

# Characteristics of Cellular and Humoral Immunity in Various Types of Anesthesia in Patients with Diabetic Foot Syndrome

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**Abstract Introduction.** In the structure of morbidity of residents of economically developed countries, diabetes mellitus occupies one of the first places. Its prevalence is 1.5–6%. Lesions of the lower extremities of various genesis occur in 30-80% of people with impaired carbohydrate metabolism. **Objective:** comparative study of the effect of general, epidural and conduction anesthesia on the state of cellular and humoral immunity in patients with diabetic foot syndrome. **Methods:** 48 patients with diabetic foot syndrome were examined, who made up 3 groups depending on the use of anesthesia methods: group I - 14 patients (29.2%) operated under epidural anesthesia (EA). Group II - 19 (39.6%) patients who were anesthetized by conduction anesthesia (CA). Group III - 15 (31.2%) patients who underwent general anesthesia (GA). The number of lymphocytes with CD3, CD4, CD8, CD20 phenotype in peripheral blood was studied and the level of IgG, IgA, IgM in blood serum was determined by ELISA. **The results obtained:** it was revealed that in patients who underwent GA, deeper changes in immunity were observed than the initial data. The indicators of patients who underwent EA are somewhat better. In patients who underwent surgery using PA, immunological parameters remained at the level of baseline data. Therefore, CA is a more gentle anesthesia with respect to its effect on the parameters of the immune system. **Conclusions.** From the position of influence on cellular and humoral immunity, the method of choice for operations on the lower extremities in patients with diabetic foot syndrome is conductive anesthesia (CA) based on stem nerve blockades.

**Keywords** Diabetic foot syndrome, Anesthesia, Cellular and humoral immunity

## 1. Introduction

In the structure of morbidity of residents of economically developed countries, diabetes mellitus (DM) occupies one of the first places. Its prevalence is 1.5–6%. Lesions of the lower extremities of various genesis occur in 30-80% of people with impaired carbohydrate metabolism. Often these lesions are complicated by the development of chronic ulcerative defects, which, with untimely diagnosis and inadequate treatment, lead to amputation of the affected limb. Every hour in the world 55 amputations of the lower extremities occur in patients with diabetes mellitus [1,2,3]. Despite significant advances in the study of the pathogenesis of diabetes mellitus and its complications, the number of leg amputations in diabetes is growing. For the first time, an ulcerative defect on the foot, as a rule, turns into a recurrent one. Within 5 years, ulcerative defects recur in 70% of cases [4,5,6]. Modern means and methods of intraoperative

anesthetic protection should ensure the normal functioning of all life support systems, have a high level of safety, be convenient and accessible to use, guarantee a high "quality of life" to the patient in the postoperative period, and also contribute to the fastest possible restoration of the structural and functional integrity of organs and tissues [7,8,9,10].

There is still a discussion in the literature about the choice of the optimal method of anesthesia for operations performed for diabetic foot syndrome (DFS). A sufficient amount of data has been accumulated indicating the advantage of neuroaxial anesthesia in comparison with general anesthesia [5,6,7].

Literature data on the effect of various anesthesia methods on the immune system in patients with DFS are few and contradictory [3,9,10].

## 2. The Aim of the Study

The aim of the study is to compare the effect of general, epidural and conduction anesthesia on the state of cellular and humoral immunity in patients with diabetic foot syndrome.

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### 3. Materials and Methods of Research

The study included 48 patients diagnosed with diabetic foot syndrome who were on inpatient treatment in the department of purulent surgery of the Bukhara Regional Multidisciplinary Medical Center. The average age of the patients was 62.5 years. Many patients (39.57%) were at the age of labor activity (from 45 to 60 years). In most cases of observation, patients suffered from type 2 diabetes mellitus (94.5%), where mainly moderate and severe degrees of severity of diabetes mellitus in the stage of subcompensation and decompensation were observed. 57.9% of patients had gangrene of the toes and 34.6% had gangrene of the distal parts of the foot.

Depending on the types of anesthesia, the patients were divided into 3 groups: Group 1 – 14 patients (29.2%) operated on for SDS under general anesthesia (GA). The second group consisted of 19 (39.6%) patients who underwent anesthesia during surgical interventions on the lower extremities by epidural anesthesia (EA). The third group consisted of 15 (31.2%) patients who underwent conduction anesthesia (stem blockade) (PA).

Immunological studies were carried out by quantitative study of the number of lymphocytes with the CD3, CD4, CD8, CD20 phenotype in peripheral blood using monoclonal antibodies of the LT series (Sorbent LLP; Moscow, Russia), determination of the level of IgG, IgA, IDM in blood serum by the ELISA method using the test system of Vector Best LLC (RF), according to the attached instructions. The control group consisted of 20 practically healthy individuals of the same age. Studies in patients were conducted before and after surgery.

The research materials were subjected to statistical processing using the Student's t-test, using the standard Windows 2000 statistical software package.

### 4. Results and Their Discussion

An analysis of the anamnestic data of the examined patients showed that by the nature of concomitant diseases, the patients of the designated groups were homogeneous. The following nosologies were most common: Coronary heart disease, PIX, arterial hypertension, COPD, diabetic nephropathy.

The results of the study showed that, in general, in the group of patients who underwent general anesthesia (GA), there was a relative instability of hemodynamic parameters at all stages of the operation. 4.0% of patients had cardiac arrhythmia, 8.0% of cases had uncontrolled hypotension. In 11.0% of patients, the duration of post-acute awakening was observed, in 7.0% of patients hypoglycemic state. In 12.0% of cases, the recurarization of relaxants was observed. Moreover, difficulties in tracheal intubation were noted in 8.0% of cases.

Epidural anesthesia (EA) was performed according to a generally accepted method using a special set of "Espokan". The results of the study showed that in the group

of patients who underwent EA, there was a relative instability of hemodynamic parameters in 8.5% of patients. 2.0% of patients had cardiac arrhythmia, 2.0% of cases had uncontrolled hypotension, 10.5% had bradycardia, 5.0% of patients had technical difficulties performing epidural anesthesia.

In patients of the third group operated under conditions of conduction (stem-nerve blockade) anesthesia, 14-15 minutes after the blockade of the nerve trunks, the effect of anesthesia was manifested, which persisted at all stages of the operation and no additional administration of analgesics was required. Hemodynamic parameters were fairly stable. At the same time, respiratory dysfunctions were not observed. The duration of analgesia in the postoperative period lasted from 7 hours to 11 hours. There were no serious complications associated with anesthesia, but the following reactions were noted: 5.0% of patients developed headache after the introduction of a local anesthetic, 2.0% developed nausea, and 3.5% of patients had muscle tremors. These symptoms were regarded by us as a toxic effect of the anesthetic. In 3.0% of patients, bradycardia was noted, which was stopped by the introduction of an atropine sulfate solution. It should be noted that the conduction of anesthesia provided a complete blockade of nociception during surgical interventions on the lower extremities, as well as a smooth course of the postoperative period with rapid activation of patients, that is, an early return to the usual meal intake and insulin therapy regimen, activity within the bed, verticalization in a sitting position.

All patients underwent routine noninvasive hemodynamic monitoring using DASH 3000 monitors: ECG, blood pressure, heart rate, SpO<sub>2</sub>.

Analysis of the results of immunological studies in patients with SDS showed that changes in cellular and humoral immunity are observed compared with the data of the control group (Fig. 1).

As can be seen from Figure 1, the level of T-lymphocytes (CD3+) and its subpopulations (T-helpers ( $P<0.01$ ) and T-suppressors ( $P<0.05$ ) was significantly reduced relative to the data of the control group. lymphocytes with CD16 phenotype in patients with SDS were reduced, and the level of B-lymphocytes was significantly increased relative to the indicators of the control group.

Analysis of data on lymphocytes with activation markers – CD25 and CD95, showed their multidirectional change, the level of lymphocytes with a marker of early activation – CD25+ cells were significantly reduced, and lymphocytes with a marker of apoptosis were significantly increased ( $P<0.05$ ). As for humoral immunity, the level of IgA and IgG was significantly increased ( $P<0.01$ ), (Fig. 2).

As you know, any operation is stressful for the body, including for the immune system. However, it turned out that anesthesia can also affect the parameters of the immune system in different ways. Analysis of the results of the study after the surgical procedure showed that general anesthesia applied during surgery in patients with SDS has an effect on both cellular and humoral immunity. As can be seen from the

data given in Fig. 3, under the influence of general anesthesia, there is a significant decrease in the number of CD3+ cells (P<0.01). The number of helper and suppressor cells is also

reduced, (P<0.05). And the number of cells with the CD25, CD95 and B-lymphocyte phenotype is higher than the initial data.

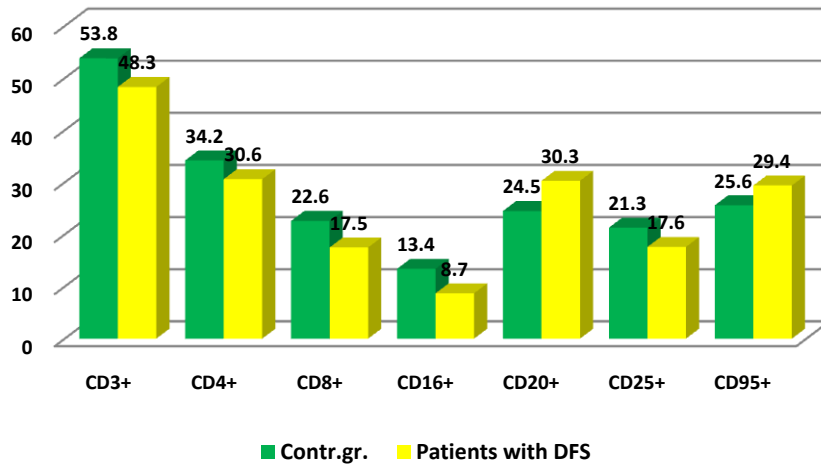


Figure 1. Показатели клеточного иммунитета у обследованных лиц

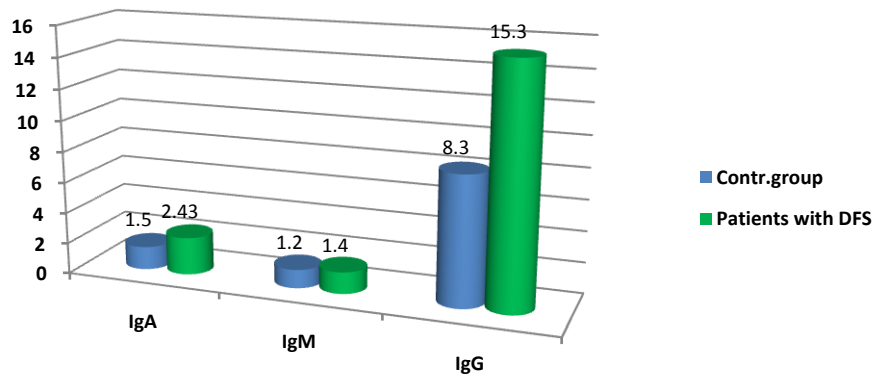


Figure 2. Indicators of humoral immunity in the examined persons

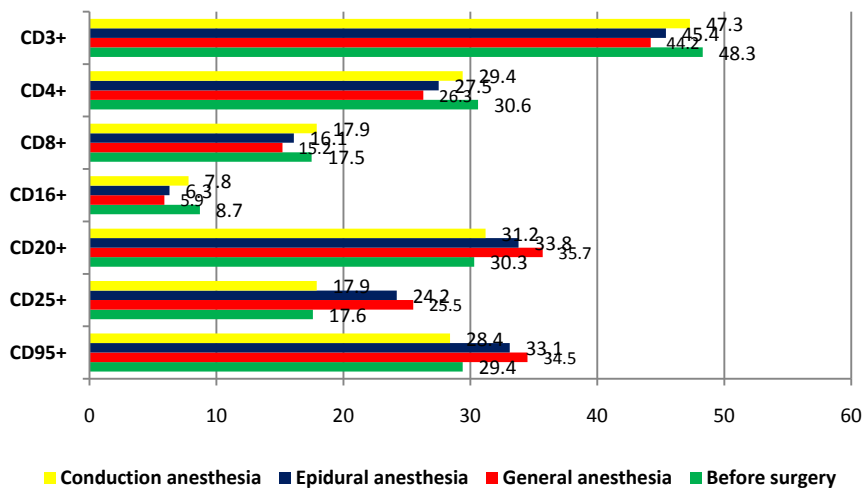
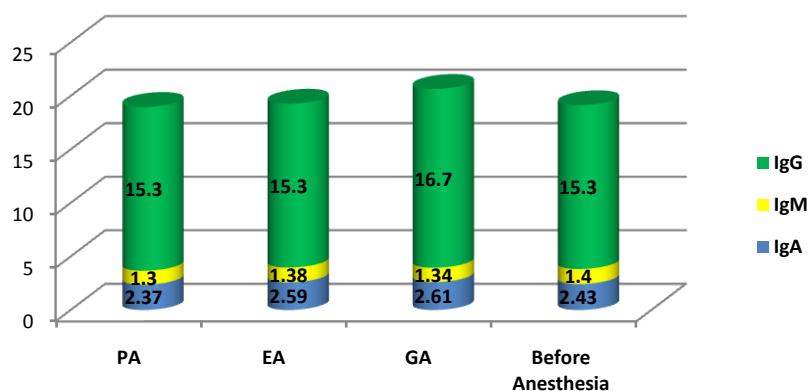


Figure 3. Dynamics of cellular immunity parameters in the examined patients



**Figure 4.** Dynamics of humoral immunity indicators in the examined patients

The analysis of the data of patients who underwent surgery using EA was also changed, and most of the indicators were changed significantly.

Analyzing the data of immunological parameters in patients who underwent surgery using PA, it was found that no significant changes were observed, except for the immunoregulation index, which was lower than in other groups ( $P < 0.05$ ). The number of NK cells in the postoperative period decreased significantly in all groups, but most pronounced in the GA group (PA – 17%; EA – 33%; GA – 42%).

According to the data given in Fig. 3, activation of cellular immunity is observed, which indicates the tension of regulatory systems and the development of unfavorable adaptation strategies, mainly in GA.

The humoral link of immunity (IgA, IgG, IgM of blood) is more resistant to the effects of surgical trauma and anesthesia. At the same time, a decrease in the level of immunoglobulins of classes A and G is observed both during epidural and general anesthesia (Fig. 4).

According to a number of authors, in general surgical patients operated under spinal and epidural anesthesia, there is moderate immunosuppression of the cellular link of immunity (a decrease in the total number of lymphocytes in the blood, CD3+, CD4+, CD8+ cells) [4,5]. At the same time, statistically significant differences in all indicators of the immune status are revealed in patients with surgical pathology of the abdominal cavity operated under conditions of GA [10]. This is not observed in patients who underwent surgery under general anesthesia. In these patients, immunosuppression in the postoperative period is further aggravated [2,8].

Thus, the conducted studies indicate that anesthesia has its effect on the immune system. However, the most sparing effect is provided by anesthesia during surgical interventions on the lower extremities in patients with diabetic foot syndrome, performed by stem blockade.

## 5. Conclusions

1. The use of general anesthesia during operations on the

lower extremities in women with diabetic foot syndrome, is accompanied mainly by the suppression of all links of cellular and humoral immunity.

2. The use of epidural anesthesia is accompanied by less tension of regulatory systems, which contributes to the conservation of protective resources of the body and the development of a favorable adaptation strategy.

3. From the position of influence on cellular and humoral immunity, the method of choice for operations on the lower extremities in patients with diabetic foot syndrome is conductive anesthesia (CA) based on stem nerve blockades.

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