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FEATURES OF THE COURSE OF NECROBIOTIC SOFT TISSUE INFECTIONS IN PATIENTS WITH DIABETES MELLITUS

Alisherzhon Bakhtiyorovich Khamdamov, dr.alyowa@gmail.com
https://orcid.org/0000-0001-6614-4806
Bukhara Medical Institute

Abstract. The combination of cytological indices and rapid microbiological signs allows for the development of a reliable set of criteria that reflect the key mechanisms of necrobiotic process development in necrotizing soft tissue infections in patients with diabetes mellitus.

Keywords: necrotizing soft tissue infections, prognosis, diabetes mellitus

Background. The problem of early diagnosis and comprehensive differentiated treatment of severe forms of NSTI in patients with diabetes mellitus remains relevant at the global, regional, and national levels [1, 3, 5, 7,9].

More than 150 million people worldwide suffer from diabetes mellitus (DM), with over 10 million in Uzbekistan. Diabetes mellitus ranks among the world's leading causes of mortality. Mortality among patients with diabetes mellitus when combined with purulent-surgical diseases reaches 20% [2,17].

Patients with diabetes mellitus experience decreased resistance due to profound metabolic disorders, severe hypovitaminosis, multiple organ failure of parenchymal organs, and impaired homeostasis, including carbohydrate metabolism disorders (hyperglycemia, glucosuria, polyuria with subsequent complications such as ketosis and angiopathy), water-salt metabolism, and immunoreactive factors [1,4,6,8,10,11].

Endogenous NO deficiency in diabetes mellitus causes disturbances in the neuroregulatory influence of the somatic and autonomic nervous systems (diabetic neuropathy) and impaired microcirculatory function. The combination of these factors contributes to the development of ulcerative defects of the feet, and the addition of secondary infection contributes to the development of purulent complications [4,12,13,14].

Distinctive features of acute purulent processes in diabetes mellitus include the predominance of purulent-necrotic processes with a tendency to spread. Moreover, a more severe course of infection is observed in the acute period: frequent septic complications, rapid development of purulent complications in soft tissues against a background of high hyperglycemia, glucosuria, and even a pre-coma state.

Furthermore, an areactive course of the purulent process is often observed due to anatomical changes in the affected organ, or a sluggish, protracted course of wound infection after the acute symptoms have subsided.

Furthermore, problems associated with inflammatory diseases of the lower extremities occur in one in three patients with diabetes mellitus during their lifetime. The treatment of surgical diseases that develop or occur in the context of diabetes mellitus is a major medical challenge, as purulent surgical infection and diabetes mellitus are mutually aggravating conditions. The course of surgical infection and diabetes mellitus has its own unique characteristics: on the one hand, any purulent process disrupts all metabolic processes in the body and leads to insulin deficiency, progression of diabetes mellitus, and its decompensation. On the other hand, metabolic disturbances, by slowing tissue regeneration and repair, complicate and aggravate the inflammatory process, facilitating its spread.

In all the available literature, we found no data on the comprehensive examination and management of patients with this pathology using physical treatment methods, and the available data are quite contradictory [1,15,16]. Overall, it should be noted that, until recently, the following treatment deficiencies persisted at the prehospital stage (upon admission to a specialized purulent surgical department): untreated or untimely treated purulent foci. small incisions and inadequate treatment of the purulent focus, absence or irrational antibiotic therapy, most often carried out without bacterial analysis, inadequate intensive care of seriously ill patients, uncompensated carbohydrate metabolism disorders, separate management of this group of patients by surgeons and endocrinologists, ignoring physical methods of influencing wounds.The search for prognostic criteria, optimization of the volume of surgical intervention and integration of modern methods of local action can significantly improve treatment outcomes, reduce the frequency of amputations and mortality and ensure more rational use of healthcare resources.

The aim of the study was to develop methods for predicting the progression of soft tissue necrobiosis in patients with diabetes mellitus.

Materials and Methods. The clinical material consisted of 128 patients with diabetes mellitus who were treated and examined for severe forms of NITI at a multidisciplinary medical center in the Bukhara region from 2016 to 2025. In accordance with the study's objectives, all patients were divided into two groups: the control group included 63 patients treated from 2016 to 2020, when the traditional approach to treating necrotizing lesions was used; the study group included 65 patients observed from 2021 to 2025, when the comprehensive LDA method we developed was used.

Results and Discussion. The obtained data showed that increasing degrees of soft tissue necrobiosis are accompanied by significant changes in the cytological characteristics of smears. Taken together, this forms a natural transition from the intact periphery to the questionable zone and further to the formed focus of necrosis, which is reflected in the values of the Spearman rank coefficients.

Among the main indices, four stood out as demonstrating the closest correlation with the progression of the necrobiotic process. The IDN had a strong direct coefficient of $r = 0.919$ at $p < 0.001$, reflecting the sequential destruction of polymorphonuclear cells as tissue dies. The IGN also showed a pronounced linear relationship ($r = 0.798$ at $p < 0.001$), consistent with an increase in the volume of detritus and lysis of cellular structures in more severe zones. A comparable behavior was demonstrated by the MCI ($r = 0.731$ at $p < 0.001$), indicating an increasing imbalance between the microbial mass and the number of protective cells. The last of the leading markers, the tissue destruction index, had a stable positive correlation ($r = 0.835$ at $p < 0.001$), emphasizing the direct relationship between the volume of destruction of the fibrous framework and the severity of necrobiosis. The other indices demonstrated moderate correlations. As the degree of soft tissue necrobiosis increased, the microbial flora structure changed consistently, reflecting a transition from a relatively intact periphery to a zone of severe destruction.

More pronounced changes were observed among Gram (-) forms, with the proportion of Gram (-) cocci increasing moderately, as confirmed by a coefficient of $r = 0.458$ at $p = 0.005$. Gram (-) rods showed significantly greater changes ($r = 0.784$ at $p < 0.001$), emphasizing their key role in the context of progressive necrobiosis. The proportion of these microorganisms clearly increased toward the zone of complete necrosis, consistent with the known ability of Gram (-) rods to actively proliferate in ischemic and damaged tissue. The strongest correlation was demonstrated by groups associated with the anaerobic component, with obligate anaerobes having a correlation coefficient of $r=0.852$ ($p<0.001$), the highest value among all indicators. The characterization of mixed microbial communities requires special attention, especially when the proportion of polymicrobial complexes had one of the highest correlation coefficients at $r=0.827$ ($p<0.001$).

The ratio of Gram (-) to Gram (+) forms also increased as tissue condition worsened ($r=0.813$ at $p<0.001$), forming a characteristic pattern that coincided with the severity of necrobiosis. This value, along with the coefficients for Gram (-) rods, obligate anaerobes, and polymicrobial complexes, is among the strongest correlation markers. The correlation coefficients for IDN reflected the most pronounced relationship

between this indicator and the rapid microbiological characteristics of the wound surface.

This set of relationships indicates that IDN and IGN simultaneously respond to the deepening of the necrobiotic process and a shift in the microbial ecosystem toward an anaerobic-Gram (-) profile. An increase in the proportion of Gram (-) forms is accompanied by increased neutrophil cytolysis and the accumulation of purulent-necrotic detritus, which creates a vicious cycle of further tissue destruction. The correlation structure of the MCI and the ITD emphasizes that these indicators reflect the most profound pathobiological elements of the necrobiotic process. Increased ratios of gram-negative (-)/gram-negative (+) and anaerobes/aerobes indicate that the active growth of anaerobic-gram-negative flora is accompanied by a pronounced deficit in local perfusion. Against this background, the MCI records an imbalance between the number of microbial masses and the cells of the inflammatory infiltrate, which becomes critical as necrobiosis progresses.

Thus, comparing cytological characteristics with microbiological parameters allowed us to identify a stable system of relationships reflecting the progression of necrobiosis from early changes to the phase of severe tissue destruction. An increase in the proportion of Gram-negative rods and obligate anaerobes was accompanied by a consistent shift in the cytological profile toward an increase in destructive neutrophils, increased purulent-necrotic decay, a growing microbial-cellular imbalance, and a loss of tissue matrix structural integrity. This configuration emphasizes that the degree of necrobiosis is determined by the simultaneous influence of microbial aggression and the local cellular response, and each of the four identified indices reflects a distinct element of this process. The combination of the identified patterns provides a sufficient basis for moving to the next stage, which requires formalizing the obtained characteristics into an integrated scale capable of quantifying the degree of necrobiosis and serving as a tool for early prediction of wound healing dynamics.

CONCLUSIONS:

1. The combination of cytological indices and rapid microbiological characteristics enables the development of a reliable set of criteria that reflect the key mechanisms of necrobiotic development in NIMT in patients with diabetes.

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