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ORIGINAL ARTICLE

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THE IMPORTANCE OF FUNCTIONAL EXAMINATION OF PATIENTS AND ASSESSMENT OF PERIPHERAL HEMODYNAMICS IN THE REHABILITATION OF PATIENTS WITH OBLITERATING ATHEROSCLEROSIS OF THE VESSELS OF THE LOWER EXTREMITIES

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ABSTRACT

Aim: To evaluate the effectiveness of the treatment and clarify the medical and social criteria for the rehabilitation of patients with obliterating atherosclerosis of the vessels of the lower extremities.

Materials and Methods: A comprehensive clinical and instrumental examination of 54 patients who underwent various types of operations for obliterating atherosclerosis of the vessels of the lower extremities 3 years ago and 11 non-operated patients who made up the control group was conducted.All examined (men) aged from 45 to 60 years. The average duration of the disease was about 7 years. Operations were performed mainly in the II and III stages of the disease.

Results: A complex clinical and functional examination of the patients revealed: in most of them, after the operation, the general condition improved or the process stabilized, periodic lameness decreased, and the intensity of pain decreased. However, intermittent lameness still persisted in 93% of them, and pain in the lower limbs at rest occurred in 41%. Calf muscle spasms were noted in 70% of patients, frostbite of the feet persisted in 51%. The pulse on the peripheral arteries was determined in 36% of the examined.

Conclusions: The main criterion for the rehabilitation of obliterating atherosclerosis of the lower extremities patients is the degree of blood circulation compensation achieved as a result of the operation. The obtained data open wide opportunities for social and labor rehabilitation of patients with obliterating atherosclerosis of the lower extremities, which allows 53% of them to return to working capacity.

KEY WORDS: the obliterating atherosclerosis of the lower extremities, the rehabilitation, reconstractive-restorations reoplethysmography and reovasography

INTRODUCTION

Over the past decade, the incidence of occlusive lesions of the arteries of the lower extremities has increased by more than 10%, the number of patients is more than 200 million people worldwide [1-3]. Currently, this pathology affects up to 10% of the population; among people over 65 years of age, the proportion of such patients increases to 15–20% [4-6]. In 60% of cases, diseases of the arteries of the lower extremities (LAIL) are combined with lesions of the coronary, brachiocephalic, and renal arteries [2-3].

In the development of occlusive lesions of the aorta and main arteries, atherosclerosis belongs to up to 94%. Systemic atherosclerosis is regarded as one of the most common, serious, and life-threatening diseases [4].

The social significance of the problem is due to both the widespread and progressive course of the disease with an increase in symptoms of lower limb ischemia, and the insufficient effectiveness of ongoing conservative therapy, including in patients undergoing surgical treatment, which affects the quality of life, working capacity, disability, and an increase in the number amputations and rather high lethality [5-6].

However, even after surgery, 85% of of therapeutic labor examination patients are recognized as disabled. Currently, the problem of social and labor rehabilitation of this category of patients is of particular importance [7].

AIM

The purpose of the study was to evaluate the effectiveness of the treatment and clarify the medical and social criteria for the rehabilitation of patients with obliterating atherosclerosis of the vessels of the lower extremities.

To prove that the leading criterion for the rehabilitation of patients with obliterating atherosclerosis of the lower extremitiesis the degree of blood circulation compensation achieved as a result of the operation, that the use of PSORPG

and RVG techniques, as well as tests conducted not only at rest, but also during exercise, in combination with clinical data, makes it possible to objectively assess the condition peripheral blood flow and the effectiveness of the operation in the long term.

MATERIALS AND METHODS

In the conditions of the surgical department of the Poltava regional hospital and the vascular department of the regional hospital, a comprehensive clinical and instrumental examination of 54 patients who underwent various types of operations 3 years ago with obliterating atherosclerosis of the lower extremities, and 11 unoperated, hematopoietic control groups was carried out.

A comprehensive clinical and functional examination of the patients revealed the following: in most of them, after the operation, the general condition improved or the process stabilized, the intermittent lameness decreased, and the pain intensity decreased. However, intermittent lameness still persisted in 93% of them, and pain in the lower limbs at rest occurred in 41%. Calf muscle spasms were noted by 70% of patients, frostbite of the feet persisted in 51% of them. The pulse on the peripheral arteries was determined in 36% of the examined. The expression of samples of plantar ischemia was: Leignel-Lawastine 4-6s, Oppel 25-15s, Samuels 20-10s, Goldflam 15-20s. X-ray revealed osteoporosis of the feet.

In a certain number of patients, the lack of improvement in the condition at the time of the examination is explained not only by the progression of the main process, which occurs in severe degrees of arterial insufficiency with a pronounced pain syndrome, caused in 23% of observations by the phenomena of ischemic polyneuropathy, but also by the presence of concomitant diseases. The atherosclerotic process was widespread in 54% of patients. Ischemic heart disease was observed in 46% of those examined, atherosclerosis of cerebral vessels – in 61%, osteochondrosis of the lumbar spine was detected in 44%, and diabetes – in 7%. To assess the state of peripheral blood circulation, we used modern non-invasive research methods: polysegmental occlusive rheoplethysmography (PS ORPG) and rheovasography (RVG). Plethysmograms were recorded on a domestic plethysmograph, at rest (lying down) and with reactive hyperemia (RH). Volumetric blood flow velocity (VVBF) was calculated for each of the three segments of the lower leg (in the upper, middle, and lower third), and then the average the indicator of the (VVBF) of the entire monosegment "shin".

We recorded the rheovasographic curves with the serial device RPG 2-02 with the "Elkar" recorder from both limbs simultaneously. The study was carried out at rest (lying down), during the orthostatic test (standing) and after the walking test until the onset of intermittent lameness (in the first 30 s after the forced stop of the patient). On the basis of the obtained data, the (VVBF) and the rheographic index (RI) were calculated.

RESULTS

The analysis of the results of the conducted studies revealed that the leading factor characterizing the degree of restoration of blood circulation after surgery is the degree of chronic arterial insufficiency (CAI). Considering the indicators characterizing the state of peripheral hemodynamics at different degrees of (CAI) at rest and after exercise, we found a number of regularities.

Carrying out tests, loads, allows you to objectively characterize the improvement of peripheral blood circulation achieved as a result of the surgical treatment. This improvement is especially clearly observed when conducting polysegmental occlusive rheoplethysmography (PSORPG) with a test on the reovasography (RVG).

In this study, it was found that the indicator of VVBF in all degrees of (CAI) in the operated patients is higher on average by 20% than in patients of the control group. However, it should be noted that when evaluating the indicators characterizing the use of tests and loads, their changes are more significant in patients with I and II degrees of (CAI). The clinically determined sharp decrease in blood flow in the III degree of (CAI) causes the fact that in operated patients, as well as in non-operated patients with this degree of insufficiency, minimal changes in hemodynamic indicators during exercise were noted (Fig. 1).

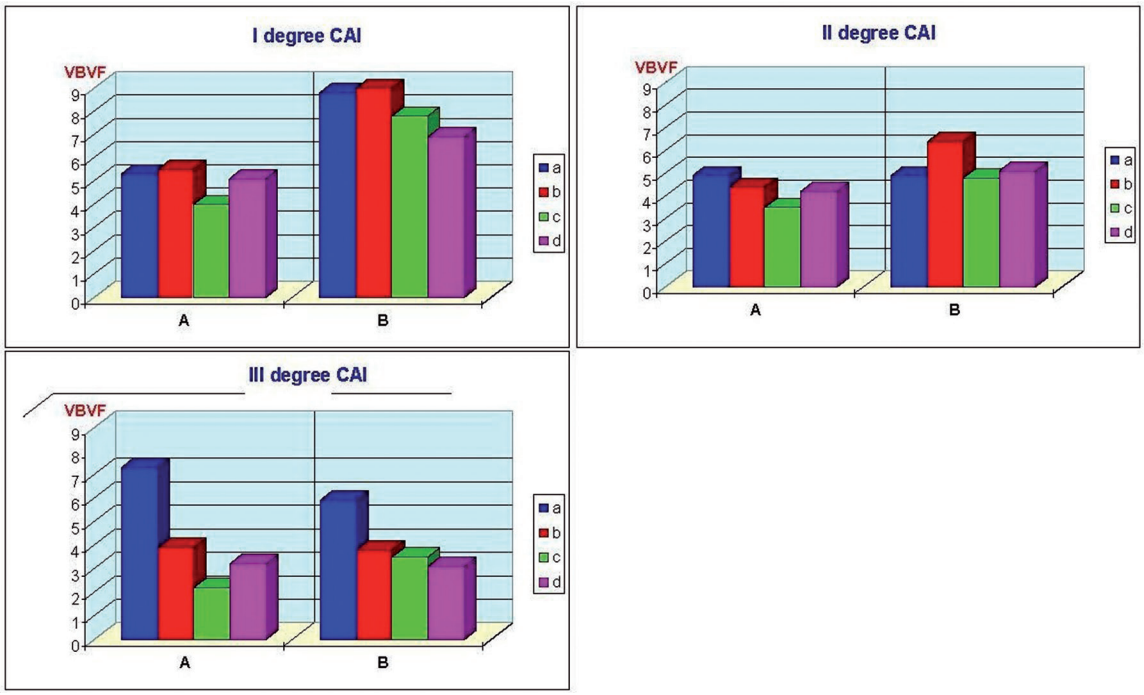
When loads of different intensity are applied, at all degrees of (CAI), the indicators of peripheral hemodynamics, characterizing reactions in response to loads of different severity, are more differentiated in operated than in non-operated patients. At the same time, only in operated patients the indicators characterizing the application of these loads have significant differences from the indicators of the state of rest ($p<0.01$) and exceed the initial ones by 10-30%, while in the control group they tend to decrease.

The test with walking until the onset of lameness, which we used when conducting (RVG) (Figs. 2, 3), which moves, as clearly as the orthostatic test, reflects the reaction of the vascular bed to the physiological workload. Practically all indicators of (VVBF) and (RI), calculated on the basis carrying out this test in operated patients, at all degrees of (CAI) significantly differ from the corresponding indicators of rest ($p<0.01$), and in the control group, no significant difference between these indicators was noted.

On the basis of the data obtained by us, clinical and functional criteria for assessing the degree of (CAI) in patients undergoing surgery for obliterating atherosclerosis of the lower extremities are proposed.

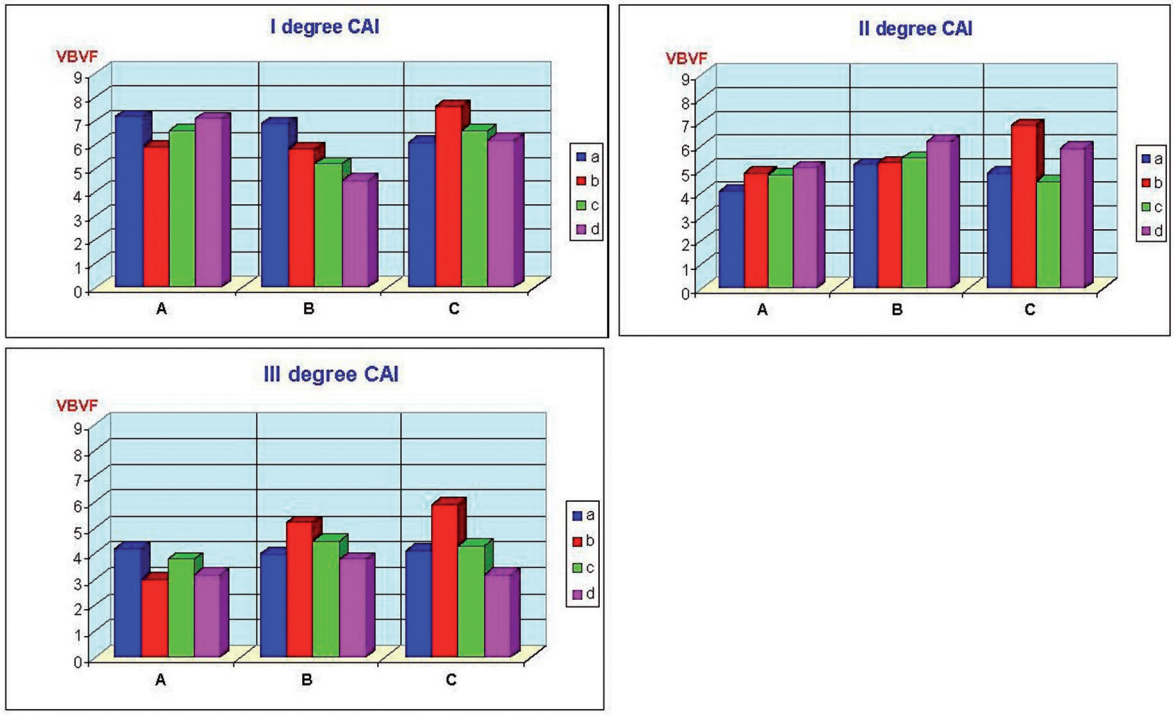
I degree of (CAI): clinically characterized by a significant improvement in the general condition of patients, the walking distance before the onset of intermittent lameness is 150 m. Pulsation of the arteries of the feet is constant or intermittent. A test on (RVG) during (PSORPG) reveals a 58% increase in (VVBF) – the maximum compared to resting (VVBF) ($p<0.01$). In non-operated patients, this increase is only 36%. When carrying out (RVG) with loads, the reactions of peripheral hemodynamics are almost similar to the reactions of healthy people and patients of the control group with stage I obliterating atherosclerosis of the lower extremities (Fig. 2).

In response to the orthostatic test, the (VVBF) and (RI) decrease, and after the walking test, these indicators



a) - in patients who underwent sympathectomy; b) - in patients who underwent combined operations; c) - in patients who underwent operations on blood vessels; d) - in patients of the control group. A) - rest; B) - reactive hyperemia.

Fig. 1. Changes in the parameters of (VVBF), ml (100 cm3•min) according to the data of occlusive rheoplethysmography in patients undergoing surgery for obliterating atherosclerosis



A) — lying down; B) — standing; C) — after loading. The rest of the designations are as in Fig. 1.

Fig. 2. Changes in the parameters of the (VVBF), ml (100 cm3•min) according to the data of reovasography in patients after various types of surgical interventions for obliterating atherosclerosis of the lower extremities

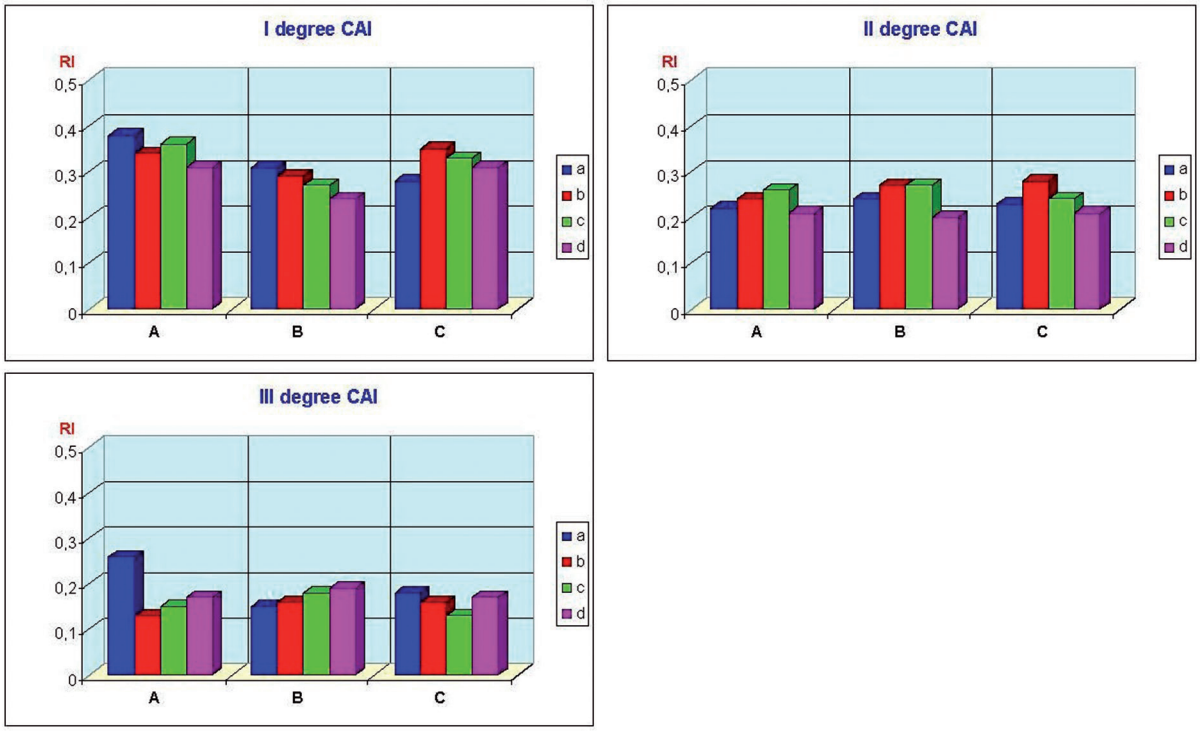


Fig. 3. Changes in (RI) indicators according to rheovasography data in patients after various types of surgical interventions for obliterating atherosclerosis of the lower extremities

increase. At the same time, the relative changes of (VVBF) and (RI) in response to a walking test before the onset of intermittent lameness are higher than in non-operated patients. Adequate responses to loads of varying severity are explained, apparently, by the almost complete restoration of blood flow in both the main and collateral vessels, which leads to a significant improvement in the blood supply of the operated limb and allows the application of the first degree of (CAI) as a compensation of blood circulation.

II degree of (CAI): is also characterized by some improvement in the general condition of patients after surgery, but their free walking distance is reduced to 100 m. There is no pulsation in the arteries of the feet, and often also in the popliteal arteries. When conducting (PSORPG) with a sample on (RG), an increase in (VVBF) was found compared to the initial one by 34% ($p<0.01$). This increase is almost half as much as in the first degree of (CAI), but at the same time it is 2.5 times greater than in the control group, where it is 14% ($p>0.05$). Rheovasography revealed an increase in (VVBF) and (RI) in response to both of the loads we used, with a higher load causing increased blood flow in the lower extremities to a greater extent. Relatively high indicators of (RI) and a significant increase in (VVBF) during (RG), together with the clinically detected improvement of blood circulation, indicate the predominant restoration of main blood flow after surgery. Additional inflow through collaterals is, apparently, insignificant and does not lead to a complete restoration of blood flow in the limb, which allows us to define the II degree of (CAI) as a subcompensation of blood circulation (Fig. 3).

At the III degree of (CAI): despite the surgery, there is pain in the lower limbs at rest, intermittent lameness with a free walking distance of about 50 m. There is a lack of pulse not only in the arteries of the feet, but also in other arteries, in combination with pronounced tissue trophic disorders and severe osteoporosis stop. However, even with this degree of (CAI) in operated patients, there is a tendency to an increase in (VVBF), when performing a test with RG, on average by 23% ($p>0.05$), while in the control group there is a tendency to decrease it with (RVG), the blood flow indicators also increase, but the differential response to loads of different severity disappears, and in response to any load, the maximum possible blood filling of the limb occurs, obviously. Numerical values of rheographic indicators practically do not differ from those of the control group ($p>0.05$). Significant differences remain only in relation to the (VVBF) when conducting a test with walking before the onset of intermittent lameness, which, along with the unlikely increase in (VVBF) in operated patients with (RVG) and low (RI) values, indicates that postoperative changes occur mainly due to collateral blood flow. The above makes it possible to determine the III degree of (CAI) as circulatory decompensation.

Examining changes in peripheral hemodynamic parameters in response to load after various types of operations, we noted that in people who underwent combined operations, these parameters increase by 1.5 times compared to the resting state especially in I and II degrees of (CAI).

In patients who are operated only on vessels (when restoring the patency of main arteries), they increase 1.5-2 times to the initial levels at all degrees of (CAI). Operations

on the sympathetic nerve trunks only partially improve or stabilize the condition of the patients, but in most of them it is possible to preserve the limb. The indicators of VVBF and RI in response to the load do not change or decrease. It should be noted here that when analyzing hemodynamic changes after various types of operations, the PSORPG technique makes it possible to objectively assess the arterial inflow reserve in the operated limb.

DISCUSSION

The ultimate goal of rehabilitation of disabled people with lesions of the lower arteries limbs is the restoration of working capacity and return to work improvement of limb function, prevention of progression of atherosclerosis and prevention of its complications. Medical rehabilitation leads to reduction and suspension of manifestations of ischemia of limb tissues due to removal vasospasm, normalization of their permeability, analgesic, trophic, anti-inflammatory effects, improvement of rheological properties of blood and microcirculation [1, 2].

It should be emphasized that patients with chronic obliterating diseases of the arteries of the lower extremities should be treated throughout their lives, taking into account the nosological form and stage of the disease. Treatment should be complex with the use of pharmacotherapy, surgical methods, physiotherapy, exercise therapy, diet, sanatorium-resort factors [4].

The analysis of the results of the conducted studies revealed that the leading factor characterizing the degree of restoration of blood circulation after surgery is the degree of chronic arterial insufficiency (CAI). Considering the indicators characterizing the state of peripheral hemodynamics at different degrees of (CAI) at rest and after exercise, we found a number of regularities [5, 6].

Carrying out tests, loads, allows you to give an objective description of the improvement of peripheral blood circulation achieved as a result of the surgical treatment. This improvement is especially clearly observed during (PSORPG) with a sample on (RVG). In this study, it was found that the index of volume velocity blood flow (VVBF) at all degrees of (CAI) in operated patients is on average 20% higher than in patients of the control group. However, it should be noted that when evaluating indicators characterizing the use of tests and loads, their changes are more significant in patients with I and II degrees of (CAI).

The clinically determined sharp decrease in blood flow at the III degree of (CAI) causes the fact that in operated patients, as well as in non-operated patients with this degree of insufficiency, minimal changes in hemodynamic indicators during exercise were noted.

Examining the changes in peripheral hemodynamic parameters in response to load after various types of operations, we noted that in people who underwent combined operations, these parameters increase by 1.5 times compared to the resting state especially in I and II degrees of (CAI). In patients who are operated only on vessels (when restoring the patency of main arteries), they increase 1.5-2 times to the initial levels at all degrees of (CAI).

Operations on the sympathetic nerve trunks only partially improve or stabilize the condition of the patients, but in most of them it is possible to preserve the limb. Indicators of obliterating atherosclerosis of the lower extremities and RI do not change or decrease in response to exercise. It should be noted here that when analyzing hemodynamic changes after various types of operations, the (PSORPG) technique makes it possible to objectively assess the arterial inflow reserve in the operated limb.

The obtained data open wide opportunities for social and labor rehabilitation of patients with obliterating atherosclerosis of the lower extremities, which allows to return to working capacity of 53% of them.

CONCLUSIONS

The main criterion for the rehabilitation of obliterating atherosclerosis of the lower extremities patients is the degree of blood circulation compensation achieved as a result of the operation. The complex application of (PSORPG) and (RVG) techniques, performed not only at rest, but also during exercise, in combination with clinical data, makes it possible to objectively assess the state of peripheral blood flow and the effectiveness of the operation performed much later. The obtained data open wide opportunities for social and labor rehabilitation of patients with obliterating atherosclerosis of the lower extremities, which allows 53% of them to return to working capacity.

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CONFLICT OF INTEREST
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*Contribution:
A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article