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DIABETIC FOOT SYNDROME. MODERN METHODS OF TREATMENT OF PATIENTS WITH CRITICAL ISCHEMIA OF THE LOWER EXTREMITIES

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Abstract:

The issue of treatment of critical ischemia of the lower extremities today is one of the main and most urgent problems of surgery. Unsatisfactory results of performed amputations of the lower extremities due to critical ischemia on the background of diabetes mellitus determine the relevance and social significance of studying the issues of prevention of amputations of the lower extremities using modern endovascular interventions, which indicates the need to optimize the tactics of surgical treatment. Improving the results of treatment of patients with critical lower limb ischemia in diabetic foot syndrome through a differential treatment approach, taking into account endovascular interventions, is the main goal. The question of the treatment of critical ischemia against the background of diabetes mellitus remains open and requires an active solution.

Keywords

critical ischemia, diabetes, diabetic foot syndrome, endovascular intervention.

Introduction

Diabetic foot syndrome refers to all pathological changes in the foot of a person with diabetes mellitus [1, 3]. These include pre-ulcerative lesions, such as abnormal corneal calluses. Ulcers or necrosis usually develop as a result of repeated trauma with a limited sense of pressure and pain in the context of diabetic polyneuropathy (for example, in the form of high pressure and shear stress, especially with deformities of the foot and toes).

The most significant manifestations of diabetic foot problems are ulceration, deforming changes in the skeleton of the foot (Charcot's foot) and amputation [4, 6, 14].

The annual rate of new cases of acute diabetic foot syndrome (DFS) is about 2%. The probability of DFS throughout the life of a person with diabetes mellitus is 19-34%. For many years, Germany has been at the top of European amputation rates, but a recent large nationwide study showed a decrease in major and minor amputations in the diabetic population compared to the non-diabetic population. The result of the study by world scientists confirms the positive trend that has already been observed in smaller and regional studies in recent years, where it is shown that 65-70% of all amputations are still performed in patients with diabetes mellitus [7, 13].

The term "critical ischemia of the lower extremities", adopted in 1982 by a working group of vascular surgeons, originally meant pain at rest with an ankle pressure of less than 40 mmHg or tissue necrosis with an ankle pressure of less than 60 mmHg in patients without DM. Patients suffering from DM did not fall under this definition due to the influence on the development of the neuropathy process and the susceptibility of these patients to infection [2, 11]. The term was considered unsuccessful for a long time and was regularly discussed due to the fact that it did not include an extensive group of patients at risk of lower limb amputation. In the 2019 International Vascular Clinical Guidelines, the term "critical ischemia threatening limb loss" was proposed, which includes much more heterogeneous categories of patients at risk of limb amputation [4, 9, 12]. Thus, critical ischemia threatening the loss of a limb is defined as damage to the peripheral arteries in combination with ischemic pain at rest or trophic disorders, as well as necrosis of any part of the foot that exists for more than 4 weeks.

Diagnostic methods used to assess lesions of the arteries of the lower extremities. Ultrasound Dopplerography, ultrasound duplex scanning with color Doppler mapping of blood flow (CDCC), radiopaque angiography (RCAG) (before surgery) give specificity and accuracy of the results of the study of the arterial bed of the lower extremities in the range of 78-89%, but the combination of both methods creates a range of 90-98%. UZDS is a first-line imaging method to confirm the diagnosis of lower limb artery disease ZANK, sometimes it is the only available method. UZDS allows you to determine the criteria for arterial stenosis (according to Jagger K. A. and co-authors in 1985) and the ankle-shoulder index (LPI) [5, 7, 10, 13].

With the advent of multispiral (64-slice) computed tomography (MSCT-64) in the early 2000s, the capabilities of CT have expanded, the scanning speed and resolution of the images obtained have significantly increased, it has become possible to reduce the volume of contrast agent (KV) injected. Multispiral computed tomography (MSCT) with intravenous bolus contrast or CT angiography (CT) is a medical imaging technique that allows you to determine the degree and extent of narrowing of the arteries. However, CT results are not used to classify ANC lesions. In addition, CT has a number of advantages over CSA: it is low invasiveness, obtaining diagnostic images of the abdominal aorta, iliac

arteries and arteries of both lower extremities in one scan, the possibility of repeating a standardized study in dynamics, including in outpatient settings. Therefore, the CTA can be considered as an alternative to the CSA. (Maslov A.L. 2022) evaluates the effectiveness of CT in determining the state of the arterial bed of the lower extremities after performing reconstructive operations, shows the value of CT when performing a study of the functioning of shunts, prostheses, stents, studies in the postoperative period with suspected paraprosthetic infection [5,8].

Critical ischemia of the lower extremities in diabetic foot syndrome, clinical manifestations. One of the most dangerous complications of diabetes mellitus (DM) is the lesion of the vessels of the lower extremities. In DM, both large vessels (macroangiopathy) and small vessels (microangiopathy) are affected. As a rule, the vessels located below the knee joint gap are affected from the main ones [10,12]. In diabetic angiopathy, hemodynamic changes occur primarily due to stenosis and occlusion of the lumen of the main arteries, which leads to a decrease in perfusion pressure, triggering a cascade of local microcirculation disorders. At the same time, diabetic foot syndrome is defined as an infection, ulcer and/or destruction of foot tissues associated with neurological disorders and/or a decrease in the main blood flow in the vessels of the lower extremities. Thus, when the arteries of the lower extremities are affected in DM, there is a mutual aggravating effect of microcirculation and the condition of the main arteries [3, 11].

Currently, due to the achievements of reconstructive surgery of occlusive lesions of the arteries, successful revascularization of the extremities has become possible in 60-70% of patients [8]. However, the timing of the functioning of vascular shunts directly depends on the initial degree of chronic limb ischemia, as well as on the state of the peripheral arterial bed [6].

In more than 70% of cases in patients with critical ischemia, amputation of the lower extremities is preceded by a foot ulcer and other complications. The methods of surgical and conservative treatment of purulent-necrotic complications of diabetic foot syndrome used in modern treatment practice do not always allow to achieve stabilization of the process, they are quite expensive and often difficult to perform [9].

According to a number of researchers, patients suffering from diabetic angiopathy of the lower extremities quite often seek medical help when the situation is already running, i.e. there are trophic disorders and pain at rest, which, according to Fontaine's classification–Pokrovsky, corresponds to chronic arterial insufficiency (KHAN) of the 3rd-4th stage. These patients develop critical ischemia of the lower extremities – decompensation of KHAN, characterized by clinical signs such as pain at rest, not relieved by narcotic analgesics, and/ or the presence of ulcerative necrotic process in the foot [10].

With the development of critical ischemia, the prognosis is unfavorable. Not eliminated critical ischemia of the lower extremities in 22% of patients leads to death or amputation within 12 months. Limb revascularization is performed only in 50% of individuals, the rest receive conservative treatment, the effectiveness of which is extremely low. Preservation

of the limb for 6 months. it is possible in no more than 40% of patients. Approximately the same amount of high amputation is performed. Diagnostic measures for critical ischemia threatening limb loss are aimed at objective confirmation of the diagnosis, determination of the localization of vascular lesion and the severity of ischemia, assessment of the possibilities of revascularization and individual risk for endovascular or open intervention [2].

First of all, when managing patients with critical ischemia threatening limb loss, it is necessary to determine the state of the main blood flow and the level of vascular damage. Diagnostic measures should include the most non-invasive and accessible methods of examination, starting with a physical examination and a thorough history collection. The main clinical sign of a violation of the main blood flow is recommended to consider the presence and appearance of trophic disorders of the lower extremities, an increase in the size of the wound defect, despite the conservative treatment. Classical criteria of critical ischemia cannot always be applied to patients with diabetic angiopathy of the lower extremities, since the severity of pain syndrome in people suffering from DM is often difficult to assess due to neuropathy. The measurement of the ankle-shoulder index (LPI) also does not always reliably reflect the presence of critical ischemia, since its values often exceed 1.3 due to pronounced Mekeberg mediocalcinosis [12].

In the case of critical lower limb ischemia developed with diabetic angiopathy, it is recommended to base on clinical signs, such as pain in the limb, as well as the presence of trophic disorders. To verify the diagnosis, it is recommended to use the arterial blood hemoglobin oxygen saturation index (TsPO2, SpO2), as well as laser Doppler flowmetry. Both of these methods can also be used to determine the dynamics of reparative processes in the foot when evaluating the effectiveness of therapeutic measures [5]. The progression of diabetic angiopathy leads to the development of gangrene and subsequent amputation of the limb. Despite conservative treatment, the disease is steadily progressing. The late stage of the disease with trophic disorders, distal segment lesion, concomitant pathology are the reasons for the refusal of reconstructive surgery in 50-75% of patients [3].

It is the methods of indirect revascularization in this situation that can be used to prevent the progression of the process leading to high amputations of lower limbs and disability. Insufficient effectiveness of existing methods of indirect revascularization (revascularization osteotrepanation, lumbar sympathectomy, etc.) leads to the search for new methods of exogenous stimulation of angiogenesis [2].

In recent years, data on the possibility of using progenitor stem cells of peripheral blood, bone marrow, adipose and embryonic tissue to stimulate neoangiogenesis have been increasingly found in the literature. As early as the end of the XX century, precursors of endothelial cells isolated from peripheral blood were used. Thus, a positive effect of treatment was established with subcutaneous administration of autologous peripheral blood stem cells in patients with obliterating diseases with end-stage ischemia of the lower extremities. The first autologous transplantation of mononuclear cells of red bone marrow

was carried out by Tateishi and Yuyama in 2002. As a result, after 24 weeks, there was an increase in LPI, indicators of transcutaneous oxygen tension and the duration of pain-free walking [6,7].

In addition, publications on the use of multipotent cells for indirect revascularization of the lower extremities are becoming more common. Studies involving patients with critical limb ischemia have shown that the use of bone marrow mesenchymal stem cell transplantation in combination with endothelial progenitor cells leads to an increase in the duration of pain-free walking and an increase in LPI. At the same time, perfusion scintigraphy confirmed an increase in perfusion in the treated limb in comparison with the second lower limb [4].

Features of treatment of critical lower limb ischemia in diabetic foot syndrome (percentage of occurrence, course and modern methods of treatment. Percutaneous transluminal balloon angioplasty was used as the main method of correction of arterial blood flow in the lower extremities [3].

In recent years, hyperspectral imaging (HSI) has emerged in the field of vascular medicine. It is a non-invasive, non-contact imaging technique that allows spectroscopically measuring tissue oxygenation without the need for contrast agents or radiation. Although the expediency of HSI in detecting perfusion disorders in patients with peripheral artery disease (PAD) has already been shown in a number of publications [8] and one of the existing HSI systems has not acquired significance for routine, clinical use. Chiang N., Jain J.K., Sleigh J. (2021) A group of scientists recently proved that hyperspectral imaging can be an important, additional tool to support and improve PAD diagnostics.

In this study, the authors emphasized the usefulness of HSI for the rapid and reliable detection of impaired tissue perfusion in patients with PAD. Thus, NSIANALYSIS of the NIR and StO2 perfusion index can be a useful, additional tool for both detecting and monitoring leg perfusion in patients with PAD in a fast, non-contact way independent of the examiner. As a consequence, a decrease in the parameters of tissue oxygen saturation can lead to further visualization of vessels to localize vascular pathologies that can be treated before significant tissue damage occurs. Although HSI is not intended to replace established methods, it overcomes a number of disadvantages of the methods currently used for PAD evaluation. To assess sensitivity and specificity, extended studies with a larger cohort and longer follow-up are needed. In this context, future studies should also consider neuropathy as a potential influence on changes in tissue oxygen saturation after revascularization [4,9]. In general, it would also allow us to study the effect of revascularization performed (local: angioplasty, thrombendarterectomy; long-range: bypass implantation, recanalization) on tissue oxygen saturation in the corresponding angiosomes.

Conclusion

The analysis of literature sources shows that scientists and practical surgeons are constantly searching for solutions to the problem of diagnosis and treatment of foot lesions at different

stages of the disease development. The actual direction of vascular surgery is the introduction of new effective methods of surgical treatment of multilevel occlusive-stenotic lesions of peripheral arteries in patients with diabetes mellitus. The incidence of obliterating atherosclerosis of the arteries of the lower extremities among patients with diabetes mellitus and the features of vascular bed damage in this category of patients make it necessary to search for optimal surgical treatment tactics to preserve the limb with the development of critical ischemia.

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