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Modern Approaches to Combined Surgical Treatment of Pyo-Necrotic Complications in Diabetic Foot Syndrome

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Abstract

The article is devoted to the analysis of modern approaches to the comprehensive surgical treatment of pyo-necrotic complications of diabetic foot syndrome. The study was conducted in the format of a systematic review and analytical synthesis of scientific publications focused on surgical debridement, limb-preserving interventions, vascular correction, antibacterial therapy, and modern methods of local wound management. Particular attention is given to the relationship between the stage of lesion according to the Wagner classification, the extent of surgical intervention, the condition of tissue perfusion, and the possibilities of limb preservation. The main elements of treatment strategy are examined, including staged debridement of the infectious focus, limited resection of infected bone tissue, microbiological control, revascularization, local antimicrobial systems, negative pressure wound therapy, and correction of metabolic disorders. It was established that treatment effectiveness is determined by the radicality of infected tissue removal and the coordination of surgical, vascular, antibacterial, and postoperative measures. It is substantiated that the isolated application of individual methods does not ensure a stable clinical outcome in severe forms of diabetic foot syndrome, since infection recurrence and repeated necrosis depend on the combination of residual osteomyelitis, ischemia, metabolic instability, and mechanical overload of the foot. An original multistage model of comprehensive surgical treatment of pyo-necrotic complications of diabetic foot syndrome is proposed, reflecting the transition from an amputation-oriented strategy to the concept of controlled radicality and long-term limb preservation. The obtained results make it possible to consider modern treatment of diabetic foot syndrome as a system of staged clinical control aimed at infection elimination, restoration of healing conditions, and reduction of the risk of recurrent ulceration.

Keywords: *Diabetic Foot Syndrome, Pyo-Necrotic Complications, Surgical Debridement, Diabetic Osteomyelitis, Revascularization, Limb Preservation, Wagner Classification.*

INTRODUCTION

Diabetes mellitus remains one of the leading causes of severe lower limb lesions and associated amputations [1]. The most complex form of the disease is considered to be diabetic foot syndrome, in which chronic ulcers rapidly become complicated by infection, tissue necrosis, and involvement of bone structures. The development of the pyo-necrotic process is closely associated with diabetic neuropathy, chronic ischemia, impaired microcirculation, and reduced immune defense [3]. An additional challenge is the growing resistance of microorganisms to antibacterial agents, which significantly complicates treatment and increases the risk of repeated surgical interventions. For a long period, radical amputational procedures remained the primary treatment method; however, high postoperative mortality and a pronounced decline in patients' quality of life led to a revision of surgical strategies. At present, treatment is increasingly based on the combination of surgical debridement, vascular correction, rational antibacterial therapy, and methods aimed at limb preservation [8].

Modern approaches to the surgical treatment of diabetic foot syndrome are focused on staged elimination of infection while preserving functionally significant tissues to the greatest possible extent. At the same time, the selection of surgical intervention volume is increasingly determined by the extent of necrosis and the stage of lesion according

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to the Wagner classification. As the disease progresses, the objectives of surgical treatment change from local debridement and preservation of the supporting function of the foot in superficial ulcerative defects to multistage infection control, revascularization, and limitation of the amputation level in deep pyo-necrotic lesions and critical ischemia. As a result, the Wagner classification is gradually ceasing to be considered solely as a tool for describing lesion severity and is increasingly being used as a basis for selecting surgical strategy. Particular importance is attributed to limited resection of infected bone tissue, timely revascularization, modern methods of local wound treatment, and comprehensive correction of metabolic disorders [11]. A significant contribution to the development of these approaches was made by studies devoted to the comprehensive surgical treatment of diabetic foot syndrome [14], including the 2008 PhD dissertation entitled "Comprehensive Surgical Treatment of Diabetic Foot Syndrome," the publication in the journal "Problems of Cryobiology and Cryomedicine" published in 2014 [15], as well as patents No. 7937 [18] and No. 25268 [16] related to methods of surgical treatment and local therapy of pyo-necrotic foot lesions. These studies placed particular emphasis on the combination of surgical debridement, correction of metabolic disorders, and staged patient management, which remains relevant in modern limb-preserving treatment strategies.

The aim of the study is to develop an analytical model of comprehensive surgical treatment of pyo-necrotic complications of diabetic foot syndrome based on the stage of lesion according to the Wagner classification, the principles of radical infection focus control, limb preservation, and multidisciplinary correction of systemic disorders. The objectives of the present study were:

– to analyze modern approaches to the surgical treatment of infectious complications of diabetic foot syndrome and diabetic osteomyelitis;

– to assess the role of staged surgical debridement and limb-preserving interventions on bone structures;

– to examine the significance of targeted antibacterial therapy and local antimicrobial drug delivery systems;

– to analyze the impact of chronic arterial insufficiency and metabolic decompensation on treatment outcomes;

– to systematize modern adjunctive treatment technologies.

The research hypothesis is that the effectiveness of treatment for pyo-necrotic complications of diabetic foot syndrome depends not only on the extent of surgical intervention. Significant importance is attributed to the combination of surgical debridement, vascular correction, and targeted antibacterial therapy. Compensation of metabolic disorders and limb-preserving postoperative management also play an important role. It is assumed that the best outcomes are achieved when these components are integrated within a unified staged multidisciplinary strategy.

The scientific novelty of the study lies in the reinterpretation of traditional surgical tactics for pyo-necrotic complications of diabetic foot syndrome through the concept of "controlled radicality." In contrast to the classical approach, in which treatment effectiveness is primarily associated with the extent of resection and amputation, the present study examines the influence of coordination among several treatment components, including surgical debridement, vascular correction, compensation of metabolic disorders, local infection control, and staged postoperative management. An integrative treatment model is proposed based on the correlation between the Wagner stage of lesion and the selection of intervention volume and limb-preservation methods.

MATERIALS AND METHODS

The study is based on the theoretical analysis of scientific publications devoted to the surgical treatment of pyo-necrotic complications of diabetic foot syndrome. Particular attention was focused on the relationship between the extent of surgical debridement, vascular status, antibacterial therapy, and the possibilities of limb preservation. Additional analysis was conducted regarding the role of staged surgical treatment, negative pressure wound therapy, local antimicrobial systems, and correction of metabolic disorders.

The work was performed in the format of a systematic review of open-access scientific publications from 2022–2026. The selected time frame was determined by the rapid revision of diabetic foot treatment strategies in recent years. Publications from 2022–2026 were prioritized because this period reflects the most recent changes in limb-preserving surgery, local antimicrobial technologies, revascularization approaches, negative pressure wound therapy, and multidisciplinary management of diabetic foot infection. Earlier studies were not excluded from the conceptual background of the problem, but they were not included in the final analytical sample in order to focus the review on contemporary clinical decision-making and current treatment priorities. The literature search was conducted using Google Scholar, ScienceDirect, SpringerLink, MDPI, and PubMed with the following keywords: "diabetic foot syndrome," "diabetic foot infection," "diabetic foot osteomyelitis," "surgical treatment," "limb preservation," "negative pressure wound therapy," "revascularization," and "Wagner classification." The study included English-language publications containing clinical and review data related to the surgical treatment of infectious complications of diabetic foot syndrome. Studies not associated with surgical aspects of treatment were excluded.

Studies focusing exclusively on conservative wound care, endocrinological management without surgical intervention, experimental laboratory models, or isolated pharmacological

treatment unrelated to surgical infection control were also excluded. Preference was given to studies evaluating limb-preserving surgery, diabetic foot osteomyelitis, vascular correction, staged debridement, and multidisciplinary treatment strategies in patients with moderate and severe forms of diabetic foot syndrome.

At the first stage, 38 publications were identified. After duplicate removal and full-text analysis, 15 sources meeting the objectives of the study were included in the final sample. The reduction of the initial sample to 15 publications was associated with the specific focus of the review. Many identified studies addressed diabetic foot ulcers in general, conservative wound care, endocrinological control, microbiological characteristics, or experimental treatment methods without direct analysis of surgical infection control. Since the aim of the present study was to develop an analytical model of comprehensive surgical treatment, only publications that contained clinically relevant data on surgical debridement, diabetic foot osteomyelitis, limb-preserving interventions, vascular correction, local antimicrobial technologies, or postoperative treatment stability were retained. Therefore, the final sample was intentionally limited to studies that were directly applicable to the surgical and multidisciplinary logic of the proposed model.

The selection process was performed sequentially and included preliminary screening of titles and abstracts followed by full-text evaluation of potentially relevant studies. Publications were assessed for clinical relevance to surgical treatment strategy, association with diabetic foot infection or osteomyelitis, and consistency with the objectives of staged limb-preserving management. The included publications were additionally assessed according to their methodological design and level of clinical evidence. Randomized controlled studies and prospective clinical investigations were considered to have the highest evidentiary value for evaluating treatment outcomes and therapeutic effectiveness. Retrospective cohort studies and case series were used primarily for analyzing real-world surgical practice, recurrence patterns, amputation rates, and complications of limb-preserving interventions. Narrative reviews were included only when they provided clinically relevant synthesis of modern treatment approaches, emerging technologies, or mechanisms of infection progression. This differentiation was necessary because the reviewed sources were heterogeneous and could not be interpreted as equivalent in evidentiary strength. Priority was assigned to studies containing clinical outcome data related to infection control, limb preservation, revascularization, postoperative recurrence, or local antimicrobial treatment technologies.

During the analysis, the extent of surgical debridement, methods of limb-preserving interventions, approaches to vascular correction, antibacterial therapy regimens, and modern wound treatment technologies were evaluated. When interpreting the findings, greater weight was assigned to studies with direct clinical outcome data, including rates of infection resolution, recurrence, repeated surgery, minor or major amputation, wound healing, and postoperative complications. Review articles were used mainly to clarify the conceptual context and to compare current treatment directions, whereas conclusions regarding the effectiveness of specific interventions were based primarily on clinical studies. This approach made it possible to avoid treating heterogeneous publications as methodologically equal and to distinguish between evidence derived from direct patient outcomes and evidence derived from expert synthesis. Additional attention was given to the relationship between infection recurrence, residual osteomyelitis, adequacy of resection margins, and the stability of postoperative wound healing under conditions of chronic ischemia and metabolic decompensation. Comparative analysis also included assessment of the role of multidisciplinary coordination in reducing the risk of major amputation and recurrent ulceration. Particular attention was also given to the relationship between the Wagner stage of lesion and the selection of surgical strategy. The analysis included evaluation of the association between the Wagner stage, the extent of surgical debridement, the necessity for vascular correction, and the probability of limb preservation. Approaches to the treatment of diabetic osteomyelitis and extensive pyo-necrotic lesions under different levels of tissue ischemia were compared. The obtained results were used to systematize modern treatment approaches and to develop a staged model of comprehensive surgical treatment of diabetic foot syndrome.

Quantitative meta-analysis was not performed because of substantial heterogeneity among the included studies regarding patient populations, Wagner stages, surgical techniques, vascular status, outcome definitions, and duration of postoperative follow-up. Therefore, the study was focused on analytical synthesis and conceptual comparison of contemporary treatment approaches.

The conceptual multistage treatment model proposed in the present study was developed through comparative synthesis of the analyzed clinical approaches and identification of recurrent factors associated with unstable healing, recurrent infection, and failure of limb-preserving surgery in advanced diabetic foot syndrome.

RESULTS

The treatment of pyo-necrotic complications of diabetic foot syndrome has undergone a conceptual transformation in recent years [1]. Analysis of the publications demonstrates that the primary reason for revising surgical approaches was the unsatisfactory long-term stability following radical amputational procedures [13]. Despite the rapid elimination of the infectious focus, major amputation was frequently associated with repeated hospitalizations, progression of

vascular insufficiency, and a pronounced decline in patients' functional activity [5]. As a result, surgical strategy has increasingly shifted toward staged limb preservation even in the presence of osteomyelitis and chronic ischemia.

The analysis of publications indicates that the dependence of surgical strategy on the Wagner stage of lesion is becoming increasingly pronounced. In Wagner stages I–II, limb-preserving interventions are more often focused on limited debridement and prevention of infection spread. However, in stage III, accompanied by osteomyelitis and deep abscesses, the primary importance is attributed to the control of bone infection and the assessment of tissue viability following resection. In Wagner stages IV–V, surgical strategy is predominantly determined by the severity of ischemia, the extent of necrosis, and the possibilities of revascularization, which substantially limits the effectiveness of isolated local debridement.

At the same time, the very approach to evaluating surgical effectiveness has also changed. Whereas previously the main criterion was considered to be the removal of the maximum possible volume of affected tissue, modern data associate long-term control primarily with the completeness of infection control and preservation of viable foot structures [2]. For this reason, limited resection of infected bone tissue has gradually ceased to be regarded as a compromise treatment option. In a number of studies, it demonstrates more stable functional recovery compared with extensive resections. At the same time, the risk of infection recurrence remains high in patients with severe ischemia, prolonged inflammatory process, and impaired tissue perfusion [6].

The analysis indicates that chronic arterial insufficiency continues to remain the principal factor contributing to unstable disease progression [7]. Even after technically successful debridement, vascular disorders most frequently determine delayed healing, repeated tissue necrosis, and the necessity for repeated interventions [17]. This relationship is particularly evident in advanced Wagner stages, where the local infectious process can no longer be considered independently from chronic arterial insufficiency. Under such conditions, the effectiveness of surgical debridement is directly limited by the possibilities of tissue perfusion and preservation of viable weight-bearing foot structures. This is especially evident in patients with the combination of osteomyelitis, deep ulcerative defects, and extensive soft tissue involvement. In such situations, one-stage radical surgery is increasingly being replaced by staged surgical tactics. Its objective consists in infection elimination and preservation of functionally significant foot segments at each stage of treatment [9].

Particular importance is attributed to the cleanliness of resection margins and microbiological examination of bone tissue [10]. The obtained data indicate that the persistence of residual infection, even in a limited volume, significantly increases the probability of repeated surgery. For this reason, limited resection in many studies is combined with mandatory examination of bone samples and subsequent adjustment of antibacterial therapy. This approach is gradually changing the very principle of surgical debridement. The extent of tissue removal is beginning to be determined not by the visual radicality of intervention, but by the ability to achieve stable infection control without critical impairment of foot biomechanics. Preservation of the weight-bearing segments of the foot becomes particularly important during limited forefoot resections, since disruption of biomechanical load distribution increases the risk of recurrent ulceration and chronic tissue instability even after successful infection control. Table 1 presents the clinical outcomes of the CLOSE-UP limb-preserving surgical protocol in patients with diabetic foot osteomyelitis.

Table 1. Clinical outcomes of the CLOSE-UP protocol in limb-preserving diabetic foot osteomyelitis surgery (Compiled by the author based on source: [12])

Parameter	**Value**	**Percentage**
Total patients	97	100%
Clinical failure within 1 year	13	13,4%
Major amputation	4	4,1%
Patients with PAD	24	24,7%
Minor amputation	88	90,7%
Debridement without amputation	9	9,3%

The structure of interventions reflects a pronounced shift in surgical strategy toward preservation of the weight-bearing function of the limb even in patients with the combination of osteomyelitis and chronic ischemia [12]. At the same time, the low frequency of major amputations does not indicate complete resolution of the problem of infection recurrence. On the contrary, clinical failure indicators demonstrate that limited resection of infected bone tissue has definite limits of effectiveness. This is particularly evident in cases of impaired tissue perfusion and extensive involvement of the plantar regions of the foot.

Analysis of the results demonstrates that the limb-preserving operation itself is no longer considered an independent stage of treatment [7]. Its long-term stability directly depends on the quality of postoperative management, correction of ischemia, and precision of antibacterial therapy. In studies

where surgical debridement was performed without subsequent vascular correction, the risk of repeated infection remained substantially higher even after adequate removal of necrotic tissues [9]. This indicates the limitations of an isolated surgical approach in severe forms of diabetic foot syndrome.

The structure of intraoperative local infection control is also changing. Analysis of the studies demonstrates that local antimicrobial systems are gradually becoming part of the surgical debridement itself rather than an additional method of postoperative management [19]. Such technologies are most actively applied following resection of infected bone tissue and in the presence of residual bone cavities. Their principal objective is the local suppression of infection under conditions of reduced tissue perfusion and limited penetration of systemic antibacterial agents.

Calcium sulfate antibiotic carriers have become the most widely used systems [12]. Their application is associated both with local antibacterial activity and with the ability to partially fill residual bone defects after debridement. At the same time, increasing interest is being directed toward bioactive glasses and combined hydroxyapatite-based materials, which additionally influence tissue repair processes. However, analysis of the publications demonstrates that the effectiveness of such technologies directly depends on vascular status and the completeness of surgical debridement. The most stable outcomes are achieved when local antimicrobial exposure is combined with comprehensive ischemia control and repeated surgical revision when necessary [4]. Table 2 presents the clinical outcomes of modern intraoperative treatment methods for diabetic foot osteomyelitis.

Table 2. Clinical outcomes of modern intraoperative techniques in diabetic foot osteomyelitis treatment (Compiled by the author based on source: [9])

Treatment method	Sample size	Clinical outcome	Outcome rate
Tobramycin calcium sulphate beads during TMA	65 feet	Postoperative revision procedures	8,2% vs 25,0%
Antibiotic calcium sulphate beads after debridement	323 patients	Clinical infection resolution	86,4%
Calcium sulfate after bone resection	48 limbs	Complete recovery	90,0% vs 78,6%
CS/HA-antibiotic mixture	70 patients	Infection eradication	90,0%
Bioactive glass after debridement	44 patients	Infection eradication	90,0% vs 61,9%

The obtained results demonstrate that local antimicrobial technologies enhance the stability of surgical infection control but do not eliminate the principal limitations of limb-preserving surgery. Even with the use of modern materials, recurrent progression of infection continues to be observed in patients with severe ischemia and polymicrobial tissue involvement [11]. This is particularly important because some studies still consider local antibiotic carriers as an independent method for reducing the risk of recurrence. However, analysis of clinical outcomes demonstrates the opposite. Without adequate debridement, control of vascular disorders, and consistent postoperative monitoring, the effectiveness of such technologies decreases sharply.

Consequently, as the Wagner stage progresses, the very logic of surgical infection control also changes. Whereas in the early stages the primary objective remains local removal of infected tissues, in severe forms of diabetic foot syndrome clinical stability begins to depend on the ability to integrate surgical debridement, vascular correction, and long-term postoperative control within a unified staged strategy.

Another contradiction also becomes apparent. The attempt to preserve the maximum possible volume of foot tissues increases the dependence of treatment outcomes on the quality of surgical infection control. The smaller the extent of resection, the greater the importance of clean resection margins, repeated surgical revision, and precision of antibacterial therapy. As a result, modern limb-preserving diabetic foot surgery is gradually forming a new treatment model in which outcome stability is determined not by the radicality of amputation, but by the ability to maintain long-term infection control while preserving the functional anatomy of the limb.

DISCUSSION

Over recent years, the approach to the treatment of pyo-necrotic complications of diabetic foot syndrome has changed significantly. Previously, surgical intervention was often delayed in favor of prolonged antibacterial therapy and local wound treatment. At present, such tactics are considered one of the causes of infection progression. In the presence of necrosis, phlegmon, or infected bone tissue, timely surgical debridement becomes the key determinant of further prognosis.

The most common problem is associated not with an insufficient extent of surgery, but with the persistence of nonviable tissue fragments. Even a small fragment of infected bone tissue is capable of maintaining inflammation, impairing granulation maturation, and leading to repeated wound opening several weeks after intervention. In clinical practice, incomplete debridement most frequently becomes the cause of repeated hospitalizations and more proximal amputations.

At the same time, modern diabetic foot surgery is not based on maximally extensive tissue excision. The surgeon's task consists not in increasing the extent of resection, but in the precise removal of all nonviable structures while preserving

the stable weight-bearing function of the foot. At Wagner stage II, the possibility of limited interventions with local resection of affected bone tissue still remains. Wagner stage III is already much more frequently accompanied by deep infection spread, formation of purulent tracts, and joint involvement. In Wagner stage IV, the surgeon faces the combination of infection, severe ischemia, tissue instability, and rapid progression of necrosis. Wagner stage V usually reflects a condition in which the local process ceases to remain local.

Particular importance is attributed to the condition of the resection margin. Bone tissue that appears viable externally does not always remain free from inflammation. If active osteomyelitis persists within the resection zone, the inflammatory process continues to spread proximally even after a technically correct surgical procedure. For this reason, removal of infected bone tissue should be accompanied by microbiological and morphological control.

In diabetic foot infection, superficial swab cultures often prove to be poorly informative. The most accurate data are obtained from tissue samples and bone fragments collected directly during surgery. This approach makes it possible to transition more rapidly from empirical antibacterial therapy to more targeted treatment.

Even a technically correct surgical procedure does not guarantee limb preservation if severe ischemia or decompensated diabetes mellitus persists. For this reason, modern treatment of diabetic foot infection has gradually shifted from an isolated surgical approach toward a multistage coordinated strategy. One of the principal causes of unstable healing remains peripheral arterial disease. Under conditions of pronounced blood flow deficiency, tissues lose the capacity for complete regeneration. Granulation tissue becomes sluggish, wound edges rapidly undergo repeated necrosis, and infection spreads significantly faster. Without preliminary revascularization, the reconstructive stage frequently loses stability already in the early postoperative period.

At Wagner stages III–IV, the vascular factor begins to play the leading role. It is precisely the combination of ischemia and infection that sharply increases the risk of major amputation. In such situations, attempts to rely solely on surgical debridement rarely provide a stable outcome. After restoration of major blood flow, the conditions for healing change fundamentally. Antibiotic delivery improves, tissue hypoxia decreases, and the probability of repeated necrosis becomes lower.

Correction of metabolic disorders also remains important. Prolonged hyperglycemia impairs microcirculation and sustains chronic inflammation. In patients with decompensated diabetes mellitus, the infectious process progresses more rapidly, while postoperative wounds retain granulation tissue significantly worse. Delayed surgical debridement in such cases is often accompanied by systemic decompensation, increasing intoxication, and expansion of surgical intervention volume.

Antibacterial therapy requires a staged approach. At the early stage, treatment is usually initiated empirically; however, after obtaining the results of deep tissue cultures, the therapeutic regimen should be adjusted as rapidly as possible.

Another challenge is created by the constant overload of the foot. Even after infection control is achieved, mechanical pressure continues to traumatize tissues and sustain chronic inflammation. Without adequate off-loading, the risk of recurrent ulceration remains high even in the presence of favorable local wound conditions. Figure 1 presents the author's model of comprehensive surgical treatment of pyo-necrotic complications of diabetic foot syndrome based on sequential control of infection, ischemia, and metabolic instability.

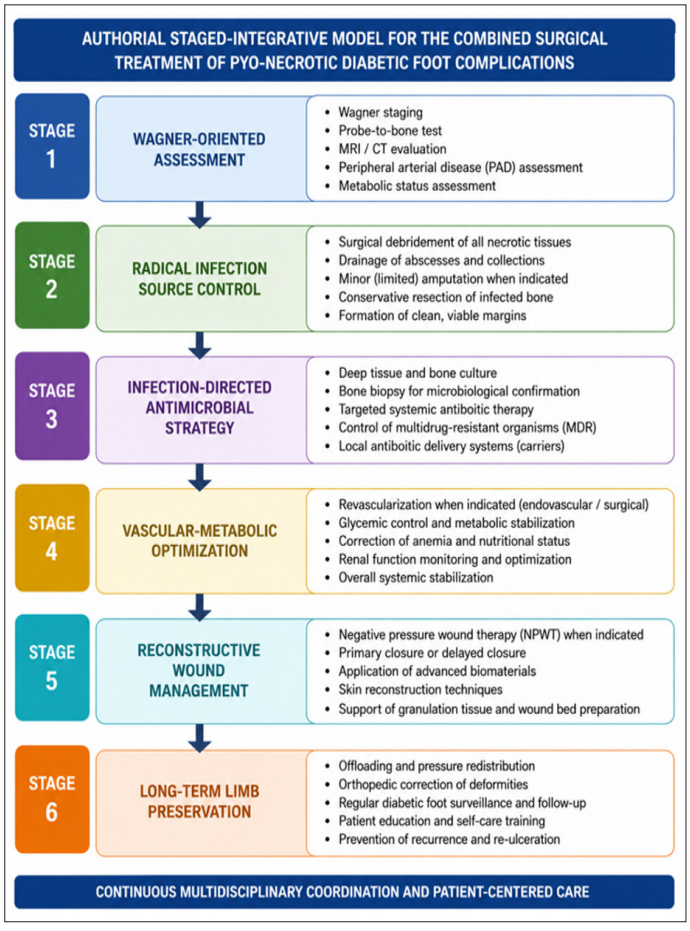

Figure 1. Multistage Model of Comprehensive Surgical Treatment of Pyo-Necrotic Complications of Diabetic Foot Syndrome (Author's Development)

The presented model is valuable not as a formal sequence of treatment stages, but as a means of explaining why isolated surgical intervention in pyo-necrotic forms of diabetic foot syndrome often fails to provide a stable outcome. Its principal logic lies in the fact that infection, ischemia, metabolic decompensation, and mechanical overload of

the foot do not act separately, but rather mutually reinforce one another. Therefore, removal of necrotic tissues alone does not resolve the problem if the conditions that caused necrosis and sustain inflammation remain present.

The operation of the model begins with assessment of the Wagner stage, since it is this classification that demonstrates the point at which local infection ceases to represent only a wound-related problem and becomes a systemic surgical risk. In the early stages, intervention may still be limited to local debridement while preserving the primary weight-bearing function of the foot. However, in Wagner stages III–IV, the surgical task becomes considerably more complex: osteomyelitis, deep purulent tracts, ischemia, and soft tissue instability make the outcome dependent on both the completeness of resection and the ability to restore conditions necessary for healing. Thus, the model effectively associates the stage of lesion not with an abstract severity of disease, but with the selection of the limit of surgical radicality.

This is precisely where its practical significance becomes evident. The model demonstrates that a limb-preserving strategy is effective only when the radicality of debridement is combined with control of the factors capable of destroying the postoperative outcome. Retained infected bone tissue sustains further progression of inflammation even after a technically successful operation. Critical ischemia sharply limits the ability of the debrided wound to form stable granulation tissue and achieve complete healing. Hyperglycemia, anemia, and impaired renal function additionally worsen tissue repair and sustain chronic inflammation. After infection control is achieved, constant overload of the foot once again creates conditions for tissue injury and recurrent ulceration. Consequently, each component of the model is aimed both at eliminating the local pathological focus and at maintaining stable conditions necessary for long-term limb preservation.

The functionality of the model is confirmed by the fact that it explains the principal causes of treatment failure identified in modern clinical studies: infection recurrence in the presence of residual osteomyelitis, repeated necrosis under persistent ischemia, failure of early wound closure in the setting of active inflammation, and recurrent ulceration in the absence of adequate foot off-loading. Therefore, the model does not oppose radical debridement to the limb-preserving approach, but rather integrates them within the concept of controlled radicality. Within this concept, the extent of tissue removal is determined not by the pursuit of the widest possible amputation, but by the necessity to achieve stable infection control without destruction of the functional anatomy of the foot.

Consequently, the proposed model demonstrates that modern comprehensive treatment of pyo-necrotic complications of diabetic foot syndrome should be evaluated not only by the fact of wound closure or elimination of acute inflammation. A more significant criterion becomes the ability of the treatment strategy to maintain the result over time: to prevent recurrent infection, preserve tissue blood supply, support healing, and reduce the risk of a new ulcerative defect. This is precisely why the multistage approach has advantages over isolated surgery: it is directed not toward one-time elimination of the pathological focus, but toward restoration of the conditions under which limb preservation becomes clinically stable.

LIMITATIONS

The present study has several limitations that should be considered when interpreting the obtained results. First, the review was based on heterogeneous publications that differed substantially in patient populations, Wagner stages, severity of ischemia, surgical techniques, definitions of treatment success, and duration of postoperative follow-up. Such variability limited the possibility of direct comparison between studies and excluded the feasibility of quantitative meta-analysis.

Second, a considerable proportion of the analyzed publications consisted of retrospective cohort studies, case series, and narrative reviews, which inherently possess different levels of clinical evidence and may be associated with selection bias and variability in treatment protocols. Although greater analytical weight was assigned to studies containing direct clinical outcome data, the overall conclusions of the review remain partially dependent on heterogeneous methodological approaches.

Third, the Wagner classification itself has certain limitations when used as the sole determinant of surgical strategy because it does not fully reflect the degree of ischemia, microbiological characteristics of infection, systemic metabolic instability, or biomechanical overload of the foot. Therefore, the proposed treatment model should not be interpreted as a rigid algorithm based exclusively on Wagner staging, but rather as an integrative conceptual framework for staged multidisciplinary decision-making.

In addition, the proposed multistage model has not yet undergone prospective clinical validation and currently represents an analytical synthesis of contemporary treatment approaches rather than a quantitatively verified predictive system. Further prospective multicenter studies are required to evaluate the relationship between surgical radicality, vascular status, postoperative recurrence, and long-term limb preservation outcomes within the framework of the proposed concept of controlled radicality.

CONCLUSION

Analysis of modern approaches demonstrates that the surgical treatment of pyo-necrotic complications of diabetic foot syndrome is no longer based exclusively on the principle of maximally radical tissue removal. The stability of treatment outcomes is determined not only by elimination

of the infectious focus, but also by the ability to maintain conditions necessary for tissue healing and long-term limb preservation.

The conducted review confirms the proposed hypothesis. The most stable outcomes are achieved through the combination of comprehensive surgical debridement, vascular correction, targeted antibacterial therapy, compensation of metabolic disorders, and consistent postoperative management. In severe forms of diabetic foot syndrome, isolated surgery is gradually losing independent effectiveness, since the risk of infection recurrence and repeated necrosis becomes increasingly determined by ischemia, metabolic instability, and chronic tissue overload.

Particular importance is attributed to the staging of lesions according to the Wagner classification. As the disease progresses, the limits of limb-preserving surgery also change: early stages still permit limited resections with preservation of the weight-bearing function of the foot, whereas advanced forms require the combination of debridement, revascularization, and long-term control of the factors sustaining chronic inflammation.

The proposed multistage model demonstrates that the effectiveness of the limb-salvage strategy is formed through the coordination of surgical, vascular, antibacterial, and reconstructive interventions. Within the concept of controlled radicality, the extent of resection is determined not by the pursuit of the widest possible amputation, but by the necessity to achieve stable infection control while preserving the functional anatomy of the foot.

Prospects for further research are associated with quantitative evaluation of the proposed model and analysis of the relationship between the Wagner stage, vascular status, and the risk of long-term recurrence. Overall, modern treatment of diabetic foot syndrome should be regarded as a system of staged clinical control aimed at long-term limb preservation.

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