

# Modern Approaches to Local Treatment of Purulent-Necrotic Complications of Diabetic Foot Syndrome

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**Abstract:** Diabetes mellitus is one of the most acute medical and social problems of our time, covering most economically developed countries. According to the forecasts of the International Diabetes Federation, 592 million people will suffer from diabetes by 2035. One of the formidable complications of diabetes mellitus is diabetic foot syndrome, as the treatment of purulent-destructive lesions of the lower extremities requires significant material costs, does not always work effectively and often ends with amputations, which are carried out 17-45 times more often than in the general population, often performing them at the level of the lower leg and hip, which increases postoperative mortality up to 50% and leads to disability of the patient. Epidemiological studies have shown that 6-30% of patients with diabetic foot syndrome with purulent-necrotic complications after the first amputation undergo amputation of the second limb within 1-3 years, after 5 years – 28-51%. All these data indicate that this problem is unresolved and it is advisable to further develop new tactical approaches to the treatment of this category of patients to reduce the incidence of disability and mortality.

**Keywords:** diabetes mellitus, diabetic foot syndrome, necrectomy, local treatment.

## Introduction

Recently, the close attention of specialists involved in the treatment of patients with diabetes mellitus has been turned to diabetic foot syndrome. This is due, on the one hand, to the growth of this disease and the dissatisfaction of doctors with the results of treatment– on the other.

The great social significance of the disease of diabetes mellitus is that it leads to early disability. The risk of coronary heart disease and myocardial infarction increases by 2 times, kidney pathology — by 17 times, gangrene of the lower extremities - by 20 times [1, 2].

The frequency of amputations in patients with diabetic foot syndrome with purulent-necrotic complications depends on the age of the patients, the duration of the disease, and the type of diabetes. Elderly people have a high incidence of diabetic foot syndrome with a tendency to generalize the inflammatory process and the development of gangrene, resulting in a greater number of large-volume amputations. The incidence of diabetic foot syndrome correlates with the duration of the underlying disease. It should be noted that with type 2 diabetes at the time of diagnosis, up to 30% of patients have changes in peripheral sensitivity or atherosclerotic lesion of peripheral arteries of varying severity. The frequency of ulcerative foot defects is the same regardless of the type of diabetes [3, 4].

Despite a sufficient amount of information on the pathogenesis, diagnosis, methods of treatment and prevention of complications of diabetes mellitus, data on the frequency and outcome of lesions of the lower extremities are still disappointing. The results of epidemiological studies conducted in various countries indicate that in the structure of all lower limb amputations of a non-traumatic nature, patients with diabetes account for 50-75% [5, 6].

A comparative analysis of the frequency of amputations showed that such operations on the lower extremities in patients with diabetes mellitus are performed 17-45 times more often than in the general population, although the frequency of obstructive lesions of peripheral arteries in diabetes mellitus exceeds

that in people without diabetes by 4 times [8]. The number of amputations in patients with diabetes mellitus is determined not only by the high frequency of obliterating atherosclerosis of peripheral arteries, but also by other factors.

The wound process in diabetic foot on the background of diabetes mellitus has certain features that are characterized by pronounced microcirculatory disorders, the presence of microthrombs, the formation of a sludge phenomenon, dystrophic and necrotic processes, the predominance of the inflammatory component over the reparative, inhibition of cell proliferation, inhibition of phagocytic activity of leukocytes, incomplete phagocytosis, a high degree of microbial contamination of wound tissues, a decrease in general and local immunological reactivity [9, 10].

Natural external factors that play a decisive role in wound healing are humidity and the value of the hydrogen index (pH) of the medium.

Successful wound healing is ensured by a large number of biochemical reactions in which pH is important. The hydrogen index is a quantitative characteristic of the acidity of solutions. Any chemical reaction proceeds faster at a certain optimal pH value, and depends on both endogenous and exogenous causes [11].

It has been proven that in diabetes mellitus, a significantly pH shift to the alkaline side occurs on the surface of the skin and in purulent wounds, which persists at all stages of the wound process. When comparing the pH-metry data with the cytological picture and the rate of wound healing, a direct relationship was revealed between the quality of the wound process and the value of the hydrogen index of the wound surface: as the wound pH increases, the healing rate decreases [6, 7].

Since pH is a key factor in the healing process, its level must be taken into account when local exposure to wounds.

Among such methods of local action, the solution of Acerbin deserves special attention. Also, various devices of controlled negative pressure level, such as vacuum extractors, are effective for the rehabilitation of residual cavities after opening abscesses and purulent-necrotic phlegmon.

The obvious positive aspects of the methods are widely covered in the literature. However, there are still no large-scale studies free from conflicts of commercial interests that would allow an objective assessment of the effectiveness of the method.

### **The purpose of the research:**

To evaluate the results of local treatment of purulent-necrotic complications of diabetic foot syndrome using a vacuum extractor and Acerbin solution.

### **Materials and methods of the research.**

The work included data from a multidirectional (retrospective-prospective) cohort study with non-parallel (historical) control. The study included an analysis of the results of treatment of 94 patients in the period from 2016 to 2020, a prospective study consisted in analyzing the effectiveness of vacuum therapy and Acerbin solution in the complex treatment of purulent diseases in patients hospitalized in the purulent-septic department of the Samarkand City Medical Association. The main criteria for inclusion of patients were: the presence of an infected wound and local trophic disorders that prevent rapid cleansing of the wound and the growth of granulation tissue. There were 55 men and 39 women. The age of the patients was 30-76 years, the average age was  $58.6 \pm 4.5$  years. Among them, 86% were 40-76 years old. The patients had a diabetic history between the ages of 8 and 21. After the onset of diabetes complications, patients went to the surgical hospital on average after  $33.1 \pm 5.3$  days, which is a delayed treatment and insufficient awareness of diabetic patients about such formidable complications as diabetic foot syndrome and diabetic gangrene of the lower extremities. Of the 94 patients, 56 were rural and 38 were urban residents. Mostly sick rural residents were very poorly informed about diabetes and its complications and did not regularly visit an endocrinologist. The patients were divided into two groups.

The main group consisted of 54 patients who received surgical treatment with a vacuum extractor and the use of Acerbin solution in complex treatment.

The control group consisted of 40 patients with traditional wound drainage and without the use of Acerbin solution. The groups were comparable in gender and age composition and local status.

Diagnostic methods for SDS included anamnesis collection (duration of DM, duration of hyperglycemia, nature of drug therapy, history of foot ulcers and surgical interventions, cardiovascular diseases, hypertension, dyslipidemia, nephropathy and retinopathy, living conditions, alcohol and smoking abuse), examination of feet, assessment of neurological status, arterial blood flow and musculoskeletal system, laboratory and instrumental diagnostics.

Laboratory diagnostics included the determination of the level of glycemia, the level of glycosylated hemoglobin (HbA1c), the presence of glucose and ketone bodies in urine, and cholesterol levels. The main method of diagnosing the infectious process in a wound is bacteriological examination. For analysis, it is necessary to take tissue samples from different sites, since the microflora may differ in different areas of the defect. In patients with neuroischemic and ischemic forms of diabetic foot syndrome, not only aerobic, but also anaerobic microorganisms were detected and their sensitivity to modern antibacterial drugs was determined.

The treatment of purulent wounds in the main group was carried out in stages: first, the improvement of blood supply to the intervention area was achieved, then surgical treatment with vacuum drainage of wounds was performed, and in the control group by the traditional method of drainage.

A prerequisite for the use of the system for the treatment of wounds with a vacuum extractor was compliance with the following points:

1. Preliminary removal of devitalized tissues surgically.
2. Delineation of the inflammation zone (absence of active expansion of the purulent-necrotic process zone, presence of demarcation).
3. Adequate blood supply to the wound area (or successful revascularization with initially existing ischemia).
4. No signs of increased bleeding of the wound.

The average duration of vacuum therapy was  $72 \pm 12$  hours. On the first day from the beginning of vacuum therapy, a constant level of negative pressure of 100-140 mm Hg was established, from the second day onwards, the operating mode of the device changed to variable with alternating levels of negative pressure of 60-75 and 120-130 mm Hg for 5 minutes.

The effectiveness of the Acerbin solution was evaluated by traditional wound parameters (the rate of necrosis and wound cleaning, reduction of exudation, development of full-fledged granulation tissue), by the timing of wound healing or its readiness for plastic replacement, as well as by the patient's subjective feelings when using the drug under study.

The results of treatment with Acerbin solution were evaluated as excellent (elimination of the focus of purulent surgical infection and full healing of the wound or the readiness of the latter for plastic closure), good (elimination of the purulent-necrotic process, partial wound healing), satisfactory (absence of radical changes in the wound process against the background of elimination of general manifestations of surgical infection and reduction of local symptoms) or unsatisfactory (negative dynamics of the wound process).

The results of the study were processed using the Statistica 10.0 statistical package (StatSoft Inc, USA). The results of the description of quantitative features, the empirical distributions of which did not show a statistically significant difference from the normal distribution law, are presented in the form of  $M \pm \sigma$ , where  $M$  is the sample mean value,  $\sigma$  is the sample standard deviation. The significance level for testing statistical hypotheses for the validity of the difference was assumed to be 0.05.

### The results of the study and their discussion.

As a result of our own research (Table. 1) it was found that the use of a vacuum extractor in the treatment of diabetic foot provided the following effects: physical rest for the wound due to a decrease in the frequency of dressings, a decrease in the volume (depth and area) of the wound due to a significant convergence of its edges, removal of excess exudate, a noticeable acceleration of granulation tissue formation (stimulation of neoangiogenesis and improvement of microcirculation).

**Table 1**  
**Results of the vacuum extractor used in patients with diabetic foot**

Evaluation criteria	Control group, n=40	Main group, n=54
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Terms of wound cleansing from necrotic tissues (day from the moment of the first operation)	17,3±0,8	11,5±0,7*
The appearance of "mature" granulation tissue in the wound – readiness for plastic closure of the wound (day from the moment of the first operation)	21,7±1,3	14,2±0,7*
Cases with successful autograft engraftment/healing after secondary sutures, %	87.2	97.92*

Note: \*  $p \leq 0,05$ .

In the main group, bleeding from the wound was observed in two cases against the background of the operation of the vacuum apparatus, which is why the vacuum extractor was removed. According to some authors, most of the complications of vacuum therapy are associated with pain, hypertrophy of granulation tissue and erosion of blood vessels with the development of bleeding. Analysis of these cases allowed us to conclude that the main cause of bleeding was a combination of factors such as disorders in the coagulation system, ongoing anticoagulant therapy and a fresh postoperative wound. Subsequently, in order to reduce the risk of bleeding during surgical interventions combined with the use of a vacuum extractor, we began to maintain a pause of 8-16 hours between surgical treatment and the installation of a vacuum extractor device, which allowed us to avoid this type of complication in the future.

Clinically, the effectiveness of the Acerbin solution used in the main group was manifested systemically and locally. The systemic effect was the elimination of common manifestations of surgical infection — improvement of the general condition of patients, normalization of body temperature, leveling of laboratory signs of inflammation in clinical blood tests. Locally, we confirmed the acceleration of necrosis and wound cleansing from purulent-necrotic tissues to  $5.2 \pm 0.6$  days (vs.  $16.7 \pm 0.9$  days in the control group;  $p < 0.05$ ); a decrease in serous-purulent exudation from the 3rd-4th day of treatment (in the control group, exudation was longer), the appearance of active granulation tissue after  $6.3 \pm 0.4$  days (vs.  $17.2 \pm 1.1$  days in the control group;  $p < 0.05$ ). As for epithelialization, in 32 (59%) patients of the main group, wounds healed by secondary tension, in 17 (31.5%) cases, conditions for plastic closure of the wound were created.

Excellent results of local treatment were obtained in 36 (66.7%) patients, good — in 12 (22.2%), satisfactory - in 6 (11.1%), there were no unsatisfactory results. In the control group, the distribution of results was as follows: excellent - 5 (12.5%), good — 21 (52.5%), satisfactory — 13 (32.5%), unsatisfactory — 1 (2.5%).

### Conclusion

Thus, it can be concluded that the methods of local treatment used by us in the complex treatment of diabetic foot syndrome allowed us to eliminate the foci of purulent surgical infection, shorten the time of wound cleansing and leads to full wound healing or accelerate the transition to the stage of its plastic closure.

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