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The First Experience of Using Allografts in Surgery of Main Arteries of Lower Limbs

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ABSTRACT The article describes the experience of using allografts in surgery of the main arteries of the lower limbs. The urgency of using bioprostheses is briefly shown. The management of patients with infectious complications remains an unsolved problem in vascular surgery. Reconstructive vascular surgery is often repeated. Operations are often performed in the presence of extensive necrosis and trophic ulcers. The autovein is not always available for reconstruction of the main artery, which is why the issue of choosing a material for repeated reconstruction remains relevant. The medical literature has shown the tendency of xenoprostheses to aneurysmal transformation in the postoperative period. There is not a lot of information in the world and domestic sources on the use of arterial allografts. The lack of clear indications and contraindications for use, optimal preservation periods, the choice of the necessary preservatives and a suitable medium do not allow the widespread use of allografts in practical surgery if there is access to the technology of vascular collection, conservation and transplantation. The problem of using allografts requires further study. In this regard, the experience of using allografts in two non-standard clinical situations is presented. It was concluded that it is possible to effectively use freshly prepared arterial allografts from a postmortem donor during reconstruction in patients with critical ischemia of the lower extremities in the absence of a suitable autovein and the impossibility of using a synthetic prosthesis.

Keywords: allograft, allograft vessel transplantation, suppuration of the prosthesis bed

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CABG – coronary artery bypass grafting
APTT – activated partial thromboplastin time
VTEC – venous thromboembolic complications
CTA – computed tomoangiography
LV – left ventricle

MV – mitral valve
MCAB – mammary coronary artery bypass grafting
INR – International Normalized Ratio
CBC – complete blood count
GUA – general urine analysis
USE – ultrasound examination
EF – ejection fraction
FC – functional class

INTRODUCTION

The number of diseases of the circulatory system in the Russian Federation, according to Rosstat, is steadily growing - 3,734,000 patients in 2010 and 4,784,000 - in 2018.A significant contribution to this statistics is made by obliterating diseases of the arteries of the lower extremities [1, 2]. In the USA, 8,500,000 people over 40 suffer from peripheral arterial disease [3]. According to various sources, up to 200 million people in the world have peripheral arterial disease [4]. Two thirds of these patients require surgical treatment. Most often, reconstructive and restorative interventions are performed using synthetic prostheses. About half of the prostheses cease to function within the first 5 years [5]. Arterial restenosis is a limiting factor in the effectiveness of reconstructive interventions [6, 7]. The leading cause of restenosis is endothelial dysfunction [8]. One of the main problems in vascular surgery is the choice of material for arterial reconstruction [9]. The use of an autovein is the gold standard. In the absence and impossibility of using this material, serious difficulties arise. In 60% of cases, this problem may occur [10]. It is not always possible to use a synthetic prosthesis as an alternative. In the presence of a purulent-inflammatory process in the area of the vascular prosthesis, there are practically no effective solutions. Today, the unsatisfactory results of using such materials dictate the need to choose a suitable graft.

Since 1993, it is possible to use domestic bioprostheses "KemAngioprosthez" – xenoprostheses – arteries of cattle treated with a preservative. A.V. Pokrovsky was one of the first to publish the results of using xenoprostheses. Aneurysmal degeneration was observed in 13% of cases in the late postoperative period. [11]. L.S. Barbarash reports only 1.9% of aneurysms and ectasias of xenoprostheses [12]. A typical complication when using xenoprostheses was aneurysmal degeneration of grafts, which was noted in 21% of cases on average 2 years after surgery in the study of I.S. Tishchenko [13].

The use of allografts may be the method of choice in cases of infectious complications, the absence of a suitable autovein, repeated reconstructions, in the presence of trophic ulcers and necrosis. In foreign medical literature, such reports are rare. [14, 15]. Cryopreserved allografts are used in most studies. Wet storage grafts are found in the works of domestic authors [16]. The non-viability of the allograft, insufficient biological inertness, a tendency to degeneration and calcification as a result of conservation, the absence of clear indications and contraindications, the optimal timing of conservation and the choice of the necessary preservatives and a suitable medium – all this does not allow the widespread use of allografts in practical surgery if there is access to the vascular harvesting technology, conservation and transplantation. The problem of using allografts requires further in-depth study.

In this regard, we present our experience of using allografts in non-standard clinical situations. Patients signed an informed consent to submit their data in a scientific medical journal.

Clinical observation № 1

Patient G., born in 1951, was admitted to the Department of Vascular Surgery at the Regional Clinical Hospital of Ryazan on September 20, 2019 with a diagnosis of “Atherosclerosis of the arteries of the lower extremities. Femoropopliteal occlusion on both sides. Condition after autovenous femoral-popliteal bypass grafting on the right of 12/11/2014. Aneurysm of the autovenous femoral-popliteal shunt on the right. Right post-thrombotic disease, recanalized form, C6. Type 2 diabetes mellitus. Hypertensive heart disease, stage III, risk 4. Chronic heart failure IIa degree, functional class (FC) II. Stomach ulcer and duodenal ulcer, remission”.

On admission, the patient complained of a painful pulsating mass in the right groin. The above complaints are noted for about a month. Additional examination. In general clinical and biochemical analyzes - without significant pathology.

Complete blood count (CBC) (09/21/2019): erythrocytes - 4.3 × 1012 / l, hemoglobin - 120 g / l, platelets - 194.6 × 109, leukocytes - 8.2 × 109 / l.

General urine analysis (GUA) (09/21/2019): color – straw-yellow, reaction – acidic, specific gravity – 1016, protein – 0, epit. cells – units, leukocytes – 1–2.

Biochemical blood test (09/21/2019): total protein – 75 g / l; urea – 8.7 mmol / l; creatinine – 0.098 mmol / l; cholesterol – 3.85 mmol / l;

Coagulogram from 09/21/2019.

Thrombin time – 19.9 s, fibrinogen – 3.62 g / l, activated partial thromboplastin time (APTT) – 28.1 s, international normalized ratio (INR) – 1.01.

Ultrasound examination of the heart from 09/23/2019: ejection fraction (EF) – 60%. Slight left ventricular (LV) myocardial hypertrophy. Violation of the diastolic function of the myocardium (type I). Dilation of the left atrium. Moderate mitral regurgitation (MV). Atherosclerosis of the aorta.

Sowing of microflora from trophic ulcer of the right leg from 09.24: Staphylococcus aureus – 106, Citrobacter freundii – 106.

Ultrasound of the abdominal cavity from 09/23/2019. Several diverticula along the course of the sigmoid colon. Otherwise, no pathology.

Duplex scanning of the veins of the right lower extremity from 24.09.2019. Conclusion: a recanalized form of postthromobic disease of the right lower limb.

Computed tomography of the lower extremities with contrast enhancement from 20.09.2019. Multiple aneurysmal enlargements along the autovenous conduit of the femoral-popliteal segment on the right up to 3 cm in diameter (Fig. 1, 2).

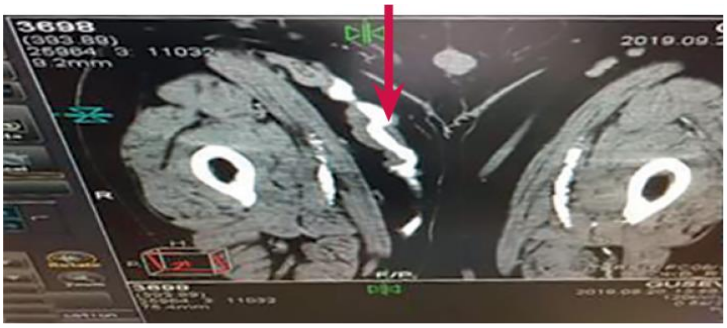

Fig. 1. Computed tomography with contrast enhancement of femoral upper third. Multiple aneurysmal deformity of the autovenous femoral-popliteal bypass (arrow)

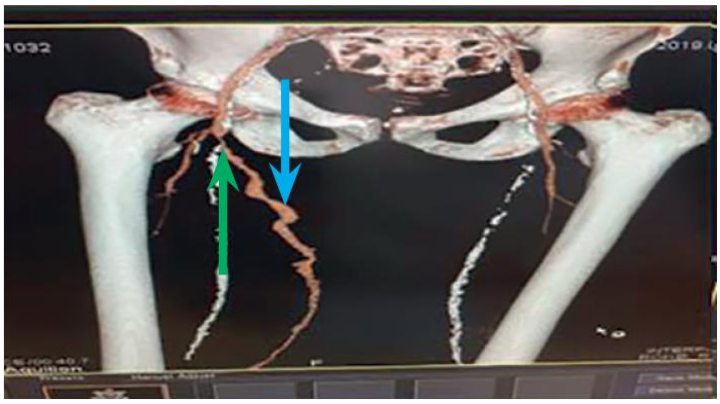

Fig. 2. Computed tomography with contrast enhancement of femoral upper third in 3D mode. Multiple aneurysmal deformity of the autovenous femoral-popliteal bypass (indicated by the blue arrow). A critical stenosis of proximal anastomosis (green arrow)

In this case, surgery was absolutely indicated. Additional examination revealed critical stenosis in the proximal anastomosis of the femoral-popliteal autovenous shunt and multiple aneurysms of the autovein on the right. It is necessary to reshunt the femoral artery. It is risky to use a synthetic prosthesis in this case: trophic ulcers of the leg can be the cause of infectious complications. There is no suitable autovein. The use of a xenoprosthesis is not optimal here, given the tendency to aneurysmal transformation.

On September 21, 2019, for the first time in the Ryazan region, the right femoral artery was transplanted: alloprosthetics with a freshly prepared allograft of the femoral-proximal-popliteal segment on the right.

The day before, during multivisceral sampling, a femoral artery allograft was removed from a postmortem donor incompatible in blood group and Rh factor, subject to all the rules and norms of transplantology. The graft is conditioned in a Custadiol solution at a temperature of + 4 ° C, no antibiotics were added to the solution.

Immediately before transplantation, the graft was prepared in the operating room for use as a material for reconstruction according to the technique back table (рис. 3).

Fig. 3. Allograft preparation (back table technique)

Back table — this is the stage of preparation of the donor graft for transplantation. It is performed as a separate surgery on the graft. A sterile table is being prepared directly next to the patient in the operating room. We work with the use of a second team of surgeons

in parallel with the main one. The allograft is removed into a tray with sterile ice, the alloartery or allovene is treated - the lateral branches are tied or stitched, the graft is checked for leaks. After that, the allograft is transferred to the main team of surgeons.

Some of the stages of transplantation are shown in Fig. 4, 5.

Fig. 4. The central anastomosis is formed. The graft is filled with blood

Fig. 5. Distal anastomosis, the graft is inserted subfascially

In the postoperative period, low molecular weight heparins were prescribed – clexane 0.6 1 time subcutaneously (to prevent venous thromboembolic complications – VTEC), antiplatelet agents – thromboass 100 mg 1 time, antibiotics taking into account sensitivity – gentamicin 160 mg 1 time intramuscularly and ceftriaxone 1.0 2 times intravenously, statins – atoris 20 mg 1 time per day. No immunosuppressants were used. Thus, the postoperative management did not differ from the scheme of the postoperative period of reconstructions with synthetic material. We have not seen a rejection reaction; there were no significant changes in general clinical and biochemical analyzes. The blood circulation in the right lower limb was compensated, the pulse in the dorsal artery of the foot was distinct. The stitches were removed, healing by primary intention. The patient was discharged in satisfactory condition on the 12th day after surgery.

At the follow-up examination after 12 weeks, the graft is functioning, there are no signs of rejection. Control computed tomoangiography (CTA) was performed (Fig. 6).

Fig. 6. Computed tomography with angiography of the arteries of the lower extremities in 3D mode. Femoral-popliteal allograft (arrow)

Clinical observation № 2

Patient R., born in 1977, was admitted to the Department of Vascular Surgery at the Regional Clinical Hospital of Ryazan on October 29, 2019 with a diagnosis: “Atherosclerosis of the arteries of the lower extremities. Leriche syndrome. Condition after bifurcation aorto-femoral bypass grafting (03/17/2015). Occlusion of the right branch of the aorto-femoral shunt. Condition after cross femoral-femoral bypass grafting from left to right (04/05/2019). Stage IV of the disease, trophic ulcer of the right leg (Fig. 7).

Fig. 7. The appearance of a trophic ulcer of the right leg

Thrombosis of the cross femoral-femoral bypass graft from 28.10.2019. Ib degree ischemia of the lower extremities. Suppuration of the bed of synthetic prostheses. Coronary artery disease: postinfarction cardiosclerosis (2019). Multivessel coronary artery disease (coronary angiography 01/22/2019). Mammacoronary bypass grafting (MCB) of the anterior interventricular artery; coronary artery bypass grafting (CABG) PDA, blunt edge branches (03/18/2019). Hypertensive heart disease st. III, gr. 3, risk 4, FC 3».

On admission, the patient complained of pain in both lower extremities at rest, numbness of the toes, trophic ulcer of the right leg, the presence of a discharge from the postoperative wound of the right thigh. Additional examination:

CBC (10/30/2019): erythrocytes – 3.8 × 1012 / l, hemoglobin – 117 g / l, platelets – 184.7 × 109, leukocytes – 8.2 × 109 / l.

Urine analysis (30.10.2019): color – straw yellow, reaction – acidic, specific gravity – 1020, protein – 0, epit. cells – 1-2, leukocytes – 1-2.

Biochemical blood test (10/30/2019): total protein – 65 g / l; urea – 2.7 mmol / l; creatinine – 0.0981 mmol / l; cholesterol – 5.85 mmol / l.

Coagulogram from 10/30/2019: thrombin time – 15.91 s, fibrinogen – 7.11 g / l, APTT – 28.1 s, INR – 1.14;

Ultrasound of the heart from 1.11.2019: myocardial hypertrophy, impaired systolic function, zones of LV hypokinesia. Left atrial enlargement. Minor regurgitation on the MV, tricuspid valve. Consolidation of the ascending aorta. Condition after CABG, MCAB (2019).

Fibrogastroduodenoscopy from 1.11.2019: Insufficiency of the cardia. Focal antral gastritis.

Crops for microflora from trophic ulcer of the right leg and postoperative wound) from 11/6/2019 – Staphylococcus epidermidis 103, Pseudomonas aeruginosa 103.

Aortoarteriography of the lower extremities (Fig. 8, 9).

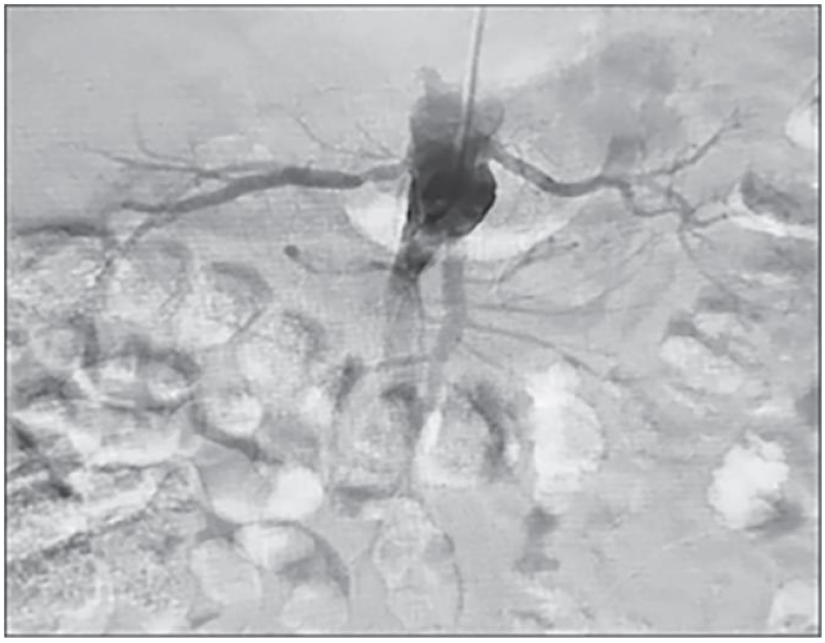

Fig. 8. Infrarenal aortic occlusion

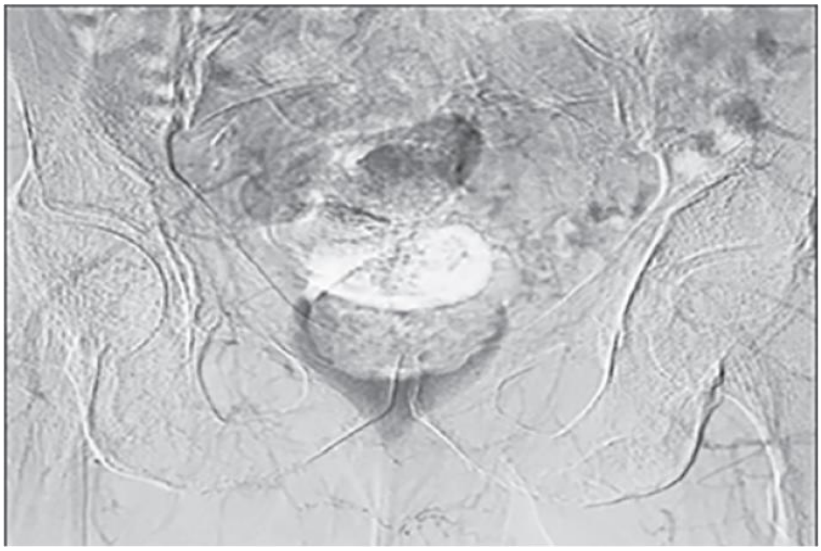

Fig. 9. Contrasted femoral arteries

Fistulography 11/01/2019: Contrast spreading along the bed of the cross femoral-femoral and aorto-femoral prostheses is noted (Fig. 10).

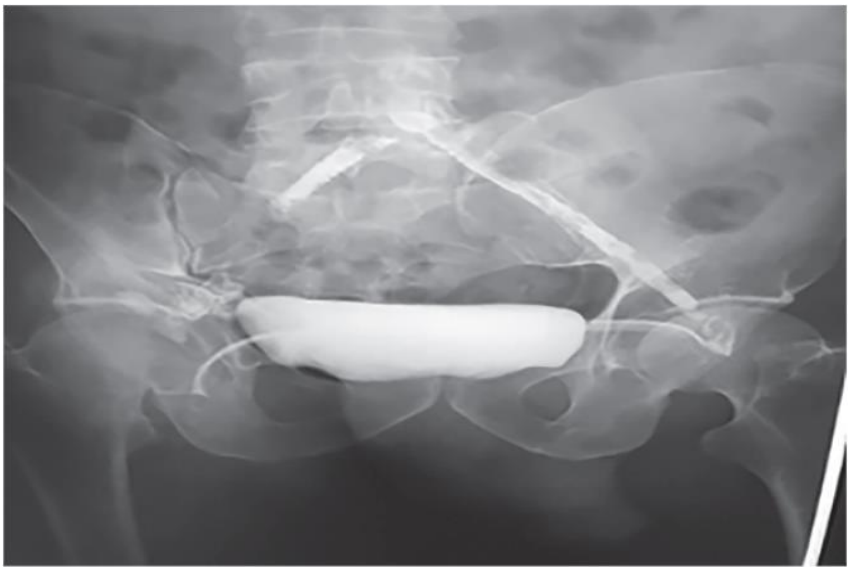

Fig. 10. Administered contrasting agent downstream femoral-femoral crossover graft and bifurcation aorto-femoral graft

The need for surgical intervention in this case was not in doubt. Attempts at conservative treatment in such a situation can result in fatal bleeding. The method of choice is the removal of the infected prosthesis followed by reshunting. It is hardly possible to use a synthetic prosthesis. Taking into account the general somatic status of the patient and the lack of surgical experience in the collection of deep auto veins, we did not consider them as material for reconstruction. Optimal in this case, it was possible to apply alloprosthetics.

Surgery 4.11.2019: Transplantation of arteries of the aorto-ilio-femoral segments. Bifurcation aorto-deep femoral reprosthetics with freshly prepared allograft. Reimplantation of the inferior mesenteric artery.

The day before, during multivisceral sampling, allografts of the aorto-ilio-femoral complexes were removed from a postmortem compatible donor for the group and Rh factor, observing all the rules and norms of transplantology. The grafts are conditioned in a solution for the cultivation of cell structures RPMI (Roswell Park Memorial Institute) with the addition of gentamicin and fluconazole at a temperature +4°C. For long-term storage of grafts, we use RPMI 1640 solution with glutamine. Add gentamicin (400 μg / ml) and fluconazole (20 μg / ml) to the preservative solution).

Immediately before transplantation, the graft is prepared in the operating room for use as a material for reconstruction according to the technique back table. Two grafts of the aorto-ilio-femoral complex (Fig. 11) were prepared separately – the lateral branches were sutured with Prolene 6/0 thread, and the tightness was checked. A bifurcation allograft was formed (Fig. 12).

Fig. 11. Aorto-ilio-femoral allografts

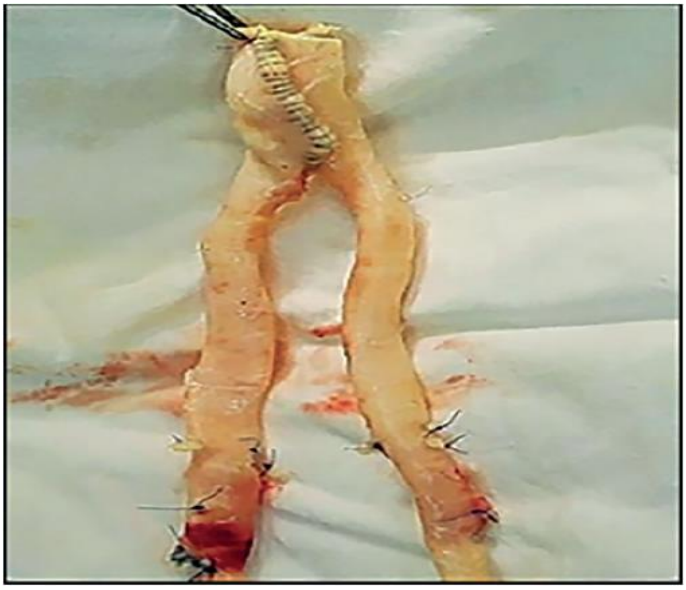

Fig. 12. Bifurcation allograft

Some stages of surgery are shown in Fig. 13–15:

In the postoperative period, low molecular weight heparins were prescribed – clexane 0.6 1 time subcutaneously (in order to prevent VTEC), antiplatelet agents – thrombotic Ass 100 mg 1 time, antibiotics taking into account sensitivity – gentamicin 160 mg 1 time intramuscularly and meropenem 1.0 2 times intravenously, statins – atoris 20 mg 1 time. No immunosuppressants were used. Control CTA was performed in the postoperative period (Fig. 16).

Fig. 13. Removed an infected synthetic prostheses

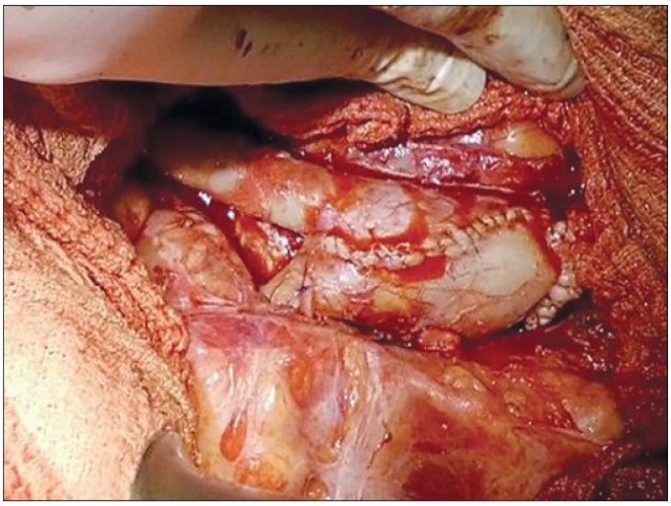

Fig. 14. Proximal anastomosis between the aorta and allograft

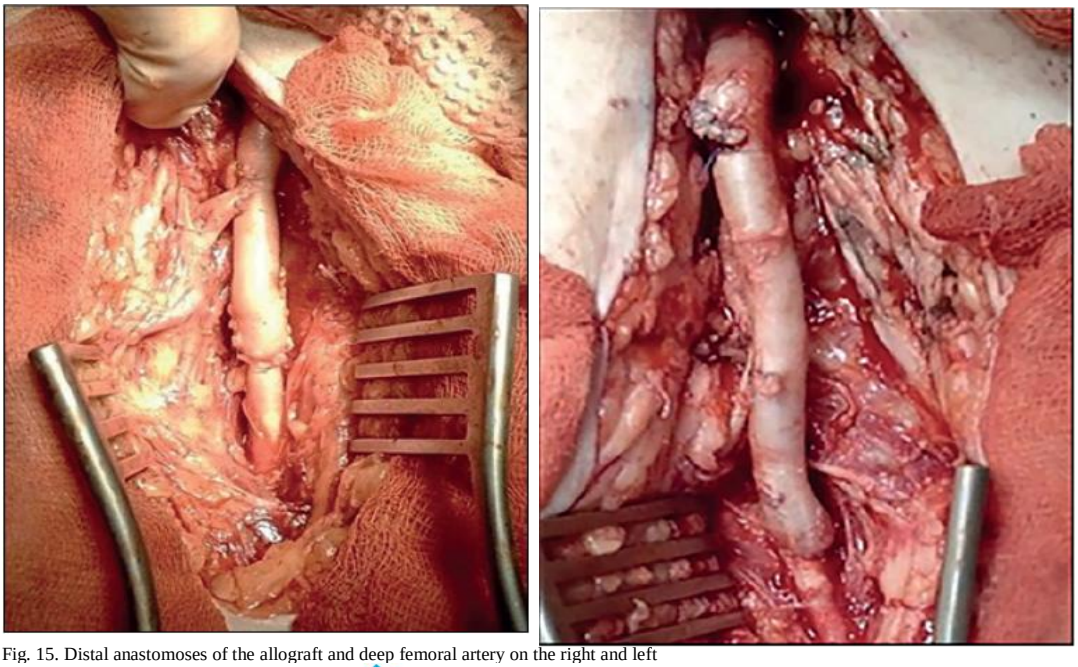

Fig. 15. Distal anastomoses of the allograft and deep femoral artery on the right and left

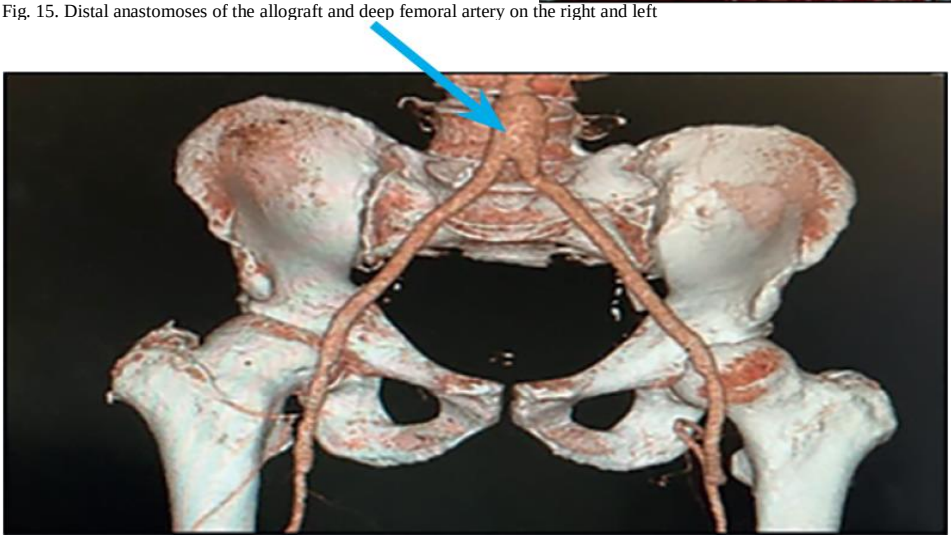

Fig. 16. Computer tomography with angiography of the aorta and bifurcation in 3D mode. Aorto-femoral allograft is indicated by a blue arrow

Postoperative management was unremarkable. We have not seen a rejection reaction; in general clinical and biochemical analyzes without significant changes. The blood circulation in the lower extremities was closer to compensation; the pulse on the branches of the allograft was distinct. Stitches removed, healing by primary intention. The patient was discharged in satisfactory condition on the 12th day after surgery.

DISCUSSION

The management of patients with trophic ulcers of the lower extremities and suppuration of postoperative wounds remains an unsolved problem in vascular surgery. Reconstructive vascular surgery is often repeated. Very often, operations are performed in the presence of extensive necrosis and trophic ulcers. Autovein is not always available for reconstruction. Until now, the question of the choice of material for reconstruction remains especially relevant. The solution may be the use of biological material - xenoprosthesis or allograft. The literature summarizes the experience of using xenoprostheses. Their tendency to aneurysmal transformation in the postoperative period is convincingly shown. There is little information in the world and domestic medical literature on the use of allografts. There are no clear answers to many questions – what is the optimal time for vascular transplantation, how does the preservative medium affect the "viability" of the graft, what is the optimal shelf life of the graft, the indications and contraindications to the use of allografts have not been specified, the endothelium of the allograft has not been studied, it is not known will there be aneurysmal degeneration of the allograft and how it often occurs. These issues undoubtedly require further study.

CONCLUSION

Our modest experience with the use of allografts in surgery of the main arteries of the lower extremities shows that the use of freshly prepared allografts from a postmortem donor can be an effective method of reconstruction in patients with critical lower limb ischemia in the absence of a suitable autovein and the impossibility of using a synthetic prosthesis.

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