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DETERMINATION OF TRANSCUTANEOUS OXYGEN TENSION FOR EVALUATING THE DEGREE OF ISCHEMIA IN PATIENTS WITH DIABETIC FOOT SYNDROME

[1]I. Ya. Dzubanovskyi, [2]R. Ya. Antoschuk, [3]S. S. Kurach, [3]V. A. Tanovetskyi

[1]Department of Surgery by Educational and Scientific Institute of Postgraduate Education, I. Horbachevsky Ternopil National Medical University, Ternopil
[2]Volyn Regional Hospital for War Veterans, Lutsk
[3]Volyn Regional Clinical Hospital, Lutsk

Abstract

One of the main syndromes that poses a direct threat to the patient's ability to work and life is diabetic foot syndrome (DFS). It is known that DFS is caused by a complex of disorders of the anatomical and functional state of the foot due to neuro-ischemic changes caused by prolonged hyperglycemia. The aim of styding was to investigate the value of transcutaneous oxygen tension during the performance of revascularization and rehabilitation interventions in patients with DFS. We studied 114 patients with purulent-necrotic forms of DFS with moderate and severe diabetes, who were determined by the value of transcutaneous oxygen tension during hospital treatment.

Therefore, determination of transcutaneous oxygen tension is the most informative way to assess the degree of ischemia before and after revascularization operations. When the value of TcpO2 at the foot ≤ 25 mm Hg we recommend performing the first stage of revascularization intervention. At TcPO2 values > 25 mm Hg, revascularization was recommended for post-primary remediation of purulent-necrotic lesions and to accelerate

healing in patients with large foot tissue defects after surgery for purulent-necrotic complications of DFS. When restoring the value of the transcutaneous voltage above 25 mm Hg it can be performed remediation interventions at almost any distal level. At values of 10-25 mm Hg – it should be done more proximal level (where the determined transcutaneous value of TcpO2 is about 15-25 mm Hg) of the demarcation line necrosis, as the risk of reamputation is higher than 75 %. At values of ≤ 10 mm Hg, we recommend performing high amputations.

Key words: diabetic foot syndrome; transcutaneous oxygen tension; diabetes mellitus; revascularization.

Introduction. Despite the significant development of modern medicine today, the problem of diabetes and its complications remains relevant. According to the WHO, the total number of patients with diabetes by 2025 will increase to 300 million and by 2030 diabetes will rise to seventh place among the leading causes of death in the world. According to statistics, about 60-80 % of patients with diabetes require an interdisciplinary approach in the treatment and diagnosis of its main complications [1-2].

One of the main syndromes that poses a direct threat to the patient's ability to work and life is diabetic foot syndrome (DFS). It is caused by a complex of disorders of the anatomical and functional state of the foot due to neuro-ischemic changes caused by prolonged hyperglycemia [3]. When combined with an infectious agent, a purulent-necrotic process develops, which significantly complicates both the DFS syndrome itself and adversely affects all body systems due to the developing systemic inflammatory response syndrome [4-5].

The severity of the course of purulent-necrotic complications of DFS is also facilitated by existing comorbidities and pathological changes in the "target organs" affected by diabetes. After all, it is known that mostly DFS develops in people older than 50 years, and in the absence of a comprehensive approach to treatment, almost 55-60 % of patients perform high amputation. Significant percentage and mortality (40-60 %) due to severe purulent-necrotic lesions of the lower extremities, due to the development of decompensation, both diabetes and comorbidities [6-7]. Several studies have shown that regardless of the type of diabetes, the risk of complications and amputation increases by 2-4 times with age and disease duration [8-9].

Among the clastic and typical pathogenetic components of DFS are usually distinguished: osteoarthropathy, neuropathy, dysfunction of the microcirculatory and main arterial bed, as well as bacterial factor [10].

However, when it comes to patients with comorbidities, it is mainly the elderly in which another important aspect that has a negative factor in vascular patency at different levels of the arterial system is general atherosclerosis. Here the process has a complementary effect, because impaired blood flow in the distal arteries contributes to tissue ischemia, and as a consequence of the progression of atherosclerosis in these departments [11]. This pathogenetic property is one of the main causes of macroangiopathy at the level of the tibial arteries, which has already been proven by many studies of hemodynamics of the arteries of the lower extremities. Usually, the diagnosis of obliterative atherosclerosis as a concomitant disease in these cases seems unreasonable and impractical, but rather the mutual burden of the manifestations of diabetic angiopathy and atherosclerosis forms a typical picture of the ischemic form of DFS [12-13].

Prolonged chronic arterial insufficiency on the background of DFS naturally in certain cases leads to the development of critical ischemia of the lower extremity, which in combination with the infectious factor causes severe forms of purulent-necrotic complications, extensive gangrene [14-15]. In these patients, the risk of performing high amputations is significantly increased, so it is important to determine the level of transcutaneous oxygen tension to determine the tactics of treatment of such patients.

The aim: to investigate the value of transcutaneous oxygen tension during the performance of revascularization and rehabilitation interventions in patients with DFS.

Materials and methods. We studied 114 patients with purulent-necrotic forms of DFS with moderate and severe diabetes, who were treated at the Volyn Regional Hospital for War Veterans.

Exclusion criteria were: patients with progressive coronary heart disease in combination with severe heart failure and severe chronic kidney disease, isolated obliterating atherosclerosis of the vessels of the lower extremities, chronic pulmonary diseases in the acute stage, cancer of various localization. The degree of diabetic spot damage was assessed according to the PEDIS classification [16]. During hospital treatment, all patients received insulin therapy and / or hypoglycemic drugs, statins, antiplatelet agents, antibiotic therapy, detoxification therapy, and analgesics.

The method of transcutaneous oxygen tension (TcPO2) is a non-invasive method used to determine the viability of tissues in critical ischemia of the lower extremities, the degree of reduction of blood flow in the treatment of DFS.

The determination was performed using the device TSM-2 (Radiometer, Denmark). The set includes a heating oxygen electrode of the "Clark" type. After calibration of the electrode with atmospheric air, measurements were performed on both lower extremities in the first interdigital spaces in the absence of a skin defect. On the skin surface, a fixing ring in which the cavity was filled with two or three drops of electrolyte solution. The electrode was then inserted into a fixation ring on the skin. The studies were performed at physiological positions, which created different conditions of load on the limb to objectively assess the state of microcirculatory blood flow and its dynamics. The results of the study were recorded in mm Hg.

Statistical processing of the obtained results was performed using a statistical package of programs "Statictica 6.0 for Windows" (StatSoft, USA). The frequency of qualitative indicators was represented in absolute (n) and relative (%) frequencies with a value of 95% confidence interval (%; 95% CI). The mean value was represented as (M±m), where M is the mean value and m is the standard deviation.

Results. According to the recommendations of the International Working Group on the Diabetic Foot (IWGDF, 2016), patients with purulent-necrotic complications of VTS with a TcpO2 value at the rate of ≤25 mm Hg, were subject to immediate revascularization of the lower extremities. There were 32 such patients (28.07 %).

Urgently, the first stage was performed sonographic monitoring, which in 98.24% of cases confirmed the presence of arterial patency of the main type. These patients underwent diagnostic arteriography, which resulted in the restoration of blood flow by: balloon angioplasty – 62 patients (56.67 %), balloon angioplasty + stenting – 39 patients (34.21 %).

At TcPO2 values> 25 mm Hg, revascularization was recommended for post-primary remediation of purulent-necrotic lesions and to accelerate healing in patients with large foot tissue defects after surgery for purulent-necrotic complications of DFS. In this case, the primary stage was the opening, drainage of phlegmon, abscesses, necrosequrectomy. In the second stage, arteriography was performed. Revascularization was performed by performing balloon angioplasty – 29.03 % of patients, balloon angioplasty + stenting – 22.58 % of patients.

Thus, the results of X-ray contrast angiography in patients with critical (≤ 25 mm Hg) and subcritical (> 25 mm Hg) values of TcPO2 confirmed occlusive-stenotic lesions of the arteries of the lower extremities.

Contralateral femoral access was used for revascularization of the femoral-popliteal segment. After puncture of the femoral artery in its middle third according to Seldinger in the lumen of the artery on a puncture needle was injected a standard conductor 0.035 inches. The 6F introducer was introduced along the conductor in the retrograde direction with a reversal in the abdominal aorta. After establishing the end of the introducer in the initial departments of the common iliac artery, arteriography was performed. After detecting areas of stenosis, the conductor passed the area of narrowing. After that, a balloon catheter was inserted, balloon angioplasty was performed.

After that, if it was not possible to achieve a stable restoration of patency, the replacement of the Smart control stent delivery system was performed. The stent was inserted into the place of balloon angioplasty, after its opening performed additional balloon angioplasty. At the final stage was performed control angioplasty.

Objective evaluation of the effectiveness of revascularization, in addition to clinical and radiological indicators (patency, residual stenosis), was performed based on the results of transcutaneous oxygen tension in the postoperative period. Thus, before surgery in patients with critical ischemia, it averaged (21.4±7.1) mm Hg. At the same time at patients with 3-4 degrees according to PEDIS classification this indicator made at 15.67 % of patients less than 10 mm Hg.

At 3-5 days after surgery in most patients with 1-2 degrees according to the PEDIS classification there was a statistically significant increase in this indicator to the level of (35.3±9.5) mm Hg. Its measurement during inpatient stay showed its average values at the level of (34.6±8.7) mm Hg.

However, in patients with severe purulent-necrotic processes (grade 3 and 4 according to the PEDIS classification) after endovascular intervention there was a pronounced edema due to inflammatory phenomena. In these patients, in contrast to patients without edema, the level of TcpO2 was (29.6±7.1) mm Hg. Prolonged edema of the foot was observed in 31.37 % of patients due to the severity of the infectious lesion, and therefore critical indicators of tissue oxygen tension – (19.5±5.8) mm Hg.

Despite the adequacy and consistency of surgical tactics and the optimal timing of rehabilitation operations in this category of patients on average up to 7-9 days after revascularization, edema persisted, especially on the dorsal surface of the foot, which

significantly disrupted microcirculation. All this necessitated the delayed implementation of remediation interventions and subsequently reconstructive plastic surgery.

In some patients 23.53 % with moderate purulent-necrotic process, but with severe heart failure, low TcpO2 ((21.5±6.2) mm Hg) after revascularization was due to the development of reperfusion syndrome. Although during inpatient treatment we observed a statistically significant increase in oxygen saturation, and at the time of discharge reached the level of suboptimal ((28.7±4.9) mm Hg), and after 1 and 3 months it was ((32.7±6.1) mm Hg and (36.7±4.2) mm Hg, respectively. Such positive dynamics was due to the weakening of the phenomena of reperfusion syndrome.

It was found that in all patients the normalization of TcpO2 after revascularization occurred only after 4-5 weeks. Thus, taking into account the dynamics of the transcutaneous oxygen index allows a differentiated approach to the main stages of surgical treatment of patients with purulent-necrotic complications of ischemic form of DFS.

Conclusion. 1. Determination of transcutaneous oxygen tension is the most informative way to assess the degree of ischemia before and after revascularization operations. When the value of TcpO2 at the foot ≤ 25 mm Hg we recommend performing the first stage of revascularization intervention. At TcPO2 values > 25 mm Hg, revascularization was recommended for post-primary remediation of purulent-necrotic lesions and to accelerate healing in patients with large foot tissue defects after surgery for purulent-necrotic complications of DFS.

2. When restoring the value of transcutaneous voltage above 25 mm Hg it can be performed remediation interventions at almost any distal level. At values of TcpO2 10-25 mm Hg – should be done proximal (where the determined transcutaneous value of TcpO2 is about 15-25 mm Hg) demarcation line necrosis, as the risk of reamputation is greater than 75%. At values of TcpO2 ≤10 mm Hg, we recommend performing high amputations.

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