

## МЕТОДЫ УЛУЧШЕНИЯ РЕЗУЛЬТАТОВ ПРИМЕНЕНИЯ СИНТЕТИЧЕСКОГО ПРОТЕЗА В ПОДКОЛЕННО-БЕРЦОВОМ СЕГМЕНТЕ ПРИ КРИТИЧЕСКОЙ ИШЕМИИ КОНЕЧНОСТИ

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**Цель.** Провести анализ непосредственных и отдаленных результатов использования синтетического протеза при бедренно-дистально-подколенном и берцовом шунтировании у больных с критической ишемией нижних конечностей.

**Материалы и методы.** В университетской хирургической клинике на базе ГБУ ГКБ им. Д.Д. Плетнева г. Москвы в период 2009-2017 гг. оперированы пациенты (n=109) в стадии критической ишемии хронической артериальной недостаточности нижних конечностей. Им выполнялись бедренно-дистально-подколенное или бедренно-берцовое шунтирование с применением синтетического эксплантата из политетрафтоэтилена (ПТФЭ). У 33 пациентов (30,3%) было выполнено шунтирование синтетическим протезом, в 76 случаях (69,7%) использовалась комбинация эксплантата с участком аутовены, в т.ч. у 44 случаев (40,4%) синтетический протез + аутовена, в 32 (29,3%) с пластикой дистального анастомоза по типу заплаты или манжеты. У 14 (12,8%) пациентов обеих групп вмешательство дополнялась интраоперационной баллонной ангиопластикой артерий голени. Отдаленные результаты оценены в сроки до 5 лет после операции. При подсчете результатов использовался анализ выживаемости Каплана-Мейера.

**Результаты.** Кумулятивная 5-летняя проходимость синтетического протеза составила 42,9%. Однако, использование протеза в комбинации с участком аутовены в виде комбинированного шунта или пластики дистального анастомоза позволило значительно улучшить как кумулятивную проходимость (54,5%), так и сохранение конечности (83,6%).

**Выводы.** Полученные результаты позволяют рекомендовать при отсутствии полноценной аутовены использование синтетического протеза в комбинации с аутовенозной пластикой дистального анастомоза, либо комбинацию протеза с небольшим участком аутовены. Для улучшения отдаленных результатов необходимо регулярное наблюдение за такими шунтами в отдаленном периоде и своевременное выполнение повторных вмешательств.

**Ключевые слова:** хроническая артериальная недостаточность; перемежающаяся хромота; критическая ишемия; гибридная операция; заплата Линтона; заплата Невила; манжета Миллера; комбинированный шунт.



## METHODS FOR IMPROVING THE RESULTS OF USING A SYNTHETIC PROSTHESIS IN THE POPLITEAL-TIBIAL SEGMENT IN CRITICAL LIMB ISCHEMIA

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**Aim.** Analysis of immediate and long-term results of using a synthetic prosthesis for femoral-distal-popliteal and tibial bypass grafting in patients with critical lower limb ischemia.

**Materials and Methods.** Patients with symptoms of chronic arterial ischemia of the lower extremities in the stage of critical ischemia (n = 109) were operated at the university surgical clinic on the base of D.D. Pletnev City Clinical Hospital, Moscow, in the period from 2009 to 2017. All the patients underwent the operation of femoral-distal popliteal or femoral-tibial bypass grafting using a synthetic explant (PTFE). Shunting with a synthetic prosthesis was performed in 33 (30.3%) patients, and in 76 (69.7%) cases a combination of an explant with a section of autovein was used in the form of a combined shunt in 44 patients (40.4%) (synthetic prosthesis + autovein) or a patch- or cuff plasty of distal anastomosis in 32 patients (29.3%). In 14 (12.8%) patients of both groups, the intervention was supplemented by intraoperative balloon angioplasty of the lower leg arteries. Long-term results were evaluated within the period up to 5 years after surgery. Kaplan-Meier survival analysis was used for the calculation of results.

**Results.** The cumulative 5-year patency of the synthetic prosthesis was 42.9%. However, use of the prosthesis in combination with the autovein section in the form of a combined shunt or plastic surgery of the distal anastomosis significantly improved the values of cumulative patency (54.5%) and limb retention (83.6%).

**Conclusions.** The results obtained make it possible to recommend the use of a synthetic prosthesis in combination with an autovenous plastic surgery of a distal anastomosis or by combining a prosthesis with a small section of an autovein in the absence of a complete autovein. Regular monitoring of such shunts in the long-term period and timely follow-up interventions are necessary for improving long-term results.

**Keywords:** *chronic arterial insufficiency; intermittent claudication; critical ischemia; hybrid surgery; Linton patch; Nevil patch; Miller cuff; combined shunt.*

Obliterating atherosclerosis with occlusal-stenotic lesion of the arteries of the infrainguinal segment is a common cause of limb amputation [1]. Modern vascular surgery, including surgery of peripheral arteries, was enriched in recent decades with fundamentally new diagnostic and therapeutic methods, which has led to a serious reduction of disability and mortality. The most significant of the new range of methods are endovascular

treatment methods, especially for femoral-popliteal and tibial lesions [2].

However, the problem of critical lower limb ischemia remains important and requires a search for methods aimed at the possibility of direct revascularization of the shin arteries. According to TASCII, type C and D infrainguinal lesions (extended – more than 15 cm – stenoses or occlusions of the superficial femoral artery with involvement of the pop-

liteal artery with significant damage to the shin arteries) most often lead to critical ischemia. Here, it is possible to use endovascular treatment methods, but preference is given to «open» surgery. Most often, in treatment of such patients with critical ischemia, femoral-distal popliteal or femoral-tibial bypass grafting is performed.

Autovein is superior to any material in terms of the duration of transplant functioning [3]. However, a common situation is absence of the autovein in result of repeated reconstructions, varicose dilatation, use of the vein for coronary artery bypass grafting (CABG), etc. A forced use of a synthetic prosthesis in such cases leads to long-term results comparable to use of the autovein only in case of application of a distal anastomosis above the knee-joint cleft [4]. The use of a synthetic prosthesis for femoral-popliteal bypass surgery includes the risks of a significant impairment of the results of interventions both in terms of prosthetic patency and limb salvage [5].

Search for methods of improvement of the results of using synthetic prosthesis in patients with critical ischemia with the absence of the adequate autovein (use of the autovein for CABG, in lower extremity varicose vein disease or in repeated reconstructions), remains one of the main unsolved tasks in peripheral vascular surgery.

Recently in our clinics a relatively new method has been introduced – hybrid surgery. A hybrid operation is a reconstructive arterial operation that is performed in the endovascular stage in a «hybrid» operation room. This method of treatment is effective in multi-level lesion, when to provide adequate function of the bypass a single-step correction of the inflow or outflow pathways is required. In some cases, within the given study we performed femoral-distal-popliteal or femoral-tibial bypass with simultaneous angioplasty of the arteries of tibial or iliac segments.

Thus, the aim of the given study was evaluation of the results of the surgical treat-

ment of patients with atherosclerotic lesion of the femoral-popliteal and tibial segments in the early and long-term postoperative period with use of a synthetic prosthesis as a transplant.

### Materials and Methods

In the university surgical clinics on the base of D.D. Pletnev Moscow City Hospital in the period 2009-2017, 109 patients with obliterating atherosclerosis of the lower limbs in the stage of critical ischemia were operated on. In all patients, occlusion of the superficial femoral artery was combined with lesion of the popliteal artery, and in most cases with the arteries of shin. In all cases the bypass material was synthetic prostheses made of polytetrafluoroethylene (PTFE). The main reasons for impossibility to use autovein were: previous taking of the vein for different arterial reconstructions – 18 cases (16.5%), loose type of structure of the great saphenous vein and its small diameter (less than 3 mm) – 79 cases (72.5%) and past phlebectomy – 12 cases (11.0%).

Patients were divided to two comparison groups. The first group included 33 patients (30.3%). They were performed femoral-distal-popliteal bypass with use of a synthetic prosthesis. The second group included 76 patients (69.7%), in whom synthetic prosthesis was supplemented with plasty of the distal anastomosis with the autovenous cuff or patch (Miller cuff, Linton patch, Neville patch) or with a combination with a portion of autovein (the average length of the autovenous segment 7 cm) in the distal part of the reconstruction.

Among the cases of use of plasty of the distal anastomose the most common was reconstruction by Linton patch type. The method has the following stages: at first longitudinal arteriotomy of the popliteal artery of 4 cm length is performed. Then a small portion (3-4 cm) of the autovein is taken. The vein is longitudinally dissected and applied with the continuous suture as a patch into the artery after which venotomy (patchotomy) is performed to up to 2 cm length. Then distal anastomose is formed with the prosthesis (Figure 1).

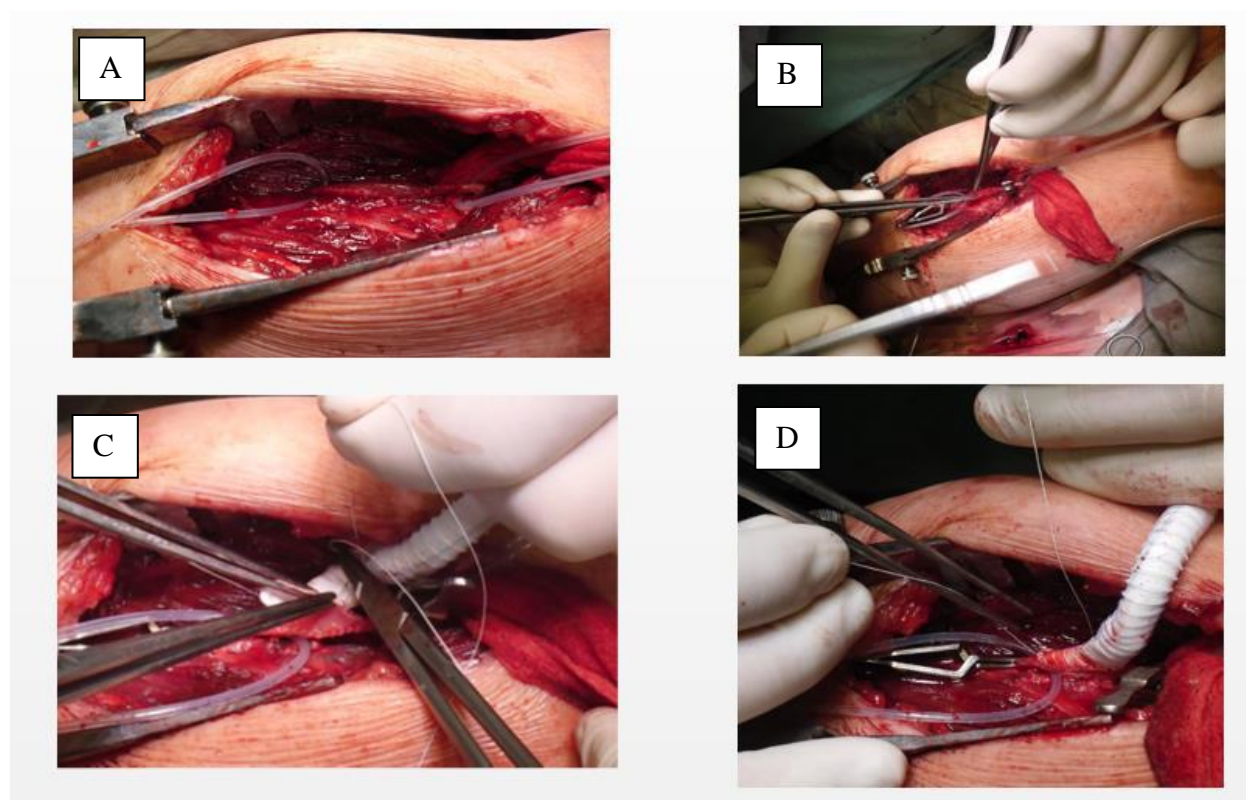


Fig. 1. Stages of formation of distal anastomosis of Linton patch type:

A – plasty of the artery with autovenous insert; B – patchotomy;  
C – anastomose between synthetic prosthesis and patch; D – completion of the anastomosis

The groups were comparable in the main statistical parameters. The average age of patients –  $71 \pm 2$  years, variations from 53 to 74 years. The leading comorbid disease was diabetes mellitus – 50 cases (45.9%).

In both groups a traditional algorithm for examination and medicinal treatment of patients with obliterating atherosclerosis of the lower limb arteries was used. The main methods of instrumental examination were ultrasound dopplerography (USDG) with stepwise measurement of ankle-brachial index (ABI), angiography.

In all patients included in this study, the type of lesion was evaluated according to the TASC classification [3]. So, in 79 individuals (72.5%), type C lesion was registered according to the TASCII classification, in 30 (27.5%) – type D in lesion to the femoral-popliteal segment. There were no differences

in clinical and demographic parameters between groups with different types of lesions (C and D).

In all the cases the peripheral resistance score was evaluated that was proposed by Rutherford in 1997. This permits to evaluate the extent of occlusal-stenotic lesion of the shin artery and its significance for bypass, to calculate the peripheral resistance score thus objectivizing this parameter. In the group of patients with isolated use of synthetic prosthesis, the following data were obtained: 1 point (the lowest) peripheral resistance was recorded in 8 (24.2%) patients, 2-8 points – in 21 (63.6%), 8-10 points – in 4 (12.1%). In patients with different kinds of plasty of the anastomose and with combined bypasses (II group) 1 point resistance was in 7 (9.2%) patients, 2-8 points – in 59 (77.6%) patients, 8-10 points – in 10 (13.1%) patients.

In some cases, 14 (12.8%), with a multi-level lesion, especially when the peripheral resistance in the shin arteries was  $> 8$ , we performed hybrid interventions. An important factor in the implementation of interventions was the technical feasibility – the availability of suitable conduits, balloon catheters, and a hybrid operating room. A typical scenario of a hybrid operation in our groups was as follows: in the conditions of a hybrid operating room, femoral-distal popliteal or femoral-tibial bypass grafting with plastic surgery of a distal anastomose or with use of the combined bypass technique is performed. Then, intraoperative angiography is performed and, in if it is necessary to correct the distal vascular bed, introducer is installed by puncture of the shunt or patch, and angioplasty of the shin arteries is performed with the functioning main bloodstream.

### Results and Discussion

Only in 25 (75.7%) out of 33 patients of the first group, reconstruction remained patent within the first month. In 17 (51.5%) patients the clinical status was +3, in 7 (21.2%) it was +2, in 9 (27.3%) it was +1. У 45 (77.5%) patients the reconstruction remained patent in the early postoperative period.

In the period from 1 to 10 days, in 13 patients thrombosis of anastomose was diagnosed. In 7 patients the patency of anastomose was restored by thrombectomy and repeated reconstruction. In one case the cause of thrombosis was a twist of the shunt in the channel, in the rest of the patients – a high peripheral resistance (8-12 points by Rutherford). In 2 patients peripheral resistance was evaluated 8 points, in 8 patients – 10 points. Only in one of

7 patients with restored magistral blood flow, a positive dynamics was preserved. In another patient amputation of the limb at the level of thigh was required.

The following postoperative complications were recorded: lymphorrhea in 6 (12.0%) patients; superficial infection of the wound in 1 (2.0%) patient; hemorrhages from the wound; diastasis of the wound in 8 (13.7%) patients; superficial diastasis of the wound in 9 (5.2%) patients; deep wound diastasis in 1 (2.0%) patient.

Systemic disorders occurred in one (2.0%) patient – acute myocardial infarction. No lethal outcomes were recorded.

Results of the early postoperative period in the second group were: within the first month in 64 (84.2%) of 76 patients the shunt remained passable. In 32 (50.0%) patients the clinical status improved +3. In 25 (39.1%) patients the clinical status was +2, and in 7 (10.9%) patients it was +1.

In 10 (13.1%) individuals in the period from 1 to 6 days thrombosis of the shunt was noted. All the patients underwent a repeated operation with thrombectomy from the shunt, or thrombectomy with repeated reconstruction. In six patients within 14 days rethrombosis of the shunt occurred. The cause of thrombosis was high peripheral resistance (8-12 points on Rutherford scale). In all the patients no amputation of the limb was required. In the early postoperative period the parameter of limb salvage was 100%.

Postoperative complications are presented in Table 1. There were no lethal outcomes in the early postoperative period.

Table 1

### Complications in Early Postoperative Period in Studied Groups

Complication	First Group	Second Group
n	33	76
Thrombosis of shunt, n (%)	13 (39.4%)	10 (13.2%)
Lymphorrhea, n (%)	6 (18.2%)	2 (2.6%)
Infection of wounds, n (%)	1 (3.0%)	2 (2.6%)
Hemorrhage from wounds, n (%)	8 (24.2%)	5 (6.6%)
Diastasis of wounds, n (%)	9 (27.3%)	10 (13.2%)
Myocardial infarction, n (%)	1 (3.0%)	0 (0%)
Exacerbation of chronic bronchitis, n (%)	0 (0%)	1 (1.3%)

Thus, the highest amount of thrombosis of shunt in the percentage ratio in the early postoperative period was seen in the first group (Table 1). Common events were postoperative bleedings, surface diastasis of wounds in the group with use of synthetic prosthesis without use of an autovein segment.

In the first group, in case of thrombosis (n=13), thrombectomy was effective in 8 patients in whom shunt thrombosis was associated with hemodynamic disorders and surgical error. In the remaining five cases, the repeated operation was ineffective due to the pronounced damage to the arteries of the shin and high peripheral resistance. One patient required limb amputation at the hip level due to the progression of necrobiotic alterations. In the second group, thrombectomy was effective in 7 out of 10 patients with shunt thrombosis. The causes of shunt thrombosis were similar.

In the first group the cumulative patency of shunt in the early postoperative period (up to 1 month) was 60.6%, in the second – 86.9%.

When analyzing the long-term results of both groups, it was found that most cases of shunt thromboses in both the first and second groups occurred in the first 12 months of observation. In the first group of patients, 19 cases (57.6%) of shunt thrombosis were recorded. In 14 of them, thrombectomy from the shunt was attempted, in half of the cases (n=7), thrombectomy was successful and was supplemented by three repeated reconstructions. Four limb amputations were performed with the underlying shunt thrombosis and ineffective thrombectomy. In three cases of thrombectomy from the shunt, the operation was supplemented with balloon angioplasty of the distal anastomosis and shin arteries, which led to the subsequent functioning of all five shunts with a minimum follow-up period of 1 year.

In the follow-up period of up to 1 year, on the basis of the results of repeated operations and sections of the limbs, critical stenosis of the distal anastomose was revealed in 8 out of 14 cases where it was the cause of thrombosis of reconstructions.

In 2 years of observations only one new thrombosis of the patent shunt was noted. This patent was successfully reoperated. In this period a primary amputation was made in one more patient that was operated earlier. The parameter of salvage of the limb by the second year of observation was 63.4%.

In 3 years 40 patients remained under observation. One patient died, and three patients left the study for different reasons. One thrombosis of the shunt was recorded without repeated interventions due to absence of events of acute or critical ischemia. Cumulative patency in the group within 3 years was 50.0%. The parameter of limb salvage was 62.5% ( $p<0.05$ ).

In 5 years 35 patients remained under observations. 3 Patients died, and two left the group. From the third to the fifth year of follow-up only two cases of the shunt thrombosis were noted. The cause was progression of atherosclerosis of the inflow and outflow pathways. Cumulative patency was 42.9%. In total during the whole five-year follow-up period 16 amputations were performed, the parameter of limb salvage in the first group of patients was 54.3%.

Cumulative patency of synthetic shunts in the first group was 48.5%. Thus, *the main share of thrombosis of shunts and amputations of limb occurred in the first year after the operation.*

In the second group of patients with use of a synthetic prosthesis in combination with an autovein, the most cases of shunt thrombosis were noted in up to one-year period. After 1 year of observation, results were obtained in 62 patients. Over the entire observation period, the shunt thrombosis was noted in 17 (22.4%) patients. The main cause of the shunt thrombosis was progression of atherosclerosis in the outflow tract. In 15 of 17 patients, successful repeated interventions were performed. In two cases, thrombectomy was combined with intraoperative balloon angioplasty of the shin arteries. Cumulative patency in the first year of observation was 77.4%. In 8

patients, amputations of the lower limbs were performed without attempts of revascularization due to the lack of satisfactory outflow pathways. The parameter of limb salvage after one year of observation was 87.1% ( $p < 0.05$ ).

In 2 years of observation the results of treatment are evaluated in 62 patients. Four new cases shunt thrombosis (6.4%) were noted. Two of them were successfully reported. In the other two cases limb amputations were performed.

In 3 years of observation 60 patients remained under observation. Three cases of thrombosis were recorded without repeated interventions in the absence of acute or critical ischemia. Cumulative patency in the group within a year was 68.3%. Limb salvage was achieved in 85.0%.

In 5 years 55 (72.4%) patients remained under observation. All in all, in 5 years there were 25 cases of thrombosis of the shunt. The main cause was progression of atherosclerosis of

the inflow or outflow pathways. Cumulative patency was 58.2%. In total in the 5-year period nine amputations were performed. Limb salvage in the first group of patients was 83.6% ( $p < 0.05$ ).

The cumulative patency and limb salvage of the two groups are shown in Figures 2 and 3.

A possibility for use of the autovenous plasty of distal anastomose in case of forced application of synthetic prosthesis in a patient with critical ischemia may be illustrated on the following example.

*Patient M.*, 70 years old, was operated on in D.D. Pletnev Moscow City Clinical Hospital in November 2012. He was troubled by pain in gastrocnemius muscle of the intermittent claudication type. In a short period of time the distance of painless walking reduced to 30 m. The patient *started to feel pain at rest*. Abuse of smoking in history. On admission to hospital, USDG of lower limbs was performed with determination of ABI (0.32).

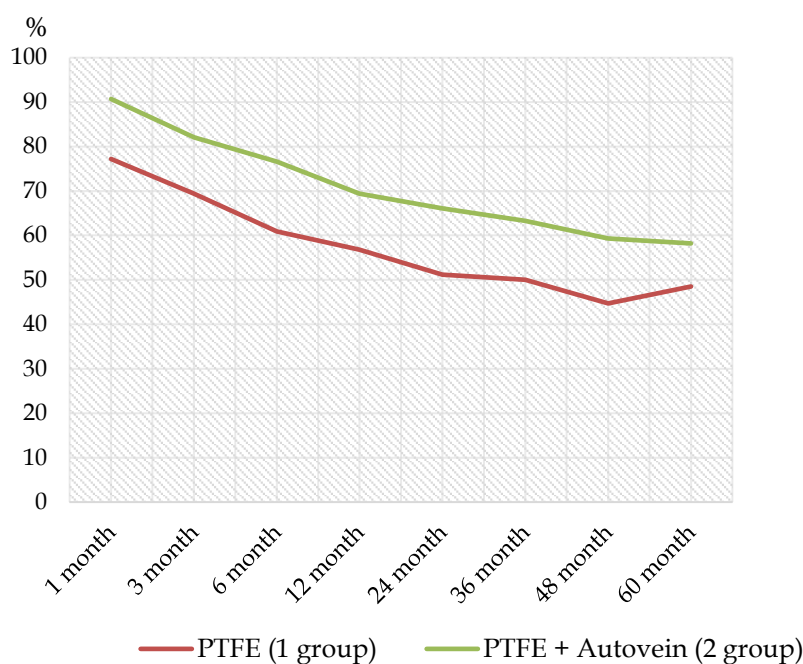


Fig. 2. Cumulative patency of synthetic prostheses in the studied groups within 60 months of observation

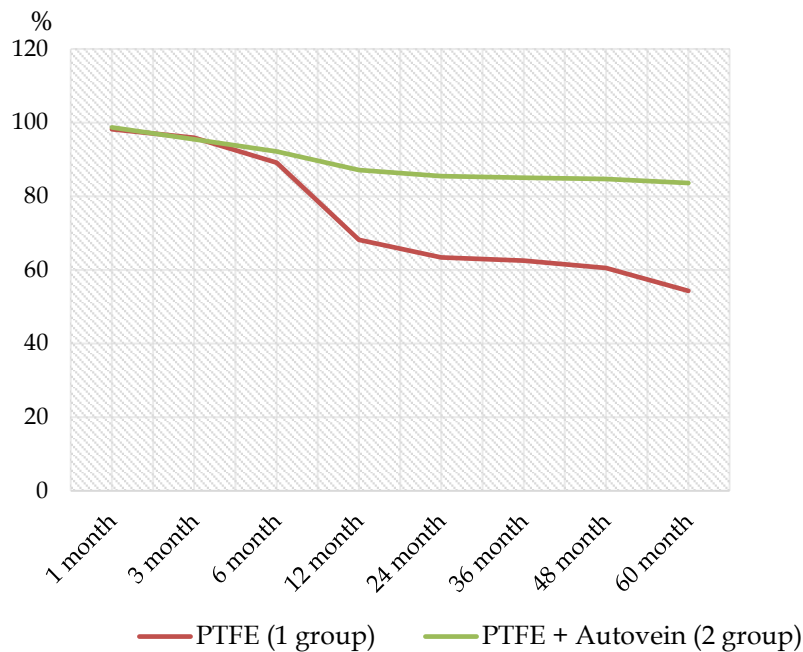


Fig. 3. Limb salvage in the studied groups within 60 months of observation



Fig. 4. Disorder in microcirculation of the left foot of patient M., 70 years old, in the form of pronounced paleness of skin in the horizontal position

In aortoarteriography, pronounced atherosclerotic alterations in the arteries of the infrainguinal segment were revealed. Mild stenosis of the common femoral artery up to 30%, occlusion of the superficial femoral artery from the orifice to the popliteal artery,

occlusion of the popliteal artery and critical stenosis of II segment of the popliteal artery were visualized. Significant (60%) stenosis of the posterior tibial artery was identified. Stenosis of the arteries of the shin. The arterial arch of the foot preserved (Figure 5).



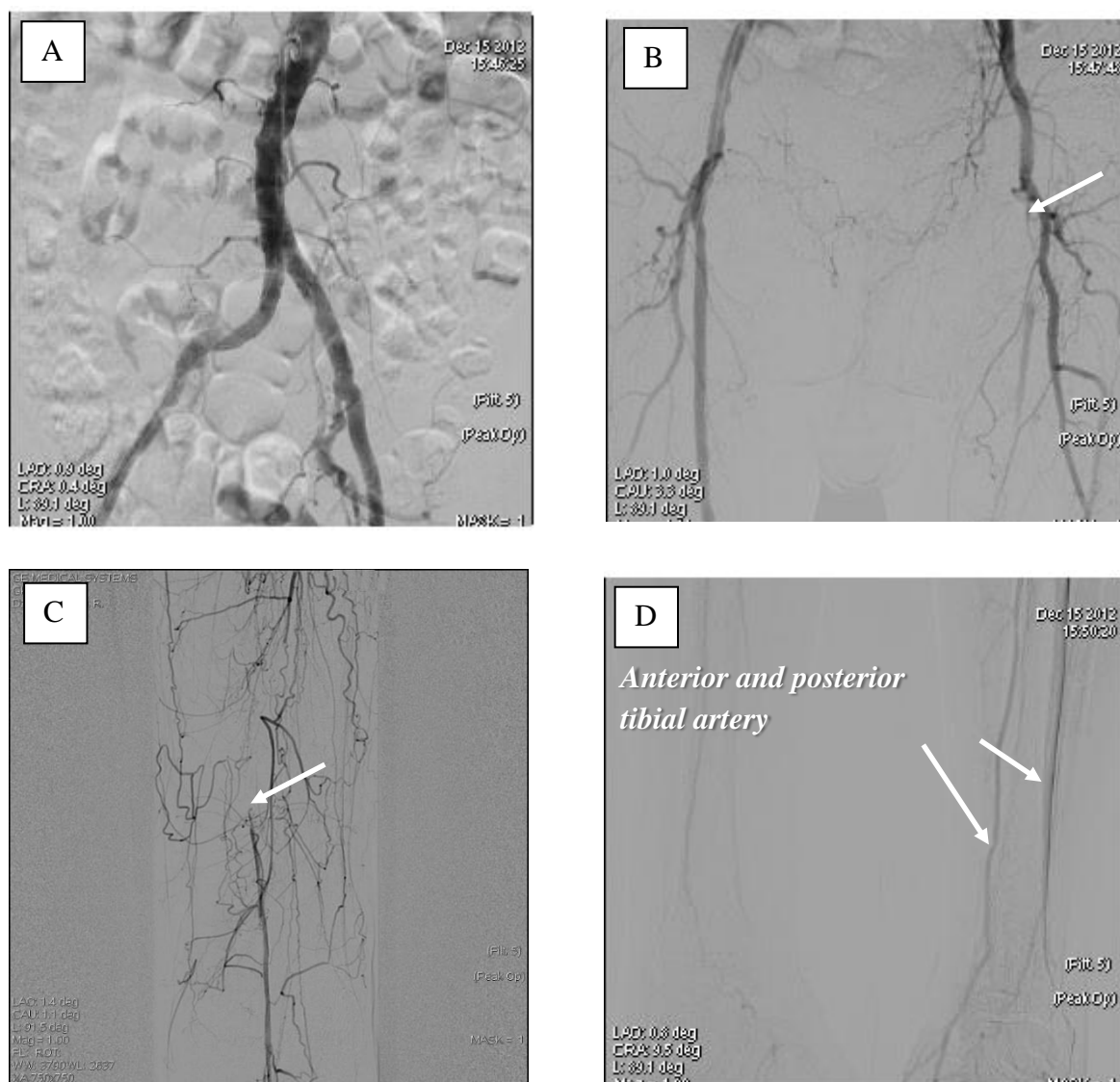


Fig. 5. Angiograms of patient M., 70 years old: A – aorto-iliac segment, without hemodynamically significant stenosis; B – occlusion of the superficial femoral artery (shown by arrow); C – hemodynamically significant stenosis of the popliteal artery (shown by arrow); D – shin arteries (shown by arrow), distal peripheral resistance evaluated as 3 points

Duplex scanning confirmed the main occlusal-stenotic lesions of the arteries of the limb, revealed the unsuitability of the large and small saphenous veins of both lower limbs as a graft for shunting. The diameter of the large saphenous vein in the upper third of both thighs was 2.5 mm, then a loose type of structure, the small saphenous vein with the diameter of <2.5 mm were revealed.

Taking into account the absence of the

autovein of satisfactory diameter for use as a shunt, a decision was taken to perform general femoral-popliteal bypass surgery with a synthetic prosthesis through a patch by Neville method.

Arteriotomy was performed of 3.5 cm length followed by plasty with a portion of autovein of patch type, due to which the diameter of the artery was increased and tissue mismatch between the prosthesis and the artery was reduced (Figure 6).

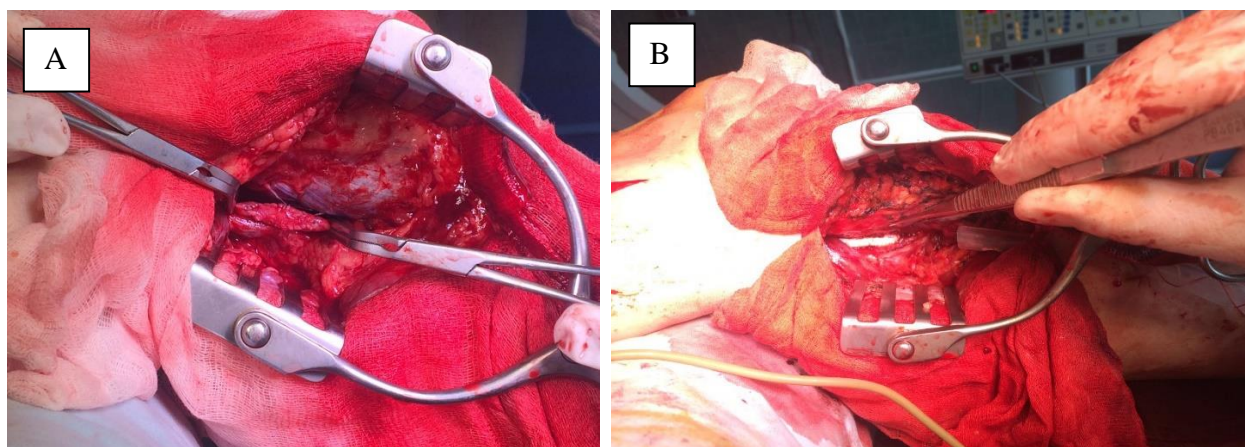


Рис. 6. Этапы оперативного вмешательства у больного М., 70 лет:  
А – формирование заплаты на широкую артериотомию; Б – сформирован анастомоз по типу конец в бок между заплатой и протезом

The next step was the patchtomy of 2/3 of the proximal patch to create the «cuff» shape which created the zone of turbulent flow of blood inside the anastomose. This accelerates the blood flow velocity in the area of the «cape» of the anastomosis, which inhibits the processes of neointimal hyperplasia. Then end-to-side anastomosis was performed between the autovenous patch and synthetic prosthesis. After formation of a distal anastomose, the prosthesis was introduced into the proximal wound. End-to-end anastomose was applied between the synthetic prosthesis and the femoral artery. After the start of blood flow, pulsation of the arteries of the foot began to be determined.

In the early postoperative period, there were no local and systemic complications. The wounds healed by primary intention. Critical ischemia regressed in the early postoperative period. The patient was observed outpatiently in the consultative diagnostic department of the hospital. The patient followed the recommendations and took double antiplatelet therapy according to the scheme: clopidogrel 75 mg once a day + acetylsalicylic acid 75 mg once a day.

In a year after the operation, in hospitalization of the patient a significant stenosis

(70%) of popliteal artery was diagnosed on aortoarteriography distal to anastomose. Clinically it was manifested by shortening of the distance of painless walking to 150 m and by weakening of pulsation on the rear surface of the foot. Balloon angioplasty was performed with a good angiographic result. The distance of painless walking was restored to more than 200 m. In the control duplex scanning conducted after 6 months, no significant stenosis was seen.

The given clinical example demonstrates surgical tactics in case of absence of a suitable autovein for reconstructive operation. The necessity for regular clinical outpatient follow-up of the reconstruction zones and outflow arteries is shown.

Thus, in necessity to use a synthetic prosthesis for femoral-popliteal and femoral-tibial bypass surgery, it is reasonable to supplement the operation with autovenous plasty of the distal anastomose or use the combined shunt technique. This approach can significantly improve the results of patency of the synthetic prosthesis in the long term. According to our data, the sphere of positive influence of these techniques is the observation period from 6 months to 1 year, when some patients of the 1<sup>st</sup> group developed

thrombosis, half of which was due to the phenomena of neointimal hyperplasia in the zone of distal anastomosis.

The fact is known that direct revascularization is always associated with damage to the endothelium. This is because arteriotomy is inevitable in application of anastomosis. The impression is that the endothelium «tries» to reduce the conflict between tissues through proliferation of intima. The lumen of anastomosis inevitably changes with remodulation of the blood flow in the lumen of the artery [6,7].

Since there is a significant difference between the tissues of the artery and prosthesis, epithelization of the arterial wall remains incomplete. Therefore, the most significant thickening of neointima of anastomose is predominantly observed in anastomoses between the synthetic prosthesis and artery, and not between the artery and the autovein [8].

There is no significant difference between duration of the functioning of the autovein and the synthetic prosthesis in the early postoperative period. Probably, this is due to the fact that the causes of shunt thrombosis are technical errors of the operation. These often include changes in the geometry of the shunt, compression of the prosthesis, twisting of the intima, incorrect surgical tactics [9].

In the period from 6 to 24 months the cause of thrombosis of the shunt is evident neointimal hyperplasia of the distal anastomose. It gradually reduces its lumen leading to thrombosis. This is the main cause of thrombosis in the group of patients with use of an isolated synthetic prosthesis. In later periods the cause of thrombosis of the shunt was progression of the disease in the inflow and outflow pathways [10].

A high peripheral resistance created by a pronounced atherosclerotic lesion of the shin arteries, considerably reduces the chances for a technical success of the operation. This many-year problem stimulated surgeons to introduce and develop hybrid surgery. It combines traditional vascular surgery and

endovascular methods. This approach is especially reasonable in case of multilevel damages. Endovascular interventions permit to effectively eliminate single stenoses of the outflow or inflow pathways. Hybrid operations were described by J.M. Porter in the 80s. In Russia, the pioneer works in this direction were published by I.I. Zatevakhin, et al. (1999) [11] and A.V. Troitsky, et al. (2005) [12].

The whole operation is performed in the operation room equipped with modern X-ray apparatus. Endovascular stage is often performed before launching the blood flow through the incomplete anastomose. Angioplasty of the tibial segment after starting the blood flow through the puncture of shunt is also possible [13-15]. Thus, traditional «open» revascularization of the femoral-popliteal segment remains the most important treatment method especially in critical ischemia.

Not less significant stage of treatment is postoperative control and observation of the operated patients. Regular duplex scanning of the lower limb arteries and reconstruction zones in one, three, six and twelve months after the operation and then after a year, permits to diagnose hemodynamically significant stenosis of anastomoses and significant stenosis in the inflow and outflow pathways. It becomes possible to use preventive operations.

Thus, in identification of hemodynamically significant stenosis in the reconstruction zone or in the inflow or outflow pathways, a planned hospitalization to department of vascular surgery is indicated with implementation of aortoarteriography. In significant stenosis of the iliac arteries, stenting of iliac arteries is indicated. In case of significant stenosis in the anastomoses of the prosthesis, peripheral resistance is evaluated. In case of satisfactory peripheral resistance, reconstructive operation is performed, if peripheral resistance is high, reconstructive surgery with balloon angioplasty of shin arteries or with unloading arteriovenous fistula is conducted.

### Conclusion

Thus, «open» revascularizations present many unsolved tasks. One of them is a problem of long-term results with use of synthetic prostheses. It is associated with the fact of a steady progression of atherogenesis in the inflow and outflow pathways, besides, a mechanism of intimal hyperplasia is triggered which inevitably leads to stenosis and occlusion of the shunt. These problems stimulated us to search for the ways of improving the results of surgical treatment of the given group

of patients.

The results of the given work permit to recommend use of synthetic prosthesis in a combination with autovenous plasty of distal anastomosis, or a combination of the prosthesis with a small portion of the autovein in case of the absence of a good autovein. To improve the long-term results, regular observation of such shunts is required in the long-term period and timely implementation of repeated interventions.

### Литература

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