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ENDOVASCULAR ANGIOPLASTY FOR REPEATED REVASCULARIZATION OF THE ARTERIAL BED IN PATIENTS WITH RECURRENT CHRONIC ARTERIAL INSUFFICIENCY

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Summary

Aim. To improve the results of repeated reconstruction of the great vessels in case of relapse of chronic arterial insufficiency by differentiated use of popliteal tibial autovenous bypass grafting and endovascular angioplasty for revascularization of the arteries of the leg.
Materials and methods. The long-term results of surgical treatment of 522 patients were examined, including 353 patients with bilateral atherosclerotic occlusion of the aortic-femoral zone and 159 patients with unilateral occlusion of the ileo-femoral segment. At the primary surgical intervention, 98 patients were diagnosed with chronic arterial insufficiency (CAI) of stage II B, in 228 – CAI of stage III, in 196 – chronic critical ischemia of the lower extremities, stage III-IV. In the long-term postoperative period, 146 (27.97 %) late complications were diagnosed, of which 78 (56.1 %) had a relapse of chronic arterial insufficiency. In 36 patients, CAI stage II B was established, and in 42 – CAI stage III. Patients were re-operated in the period of 5.4 ± 1.9 years after primary revascularization. All men were 64.4 ± 3.1 years old.
Results. The multilevel atherosclerotic lesions of the reconstructed arterial bed, cicatricial changes after the initial surgical intervention, progressive atherosclerotic lesions of the outflow tract required multi-story shunting operations. The success of shunting surgery depends on sufficient revascularization of the outflow paths – the arterial bed of the ankle segment. Revascularization of the distal arterial bed was achieved using popliteal-tibial autovenous bypass grafting (19 cases) and endovascular angioplasty (30 observations). To reduce peripheral vascular resistance and increase the volume of the peripheral vascular bed in 19 (63.3 %) cases, endovascular balloon angioplasty of two tibial arteries was performed simultaneously. The postoperative period in 10 (12.8 %) patients was complicated by the development of thrombosis of the reconstruction segment. In 7 cases, thrombosis of the reconstruction segment was eliminated. The using of popliteal-tibial autogenous bypass grafting and endovascular angioplasty during revascularization of the ankle segment provided satisfactory results in repeated reconstructive operations in 87.2 % of cases.
Conclusions. For the revascularization of the lower leg arteries, the use of popliteal autovenous shunting and endovascular angioplasty provides 87.2 % satisfactory results in repeated reconstructive operations for chronic arterial insufficiency relapse.

Keywords: **endovascular angioplasty, chronic arterial insufficiency, revascularization**

INTRODUCTION

Impairment of the patency on reconstructed arteries in the long-term postoperative period remains at a high level [1]. The main reason for the development of this complication is the progression of non-coronary atherosclerotic process [8].

Multi-level atherosclerotic lesions of the reconstructed arterial bed, the presence of a scar and its changes after primary surgery, progressive atherosclerotic damage to the outflow tract (tibial arterial segment) create technical difficulties during repeated revascularization [4]. Thus, bypass surgical interventions for occlusion of the femoral segment

and stenotic-occlusive lesions of the popliteal tibial arteries do not bring a positive result in a number of observations [7, 8]. Perhaps popliteal-tibial autovenous shunting as part of multi-level shunting operations is a provoking factor for thrombosis of the reconstruction zone, or such shunting, for some reason, cannot provide adequate blood flow in the reconstruction zone [2, 3]. The use of endovascular angioplasty of the tibial segment in case of multilevel reconstruction of the arterial bed will make it possible to prevent the development of a number of complications [5].

AIM

To improve the results of repeated reconstruction of the major vessels in case of relapse of chronic arterial insufficiency with the help of differentiated use of popliteal-tibial autovenous bypass and endovascular angioplasty for revascularization of the arteries of the lower limbs.

MATERIALS AND METHODS

Long-term results of surgical treatment of 522 patients with obliterating atherosclerosis of the aorta and major arteries of the lower limbs were monitored in period from 2006 to 2019. The sample included 353 operated patients with bilateral atherosclerotic occlusion of the aorto-femoral zone and 159 operated patients with unilateral atherosclerotic occlusion of the iliofemoral segment. In 354 (67.8 %) of them, there was blood flow disturbance in the distal zone of the femoral artery.

During primary surgery, 98 patients were diagnosed with stage II B of chronic arterial insufficiency (CAI). (According to the classification of Fontaine R. taking into account the criteria of the European Working Group (1992), in 228 – CAI of III A stage, and in 196 cases – CAI of III B-IV stage. In the long-term postoperative period, 146 (27.97 %) late complications were diagnosed, of which 78 (56.1 %) had a relapse of chronic arterial insufficiency. Stage II B of CAI was established in 36 patients, and stage III A of CAI in 42 patients. All patients were men in 100 % with an average age of 64.4 ± 3.1 years, were re-operated in 5.4 ± 1.9 years after the initial surgery.

Three groups of patients were identified. The distribution was based on the prevalence of atherosclerotic lesions of the arterial bed and the volume of its primary reconstruction. Group I (22 patients under observation) whose primary surgery was reconstruction of the aorto\iliofemoral zone in the absence of hemodynamically significant atherosclerotic lesions of the infrainguinal arterial bed. Group II included 43 patients whose primary operation was reconstruction of the aorto\iliofemoral zone in conditions of stenotic-occlusive lesions of the femoral-distal segment. Group III (13 cases) and reconstruction of the aorto\ilio-femoral zone supplemented with autovenous femoral-distal bypass as primary operation.

The timing of the formation of CAI relapse is influenced by the initial state of the major bed and the volume of reconstructive intervention. Thus, the period of CAI recurrence in patients with multilevel reconstruction of the arterial bed is 2.8 years shorter than in patients without disruption of blood flow along the distal zone of the femoral artery and revascularization of only the aorto\ilio-femoral zone.

Operated patients with progression of the atherosclerotic process are characterized by the identification of targets with more intense development of atherosclerotic lesions of the arterial bed. These include of the trauma of segments of arterial bed (anastomoses and endarterectomy areas) and the tibial arterial zone. In connection with the above results, we can say that the progression of the atherosclerotic process more often affected the area of the distal anastomosis of the aorto\ilio-femoral shunt – in 36 (46.2 %) cases, the femoral-popliteal segment – in 49 (62.8 %) cases, segment of the femoral-distal autovenous shunt – in 13 (15.8 %) patients, tibial arterial bed – in 51 (65.4 %) cases. The combination of segments of intense damage by the atherosclerotic process contributed to the accelerated development of chronic arterial insufficiency relapse and required multi-level revascularization of the arterial bed. To ensure the functioning of femoral-distal bypass operations, we used surgical interventions for revascularization of arterial segments of lower limb including popliteal-tibial autovenous bypass and endovascular angioplasty.

RESULTS

78 patients underwent repeated revascularization, of which the relapse of chronic arterial insufficiency in 36 patients was stage II B, and in 42 – stage III A. Repeated reconstruction of the main bed was carried out with taking into account the characteristics of the primary surgical intervention, the localization of the stenotic-occlusive process, its prevalence and its combination with other segments of the arterial bed.

In case of critical stenosis of the distal part of aorto\iliofemoral shunt anastomosis that combined with stenosis of the entry of the deep femoral artery (DFA) (55-70 %) (36 cases), widespread occlusion of the superficial femoral artery (SFA) and popliteal artery (PA) (18 observations), occlusion of the distal part of femoral autovenous shunt (4 observations) and the stenotic-occlusive process of the tibial arteries (25 observations) we carried out complete resection of the distal anastomosis in 7 cases, and in 29 they limited themselves to its exclusion without complete isolation, followed by distal zone of femoral aloshuntation. During allobypass surgery, the proximal anastomosis was formed in the area of the distal anastomosis of the aorto/ilio-femoral allograft, and the distal part was formed with the popliteal artery. In 21 cases, the distal 1/4 segment of

the femoral-distal shunt was replaced with an autovenous vein. In all cases, we formed an anastomosis of the DFA orifice with a distal part of femoral aloshunt. In 9 cases, we performed popliteal-posterior tibial (PPT) autovenous shunting and in one case, popliteal-anterior tibial (PAT) autovenous bypass surgery. In 14 cases, endovascular balloon angioplasty of the tibial arteries was performed (in 9 cases – 2 arteries of the leg, in 3 cases – endovascular balloon angioplasty of the PAT, in 2 cases – endovascular balloon angioplasty of the tibioperineal trunk).

In a patient with a false aneurysm of the distal anastomosis of the aorto/iliofemoral graft and occlusion of the femoral-distal autovenous shunt, we performed a complete resection of the aorto/iliofemoral distal anastomosis graft aneurysm and the orifice of the DFA was also cut off. During alloprotesis bypass, we formed the proximal an end-to-end anastomosis with the distal segment of the aorto/iliofemoral alloprosthesis, and the distal anastomosis was sutured to the end of the PA alloprosthesis. The distal 1/4 segment of the realoshunt was replaced with an autovein. Restoration of blood circulation through the deep femoral artery was carried out by suturing its orifice into a realoshunt.

In case of widespread occlusion of the SFA and occlusion of the PA (28 cases) in combination with an occlusive-stenotic process of the tibial arteries (23 observations), femoral-distal shunting (23 cases) and autovenous shunting (5 observations) were performed. In these surgical interventions, we formed a proximal anastomosis with a distal anastomosis of the aorto/iliofemoral aloprosthesis and a distal anastomosis at the level of the PA. In all cases, before the formation of the distal anastomosis of the distal femoral shunt, its distal segment was replaced with an autovenous vein and then we performed endarterectomy of the PA. In 5 cases we performed PPT autovenous shunting, in one case we performed PAT) autovenous bypass surgery. In 13 cases, endovascular balloon angioplasty of the tibial arteries was performed, of which in 8 cases 2 arteries of the shin were operated on, in 2 cases – the tibioperineal trunk, in 2 cases – the PTA and in 1 case – the PAT.

In case of occlusion of the femoral-distal autovenous shunt and stenotic-occlusive process of the tibial arteries (8 cases), we performed femoral-distal reautovenous shunting (2 cases), realoshunting (3 cases), thrombectomy from the autovenous shunt and restoration of anastomotic function (3 observations). The above surgical interventions were supplemented: in 1 case, PPT with autovenous shunting, in 2 cases, PAT autovenous shunting, in 3 cases, endovascular balloon angioplasty of the tibial arteries (in 2 cases, endovascular balloon angioplasty of two arteries of the shin, in one case, the tibioperineal trunk). In 2 cases, it was not possible to perform revascularization surgery of the tibial arteries, so therefore we performed revascularizing osteotrepanation of the tibia.

DISCUSSION

The aggressiveness of the atherosclerotic process is the main reason for the formation of relapse of chronic arterial insufficiency in patients. The targets of intense damage by the atherosclerotic process include places of trauma to the arterial bed (anastomoses, endarterectomy zone) (5) and the tibial arterial bed (6). In connection with the above, a significant prevalence of atherosclerotic lesions of arterial segments was observed in patients who had previously undergone multilevel revascularization of the main arterial bed. Such patients were characterized by a shortening of the period of formation the relapse of chronic arterial insufficiency by almost 2.8 years.

Multilevel atherosclerotic lesions of the reconstructed arterial bed of the lower limbs, scar changes after primary surgery, and progressive atherosclerotic lesions of the outflow tract (tibial arterial segment) create technical difficulties during repeated revascularization. The most common surgical interventions of these conditions are bypass surgery, which can involve multiple arterial segments, and revascularization of the tibial arterial bed. At the same time, the success of bypass surgical interventions is directly dependent on sufficient revascularization of the outflow tract – the arterial bed of the shin. The last one was achieved by using popliteal-tibial autovenous shunting and endovascular balloon angioplasty. We performed 19 popliteal-tibial autovenous bypasses, of which 15 were PPT autovenous bypasses and 4 PAT autovenous bypasses. In 8 of 19 popliteal-tibial autovenous bypass graftings, the distal anastomosis was formed with the posterior tibial artery at the level of the medial malleolus. To create optimal conditions for the functioning of the distal anastomosis, to prevent its stenosis in 3 cases during the formation of the distal anastomosis, the distal segment of the autovenous shunt was sutured with the formation of the orifice of the PTA and the same vein behind the medial malleolus. In 5 cases, the formation of a distal anastomosis was performed by anastomosing the distal segment of an autovenous shunt with a fistula which was formed from the PTA and the same vein behind the medial malleolus.

During revascularization of the ankle arterial bed, 30 endovascular angioplasties were performed, which amounted to 58.8 % of the total number of revascularization surgical interventions for stenotic-occlusive process of the tibial arteries. In order to reduce peripheral vascular resistance and increase the volume of the peripheral vascular bed, endovascular balloon angioplasty of two tibial arteries was performed simultaneously in 19 (63.3 %) cases.

The postoperative period of 8 (10.3 %) patients was complicated by the development of thrombosis of the reconstruction segment. Of these, in 6 cases we diagnosed thrombosis of the reconstruction segment, in 5 patients with popliteus-tibial autovenous bypass, and in one patient with endovascular angioplasty.

Out of 8 observations, in 7 cases of the reconstruction segment thrombosis the restoration of blood flow in the arteries of the shin was achieved.

We obtained satisfactory results of surgical treatment with repeated revascularization of the great arteries in conditions of relapse of chronic arterial insufficiency in 87.2 % of cases. In 2 (2.6 %) cases in which distal femoral bypass grafting was supplemented with revascularizing osteotrepanation of the tibia, a reduction in the manifestation of chronic arterial insufficiency could not be achieved.

CONCLUSIONS

The use of popliteal-tibial autovenous bypass and endovascular angioplasty for revascularization of the arteries of the leg provides 87.2 % satisfactory results of repeated reconstructive operations for relapse of chronic arterial insufficiency.

Prospects for further research. The issue of early diagnosis of postoperative complications is quite relevant for patients after reconstructive vascular operations, since due to the large number of comorbid conditions, it can lead to a significant deterioration in the quality of life. Therefore, this topic requires further research in order to reduce the number of complications.

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COMPLIANCE WITH ETHICAL REQUIREMENTS

The research was conducted by the fundamental principles outlined in the «Rules of Ethical Principles for Conducting Medical Research Involving Human Subjects», as stated in the Helsinki Declaration (1964-2013).

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Резюме

ЕНДОВАСКУЛЯРНА АНГІОПЛАСТИКА ПРИ ПОВТОРНІЙ РЕВАСКУЛЯРИЗАЦІЇ АРТЕРІАЛЬНОГО РУСЛА У ХВОРИХ З РЕЦИДИВОМ ХРОНІЧНОЇ АРТЕРІАЛЬНОЇ НЕДОСТАТНОСТІ

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Мета. Покращити результати повторної реконструкції магістральних судин при рецидиві хронічної артеріальної недостатності шляхом диференційованого застосування для реваскуляризації артерій гомілки підколінно-гомілкового аутовенозного шунтування та ендоваскулярної ангіопластики.
Матеріали та методи. Обстежені протягом 2006-2019 років. Віддалені результати хірургічного лікування 522 пацієнтів, з них 353 пацієнтів з двосторонньою атеросклеротичною оклюзією аорто-стегнової зони та 159 хворих з одностороннім оклюзійним процесом клубового сегмента. При первинному хірургічному втручанні у 98 пацієнтів діагностовано ХАН II Б ст. (за класифікацією Fontaine R. з урахуванням критеріїв Європейської робочої групи (1992)), у 228 – ХАН III ст., у 196 – хронічна критична ішемія нижніх кінцівок III-IV ст. Хворі повторно оперовані через 5,4±1,9 років після первинної реваскуляризації. Усі чоловіки віком 64,4±3,1 років.
Результати дослідження та обговорення. Багаторівневість атеросклеротичного ураження реконструйованого артеріального русла, рубцеві зміни після первинного оперативного втручання, прогресуюче атеросклеротичне ураження шляхів відтоку вимагали проведення багатоповерхових шунтуючих операцій. Успішність при таких оперативних утручаннях, як шунтування, знаходиться в прямій залежності від достатньої реваскуляризації шляхів відтоку – артеріального русла гомілковостопного сегмента. Остання досягалася застосуванням підколінно-гомілкового аутовенозного шунтування (19 випадків) та ендоваскулярної ангіопластики (30 спостережень). Для зниження периферичного судинного опору та збільшення обсягу периферичного судинного русла у 19 (63,3 %) спостережень проводили одночасно ендоваскулярну балонну ангіопластику двох гомілкових артерій. Післяопераційний період у 8 (10,3 %) пацієнтів ускладнився розвитком тромбозу сегменту реконструкції. У 5 спостереженнях удалося ліквідувати тромбоз сегмента реконструкції. Використання при ревакуляризації артерій гомілки підколінно-гомілкового аутовенозного шунтування та ендоваскулярної ангіопластики забезпечило у 87,2 % спостережень задовільні результати повторних реконструктивних операцій.
Висновки. Для реваскуляризації артерій гомілки використання підколінно-гомілкового аутовенозного шунтування та ендоваскулярної ангіопластики забезпечують отримання 87,2 % задовільних результатів при повторних реконструктивних операціях щодо рецидиву хронічної артеріальної недостатності.

Ключові слова: **ендоваскулярна ангіопластика, хронічна артеріальна недостатність, реваскуляризація**