtained during the study showed that patients had a much more severe clinical condition upon admission. Among the patients examined during their initial visit to the hospital, 56 (35.7%) of 157 had total foot ischemia with signs of partial foot muscle contracture. Indeed, this condition complicated our tasks in terms of choosing surgical procedures and preserving the musculoskeletal function of the lower limb as a whole.

Severe foot ischemia without any trophic disorders was observed in only 5 cases (3.2%), which was treated conservatively after revascularization of the peripheral arteries. Distal gangrene involving the toes was observed in 40 patients (25.5%).

Of course, the primary goal in treating severe foot ischemia is to preserve the feet or the weight-bearing function of the limb in patients with diabetic foot syndrome, but an initial incorrect or inadequate surgical strategy can worsen the situation, leading to limb loss or death.

In patients, using non-invasive and invasive methods of studying the condition of the peripheral arterial bed, the severity of mediocalcinos development was determined, which determines the degree of ischemia in the foot. Calcification of arterial walls is a gross metabolic disorder against the background of diabetes mellitus, which is not uncommon in patients with diabetic foot syndrome. Our study included patients with pronounced foot ischemia and these patients did not have I-degree mediocalcinos. According to the examination data, only II and III degrees of arterial wall damage were observed in patients.

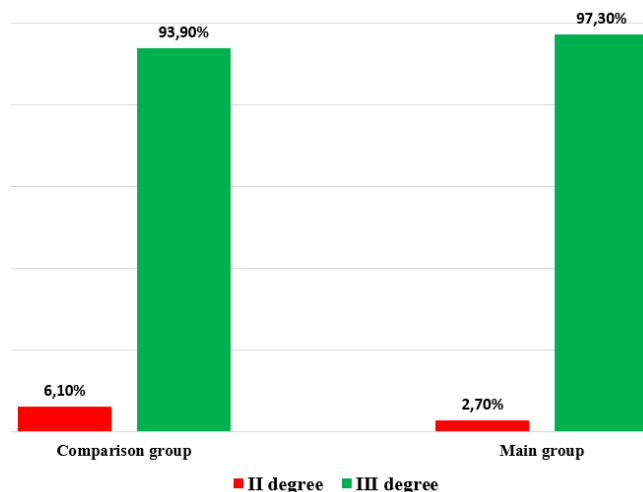


Figure 1. Severity of medial calcification of the arteries of the lower extremities

3. Results and Discussion

In our study, the control group consisted of 85 patients who underwent endovascular revascularization procedures for purulent-necrotic lesions. Conservative treatment consisted of eliminating factors that could further worsen arterial blood supply to the lower extremities. Simultaneous correction of blood lipid and glucose levels was also performed.

Drug treatment included the prescription of dual anticoagulant therapy and prostaglandin E1 (vasostenon). Along with systemic vascular therapy, patients underwent local therapy, which included modern dressing preparations and, of course, vacuum therapy to accelerate the healing process against the background of ischemia relief. Within 10-14 days after the application of these procedures to the infected and trophic wound, its cleansing from detritus and discharge was observed, which directly contributed to the growth of granulation tissue with the transition to the second phase of the wound healing process.

Despite adequate treatment, the comparison group continued to experience adverse outcomes associated with a high frequency of amputations and repeat secondary surgical interventions. In our opinion, the main reason for this was the failure to take into account the timing of primary radical surgical interventions on the foot. We consider the simultaneous removal of all necrotic tissues immediately

after improving arterial blood flow through endovascular revascularization to be inappropriate, since a minimum of 4-5 days is required for the remodeling of the collateral arterial network (according to our data). Oxygen tension indicators in the postoperative period also confirm our actions.

An analysis of the immediate results of surgical treatment in the study groups showed that in the main group, the frequency of good treatment outcomes improved by almost 10%, and high amputation of the lower extremities decreased fourfold. The rate of minor amputations of the foot was higher in the main group than in the comparison group (10.6–14.7%) (see Fig. 2).

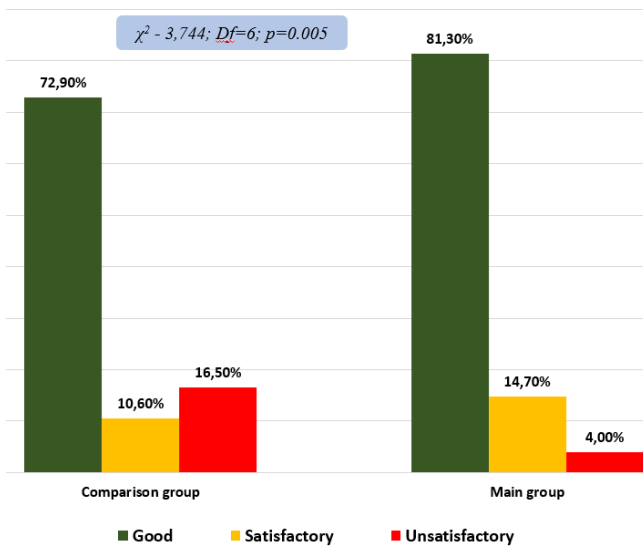


Figure 2. Comparative analysis of immediate treatment outcomes

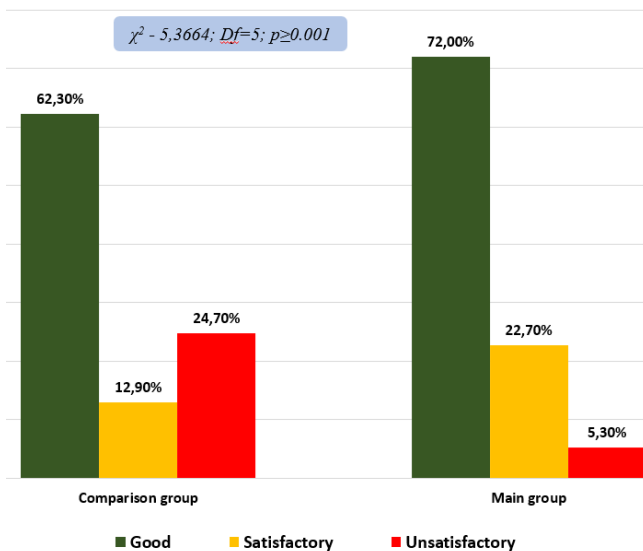


Figure 3. Comparative analysis of the immediate treatment results

The results of the nearest observation period (3 months) also indicated the effectiveness of the surgical treatment strategy in the main group. At the same time, against the backdrop of a wait-and-see strategy, we managed to preserve most of the weight-bearing function of the lower limb from

12.9% to 22.7% (see Fig. 3). It should be noted that the number of patients undergoing high amputations decreased fivefold (from 24.7% to 5.3%). This fact once again proves the effectiveness of a wait-and-see surgical approach in the treatment of purulent-necrotic wounds against the background of severe ischemia in DFS.

One of the important indicators in assessing the effectiveness of the therapy is the frequency of repeat operations. In comparative terms, it can be said that in the main group this indicator was 2 times lower than in the comparison group (24.0 and 44.8%, respectively). Early debridement or surgical intervention cannot provide a complete picture of the extent of tissue damage in the ischemic part of the foot. In this regard, the use of more obvious and objective methods of assessing tissue viability guarantees a favorable outcome in the postoperative period.

Another important factor in the treatment of foot gangrene is the musculoskeletal function of the lower limb, which directly determines the quality of life during the rehabilitation stage of treatment.

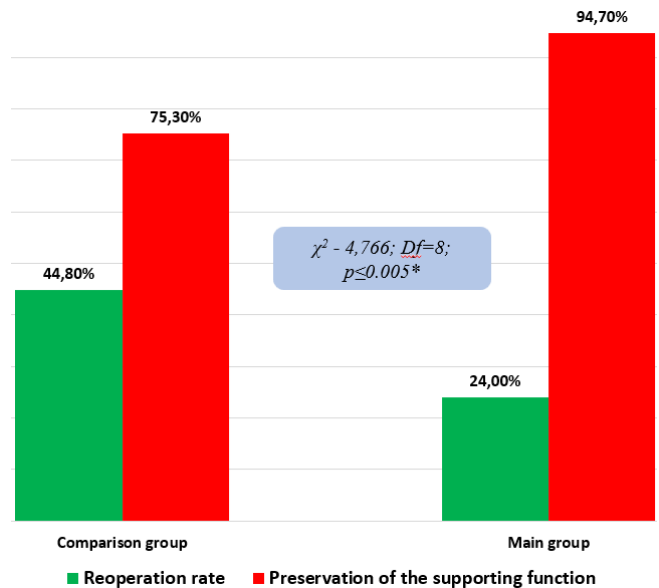


Figure 4. Comparative characteristics of the effectiveness of surgical tactics

A more pronounced difference in the effectiveness of the chosen surgical approach in the main group was observed when comparing the results in terms of preservation of the rear part of the foot. Loss of the distal part of the foot (Sharpe amputation or atypical resection) is sometimes considered a favorable outcome, especially in patients with total ischemia or gangrene of the foot. With the help of the developed surgical approach, we were able to improve our results by 20% and thereby reduce the number of patients with high amputation.

After one or two years, the extent to which the positive results of treatment (limb preservation) change or the possible survival rates require further research. We also did not study the long-term results of limb amputations and recurrences of arterial pathology with manifestations of critical ischemia in

the study group of patients, as this was not part of our task.

Thus, the data obtained above indicate that all complications or adverse outcomes during the initial treatment of patients were associated with the suboptimal timing of surgical intervention in the comparison group. At a later stage, these operations directly led to secondary complications and limb loss. This confirms that in the early period after the restoration of arterial blood flow, the development of collateral blood supply with arterial vessel modeling contributes to compensating for arterial blood circulation in the limb and preventing the progression of critical ischemia.

4. Discussion

Drug treatment included the prescription of dual anticoagulant therapy and prostaglandin E1 (vasastenon). Along with systemic vascular therapy, patients underwent local therapy, which included modern dressing preparations and, of course, vacuum therapy to accelerate the healing process against the background of ischemia relief. Within 10-14 days after the application of these procedures to the infected and trophic wound, its cleansing from detritus and discharge was observed, which directly contributed to the growth of granulation tissue with the transition to the second phase of the wound healing process.

Despite adequate treatment, the comparison group continued to experience adverse outcomes associated with a high frequency of amputations and repeat secondary surgical interventions. In our opinion, the main reason for this was the failure to take into account the timing of primary radical surgical interventions on the foot. We consider the simultaneous removal of all necrotic tissues immediately after improving arterial blood flow through endovascular revascularization to be inappropriate, since a minimum of 4-5 days is required for the remodeling of the collateral arterial network (according to our data). Oxygen tension indicators in the postoperative period also confirm our actions. Our study has some limitations. We performed a retrospective analysis of a prospectively observed cohort from a single department. The choice of endovascular revascularization treatment was not randomized. Ischemic wounds were not stratified according to their location and extent. Finally, ambulatory status was not assessed prior to revascularization.

5. Findings

1. After revascularization and surgical interventions on the foot in the long term, the optimal condition for reconstructive surgery is considered to be $tcpO_2 < 35.4 \pm 4.6$ mmHg. For the use of VAC therapy after reconstructive surgery (with local tissues or autodermoplasty), the transcutaneous oximetry index should be higher than $tcpO_2 < 39.7 \pm 9.3$ mmHg.
2. In cases of distal tissue damage, the optimal time for foot surgery is on the third day, with oxygen tension reaching $tcpO_2 - 35.4 \pm 9.6$ mmHg on the day of

revascularization. Restoration of blood flow in cases of total foot ischemia only on the 6th-7th day leads to an increase in the transcutaneous oximetry index to $tcpO_2 - 34.8 \pm 5.7$. In wet gangrene, after opening the lesion on the 5th day after revascularization, oxygen tension increases to $tcpO_2 - 34.5 \pm 8.3$, which makes it possible to perform necrectomy.

3. Using improved surgical techniques with optimal timing of foot surgery, it was possible to reduce the frequency of repeat operations from 44.8% to 24.0% ($p \leq 0.001$) and increase the number of patients with preserved musculoskeletal function of the lower extremities from 75.3% (in the comparison group) to 94.7% (in the main group) ($p \leq 0.005$).

Consent

It is not applicable.

Ethical Approval

It is not applicable.

Competing Interests

Authors have declared that no competing interests exist.

REFERENCES

- [1] Conte M.S., Bradbury A.W., Kolh P., White J.V., Dick F., Fitridge R., et al.; GVG Writing Group. Global vascular recommendations for treating chronic ischemia threatening extremities. *J Vasc Surg* 2021; 69: 3S-125S. e40. <https://doi.org/10.1016/j.jvs.2019.02.016>.
- [2] Fowkes FG, Rudan D, Rudan I, Aboyans V, Denenberg JO, McDermott MM, and others. Comparison of global assessments of the prevalence and risk factors for peripheral artery disease in 2020 and 2021: systematic review and analysis. *Lancet* 2013; 382: 1329-40. [https://doi.org/10.1016/S0140-6736\(13\)61249-0](https://doi.org/10.1016/S0140-6736(13)61249-0).
- [3] Noreze M. Arterial ischaemia de los miembros. *Cirugia de Michans Editorial El Ateneo*; 6a Ed.2023. pp. 1124-34.
- [4] Kempchinsky R. *Chronic Ischemic Leg: Review. Vascular Surgery*, Rutherford, 5th edition, Saunders, pp. 917-27, 2020.
- [5] Norgren L., Hayatt V.R., Dormandi J.A., Neler M.R., Harris K.A., Faux F.G. Inter-Public Consensus on the Treatment of Peripheral Arterial Diseases (TASC II). *Eur J Vasc Endovasc Surg* 2017; 45: S5-S67. <https://doi.org/10.1016/j.ejvs.2006.09.024>.
- [6] Hirsch AT, Haskal ZJ, Hertzner NR, Bakal CW, Creager MA, Halperin JL, and others. ACC/AHA Recommendations 2005 for the Management of Patients with Peripheral Arterial Diseases *J Am Coll Cardiol* 2024; 47: 1239-312. <https://doi.org/10.1016/j.jacc.2005.10.009>.

- [7] Aber A, Lumley E, Phillips P, Woods HB, Jones G, Michaels J. Topics that determine the quality of life in patients with peripheral artery disease: a systematic overview. *Patient* 2019; 11: 489-502. <https://doi.org/10.1007/s40271-018-0307-7>.
- [8] Devi-Smith F., Coulter E., Kennon B., Wyke S., Paul L. Factors affecting the quality of life after limb amputation in peripheral arterial occlusion disease: a systematic review of literature. *Prosth Orthot Int.* 2022; 41: 537-47. <https://doi.org/10.1177/0309364617690394>.
- [9] Khalil E., Ozkan S. Quality of life related to health after vascular surgery and endovascular treatment in patients with critical limb ischemia. *Pak J Med Sci* 2024; 36: 877-83. <https://doi.org/10.12669/pjms.36.5.2680>.
- [10] Josami S., Albertal M., Cefferer P., Pfund G., Fabiani A., Nauw G., et al. Treatment de la isquemia critique de membres inferiores. *Reverend Argent Cardiol.* 2020; 78: 129-33.
- [11] Torrealba H.I., Vargas H.F., Marine L.A., Bergoing M.P., Mertens R.A., Valdes F.J. Endovascular treatment of chronic limb ischemia. Endovascular treatment of critical distal ischemia of extremities. Experience in conducting 48 procedures]. *Precious Honey Chil* 2023; 148: 1734-41. <https://doi.org/10.4067/S0034-98872020001201734>.
- [12] Farber A, Menard MT, Conte MS, Kaufman JA, Powell RJ, Choudhry NK, et al.; BEST-CLI Investigators. Surgery or endovascular therapy for chronic ischemia threatening extremities. *N English J Med* 2022; 387: 2305-16. <https://doi.org/10.1056/NEJMoa2207899>.
- [13] Mufarrih Sh.H., Khan M.S., Kureshi N.K., Akbar M.S., Kazimuddin M., Gold Zweig A.M. et al. Endovascular revascularization strategy against surgical strategy for chronic ischemia threatening extremities: meta-analysis of randomized controlled trials. *Am J Cardiol* 2024; 214: 149-56. <https://doi.org/10.1016/j.amjcard.2024.01.007>.
- [14] Kodama A., Takahara M., Iida O., Soga Y., Terashi H., Kawasaki D. et al. Outpatient status over time after revascularization in patients with threatening chronic ischemia of the extremities. *J Atheroscler Thromb* 2022; 29: 866-80. <https://doi.org/10.1177/10741434221100000>.
- [15] Taylor SM, Kalbaugh CA, Blackhurst DW, Cass AL, Trent EA, Langan EM 3rd, et al. Factors determining functional outcome after revascularization in critical limb ischemia: analysis of 1000 sequential vascular interventions. *J Vasc Surg* 2016; 44: 747-55. <https://doi.org/10.1016/j.jvs.2006.06.015>.
- [16] Okazaki J, Matsuda D, Tanaka K, Ishida M, Kuma S, Morisaki K, et al. Analysis of wound healing time and wound-free period as results after surgical and endovascular revascularization in critical ischemia of the lower extremities. *J Vasc Surg* 2025; 67: 817-25. <https://doi.org/10.1016/j.jvs.2017.07.122>.
- [17] Browder SE, Ngeve SM, Hamrick ME, Wood JE, Parodi FE, Pascarella LE, et al. Analysis of wound healing time and wound-free period in patients with chronic limb-threatening ischemia treated with and without revascularization. *J Vasc Surg* 2023; 76: 1667-1673. e1. <https://doi.org/10.1016/j.jvs.2022.05.025>.
- [18] Sano M., Yamamoto K., Seo A., Akai A., Akagi D., Takayama T., et al. Healing of wounds after revascularization in critical ischemia of the extremities. *Int Angiol* 2021; 38: 225-9. <https://doi.org/10.23736/S0392-9590.19.04096-3>.
- [19] Noreze M., Parodi M., Padilla E., La Moura R. Post-surgical restoration and infrainguinal revascularization. *Angiology* 2017; 59: 317-24. [https://doi.org/10.1016/S0003-3170\(07\)75060-5](https://doi.org/10.1016/S0003-3170(07)75060-5).
- [20] Ochoa Chaar CI, Gholitabar N, Goodney P, Dardik A, Abougergi MS. Re-hospitalization one year after open and endovascular revascularization in critical limb ischemia. *Ann Vasc Surg* 2019; 61: 25-32. <https://doi.org/10.1016/j.avsg.2019.07.003>.
- [21] Bhandari N., Newman J. D., Berger J. S., Smilovitz N. R. Diabetes Mellitus and Results of Lower limb revascularization in Peripheral Arterial Diseases. *Eur Heart J Qual Care Clin Outcomes* 2022; 8: 298-306. <https://doi.org/10.1093/ehjqcco/qcaa095>.