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# Возможности применения аллографтов в хирургическом лечении аневризм подколенных артерий

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## АННОТАЦИЯ

**Обоснование.** Золотым стандартом выбора при реконструктивных операциях на инфраингвинальных артериях является аутовенозный кондуит из большой подкожной вены. Однако, при отсутствии пригодной аутовены возникают трудности выбора подходящего материала для реконструкции. Не всегда в качестве альтернативы в области коленного сустава возможно использовать синтетический протез, особенно в дистальной позиции. Неудовлетворительные результаты использования таких материалов диктуют необходимость выбора подходящего графта. В данной статье приведен опыт применения (два клинических случая) аллографтов от посмертного донора в хирургическом лечении аневризм подколенных артерий. Показана возможность их использования в экстренных клинических ситуациях. В первой клинической ситуации пациенту ранее была выполнена флебэктомия. Во втором случае подкожные вены нижних конечностей имели рассыпной тип и недостаточный диаметр для реконструкции.

**Заключение.** По результатам представленных примеров сделан вывод о возможности эффективного использования аллографтов от посмертного донора у пациентов с истинными аневризмами подколенных артерий.

**Ключевые слова:** аллографт; трансплантация сосуда; аневризма подколенной артерии; графт

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# Potentials of Using Allografts in Surgical Treatment of Popliteal Artery Aneurysms

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## ABSTRACT

**BACKGROUND:** The gold standard in reconstructive surgical operations on the infrainguinal arteries is the autovenous conduit from the great saphenous vein. However, in the absence of a suitable autovein, difficulties are encountered in the selection of a suitable material for reconstruction. The use of a synthetic prosthesis as an alternative in the knee joint region is not always possible, especially in the distal position. Unsatisfactory results of using such materials dictate the need to choose a suitable graft. The paper describes two case experiences of using allografts from a deceased donor for the surgical treatment of popliteal artery aneurysms. The cases present their potential for use in emergency clinical situations. In the first case, the patient had previously undergone phlebectomy. In the second case, the saphenous veins of the lower limbs had scattered branches and insufficient diameter for reconstruction.

**CONCLUSION:** The described cases presented the possible effective use of allografts from a deceased donor in patients with true popliteal artery aneurysms.

**Keywords:** *allograft; vessel transplantation; popliteal artery aneurysm; graft*

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## LIST OF ABBREVIATIONS

PA – popliteal artery  
PTFE – polytetrafluoroethylene  
DUS – duplex ultrasound scanning

## BACKGROUND

The most common aneurysms of the limb arteries are popliteal localization aneurysms, with their share reaching 70%–90% [1, 2]. Up to 1% of patients have a popliteal artery (PA) aneurysm [3, 4]. Most of these patients require surgical treatment [5]. Open [6] and endovascular treatment methods [7] are used, or a hybrid approach that combines the use of open bypass surgery and intraoperative thrombolysis [8]. The autovein remains the “gold standard” treatment for treating PA aneurysms. In the absence or impossibility of using this material, serious difficulties arise. This problem occurs in more than 60% of cases [9]. Synthetic prostheses are often used as an alternative to the autologous material used in reconstructive interventions of the large arteries of the limbs. However, *about half of these synthetic prostheses get thrombosed within the first five years* [10]. There are many reasons for these results, but the leading one is reconstruction zone restenosis resulting in intimal hyperplasia due to epithelial dysfunction [11, 12]. Inherent endothelial morphological and functional peculiarities are necessary for several specific functions aimed at the optimal adaptation to hemodynamic conditions and metabolism, perfusion regulation, hemostasis, and homeostatic maintenance [13]. The *cytotoxicity of synthetic and biological prostheses* plays an important role in developing intimal hyperplasia and *contributes to endothelial dysfunction*. A less pronounced effect of polytetrafluoroethylene (PTFE) relative to polyethylene terephthalate (Dacron) on the metabolic activity of endotheliocytes has been proven *in vitro* [14]. Therefore, the choice of the material for reconstruction remains relevant and is widely discussed in the literature [13–15].

A significant limitation to using synthetic prostheses is the anatomic location of the pathological process, which is *especially evident in the popliteal position*. Today, the unsatisfactory results of using such materials dictate choosing a suitable graft. A method of choice, in this case, can be to use allografts. In the international medical literature, cases of cryopreserved allografts are reported [16–18]. According to the literature data in the Russian Federation, wet-preserved homografts are used in large-artery surgery [19, 20].

Corresponding linear arterial allografts of PA can be more hemodynamically correct in PA aneurysm cases and better suit the architecture of arteries of this region from the point of view of the topography. The absence of clear indications and contraindications of optimal timing and

preservation methods remain significant limiting factors for the wide use of allografts in the routine practice of a cardiac surgeon, even with access to the technology of vascular sampling, preservation, and transplantation. These issues undoubtedly require further investigation and principal discussion from positions of evidence-based medicine.

In this article, based on two clinical cases, the possibilities of using arterial allografts as material for reconstruction in urgent PA aneurysm surgery are shown.

### Case Report 1

Patient R., 1957, year of birth, was admitted to the department of vascular surgery of the Ryazan Regional Clinical Hospital on May 20, 2021, for life-saving indications with the diagnosis: *Atherosclerosis. Acute thrombosis of arteries of the femoropopliteal segment on the left. PA aneurysm on the left. Ila degree ischemia (classification of I.I. Zatevakhin). II stage 2 degree essential hypertension, high risk of cardiovascular complications. Condition after phlebectomy on both sides (2005)*.

On admission, the patient presented with **complaints** of pain in the left lower limb at rest, reduced sensitivity, and the volume of active movements in the left toes. The above complaints had been present for about one day.

**Common clinical tests** were without clinically significant deviations.

**Heart ultrasound.** The patient had mild hypertrophy of the left ventricular myocardium, a left ventricular ejection fraction of 65%, left atrial dilatation, and moderate mitral valve regurgitation. Atherosclerosis of the aorta was also evident.

In **duplex ultrasound scanning** (DUS) of the left lower limb arteries, a *thrombosed PA aneurysm* up to 3 cm in diameter and up to 5 cm in length was detected. No compression of the vein was seen.

Preliminarily, multivisceral harvesting was performed on May 8, 2020, from a deceased donor. The PA allograft was taken and was conditioned in custodial solution with the addition of gentamycin (400 µg/ml) and fluconazole (20 µg/ml) at 4°C. It was prepared under operating room conditions as the material for reconstruction.

On May 21, 2021, **prosthetics of PA** were performed using an arterial allograft with ligation of the true thrombosed aneurysm on the left (Figure 1).

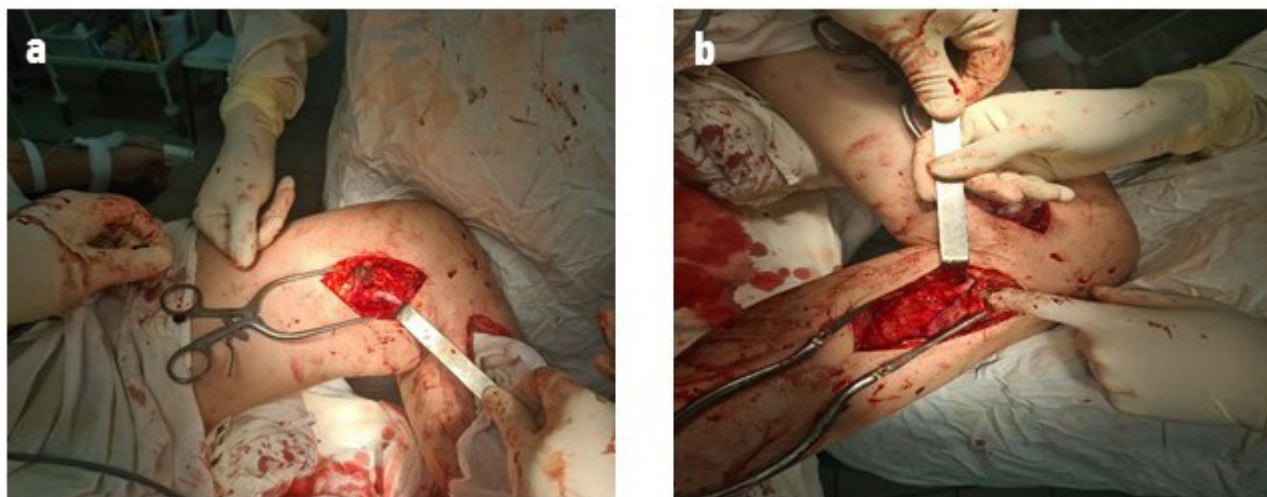


Fig. 1. Case report 1. Prosthetics of the popliteal artery using an arterial allograft with ligation of the true thrombosed aneurysm on the left: central anastomosis of the allograft and popliteal artery (a); peripheral anastomosis of the allograft and popliteal artery (b).

The postoperative management protocol corresponded to the Russian national recommendations on managing patients with diseases of the lower limb arteries [21].

No graft rejection reaction was observed in the postoperative period, and general clinical and biochemical blood parameters were without pathological changes. There was a complete compensation of blood circulation in the left lower limb: sensitivity and active

movements in the toes of the foot were in full volume, and the pulse on the arteries of the foot was determined. In DUS control, the main blood flow up to the medial malleolus was recorded (Figure 2).

The sutures were removed, and the wound healed by primary intention. On the tenth day after the reconstructive surgery, the patient was discharged in satisfactory condition.



Fig. 2. Case report 1. Scan of the posterior tibial artery near the medial malleolus.

## Case Report 2

Patient E., 1965 year of birth, was admitted to the department of vascular surgery of the Ryazan Regional Clinical Hospital on April 24, 2021, for life-saving indications with the diagnosis: *Atherosclerosis. Acute thrombosis of arteries of the femoropopliteal segment on the left. PA aneurysm on the left. IIab-IIIa degree ischemia (classification of I. I. Zatevakhin).*

On admission, the patient presented with **complaints** of pain in the left lower limb at rest, reduction of sensitivity, and movements in the left toes. The above complaints had been noted for about three hours.

**Common clinical tests** were without clinically significant deviations.

**DUS** of the left lower limb arteries detected a thrombosed PA aneurysm about 3.5 cm in diameter

and about 6 cm in length. No vein compression was detected. Evaluation of the angiological status of the left lower limb showed the absence of superficial and deep sensitivity active movements (passive movements were preserved). The patient's shin muscles were sharply painful to palpation. According to the Russian national recommendations on managing patients with diseases of the lower limb arteries, urgent surgical intervention was indicated to save the limb [21].

Emergency surgery was conducted considering the severity of ischemia — **PA prosthetics** using an arterial allograft with ligation of a true thrombosed aneurysm on the left (Figure 3). The graft was performed subfascially and orthotopically. Given the diameter and extent of the PA aneurysm the absence of compression of the surrounding tissues, it was decided not to resort to excision of the aneurysm.

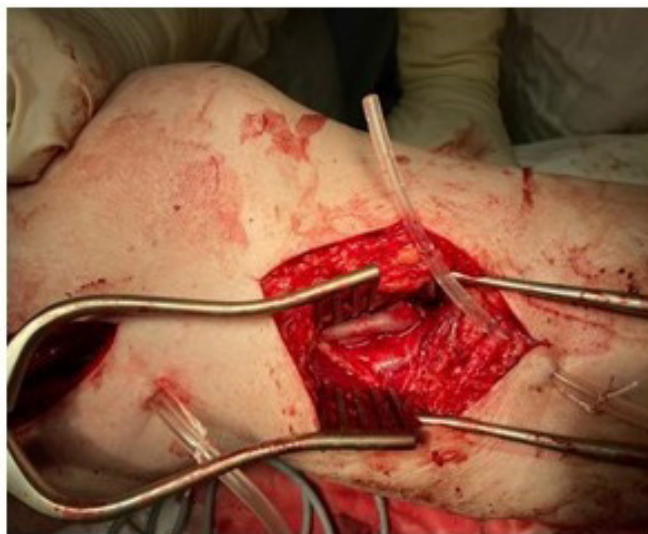


Fig. 3. Case report 2. Peripheral anastomosis of the graft and popliteal artery.

Preliminarily, in multivisceral harvesting (08.05.2020), an allograft was taken from the deceased donor PA. It was conditioned in custodial solution with the addition of gentamycin (400 µg/ml) and fluconazole (20 µg/ml) at 4°C. It was prepared under operating room conditions as the material for reconstruction.

No graft rejection reaction was observed, general clinical and biochemical blood parameters were without pathological changes. There was a complete compensation of blood circulation in the left lower limb: sensitivity and active movements in the toes were in full volume, and peripheral pulsation was determined.

The sutures were removed, and the wound healed by the primary intention. On the twelfth day after the reconstructive surgery, the patient was discharged in satisfactory condition.

At the control examination three months later (Figure 4), compensation of circulation was noted, and no signs of inflammation in the area of surgery were present. DUS control: there were no data for aneurysmal transformation and calcification of the graft.

At present, both patients are under medical supervision.

## DISCUSSION

According to the data of J. Podlaha, surgical treatment of PA aneurysms should be started as soon as possible after making the diagnosis, preferably before the ischemic complications have occurred [18]. Surgical treatment for severe acute ischemia of limbs is mandatory and does not require discussion.



**Fig. 4.** Case report 2. Control examination after three months: postoperative wounds.

In prosthetics of the PA due to an aneurysm, we use two approaches — *medial* (along the medial surface of the upper one-third of the lower leg) and *posterior* (through the popliteal fossa in the projection of the PA). If an aneurysmectomy is necessary, priority is given to the posterior access. Indications for aneurysmectomy include compression of the tissues surrounding the aneurysm (nerves or veins) and a large-sized aneurysm (more than 3.5 cm in diameter). In cases where only the artery is involved in the pathological process, it is possible to limit the intervention by ligating the aneurysm above and below the aneurysmal sac using the medial access approach.

In the described clinical cases, difficulties arose with the reconstruction material for PA aneurysms. Autovenous conduit from the great saphenous vein remains the "gold standard" of choice for reconstructive operations on the infrainguinal arteries. However, in the absence of a suitable autovein, difficulties with choosing a suitable material for reconstruction arise; it is not always possible to use a synthetic prosthesis as an alternative, especially in the distal position and knee joint area.

In the first clinical situation, the patient preliminarily underwent phlebectomy. In the second situation, the veins of the lower limbs were of the scattered type and had insufficient diameter to be used in the reconstruction.

Unsatisfactory results of using synthetic materials, especially in the popliteal position, dictate the need to choose a suitable graft. According to C. Brandon et al., cryopreserved allografts are a valuable alternative to prosthetic materials in the absence of autologous veins. In most studies, the parameters of limb saving, and patency are higher than those described for prosthetic grafts at the infrapopliteal level [22].

According to the data of L. Mezzetto et al., the treatment of PA aneurysms using a cryopreserved homograft proved its safety and efficiency both in the short-term and long-term period [16].

Considering the above, it was decided to use allografts from a deceased donor as the material for reconstructing vessels in the given clinical cases.

## CONCLUSION

The presented clinical examples showed the possibility of successful use of freshly prepared allografts from a deceased donor in patients with PA aneurysms. In the near and distant future, there were no signs of a graft rejection reaction, aneurysmal transformation, and calcification of allografts were detected.

Undoubtedly, it is necessary to conduct additional studies using biological plastic materials for reconstructive surgical treatment of the main arteries and fundamental analysis from positions of evidence-based medicine.

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final approval of the version to be published and agree to be accountable for all aspects of the work.

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**Согласие на публикацию.** В статье использованы обезличенные клинические данные пациентки в соответствии с подписанным ей добровольным информированным согласием.

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