

Case report

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Distal Bypass Surgery for Critical Ischemia Using a Related Donor Vein

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ABSTRACT The article presents a case of using the trunk of the great saphenous vein from a living related donor in elective surgery for the main arteries of the lower leg. The possibility of using a vein from a relative in special clinical situations is shown. High risks of repeated interventions aimed at relieving early and late complications of vascular reconstructions remain an urgent problem in angiosurgery. Very often, operations are performed in the presence of extensive necrosis and trophic ulcers (stage IV according to the Fontaine-Pokrovsky classification). The gold standard for choosing a shunt during reconstructive operations on the infrainguinal arteries was and remains an autovenous conduit from the great saphenous vein (C, D type of arterial bed lesion according to TASC II). During repeated reconstructions in the absence of a suitable autovein and with the distal position of the peripheral anastomosis, it is not always possible to use a synthetic prosthesis as a reliable alternative. Unsatisfactory results of using such materials dictate the need to choose a suitable graft.

The problem of using allografts requires further in-depth study. In this regard, the case of using a donor vein as a material for reconstruction is given. It was concluded that it is possible to effectively use allovein from a related donor in a patient after previously performed reconstructive interventions and in the absence of autologous material for bypass surgery.

Keywords: allograft, graft, allovein, vessel transplantation, related donor vein, critical ischemia

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CFA – common femoral artery
 CIA – common iliac artery
 DFA – deep femoral artery
 FAP – femoral artery proper

FC – functional class
 l/3 – lower third
 m/3 – middle third
 u/3 – upper third

INTRODUCTION

More than 20% of all cardiovascular disorders are chronic obliterating diseases of the arteries of the lower extremities [1]. Two thirds of these patients require surgical treatment.

Undoubtedly, at the moment, the gold standard used in surgery for lower extremity arterial disease is the autogenous vein graft. It does not require selection, conservation, or other preparation methods necessary for its use. According to C. Moreira et al., its use is not always possible (15–40%) due to various reasons: previous surgical interventions using an autovein, insufficient diameter and (or) length, varicose veins [2]. According to A.V. Pokrovsky et al., it is unavailable in 30% of cases [3], and in case of repeated interventions this figure reaches 50% [4]. According to M. Albers et al, the use of synthetic prostheses in the infrapopliteal segment does not yield good results; their five-year patency rate is 40% [5]. A study by S. Masmejan et al shows good outcomes of lower extremity arterial reconstruction for critical ischemia using cryopreserved allografts with missing autovein in 38 patients. Of the 42 bypasses: proximal anastomosis into the femoral artery was performed in 41 cases (98%), distal anastomosis into the tibial arteries – in 21 cases (50%), into the tibioperineal trunk – in 9 cases (22%), and into the distal popliteal artery – in 12 cases (28%). In the postoperative period, there were 15 complications in 12 patients (5 occlusions, 1 stenosis, 4 bleeding and 5 postoperative wound dehiscence), requiring 13 re-interventions. One limb amputation was also performed due to

shunt occlusion and the development of irreversible ischemia [6]. There is very little information in world sources about the use of allografts from a posthumous donor [7–9]. And we have not found in the literature any descriptions of using donor vessels from living related donors in reconstructive interventions on the main arteries for critical ischemia.

From a legal, moral and ethical point of view, it is possible to use this technique in practical work. According to the law on transplantation of human organs and (or) tissues, this can only be used if other medical means cannot guarantee the preservation of the recipient's life or restoration of his health [10]. This is also reflected in the Federal Law of November 21, 2011 No. 323-FZ “On the Fundamentals of Protecting the Health of Citizens in the Russian Federation” [11].

Prostheses made of synthetic materials is most often considered as an alternative, but their use in a position below the knee joint cleft is characterized by a higher likelihood of complications [12], in the structure of which thrombosis and restenosis continue to be the leading limiting factors for the success of reconstructive interventions [13]. The use of modern antithrombotic drugs can reduce the incidence of thrombotic complications, but the problem is still far from being solved [14].

Currently, vascular surgeons also have an allograft from the living related donor in their arsenal. It is used in special clinical situations when alternative approaches are, in principle, no longer possible or are highly questionable.

In this regard, we present an observation of the use of a donor related vein (trunk of the great saphenous vein) as a conduit for bypassing the posterior tibial artery in critical ischemia.

The aim of our study was to evaluate the possibility of using donor material from a relative during reconstruction in the absence of an autologous vein, a graft from a posthumous donor, and the progression of critical limb ischemia.

A clinical observation

A 72-year-old patient was admitted to the Department of Vascular Surgery of the State Budgetary Institution of the Ryazan Region "Regional Clinical Hospital" on September 13, 2021 with a diagnosis of obliterating atherosclerosis of the lower limb arteries. Femoropopliteal occlusion on both sides. Stage IV of the disease on the left. Condition after carotid endarterectomy on the left (02/20/2020), condition after stenting of the common iliac artery (CIA) on the left (03/15/2020), condition after femoral-distal-popliteal bypass using reversed autogenous vein on the left (04/10/2021); coronary heart disease: postinfarction cardiosclerosis (06/05/2012), functional class (FC) II heart failure, stage III hypertension, risk 4, IIa FC II chronic heart failure, type II diabetes mellitus, condition after acute cerebrovascular accident (11/23/2005).

Upon admission, the patient complained of pain in the left foot, necrosis of the first and second toes of the left foot. She was completely examined. HLA typing and anti-HLA antibodies, ABO compatibility were not taken into account. Computed tomography of the arteries of the lower extremities was performed (Fig. 1). Right: the CIA, external iliac artery, common femoral artery (CFA), deep femoral artery (DFA), femoral artery proper (FAP) are contrasted satisfactorily; occlusion of the popliteal artery is 4 cm, the infragenicular arteries are contrasted satisfactorily. Left: a stent is visualized in the CIA, passing, the CFA with uneven contours, there is stenosis of 75–80% at the mouth of the DFA, occlusion of the FAP and popliteal artery for 46 cm, the

infragenicular arteries are contrasted satisfactorily. Preparation for surgery did not differ from the standard for interventions on the arteries of the lower extremities.

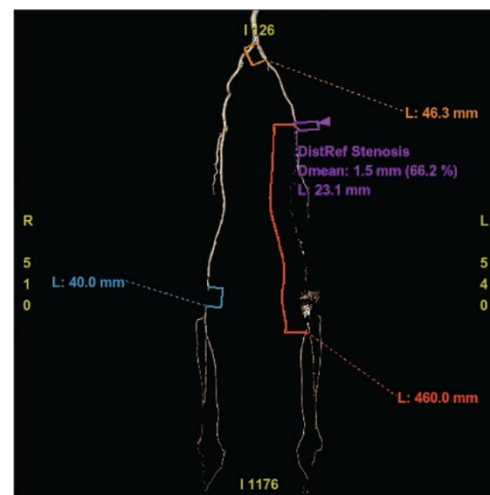


Fig. 1. Computed tomography of the arteries of the lower extremities

Also, on September 13, 2021, a related donor of the trunk of the great saphenous vein (grandson), 27 years old, was admitted to the Department of Vascular Surgery of the State Budgetary Institution of the Ryazan Region "Regional Clinical Hospital".

Additional examination. According to duplex scanning of the veins of the lower extremities, the deep veins and saphenous veins are passable, compression is complete. The diameters of the great saphenous vein on the left in the upper third (u/3) of the thigh are 4.3 mm, in the middle third (m/3) of the thigh - 3.9 mm, in the lower third (l/3) of the thigh - 3.8 mm, in the u/3 of the tibia - 4.1 mm, in the m/3 of the tibia - 3.7 mm, in the l/3 of the tibia - 3.2 mm.

On September 14, 2021, under spinal anesthesia, the great saphenous vein was harvested from the related donor (Fig. 2). The preparation of the conduit did not differ from the technique used for autovenous bypass grafting.

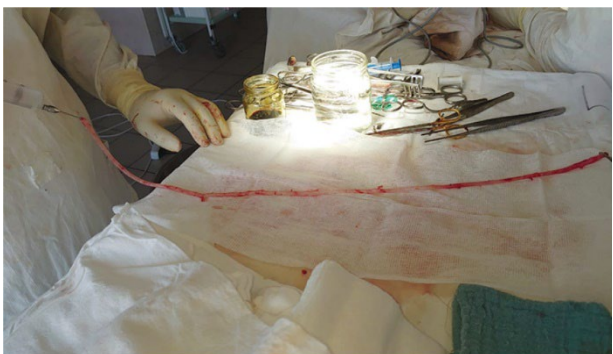


Fig. 2. Donor allo vein

The transplant was placed in a sterile saline solution without the addition of preservative media, antibiotics and anticoagulants. The recipient was then immediately taken sequentially to the operating room.

On September 14, 2021, a total femoral-posterior-tibial bypass with the reversed donor vein was performed using the standard technique on the left (Fig. 3, 4).



Fig. 3. Central anastomosis of the vein and common femoral artery

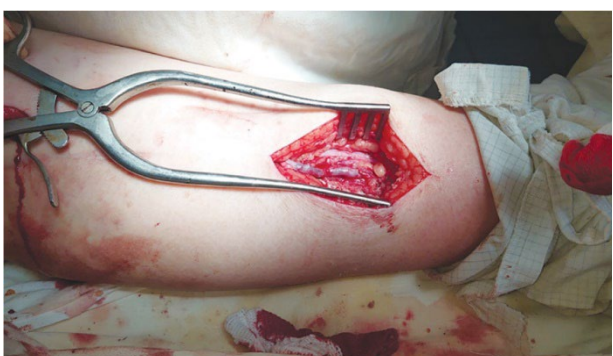


Fig. 4. Distal anastomosis of the vein and posterior tibial artery

The postoperative management protocol complied with the Russian national recommendations for the management of patients with lower extremity arterial diseases [15].

No graft rejection reaction was observed, and there were no pathological changes in general clinical and biochemical blood parameters. There was complete compensation of blood circulation in the left lower limb: sensitivity and active movements in the toes in full, peripheral pulsation was determined at the medial ankle. The patient was discharged in satisfactory condition on the 7th day after the reconstructive surgery.

At a follow-up examination after 1 year, compensation of blood circulation in the left lower limb takes place: peripheral pulsation is detected at the medial malleolus, the shunt is functioning; according to duplex scanning, no pathological changes of the autovenous shunt in the vein are detected.

The related donor was discharged in satisfactory condition on the 7th day after harvesting the trunk of the great saphenous vein; there was also complete compensation of blood circulation in the lower extremities: peripheral pulsation was detected, there was no edema. At a follow-up examination after 1 year, blood circulation in the lower extremities is compensated: peripheral pulsation is detected, there is no edema. There are no symptoms of chronic venous insufficiency.

DISCUSSION

Considering the location and extent of the lesion (80% stenosis of the DFA mouth, occlusion of the native femoral and popliteal arteries), endovascular intervention was not considered as a method of choice. In this clinical case, the choice of graft material was of paramount importance. The patient was previously operated on using the autologous great saphenous vein ipsilaterally; on the contralateral side, the autologous vein is unsuitable for reconstruction. At the time of admission, our Clinic did not have donor grafts from the posthumous donor. Due to unsatisfactory long-term results of using synthetic prostheses in a position below the knee joint cleft, we did not consider this technique.

Since 1993, it has been possible to use domestic KemAngioprotez arterial bioprostheses - xenoprostheses - bovine arteries treated with a preservative. A.V. Pokrovsky was one of the first to publish the results of using the xenoprostheses. Aneurysmal degeneration was noted in 13% of cases in the late postoperative period [16]. L.S. Barbarash reports only 1.9% of xenoprosthetic aneurysms and ectasia [17]. A characteristic complication when using xenoprostheses was aneurysmal degeneration of the shunts, which was noted in 21% of cases on average 2 years after surgery in the study by I.S. Tishchenko [18].

According to the Order of the Ministry of Health of the Russian Federation, vessels are included in the list of transplantation objects [19]. Also, considering that the Clinic (the State Budgetary Institution of the Ryazan Region "Regional Clinical Hospital") where the patient was treated is included in the list of organizations that, according to the Order of the Ministry of Health of the Russian Federation have the right to harvest, procure and transplant human organs and (or) tissues [20], it was decided to use an allo vein from the living related donor as a material for vascular reconstruction, given the lack of a suitable autogenous vein, repeated access, distal position of potential peripheral anastomosis and toe necrosis.

REFERENCES

1. Zudin AM, Zasorina MA, Orlova MA. Epidemiology of chronic critical limb ischemia. *Pirogov Russian Journal of Surgery*. 2014;(10):78–82. (In Russ.)
2. Moreira C, Leung A, Farber A, Rybin D, Doros G, Siracuse JJ, et al. Alternative conduit for infrageniculate bypass in patients with critical limb ischemia. *J Vasc Surg*. 2016;64(1):131–139.e1. PMID: 27345506 <https://doi.org/10.1016/j.jvs.2016.01.042>
3. Pokrovskij AV, Jahontov DI. Role of Venous Cuff in Femoral-Tibial Bypass Surgery. *Bulletin of Pirogov National Medical & Surgical Center*. 2013;8(4):18–24. (In Russ.)
4. Neville RF, Tempesta B, Sidway AN. Tibial bypass for limb salvage using polytetrafluoroethylene and a distal vein patch. *J Vasc Surg*. 2001;33(2):266–271. PMID: 11174777 <https://doi.org/10.1067/mva.2001.113131>
5. Albers M, Battistella VM, Romiti M, Rodrigues AAE, Pereira CA. Meta-analysis of polytetrafluoroethylene bypass grafts to infrapopliteal arteries. *J Vasc Surg*. 2003;37(6):1263–1269. PMID: 12764274 [https://doi.org/10.1016/s0741-5214\(02\)75332-9](https://doi.org/10.1016/s0741-5214(02)75332-9)
6. Masmejan S, Deslarzes-Dubuis C, Petitprez S, Longchamp A, Haller C, Saucy F, et al. Ten Year Experience of Using Cryopreserved Arterial Allografts for Distal Bypass in Critical Limb Ischaemia. *Eur J Vasc Endovasc Surg*. 2019;57(6):823–831. PMID: 31130420 <https://doi.org/10.1016/j.ejvs.2018.11.020>
7. Antonopoulos CN, Papakonstantinou NA, Hardy D, Lyden SP. Editor's Choice – Cryopreserved Allografts for Arterial Reconstruction after Aortoiliac Infection: A Systematic Review and Meta-Analysis. *Eur J Vasc Endovasc Surg*. 2019;58(1):120–128. PMID: 31202580 <https://doi.org/10.1016/j.ejvs.2019.03.003>
8. Kalinin RE, Solanik NA, Suchkov IA, Suchkov IA, Egorov AA, Kaprov VV. The place of arterial allograft in reconstructive surgery of the main arteries of the lower extremities. *Pirogov Russian Journal of Surgery*. 2020;(9):69–74. (In Russ.) <https://doi.org/10.17116/hirurgia202009169>
9. Kalinin RE, Suchkov IA, Karpov VV, Pshennikov AS, Egorov AA. The First Experience of Using Allografts in Surgery of Main Arteries of Lower Limbs. *Russian Sklifosovsky Journal Emergency Medical Care*. 2020;9(3):442–448. <https://doi.org/10.23934/2223-9022-2020-9-3-442-448>
10. O transplantatsii organov i (ili) tkaney cheloveka (s izmeneniyami i dopolnениями): Zakon RF ot 22 dekabrya 1992 g. No 4180-I. (In Russ.) Available at: <http://base.garant.ru/136366/> [Accessed Jan 29, 2024]
11. Ob osnovakh okhrany zdorov'ya grazhdan v Rossiyskoy Federatsii: Federal'nyy zakon ot 21 noyabrya 2011 g. No 323-FZ. (In Russ.) Available at: <https://base.garant.ru/12191967/> [Accessed Jan 29, 2024]

In our opinion, these conditions do not leave an alternative choice for guaranteed success of reconstructive surgical intervention. Removal of organs and tissues for transplantation from the living donor is permissible only if, according to the conclusion of the medical commission of a healthcare institution with the involvement of relevant specialists, drawn up in the form of a protocol, significant harm will not be caused to his health [11]. Removal of organs and tissues for transplantation is permitted from the living donor only in case of his informed voluntary consent [10]. These paragraphs of Article 47 of the Federal Law No. 323-FZ «On the Fundamentals of Protecting the Health of Citizens in the Russian Federation» dated November 21, 2011 (amended on July 2, 2021; entered into force on July 13, 2021) we have fully complied with.

CONCLUSION

The presented clinical case showed the safety for the donor and the possibility of successful use of donor material (related transplantation of the trunk of the great saphenous vein from the living donor) in the surgical treatment of critical limb ischemia in the absence of an autologous vein, both in the immediate and late postoperative periods. To obtain more reliable data, the issue of using related allografts requires further in-depth study.

12. Pokrovsky AV, Dan VN, Zotikov AE, Chupin AV, Shubin AA, Tedelev AK. Long-Term Outcomes of Femoropopliteal Bypass Above the Knee-Joint Fissure by Means of Vascular Prosthesis "Ecoflon" in Patients with Atherosclerotic Lesions of Lower Limb Arteries. *Angiology and Vascular Surgery. Journal named after Academician A.V. Pokrovsky.* 2007;13(2):143–149. (In Russ.)
13. Kalinin RE, Suchkov IA, Chobanyan AA. Prospects for forecasting the course of obliterating atherosclerosis of lower limb arteries. *Science of the young (Eruditio Juvenium).* 2019;7(2):274–282. (In Russ.) <https://doi.org/10.23888/HMJ201972274-282>
14. Katelnitskiy II, Katelnitskiy II, Livadnyaya ES. Advantages of modern methods of prevention of thrombotic complications in patients with critical ischemia of lower limbs after reconstructive operations. *I.P. Pavlov Russian Medical Biological Herald.* 2020;27(4):487–494. <https://doi.org/10.23888/PAVLOVJ2019274487-494>
15. *Natsional'nye rekomendatsii po diagnostike i lecheniyu zabolevaniy arteriy nizhnikh konechnostey g. Moskva, 2019 g.* (In Russ.) Available at: http://www.angiolsurgery.org/library/recommendations/2019/recommendations_LLA_2019.pdf [Accessed Jan 29, 2024]
16. Pokrovskiy AV, Dan VN, Chupin AV, Gryazov OG. Primenenie biologicheskikh transplantatov v bedrenno-podkolenno-bertsovoy pozitsii. *Angiology and Vascular Surgery. Journal named after Academician A.V. Pokrovsky.* 1996;(3):91–100. (In Russ.)
17. Barbarash LS, Ivanov SV, Zhuravleva IYu, Anufriev AI, Kazachek YaV, Kudriavtzeva YuA, et al. Twelve-Year Experience of Bioprosthesis Implantation into Infrainguinal Arteries. *Angiology and Vascular Surgery. Journal named after Academician A.V. Pokrovsky.* 2006;12(3):91–97. (In Russ.)
18. Tishchenko IS, Zolkin VN, Maksimov NV, Korotkov IN, Demidov IYu, Barzaeva MA. Two-Year Results of Infrainguinal Reconstructions Using Autovenous Shunts and Xenografts. *Angiology and Vascular Surgery. Journal named after Academician A.V. Pokrovsky.* 2016;22(4):130–135.
19. *Ob utverzhdenii perechnya ob"ektov transplantatsii (s izmeneniyami i dopolneniyami). Prikaz Ministerstva zdravookhraneniya RF i Rossiyskoy akademii nauk ot 4 iyunya 2015 g. No 306n/3.* (In Russ.) Available at: https://base.garant.ru/71096134/53f89421bbdaf741eb2d1ecc4ddb4c33/#block_1000 [Accessed Jan 29, 2024]
20. *Perechen' uchrezhdeniy zdravookhraneniya, osushchestvlyayushchikh zabor, zagotovku i transplantatsiyu organov i(ili) tkaney cheloveka. Prilozhenie k prikazu Ministerstva zdravookhraneniya Rossiyskoy Federatsii i Rossiyskoy akademii nauk ot 20 fevralya 2019 g. No 73n/2.* (In Russ.) Available at: https://base.garant.ru/72196668/53f89421bbdaf741eb2d1ecc4ddb4c33/#block_1000 [Accessed Jan 29, 2024]

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