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**Khanchi Mead**  
[orcid.org/0000-0002-9372-4707](https://orcid.org/0000-0002-9372-4707)

**Matkerimov A.Zh.**  
[orcid.org/0000-0001-8492-2958](https://orcid.org/0000-0001-8492-2958)

**Tergeussizov A.S.**  
[orcid.org/0000-0002-5069-4034](https://orcid.org/0000-0002-5069-4034)

**Demeuov T.N.**  
[orcid.org/0000-0002-5897-2967](https://orcid.org/0000-0002-5897-2967)

**Baubekov A.A.**  
[orcid.org/0000-0001-7197-4871](https://orcid.org/0000-0001-7197-4871)

**Zhakubayev M.A.**  
[orcid.org/0000-0002-0376-3172](https://orcid.org/0000-0002-0376-3172)

**Tajibayev T.K.**  
[orcid.org/0000-0002-9007-063X](https://orcid.org/0000-0002-9007-063X)

**Khanchi M.M.**  
[orcid.org/0000-0002-0229-3770](https://orcid.org/0000-0002-0229-3770)

**Shamshiev A.S.**  
[orcid.org/0000-0001-5868-057X](https://orcid.org/0000-0001-5868-057X)

**Corresponding author:**

**Khanchi Mead** – vascular surgeon,  
 "A.N. Syzganov National Scientific  
 Center for Surgery" JSC, Almaty,  
 Kazakhstan.  
 E-mail: [miad01@mail.ru](mailto:miad01@mail.ru)

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The authors declare that they have no  
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# SURGICAL TREATMENT OF ARTERIAL ANEURYSMS OF THE LOWER LIMB

**Khanchi Mead, Matkerimov A.Zh, Tergeussizov A.S.,  
 Demeuov T.N., Baubekov A.A., Zhakubayev M.A.,  
 Tajibayev T.K., Khanchi M.M., Shamshiev A.S.**

JSC «A.N. Syzganov National Scientific Center for Surgery», Almaty, Kazakhstan

**Abstract**

Peripheral artery aneurysms are dangerous with possible complications such as ruptures, bleeding, thromboembolism in the distal bed with subsequent tissue ischemia, neurological disorders due to pressure of closely located nerve trunks.

One of the most common causes of peripheral artery aneurysms is trauma. Special attention should be paid to a significant increase in the number of iatrogenic injuries. From 2000 to 2019, 46 patients were operated on the arteries of the lower extremities. Operations of various types of reconstructions were performed. The total age of the patients ranged from 30 to 76 years, the average age of the patients was  $43.3 \pm 6.5$  years.

A total of 6 (9.2%) patients were operated on with combined aneurysmal lesion of the femoral and popliteal arteries. In the postoperative period, 91.5% of patients with peripheral artery aneurysm had positive clinical results. 4 (8.5%) developed complications. Long-term results were tracked in the period from 3 months to 3 years. A clinical examination was performed, supplemented by ultrasound control. 2 cases of thrombosis in the distal anastomosis were identified, which were restored after reconstruction of the distal anastomosis.

Objective: to improve the diagnosis and results of surgical treatment of patients with lower limb arteries.

## Аяқ артерияларының аневризмасын хирургиялық емдеу

**Хат алысатын автор:**

**Ханчи Миад** – дәрігер-  
 ангиохирург, «А.Н. Сызғанов  
 атындағы Ұлттық ғылыми хирургия  
 орталығы» АҚ, Алматы қ., Қазақстан.  
 E-mail: [miad01@mail.ru](mailto:miad01@mail.ru)

**Мүдделер қақтығысы**

Авторлар мүдделер қақтығысының  
 жоқтығын мәлімдейді

**Түйін сөздер**

перифериялық артерия  
 аневризмасын хирургиялық  
 емдеу, жалпы сан  
 артериясының аневризмасы,  
 тізеасты артериясы, аяқ  
 артериясының аневризмасы  
 бар науқастарды  
 диагностикалау және  
 хирургиялық емдеу нәтижелері

**Ханчи Миад, Маткеримов А.Ж., Тергеусизов А.С., Демеуов Т.Н., Баубеков А.А.,  
 Жакубаев М.А., Тажибаяев Т.К., Ханчи М.М., Шамшиев А.С.**

«А.Н. Сызғанов атындағы Ұлттық ғылыми хирургия орталығы» АҚ, Алматы қ., Қазақстан

**Аңдатпа**

Перифериялық артериялардың аневризмасы жарылулар, қан кетулер, кейіннен ишемия орын алуы мүмкін тіндердің дисталды өзегінің тромбозымен, неврологиялық бұзылыстар, жақын орналасқан жүйке діңдерінің қысымының салдары секілді ықтимал асқынуларымен қауіпті.

Жарақаттар – перифериялық артериялар аневризмасының ең жиі тараған себептерінің бірі. Ятрогенді жарақаттар санының едәуір өсуіне ерекше назар аудару қажет. 2000-2019 жылдар аралығында 46 науқастың аяқ артериясына ота жасалды. Реконструктивті оталардың алуан түрлері орындалды. Науқастардың жалпы жасы 30-70 жас аралығын құрады, науқастардың орташа жасы  $43,3 \pm 6,5$  жасты құрады.

Сан және тізеасты артерияларының жанамалас аневризмалық зақымдалуы бар барлық науқастардың 6-на (9,2%) ота жасалды. Отадан кейінгі жақын кезеңде перифериялық артериялардың аневризмасы бар науқастардың 91,5%-ында оң клиникалық нәтижелер анықталды. 4 (8,5%) науқаста асқынулардың дамуы байқалды. Ұзақ мерзімді нәтижелер 3 айдан 3 жылға дейінгі мерзімде бақыланды. Ультрадыбыстық бақылаумен толықтырылған клиникалық тексеру жүргізілді. Дисталды анастомоздың реконструкциясынан кейінгі дисталды анастомоздардағы тромбоздың 2 жағдайы анықталды.

## Хирургическое лечение аневризм артерий нижних конечностей

**Ханчи Миад, Маткеримов А.Ж., Тергеусизов А.С., Демеуов Т.Н., Баубеков А.А., Жакубаев М.А., Таджибаев Т.К., Ханчи М.М., Шамшиев А.С.**

АО «Национальный научный центр хирургии им. А.Н. Сызганова», г. Алматы, Казахстан,

### Аннотация

*Аневризмы периферических артерий опасны возможными осложнениями такими, как разрывы, кровотечения, тромбозы в дистальном русле с последующей ишемией тканей, неврологические расстройства, вследствие давления близко расположенных нервных стволов.*

*Одной из наиболее распространенных причин развития аневризм периферических артерий являются травмы. Особое внимание необходимо уделить значительному увеличению количества ятрогенных травм. С 2000 года по 2019 год оперированы 46 больных на артерии нижних конечностей. Были выполнены операции различных видов реконструкций. Общий возраст пациентов составил от 30 до 76 лет, средний возраст пациентов составил  $43,3 \pm 6,5$  лет.*

*Всего с сочетанным аневризматическим поражением бедренной и подколенной артерии оперированы 6 (9,2%) больных. Ближайших в послеоперационном периоде у больных с аневризмой периферических артерий выявлены положительные клинические результатов у 91.5%. У 4(8.5%) развивались осложнения. Отдаленные результаты прослежены в срок от 3 месяцев до 3 лет. Проводилось клиническое обследование, дополненное ультразвуковым контролем. Выявлены 2 случая тромбоза в дистальном анастомозе, которые были восстановлены после реконструкции дистального анастомоза.*

### Relevance

Peripheral artery aneurysms are dangerous with possible complications such as ruptures, bleeding, thromboembolism in the distal bed with subsequent tissue ischemia, neurological disorders due to pressure of closely located nerve trunks.

One of the most common causes of peripheral artery aneurysms is trauma. Special attention should be paid to a significant increase in the number of iatrogenic injuries. Peripheral artery aneurysms can be an independent disease or a consequence of an artery injury. Ultrasound duplex scanning is recognized as the «gold standard» for the diagnosis of this disease, since this method is used to visualize not only the aneurysm itself, but also the presence or absence of parietal blood clots, as well as the possibility of assessing the inflow and outflow routes [1,2,3]. In recent years, there has been a tendency to increase the number of patients with this pathology. The incidence of peripheral aneurysms ranges from 3.4 to 6.7% [4,5,]. The best option for surgical treatment is an aneurysm resection with prosthetics, which provides better patency of shunts in the long term compared to shunting and ligation of the aneurysm[6]. Despite the relative rarity, peripheral artery aneurysms are a formidable pathology that poses a real threat to the loss of a limb and even the life of the patient [7]. Only at the end of the XX century developing endovascular methods have brought novelty to aneurysm surgery[8]. However, open reconstructive operations have not lost their relevance and need to be improved taking into account modern diagnostic and technical capabilities [9,10,11,12,13].

### Material and methods

In the Department of Vascular Surgery of the National Scientific Center of Surgery named after A. N. Syzganov, from 2000 to 2019, 46 patients with arterial aneurysms of the lower extremities were operated on. Of these, 5 patients underwent surgery for distal anastomosis aneurysm after ABS and ABP. The total age of the patients ranged from 30 to 76 years, the average age of the patients was  $43.3 \pm 6.5$  years.

A total of 6 (9.2%) patients were operated on with a combined aneurysmal lesion of the femoral and popliteal arteries.

### Characteristics of patients with atherosclerotic femoral artery aneurysm

The main complaints of patients with femoral artery aneurysm were about a pulsating formation in the aneurysm area (12 (41.3%) patients complained).

The distribution of patients by gender and age shows a clear predominance of male patients - 35 men (76%) and 11 women (24%). With NAA, men - 1 (2%), women - 4 (8%). The etiological factor of peripheral artery aneurysm development was atherosclerotic in 41 (89%) and nonspecific inflammation in 5 (10%) patients.

Complaints about the presence of intermittent lameness associated with ischemia of the affected limb were presented by 25 (55%) patients. 7 (15%) patients had pain at rest and 2 (4.5%) had trophic disorders in the foot area, which corresponded to the 4th degree of ischemia. Only 12 (26%) patients had an asymptomatic aneurysm, which is slightly

**Автор для корреспонденции:**  
**Ханчи Миад** – врач-ангиохирург,  
АО «Национальный научный центр  
хирургии им. А.Н. Сызганова»,  
г. Алматы, Казахстан.  
E-mail: miad01@mail.ru

### Конфликт интересов

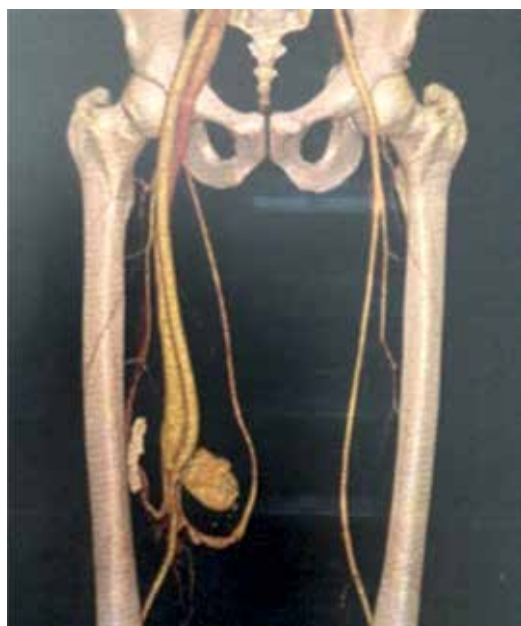
Авторы заявляют об отсутствии конфликта интересов

### Ключевые слова

хирургическое лечение аневризм периферической артерии, аневризмы общей бедренной артерии, подколенной артерии, диагностика и результаты хирургического лечения больных с артериями нижних конечностей

**Figure 1.**

Is a schematic image of the MSCT. In the middle third of the thigh on the right, there is an arterio-venous junction between the superficial femoral vein and the artery, with a diameter of 2.6 mm. Also at this level, the presence of an aneurysmal sac, 85x63x78 mm in size, partially thrombosed, is determined on the medial surface. The width of the leg is 8.2 mm.



more than in patients with popliteal artery aneurysm (15.8%).

Features of the anamnesis of the disease. We found that the duration of the disease affected the presence of multiple aneurysms, the size of aneurysms, and the clinical picture.

**Characteristics of patients with atherosclerotic popliteal artery aneurysm**

The main complaints of patients with popliteal artery aneurysm: patients with popliteal artery aneurysm most often complained of the presence of a tumor-like, pulsating formation and local pain of varying intensity in the popliteal fossa, which was noted in 6 (12%) patients. Surgical interventions were performed in all 46 patients with arterial aneurysms of the lower extremities using various surgical techniques.

Performing reconstruction on the arteries is the only way to preserve the main blood circulation in the area of distal localization of the aneurysm.

Reconstructive surgery was performed in all cases, the most common type of surgery was resection of an aneurysm with a lateral suture (28 cases (60%)), and resection of an artery aneurysm with an autovenous patch was performed in

10 cases (22%), with autovenous prosthetics - 6 (15%), resection of an aneurysm of an end - to-end artery-3(8%).

The results of surgical treatment depend on the concomitant diseases. The best long-term results are observed in patients with asymptomatic aneurysms. There is evidence that surgical treatment of asymptomatic aneurysms is significantly better than symptomatic aneurysms [12].

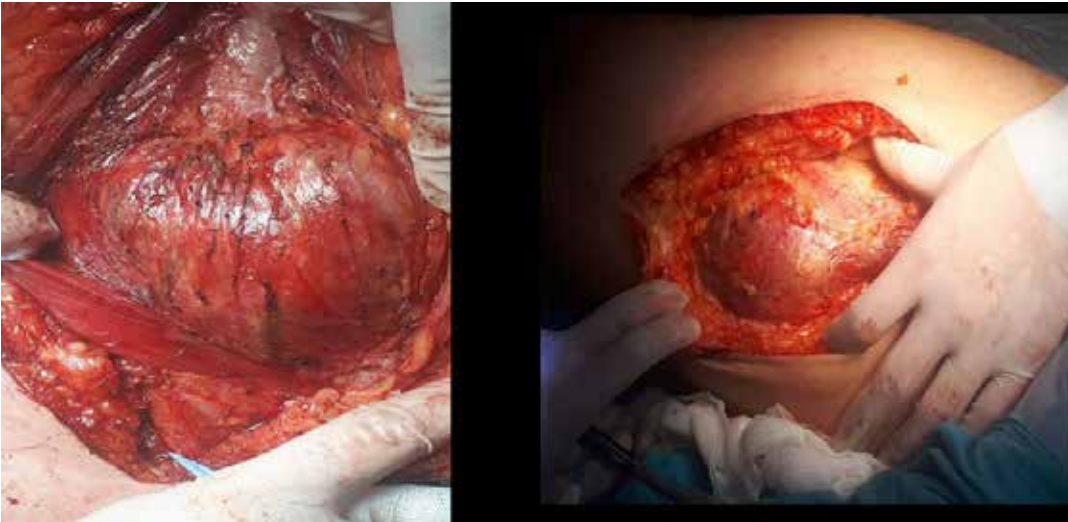
Thus, to date, there is no clear algorithm for surgical treatment of arterial aneurysms of the lower extremities with femoral and popliteal aneurysms, which leads in a large number of cases to the development of complications (rupture, thrombosis, thromboembolism). In addition, despite the development of a large number of different types of treatment of patients with this disease, there is no single tactic for treating patients with femoral and popliteal aneurysms, depending on their localization, prevalence and severity of hemodynamic disorders.

**A clinical example of a patient**

Patient, 26 years old, with a diagnosis of Post-traumatic false aneurysm of the superficial femoral artery of the middle third of the right thigh with the formation of an arteriovenous fistula.

**Table 1.**  
Distribution of patients depending on localization

№	Localization of aneurysm	Quantities	%
1	Arteria iliaca externa	2	4%
2	Arteria femoralis	21	46%
3	Arteria profunda femoris	2	4%
4	Surface of the femoral artery	10	22%
5	Arteria poplitea	6	12%
6	Aneurysm of distal anastomosis after bifurcation aorto-femoral shunting (BAFSH) and bifurcation aorto-femoral prosthetics (BAFPR)	5	12%
	<b>Total</b>	<b>46</b>	<b>100%</b>



**Figure 2.** Is a schematic image. Tumor-like formation in the medial surface of the middle third of the thigh on the right, measuring 10\*8 cm



**Figure 3.** Schematic image. Resection of a false aneurysm of the superficial femoral artery on the right with autovenous prosthetics

I received complaints: according to the patient, in 2010 he received a knife wound in the middle third of the medial surface of the thigh on the right. The ambulance team was taken to the hospital. Primary surgical treatment of the wound was performed, recommendations were given (there is no discharge on the hands). After that, the patient did not go to the doctors, the wound healed by primary tension. In dynamics, a tumor-like formation appeared on the site of the postoperative scar. No further treatment was carried out, the formation increased in size in dynamics, and therefore the patient applied to the A. N. Syzganov National Scientific Center.

Computed tomography (12.07.2019):

Conclusion: the condition after superficial femoral artery (SFA) bypass surgery on the right, the CT picture is more consistent with shunt occlusion. The CT picture may correspond to an arteriovenous junction between the superficial femoral vein and the artery. Results of the study: on CT angiography of the abdominal aorta and vessels of the lower extremities after intravenous bolus contrast enhancement (Ultravist 370-120 ml) in the axial, sagittal and coronal projections of the aorta at the bifurcation level-18.8 mm – In the middle third of the thigh on the right, there is an arteriovenous junction between the superficial femoral vein and the artery, with a diameter of 2.9

mm. The femoral-femoral shunt on the right is not visualized.

The course of the operation: an incision was made at the level of the middle third of the thigh 20 cm above the aneurysmal expansion, the superficially femoral artery was isolated, an arterial clamp was applied above and below the aneurysm on the superficially femoral artery (SFA). During the revision, there is an aneurysm measuring 20.0 x 15.0 cm. Due to the pronounced inflammatory process, disturbed anatomy, inflammatory tissue changes, an aneurysmal sac is isolated, which actively pulsates during revision and is tightly soldered to the surrounding tissues when isolated, the aneurysmal sac is excised with the aneurysm wall. The aneurysm cavity was opened. Organized thrombomasses were removed from the cavity. The affected area of the aneurysmal sac defect was removed, an arteriovenous fistula is noted on the posterior surface. Given this circumstance, the aneurysmal sac is stitched, bandaged. Above 5 cm of the aneurysmal sac, a Crawford clamp is applied to the PBA, the distal part is stitched, bandaged. There are conditions for proximal anastomosis. Below 4 cm of the aneurysmal sac, a Crawford clamp is applied to the PBA, the proximal part is stitched, bandaged. There are conditions for the imposition of distal anastomosis. It was decided to perform femoral-femoral

**Figure 4.**

Schematic representation. Posttraumatic aneurysm of the popliteal artery on the left. Operation: resection of the left popliteal artery aneurysm with uncoupling of the arteriovenous fistula



autovenous prosthetics. A proximal end - to-end anastomosis was applied, and a distal end - to-end anastomosis was formed. Pulsating blood flow was obtained, distal pulsation is good.

**Assessment of the immediate and long-term results of surgical treatment**

A retrospective analysis of the results of the examination of 46 patients with peripheral artery aneurysm (PAA), as well as data on the effectiveness of their surgical treatment, allowed us to characterize in a new aspect the value of diagnostic tests aimed at determining the functional significance of reconstructive operations on vessels with preservation of the main circulation in the area of distal localization of the aneurysm.

We evaluated the immediate and long-term results of surgical treatment by preserving the main blood circulation in the area of the distal localization of the aneurysm.

In total, 4 (8.5%) of all 46 operated patients developed surgical complications in the immediate postoperative period. Analyzing, we came to the conclusion that good and satisfactory results were obtained in 91.5%.

Postoperative complications are presented after aneurysm resection and reconstruction on n\k vessels, mainly with the diagnoses of post-traumatic false aneurysm, post-injection false aneurysm, the occurrence of hematomas that have a risk of

infection of the surrounding tissues with possible generalization, edema of the surrounding tissues with the development of lymphorrhea, suppuration after surgical wounds and shunt thrombosis.

When analyzing the long-term results of APA treatment in patients who underwent reconstructive surgery, limb ischemia was detected in 5 cases, the condition of these patients is considered satisfactory. After conservative treatment of limb ischemia, there are tendencies to regression.

Thrombosis of distal anastomoses was detected in 2 cases. In one case, the amputation of the n\k was performed, and in the other case, a thromboectomy was performed and blood flow was restored.

Relapse of an aneurysm of anastomosis - in 1 case, in which a false aneurysm was excised by alloprosthetics with a synthetic prosthesis.

Thus, in the immediate postoperative period, 91.5% of patients with PAA had positive clinical results after the operations performed by us. 4 (8.5%) developed complications.

Performing reconstruction on the arteries is the only way to preserve the main blood circulation in the area of distal localization of the aneurysm.

Long-term results were tracked in the period from 3 months to 3 years. A clinical examination was performed, supplemented by ultrasound control. The results of the research methods were compared with the initial ones performed in the early postoper-

**Table 2.**

Surgical complications of the postoperative period in patients with peripheral artery aneurysm

Complication	quantities
Lymphorrhea	2
Bleeding	1
Shunt thrombosis	2
<b>Total</b>	<b>5</b>

ative period. When analyzing the results of the long-term postoperative period, the following data were obtained: no mechanical damage to the implant was detected, the formation of anastomotic aneurysms was not detected, the patency of all vascular structures except for 2 cases caused by thrombosis of the distal anastomosis, after reconstruction in the distal anastomosis, blood flow was restored.

The main risk factors for the complicated course of the immediate postoperative period in patients with peripheral artery aneurysms were: age over 60 years-55%; diabetes mellitus-10%; medium and large aneurysm size -10%; arteriosclerosis-21%; nonspecific aortoarthritis (NAA) - 1%; arterial hypertension -3%.

## **Conclusion**

The problem of surgical treatment of peripheral artery aneurysms with different etiology.

Patients with pulsating hematomas and false aneurysms of the arteries of the lower extremities were analyzed. From 2000 to 2019, aged 40 to 76 years. In patients, the cause of pathology was mainly post-traumatic false aneurysm, post-injection false aneurysm, aneurysm of distal anastomosis after aortobedial bifurcation bypass surgery (ABBS) and aortobedial bifurcation prosthetics (ABBP).

To reduce the risk of aneurysm formation after ABBS and ABBS, the formation of a distal anastomosis is recommended during femoral artery prosthetics in order to prevent anastomosis failure, this method was used by us in 5 cases. To strengthen the distal anastomosis during prosthetics, it is proposed to use a segment of a vascular prosthesis with a length of 20 mm. Before removing the clamp from the aorta, the segment of the prosthesis is moved along the entire length of the vascular prosthesis towards the formed anastomosis in such a way that the segment of the prosthesis annularly covers the entire area of the anastomosis along the perimeter.

The proposed method, with its simplicity of execution, reliably ensures the tightness of the anastomosis and significantly reduces the risk of false aneurysms.

It is defined as one of the most complex areas of surgery. Recently, aneurysms of peripheral arteries of various arterial basins, their defeat, the choice of reconstruction tactics to prevent complications in the distal basin, improving the results of surgical treatment in patients by optimizing the diagnostic process, the choice of safe surgical tactics are the subjects of discussion in domestic and foreign literature. Frequent topics of discussion in the literature:

1. Study of the frequency of occurrence of peripheral artery aneurysms with different etiology

2. Diagnosis of patients with peripheral artery aneurysm.

3. Development of optimal tactics for the treatment of patients with peripheral artery aneurysms

4. Assessment of immediate and long-term results.

Conclusion:

The problem of surgical treatment of peripheral artery aneurysms with different etiology.

Patients with pulsating hematomas and false aneurysms of the arteries of the lower extremities were analyzed. From 2000 to 2019, aged 40 to 76 years. In patients, the cause of pathology was mainly post-traumatic false aneurysm, post-injection false aneurysm, aneurysm of distal anastomosis after aortobedial bifurcation bypass surgery (ABBS) and aortobedial bifurcation prosthetics (ABBS).

To reduce the risk of aneurysm formation after ABBS and ABBS, the formation of a distal anastomosis is recommended during femoral artery prosthetics in order to prevent anastomosis failure, this method was used by us in 5 cases. To strengthen the distal anastomosis during prosthetics, it is proposed to use a segment of a vascular prosthesis with a length of 20 mm. Conclusions:

– The most frequent cases of aneurysm development were atherosclerosis in 25 (55%) in the first place, post-infectious false aneurysm was noted in 2 (4%) patients, after invasive endovascular interventions and post-traumatic false aneurysm in 14 (30%). Also after ABBS and ABB 5 (11%).

– Distribution of patients depending on arterial basins.

– Ultrasound, MSCT, angiography allow you to objectively assess hemodynamics and determine treatment tactics.

– The method of choice is reconstructive plastic surgery to eliminate an aneurysm with the restoration of the main blood flow.

Recommendations:

– Taken into account, when identifying clinical manifestations of pulsating formation and circulatory disorders in one arterial pool, a thorough examination is necessary. Ultrasound duplex scanning, angiography, MSCT are performed if arteriovenous forms of peripheral arteries are suspected.

– Alternatively, preference in choosing reconstructive or organ-bearing surgery in patients with peripheral artery aneurysms will restore blood flow to the distal basin.

– Monitoring of the state of restored blood flow in arterial pools with the use of vascular ultrasound 2 times a year, mandatory visualization of proximal and distal anastomoses.

– All types of operations aimed at restoring blood flow have an equal right to use. The choice of a particular method depends on the size of the aneurysm, the condition of the vessels outside the aneurysm, the size of the defect formed after radical resection of the aneurysm sac.

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