DOI 10.26724/2079-8334-2023-1-83-174-178
UDC 616.13-002.18-004.6-005

V.V. Shaprynskyi
SIS "Research and Practical Center of Preventive and Clinical Medicine"
State Administrative Department, Kyiv

ANALYSIS OF RESULTS AND COMPLICATIONS AFTER OPEN OPERATIONS DUE TO OCCLUSIVE-STENOTIC LESIONS OF THE MAIN ARTERIES IN THE INFRARENAL DEPARTMENT OF THE AORTA

e-mail: vasyl.shaprynskyy@gmail.com

The paper analyzes the efficacy of surgical treatment and its complications after open operations in patients with critical ischemia of the lower extremities due to atherosclerotic occlusive-stenotic lesions of the main arteries in the infrarenal aorta. The results of treatment in 98 (100 %) patients who were operated on by the open method were studied. Patients of the main group (43 (43.9 %)) were treated with an improved diagnostic and treatment algorithm, the risk of postoperative rethrombosis was predicted with an individual choice of reconstructive and restorative surgery, and the developed method of anastomosis formation was used. The developed approaches to treatment permitted to improve results and reduce postoperative complications from 14.54 % to 6.98 %, the number of repeated operations from 14.54 % to 4.65 %, the number of amputations from 9.09 % to 2.32 %, reduce length of patients' stay in the hospital and reduce postoperative mortality from 7.27 % to 4.65 %. The obtained data correlate with the data of foreign colleagues, but require further long-term studies.

Key words: obliterating atherosclerosis, critical ischemia, revascularization.

В.В. Шапринський

АНАЛІЗ РЕЗУЛЬТАТІВ І УСКЛАДНЕНЬ ПІСЛЯ ВІДКРИТИХ ОПЕРАЦІЙ З ПРИВОДУ ОКЛЮЗІЙНО-СТЕНОТИЧНИХ УРАЖЕНЬ МАГІСТРАЛЬНИХ АРТЕРІЙ ІНФРАРЕНАЛЬНОГО ВІДДІЛУ АОРТИ

В роботі проаналізовано ефективність хірургічного лікування та його ускладнення після відкритих операцій у хворих на критичну ішемію нижніх кінцівок з приводу атеросклеротичного оклюзійно-стенотичного ураження магістральних артерій інфраренального відділу аорти. Вивчено результати лікування у 98 (100 %) пацієнтів, які були прооперовані відкритим методом. Хворим основної групи (43 (43,9 %) пацієнти) застосовувався удосконалений діагностичний та лікувальний алгоритм, проводилось прогнозування ризику виникнення післяопераційних ретромбозів з індивідуальним вибором реконструктивно-відновлювального оперативного втручання, застосовувався розроблений спосіб формування анастомозу. Розроблені підходи до лікування дозволили покращити результати та знизити післяопераційні ускладнення з 14,54 % до 6,98 %, кількість повторних операцій з 14,54 % до 4,65 %, кількість ампутацій з 9,09 % до 2,32 %, скоротити тривалість перебування хворих у стаціонарі та знизити післяопераційну летальність з 7,27 % до 4,65 %. Отримані дані корелюють із даними заробіжних колег, проте потребують подальших довготривалих досліджень.

Ключові слова: облітеруючий атеросклероз, критична ішемія, реваскуляризація.

The study is a fragment of the research project: "Optimization of surgical treatment of patients under a multimodal rapid recovery program based on the improvement of minimally invasive surgical interventions, in particular with the use of nanobiosensor technologies and their anesthesiological support", state registration No. 0122U000233.

Obliterating atherosclerosis of the lower extremity's vessels is an extremely urgent problem of vascular surgery because it often leads to persistent disability, disablement, and mortality [5]. All this is of great economic, medical and social importance. Despite modern endovascular technologies in the treatment of occlusive-stenotic lesions of main arteries in atherosclerosis and their constant technical improvement, there is still a high incidence of amputations and high mortality, both in the near and in the distant postoperative period [8, 13]. Among these operations, a certain percentage is occupied by open methods of reconstructive operations, which are determined by a number of indications and anatomical conditions for their performance [2, 7]. Thus, open methods of revascularization remain the method of choice in patients with extensive atherosclerotic occlusive-stenotic lesions of arteries in the absence of hybrid intervention options, and the allo-shunt is the material of choice in the absence of an autovein [6, 14].

The main early postoperative complications after open reconstructive interventions performed on main arteries include shunt thrombosis and bleeding. Thrombosis is the most common complication after reconstructive surgery. The incidence of early postoperative thrombosis ranges from 1–3 % to 10–25 %. Acute thrombosis of the branch in most cases is associated with technical errors in the formation of the distal anastomosis. Also, the cause of thrombosis can be inadequate outflow tracts and their incorrect preoperative and intraoperative assessment [11]. Prosthesis thrombosis can also be caused by twisting or bending of the prosthesis branch. All these complications significantly worsen the immediate results of the treatment and indirectly affect the long-term results.

The purpose of our study was to analyze the efficacy of surgical treatment and complications after open operations in patients with occlusive-stenotic lesions of the main arteries in the infrarenal section of the aorta due to atherosclerosis.

Materials and methods. The total of 98 patients with occlusive-stenotic lesions of the arteries in the infrarenal department of the aorta, who were operated on by the open method, were treated at the surgical center of minimally invasive surgery at the state scientific institution "Scientific and Practical Center of Preventive and Clinical Medicine" at the State Administration of Affairs in the city of Kyiv from 2014 to 2021. All patients were divided into: a comparison group, which included 55 patients (56.12 %), operated on from 2014 to 2017, who underwent a standard complex of examination and treatment (ESVS – TASC II 2007 international recommendations), and the main group, which was representative to the first one in terms of gender, age, nosologies, nature and localization of arterial lesions, ischemia, which included 43 patients (43.88 %) operated on from 2018 to 2021. In the main group, updated guidelines for the diagnosis and treatment of peripheral arterial diseases (2017 ESC Guidelines on the Diagnosis and Treatment of Peripheral Arterial Diseases, in collaboration with the European Society for Vascular Surgery (ESVS) and global vascular guidelines for the management of chronic threatening ischemia of the lower extremities in 2019 were applied (Global Vascular Guidelines on the Management of Chronic Limb-Threatening Ischemia). In-depth examination methods were used in this group (mandatory CT – angiography or subtraction angiography, ultrasound Doppler study of hemodynamics, which also included determination of the resistance index, volumetric blood flow, osteobrachial index, transcutaneous determination of oxygen tension in TCPO2 tissues). In the main group, on the basis of an in-depth examination, an individual choice of reconstructive and restorative operations was applied, including the use of the developed method of anastomosis in severe arterial wall calcification of large arteries (utility model patent of Ukraine 130517). It was also special that we carried out preoperative prediction of risk factors for rethrombosis of the operated limb's arterial bed, based on the results of a preoperative analysis of 18 risk factors (DOI: 10.31393/reports-vnmedical-2022-26(1)-18).

There were 70 (71.42 %) and 72 (73.47 %) men in the comparison group and the main group, respectively, and 28 (28.58 %) and 26 (26.53 %) women, respectively. The majority of patients were aged from 46 to 76 years - 72.0 % in the comparison group and 74.13 % in the main group. The right lower extremity was affected more often in 60 (61.22 %) patients than the left – 38 (38.78 %) in the main group, in the comparison group the ratio was correlated 57 (58.16 %) to 41 (41.84 %). Among 98 patients, 14 (14.29 %) were previously operated on in other medical institutions, including 5 patients of the main group and 9 of the control group (all patients previously underwent reconstruction at the level of the femoral-popliteal segment with unsatisfactory results).

To assess the degree of limb ischemia, we used the classification of chronic ischemia of the lower limbs according to Rutherford, 1997. There were 32 (32.66 %) category 4 patients, 38 (38.77 %) category 5 patients, and 28 (28) category 6 patients (28.57 %) of patients. The distribution in the main group and in the comparison group was representative.

In the preoperative period, all examined patients received standard conservative therapy, taking into account concomitant pathology. In the main group of patients, antithrombotic therapy (drugs based on ASA 75– 100 mg or drugs based on clopidogrel 75 mg) was not canceled during the operation.

All patients (98) with occlusive-stenotic lesions of the main arteries in the infrarenal section of the aorta, who were operated on by the open method, were distributed according to anatomical segments. Thus, 16 (16.32 %) operative interventions were performed on the aorto-iliac segment, 11 (11.22 %) on the iliac-femoral segment, 48 (48.98 %) on femoral-popliteal segment, 19 (19.4 %) popliteal-tibial operations, on ankle-foot segment – 4 operations (4.08 %).

Besides, in 12 cases, a combination of occlusive-stenotic lesions in different arterial segments (multilayered lesions) was noted. Thus, in 8 cases, a simultaneous lesion of the aorto-iliac and femoral-popliteal segments was noted, and in 4 cases a combined lesion of the aorto-iliac and popliteal-tibial segments was noted.

We performed duplex ultrasound scanning of the abdominal aorta, arteries of the lower extremities and areas of reconstruction in all 98 (100.0 %) patients. According to our data, duplex scanning is a highly specific method for postoperative control of the reconstruction area.

X-ray contrast angiography or spiral computed tomography with arterial contrasting (with 3D modeling) was performed in all patients of the main group. At the same time, the localization, extent, degree and nature of stenosis or occlusion were determined, the condition of the collateral bed was assessed, and the nature and volume of surgical intervention was predicted. In addition, in the presence of multifocal atherosclerosis symptoms, angiography of the carotid and coronary arteries was performed.

The choice of the surgical intervention type was based on the classification of anatomical lesions of the segments according to TASC-II. In particular, the immediate indications were the length of the affected segment of the artery more than 20 cm, the technical impossibility of performing endovascular intervention and the patient's refusal to perform it. In addition, the choice of the method of limb revascularization was determined by the presence of concomitant pathology and damage to other vascular pools (coronary, brachiocephalic). At the same time, the patient's age, general condition and severity of concomitant pathology were taken into account. This permitted to choose an individually optimal type of intervention.

Results of the study and their discussion. All 98 patients with occlusive-stenotic lesions of the arteries in the infrarenal section of the aorta underwent surgical interventions on the aorta and arteries of the lower extremities by an open method. Operations were performed under general or spinal anesthesia with additional sedation. Types of open surgical interventions according to anatomical segments are presented in Table 1.

Table 1

Types of open operative interventions with their distribution by segments

Segments	Type of operation	Number. Total and groups (main/comp)	Total
aorto-iliac	1. Prosthesis of the aorta 2. Aorto-femoral bifurcation allo-shunt	4 (2/2) 12 (5/7)	16 (16.33 %)
Iliac-femoral	1. Tracheofemoral allo-shunt 2. Thrombintimectomy of the iliac arteries	9 (5/4) 2 (1/1)	11 (11.22 %)
femoral-popliteal	1. Endarterectomy from the common femoral artery 2. Profundoplasty with an autovenous patch 3. Profundoplasty with allo-patch 4. Femoro-femoral autovenous shunting 5. Femoro-femoral allo-shunt 6. Femoral-popliteal allo-shunt above the knee joint cleft 7. Femoral - popliteal allo-shunt above the knee joint cleft 8. Femoral-popliteal autovenous allo-shunt below the knee joint cleft 9. Femoral - popliteal autovenous shunting below the knee joint cleft	5 (2/3) 6 (2/4) 2 (1/1) 5 (3/2) 7 (3/4) 8 (4/4) 6 (2/4) 3 (2/1) 6 (3/3)	48 (48.98 %)
popliteal-tibial	1. Femoral-proximal tibial autovenous shunting 2. Femoral-distal tibial autovenous shunting 3. Femoral-distal tibial autovenous shunting "in situ"	10 (5/5) 6 (2/4) 3 (3 main.)	19 (19.39 %)
talocrural	1. Popliteal-foot autovenous shunting 2. Tibia-foot autovenous shunting	3 (1/2) 1 (compar. group)	4 (4.08%)
Total		98	98

As can be seen from table 1, the largest number of surgical interventions in patients was performed in the femoral-popliteal and popliteal-tibial segments with the use of shunts and prostheses. In order to revascularize the lower extremities in segments 1 and 2, various synthetic prostheses were used as shunt material in 100 % of cases; in 3, 4, 5 segments, in addition to endarterectomy (in 5 patients), various synthetic prostheses were used – in 15 (22.73 %), autovenous shunting – in 46 (69.7 %), their combination - in 12 (18.2 %) of patients.

In the majority, 93 (94.9 %) patients of both groups underwent shunting surgery for occlusive-stenotic lesions in the infrarenal section of the aorta and peripheral arteries, and only 5 (5.1 %) patients underwent thrombintimectomy and endarterectomy.

It should be noted of the high frequency of direct revascularization operations in the structure of all surgical interventions on the arteries in the infrarenal section of the aorta. Among them, almost 70 % of patients underwent autovenous shunting.

In the patients of the main group, in whom calcification of the vascular wall of large arteries was noted, the anastomosis was formed according to our own improved technique. The essence of the method is to create an autoarterial duplication from the wall of a large artery (aorta, iliac arteries, common femoral artery) after its previous desobliteration (endarterectomy, removal of calcinosis), in which only thin adventitia remains. Desobliteration is performed before or during the direct formation of an allo-shunt anastomosis with an artery or aorta.

When applying an anastomosis with a desobliterated thinned wall of an artery, the technique of creating a duplicate of a thinned arterial desobliterated wall by folding from the middle to the outside was used, which permitted to take a double wall of the artery into the seam, thus significantly reducing the risk of cutting the seams, the formation of aneurysms of the arterial thinned wall, and it also created tightness and the reliability of allo-shunt attachment.

We did not observe complications in the form of failure in the area of various anastomoses types in the early postoperative period, and this gives a reason to compete with the treatment results of foreign colleagues [7].

It should be said that autovenous shunting is the method of choice in patients with extensive lesions of the arterial segments, especially for lesions of the arteries below the knee joint cleft.

We observed 12 cases of multi-layered occlusive-stenotic lesion (7 in the comparison group, 5 in the main group). Thus, we successfully performed simultaneous reconstruction of two vascular segments at the same time with good results by combining allo- and autovenous shunting. However, according to the results of our studies, it is better to eliminate multi-layered occlusive-stenotic lesions by less traumatic methods, namely by endovascular and hybrid methods of treatment. The same data are presented by domestic colleagues regarding improved methods of endovascular treatment [11, 12], in which, according to the obtained results of experimental studies, it was established that when performing stepwise dosed angioplasty by the proposed method using balloons of different diameters and lengths, the incidence of thrombotic complications in the early postoperative period decreases.

In the early postoperative period, 10 (10.2 %) patients underwent repeated surgical interventions: in the comparison group – in 7 (12.7 %) and in the main group – in 3 (6.5 %) due to rethrombosis of the revascularized segment that was clinically manifested by progressive limb ischemia. Among the causes of rethrombosis were: questionable ways of blood outflow – in 8 patients, in 1 patient – technical reasons, in another 1 patient – infection of the allograft was established. These patients urgently underwent restoration of main blood flow by means of thrombectomy, autovenous plasty of the distal anastomosis and autovenous revascularization in 7 patients of the comparison group, thrombectomy and autovenous plasty of the distal anastomosis in 3 patients in the main group.

Thus, thrombectomy, endarterectomy and direct revascularization operations were performed in 7 patients of the comparison group, thrombectomy and femoral-popliteal autovenous shunting operations were performed in 3 patients of the main group on different segments. Our studies show sufficiently high efficacy and the need for early repeated surgical interventions.

Having analyzed the criteria for the possible occurrence of reocclusion in the early postoperative period on the basis of mathematical logistic regression with heterogeneous dispersion, it was established that such factors as: the presence of complex anatomical conditions (beta=3.5080, p=0.034), the presence of two or more multi-layered occlusions (beta= 9.0073, p=0.002), the presence of technical errors during the intervention (beta=8.0802, p=0.004), the risk of reocclusion increases significantly with the increase in the lesion's length (beta=0.5214, p=0.005). An increase in the length of the artery lesion for each additional centimeter increases the risk of reocclusion by 0.168 times. Thus, in the case of prolonged occlusions in the main group, we tried to use the autovein as a shunt as much as possible, and in its absence on the ipsilateral side, sampling was performed on the contralateral limb. In the absence of adequate length, alloautoshunt was combined. Thanks to the developed scale for predicting rethrombosis in the reconstruction area at the diagnostic stage, we managed to reduce these complications to 30 % in the main group.

Among complications in the early postoperative period, thrombosis was diagnosed in both studied groups, which we found in 11 (11.22 %) patients, and in 4 ones previously operated in the early postoperative period. It should be noted that the incidence of thrombosis in the early postoperative period was statistically higher ($p<0.05$) in 8 (14.54 %) patients of the comparison group than in 3 ones (6.97 %) of the main group.

In 3 cases of the main group, it was possible to restore blood flow, thereby saving the limb. Of the 8 patients in the comparison group, 5 also managed to restore blood flow, and in 3 patients the attempt was unsuccessful. These patients underwent limb amputation at the level of the thigh due to progressive ischemia. The main reasons for reocclusions were the lack of outflow pathways.

According to the results of our study, the incidence of local complications in both groups in the form of hematomas, bleeding from the wound, lymphorrhea, tissue swelling, thanks to good hemostasis and adequate vacuum drainage of wounds, did not differ statistically and was noted in the comparison group in 5 (9.09 %) patients, in in the main group - in 4 ones (9.3 %). Out of 98 patients, 6 (6.12 %) patients underwent lower limb amputations. In the main group, limb amputation was performed in 1 (2.32 %) patient, and in the comparison group there were 5 (9.09 %) amputations. The reasons for amputations in the early postoperative period were thrombosis of shunts, poor outflow tracts, and the presence of a significant diffuse lesion block.

According to studies by Benedetto F. and colleagues [3], the outflow tract is one of the key conditions for the duration of shunt patency, and the shorter the shunt length, the better duration of shunt

patency. Mortality in the early postoperative period in the comparison group was 7.27 % (4 patients died), in the main group – 4.65 % (2 patients died). After performing an analysis of postoperative mortality, we noted that in the main group, mortality was almost twice as low. Among the most frequent causes of death in patients with occlusive-stenotic lesions of the arteries in the infrarenal section of the aorta and peripheral arteries on the basis of atherosclerosis were mainly acute left ventricular failure, acute myocardial infarction, multiorgan failure, which correlates with the data of foreign analyzes [9].

According to studies by Thomas C.F. Bodewes and colleagues [4], when planning the revascularization of occlusive-stenotic lesions of the arteries in the infrainginal basin, it should also be taken into account that, despite the minimal trauma of one stage of endovascular operations, the long-term results of open surgical treatment provide better long-term patency and a decrease in the mortality rate of patients due to a decrease in the number of repeated interventions in contrast to endovascular ones.

Thus, the developed approaches to treatment permitted to improve results and reduce postoperative complications from 14.54 % to 6.98 %, the number of repeated operations from 14.54 % to 4.65 %, the number of amputations from 9.09 % to 2.32 %, to reduce the length of patients' stay in the hospital and to reduce postoperative mortality from 7.27 % to 4.65 %.

Conclusions

1. Clear planning of the examination using the data of ultrasound, MSCT with vascular contrast, arteriography, study of accompanying pathology, adequate preoperative preparation permitted to plan the optimal individual volume of surgical intervention.

2. Good hemostasis during the entire operation, adequate vacuum drainage of wounds permit to significantly reduce wound postoperative complications and activate the patient as early as possible.

3. The study of factors that influence the occurrence of reocclusion after revascularization operations and the development of a prognostic mathematical model for determining the risk of possible occurrence of reocclusion in the early postoperative period permits to prevent them.

References

1. Sakevych RP, Oksak HA, Ryabushko RM, Kravtsiv MI, Lyakhovskyy VI. Rezultaty endovaskulyarnoho likuvannya krytychnoyi ishemiyi nyzhnikh kintsivok u khvorykh na tsukrovyy diabet. Svit medytsyny ta biolohiyi. 2017. T. 2 (60). S. 110–113. [in Ukrainian]

2. Almasri J, Adusumalli J, Asi N, Lakis S, Alsawas M, Prokop LJ, et al. A systematic review and meta-analysis of revascularization outcomes of infrainguinal chronic limb-threatening ischemia. J Vasc Surg. 2018 Aug;68(2):624–633. doi: 10.1016/j.jvs.2018.01.066.

3. Benedetto F, Spinelli D, Pipitò N, Barillà D, Stilo F, De Caridi G, et al. Inframalleolar bypass for chronic limb-threatening ischemia. Vasc Med. 2021 Apr;26(2):187–194. doi: 10.1177/1358863X20978468.

4. Bodewes TCF, Darling JD, Deery SE, O'Donnell TFX, Pothof AB, Shean KE, et al. Patient selection and perioperative outcomes of bypass and endovascular intervention as first revascularization strategy for infrainguinal arterial disease. J Vasc Surg. 2018 Jan;67(1):206–216.e2. doi: 10.1016/j.jvs.2017.05.132.

5. Conte MS, Bradbury AW, Kolh P, White JV, Dick F, Fitridge R. Global Vascular Guidelines on the Management of Chronic Limb-Threatening Ischemia. Eur J Vasc Endovasc Surg. 2019 Jul;58(1S):S1-S109.e33. doi: 10.1016/j.ejvs.2019.05.006.

6. Jones CE, Richman JS, Chu DI, Gullick AA, Pearce BJ, Morris MS. Readmission rates after lower extremity bypass vary significantly by surgical indication. J Vasc Surg. 2016 Aug;64(2):458–464. doi: 10.1016/j.jvs.2016.03.422.

7. Khoury H, Morales RR, Sanaiha Y, Rudasill S, Jaman R, Gelabert H, et al. Trends in mortality, readmissions, and complications after endovascular and open infrainguinal revascularization. Surgery. 2019 Jun;165(6):1222–1227. doi: 10.1016/j.surg.2019.03.019.

8. Kobayashi T, Hamamoto M, Okazaki T, Hasegawa M, Takahashi S. Does the Global Limb Anatomic Staging System Inframalleolar Modifier Influence Long Term Outcomes of Chronic Limb Threatening Ischaemia after Distal Bypass? Eur J Vasc Endovasc Surg. 2021 Oct;62(4):590–596. doi: 10.1016/j.ejvs.2021.07.010.

9. Krzanowski M, Partyka L. "Global vascular guidelines on the management of chronic limb-threatening ischemia" is an important milestone, but some questions remain. J Vasc Surg. 2020 Jan;71(1):348. doi: 10.1016/j.jvs.2019.08.267.

10. Naazie IN, Zarrintan S, Arhuidese I, Al-Nouri O, Abou-Zamzam A, Malas M. Contemporary outcomes of concomitant suprainguinal bypass with infrainguinal revascularization procedures in patients with chronic limb-threatening ischemia. J Vasc Surg. 2022 Mar;75(3):989–997.e1. doi: 10.1016/j.jvs.2021.08.105.

11. Pennywell DJ, Tan TW, Zhang WW. Optimal management of infrainguinal arterial occlusive disease. Vasc Health Risk Manag. 2014 Oct 24; 10:599–608. doi: 10.2147/VHRM.S50779.

12. Puzyrov GS, Lyakhovskyi VI, Shepitko VI, Sydorenko AV. Morphological justification of the stepwise dosed balloon angioplasty application compared to standard methods in patients with diabetic foot. World of medicine and biology. 2020. № 3 (73). p. 87–91.

13. Simons JP, Schanzer A, Flahive JM, Osborne NH, Mills JL Sr, Bradbury AW, et al. Survival prediction in patients with chronic limb-threatening ischemia who undergo infrainguinal revascularization. Eur J Vasc Endovasc Surg. 2019 Jul;58(1S):120–134.e3. doi: 10.1016/j.ejvs.2019.04.009.

14. Zhang JQ, Curran T, McCallum JC, Wang L, Wyers MC, Hamdan AD, et al. Risk factors for readmission after lower extremity bypass in the American College of Surgeons National Surgery Quality Improvement Program. J Vasc Surg. 2014 May;59(5):1331–9. doi: 10.1016/j.jvs.2013.12.032.

Стаття надійшла 17.01.2022 р.