DOI: 10.56871/RBR.2024.67.22.002
UDC 616.13-004.6-005.4+617.58-005+616-089.811

EXTRAANATOMIC CROSSOVER AUTOVENOUS BYPASS — RECONSTRUCTION OF THE RESERVE IN PATIENTS WITH A HIGH RISK OF AMPUTATION AND LOW LIFE EXPECTANCY OR AN ALTERNATIVE TO TRADITIONAL TREATMENT?

© Alexey G. Borisov[1], Alisa V. Atmadzas[1], Kirill A. Atmadzas[1], Nikita N. Gruzdev[1], Vitalyi B. Kozhevnikov[1, 3], Arshed A. Kuchay[1], Aleksandr N. Lipin[1, 2], Anton G. Orlov[1], Sofya E. Pak[3], Roman S. Sobolev[1], Yanis P. Eminov[1], Irina M. Khokhlova[1]

[1] Limb Salvage Center, City Hospital No. 14. 19/9 Kosinov str., Saint Petersburg 198099 Russian Federation
[2] Military Medical Academy named after S.M. Kirov. 6 Akademician Lebedev str., Saint Petersburg 194044 Russian Federation
[3] North-Western State Medical University named after I.I. Mechnikov. 41 Kirochnaya str., Saint Petersburg 191015 Russian Federation

Contact information: Alexey G. Borisov — Cardiovascular Surgeon. E-mail: borisov_spb@yahoo.com ORCID: https://orcid.org/0009-0003-3900-2652 SPIN: 8049-4107

For citation: Borisov AG, Atmadzas AV, Atmadzas KA, Gruzdev NN, Kozhevnikov VB, Kuchay AA, Lipin AN, Orlov AG, Pak SE, Sobolev RS, Eminov YaP, Khokhlova IM. Extraanatomic crossover autovenous bypass — reconstruction of the reserve in patients with a high risk of amputation and low life expectancy or an alternative to traditional treatment? Russian Biomedical Research. 2024;9(3):15–20.
DOI: https://doi.org/10.56871/RBR.2024.67.22.002

Received: 24.06.2024 **Revised: 02.08.2024** **Accepted: 16.09.2024**

Abstract. Introducion. Critical limb threatening ischemia is worst peripheral artery disease with high percent of morbidity and disability. ***Purpose of the study*** — to evaluate early (complications and major adverse events) and long-term (patency, limb salvage, survival) outcomes in patients with chronical limb threatening ischemia who underwent crossover autovenous bypass surgery. ***Material and method.*** A retrospective analysis of the early and long-term results of observation of 28 patients who underwent cross-bypass surgery performed in 2017–2023 was carried out. 100% of bypass operations were performed with autovenous material. High comorbidity (coronary artery disease, arterial hypertension, dyslipidemia, history of myocardial infarction, history of acute stroke, cardiac arrhythmias, diabetes mellitus, obstructive bronchitis, anemia, obesity). Follow-up is 12 months. ***Results.*** Early postoperative complications were: 14.3% — wound complications, 3.6% — bleeding, 7.2% — bypass thrombosis, 3.6% — acute cerebrovascular disturbance, 17.9% — high limb amputation (in 4 of 5 observations, revascularization was performed to reduce the level of amputation), 3.6% — death. Results after 12 months were: bypass patency — 82.1%, limb salvage — 71.4%, survival — 89.3%. There were no cases in which critical ischemia of the healthy lower limb developed. ***Conclusion.*** Crossover autovenous bypass can be considered by a vascular surgeon both as a reserve option for redo-surgery on the arteries of the lower extremities and as an alternative to traditional anatomical reconstructions. This study demonstrates the low complication rate and good long-term patency of this reconstructions.

Keywords: atherosclerosis, chronic limb threatening ischemia, extraanatomic bypass, autogenous vein bypass

ПЕРЕКРЕСТНЫЙ АУТОВЕНОЗНЫЙ ШУНТ — РЕКОНСТРУКЦИЯ РЕЗЕРВА У ПАЦИЕНТОВ С ВЫСОКИМ РИСКОМ АМПУТАЦИИ И НЕВЫСОКОЙ ОЖИДАЕМОЙ ПРОДОЛЖИТЕЛЬНОСТЬЮ ЖИЗНИ ИЛИ АЛЬТЕРНАТИВА ТРАДИЦИОННЫМ ОПЕРАЦИЯМ?

© Алексей Геннадьевич Борисов[1], Алиса Владимировна Атмадзас[1], Кирилл Александрович Атмадзас[1], Никита Николаевич Груздев[1], Виталий Борисович Кожевников[1, 3], Аршед Ахмад Кучай[1], Александр Николаевич Липин[1, 2], Антон Георгиевич Орлов[1], Софья Эдуардовна Пак[3], Роман Сергеевич Соболев[1], Янис Павлович Эминов[1], Ирина Михайловна Хохлова[1]

[1] Городская больница № 14. 198099, г. Санкт-Петербург, ул. Косинова, 19/9
[2] Военно-медицинская академия им. С.М. Кирова. 194044, г. Санкт-Петербург, ул. Академика Лебедева, 6
[3] Северо-Западный государственный медицинский университет имени И.И. Мечникова. 191015, г. Санкт-Петербург, ул. Кирочная, 41

Контактная информация: Алексей Геннадьевич Борисов — врач сердечно-сосудистый хирург. E-mail: borisov_spb@yahoo.com
ORCID: https://orcid.org/0009-0003-3900-2652 SPIN: 8049-4107

Для цитирования: Борисов А.Г., Атмадзас А.В., Атмадзас К.А., Груздев Н.Н., Кожевников В.Б., Кучай А.А., Липин А.Н., Орлов А.Г., Пак С.Э., Соболев Р.С., Эминов Я.П., Хохлова И.М. Перекрестный аутовенозный шунт — реконструкция резерва у пациентов с высоким риском ампутации и невысокой ожидаемой продолжительностью жизни или альтернатива традиционным операциям? // Российские биомедицинские исследования. 2024. Т. 9. № 3. С. 15–20. DOI: https://doi.org/10.56871/RBR.2024.67.22.002

Поступила: 24.06.2024 **Одобрена: 02.08.2024** **Принята к печати: 16.09.2024**

Резюме. ***Введение.*** Критическая ишемия нижних конечностей — крайне тяжелое проявление заболеваний периферических артерий, сопровождающееся высоким уровнем инвалидизации и летальности ***Цель исследования*** — оценить ранние (осложнения и неблагоприятные события) и отдаленные (проходимость, сохранение конечности, выживаемость) результаты у пациентов с критической ишемией нижней конечности, которым были выполнены перекрестные аутовенозные шунтирующие операции. ***Материалы и методы исследования.*** Проведен ретроспективный анализ ранних и отдаленных результатов наблюдения 28 пациентов, перенесших перекрестные шунтирования, проведенных в 2017–2023 гг. 100% шунтирующих операций выполнены аутовенозным материалом. Пациенты коморбидны (ишемическая болезнь сердца, артериальная гипертензия, дислипидемия, инфаркт миокарда в анамнезе, острое нарушение мозгового кровообращения в анамнезе, нарушения ритма сердца, сахарный диабет, хроническая обструктивная болезнь легких, анемия, ожирение). Период наблюдения — 12 месяцев. ***Результаты.*** Ранние послеоперационные осложнения: 14,3% — раневые осложнения, 3,6% — кровотечения, 7,2% — тромбоз шунта, 3,6% — острое нарушение мозгового кровообращения, 17,9% — высокая ампутация конечности (в 4 из 5 наблюдений реваскуляризация была выполнена с целью снижения уровня ампутации), 3,6% — летальный исход. Результаты через 12 месяцев: проходимость шунта — 82,1%, сохранение конечности — 71,4%, выживаемость — 89,3%. Наблюдений, при которых развилась критическая ишемия здоровой нижней конечности, не выявлено. ***Заключение.*** Перекрестное аутовенозное шунтирование может рассматриваться сосудистым хирургом и как операция резерва при повторных реконструктивных вмешательствах на артериях нижних конечностей, и как альтернатива традиционным анатомическим реконструкциям. Данное исследование демонстрирует низкую частоту осложнений и хорошую отдаленную проходимость таких реконструкций.

Ключевые слова: атеросклероз, критическая ишемия нижней конечности, экстраанатомическое шунтирование, аутовенозное шунтирование

INTRODUCTION

Chronic limb threatening ischemia (CLTI) is an extremely severe manifestation of peripheral arterial disease. Due to unfavorable prognosis (according to literature data, mortality and high amputation within a year from the disease manifestation amounted to 22%, and in the distant period — quite disappointing results: high limb amputation within 4 years is up to 67.3%, the risk of patients' death within 4 years is up to 63.5%), this condition is singled out by researchers and clinicians as a separate nosology [1]. CLTI patients often have multilevel lesions of lower limb arteries, including prolonged occlusion of iliac arteries [1, 2]. The absolute majority of patients with CLTI are polymorbid and, in addition to multifocal atherosclerosis, have concomitant diseases of cardiovascular, respiratory, endocrine systems, and cancer is common [1, 2, 10]. Most studies recommend anatomical reconstructions - balloon angioplasty with/without stenting of iliac arteries, aorto/iliac-femoral bypass [1–5, 11, 12] in case of occlusion of iliac arteries. Endovascular option in the treatment of patients with multilevel lesions is not always available due to pronounced calcinosis and prolonged occlusion of the arteria. The open anatomic revascularization is often associated with high risks of adverse effects and long duration of intervention, especially in patients with previous reconstructions in this area. The

presence of extensive scarring in the area of surgery, the presence of a possible infectious focus and synthetic prosthesis in the area of future reconstruction, and possible previous ligation of native arteries may also be factors that require caution when performing anatomic reconstructions. Due to comorbidity and high perioperative risk, even in studies recommending anatomic reconstruction in the aorto-iliac segment, the possibility of extraanatomic bypass for patients in this group is preserved and recommended [1–5, 13, 14]. There are also studies that suggest crossover bypass surgery as primary surgery for unilateral occlusion of the iliac arteries [6-8, 15], including intermittent claudication [9, 16].

AIM

To evaluate early (complications and adverse events) and long-term (patency, limb preservation, survival) outcomes in patients with critical lower extremity ischemia who underwent crossover bypass surgery.

MATERIALS AND METHODS

A retrospective analysis of early and long-term follow-up results of 28 patients who underwent crossover bypasses in 2017–2023 in the "St. Petersburg State Budgetary Healthcare Institution "City Hospital No. 14" was performed.

The study was performed in accordance with the standards of good clinical practice and the principles of the Declaration of Helsinki. Written informed consent was obtained from all patients before inclusion in the study.

Inclusion criteria: patients who underwent extraanatomic (crossover) bypass by autologous vein to bypass iliac artery occlusion for the treatment of CLTI (100% of patients with trophic defects of ischemic genesis).

Exclusion criteria: patients whose contact was lost immediately after discharge from the hospital.

Characteristics of the group: an average age was 63.9 years. There was 3 women (10.7%) and 25 men (89.3%).

The average period of hospitalization was 41 days, which was due to the need to treat trophic changes in the lower limb suffering from CLTI.

Concomitant pathology: coronary heart disease (CHD) (100%), arterial hypertension (95.7%), dyslipidemia (80.4%), history of myocardial infarction (28.6%), history of acute cerebral circulatory failure (25%), cardiac rhythm disorders (50%), diabetes mellitus (25%), chronic obstructive pulmonary disease (COPD) (78.2%), anemia (42.9%), obesity (42.9%).

Full perfusion of the two lower limbs in these patients was ensured in most cases due to passable (without hemodynamically significant stenoses) iliac arteries on the limb-donor of the inflow artery, which at the time of the study had no symptoms of peripheral arterial disease, or anamnestically there were indications of a mild degree of intermittent claudication (painless walking for a distance of 100 meters or more). In one case (3.6%) a passable aorto-bifemoral shunt was used, in one case (3.6%) balloon angioplasty of the iliac arteries was preventively performed on the healthy limb in order to perfuse two limbs from one lumen of the iliac arteries if there was an indication of ligation of the iliac arteries of the limb suffering from CLTI.

The level of proximal anastomosis (inflow artery for the shunt), N (%) — common femoral artery — 23 (82.1%), deep femoral artery — 2 (7.1%), superficial femoral artery — 2 (7.1%), functioning branche of the aorto-bifemoral shunt — 1 (3.6%). Level of distal anastomosis (outflow artery for the shunt), N (%) — contralateral common femoral artery — 6 (21.4%), contralateral deep femoral artery — 12 (42.8%), contralateral superficial femoral artery — 4 (14, 3%), contralateral poplitea artery — 3 (10.7%), contralateral posterior tibial artery — 1 (3.6%), contralateral anterior tibial artery — 1 (3.6%), contralateral femoral-popliteal bypass — 2 (7.1%).

15 patients (53.6%) had a history of lower limb arterial interventions for CLTI, of which 10 (35.7% of the total group) underwent aorto-femoral bifurcation or linear bypass with a synthetic prosthesis.

100% of the bypass surgeries were performed with autovenous. In 8 cases (28.6%) the in situ vein technique was used, in the remaining 20 cases (71.4%) a reversed vein was used. Autovenous material used: 21 (75%) — trunk of the great saphenous vein of the limb suffering from CLTI used, 4 (14.3%) — small saphenous vein used, 2 (7.1%) — trunk of the great saphenous vein of the contralateral lower limb used.

13 patients (46.4%) required necrectomy or small amputations during hospitalization. The peculiarity of this group of patients was the high frequency of "non-preserved" feet — in 4 cases (14.3%) due to the lack of possibility of preserving a supportable foot or high risk of sepsis development (the decision was made by a consilium consisting of a multidisciplinary group of specialists) a cross bypass operation was performed to reduce the amputation level. Thus, performing amputation at the level of the tibia in such observations was a success of surgical intervention (in 100% of cases, technical success was achieved — it was possible to heal the wounds of the stump of the tibia with primary

tension). A clinical example of such a foot is presented in Figure 1.

Preoperative examination: a search for autovenous material was performed sonographically. An assessment of steno-occlusive arterial lesions and choice of the method of surgical intervention was performed according to the data of direct subtractive angiography and/or computed tomography with angiocontrast.

Fig. 1. An example of a foot requiring amputation. Patient K., 53 years old, admitted with wet gangrene of the distal parts of the left foot; at the time of admission, sanitation of the necrotic lesion was performed, the possibility of preserving a weight-bearing foot was lost (deep and extensive tissue necrosis, exposure of the articular surfaces of the talus and calcaneus). 6 days after foot resection, revascularization surgery was performed. The photo shows a foot wound on the first day after revascularization. In the presented clinical case, the patient managed to save his knee joint

Рис. 1. Пример стопы, требующей ампутации. Пациент К., 53 года, поступил с влажной гангреной дистальных отделов левой стопы, при поступлении выполнена санация некротического очага, возможность сохранения опороспособной стопы потеряна (глубокий и обширный некроз тканей, оголение суставных поверхностей таранной и пяточной костей). Спустя 6 суток после резекции стопы выполнена реваскуляризирующая операция. На фото представлена рана стопы в первые сутки после реваскуляризации. В представленном клиническом случае пациенту удалось сохранить коленный сустав

Postoperative therapy: within three days — low molecular weight heparins (enoxaparin) administered subcutaneously in a prophylactic dose, further — acetylsalicylic acid 100 mg + rivaroxaban 5 mg daily get per os during the life.

RESULTS AND DISCUSSION

Complications and undesirable effects detected in the early postoperative period (within 30 days) are presented in Table 1.

The long-term results (evaluated after 12 months) demonstrate that crossed shunts have good patency rates in the long-term period. After discharge from the hospital, only one shunt occlusion was detected during one year of follow-up (Table 2).

Satisfactory indices of distant patency, limb preservation, and survival rates after extraanatomic bypasses have been shown, indicating their effectiveness. It should be noted that during the study there were no cases of critical ischemia or amputation of the lower limb, on the side of which the driving anastomosis of the shunt was performed (healthy limb, donor limb) — a factor that most often causes fear of cross-reconstructions in vascular surgeons.

CONCLUSION

1. Cross-over autovenous bypass may be considered by the vascular surgeon as a backup operation for repeated reconstructive interventions on lower limb arteries or as an alternative to traditional anatomic reconstructions.

2. This study demonstrates a low complication rate and good long-term patency of such reconstructions.

ADDITIONAL INFORMATION

Author contribution. Thereby, all authors made a substantial contribution to the conception of the study, acquisition, analysis, interpretation of data for the work, drafting and revising the article, final approval of the version to be published and agree to be accountable for all aspects of the study.

Competing interests. The authors declare that they have no competing interests.

Funding source. This study was not supported by any external sources of funding.

Consent for publication. Written consent was obtained from the patient for publication of relevant medical information within the manuscript.

ДОПОЛНИТЕЛЬНАЯ ИНФОРМАЦИЯ

Вклад авторов. Все авторы внесли существенный вклад в разработку концепции, проведение исследования

Table 1

Early postoperative complications

Таблица 1

Ранние послеоперационные осложнения

Осложнение/неблагоприятное событие / Complication/adverse event	Число наблюдений / Number of observations	%
Раневые осложнения (лимфорея, нагноение раны, гематома) / Wound complications (lymphorrhea, wound suppuration, hematoma)	4	14,3
Большие кровотечения / Major bleeding	1	3,6
Тромбоз шунта / Shunt thrombosis	2	7,2
Острое нарушение мозгового кровообращения / Acute cerebrovascular accident	1	3,6
Инфаркт миокарда / Myocardial infarction	0	0
Тромбоэмболия легочной артерии / Pulmonary embolism	0	0
Высокая ампутация нижней конечности, страдающей критической ишемией, из них — случаи, при которых показанием к шунтирующей операции служило снижение уровня высокой ампутации / High amputation of the lower limb suffering from critical ischemia, including cases in which the indication for bypass surgery was to reduce the level of high amputation	5 4	17,9 14,3
Высокая ампутация нижней конечности, со стороны которой формировался приводящий анастомоз, не страдающей критической ишемией / High amputation of the lower limb, from which the adducting anastomosis was formed, not suffering from critical ischemia	0	0
Летальный исход / Death	1	3,6

Table 2

Long term results after 12 months

Таблица 2

Отдаленные результаты через 12 месяцев

Фактор / Factor	Число наблюдений / Number of observations	%
Проходимость шунта / Shunt patency	22	82,1
Сохранение конечности, к которой была выполнена шунтирующая операция от контралатеральной нижней конечности / Preservation of the limb to which bypass surgery was performed from the contralateral lower limb	20	71,4
Сохранение контралатеральной нижней конечности (из числа пациентов, достигнувших периода наблюдения) / Preservation of the contralateral lower limb (among patients who reached the follow-up period)	25	100
Выживаемость / Survival	25	89,3

и подготовку статьи, прочли и одобрили финальную версию перед публикацией.

Конфликт интересов. Авторы декларируют отсутствие явных и потенциальных конфликтов интересов, связанных с публикацией настоящей статьи.

Источник финансирования. Авторы заявляют об отсутствии внешнего финансирования при проведении исследования.

Информированное согласие на публикацию. Авторы получили письменное согласие пациентов на публикацию медицинских данных.

REFERENCES / ЛИТЕРАТУРА

1. Conte M.S., Bradbury A.W., Kolh P. et al. Global vascular guidelines on the management of chronic limb-threatening ischemia. J Vasc Surg. 2019;69(6S):3S–125S.e40. DOI: 10.1016/j.jvs.2019.02.016.
2. Fitridge R., Chuter V., Mills J. et al. The intersocietal IWGDF, ESVS, SVS guidelines on peripheral artery disease in people with diabetes and a foot ulcer. Diabetes Metab Res Rev. 2024;40(3):e3686. DOI: 10.1002/dmrr.3686.
3. Nordanstig J., Behrendt C.A., Baumgartner I. et al. Editor's Choice — European Society for Vascular Surgery (ESVS) 2024

Clinical Practice Guidelines on the Management of Asymptomatic Lower Limb Peripheral Arterial Disease and Intermittent Claudication. Eur J Vasc Endovasc Surg. 2024;67(1):9–96. DOI: 10.1016/j.ejvs.2023.08.067.

4. Indes J.E., Pfaff M.J., Farrokhyar F. et al. Clinical outcomes of 5358 patients undergoing direct open bypass or endovascular treatment for aortoiliac occlusive disease: a systematic review and metaanalysis. J Endovasc Ther. 2013;20:443–455. DOI: 10.1583/13-4242.1.
5. Chiu K.W., Davies R.S., Nightingale P.G., Bradbury A.W., Adam D.J. Review of direct anatomical open surgical management of atherosclerotic aorto-iliac occlusive disease. Eur J Vasc Endovasc Surg 2010;39:460–471. DOI: 10.1016/j.ejvs.2009.12.014.
6. Testini M., Todisco C., Greco L. et al. Femoro-femoral graft after unilateral obstruction of aorto-bifemoral bypass. Minerva Cardioangiol. 1998;46(1–2):15–19.
7. Ricco J.B., Probst H. Long-term results of a multicenter randomized study on direct versus crossover bypass for unilateral iliac artery occlusive disease. J Vasc Surg. 2008;47(1):45–53. DOI: 10.1016/j.jvs.2007.08.050.
8. Pai M., Handa A., Hands L., Collin J. Femoro-femoral arterial bypass is an effective and durable treatment for symptomatic unilateral iliac artery occlusion. Ann R Coll Surg Engl. 2003;85(2):88–90. DOI: 10.1308/003588403321219830.
9. Capoccia L., Riambau V., da Rocha M. Is femorofemoral crossover bypass an option in claudication? Ann Vasc Surg. 2010;24(6):828–832. DOI: 10.1016/j.avsg.2010.03.021.
10. Kuchay A.A., Lipin A.N., Gruzdev N.N., Borisov A.G., Kashapov I.S. Critical limb threatening ischemia and its management. Russian Biomedical Research. 2024;9(1):33–46. DOI: 10.56871/RBR.2024.68.81.005. (In Russian).
11. Kuchay A.A., Lipin A.N. et al. The hybrid surgery concepts for atherosclerotic lesions of lower limb arteries. Atherosclersis and dyslipidemias. 2023;3(52):37–43. (In Russian).
12. Kuchay A.A., Lipin A.N., Gruzdev N.N. et al. Lower extremity peripheral artery disease: contemporary epidemiology, management and future trends (a scientific statement). Russian Biomedical Research. 2023;8(4):54–64. (In Russian).
13. Kuchay A.A., Lipin A.N., Karelina N.R., Artyukh L.Yu. Revascularization of lower limb based on the angiosome concept with early local flap reconstruction (a case report). Forcipe. 2022;5(4):29–35. (In Russian).
14. Kuchay A.A., Lipin A.N., Karelina N.R. et al. Revascularization in extended occlusions of the superficial part of the femoral artery and multi-storey lesions of the arteries of the lower extremity. Forcipe. 2022;5(3):4–14. (In Russian).
15. Kurianov P., Lipin A., Antropov A. et al. Popliteal artery angioplasty for chronic total occlusions with versus without the distal landing zone. Annals of vascular surgery. 2020;62(68):417–25. (In Russian).
16. Kuchay A.A., Lipin A.N., Antropov A.V. et al. Treatment of multilevel lesions of arteries in lower extremities in cases of CLTI. Medical Alliance. 2022;10(S3):187–9. EDN: IWSMIP. (In Russian).