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TRAUMATIC INJURIES OF VASCULARS AND THEIR CONSEQUENCES

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This monograph is dedicated to my teacher in life and science, the founder of the interregional center of vascular surgery in Samarkand (1974), Laureate of the Lenin Komsomol of Uzbekistan, Excellent Healthcare Worker, Associate Professor Khamrakulov Zafar Sindarovich.

TRAUMATIC INJURIES OF VASCULARS AND THEIR CONSEQUENCES

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The monograph is devoted to the study of the clinic, the diagnostic algorithm and special instrumental methods, as well as the most widely used modern methods of surgical treatment of traumatic vascular injuries and their consequences. The important role of angiography, ultrasound, Dopplerography, DS and MSCT for clarifying the diagnosis and choosing the most optimal method of surgical intervention is shown. Indications and contraindications are presented for: conservative treatment; restorative and reconstructive operations; ligation of vessels. The work describes the organization and methods of emergency care for traumatic vascular injuries and their consequences.

The book is intended for vascular surgeons, surgeons, traumatologists, masters and emergency and emergency doctors.

The book contains 94

figures, 49 tables, a bibliography of 215 titles.

Reviewers:

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TABLE OF CONTENTS

LIST OF ABBREVIATIONS AND SYMBOLS

AAA	–	abdominal aortic aneurysm
BP	–	blood pressure
ALT	–	alanine aminotransferase
AST	–	aspartate aminotransferase
SMA	–	superior mesenteric artery

CHD	–	congenital heart disease
HIV	–	human immunodeficiency virus
ICP	-	intracranial pressure
DFA	–	deep femoral artery
DS	-	duplex scanning
PTA	-	posterior tibial artery
ESV	–	end-systolic volume
EDV	–	end-diastolic volume
ABI	–	ankle-brachial index
MSCT	–	multislice computed tomography
MRT -	–	magnetic resonance tomography
IMA	–	inferior mesenteric artery
IEGA	–	inferior epigastric artery
EIA	–	external iliac artery
EIV	–	external iliac vein
IVC	-	inferior vena cava
CIA	–	common iliac artery
CIV	–	common iliac vein
CCA	–	common carotid artery
SFA	–	superficial femoral artery
STA	-	anterior tibial artery
PTI	–	prothrombin index
REVO	-	roentgen-endovascular temporary occlusion of vessels
CVS	-	cardiovascular system
TAVF	–	traumatic arteriovenous fistula
TAA	-	traumatic arterial aneurysm
US	–	ultrasound examination
SV	–	stroke volume
EF	-	ejection fraction
HR	–	heart rate
ECHO-CG	–	echocardiography
IA	-	iatrogenic aneurysm
CG	-	control group
OG	-	main group

Foreword:

History of Vascular Trauma Treatment

Regardless of the era of the human history a trauma has always been of great medical, social and economic importance. Allow me to share with you one interesting example at the beginning of this foreword. Few decades ago anthropologist Margaret Mead (1901-1978) was

asked by students what she considered to be the first sign of civilization. The students expected Mead to talk about fishhooks, clay pots, or grinding stones. However, Mead answered that the first sign of civilization was a healed previously broken thighbone. *Mead explained that in the animal kingdom, If an animal breaks its leg, it will die. No animal with a broken leg survives long enough for the bone to heal. That also applies to the first human comunity. Healed thighbone after previous fracture is evidence that someone helped and cared for an injured person until complete recovery. Helping someone else through difficulty is where civilization starts. We are at our best when we serv others*[1].

Vascular trauma causes considerable medical consequences for injured persons. Hundred years ago abdominal and chest vascular trauma were almost always fatal, while periferal vascular trauma at least caused the injured person severely disabled. Mortality caused by vascular trauma reduced the current population at the time, while disability of injured survivors reduced the working capacity of the entire community. Namely, the community must spend significant resources on basic care for the disabled. The importance of vascular trauma is additionally increased by the fact that it mostly occurs in young people.

Because of that, trauma management is very important. At the beggining of the 20th century Halsted explained that improtance in this way: *„One of the chief fascinations in surgery is the management of wounded vessels. The advances in vascular surgery are typical of those in other fileds of medicine and surgery. Each step is discovered and recorded only to be rediscovered by other individuals who failed to read profit by the experience of others"*[2].

However, the history of vascular trauma management is much longer. Ebers papirus includes a description of the first methods of hemostasis performed by Egyptians in 1600 B.C. They used styptics prepared from mineral or vegetable matter including lead sulphate, antimony and copper sulphate[2]. One of them-cooper sulphate, again became popular several hundred years later during the Middle Ages in Europe, and was known as the hemostatic „button"[2]. Susruta in ancient India (500 B.C.) used cold, compression, elevation, hot oil, and ligature of blood vessels with fibers of plants or hair to control hemorrhage[2]. About 1000 years B.C the Chinese used thight bandaging and styptics, to controle hemorrhage[2].

The arterial ligature as controle of hemorrhage, for the first time was used by the famous Ancient physician Celsus at 25 A.D. After him during the first three centuries A.D, Galen, Heliodorus, Rufus of Ephsus and Archigenes advocated ligation or compression, of a bleeding vessel to control hemorrhage[2].

In the second century A.D. Antyllus treated false traumatic arterial aneurysm by ligature above and below the lesion, followed with incision of the aneurysm sac and extraction of the clot[2]. However, besides that experience the use of ligature in the treatment of injured

vessels was forgotten for almost 1200 years. During the Middle Age in Europe cautery was used almost exclusively to control hemorrhage[2]. Jerome of Brunscwick, an Alsatian army surgeon, acually preceded Pare in describing to use of ligatures as the best way to stop hemorrhage. His recomendations were recorded in a testbook published in 1497 and provided a detailed account of the treatment of gunshot wounds[2]. Ambroise Pare, who had a wide expeience in the surgery of trauma on the battlefield, firmly established the use of ligature for control of hemorrhage from injured blood vessels. In 1552 he introduced an amputation of inured leg above the line of demarcation. The vessels were ligated with linen, leaving the ends long. Pare also developed the „bec de corbin“ ancestor of the vessel prior to ligating it. Previously, inured vessels had been grasped with hooks, tenaculums or the assistants fingers[3].

The development of the tourniquet was another advance in the control of hemorrhage. In 1674 Morel introdiced a stick into the bandage and twisted it until arterial flow stopped[2]. The screw tourniquet came into use shortly thereafter.

The first repair of injuried artery has been described aobout one hudred years later. On a suggestion by Lambert, Hallowell in 1759, repaired a wound of the brachial artery by placing a pin through the arterial walls and holding the edges in apposition by applying a suture in a figure-of-eight fashion about the pin[4]. This technique known as the „farriers stitch“, had been utilized by veterinarians earlyer, but had fallen into disrepute following unsuccessful experience[4].

In 1873 Friedrich von Esmarch, a student of Langenbeck, introduced elastic tourniquet bandage for first aid use on the battlefield. Previously it was thought that such compression would irreversibly injure vessels. His discovery permitted surgeons to operate electively on extremities in a dry, bloodless field[5].

The same year Pick provided an interesting and detailed account of his management of a large false femoral aneurysm by digital compression, which had disastrous results. This digital compression directly over the pulsating mass was applied continuously initially and then for a considerable period of the waking hours until four days later when the area became so tender that the compression had to be discontinued. This maneuver has initiated thrombus formation in the false aneurysm than one week that the distal pulses could not be felt over distal arteries. However, gangrene developed approximately three weeks after the initiation of the digital compression, and an amputation was performed at the hip level. The patient had a stormy postoperative course after which he died[6].

With the combined developments of anesthesia and asepsis, several reports of attempts to repair arteries appeared in the latter part of the nineteenth century. In 1865 Henry Lee attempted repair of arterial lacerations without suture[7]. Glück in 1883 reported 19

experiments with arterial suture, but all experiments failed because of bleeding from the holes made by the suture needles. He also devised aluminum and ivory champs to unite longitudinal incisions in a vessel, and it was recorded that the ivory clamps succeeded in one experiment on the femoral artery of a large dog[8]. Von Horoch reported six experiments including one end-to-end anastomosis of artificially injured vessels. It was done in 1887, however all of which were thrombosed[9]. In 1889 Jassinowsky showed experimentally that arterial wounds could be sutured with preservation on the lumen[10].

On April 6, 1888 Rudolph Matas operated a young male patient with large traumatic aneurysm of the brachial artery developed due to multiple gunshot. After a ligation of the main proximal and distal arteries, he opened the aneurysm sac and sutured intrasacculary, all collaterals with back bleeding[11]. Fefteen years later Matas described a reconstructive endoaneurysmorrhaphy in the treatement of traumatic false aneurysms[12].

Two important experimental works emerged. In 1889. Bruci sutured six longitudinal arteriotomies in dogs. The procedure was successful in four of them. Next year Muscatello successfully sutured a partial transection of the abdominal aorta in dog[2].

In 1893, Israel, in a discussion of paper by Glück, described closing a laceration in the common iliac artery created during an operation for peri typhlitic abscess. The closure was accomplished by five silk sutures[13]. By using catgut suture in 1894 Heidenhain closed a 1 cm wound in the axillary artery made accidentally during removal of adherent carcinomatous glands. The patient recovered without any circulatory disturbances[14].

However, some world leading surgeons did not believe in the success of this type of arterial repair. One of them was a Murphy who in the end of the 19th century, had carefully reviewed earlier clinical and experimental studies of arterial repair and had evaluated different techniques extensively in laboratory studies. He attempted to determine experimentally how long defects of the artery could be removed and still allow an anastomosis. He found also that 1 inch of calf carotid artery could be removed, and the ends still approximated by invagination sutured technique because of elasticity of the artery. Murphy concluded that arterial repair could be done with safety when no more than three-fourths of an inch of an artery had been removed, except in certain locations such as the popliteal fossa or the axillary space where the limb could be moved to relieve tension on the repair. He concluded that when more than one-half of the artery was destroyed, it was better to perform an end-to-end anastomosis by invagination rather than to attempt repair of the laceration. This repair was done by introducing sutures into the proximal artery, including only the two outer coats, and using three sutures to invaginate the proximal artery into the distal one, reinforcing the closure with an interrupted suture. In 1896 Murphy performed the first successful repair of wounded femoral artery by

end-to-end anstomosis using invagination technique. Before the suture the invagination of proximal into distal arterial end was peformed[15]. His patient was 29-year-old male shot twice, including with open wound of the open femoral triangle. The patient was admitted to Cook Country Hospital in Chicago on September 19. 1896. approximately two hours after wounding. There was no hemorrhage or increased pulsation noted at the time. Murphy first saw the patient 15 days later. He found a large bruit surrounding the site of injury. Distal pulses were barely perceptible. Two days later, when demonstrating this patient to students, a thrill was also detected. Murphy mentioned that a pulsation could be felt in the dorsal pedal artery four days following the operation. The patient had no edema and no disturbance of his circulation during the reported three months of observation[15].

Figure1.J.B. Murphy

In the beginning of the 20th century Carrel and Guthrie performed few well-known experimental studies. After that triangular end-to-end anastomosis of inured vessels was introduced in surgical practice[16]. This is still very important for repairing small diameter blood vessels.

Figure 2. A. Carrel

With special pride and pleasure, here I mention an extraordinary serbian surgeon Vojislav Soubbotich because of his experience from Balkan wars (1912-1913). Seventeen traumatic arterio venous fistulas (AVF) and sixty false traumatic aneurysms, were treated by himself and his coworkers. They performed 45 ligations and 32 repair, including 19 arteriorrhaphies, 13 venorrhaphies and even15 end-to-end anastomoses. Soubbotichs experience has been published in the most known medical journal at that time -„Lancet“[17]. Famous Rudolph Matas in discussing on that report spoke about Soubbotich with words filled with praise[18]. He said*: "Doctor Soubbotitch had made a most timely and valuable contribution to the surgery of the blood-vessels resulting from wound in war. The Balkan conflict has afforded unusual opportunities*

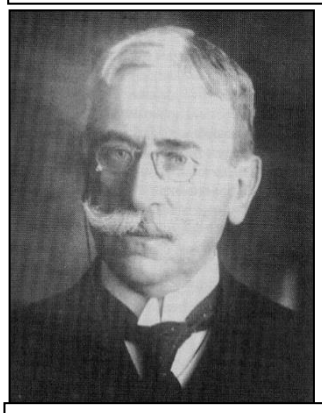


Figure 3. V. Subbotich

for the observation of vascular wounds inflicted with modern military weapons, and Lieut.-Colonel Soubbotitsh's report, based on material fresh from the field of action, had fully confirmed the belief that this last war, waged in c lose proximity to well-equipped surgical centers, would also offer an unusual opportunity for the study of the most advanced methods of treating injuries of the blood-vessels. The report shows that the Balkan conflict has been no exception to the rule, and that vascular injuries, especially arterial and arteriovenous aneurysms, have become a conspicuous feature of modern military surgery, and that this class of injuries must command the closest attention of the modern military surgeon. It is one of the notable features of this report that the suture (circular and lateral) has been utilized more often in the Balkan conflict than in any previous wars; and judging also by Dr. Soubbotitch's statistics, the success obtained by the surgeons of his staff in the Serbian Army Hospital at Belgrade far surpasses those obtained by military surgeons in previous wars, with the exception perhaps of the remarkably favorable results obtained by Kikuzi, with the intra-saccular ligation, in the Japanese Reserve Hospitals"[29].

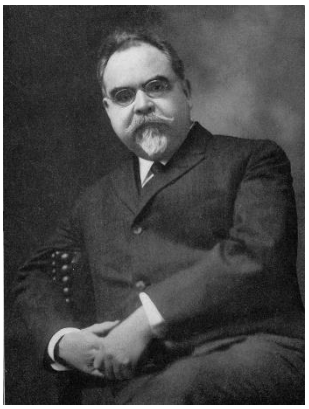
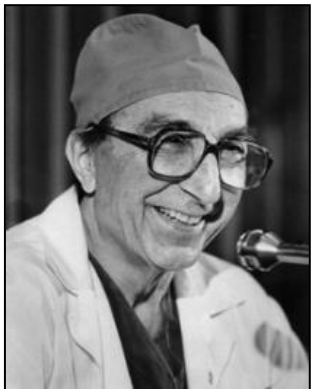


Figure 4. R.

Our contemporary N. Rich said that Soubbotich`s technique and results had been overcomed forty years later, during Korean conflict (1952-1954)[19]. Soubbotitch's results published in Lancet more than 100 years ago, were quoted 20 times including most recently published books and articles[20].

Figure 5. N. Rich

According to Nolan data during the early part of the Great War, German surgeons successfuly repaired more than 100 injuried vessels[21]. They were vascular injuries caused by low velocity missels. However, during the secend part of the Great War, mostly injuries were caused by explosives and high velocity bullets. That has been combined with very slow evacuation of the wounded persons**.** That is why the arterial repair was impossible. British surgeon Makins noted that ligature was the main method, in vascular trauma treatment during the Great War[22].



Out of 2471 arterial injuries from the second wolrd war analyzed by DeBakey and Simeone, only 81 repairs were found including 3 end-to-end anastomosis[23]. Allow me to remind You that

Subotich performed 15 end-to-end anastomoses more than 30 years ago[17]. In all other cases form this study arterial injuries have been treated with a ligature, and it was folowed with the amputation rate of 49%[23].

Figure6.M.DeBakey

In a total experience with 304 arterial injuries in Korean conflict, 269 were repaired and 35 ligated. The over-all amputation rate was 13%[24, 25]. Reconstructive procedures, improvements of anesthesia, blood transfussion, antibiotics, as well as rapid evacuation often by helicopter, were of great importance for limb salvage. In the second World War the time lag exceeded 12 hours in most injuries. During the Korean Conflict the average time lag was 9 hours. while in Vietnam this shortened to 1 to 2 hours. Looking back from the helicopter transport in Vietnam to the horse cart in the Great War. It was one of the reasons because results after the treatment of war vascular injuries during Vietnam war, were better than before. Rich and co-workers described about 1000 arterial injuries during Vietnam war. Mostly of them have beeen underwent vascular repairs, which were followed by the amputation rate of 13%[26, 27].

Dzanelidze was the first to successfully suture a laceration of the ascending aorta in Sankt Petersbourg in 1922[28].

Figure7. I.I. Dzhanelidze

In 1988 Volodos significantely improved the treatment of aortic injury. Namely, he repaired succefuly blunt injury of thoracic aorta by using endovascular stent graft. It was the begening of endovascular era[29]

At the end of the 20th century former Yugoslavia experienced civil war, while Serbia experienced NATO bombing. Thanks to those unplesent facts my generation of vascular surgeons and I personaly, had

Figure8. N.L.Volodos

an oportunity to treat a significant number of wars injuries[30-37]. What have we learned?

1. Strategy during management of peripheral **vascular trauma**

Through history, management of vascular trauma has passed through three phases of development: lifesaving, extremity-saving and finally saving of functional extremity[38]. It could be assumed that this order of main objectives is still adoptable in the modern approach to vascular injury. That is why primary bleeding control, rapid transportation of the injured, adequate diagnosis and timely vascular repair are necessary.

2. Primary Bleeding Control

The first step in successful management of peripheral vascular trauma is primary bleeding control. It directly saves the life of the injured person. However, if not performed adequately, primary bleeding control can additionally damage already injured vessels[39]. The way of initial approach to primary hemostasis significantly influences the extent and perspective of for coming vascular reconstruction. Due to these medical personnel (doctors, nurses, etc.) near the battle lines must be trained to establish effective and proper primary bleeding control.

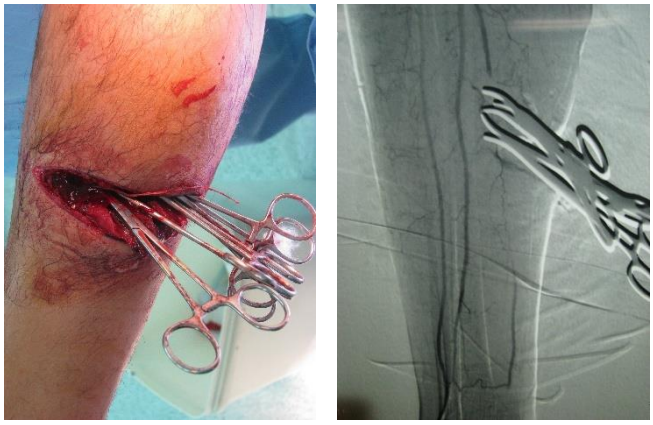
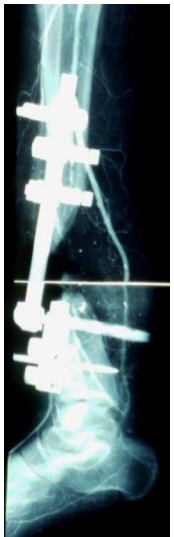


Figure 9a, b. Deep cut injury of the front side of the lower leg (below the knee) caused a transection of the anterior tibial artery. **(a)** Numerous, mostly unnecessary clamps were used for primary bleeding control. **(b)** The DSA shows that these clamps caused additional damage (distal thrombosis) of the anterior tibial artery[39].

3. Vascular Repair or Primary Amputation?

The first question that vascular surgeon has to answer before the treatment of peripheral vascular trauma even begin is whether there is a point in doing vascular repair[39,40]. According to actual guidelines, indications for primary amputation in the cases of vascular trauma include: bone fracture with loss of continuity of more than 6cm in length; massive soft tissue damage and loss; prolonged limb ischemia; severe nerve destruction; major veins obstruction and extensive calf wounds associated with small vessels injury[39,40]. Even though these indications



are quite clear, the decision regarding primary amputation following vascular trauma is quite difficult, especially in young patients.

Figure 10. Angiography presents patent bypass from median to distal (retromaleolar) part of the posterior tibial artery at patient who experienced explosive wound of the lower leg. The patient had also very complex tibial and fibular fractures with a long bone defect associated with massive soft. Consequently, it was unlikely to expect functional recovery of the extremity. A few months later a secondary amputation was performed, but we assume the primary one was better option in this case[39].

4. Diagnosis

The diagnosis of peripheral arterial injury is not always simple. Namely, minor surface wounds can hide behind them serious vascular injury.

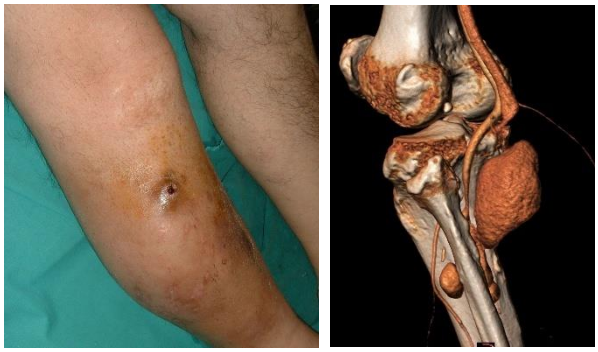


Figure 11 a, b. (a) Minor surface wound below the knee. **(b)** MDCT angiography showed a fistula between popliteal artery and vein.

How to recognize and avoid missing of periheral vascular lesion when so called "hard signs" of vascular trauma (external arterial bleeding, acute limb ischemia, absent distal pulses, expanding hematoma, false aneurysm, and bruit/thrill over area of injury) are not present[41]? We use a simple diagnostic algorithm regarding cases of suspected peripheral arterial injuries [39,42,43].

Firstly, additional diagnosis (DSA or MDCT angiography) is indicated in all cases with "soft" signs of vascular trauma (history of severe bleeding, diminished distal pulses, small nonexpanding hematoma, injury to anatomically related nerve, and anatomic proximity of wound to a major vessels)[36,39,42,43.44,]. In addition, we also recommend DSA or MDCT angiography in all hemodynamically stable patients with "hard signs" of vascular injuries. These procedures are essential in confirming or excluding the presence of arterial trauma. Additionally, they present its location, extent and complexity. DSA or MDCT angiography findings suggest also a surgical approach as well as the type of vascular repair. However, according to our experience, lesser vascular lesions can be omitted on initial MDCT angiogram. Whenever initial MDCT finding is not in accordance with clinical presentation it should be checked with conventional angiography (DSA) during observation period. Finally, in our opinion, only hemodynamically unstable patients with "hard signs" of vascular injuries require immediate surgical exploration without additional diagnosis[37,39, 44].

5. Vascular Repair

In relation to arterial vascular repair, the following are important: the selection of repair procedure; the choice of vascular graft; treatment of associated venous injuries, the presence of associated other complex injuries and finally, approach to prolonged limb ischemia[38].

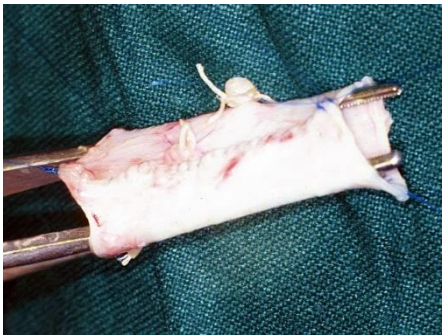
The simplest methods of injured arterial repair are lateral suture or end-to-end anastomosis. However, they can be only performed in cases when defect between edges of injured artery is not too long (<2 cm)[39,42,44].

Otherwise, graft interposition or bypass procedure is indicated. Autologous saphenous vein is the material of choice for repair of injured peripheral vessels. Prosthetic grafts should be avoided because of secondary infection[39,42.44].

6. Associated Venous Injury

The repair of associated venous injury vein improves patency of already repaired artery, minimizes swelling of extremity and development of compartment syndrome as well as long-term chronic venous insufficiency[39,42,44].

For these reasons repair of injured iliac, femoral, popliteal and subclavian veins in all hemodynamically stable patients is recommendable[36.39,42,44].



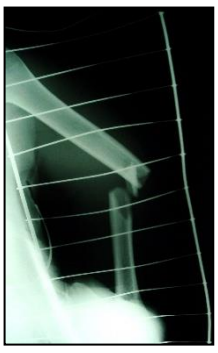
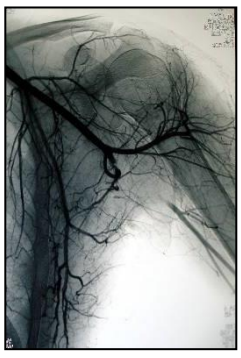
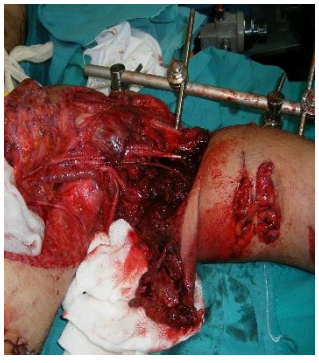
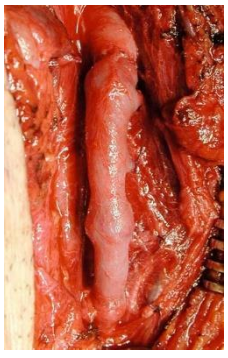
A great and mid-sized veins should be repaired with panel or spiral venous grafts that require additional preparation time.

Figure 12 a, b. Creation of panel saphenous vein graft for repair of mid/great sized injured vein[39].

7. Complex Injuries

Complex injuries should be treated interdisciplinary by an experienced team consisting of vascular surgeons and other specialists[39,42,44]. A significant number of patients with injured peripheral vessels have also associated bone fractures. In such cases, first performed vascular reconstruction might be compromised by traction and secondary movement of bone fragments[30,32,39,42,43,44]. Due to this, after proximal and distal bleeding control and eventual shunt insertion, bone fracture fixation must precede vascular repair.

In the beginning of civil war in former Yugoslavia we used to perform vascular repairs with standard anatomic vascular reconstructions. However, the result has not been satisfied. Namely during the early postoperative period, we revealed that in cases with contaminated or infected wounds as well as in cases with massive skin destruction and soft tissue loss, anatomic reconstruction was significantly associated with secondary hemorrhage, usually resulting in major amputations[30,32,39,42,44]. Acknowledging this we assumed that the anatomic reconstruction of injured artery should be avoided in the presence of contaminated wounds and massive soft tissue damage and loss. In such cases extraanatomical procedures provided significantly better early outcome and limb saving[30,32,34,39,42,44].

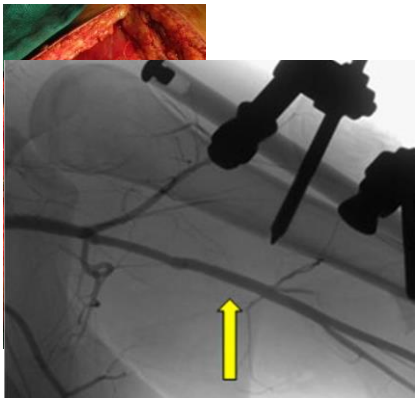


Figure 13 a, b, c, d, e, f, g. Humeral fracture with complete dislocation caused the injury of the axillar artery. **(a)** Radiography. **(b)** DSA shows traumatic thrombosis of contused axillar artery. **(c)** Step 1: Bleeding control and temporary shunt insertion. **(d)** Step 2: Bone fracture stabilization by external fixation. Massive skin and muscular destruction are notable. **(e)** Step 3: Injured axillar artery is replaced with saphenous vein graft. **(f)** Step 4: Reconstruction of soft tissue defect using vascularized muscular flap**. (g)** Control DSA shows patent saphenous vein graft (yellow arrow).

8. Late revascularization

The late (or delayed) revascularization after peripheral arterial injuries can be followed by many significant disorders. Those are compartment syndrome, muscle contracture and necrosis, disabling efferent neuralgia, poor functionality and eventually major amputation. Patients with untreated traumatic arteriovenous fistulas can even develop congestive heart failure[36,37].

The most threatening sequels of late revascularization can be prevented by using temporary vascular shunt. Its use should be considered in cases of prolonged limb ischemia, in polytraumatized patients and in patients with associated orthopedic injuries. If compartment syndrome occurs, immediate fasciotomy releasing all four calf compartments is neccessary[45]. Fasciotomy is rarely indicated in the upper extremity.

9. Early complications after vascular repair

Anastomotic stenosis, arterial thrombosis and infection, are the most frequent and severe early complications following repair of inured peripheral artery[32,39,42].

Anastomotic stenosis is especially common in cases of small arteries repair (crural arteries, etc.), also when reconstruction is performed by inexperienced vascular surgeons. The oblique shape of end-to-end anastomosis prevents stenosis and provides better early and long-term patency. This technique was originally described by Alexis Carrel more than a century ago[16].

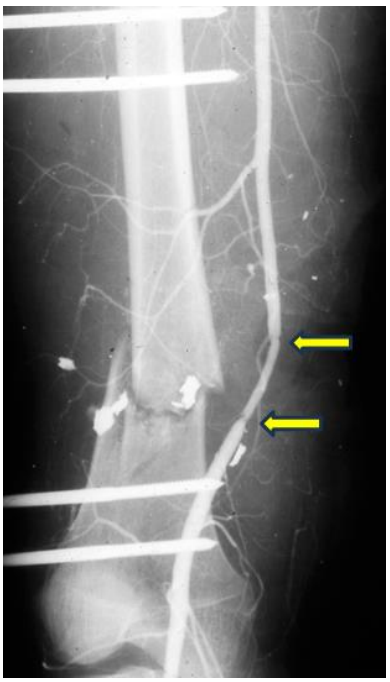


Figure 14. Superficial femoral artery repaired with autologous saphenous vein in a patient with associated femoral fracture. Control angiography shows significant stenosis (yellow arrow) on both proximal and distal anastomoses.

Residual distal thrombosis can compromise adequately performed proximal reconstruction of the injured artery. For this reason, exploration of distal arteries using Fogarty catheter before repair is [32,39,42,44].

In the cases of arterial contusion, the abundant resection of the damaged artery is necessary prior to reconstruction. Inadequate arterial debridement is a common cause of arterial thrombosis during early postoperative period[32,39,42,44].

Inadequate debridement of damaged/necrotic tissue, anatomic vascular repair in the presence of contaminated wounds and in cases with massive soft tissue damage and loss, as well as primary skin closure, increases the risk of early infection and secondary hemorrhage after vascular trauma treatment[32,34, 39,44]. In such circumstances, new extra anatomic reconstruction should be considered. If it is unfeasible, amputation is the only remaining and lifesaving option.

10. Endovascular repair of injured vessels

Endovascular procedures have an important place in the treatment of vascular trauma. Since Volodos`s time it is the first choice in the treatment of blunt injuries of thoracic aorta[29,46]. However, it has also important role in the treatment of peripheral vascular injuries. According to common opinion, they are indicated in the following cases. First, endovascular procedures are methods of choice for the treatment of injured internal carotid and vertebral arteries in zone III of the neck, and for sub clavicular segments of subclavian artery[47,48].

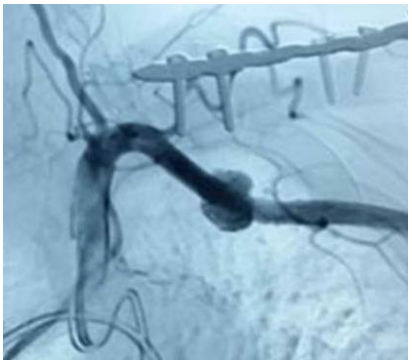
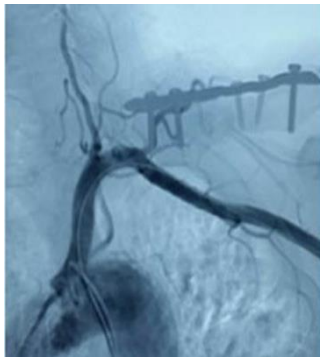



Figure 15 a, b. (a) DSA shows false traumatic aneurysm of the subclavian artery caused by clavicle fracture. **(b)** In this case clavicle makes more difficult or even disables surgical approach. Due to this endovascular repair (placement of covered stent graft) was successfully perforemed[39].

An embolization is the ideal procedure in the cases of bleeding from surgically unapproachable mid and small arteries. Endovascular repair should be the first choice for the treatment of the same complex peripheral vascular injuries[39,42,47,48]. Endovascular repair can be also used for the treatment of early and long-term stenosis after open repair of injured artery. On the other hand, endovascular repair of peripheral arterial injuries has also several strict contraindications[39,42,47,48]. They include hemodynamically instable patients, extensive vascular injuries, injuries without sufficient proximal or distal vascular fixation points, as well as arterial transections.

11. Pediatric vascular trauma

Main characteristics of pediatric vascular trauma are arterial vasospasm, less developed collateral circulation and smaller total volume of blood with limited tolerance to hemorrhagic shock in comparison with adults[49-51]. Due to this, pediatric vascular injury requires more aggressive and earlier intervention.

Several factors unique for children should be considered during their vessel repair. Firstly, dimensions of the injured vessels make surgical correction more complex and increase complication rate. Secondly, circumferential running suture causes a "purse stringing" effect with further arterial growth[16]. For this reason, interrupted suture repair that allows vessel development is recommendable. Also, during repair of injured vessels in children, surgeons should think about a significant risk for growth and developmental complications including limb-length disparities, claudication, and decreased perfusion. Finally, there are significant limitations for the use of synthetics or allografts due to long-term patency concerns[49-51]. On the

other hand, vein graft dilatation should be expected over time. This is why some authors suggest reinforcement of the vein graft with synthetic mesh.

A neointimal hyperplasia is potentially more frequent because of longer follow up after repair of injured vessels in children compared to adults[51].

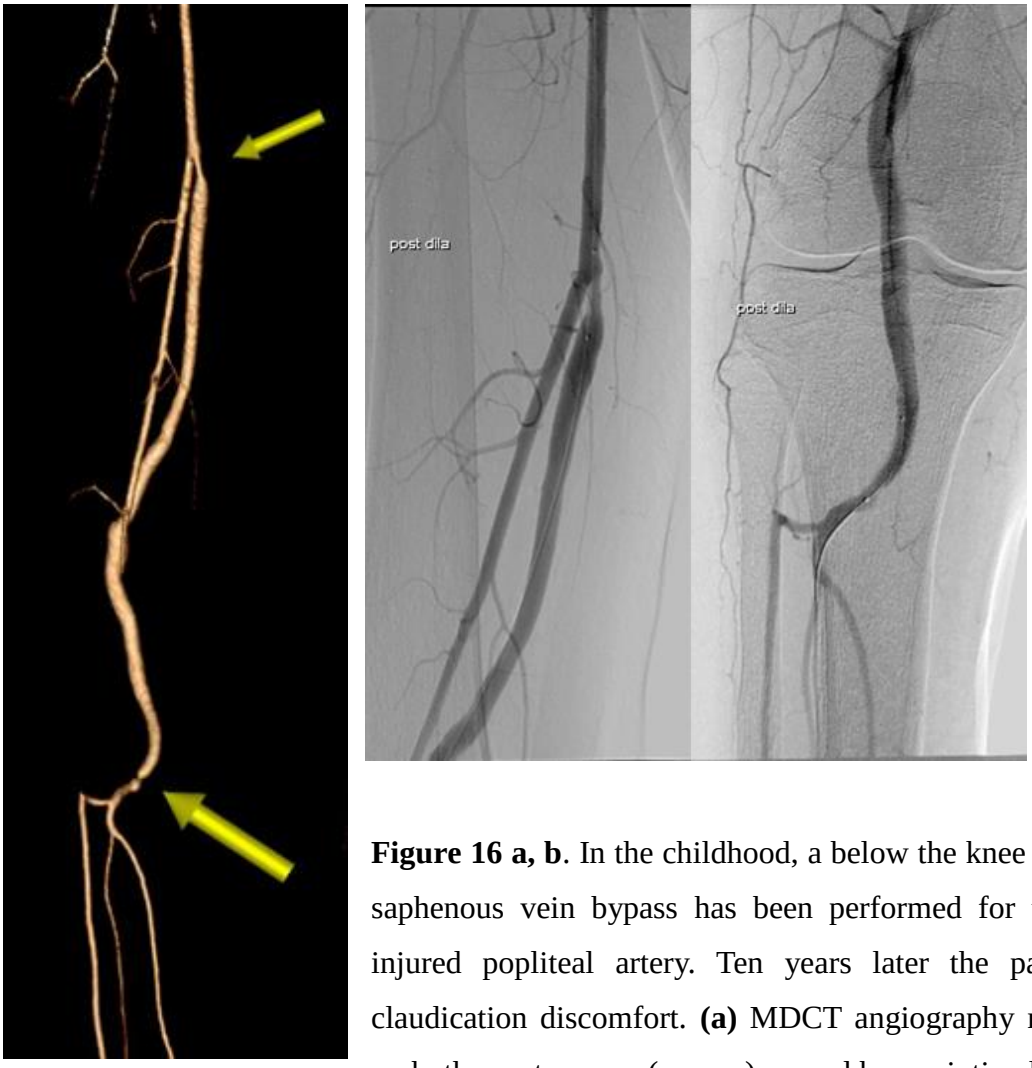
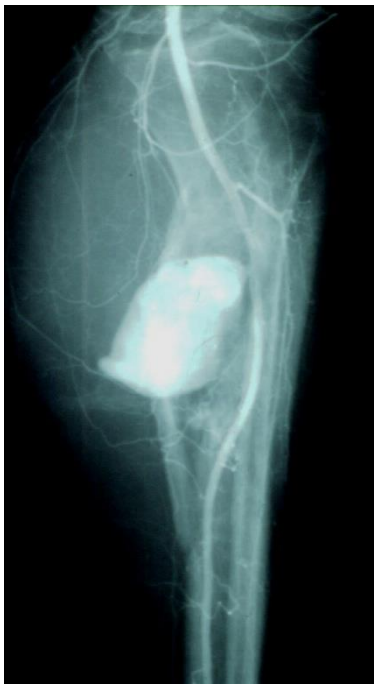


Figure 16 a, b. In the childhood, a below the knee femoro-popliteal saphenous vein bypass has been performed for the treatment of injured popliteal artery. Ten years later the patient developed claudication discomfort. **(a)** MDCT angiography revealed stenosis on both anastomoses (arrows) caused by neointimal hyperplasia**. (b)** Control angiography confirmed successful PTA of both stenoses.

From our perspective, it seems reasonable to use endovascular techniques at least as a bridge in children with multiple associated injuries[51]. There are no clearly defined recommendations on who should operate vascular injuries in children: pediatric or vascular surgeons? Unfortunately, in most countries, including Serbia, pediatric surgeons do not have adequate education in vascular surgery during their specialization. At the same time vascular surgeons are not educated in pediatric surgery. Probably vascular and pediatric surgeons should collaborate[49-51].

12. War versus Civil Vascular Trauma

According to the common opinion the management of vascular injuries is fundamentally differnt compared war and civil circumstances. However, in nowdays it is not necesserilly so. Besides natural disasters (earthquakes, etc.), traffic, industrial and agricultural trauma as well as increasing frequency of terrorist attacks, even sport injuries can be accompanied by severe damage of blood vessels.



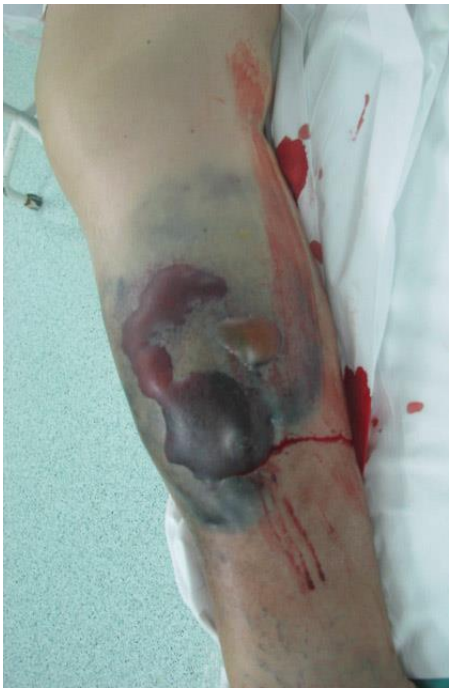


Figure 17 a, b. (a) The serious leg injury was a consequence of a so-called "slide tackle" during a football match. **(b)** Besides a tibia fracture, the patient had a false traumatic aneurysm of the popliteal artery. We managed to save this patient's leg, but he was not able to play football again[8].

An insignificant difference regarding the early outcome between war and peacetime vascular injuries was also presented in our study published in 2005[34]. That study compared 273 civil and 140 war vascular injuries. According to univariate analysis, out of a total of 54 included variables only failed revascularization, associated nonvascular injuries, secondary operation, explosive injury, war injury, arterial contusion, popliteal artery injury and delayed treatment significantly increased the amputation rate after repair of injured peripheral arteries. However, multivariate logistic regression analysis of the previous eight variables showed that only failed revascularization, associated nonvascular injuries and secondary operation significantly increased the amputation rate after arterial vascular repair.

Our new retrospective study includes 222 cases of extremity vascular injuries treated between 2005 and 2020. Has anything changed in the meantime? We did not have war injuries, however rresults of our two studies are relatively simmilar. As in our previous study failed revascularization was also significant predictor of an early limb loss in our second study[44].

13. Long-term complications after repair of peripheral vascular trauma

Two main long-term complications after open repair of injured peripheral arteries are true vein graft aneurysms and stenosis due to neointimal hyperplasia[39,42,44]. Long-term results after endovascular repair of injured peripheral arteries are not yet completely clear[46-48]. Endograft migration, fracture and stenosis caused by neointimal hyperplasia are potential complications.

Take Home Meseage

Regarding the causes of vascular trauma, we have noticed a significant change in the last 100 years. Before that, they mainly appeared during wars. However, with industrial development during the last century, the number of civilian vascular injuries has significantly increased due to a greater number of traffic and factory accidents. In terms of their intensity, these injuries do not differ much from war injuries. Unfortunately war vascular trauma is permanently current. It is enough to remember the number of new conflicts after the Second World War. Some of them started in the last couple of years and are still ongoing (Iraq, Middle East, Libya, Ukaraine, etc.). At the same time the number of terrorist incidents increase as well. On the other hand, the prognosis of patients with vascular trauma has improved significantly thanks to new advanced diagnostic, anesthesiologic and surgical procedures. It could be said that there is a constant race between increasing number and severity of vascular injuries, and the development of treatment options. This balance is very unstable and easily disturbed.

Changes in the local economic, cultural and political conditions could influence the structure of the patients with vascular trauma and influence potentially strategies and even results. It is hard to say what will happen in the future. The best possible thing would be if there were not any wars. Unfortunately, we all know how impossible that is. The rapid development of modern weapons which is obvious to all of us, must be accompained with development of the evacuation and medical treatment if we would like a satisfying result.

References

1. Ira Byock. The best Care Possible: A Physician`s Quest to Transform Care Through the End of Life. Avery 2012.
2. Historical aspects of vascular trauma. Rich NM In: Rich NM, Spencer FC (eds). Vascular Trauma. ISBN 0-7216-7580-8. W.B. Saunders Corp, Philadelphia, London, Toronto, 1979. pp:3-22.

3. Pare A. The apologie and treatise of Amboise Pare Containg the Voyages Made into Diverse Places with many of his writings upon surgery. In: Keynes G (ed). The University Of Chicago Press. Chigago, 1952.
4. Hallowell (1759). Cited by Lambert: Extract of Letter from Mr. Lambert, Surgeon at Newcastle upon Tyne, to Dr Hunter, giving an account of a new method of a new method of treating an aneurysms. Med Obser Inq; London 1762, Ch. 30, p.360.
5. Esmarch F. The surgeon's handbook of the Treatment of the Wounded in War. L. W. Shmidt. New York 1878.
6. Pick TP. On partial rupture of arteries from external violence. St. Georges Hosp Rep London 1873; 6: 161.
7. Shumacher HB Jr, Muhm HY. Arterial Suture Techniques and Grafts: Past, Present and Future. Surgery 1969; 66 (2):419-33.
8. Glück T. Uber Zwei Falle von Aortenaenaneurysms Nebst Bemerkungen Uber dei Naht der Blutgefasse. Arch Klin Chir 1883; 28:548.
9. Von Horach C. Die Gefassnaht. Allg Wein Med Ztg 1888; 33:263.
10. Jassinowsky A. Die Arterinnhat. Eien Experimentale Studie. Inaug Diss Dorpart 1889.
11. Matas R. Traumatic Aneurysms of the Left Brachial Artery. Incision and Partial Excision of the sac. Recovery Phila Med News 1888; 53:462.
12. Matas R. An Operation for Radical of Aneurysm Cure of Aneurysm Based on Arteriorraphy. Ann Surg 1903; 37(2):161-96.
13. Israel: Cited in Murphy JB. Resection of Arteries and Veins Injured in Continuity: End-to-end Suture-Experimental Clinical Research. Med Rec 1897; 51:73.
14. Heidenhain L. Uber Naht von Arterienwounded. Cnetralbl Chir 1895; 22:1113.
15. Murphy JB. Resection of Arteries and Veins Injuried in Continuity-End-to-End Suture-Experimental and Clinical Research. Med Rec 1897; 51:73.
16. Carrel A. The surgery of blood vessels. Johns Hopkins Med J 1907; 18:18.
17. Soubbotich V. Military experiences of traumatic aneurysms. Lancet 1913; 2:720-721.
18. Matas R. The suture as applied to a surgical care of aneurysm. Trans Seventeenth Int Congress London, 1913.
19. Rich N, Clagett P, Salander JM, Piščević S. The Matas/Soubbotitch connection. Surgery 1983; 93 (1):17-19.
20. Davidovic LB, Tomic I, Fatic N. Homage to Professor Soubbotich and His Relevance in the Treatment of War Wounds. Ann Vasc Surg 2015; 29(7):1486-7.
21. Nolan B. Vascular Injuries. J Roy Coll Surg 1968; 13(2):72-83.

22. Makins GH. Gunshot Injuries of the Blood Vessels. John Wrightand Sons Ltd, Bristol, UK, 1919.
23. De Bakey ME, Simeone FA. Battle injuries of arteries in World War II: an analysis of 2471 cases. Ann Surg 1946; 123: 534-79.
24. Hughes CW. Acute vascular trauma in the Korean War. Casualties: an analysis of 180 cases. Surg Gynecol Obstet 1854; 99(1):91-100.
25. Hughes CW. Arterial Repair during the Korean War. Ann Surg 1958 A; 147(4):555-61.
26. Rich NM, Baugh JH, Hughes CW. Acute arterial injuries in Vietnam: 1000 cases. J Trauma 1970; 10(5):359-69.
27. Rich NM. Vascular Trauma in Vietnam. J Cardiovasc Surg 1970; 11(5):368-77.
28. Джанелидзе Ю. Ю. Случай зашивания раны босходящей аорты. In (ed) Джанелидзе Ю. Ю. Том II. Хиругия сердаца и курупныц сосусдов. Типография Госэнергоиздата, Москва, Шлюзпвая наб. 10; Изд-ава АМН СССР, Москва, Соляанка 14. 1953. Pp 18-28.
29. Володосй НЛ, Карпович ИП, Шеханин ВЕ, и другие. Случай динстационного чрезбедреного эндопретезирования грудной аорты самофиксирующимся синтетическим протезом при травматической аневризме. Грудн Кхир 1988; 6:84-8.
30. Davidovic L, Lotina S, Kostic D, et al. Popliteal artery war injuries. Cardiovascular Surgery 1997; 5(1):37-41.
31. Davidovic L, Lotina S, Vojnovic B, et al. Post-traumatic AV fistulas and pseudoaneurysms. J Cardiovasc Surg (Torino) 1997; 38(6): 645-51.
32. Velinovic M, Davidovic L, Lotina S, et al. Complications of operative treatment of injuries of peripheral arteries. Cardiovascular Surgery 2000; 8(40):256-64.
33. Fingerhut A, Lappaniemi A, Androulakis G, Archodovassilis F, Bouillon B, Cavina E, Chaloner E, Chiarugi M, Davidovic L, et al. The European Experience with Vascular Injuries. Surg Clin North Am 2002; 82(1):175-188.
34. Davidovic L, Cinara I, Ille T, et al. Civil and War Peripheral Arterial Trauma: Review of Risk Factors Associated with Limb Loss. Vascular 2005; 13(3):141-7.
35. Dragas M, Davidovic L, Kostic D, et al: Upper extremity arterial injuries: Factors influencing treatment outcome. Injury 2008; 40(8):815-9.
36. Davidovic LB, Banzic I, Rich N, et al. False Traumatic Aneurysms and Arteriovenous Fistulas: Retrospective Analysis. World J Surg 2011; 35(6):1378-86.
37. Marković M, Davidović L, Kuzmanović I, et al. Giant posttraumatic pseudoaneurysm of the peroneal artery with arteriovenous fistula and fibular notch. Am Surg 2009;75(7):627-9.

38. Fingerhut A, Lappaniemi A, Androulakis G, et al. Surg Clin North Am 2002; 82(1):175-188.
39. Davidovic LB, Markovic M. Serbia. In: Rasmussen TE, Nigel R.M. (eds). Rich`s Vascular Trauma 4th Edition. Elsevier, Philadelphia-USA, 2021. ISBN: 9780323697668. pp.377-387.
40. Mackenzie EJ, Bosse MJ, Kellam JF, et al. Factors influencing the decision to amputate or reconstruct after high-energy lower extremity trauma. J Trauma 2002; 52(4):641-649.
41. Feliciano DV, Herskowitz K, O'Gorman RB et al. Management of vascular injuries in the lower extremities. J Trauma 1988; 28(3):319-28.
42. Davidovic LB. Europe: Serbia. In: Rasmussen TE, Nigel R.M. (eds). Rich`s Vascular Trauma 3rd Edition. Elsevier, Philadelphia-USA, 2015, pp.309-15.
43. Dragas M, Davidovic L, Kostic D, et al. Upper extremity arterial injuries: Factors influencing treatment outcome. Injury 2008; 40(8):815-9.
44. Davidovic L, Koncar I, Dragas M, et al. Treatment of Vascular Non-Iatrogenic Injuries of Upper and Lower Extremities in Tertiary Vascular Centre. J Cardiovasc Surg (Torino) 2023; 64(1):74-81.
45. Mubarak SJ, Hargens AR. Acute compartiment syndromes. Surg Clin North Am 1983; 63(3):539-65.
46. Wahlgren CM, Aylwin C, Davenport RA, Davidovic LB, wt al. European Society for Vascular Surgery (ESVS) 2025 Clinical Practice Guidelines on the Management of Vascular Trauma. Eur J Vasc Endovasc Surg 2025; 69:179-237.
47. Du Toit DF, Strauss DC, Blaszczyk M, et al. Endovascular repair of penetrating thoracic outlet arterial injuries. Eur J Vasc Endovasc Surg 2000; 19(5):489-495.
48. Shalhub S, Starnes WB, Tran NT. Endovascular treatment of axillosubclavian arterial transection in patients with blunt traumatic injury. J Vasc Surg 2011; 53(4):1141-4.
49. Lazarides MK, Georgiadis GS, Papas TT, et al. Operative and nonoperative management of children aged 13 years or younger with arterial trauma of extremities. J Vasc Surg 2006; 43(1):72-6. discussion 76.
50. Wahlgren CM, Kragsterman B. Management and outcome of pediatric vascular injuries. J Trauma Acute Care Surg 2015; 79(4):563–7.
51. Markovic MD, Cvetkovic SD, Koncar IB, et al Treatment of pediatric vascular injuries: the experience of a single Non-Pediatric referral center. Int Angiol 2019; 38(3):250-5.

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A man should not be valued for being learned,
But for his promise to be law.
If a man's word and deed are one,
He is truly worthy of respect.
Omar Khayyam

PREFACE

Vascular surgery, over its 200-year history, has come a long and complex path of development from the first vascular suture applied to a damaged brachial artery (in 1759 by Hollowel) to the current state of vascular surgery. The development of vascular surgery has become possible due to the use of all the achievements of modern biology, medicine and other sciences. Despite the progress of medical science, the incidence of acute vascular diseases and injuries remains high.

Further improvement in the quality of treatment for damage to major vessels depends on continuous improvement of: diagnostics; surgical treatment; introduction of the latest diagnostic equipment; operating equipment; special instruments and the introduction of modern achievements in pharmacology, physiotherapy and others.

It should be noted that most patients after reconstructive and restorative operations on blood vessels require: intensive treatment, constant medical and nursing supervision.

In recent years, the number of patients with traumatic vascular injuries and their consequences has increased. Unfortunately, until now, practicing doctors, in particular doctors of district hospitals, are little familiar with modern methods and principles of early diagnosis and surgical treatment of patients with traumatic vascular injuries and their consequences. In this regard, a large number of organizational, diagnostic, tactical and technical errors are committed, leading to disability and even death of patients. Therefore, prevention of vascular injuries is extremely necessary; active propaganda of the achievements and possibilities of vascular surgery among population. It is appropriate to note that when providing assistance to patients with traumatic vascular injuries, rational organizational approaches to their diagnosis and treatment are of particular importance. It should

be emphasized that vascular surgery departments have been operating in specialized surgery centers for more than 40 years, providing highly qualified care for acute trauma and chronic pathology of the main and peripheral arteries and veins. However, in the presence of: combined bone and vascular injuries; major blood loss; shock and other factors, it is not always possible to provide emergency care to patients in general surgery departments.

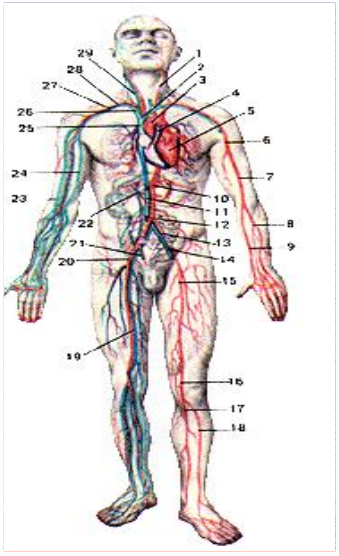
The most important task of medical practice is to bring specialized vascular surgery care closer to district and city hospitals. One of the ways to solve the problem is to organize mobile teams of vascular surgeons. In this direction, we have accumulated a certain experience in treating patients with vascular injuries and their consequences. For practicing physicians, the analysis of the causes of diagnostic, organizational, tactical and technical errors at different stages of treatment of patients with traumatic injuries of the main and peripheral vessels is of undoubted interest. In the process of detailed examination of patients using modern clinical and instrumental methods, the following were assessed: criteria of limb ischemia; state of arterial and venous blood flow; sufficiency of collateral blood supply; its microcirculation and others. These indicators are the key to success in treating this group of patients with their timely and correct diagnosis. Untimely diagnosis of damage to the main arteries and veins leads to: occurrence of traumatic aneurysms and arteriovenous fistulas; to amputations of limbs and fatal outcomes. In solving these problems, the vascular surgery departments are a scientific and methodological center. Our research is based on the materials of the vascular department of the specialized scientific practical medical center of surgery named after Academician V. Vakhidov. When writing the monograph, we tried to present the material at a modern level, taking into account the latest achievements of medical science and practice.

The authors will deeply appreciate critical comments and suggestions from users of the monograph aimed at improving its content.

CHAPTER I. BRIEF INFORMATION ABOUT THE VESSELS OF THE ARTERIAL AND VENOUS SYSTEM

Information about the vessels of the arterial system

The walls of the arteries consist of three layers: the outer (tunica adventitia), the middle (tunica media) and the inner (tunica intima). The adventitia is formed by longitudinal bundles of collagen fibers, including elastic fibers, which are especially pronounced at the border with the middle layer. The outer layer (tunica adventitia) is more developed in large and medium-caliber arteries, small vessels have a weakly expressed adventitia. The middle layer (tunica media) is represented by several membranes of circularly located smooth muscle fibers. They contain a network of elastic fibers. The muscular layer is more developed in medium-caliber vessels. With a decrease in the diameter of the artery, the number of muscular elements also decreases. Depending on the prevalence of certain morphological elements on the vessel walls, arteries are divided into elastic, muscular and mixed. Elastic arteries are: aorta; brachiocephalic trunk; subclavian, carotid, renal, experiencing high pressure of blood coming from the left stomach during systole. Smaller arteries are classified as muscular or mixed vessels. The development of the muscular layer promotes active movement of blood to the periphery. The walls of the arteries have their own arterial and venous vessels, as well as lymphatic vessels. They penetrate through the adventitia to the middle layer and form a capillary network. The intima has no blood vessels. Innervation is carried out by the sympathetic and parasympathetic nervous systems. A direct continuation of the arterial network is the microcirculation system, uniting vessels with a diameter of 2 to 100 microns. Microcirculatory systems include five elements: arteriole; pericapillary arteriole; capillary; postcapillary venule.

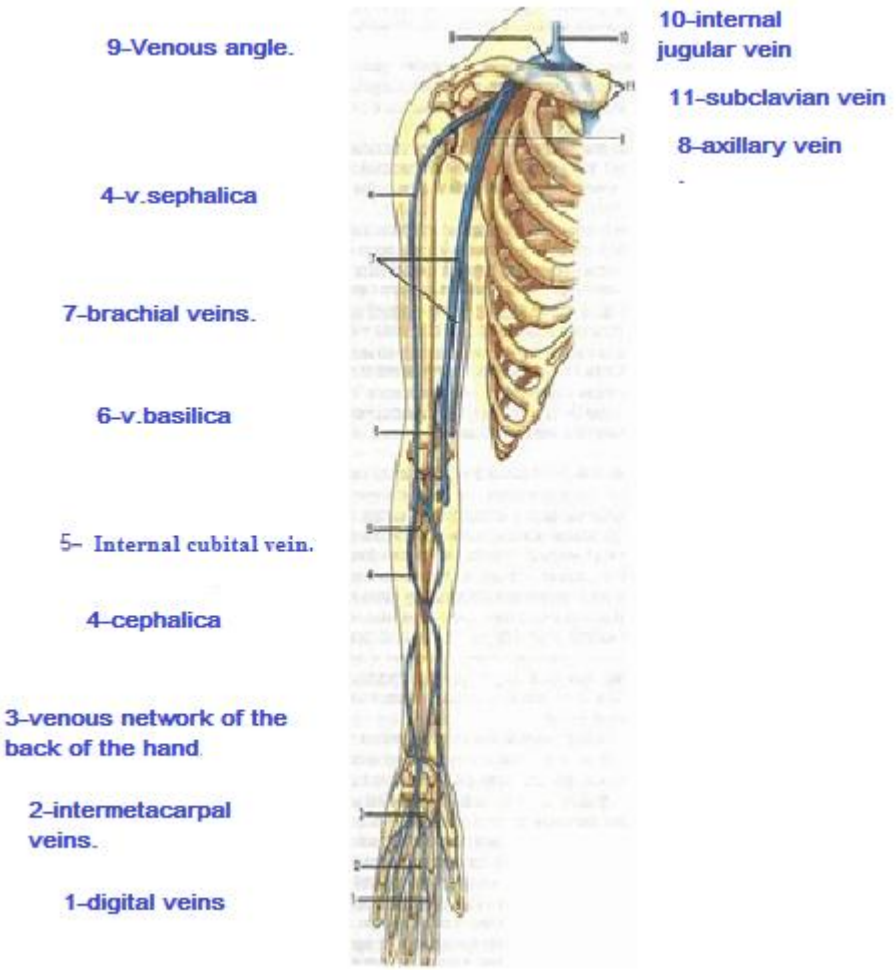


The vertebral artery a. vertebralis is paired - one enters the neck through the openings of the transverse processes of the cervical vertebrae, and the other enters

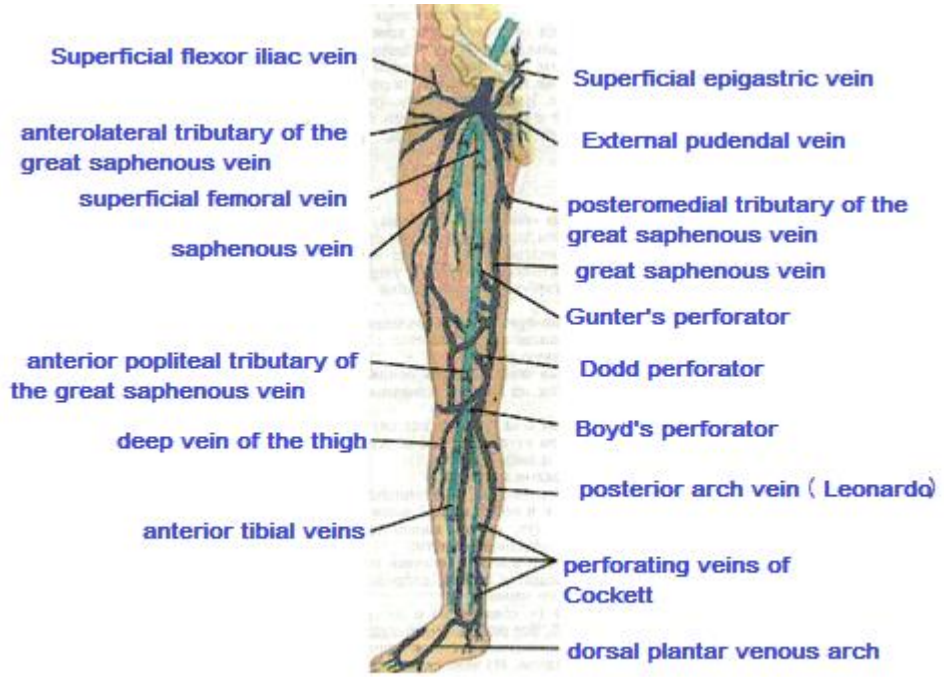
the cranial cavity through the foramen magnum. At the base of the skull, both vertebral arteries merge, forming the basilar artery a. basilaris, in a groove on the lower surface of the pons. From a. basilaris, two aa. cerebri posteriores depart, which connect through the posterior communicating artery with the middle cerebral artery.

Thus, the Willis arterial circle arises - circulus arteriosus cerebri (Willissii), which is located in the subarachnoid space of the base of the brain and surrounds the sella turcica at the base of the skull.

Anatomical features of the venous system



Anatomy of the veins of the upper limb



Anatomy of the veins of the lower limb

The venous system provides blood outflow from tissues and organs, receiving it from capillaries and arteriovenous anastomoses. The venous system has two main functions: transport and reservoir. The venous system contains about 70% of the total blood volume, with most of it located in venules and small veins up to 1-2 mm in diameter. Just like in arteries, the venous wall consists of three membranes: internal; middle and external. The outer membrane of the veins mainly consists of collagen fibers. The adventitia contains the vasa vasarum, which provides blood supply to the venous wall. The inner membrane of the veins is the thinnest and receives nutrition from the flowing blood. The inner membrane is represented by a layer of endothelial cells. In small veins and venules, this layer is not expressed. The middle membrane of the muscular layer is determined depending on the caliber of the vein. In venules, it is represented by circular fibers of smooth muscles. In medium-sized veins, it is also circular, but has longitudinally located muscle fibers. The muscle layer is most pronounced in the superficial main veins of the extremities, especially the lower ones. For the veins of the lower extremities, which are most often the object of surgical interventions,

information about the large and small saphenous veins, deep veins of the thigh and distal parts of the popliteal vein is very important.

The great saphenous vein (v. sapena magna), within the lower leg, is usually represented by one large trunk with multiple small tributaries. Removal of the great saphenous vein as an independent surgical intervention or to obtain a graft should be accompanied by ligation of its terminal tributaries and the main trunk, directly at the site of entry into the femoral vein. However, it is often necessary to observe separate inflow of three main tributaries: superficial external pudendal vein (v.pudenda externa superficialis), superficial epigastric vein (v.epigastrica superficialis), superficial vein surrounding the ilium (v.circumflexa ilei superficialis). Distal by 0.5-2.5 cm, two larger accessory veins flow into it: v.saphena accessoria medialis and v.saphena accessoria lateralis. These two tributaries are often well expressed and sometimes have the same diameter as the main trunk of the great saphenous vein. The small saphenous vein (v.sapena parva) rarely has a diameter sufficient for use as a graft, but plays an important role in compensating venous outflow in thrombosis of the deep veins of the leg.

The small saphenous vein drains into the popliteal vein in 70% of cases. The small saphenous vein drains into the femoral vein in 22.5% of cases; into the deep veins within the upper third of the leg in 6.9%. The popliteal vein (v. poplitea) is formed as a result of the fusion of paired deep veins of the leg. The level of formation of the popliteal vein trunk and the nature of its anatomical structure vary. There are three type of popliteal vein formation: in the middle of the popliteal fossa, above the level of the joint space; within the popliteal fossa, below the joint space and in the middle third of the leg.

The deep femoral vein (v.propunda femoris) is formed as a result of the fusion of muscle tributaries, which flows into the femoral vein. The level of fusion of the femoral veins is not constant and can vary within the upper quarter of the thigh, most often 6-7 cm below the inguinal ligament. A single long trunk with small tributaries was observed in 34%. A single short trunk with multiple large

tributaries was observed in 47%. Doubling of the trunk of the deep vein of the thigh was observed in 19%.

Superficial veins connect with deep veins through communicating veins. A distinction is made between direct and indirect communicating veins. The first of them directly connect the subcutaneous veins with the deep ones; the second - carry out this connection by means of small venous trunks and muscular veins. Direct communicating veins are located mainly on the medial surface of the lower third of the leg, where there are no muscles, and also on the feet. Normally, the diameter does not exceed 1-2 mm.

The first description of venous valves is given by the Italian surgeon Fabricius in 1574. The greatest number of valves are in veins of small and medium caliber. The external iliac, internal jugular and subclavian can be considered valvular veins. The veins of the extremities, muscular and subcutaneous veins of the body contain a large number of valves. In the largest vena cava of the body, the upper and lower valves are absent. They are rare in the innominate and common iliac veins. Thus, there are no valves: in the renal veins and the portal vein system; intracranial veins and sinuses. Veins have valves that prevent backflow of blood and promote its movement in a centripetal direction. The movement of blood is also promoted by: contractions of the heart, muscles of the shin and thigh; the suction action of the chest; intra-abdominal pressure. In this process, the tone of the venous system plays an important role.

The inner surface of the veins of the extremities

Physiology of the veins of the lower extremities

All veins of the lower extremities are equipped with bicuspid valves, which ensure blood flow in one direction from: superficial veins - to deep; distal areas - to proximal. Under the influence of retrograde blood flow, the valve closes, which promotes centripetal movement of blood and protects venules and capillaries from a sharp increase in pressure during the activity of the muscular pump. When a person stands, the hydrostatic pressure of the blood impedes venous outflow from the lower extremities. However, any contraction of the muscles of the lower leg and thigh drives blood through the veins in the proximal direction, and the venous valves, as mentioned above, prevent retrograde blood flow. This mechanism is called a muscular-venous pump or "peripheral heart". The flaps of full-fledged valves are strong and withstand pressure up to 3 atm. During walking, the pressure in the veins of the lower leg decreases by more than two times. All veins that drain blood from the muscles are equipped with valves. There are no valves in: the vena cava; the portal vein; the liver veins; the lungs and cerebral veins.

The transition from a lying to a standing position leads to an increase in hydrostatic pressure in the veins of the lower extremities. At the same time, in the arteries, the hydrostatic pressure also increases, within the same limits. Therefore, a change in body position is not accompanied by changes in the ratio of pressure in the veins and arteries, at the corresponding levels.

Above the inguinal ligament, venous blood moves toward the heart due to the respiratory movements of the diaphragm and the difference between intra-abdominal and intrathoracic pressure.

CHAPTER II. THE CURRENT STATE OF TRAUMATIC VASCULAR INJURIES AND THEIR CONSEQUENCES

2.1 Traumatic injuries of blood vessels of the extremities. Vascular injury remains one of the complex and unresolved problems of modern surgery in conditions of high risk of amputation and death of victims. The frequency of limb amputations due to traumatic vascular injury, according to various sources, is 5.3-9.1%, and in 3.7% of cases the severity of the injury and large volume of blood loss are accompanied by a fatal outcome. [6, 8]. This literature review analyzes the current state of the etiology, methods of early diagnosis and treatment of traumatic injuries of the vessels of the extremities and their consequences. As studies show, damage to large arterial and venous vessels leads to a fatal outcome in 10-56% of patients. According to Korolev M.P. (2011) and others [10], such outcomes were observed in 25.3% of cases. In most cases, the authors note [2,3], it is due to negative results of surgical treatment, from 27-75%. This work is devoted to traumatic injuries of the limb vessels. However, some issues remain an unsolved problem and, in our opinion, are only debatable.

Thus, during military operations, wounds with vascular damage make up (according to the results of the wars in Croatia and Afghanistan) from 7,5 to 75% [1,2,25]. In wartime, damage to the subclavian and axillary arteries make up 3,2-23,7%[[25] of all arterial injuries to the upper limb. In peacetime, these injuries, according to Gumanenko E.K., make up 15-30% [7]. In 38,4-95% of cases, injuries to the arteries of the extremities are accompanied by bone fractures. The mortality rate for vascular injuries in the counter-terrorism operation in the North Caucasus (1999-2003) reached 7.6%, according to the results of NATO military operations in Iraq and Afghanistan (2001-2014), this figure also amounted to 5,0–8,4% [20, 22, 26]. In peacetime, one of the severe types of injury is injury to the main cervical vessels [12]. Their treatment often ends with unsatisfactory results, reaching 27 -75%. In injuries to the vertebral artery, the cervical region

accounts for 25-37% of cases. In this case, anatomical and topographic features of the direction of the vertebral artery play a large role, which determine the high probability of its compression during injury. According to the mechanism of vascular injury, penetrating injuries, closed injuries and arterial spasm are distinguished [6]. Today, the problem of diagnostics and treatment of damage to the main arteries remains relevant. Therefore, it requires further research and timely comprehensive medical care in order to minimize the number of its early and late complications [5,13,14]. At the same time, the computed tomography method allows us to identify bone fractures and the presence of a foreign body during trauma. In the long term, this method allows us to detect areas of destruction and bone sequestration in time. [14]. Diagnostics of arterial damage is often accompanied by certain difficulties, especially in closed and combined injuries. It should be noted that preoperative angiography must be performed to determine the localization and extent of arterial damage. In addition, these processes wit are associated with certain signs of damage. Thus, unclear signs include: bleeding from the wound, localization of the wound, closed injuries to large vessels and joints, a small pulsating hematoma and neurological disorders. This also includes large blood loss with hypotension and shock [9]. In this case, vascular angiography is performed with obvious viability of the limbs, when the peripheral pulse is absent for an unclear reason. In case of injury to the vertebral arteries, a more informative diagnostic method is color duplex scanning, which allows assessing the local and systemic hemodynamic significance of extravasal influences. The degree of circulatory impairment in the vertebral artery during injury largely determines the treatment tactics. During control DS, 1 month after surgical treatment, positive dynamics of the vertebral artery (VA) was observed in 5-7.1% of cases. Thus, angiography remains the "gold standard" for diagnosing

traumatic vascular injuries. It should be noted that non-invasive methods of vascular injury diagnostics include Dopplerography, which has clear advantages over angiography and often allows for dynamic patient monitoring [21]. Duplex scanning helps to detect damage to arteries and veins, the location of a traumatic arteriovenous fistula or the presence of a pseudoaneurysm [4]. This method is reliable and accurate, as is surgical angiography of those screened. It can be used for minimal arterial injuries [37]. Currently, the possibilities have significantly expanded and indications for endovascular treatment of victims with damage to the arteries of the limb have improved. To a greater extent, this concerns the arteries of adjacent areas, especially in case of blunt trauma. The problem of providing emergency specialized care for traumatic vascular injuries, despite the successes achieved, remains relevant today [11]. Mortality in injuries of the main arteries and veins is 8-26.4%, and the frequency of limb amputations is 10.8-26% and does not tend to decrease. Satisfactory results after repeated interventions were obtained in patients with a good condition of the distal bed and operated on early after the detection of complications [16].

For many victims, when restoring arteries, it is necessary to assess the viability of the muscles. Six patients (3.2%) died from concomitant severe injuries. In 16 cases (15.1%), repeated amputation was required [23]. In line with the above, we analyzed the literature characterizing various approaches to the diagnosis of limb compartment syndrome - a pathology clinically significant for surgeons of different specialties and having different options for performing decompression fasciotomy. Depending on the surgical school, the technique of performing operations has significant differences. At the moment, there are no large randomized clinical studies on this issue. In this regard, there is still no clear answer about the best option for fasciotomy. Therefore, further research in this area is required [17]. General surgeons should be trained in REC skills [24]. Many specialized scientific and practical courses on endovascular surgery have been

organized worldwide [18,19,27]. Thus, complications of traumatic injuries to the vessels of the extremities cannot always be foreseen, and they present certain difficulties in their treatment. Due to the inconsistency of the results of the work performed and the views of researchers on many issues of diagnostics, treatment tactics for patients with vascular trauma, it is necessary to use the most modern technologies for the most accurate prediction of their outcomes. In this regard, it is necessary to develop an organization of medical measures for the timely prevention of complications in traumatic vascular injuries.

List of used references

1. Abugov S.A., Polyakov R.S., Puretsky M.V., Mardanyan G.V., Pirkova A.A., Krainikov D.A., Vartanyan E.L., Charchyan E.R. Results of endovascular treatment of aneurysms of the common iliac artery. Surgery. Journal named after N.I. Pirogov. 2021;(6 2):52 58. 3. Aliev S.A., Bayramov N.Yu. Results of treatment of wounded with mine-explosive trauma. Surgery. N.I. Pirogov Journal. 2022;(12):67-77.

2.Bakhriddinov F.Sh., Zayniddin Norman Ugli. Surgical treatment of traumatic vascular injuries in peacetime conditions// Bulletin of emergency medicine. 2016;2:32

3. Bacharev S.M. . Angiographic diagnostics and endovascular treatment of arterial trauma: author's abstract. diss... candidate of medical sciences; M., 2009.24 p.

4. Bliznets D.G., Runkov A.V., Zyryanov M.N., Shlykov I.L. Pseudoaneurysm of the superior gluteal artery after insertion of an iliosacral screw - a case of conservative treatment with spontaneous regression // Genius Orthopedics, 2019; 25 (1): 93-101.

5. Boyko V.V., Lurin I.A., Taraban I.A., Drozd I.A. Damage to the main arteries of the extremities (relevance, general issues, classification). Part 1 // Kharkiv surgical school. 2015;4: 137–143.

6.Valiev E.Yu., Khakimov R.N., Ismailov A.D., Karimov B.R., Saydaliev Z.R. Ganiev O.A. Surgical treatment of patients with combined bone and vascular

injuries of the lower extremities//Bulletin of emergency medicine, 2018; (11) 4: 84-89.
7. Gumanenko EK Military field surgery. St. Petersburg Folio: 2004; 464.
8. Kiselev V.A., Mokhov E.M., Vardak A.M. Analysis of diagnostic errors and tactics of surgical treatment of injuries of the main arteries of the extremities. Bulletin of experimental and clinical surgery. 2015;8(4):325-34.
9. Komarov R. N., Kurdo S. A. et al. On the issue of injury of the great vessels. Surgery. Pirogov Journal. 2011;11: 93-94.
10.Korolev MP, Urakcheev Sh.K., Postukhova NK. Surgical treatment of large vessel injuries// Vestnik khirurgiya. 2011; 6: 56-58.

11. Korotkov D.A., Mikhailov D.V. Rengenendovascular occlusion of pulsating hematomas and false aneurysms// Angiology and vascular surgery. 1998;4:134-136.
12. Pushkin S.Yu., Kameev I.R., Abashkin N.Yu. Surgical treatment of multiple neck injuries. Surgery. Pirogov Journal. 2022;(2):75 78.
13. Satueva E. Ya. Surgical methods of treatment of false aneurysm of the femoral artery in patients with drug addiction// Bulletin of medical Internet conferences (ISSN 2224-6150), 2016; 6 (5): ID: 2016-05-24-T-6753.
14. Svetlikov A.V., Reva V.A., Ignatenko M.V. Use of endovascular balloon occlusion of the aorta in hemodynamically unstable patients with bleeding // Angiology and vascular surgery. 2021; (27)1: 72-74
15. Seliverstov D.V., Suchkov I.A., Ryabova M.N., Gazaryan Z.S., Yudin V.A., Vvedensky A.I., Pshennikov A.S. Treatment tactics for non-combat mine-blast injuries of the lower extremities. Surgery. Journal im. N.I. Pirogov. 2020;7:97–101. https://doi.org/10.17116/hirurgia202007197.
16. Sultonyan T.L., Sargsyan A.S., Khachatryan A.M. Complications after reconstructive surgeries on the main arteries of the extremities and methods of their correction//Angiol. i vascular. surg. 2013;1: 124-128.

17. Fokin A. A., Bagaev K. V., Sazanov A. V., Zaitsev S. S. Fasciotomy, subfascial pressure, compartment syndrome// Bulletin of the Chelyabinsk Regional Clinical Hospital. 2017; 4:33–38.

18. Borger van der Burg, B. L.S., Boudewijn L.S., Hörer T.M. et al.Vascular access training for REVO placement: a feasibility study in a live tissue-simulator hybrid porcine model // J. R. Army Med. Corps. 2019; 165(3) 147–151.

19. Brenner, M. Basic endovascular skills for trauma course: bridging the gap between endovascular techniques and the acute care surgeon//J. Trauma Acute Care Surg. 2014; 77(2)286–291.

20. Markov, N. P., Dubose J.J., Scott D. et al. Anatomic distribution and mortality of arterial injury in the wars in Afghanistan and Iraq with comparison to a civilian benchmark // J. Vasc. Surg. 2012; 56(3). 728–736.

21. Moussa Pacha H, Alraies M.C, Soud M, Bernardo N.L. Minimally invasive intervention of radial artery pseudoaneurysm using percutaneous thrombin injection//Eur Heart J. 2018;39(3):257. Available from: https://doi. org/10.1093/eurheartj/ehx592.

22. Patel, J. A., White J.M., White P.W. et al. A contemporary, 7-year analysis of vascular injury from the war in Afghanistan // J. Vasc. Surg. 2018; 68, (6):1872–1879.

23.Radonic V., Baric D., Tudor M. et. al. Vascular injuries in war//Chirurg. 1995; vol.66, 9: 883-886.

24. Rasmussen, T. E., Woodson J., Rich N.M. et al. Vascular trauma at a crossroads// J. Trauma. 2011; 70,(5):1291–1293.

25. Stannard, A., Brown K.V., Benson C. et al. Outcome after vascular trauma in a deployed military trauma system//Br. J. Surg. 2011; 98, 461 (2):228–234.

26. Schaub F.,Theisis W., Bousch R. Manaagment of 219 consecututive cases of postkatherization psevdoaneurysms//J.Am.Coll.Cardiol.1997; 30: 370-375.

27. Villamaria, C.Y., Eliason J.L., Napolitano L.M. et al. Endovascular Skills for Trauma and Resuscitative Surgery (ESTARS) course: curriculum

development, content validation, and program assessment//J. Trauma Acute Care Surg. 2014;76(4). 929–935.

2.2. Traumatic bone and vascular injuries of the extremities

Timely diagnostics and optimization of surgical treatment tactics for patients with combined bone and vascular injuries remains one of the pressing problems of modern vascular surgery. This problem arose at the intersection of traumatology and vascular surgery. Currently, the increase in traumatic injuries to blood vessels and bones is associated with a sharp increase in the speed of vehicles, the intensification of labor, and scientific and technological progress. Mine-blast injuries (MBT) in peacetime differ significantly from injuries sustained during military operations [22]. In peacetime, 0,3-4% of vascular injuries are associated with vessels and 17.5% - gunshot injuries. 2% of patients have open fractures with injuries to the main vessels [10,21]. Vascular injuries are considered to be severe injuries due to the high frequency of complications and fatal outcomes of up to 25.5% [1]. In most cases, combined trauma of blood vessels and bones is diagnosed 14.4% [10]. The amputation rate after combined trauma is up to 40% [2]. In bone fractures, a significant number of vascular injuries occur during military operations and range from 20-31.25%. Peacetime accounts for 2-10,5% of such injuries [6]. The high frequency of combined injuries leads to the fact that the tactics of surgical treatment of bone and vascular injuries should be individual [15, 26, 34]. Bone and vascular injuries of the upper and lower extremities are often accompanied by a serious condition of the victims, requiring, first of all, resuscitation measures [11]. In recent years, a new direction has appeared in traumatology and vascular surgery, studying the clinical signs, course, diagnosis and treatment of blood vessels and bones [5]. Such injuries occur when an artery is pinched between bone fragments. Damage to arteries by bone fragments during operations has been observed with accidental extension of injured limbs. In practice, such cases have been described by a number of researchers [9,10]. As noted by some researchers [5,10], the presence of mobility leads to external bleeding and limb ischemia. In this case, intensive care should be provided. This

does not apply to rentgenoraphic examinations of bone injuries and the choice of surgical scope. Other researchers of this problem [10,14] note the presence of a long-term spasm in severe combined injuries, which is sometimes eliminated by conservative treatment. It should be noted that severe reflex spasm led to gangrene, requiring amputation of the limbs.

A number of researchers [6,29] emphasize that gangrene may develop due to massive muscle damage in combined injuries. In the case of a bone fracture, the vessel injury has its own characteristic specificity. Various vascular injuries and pathomorphological changes of varying severity are observed. The literature [10] contains data on the diagnosis of bone and vascular injuries. However, a number of researchers note [3,10,16] that it is necessary to take into account the nature of the fracture of bones and muscles. The authors [6,10] observed that sclerotic changes in the arterial wall affect the course of bone and vascular injuries. More than a day, the diagnosis of a rupture of the popliteal artery with a fracture of the fibula leads to gangrene of the extremities. At the same time, the outcome of most trauma patients with injuries is unsatisfactory. The diagnosis of bone and vascular injuries is based on clinical data, ultrasound Dopplerography and angiography. In bone and vascular injuries, angiography is often used when it is necessary to visualize and clarify the area of damage, and especially when there is a suspicion of bone fractures and joint dislocations [17,18]. The main method for diagnosing bone fractures and dislocations is an X-ray examination (63.4% of patients). As noted by another author [32], which was mainly based on clinical data: swelling, weakening of the pulse and limb ischemia. Without the use of additional research methods, only 26 (64.4%) patients. At work (19%) with vascular injuries. In addition to vascular injury, 34 patients (50%) had complex fractures, another 34 patients (50%) had multiple fractures [32]. To determine the degree of ischemia, ultrasound Doppler imaging, anography and MSCT were used [4]. Thus, Nazarov Kh.N. (2014) et al. [16] report that 46 patients underwent vascular reconstruction after application of the Ilizarov apparatus. Early

complications developed after the operation: wound suppuration (30%), arterial thrombosis (9%) and bleeding (9%).

A number of researchers [12,16] consider the optimal time for recovery of vascular injuries to be within 6 hours. After 6-7 hours, even restoration of blood flow leads to gangrene and forced amputation. Endovascular interventions are possible only in elective surgery in modern trauma centers [7]. Indications for limb amputation have now appeared for predicting (a developed scale) [22]. Thus, various fixation methods were used for gunshot fractures, most often extrafocal osteosynthesis with external fixation devices. Plaster bandages were applied for perforated fractures. A number of researchers note that false aneurysms of the axillary arteries are a rare disease. The literature indicates the main causes as stab wounds and fractures of the humerus [27, 35]. A common cause of limb gangrene (20-40%) is a violation of intra-tissue and intraosseous blood circulation with purulent complications [6]. Partial amputation in bone-vascular injuries according to the materials of the Afghan war reaches 30% [6]. In case of arterial spasm, bone fractures were eliminated using different methods - blockade according to Vishnevsky A.A. (1943), wetting the spasmed area with 2.5% papaverine [13]. In addition, various methods of suturing arteries are often used. Thus, equipment with tantalum staples is used for mechanical suturing of vessels. Transplants are also used to replace defects (patch) of large vessels. In autoplasty, the great saphenous vein of the thigh is mainly used. Synthetic grafts (lavsan, dokran, terylene, etc.) are widely used. Generalized experience in treating combined bone and vascular injuries during the Second World War is supported by examples of severe gunshot wounds. In this case, the only way to prevent limb amputation is vascular suture of the injured artery.

In recent years, surgical treatment of bone and vascular injuries has been replenished with various methods. In the literature, observations of a large number of favorable treatments for such injuries often appear [6]. Most scientists believe that, first of all, it is necessary to perform bone osteosynthesis [24,28,32]. However, there are other opinions on the method of restoring vascular damage

[27]. Elimination of the rupture by using temporary vascular bypass to restore blood circulation. In this case, an important issue is the choice of fixation of bone fragments. In recent years, external fixation of bone fractures has been used [31]. Indications for external fixation in cases of extensive soft tissue damage or comminuted fractures [10,30]. Intermodular osteosynthesis is applied in cases of fractures of the humerus, femur and tibia [10,35]. There are different opinions in the literature on the choice of tactics of surgical treatment for bone and vascular injuries. Thus, some [19] consider restoration of blood flow to be primary. Our experience of surgical treatment of this category of patients and analysis of postoperative complications such as thrombosis, disseminated intravascular coagulation, purulent complications, allow us to disagree with this opinion. We believe that in bone and vascular injuries, initial stable fixation of fragments makes it possible to determine the true defect between the ends of the vessels and choose the appropriate option for vascular suture or plastic surgery. The most effective method of temporary or final fixation of tubular bone fragments is intramedullary osteosynthesis. The choice of surgical treatment tactics depends on the individual indicators of the patient. The choice of the method of reconstructive surgery depends on: the nature of the vascular injury, its length and the presence of infection in the wound. The sequence of restoration of anatomical structures is as follows: artery, vein, fixation of bone fragments and plastic surgery of nerve trunks [10]. In this case, good and satisfactory results are 91.8%, amputation - 5% and mortality - 3.2% [10]. It should also be noted that if during reconstructive operations on the upper limb the primary goal is to ultimately restore sensitivity and movements of the forearm and hand, then the main function of the lower limb is supporting, which can be successfully compensated with the modern development of prosthetics [20]. Despite the successes in the diagnosis and surgical treatment of bone and vascular injuries and their consequences, there is still no consensus on the indications and contraindications for reconstructive operations and their scope. At the same time, there is no clear justification for the stages (after the formation of a traumatic aneurysm) of surgical treatment of

injuries and their consequences. Thus, there is no unified classification of bone and vascular injuries and no consensus on the choice of a method of surgical treatment of bone and vascular injuries. Experience shows that optimization of the choice of surgical treatment method depends on timely diagnostics and its individual implementation, depending on the external and internal factors affecting them. Based on the above, it can be said that diagnostics and surgical treatment of bone and vascular injuries are insufficiently developed and require further development.

List of used references

1.Bakhriddinov F.Sh., Zayniddin Norman Ugli. Surgical treatment of traumatic vascular injuries in peacetime conditions//Bulletin of emergency medicine. 2016;2:32

2.Boyko V.V., Lurin I.A., Taraban I.A., Drozd I.A. Damage to the main arteries of the extremities (relevance, general issues, classification). Part 1//Kharkiv surgical school. 2015;4: 137–143.

3.Valiev E.Yu., Khakimov R.N., Ismailov A.D., Karimov B.R., Saydaliev Z.R. Ganiev O.A. Surgical treatment of patients with combined bone and vascular injuries of the lower extremities//Bulletin of emergency medicine, 2018; (11) 4: 84-89.

4.Gavrilenko A. V., Kotov A. E., Molokopoi S. N. Clinical case rupture of acute aneurysm of the superficial femoral artery//Annals of surgery. 2012; (3): 59-61

5. Gavrilenko A.V., Vakhtaryan P.E., Kotov A.E., Alikin K.Yu. Surgical treatment of aneurysm of the deep femoral artery arteries// Angiology and vascular surgery.2013;2: 139-141.

6.Gumanenko EK Military field surgery. St. Petersburg Folio: 2004; 464.

7. Esipov, AV, Pinchuk O.V, Obraztsov A.V, et al. Treatment of combined bone and vascular injuries of the extremities in a multidisciplinary military hospital // Military-medical journal. -2020; 341 (1): 34–38.

8. Zatevakhin I. I., Zolkin V. N., Shikovsky V. N. et al. Five-year result of emergency endoprosthetics of an abdominal aortic aneurysm in case of its rupture // Kuban. med. vestn. 2013;5: 95–98

9. Zotov S.P., Zaitsev S.S., Fastakovskiy V.V., Orlyakhin A.V., Chistyakov A.S. A case of successful surgical treatment of a combined neck wound with rare variants of damage to the vertebral artery// Angiology and vascular surgery. 2010; 4:189-190.

10. Karimov E.A. Surgical treatment of vascular injuries. Abstract of Doctor of Medicine. Tashkent: 1992; 38.

11. Karim-Zade G.D., Malikov M.Kh., Nematzoda O., Davlatov A.A., Khairulloi Narzillo., Makhmadkulova N.A. On the issues of diagnostics and treatment of vascular injuries of the upper extremities. Avicenna Bulletin. 2019; 21(2):305-13. Available from: http://dx.doi.org/10.25005/2074-0581-2019-21-2-305-313.

12. Kungertsev E.V., Mikhailov I.P., Vinogradov Yu.A., Bodorenko A.N. Clinical case of surgical treatment of false aneurysm of the axillary artery // Annals of surgery 2012; 6: 48-51.

13. Korotkov D.A., Mikhailov D.V. Rentgenendovascular occlusion of pulsating hematomas and false aneurysms// Angiology and vascular surgery. 1998;4:134-136.

14. Leshchinskaya O.V., Kudryashova N.E., Mikhailov I.P., Chernysheva O.A. Posttraumatic false aneurysm of the femoral artery with arteriovenous anastomosis in a 32-year-old patient (clinical observation). Sklifosovsky Journal Emergency Medical Care. 2019;8(4):458–462. https://doi.org/10.23934/2223-9022-2019-8-4-458-462

15. Markov N. P., Dubose J.J., Scott D. et al. Anatomic distribution and mortality of arterial injury in the wars in Afghanistan and Iraq with comparison to a civilian benchmark // J. Vasc. Surg. 2012; 56(3). 728–736.

16. Nazarov, Kh. N., Gaibov A.D, Sadriev O.N Surgical tactics for combined osteovascular injuries of the lower extremities // Vestn. Avicenna. 2014; 61(4): 45–49.

17. Samokhvalov I. M., Gumanenko E. K., Samokhvalova Combat trauma of blood vessels. Bleeding and blood loss. Infusion-transfusion therapy in the wounded // Military field surgery of local wars and armed conflicts. M.: GEOTAR-Media, 2011. – P. 135–147.

18. Samokhvalov, I. M. Features of treatment of gunshot and mine-explosive trauma of the vascular bed// Vascular surgery. National guidelines. M.: GEOTAR-Media, 2014; 242–256.

19. Ter-Akopyan A.V., Kalinin A.A., Kryuchkova O.V., Abramov A.S., Tagaev N.B. Embolization of false aneurysm of the inferior gastroduodenal artery // Angiol. i vascular. shir. 2020; (26) 1: 138-141.

20. Khadzhibaev A.M., Asamov R.E., Minaev T.R. and others. Our experience in surgical treatment of multiple and combined injuries of the upper limb//Emergency Med. help. 2010; 1:62-65.

21. Tsygankov V.N., Frantsevich A.M., Varava A.B. Endovascular treatment of posttraumatic arteriovenous fistulas of the subclavian artery//Angiology and vessel surgery. 2013; (19)3: 151-159.

22. Shapovalov V.M., Gladkov R.V. Peacetime blast injuries: epidemiology, pathogenesis and main clinical manifestations//Medical, biological and socio-psychological problems of safety in emergency situations. 2014;3:5-16.

23. Shchedrenok V.V., Zakhmatova T.V. et al. Surgical correction of blood flow disorders in the vertebral artery in trauma and degenerative diseases // Bulletin of surgery. 2014;1:51-53.

24. Angiletta D., Pulli R., Marinazzo D. et al. Surgical and endovascular treatment of extracranial carotid artery aneurysms: early and longterm results of a single center//Ann. Vasc. Surg. 2014; Vol. 30: 493-495.

25. Bernat I, Horak D, Stasek J, Mates M, Pesek J .et al. ST-segment elevation myocardial infarction treated by radial or femoral approach in a multicenter randomized clinical trial: the STEMI-RADIAL trial//Journal of the American College of Cardiology. 2014; 63(10): 964-972. |

26. Siddique M.K.., Post-traumatic arteriovenous fistula reporting with haematuria after 25 years//J Coll Physicians Surg Pak. 2012; 22(9):591–593. PMID: 22980616.

27. Cano-Trigueros E, Díaz-Serrano R. Postraumatic pseudoaneurysm of the axillary artery presenting as an axillary tumor//Cir Esp. 2018; 96(7):451. https://doi.org/10.1016/j.ciresp.2017.11.010

28. Katsamouris A.N., Steriopoulos, Katonis, et al. Limb arterial injuries associatated with limb fractures: clinical presentation assessment and management // Europ J. Vase, endovase. Surg. 1995; Vol. 9, 1: 64-70.

29. Malte K., Perings. S. M., Thomas J. et al. Incidence and clinical outcome of iatrogenic femoral arteriovenous fistulas// J. Am. Coll. Cardiol. 2002; 40: 291 - 297.

30. Picard C, Belot A, Long A, Rouviere O, Chotel F, Dijoud F, et al. Kimura disease mimicking an aneurysm of the radial artery// J Pediatr. 2015;167(5):1166-6.e2. Available from: https://doi.org/10.1016/j.jpeds.2015.07.069.

31.Porceelin M., Bevnardo B., Capasso R. et al. Combined vascular injuries and limb fractures // Minerva Cardioangiol. 1997; vol. 45, 4: 131-138.

32. Priestley R., Brav P., Bray A., Hunter J. Iatrogenic vertebral arteriovenous fistula treated with a hemobahn stent-graft//Endovasc. Ther. 2003; Vol. 10, 36: 657 - 663.

33. Radonic V., Baric D., Tudor M. et. al. Vascular injuries in war//Chirurg. 1995; vol.66, 9: 883-886.

34.Turner C.A., Stockinger Z.T., Gurney J.M. Vascular surgery during U.S. combat operations from 2002 to 2016: Analysis of vascular procedures performed to inform military training//J. Trauma Acute Care Surg. 2018; 85(1): S145–S153.

35. Schumann D.R, Superti M.J, Seyboth F.C, Jacomel G.E. Brachial plexus injury secondary to pseudoaneurysm of axillary artery after glenohumeral dislocation: case report//Rev Bras Ortop. 2017; 52(4): 491-495. https://doi.org/10.1016/j.rboe.2017.06.004.

2.3. Jatrogenic damage to blood vessels:diagnostics and methods of surgical treatment

The emergence of new methods of examining a patient, an increase in unprofessional medical manipulations for diagnosis and treatment led to the socalled "iatrogenic injuries" [43]. The problem of developing modern diagnostics and tactics of surgical treatment of patients with iatrogenic vascular injuries and their consequences, as researchers emphasize, remains one of the topical and debatable problems of modern surgery [21,30,49]. In total, iatrogenic injuries account for 1 to 10% of hospital mortality. Jatrogenic vascular injuries (JVI) are described in the literature; they occur in all areas of surgery [6]. According to A.V. Khmelova [22], the term "iatrogenesis" should be understood as "any undesirable consequences of preventive, diagnostic and therapeutic interventions or procedures leading to dysfunctions of the body, disability or death, complications of medical measures that developed as a result of both erroneous and correct actions of the doctor." The true frequency of iatrogenic injuries is unknown, due to the complexity of their systematization from the number of surgical interventions in various diseases [17]. Iatrogenic injuries of peripheral arteries, as a rule, occur due to damage to arteries by sharp objects during diagnostic and therapeutic manipulations. In this case, all layers of the vascular wall are damaged [29]. Iatrogenic vascular injuries occur during laparoscopic and, in some cases, complex reconstructive surgeries [10,34,36]. In the pathogenesis, great importance is attached to has a narrow surgical field. This is due to an inadequate choice of optimal access, tumor prevalence and other reasons [35]. The risk of vascular damage during traumatological interventions [16]. At the same time, surgical treatment of UT is possible using rentgen endovascular methods [14,31]. In recent years, the number of iatrogenic injuries during lumbar laminectomy has also increased (0,08%) [23]. When thrombin is injected into the aneurysm cavity, the efficiency is up to 90-100%. However, after this, various complications develop, mainly the development of false aneurysms [25,26,31,40,41]. Usually, after an injury, a pulsating hematoma occurs in the wall of the radial artery, but it is recognized and treated in time [5, 4]. False iatrogenic

aneurysm of the main arteries of the extremities complicated by arrosive bleeding in patients suffering from drug addiction. This is a severe disease, in which the mortality and amputation rate exceed 50% [11]. According to Asfour V. et al [24] (2018), the incidence of complications and fatal outcomes ranges from 6 to 13%. Most often occurs during the installation of a needle or primary trocar [24,34]. However, it is not always possible to determine the degree of vessel involvement in the tumor process, even using MSCT [27]. Patel A. et al [40], incorrectly performed artery puncture during catheter implantation in the central vein, ranges from 4.2 to 9%. Therefore, the doctor is required to have knowledge and experience in implantation. The literature describes cases (during catheterization) of damage to the subclavian artery and vein [12]. Vascular iatrogenic injuries are often encountered in hip and knee joint surgeries [16]. Researchers [15,16] treated 97 patients with iatrogenic vascular injuries of various types and locations. In this case, thrombosis was detected in 66.5%, pulsating hematomas and false aneurysms in 24.5%, and others in 9% of patients.

Emergency or urgent surgeries were performed to restore ischemic limbs. A total of 97 patients were operated on. Thrombectomy and suturing of the vascular wall defect were performed in 72 (74.3%) patients. At the same time, fixation with iliosacral screws remains one of the effective methods for treating unstable pelvic injuries due to its minimally invasiveness and low trauma. However, the proximity of the superior gluteal vascular-nerve bundle to the entry point of the iliosacral screws determines the risk of iatrogenic injury to the superior gluteal artery [3]. In addition to iatrogenic complications, pseudoaneurysms are observed. A pseudoaneurysm is a false aneurysm. It occurs when the wall of a blood vessel is damaged. They occur in more than 60% of cases. They are most common after endovascular cardiac interventions, based on anticoagulant or thrombolytic therapy [37]. Bleeding complications are a significant source of morbidity and mortality in patients undergoing cardiac catheterization. Numerous studies, including the recently published large RIVAL trial, have compared the outcomes of transfemoral and transradial approaches. The current study aimed to investigate

whether transradial access would be superior to transfemoral access in patients with ST-segment elevation myocardial infarction (STEMI) [43]. Some scientists believe that traditional treatment of iatrogenic false aneurysms is associated with a high risk of developing various types of complications - wound infection, rough scar, pain in the wound area [33]. Intensive development of endovascular methods and orthopedic operations contributes to the emergence of iatrogenic, that is, doctor-induced (medical manipulations) complications, such as bleeding, thrombosis, pulsating hematomas, spasms, arteriovenous fistulas, dissections, etc. Due to the fact that such diseases are rarely diagnosed at a curable stage. In some cases, subclinical false aneurysms are detected accidentally during ultrasound examinations [23]. The diagnosis of traumatic iatrogenic aneurysm is established on the basis of clinical, ultrasound Doppler and MSCT data. Clinical signs are revealed during examination of any patient. Currently, ultrasound Doppler + DS has become the main method for diagnosing JA [18]. The most informative method for studying JA is MSCT, which allows non-invasive and more accurate assessment of the state of the arterial and venous vessel. Timely establishment of the causes of iatrogenic trauma (JT) after diagnostic and therapeutic procedures is necessary for the prevention of complications and their rapid surgical correction, although this is difficult to achieve [20]. In recent years, many consequences of vascular injuries associated with the use of angiography have been described in the literature. Some researchers note that iatrogenic vascular injuries during rentgen examination and probing are manifested in the form of thrombosis, perforation of the vessel wall. It occurs from 0,2 to 0,8% of cases [19]. Currently, modern methods of surgical treatment of various manifestations of JA are used. The correct method of treatment is compression treatment. For this purpose, TR Band has been proposed as an effective noninvasive method for treating pseudoaneurysms after catheterization [28]. In this case, treatment of spontaneous closure of the arterial puncture site after anography. This treatment is carried out within 15-30 minutes after the procedure. This procedure prevents the formation of a pseudoaneurysm [44]. For the

treatment of catheterization aneurysms, direct pressure with a hand on the specified area is used to stop blood flow in the aneurysm [197]. This can be achieved by bandaging under ultrasound control. Control angiography 3 weeks and 5 months after treatment did not reveal fistulas and stenosis inside the stent grafts. Another 2-cm stent graft was delivered, which was successfully placed through the fistula. The AVF completely disappeared. Babunashvili A. M. et al (2017) [1] described a new technique and technology for the treatment of radial artery pseudoaneurysm (RAP) caused by transradial access (TRA) using coronary angiography. Traditional external compression with cessation of radial blood flow leads to a local environment associated with an increased likelihood of radial artery occlusion (RAO). This technology involves obtaining ipsilateral unilateral access to the radial artery, distal to the RAP neck, followed by prolonged stay of the sheath in the RAP neck, which allows thrombosis of the RAP sac. This maintains the patency of the radial artery lumen [1]. Indications for the use of endovascular methods in the treatment of post-traumatic radial artery aneurysms are: limited availability of the technique, the impossibility of subsequent use of the radial artery for repeated endovascular interventions [1,39,45].Ultrasonography confirmed the diagnosis of pseudoaneurysm. Therefore, TR Band was used to compress the mass. Therefore, the use of transradial bandages (TR Band) is proposed as an effective conservative non-invasive method for the treatment of pseudoaneurysms after catheterization [28]. Tsiafoutis I., Zografos T. et al (2018), [45] note that after the procedure, at the radial puncture site, the patient had a gradually expanding pulsating mass, which was confirmed by ultrasound. It was a large pseudoaneurysm originating from the right radial artery, measuring 27 × 17 mm. After 2 unsuccessful attempts at manual compression and due to a limited amount of thrombin, percutaneous endovascular repair was chosen as an alternative to surgical repair [45]. Open reconstructive and restorative surgeries are the optimal surgical treatment for iatrogenic aneurysms, especially complicated forms [10]. It should be noted that before the proposed compression method, aneurysms were treated only surgically.

Korotkov D.A. et al. [9] believe that endovascular occlusion of vessels is a low-traumatic and independent method of treatment. In surgical interventions for injuries and aneurysms, a stent graft is often used [7]. Successful performance of endovascular operations, especially on arterial aneurysms, is associated with strict selection patients [20]. There are isolated reports in the literature on surgical treatment of iatrogenic axillary artery aneurysms after endovascular surgery [38,46]. However, their treatment is also associated with complications. Staphylococcus aureus was isolated in more than 90% of all reported cases. Rupture of a false aneurysm can be serious and may occur days or weeks after hospital discharge. Surgical treatment of infected radial artery pseudoaneurysm is highly recommended, including removal of the false aneurysm and repair or ligation of the artery [32]. Compression is painful and often requires anesthesia. Good results with such treatment are from 47-100% of patients. Postoperative recurrence is about 30%. If the false aneurysm is more than 3 cm in diameter, a lateral suture is performed. [42]. If the aneurysm is large in diameter, it is necessary to surgically evacuate the hematoma and reconstruct the damaged vessel. In some cases, it is impossible to perform a puncture of the cavity due to filling with a thrombus. In such cases, a number of researchers note the correctness of the compression method of treatment under ultrasound control, which makes it necessary for surgical treatment, especially for large aneurysms [47]. Until now, surgical reconstruction has been a traditional, gold standard in the treatment of iatrogenic aneurysms. Some authors consider an increase in the size of the aneurysm, aneurysm rupture and the presence of limb ischemia to be absolute indications [42]. Currently, special attention is paid to a promising minimally invasive direction in angiology: puncture obliteration of false aneurysms using thrombin [13]. For infected false aneurysms, the method of choice is bypass autovenous shunting outside the zone of infection and inflammation. A common complication is an allergic reaction and arterial thromboembolism. At the same time, the risk of thrombotic complications increases with repeated administration of thrombin [48]. Reconstruction of

arteriovenous fistula (AVF) after hemodialysis remains difficult. Due to proximal stenosis of v. cephalica, the patient developed aneurysms of the "fistula" veins: segment of v. cephalica and v. intermedia cubiti, complicated by thrombosis of the AVF. Blood outflow from the AVF was carried out in a retrograde direction. As the author notes, a week after the thrombosis, the aneurysm of v. intermedia cubiti containing dense thrombi was excised. Aneurysmography of v. cephalica was performed, the excess wall was excised. An anastomosis of the reconstructed vein with the brachial artery distal to the previous anastomosis was formed. Plastic surgery of the stenotic proximal segment of v. cephalica was performed using the resected walls of the aneurysm. After 1 year, the AVF is successfully used for hemodialysis [2]. In our opinion, the division of operations based on absolute and relative indications for patients with iatrogenic aneurysms of arteries and veins is incorrect. The presence of a false aneurysm is an absolute indication for surgical correction of patients. Modern principles of diagnostics and tactics of surgical treatment include the following stages: preoperative correction, active surgical tactics, application of lateral, circular sutures and prosthetics and vascular plastic surgery. With the steady increase in the incidence of iatrogenic aneurysms, their surgical treatment is becoming increasingly important. The most effective methods for diagnosing these diseases are ultrasound Doppler imaging and MSCT. For the correct treatment of iatrogenic aneurysms, vascular reconstruction is of great importance. Thus, iatrogenic vascular injuries and their consequences represent a rather heterogeneous group of injuries. It should be noted that to date, an algorithm of tactical and therapeutic actions, a working classification of various vascular injuries and their complications have not been developed, modern effective and optimal approaches, and scientific and methodological recommendations for their diagnosis and surgical treatment have not been proposed. In the practical work of medical institutions, especially surgical hospitals and specialized Vascular Surgery Centers, it is necessary to pay more serious attention to the detection and treatment of iatrogenic vascular injuries.

List of used references

1. Babunashvili AM., Pancholy S.B., Kartashov D.S. New technique for treatment of postcatheterization radial artery pseudoaneurysm//Catheter Cardiovasc Interv. 2017; 89(3):393-398. Available from: https://doi.org/10.1002/ccd.26717.

2. Baikov B.V., Zulkarnaev A.B., Yankovoy A.G., Strugaylo E.V. Complex reconstruction of arteriovenous fistula for hemodialysis. Surgery. Journal im. N.I. Pirogov. 2021;(1):90-92.

3. Boyko V.V., Lurin I.A., Taraban I.A., Drozd I.A. Damage to the main arteries of the extremities (relevance, general issues, classification). Part 1 // Kharkiv surgical school. 2015;4: 137–143.

4. Vereshchagin S.V., Abramenko A.V., Khomyachuk O.A.and others. Endovascular treatment of a patient with a false aneurysm of the splenic artery with severe tortuosity of the arterial bed//Endovascular neuroradiology 2020;1(31): 68-74

5. Vinogradov R.A., Matusevich V.V., Kazantsev A.N., Sukhoruchkin P. .V. Resection of arteriovenous malformation of the lumbar region//Surgery. Journal im.N.I.Ptrogov.2022;(7):101-105.

6. Kalinin A. A., Patlachuk M. V., Morozov S. P. et al. Staged treatment for aneurysms of the popliteal, iliac and femoral arteries // Surgery. 2013;8: 67–69.

7. Karimov E.A. Surgical treatment of vascular injuries. Abstract of Doctor of Medicine. Tashkent: 1992; 38.

8. Karpenko A.A., Starodubtsev V.B., Edemsky A.G., Chernyavsky A.M. Experience in surgical treatment of post-traumatic arteriovenous aneurysms in the aorto-renal zone // Angiology and vessel surgery. 2011; (17)2:139-144.

9. Korotkov D.A., Mikhailov D.V. X-ray endovascular occlusion of pulsating hematomas and false aneurysms// Angiology and vascular surgery. 1998;4:134-136.

10. Kungertsev E.V., Mikhailov I.P., Vinogradov Yu.A., Bodorenko A.N. Clinical case of surgical treatment of false aneurysm of the axillary artery // Annals of surgery 2012; 6: 48-51.

11. Malikov M. Kh., Davlatov A. A., Ibragimov E. K., Kamolov A. N., Karimzade G. D., Makhmadkulova N. A., Khairulloi N., Mirzobekov H. F. Reconstructive surgery of combined injuries to the upper extremities. Avicenna Bulletin. 2018;20(4):410-5. Available from: https://doi.org/10.25005/2074-0581-2018-20-4-410-415.

12. Osmolovskiy A.N. Comparative Analysis of Subclavian Vein Puncture Methods. Advances in Modern Science. 2017; 2(3): 160–164.

13. Panfilov D.S., Kozlov B.N., Panfilov S.D., Pryakhin A.S. Treatment of iatrogenic false aneurysms of the femoral arteries// Angiology and vascular surgery 2018; (24)3:19-24.

14. Prozorov S.A., Belozerov G.E., Ivanov P.A., Bocharov S.M. Endovascular treatment of vascular complications after traumatological operations. Endovascular surgery. 2017;4(3):213-218.

15. Pryadko SI. Diagnostics and tactics of surgical treatment of iatrogenic injuries of the main vessels// Thoracic and cardiovascular surgery. 1997; 2:188.

16. Safarov D. M. Complications in hip arthroplasty. Avicenna Bulletin. 2017; 19 (4): 524–527.

17. Unguryan V. M., Grinev M. V., Demko A. E., Povzun S. A. Iatrogenic manipulations in abdominal surgery// Vestnik of surgery im. I. I. Grekov. 2013;172(5):046-050.

18. Fokin A. A., Kireev K. A., Moskvicheva M. G., Kireeva T. S. Prevention of post-puncture iatrogenic false aneurysms of the femoral arteries after coronary interventions for myocardial infarction// Angiology and vascular surgery. 2016; 22 (2): 139–144.

19. Fokin A. A., Bagaev K. V., Sazanov A. V., Zaitsev S. S. Fasciotomy, subfascial pressure, compartment syndrome// Bulletin of the Chelyabinsk Regional Clinical Hospital. 2017; 4:33–38.

20. Khadzhibaev A.M., Asamov R.E., Minaev T.R. and others. Our experience in surgical treatment of multiple and combined injuries of the upper limb//Emergency Med. help. 2010; 1:62-65.

21. Khamrakulov Z.S. On the issue of iatrogenic aneurysms//Med. zhurn. Uzbekistan. 1981;1:71-73.

22. Khmeleva A.V. Certain aspects of using special knowledge in investigating iatrogenic crimes//Almanac of modern science and education. 2016;5(107):86-90.

23. Shumilina M.V., Zandneprovskaya V.V, Sushkova A.V. Iatrogenic vascular injuries // Clinical physiology of blood circulation.2020;17(2):130-141.

24. Asfour V, Smythe E, Attia R. Vascular injury at laparoscopy: a guide to management//J Obstet Gynaecol. 2018; 38(5):598-606. https://doi.org/10.1080/01443615.2017.1410120.

25. Alerhand S, Apakama D, Nevel A, Nelson B.P. Radial artery pseudoaneurysm diagnosed by point-of-care ultrasound five days after transradial catheterization: A case report//World J Emerg Med. 2018;9(3):223-6. Available from: https://doi.org/10.5847/wjem.j.1920-8642.2018.03.010.

26. Cauchi M.P, Robb PM, Zemple R.P, Ball T.C. Radial artery pseudoaneurysm: a simplified treatment method//J. Ultrasound Med. 2014;33(8):1505-9. Available from: https://doi.org/10.7863/ultra.33.8.1505.

27. Gallieni M, Hollenbeck M, Inston N. Clinical practice guideline on peri- and postoperative care of arteriovenous fistulas and grafts for haemodialysis in adults. //Nephrol Dial Transplant. 2019; 34(2):1-42. https://doi.org/10.1093/ndt/gfz072.

28. Ghanavati R., Arab Ahmadi M., Behnam B. Successful nonsurgical treatment of a radial artery pseudoaneurysm following transradial coronary angiography// J. Tehran Heart Cent. 2017; 12(2): 82-4

29. Goncu T, Toktas F, Tiryakioglu O, Yumun G, Demirtas S, Yavuz S. Posttraumatic true aneurysm of the ax illary artery following blunt trauma//Case reports in medicine 2010; 20: 210391.

30. Han A, Ahn S, Min SK. Oncovascular Surgery: Essential Roles of Vascular Surgeons in Cancer Surgery//Vasc Specialist Int. 2019; 35(2):60-69. https://doi.org/10.5758/vsi.2019.35.2.60

31. Hahalis G, Tsigkas G, Kakkos S, Panagopoulos A, Tsota I, Davlouros P, et al. Vascular complications following transradial and transulnar coronary angiography in 1600 consecutive patients//Angiology. 2016;67(5):438-43. Available from: https://doi.org/10.1177/0003319715592095.

32. Hashimoto H, Fukushima Y, Kumita Sh, Miyamoto M, Takagi G.Prognostic value of lower limb perfusion single photon emissioncomputed tomography computed tomography in patients withlower limb atherosclerotic peripheral artery disease//Jpn J Radiol. 2017; 35(2):68–77. https://doi.org/10.1007/s11604-016-0602-y

33. Johnson, M. A., Neff L.P., Williams T.K. et al. Partial resuscitative balloon occlusion of the aorta (REVO): clinical technique and rationale//J. Trauma Acute Care Surg. 2016; 81(5): (suppl. 2). S133– S137.

34. King N, Friedman J, Lin E, Traylor J, Wong J, Tsai S, Chaudhari A, Milad M. Systematic review of major vascular injuries during gynecologic lapraroscopy for benign indications//American Journal of Obstetrics & Gynecology. 2019; 220 (3):766-767. https://doi.org/10.1016/j.ajog.2019.01.132.

35. Kleive D, Sahakyan MA, Khan A, Fosby B, Line PD, Labori KJ. Incidence and management of arterial injuries during pancreatectomy//Langenbecks Arch Surg. 2018;403(3):341-348. https://doi.org/10.1007/s00423-018-1666-1.

36. Louie B.E. Catastrophes and complicated intraoperative events during robotic lung resection//J Vis Surg. 2017; 3:52. https://doi.org/10.21037/jovs.2017.02.05

37. Majwal T. K., Ismoil A., Alagily R., Invas J.. Renal artery stenosis associated with saccular aneurysms and arteriovenous fistula//Cardiol. -2002; Vol. 14, 7: 411 - 413.

38. Mehta S.R., Sanjit S Jolly, John Cairns, Kari Niemela, Sunil V Rao, et al. Effects of radial versus femoral artery access in patients with acute coronary

syndromes with or without ST-segment elevation//J. Am.Coll.Cardiol.2012; 50(24): 2490-2499.

39. Nough H, Bagherinasab M, Emami M, Sarebanhassanabadi M, Hadiani L. Endovascular treatment of post-traumatic pseudoaneurysms of ulnar and radial artery//Acta Med Iran. 2014;52(11):865-867

40. Patel A.R, Patel A.R, Singh S, Singh S, Khawaja I. Central Line Catheters and Associated Complications: A Review. Cureus. 2019;11(5):e4717. https://doi.org/10.7759/cureus.4717.

41. Paxiuta J, Lobão MJ, Carvalho L. Radial artery pseudoaneurysm: rare complication of a frequent procedure//BMJ Case Rep. 2017;10:2016218313. Available from: https://doi.org/10.1136/bcr-2016-218313.

42. Ricci M.A., Trevisani G.T.,Pilcher D.B.Vascular complicationis of cardiac catherization//Am.J.Surg.1994; 167: 375-378.

43. Seidel, F. Miranda, Leandro V Fregadolli; Yatrogenic pseudoaneurysm of axillary artery//Arquivos Brasileiros de Cardiologia 2011; 86(4):303-305.

44. Toda R., Yuda T., et al. Surgical repair ofa solitari deep femoralis aneurysm: report of two cases surg//Taday.2000; 30:4 81-483.

45. Tsiafoutis I., Zografos T., Koutouzis M., Katsivas A. Percutaneous endovascular repair of a radial artery pseudoaneurysm using a covered stent//JACC Cardiovasc Interv. 2018; 11(11): 91-92. Available from: https://doi. org/10.1016/j.jcin.2018.03.047.

46. Weger N., Klaasen Z., Sturt C., Hertz S. Endovascular treatment of pseudo aneurysm after an jatrogenic axillary artery injiury//Ann.Vasc.Surg.2010; (24), 6:826.

47. Wixon C.L., Philpott J.W., Bogey W.M., Jr.,Powell C.S. Duplex –directed thrombin injection as a method to treat femoral artery, pseudoaneurysms//J.Am.Coll. Surg.1998; 187: 464-466.

48. Schaub F., Theisis W., Heinz M.Nev aspects in ultrasound-duided compression repoir of catherezation femoral artey injuries//Circulation.1994; 90: 1861-1865.

49. Yared K., Baggish A.L, Wood MJ. High output heart failure resulting from a remote traumatic arteriovenous fistula//Can J Cardiol. 2009; 25(4):143-144. PMID: 19340363 https://doi.org/10.1016/s0828-282x (09)70083-2.

2.4. Diagnostic methods and surgical tactics for treating traumatic arterial aneurysms

Diagnostics and optimization of surgical treatment of vascular injuries in peacetime and wartime are still relevant [7, 8, 51]. Surgical treatment of vascular injuries and their consequences has a 2000-year history. Despite this, some issues remain insufficiently resolved and require further development. Until the beginning of the 20th century, surgical interventions for traumatic vascular injuries and their consequences were mainly palliative in nature [11]. The problem of timely diagnosis and treatment of damage to the main peripheral vessels is relevant, since in the absence of emergency specialized care, these injuries, in addition to fatal bleeding, are often complicated by the development of a false aneurysm [57] Thus, with stab, stab-cut wounds with a narrow wound channel and a closed thrombus, with damage to the subclavian artery, traumatic aneurysms or traumatic arteriovenous fistulas may occur [38, 59]. Over the past decade, due to the increase in the frequency of conflicts with the use of bladed weapons, cases of damage to peripheral arteries with the subsequent development of a pulsating hematoma and false aneurysm have become more frequent [30, 53].

Ligation of vessels remains the main method and is used to stop bleeding to save the life of the victim. However, this causes a high percentage of amputations [50]. Despite the improvement of conditions for providing medical care for injuries to peripheral vessels, the incidence of false aneurysms remains high and amounts to 0.001%11.2% [16, 29, 48]. Among peripheral vessels, false aneurysms of the radial artery are encountered in most cases [28]. In recent years, due to a sharp increase in the number of injuries, damage to the main and peripheral vessels has increased [169]. In this case, the mortality rate is 15-25.5%, and amputations - 17.3% of patients [62]. Pryadko S.I. et al. [24] note that out of 132 patients with aneurysms of peripheral arteries, 72 (54.5%) had traumatic aneurysms. Aneurysm of the deep femoral artery occurs in 0.5-2.6% of cases and

is more often observed in men [58]. Pseudoaneurysm of the splenic artery (SA) is a rare disease, even more rarely it is detected as a cause of acute bleeding from the upper gastrointestinal tract [32]. Aneurysms of the splenic artery are always discovered by chance . Embolization of a false aneurysm of the inferior gastroduodenal artery with a separated microcoil, the possibility of endovascular superselective embolization of the target vessel has been shown [27]. Endovascular prosthetics was performed on the splenic artery affected by a false aneurysm and its embolization was carried out using a traditional technique using standard angiographic catheters. As noted by the researchers, endoprosthetics (stent graft implantation) is performed in the presence of a vascular defect, aneurysm or arteriovenous fistula (AVF) [1,34,49]. Despite the achieved capabilities of endovascular treatment methods, surgical intervention remains the "gold standard" in the treatment of patients with occlusion of the celiac trunk in combination with aneurysm of the pancreaticoduodenal arteries [20]. In recent years, there has been a tendency towards an increase in the number of patients with TAA, and it ranges from 3,4-6,7% [9,26]. The literature reports on a single surgical treatment of iatrogenic aneurysms of the axillary artery after endovascular operations [18, 61]. Therefore, open reconstructive and restorative operations have not lost their relevance and need to be improved taking into account modern methods and technical capabilities [29]. However, the frequency of unfavorable outcomes of operations with posttraumatic complications remains high. In other studies [19], out of 32 patients with post-puncture false aneurysms of the femoral arteries after endovascular manipulations, puncture treatment was effective in 30 (93.7%) patients. In 2 (6.3%) cases, the results of puncture treatment were unsatisfactory, which required surgery. In the long term, there were no relapses [19]. In peacetime, the formation of aneurysms is mainly associated with diagnostic errors in the choice of tactics for surgical treatment of vascular damage [31,36]. The most common consequences of surgical treatment of a false aneurysm of the femoral artery is the development of gangrene, which is largely associated with the very technique of ligation of the external iliac and

femoral arteries [22]. As the author emphasizes, the indication for hospitalization in 42% of cases was a rupture of a false aneurysm of the femoral artery, and in 58% - a threat of rupture of a false aneurysm of the femoral artery [22]. Closure of stent grafts in the near or late postoperative period, as well as possible deformation of the implanted stent grafts due to various movements in the wrist joint [5]. Patients underwent angiography, ultrasound and computed tomography (CT), according to indications. The use of CT is considered especially valuable in mixed aneurysms, which allows improving the results of surgical treatment of traumatic aneurysms of the arteries of the lower extremities. In this case, the following were observed: good results - 41 (66.4%); satisfactory - 17 (11.2%) and unsatisfactory - 4 (6.4%) patients.

Other researchers [13] did not perform reconstruction in 14 observations of patients. In this case, ligation operations were performed, and in some cases, partial removal of the aneurysm was performed. Three patients underwent resection of the aneurysm with replacement with a stent graft [17]. An iliac artery aneurysm is characterized by an expansion of the lumen of the artery, which is 1.5 times larger than the normal diameter of the artery. In clinical practice, this disease is rare. It is associated with arterial hypertension, smoking and is more often observed in men [21]. Aneurysms of the common iliac artery, combined with an aneurysm of the infrarenal part of the abdominal aorta, occur in approximately 20% of patients [2]. To detect a false aneurysm of the splenic artery, MSCT is a valuable diagnostic method. At the same time, endovascular stenting of a pseudoaneurysm of the splenic artery is a promising treatment method [3]. It should be noted that splenic artery aneurysms (SAA), especially given their asymptomatic course, can occur in a variety of situations. In uncomplicated cases, endovascular techniques can be used in the absence of morphological changes requiring a resection approach [15]. It should be emphasized that in case of traumatic aneurysm, radical surgical intervention is resection of the affected area of the vessels. Patients with aneurysms of extracranial arteries of any localization are shown surgical treatment in order to

prevent rupture of the aneurysm, development or worsening of neurological symptoms [6]. It should be emphasized that the problem of surgical treatment of arterial aneurysms has not lost its relevance and for its solution requires a balanced approach from the surgeon [25,55]. In case of traumatic aneurysm, radical surgical intervention is resection of the affected area of the vessels. A slightly different tactic of surgical intervention for arteriovenous aneurysm. In such an aneurysm, the venous wall differs little from the arterial wall, which can lead to various complications, in particular, to early thrombosis and suppuration of the wound with arrosive bleeding [124]. Rupture is a natural outcome of an abdominal aortic aneurysm [12, 23, 61]. The development of technologies has contributed to the emergence of less invasive methods for treating aneurysms, which include endovascular embolization of the aneurysm cavity with coils and stent graft installation. The use of the above methods in the treatment of false aneurysms has shown its effectiveness in 50-97.2% of cases; these results were significantly influenced by the size of the aneurysm, the depth of its location in the tissues and the number of chambers in the aneurysm itself [41, 44, 47, 52, 56, 60].Despite the advantages of the compression method of treating false aneurysms, its effectiveness is 49-88%, and every twentieth patient has a risk of developing acute rupture of the aneurysm with bleeding, embolism of the distal bed or thrombosis of the arteries [31, 36, 43, 48]. It should be noted that some authors are supporters of the use of minimally invasive treatment methods and resort to open surgical interventions after their ineffectiveness [40, 44] At the same time, the question of choosing a method of reconstructive surgery, after removal of the aneurysm, is decided depending on the nature of the vascular damage, the condition of the wall around the defect and the distal arterial bed [33]. Experience shows that operations for traumatic vascular injuries are possible 2 days after the injury, but not later than 4 weeks. As noted by researchers, open surgical restoration of the popliteal artery has yielded good results, with a low level of perioperative complications and excellent durability in very long-term conditions, which is a benchmark for alternative methods such as endovascular

restoration [33]. It is appropriate to note that circular and lateral sutures are often used for traumatic aneurysms. At the same time, autovein plastic surgery is also used during operations. In this case, the best plastic material is the autovein of the great saphenous vein of the thigh. Indications for the application of a lateral suture are limited with a large diameter of the vascular defect. The use of a lateral or circular suture in such cases can lead to vascular stenosis [16]. In surgical treatment of traumatic aneurysms, the creation of adequate hemostasis is an important condition for the operation, on which its outcome largely depends.

Currently, several methods of exsanguination of the operated vascular pool are known. Traditionally, it was considered to be preliminary isolation and compression of the artery forming the aneurysm above and below the damage zone. In our opinion, the choice of tactics for surgical treatment of traumatic aneurysms of the main arteries, especially with the rapid development of rentgenendovascular surgery, remains debatable (stenting of vessels). In this clinical situation, as the author notes, open surgical tactics were dictated by the etiology of the false aneurysm and its localization, as well as neurological disorders of the right upper limb caused by compression of the brachial nerve. However, the experience of endovascular operations for ruptured aneurysms of the popliteal and femoral arteries remains minimal throughout the world [37]. According to a number of authors, the possibilities of using endovascular balloon occlusion of the aorta are of great interest [23, 35, 39, 42, 45, 54]. Further study of this issue led to the development of more modern methods of endovascular hemostasis using balloon catheters. We have described for the first time a method of using the method of temporary rentgenendovascular temporary occlusion to stop bleeding from a false aneurysm of the subclavian artery. The method made it possible to block the inflow and outflow of blood, which contributed to a significant reduction in the duration of the operation and its trauma. Blood loss, while minimal, averages 100-200 ml. In patients who have undergone reconstructive surgery for a posttraumatic aneurysm of the main vessel, the condition usually improves, and pulsation in the limb is normalized.

Rehabilitation of labor activity is also indicative. Most patients, after the elimination of the aneurysm, participate in socially useful work, production and in everyday life. Reconstructive and restorative operations are carried out using microsurgical techniques and are aimed at restoring all damaged structures, i.e. a multidisciplinary approach is used [37]. Thirteen patients had unilateral aneurysm of the internal carotid artery (ICA) at the base of the skull. Of these, two were post-traumatic. As the author notes, the overall stroke-free survival is 10 years, the absence of ipsilateral stroke and patency were 90.9% and 92.3% [14]. Based on the above, for optimal diagnostics and selection of surgical treatment tactics for traumatic arterial aneurysms (TAA), it is necessary to develop a treatment and diagnostic algorithm. Based on this algorithm, the optimal choice of surgical treatment tactics for traumatic arterial aneurysms will be implemented. In this case, it is recommended to use staged rentgenendovascular temporary occlusion of vessels (REVO) for high-quality surgical treatment of TAA.

List of used references

1. Abugov, S. A., Saakyan Yu.M., Puretsky M.V. and others Endoprosthetics of post-traumatic false aneurysm of the subclavian artery//Endovasc. hir. 2018; 5(2): 265–270.
2. Abugov S.A., Polyakov R.S., Puretsky M.V., Mardanyan G.V., Pirkova A.A., Krainikov D.A., Vartanyan E.L., Charchyan E.R. Results of endovascular treatment of aneurysms of the common iliac artery. Surgery. Journal named after N.I. Pirogov. 2021;(6 2):52 58.
3. Valiev E.Yu., Khakimov R.N., Ismailov A.D., Karimov B.R., Saydaliev Z.R. Ganiev O.A. Surgical treatment of patients with combined bone and vascular injuries of the lower extremities//Bulletin of emergency medicine, 2018; (11) 4: 84-89.
4. Gaibov A.D, Sultanov D.D, Sadriev O.N. Diagnostics and principles of surgical treatment of aortic arch branch aneurysms. Cardiology and cardiovascular surgery. 2017; 10(5):58-63. Available from: https://doi. org/10.17116/kardio201710558-63.

5. Gumanenko EK Military field surgery. St. Petersburg Folio: 2004; 464.

6. Grinev K. M., Chernyakov I.S., Vakhit K.M., Vinokurov A.Yu., Vladimirov P.A. Remote results of surgical treatment of aneurysms of extracranial arteries // Bulletin of Surgery named after I.I. Grekov. 2014;173(4) :22-24. https://doi.org/10.24884/0042-4625-2014-173-4-22.

7. Zayniddin Norman ugli., Bakhriddinov F.SH. Optimizasion of the surgical tactics in localizations of vascular injury consegueces //J.European science revive. 2017; 1-2:15-20.

8. Zayniddin Norman ugli. To the question of classification and prevention yatrogenis damage to vessels//J.Europen Science Review. 2018;11-12:124-130.

9. Kalinin A. A., Patlachuk M. V., Morozov S. P. et al. Staged treatment for aneurysms of the popliteal, iliac and femoral arteries // Surgery. 2013;8: 67–69.

10. Karimov E.A. Surgical treatment of vascular injuries. Abstract of Doctor of Medicine. Tashkent: 1992; 38.

11. Kozlov B.N., Kuznetsov M.S., Panfilov D.S., Nasrashvili G.G., Bogdanov Yu.I., Katkov V.A. et al. Disconnection of arteriovenous fistula in a patient with posttraumatic false arteriovenous aneurysm. Cardiology and cardiovascular surgery. 2015; 8 (5): 64–68. https://doi.org/10.17116/kardio20158564-68.

12. Kostyrnoy A.V., Potapenkov M.A., Argunova A.E., Chornobryvyi V.I. Choice of surgical tactics for traumatic vascular injury// Bulletin of science and education. 2017;1(25): 95-97.

13. Maksimov A. V., Feyskhanov A. K. Surgical treatment of true aneurysms of permanent vascular access // Angiology and vascular surgery. 2021; 2: 134–136.

14. Malikov S., Thomassin J. M., Magnan P. E. et al. Open surgical reconstruction of the internal carotid artery aneurysm at the base of the skull//J. Vasc. Surg. 2010; (50) 2: 323-329.

15. Melnikov M.V., Ivanov M.A., Apresyan A.Yu., Zelinsky V.A., Novitskaya T.A., Andreev V.V., Koplyarova N.S. Cystic medianecrosis as a cause of splenic artery aneurysm // Grekov Surgery Bulletin. 2013;172(4):082-084. https://doi.org/10.24884/0042-4625-2013-172-4-082-084.

16. Mikhailov M.S., Ridel V.Yu., Musaev A.B. Surgical treatment of aneurysm of the extracranial internal carotid artery// Angiol. i vascular. shir.2020; (26)3: 167-170

17. Novikov Yu.V., Byrikhin N.I., et al. Injuries to the Great Vessels. Clinical Angiology. Manual Vol. 2/Ed. by A.V. Pokrovsky T..2.M:. Medicine, 2004; 555–584.

18. Oparin A.Yu., Kruglov E.V., Karasov I.A. A Case of Surgical Treatment of Giant Posttraumatic False Aneurysm of the Axillary Artery//Angiology and Vascular Surgery 2021; (27)1: 159–162

19. Panfilov D.S., Kozlov B.N., Panfilov S.D., Kuznetsov M.S., Nasrashvili G.G., Shipulin V.M. Puncture treatment of false aneurysms of the femoral arteries using human thrombin. Angiology and vascular surgery 2016; (22)4: 62-66.

20. Pokrovsky A.V., Zemskov N.N., Shor N.A. Injuries to the main vessels of the extremities. - Kyiv.: Health; 1983; 210.

21. Ryazanov A. N., Soroka V. V., Nokhrin S. P., Mikhelson E. P., Magamedov I. D., Platonov S. A., Kiselev M. A. Clinical case of successful treatment of false aneurysm of the subclavian artery. Grekov Surgery Bulletin. 2019; 178(2):69–72. DOI: 10.24884/0042-4625-2019-178-2-69-72.

22. Satueva E. Ya. Surgical methods of treatment of false aneurysm of the femoral artery in patients with drug addiction// Bulletin of medical Internet conferences (ISSN 2224-6150), 2016; 6 (5): ID: 2016-05-24-T-6753.

23. Svetlikov A.V., Reva V.A., Ignatenko M.V. Use of endovascular balloon occlusion of the aorta in hemodynamically unstable patients with bleeding // Angiology and vascular surgery. 2021; (27)1: 72-74

24. Sultonyan T.L., Sargsyan A.S., Khachatryan A.M. Complications after reconstructive surgeries on the main arteries of the extremities and methods of their correction//Angiol. i vascular. surg. 2013;1: 124-128.

25. Sokolov V.A. Vascular complications of musculoskeletal injuries. Compartment syndrome. Multiple and combined injuries. Moscow: GEOTR-Media, 2006; 239-243.

26. Soroka VV Vascular injuries: from skill to science. SPb.: Beresta, 2013. 452 p.
27. Ter-Akopyan A.V., Kalinin A.A., Kryuchkova O.V., Abramov A.S., Tagaev N.B. Embolization of false aneurysm of the inferior gastroduodenal artery // Angiol. i vascular. shir. 2020; (26) 1: 138-141.
28. Almasri J, Alsawas M, Mainou M. Outcomes of vascular access for hemodialysis: A systematic review and meta-analysis//J Vasc Surg. 2016; 64(1):236-243.
29. Bracale U. M., Corte G., Di Gregorio A. et al. Surgical repair of popliteal artery aneurysms remains a safe treatment option in the endo- vascular era : a 10-year single-center study//Ann. Ital. Chir. 2011; (82), 6:443–448.
30. Bhuyan S.K, Dey S, Baruah P.K, Bordoloi B.J. A Pseudoaneurysm of a peripheral artery arising four years after trauma to a limb: a case report. JBJS Case Connect. 2016;6(1):e71-e75. Available from: https://doi.org/10.2106/JBJS.CC.O.00127.
31. Ceccanti S, Frediani S, Andreoli GM, Giannini L, Ferro R, Cozzi DA. Effective compression bandage for repair of a complicated radial artery pseudoaneurysm//Ann Vasc.Surg.2014;28(5):1319.e9-12.Availablefrom: https://doi.org/10.1016/j.avsg.2013.12.006.
32. Chia C., Pandya G.J., Kamalesh A., Shelar V.G. Splenic Artery psevdoanevrebysm Masquerading as a Pancreatic Cyst-a Diagnostic Challenge//International Surgery.2015; 100:6: 1069-1107.
33. Dorigo W., Pulli R., Allessi Innocepti A. A 33-year experience with surgical management of popliteal artery aneurysms// J. Vasc Surg.2015: Vol.62:1176-1182.
34. Engel, A. Diagnostic imaging in combat trauma//Armed conflict injuries to the extremities: a treatment manual / eds. A. Lerner, M. Soudry –Springer, 2011. – P. 95–114.
35. Forte D. M., Do W.S., Weiss J.B. et al.Titrate to equilibrate and not exsanguinate! Characterization and validation of a novel partial resuscitative

endovascular balloon occlusion of the aorta catheter in normal and hemorrhagic shock conditions//J. Trauma Acute Care Surg. 2019; 87(5): 1015– 1025.

36. Ghanavati R., Arab Ahmadi M., Behnam B. Successful nonsurgical treatment of a radial artery pseudoaneurysm following transradial coronary angiography// J. Tehran Heart Cent. 2017; 12(2): 82-4.

37. Hachem K., Kfoury J., Tohme J., Chalhoub V. Rupture of an infected radial artery false aneurysm//Can J Anaesth. 2017; 64(1):92-3. Available from: https://doi. org/10.1007/s12630-016-0737-4.

38. Hahalis G, Tsigkas G, Kakkos S, Panagopoulos A, Tsota I, Davlouros P, et al. Vascular complications following transradial and transulnar coronary angiography in 1600 consecutive patients//Angiology. 2016;67(5):438-43. Available from: https://doi.org/10.1177/0003319715592095.

39. Hörer, T. M. A., Cajander P., Jans A. et al. case of partial aortic balloon occlusion in an unstable multi-trauma patient // Trauma. 2016; 18(2)150–154.

40. Igari K, Kudo T, Toyofuku T, Jibiki M, Inoue Y. Surgical treatment of aneurysms in the upper limbs//Ann Vasc Dis. 2013;6(3):637-41. Available from: https:// doi.org/10.3400/avd.oa.13-00024.

41. Jargiełło T, Sobstyl J, Światłowski Ł, Kuczyńska M, Kuklik E, Sojka M, et al. Ultrasound-guided thrombin injection in the management of pseudoaneurysm after percutaneous arterial access// J Ultrason. 2018;18:859. Available from: https://doi.org/10.15557/JoU.2018.0012.

42. Johnson, M. A., Neff L.P., Williams T.K. et al. Partial resuscitative balloon occlusion of the aorta (REVO): clinical technique and rationale//J. Trauma Acute Care Surg. 2016; 81(5): (suppl. 2). S133– S137.

43. Joseph V, Sambhaji C, Prakashini K. Radial artery pseudoaneurysm managed by prolonged ultrasound-guided compression repair and aided by interval application of compression device//Australas Med J. 2013;6(4):192-5. Available from: https://doi.org/10.4066/AMJ.2013.1677.

44. Iłżecki M, Zubilewicz T, Przywara S, Wojtak A, Kęsik JJ, Olejniczak-Nowakowska M, et al. Efficacy evaluation of bio trombina ® 400 in mini mall y

invasive treatment of complications (pseudoaneurysms), after venipuncture for diagnostic purposes. Authors' own experience – case study of 38 patients//Pol Przegl Chir. 2014;86(8):359-63. Available from: https://doi.org/10.2478/ pjs-2014-0064.

45. Matsumura, Y. , Matsumoto J., Kondo H. et al. Partial occlusion, conversion from thoracotomy, undelayed but shorter occlusion: resuscitative endovascular balloon occlusion of the aorta strategy in Japan // Eur. J. Emerg. Med. 2018; 25(5) 348–354.

46. Muckart, D. J., Pillay B., Hardcastle T.C. et al. Vascular injuries following blunt polytrauma // Eur. J. Trauma Emerg. Surg. 2014; 40(3): 315–322.

47. Moussa Pacha H, Alraies MC, Soud M, Bernardo NL. Minimally invasive intervention of radial artery pseudoaneurysm using percutaneous thrombin injection//Eur Heart J. 2018;39(3):257. Available from: https://doi. org/10.1093/eurheartj/ehx592.

48. Nazer B, Boyle A. Treatment of recurrent radial artery pseudoaneurysms by prolonged mechanical compression//J Invasive Cardiol. 2013;25(7):358-363.

49. Nitecki, S. S., Karram T., Ofer A. et al. Management of combat vascular injuries using modern imaging: are we getting better? // Emerg. Med. Int. 2013; 1 (2013): 1–6.

50. Patel A.R, Patel A.R, Singh S, Singh S, Khawaja I. Central Line Catheters and Associated Complications: A Review. Cureus. 2019;11(5):e4717. https://doi.org/10.7759/cureus.4717.

51. Porceelin M., Bevnardo B., Capasso R. et al. Combined vascular injuries and limb fractures // Minerva Cardioangiol. 1997; vol. 45, 4: 131-138.

52. Raherinantenaina F., Rokoto-Ratsimba H.N., Rajaonanahary T.M Management of extremity arterial psevdoaneurysms associadet with osteochondromas//Vascular 2016; 24(6):628-637.

53. Ratschiller T, Müller H, Schachner T, Zierer A. Pseudoaneurysm of the radial artery after a bicycle fall//Vasc Endovascular Surg. 2018;52(5):395-7. Available from: https://doi.org/10.1177/1538574418764058.

54. Russo, R.M., Williams T.K., Grayson J.K. et al. Extending the golden hour: partial resuscitative endovascular balloon occlusion of the aorta in a highly lethal swine liver injury model // J. Trauma Acute Care Surg. 2016; 80(3): 372–378.
55. Seidel, F. Miranda, Leandro V Fregadolli; Yatrogenic pseudoaneurysm of axillary artery//Arquivos Brasileiros de Cardiologia 2011; 86(4):303-305.
56. Sessa M, Tonni D, Salsi D, Bodini FC, Michieletti E, Cuda D. Management of radial artery pseudoaneurysm in radial forearm free flap: case report and review of the literature. Radiol Case Rep. 2018;14(1):10-3. Available from: https://doi.org/10.1016/j.radcr.2018.08.021.
57. Siddique M.K, Majeed S, Irfan M, Ahmad N. Missed vascular injuries: presentation and outcome//J Coll Physicians Surg Pak. 2014;24(6):428-431.
58. Schaub F.,Theisis W., Bousch R. Manaagment of 219 consecututive cases of postkatherization psevdoaneurysms//J.Am.Coll.Cardiol.1997; 30: 370-375.
59. Tatli E, Buturak A, Cakar A, Vatan BM, Degirmencioglu A, Agac TM, et al. Unusual vascular complications associated with transradial coronary procedures among 10,324 patients: case based experience and treatment options//J Interv Cardiol. 2015;28(3):305-12. Available from: https://doi. org/10.1111/joic.12206.
60. Tsiafoutis I., Zografos T., Koutouzis M., Katsivas A. Percutaneous endovascular repair of a radial artery pseudoaneurysm using a covered stent//JACC Cardiovasc Interv. 2018; 11(11): 91-92. Available from: https://doi. org/10.1016/j.jcin.2018.03.047.
61. Weger N., Klaasen Z., Sturt C., Hertz S. Endovascular treatment of pseudo aneurysm after an jatrogenic axillary artery injiury//Ann.Vasc.Surg.2010; (24), 6:826.
62. Wixon C.L., Philpott J.W., Bogey W.M., Jr.,Powell C.S. Duplex –directed thrombin injection as a method to treat femoral artery, pseudoaneurysms//J.Am.Coll. Surg.1998; 187: 464-466.

2.5. Traumatic arteriovenous fistula and methods of its treatment

Surgical treatment of traumatic arteriovenous fistula (TAVF) is one of the urgent problems of modern angiology [6, 7]. Until recently, vascular trauma was

considered the prerogative of wartime. However, the events of recent decades have shown an increase in vascular damage in peacetime, which is 2% of the overall structure of trauma [33]. Currently, the incidence of posttraumatic aneurysms and vascular fistulas among all injuries reaches 15-28% [13,33]. The incidence rate strongly depends on the level of AVF: up to 20% for proximal AVF and up to 2% for distal AVF [30]. However, treatment of traumatic vascular injuries remains a complex, unsolved problem to date. It is associated with a constant increase in the number of victims with vascular injuries, diagnostic errors occurring in 30% of cases, as well as a high percentage of unsatisfactory treatment results, reaching 27-75% [9]. The cause of arterial injury is repeated exercises, such as knee flexion, blunt trauma, pulsating friction of the vessel wall from exostosis [33]. Aneurysmal transformation of an arteriovenous fistula (AVF) is not a rare complication.With this complication, the risk of arrosive bleeding increases significantly. In case of bleeding, the traditional operation is considered to be ligation of the fistula vein [2,3]. Arteriovenous fistula is a pathological condition, which is a direct connection between an artery and a vein, leading to the flow of arterial blood into the venous bed (bypassing the capillary network). It develops due to various reasons - gunshot wound, cold weapon wound, blunt trauma, etc. [33]. In certain situations, the connection between the artery and vein persists, turning into an AVF, when blood is discharged directly from the artery to the vein, or into an arteriovenous fistula, when a channel for blood flow is formed between the artery and the vein [1]. In peacetime, vascular trauma in the structure of injuries ranges from 0.2 to 4%. According to researchers [33], the cause of TAVF in 63% of victims was a wound with a cold weapon, in 26% - a gunshot wound, in 1% - a blunt object injury. Most often, the fistula was localized in the following areas: neck and chest (54% of observations), upper limbs (22%), lower limbs (20%) [38]. During the war in Lebanon (1975 - 1990), out of 661 wounded with injuries to peripheral vessels: 31 (4.6%) - were diagnosed with TAVF; 74% - a feeling of pulsation. All patients underwent angiography. Recently, the number of patients with iatrogenic arteriovenous fistulas has

increased. Thus, out of 271 patients, after cardiac catheterization, in 10, during the observation period of up to 3 years, according to duplex scanning data, arteriovenous fistula was detected in 88 (0,88%) [10]. Of the 7 observations of TAVF: 4 cases were a consequence of a road traffic accident; 2 were iatrogenic, 1 was an idiopathic phenomenon. All patients were operated on. One of them died. During the observation period, from 1.5 to 6 years, relapses were not observed. The formation of post-traumatic TAVF and pseudoaneurysms is a consequence of inadequate revision of the vessels during primary surgical intervention with early diagnosis of injury [14]. The presence of TAVF is an indication for surgery [4,12]. The diagnosis of TAVF should be based on the detection of a constant, increasing during systole, as well as systolic-diastolic tremor over the pathological junction. Often, more than one year passes from the time of injury to the moment of diagnosis, when patients receive treatment aimed at correcting secondary manifestations, which does not bring the desired result [8]. Traditionally, minimally invasive research methods such as ultrasound, CT, magnetic resonance angiography or invasive angiography are used to diagnose TAVF [26]. Arm ischemia is a rare but severe complication of TAVF that requires careful diagnosis. Sometimes, it occurs with an unclear clinical picture, which can be due to both severe developed trophic disorders and a combination of two causes (venous insufficiency and steal syndrome). In these cases, a comprehensive examination is necessary. Angiography can significantly expand the possibilities of diagnosis and treatment [36]. Some researchers emphasize the importance of periodic assessment of the AVF condition using ultrasound examination, which is prescribed by clinical guidelines [17, 37]. However, these research methods, providing an assessment of blood flow in the main vessels, do not provide sufficient information on the state of the microcirculatory bed. In contrast, threephase scintigraphy with 99mTc-pyrfotech allows: to assess tissue blood flow, to identify ischemia, infiltrative and necrotic changes [29]. With an increase in blood flow through the TAVF, right ventricular failure (shortness of breath, weakness, fatigue, pain in the heart, etc.) joins and gradually progresses. To

diagnose post-traumatic arteriovenous fistulas, it is necessary to establish their localization, the volume of blood passing through the arteries and venous bed. The simplest in the diagnosis of TAVF is sonoangioscanning and paO2 study in the perforating vein [18]. TAVF manifests itself with various clinical symptoms, and it may be difficult to detect. Thus, the authors report rare observations of noniatrogenic arteriovenous fistulas in the pelvic region, detected by angiography 14 and 20 years after the injury. Therefore, the use of angiography allows for a better diagnosis of TAVF [6, 31]. Elimination of TAVF requires experience, knowledge of topographic anatomy, mastery of the technique of applying vascular sutures, and the ability to stop profuse bleeding. If the operation is not performed within the first day after injury, it should be performed 1 week after the elimination of the inflammatory reaction of tissues in the wound area [23]. Other researchers [11, 35] recommend that if the operation is not performed within the first day, it is better to perform it after 1–4 months, when enough collaterals have formed. Improvement of reconstructive surgery techniques has reduced the frequency of limb amputations, decreasing from 16 to 3.6% during a 10-year observation period. To successfully perform reconstructive surgery on vessels for TAVF, it is necessary to have 2–2.5 liters of blood in reserve for one operation. Before performing vascular reconstruction, it is necessary to check the patency of the distal bed. For this purpose, angiography should be performed during the operation, if this has not been done before. Based on these recommendations, reconstructive surgeries were performed on 46 patients, of which 27 received a transplant and 12 underwent autovenous bypass [12]. Most surgeons prefer the method of dissecting the TAVF with subsequent restoration of vessel patency. After dissecting the TAVF, a lateral, circular suture is applied, autovenous bypass and prosthetics are used [12]. Maintaining the TAVF function using only native veins was dictated by the fact that the use of synthetic prostheses provides worse surgical results [20]. When eliminating TAVF, the state of venous blood flow is of great importance [15]. After surgical treatment of patients with TAVF, the mortality rate was 8.5%, the frequency of limb

amputation was 2.6%. In other studies, the mortality rate was 2.3%. Traumatic vascular injuries and their consequences include arteriovenous fistulas, etc. [22]. The formation of TAVF is due to various errors in the diagnosis and tactics of treating vascular damage.Thus, out of 46 patients with consequences of vascular trauma, 5 developed an arteriovenous fistula [22]. At the same time, as the authors note, the patients had changes in cardiac activity (tachycardia, hypertrophy of the left and right sections) caused by venous hypertension. Reflux of arterial blood also leads to the development of venous hypertension with the formation of valve insufficiency, pathological vertical reflux. As a consequence, to varicose transformation of superficial veins, and subsequently to the occurrence of trophic disorders, including edema, pigmentation, compaction and ulceration . In the normal course of the disease, the diagnosis of the consequences of vascular trauma is not difficult. In addition, all patients undergo rentgen contrast examination. In the normal course, the diagnosis of the consequences of vascular trauma was not difficult. It should be emphasized that TAVF is manifested by various clinical symptoms and difficulties in its detection are possible. Thus, the authors report rare observations of non-iatrogenic arteriovenous fistulas in the pelvic region, detected by angiography 14 and 20 years after the injury. Therefore, the use of angiography allows better diagnosis of TAVF [31]. Traumatic injury to the vertebral artery occurs extremely rarely. At the same time, the stent graft was successfully used through the fistula. AVF completely disappeared, the right VA was well preserved. Control angiography 3 weeks and 5 months after treatment did not reveal fistulas and stenosis inside the stent grafts [40]. Sudden onset of heart failure may be due to aortovenous ejection [39,42]. The severity of clinical symptoms depends on the duration of the disease, the size and localization of the fistula. At the same time, multiprojection angiography is considered the "gold standard" of diagnosis. As the author notes [35], open intervention was the method of choice in the treatment of arteriovenous fistula in two patients after a stab wound to the abdominal cavity. In both cases, there was a clinical picture of cardiopulmonary insufficiency caused by overload of the right heart. Surgical

treatment was performed in the amount of elimination of arteriovenous anastomosis and aneurysm of the juxtarenal part of the abdominal aorta and left renal artery. [35]. Some authors note that the rentgenendovascular method can be an alternative to surgical techniques [40].The rentgenendovascular method of treatment allows to successfully replace technically complex, traumatic surgical interventions for false arteriovenous fistulas [18]. Currently, two types of treatment for this pathology are used - surgical and intravascular with the use of stents. In the foreign literature, there are more and more reports on the successful treatment of arteriovenous fistulas of peripheral arteries. Existing methods of surgical correction are traumatic and multi-stage. None of the existing methods of eliminating arteriovenous fistulas can be effectively used in this form of the disease. Only their combined use allows for positive results with minimal trauma and blood loss, although complete relief of the patient from the disease and suffering in some cases is not possible [5]. It should be noted that with the combined use of: surgical intravascular treatment, the consequence of blood discharge from the arterial system is a decrease in blood flow to the limb, which can lead to the occurrence or aggravation of symptoms of its ischemia [32]. It should be noted that relapse of the steal syndrome in all cases occurred after operations in the variant of plication of arteriovenous accesses. As the author notes, repeated reconstructions were successful and access for hemodialysis was preserved. Repeated interventions included: 3 operations on brachiocephalic fistulas, including: 2 - proximalization of arterial inflow, 1 - distal revascularization. In 2 patients with radiocephalic fistulas, a relapse with retrograde blood flow into the fistula developed, which required ligation of the distal portion of the radial artery. In the long-term follow-up period, 2 patients died [16]. Of the 55 patients, a lateral vessel suture was applied in 46; a circular suture in 9. If it was impossible to apply a lateral or circular suture, autovenous bypass was performed or a synthetic vascular prosthesis was used. Limb amputation was performed in 22 (40%) patients. The experience of surgical treatment of 359 patients with traumatic injury to the main vessels was studied.

Undiagnosed vascular injury and formation of arteriovenous fistulas were detected in 48 patients. Arterial circulation was restored in 77.4% of patients, limb amputation was performed in 6.9%, 2.5% of patients died. Other researchers [19,28] used a complex of instrumental methods for diagnosing patients with TAVF: radionuclide angiography, rentgencontrast angiography, magnetic resonance angiography, color Dopplerography. Regarding TAVF, depending on the stage of the disease, surgical tactics were used taking into account its features. Thus, out of 18 patients with TAVF, ligation operations were performed in 5. In all observations, after vein ligation, chronic venous insufficiency developed in the late period. Average treatment results were noted: good - 87.3%; satisfactory - 7.6%; poor - 3.4% of patients. In medical practice, in rtntgtn endovascular interventions for injuries, aneurysms and arteriovenous fistulas, coated intravascular stents are increasingly used [32]. It should be noted that rentgenendovascular interventions for TAVF are rarely performed. In everyday medical practice, endovascular intervention is increasingly used. At the same time, operations using coated intravascular stents for traumatic arteriovenous fistulas are rarely performed [31]. Foreign researchers successfully use a stent graft in the presence of an arteriovenous fistula between the vertebral arteries and a vein with significant blood flow [37, 41]. As the researchers emphasize, hemodynamically significant pathological arteriovenous flow causes overload of the right heart, as well as severe chronic arterial or venous insufficiency of the distal extremities [16, 38]. The use of a stent made it possible to successfully eliminate hemodynamically significant arteriovenous fistulas at the level of the external iliac artery. In this case, it was possible to avoid performing traumatic and technically complex surgical intervention [6]. It is appropriate to note that angiography must be performed to revise the wound for the presence of an arteriovenous fistula [25]. Since the end of the 20th and beginning of the 11th century, due to the widespread use of drug addiction in the world, the number of arteriovenous fistulas has increased significantly as a result of vascular damage during the administration of narcotic substances. In such cases, arteriovenous

fistulas become infected, which often prevents reconstructive surgeries [21,24,34].Thus, modern approaches to the development of tactics and methods for treating vascular damage and its complications are one of the urgent problems of vascular surgery that requires an urgent solution. Due to the inconsistency of the results of surgical treatment, it is necessary to pay special attention to diagnostics, optimization of the choice and tactics of treating patients. In our opinion, when treating TAVF, it is necessary to promptly use modern medical methods and technologies that allow more accurate diagnosis and prediction of the effectiveness of the results of surgical treatment of patients, as well as scientific and practical recommendations for the timely prevention of complications of traumatic injuries to blood vessels. The main problem of TAVF is profuse bleeding during surgery. Therefore, bleeding from arteries and veins can be observed simultaneously.To prevent it, we recommend rentgenendovascular temporary occlusion of vessels, which reduces bleeding from arteries and veins, thereby reducing the risk of injury and complications.

Surgical treatment of infected arteriovenous fistulas should be performed before the development of a purulent process in the fistula area and arrosive bleeding, which creates conditions for restoring vascular conductivity.

2.5. Traumatic arteriovenous fistula and methods of its treatment

Surgical treatment of traumatic arteriovenous fistula (TAVF) is one of the urgent problems of modern angiology [6,7]. Until recently, vascular trauma was considered the prerogative of wartime. However, the events of recent decades have shown an increase in vascular damage in peacetime, which is 2% of the overall structure of trauma [34]. Currently, the incidence of posttraumatic aneurysms and vascular fistulas among all injuries reaches 15-28% [14,34]. The incidence rate strongly depends on the level of AVF: up to 20% for proximal AVF and up to 2% for distal AVF [31]. However, treatment of traumatic vascular injuries remains a complex, unsolved problem to date. It is associated with a constant increase in the number of victims with vascular injuries, diagnostic errors occurring in 30% of cases, as well as a high percentage of unsatisfactory treatment

results, reaching 27-75% [10]. The cause of arterial injury is repeated exercises, such as knee flexion, blunt trauma, pulsating friction of the vessel wall from exostosis [34]. Aneurysmal transformation of an arteriovenous fistula (AVF) is not a rare complication.With this complication, the risk of arrosive bleeding increases significantly. In case of bleeding, the traditional operation is considered to be ligation of the fistula vein [2,3]. Arteriovenous fistula is a pathological condition, which is a direct connection between an artery and a vein, leading to the flow of arterial blood into the venous bed (bypassing the capillary network). It develops due to various reasons - gunshot wound, cold weapon wound, blunt trauma, etc. [34]. In certain situations, the connection between the artery and vein persists, turning into an AVF, when blood is discharged directly from the artery to the vein, or into an arteriovenous fistula, when a channel for blood flow is formed between the artery and the vein [1]. In peacetime, vascular trauma in the structure of injuries ranges from 0.2 to 4%. According to researchers [34], the cause of TAVF in 63% of victims was a wound with a cold weapon, in 26% - a gunshot wound, in 1% - a blunt object injury. Most often, the fistula was localized in the following areas: neck and chest (54% of observations), upper limbs (22%), lower limbs (20%) [39]. During the war in Lebanon (1975 - 1990), out of 661 wounded with injuries to peripheral vessels: 31 (4.6%) - were diagnosed with TAVF; 74% - a feeling of pulsation. All patients underwent angiography. Recently, the number of patients with iatrogenic arteriovenous fistulas has increased. Thus, out of 271 patients, after cardiac catheterization, in 10, during the observation period of up to 3 years, according to duplex scanning data, arteriovenous fistula was detected in 88 (0,88%) [11]. Of the 7 observations of TAVF: 4 cases were a consequence of a road traffic accident; 2 were iatrogenic, 1 was an idiopathic phenomenon. All patients were operated on. One of them died. During the observation period, from 1.5 to 6 years, relapses were not observed. The formation of post-traumatic TAVF and pseudoaneurysms is a consequence of inadequate revision of the vessels during primary surgical intervention with early diagnosis of injury [15]. The presence of TAVF is an indication for surgery

[4,13]. The diagnosis of TAVF should be based on the detection of a constant, increasing during systole, as well as systolic-diastolic tremor over the pathological junction. Often, more than one year passes from the time of injury to the moment of diagnosis, when patients receive treatment aimed at correcting secondary manifestations, which does not bring the desired result [9]. Traditionally, minimally invasive research methods such as ultrasound, CT, magnetic resonance angiography or invasive angiography are used to diagnose TAVF [27]. Arm ischemia is a rare but severe complication of TAVF that requires careful diagnosis. Sometimes, it occurs with an unclear clinical picture, which can be due to both severe developed trophic disorders and a combination of two causes (venous insufficiency and steal syndrome). In these cases, a comprehensive examination is necessary. Angiography can significantly expand the possibilities of diagnosis and treatment [37]. Some researchers emphasize the importance of periodic assessment of the AVF condition using ultrasound examination, which is prescribed by clinical guidelines [18, 38]. However, these research methods, providing an assessment of blood flow in the main vessels, do not provide sufficient information on the state of the microcirculatory bed. In contrast, threephase scintigraphy with 99mTc-pyrfotech allows: to assess tissue blood flow, to identify ischemia, infiltrative and necrotic changes [30]. With an increase in blood flow through the TAVF, right ventricular failure (shortness of breath, weakness, fatigue, pain in the heart, etc.) joins and gradually progresses. To diagnose post-traumatic arteriovenous fistulas, it is necessary to establish their localization, the volume of blood passing through the arteries and venous bed. The simplest in the diagnosis of TAVF is sonoangioscanning and paO2 study in the perforating vein [19]. TAVF manifests itself with various clinical symptoms, and it may be difficult to detect. Thus, the authors report rare observations of noniatrogenic arteriovenous fistulas in the pelvic region, detected by angiography 14 and 20 years after the injury. Therefore, the use of angiography allows for a better diagnosis of TAVF [6, 32]. Elimination of TAVF requires experience, knowledge of topographic anatomy, mastery of the technique of applying vascular

sutures, and the ability to stop profuse bleeding. If the operation is not performed within the first day after injury, it should be performed 1 week after the elimination of the inflammatory reaction of tissues in the wound area [24]. Other researchers [12, 36] recommend that if the operation is not performed within the first day, it is better to perform it after 1–4 months, when enough collaterals have formed. Improvement of reconstructive surgery techniques has reduced the frequency of limb amputations, decreasing from 16 to 3.6% during a 10-year observation period. To successfully perform reconstructive surgery on vessels for TAVF, it is necessary to have 2–2.5 liters of blood in reserve for one operation. Before performing vascular reconstruction, it is necessary to check the patency of the distal bed. For this purpose, angiography should be performed during the operation, if this has not been done before. Based on these recommendations, reconstructive surgeries were performed on 46 patients, of which 27 received a transplant and 12 underwent autovenous bypass [13]. Most surgeons prefer the method of dissecting the TAVF with subsequent restoration of vessel patency. After dissecting the TAVF, a lateral, circular suture is applied, autovenous bypass and prosthetics are used [13]. Maintaining the TAVF function using only native veins was dictated by the fact that the use of synthetic prostheses provides worse surgical results [21]. When eliminating TAVF, the state of venous blood flow is of great importance [16]. After surgical treatment of patients with TAVF, the mortality rate was 8.5%, the frequency of limb amputation was 2.6%. In other studies, the mortality rate was 2.3%. Traumatic vascular injuries and their consequences include arteriovenous fistulas, etc. [23]. The formation of TAVF is due to various errors in the diagnosis and tactics of treating vascular damage.Thus, out of 46 patients with consequences of vascular trauma, 5 developed an arteriovenous fistula [23]. At the same time, as the authors note, the patients had changes in cardiac activity (tachycardia, hypertrophy of the left and right sections) caused by venous hypertension. Reflux of arterial blood also leads to the development of venous hypertension with the formation of valve insufficiency, pathological vertical reflux. As a consequence, to varicose

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List of used references

1. Abugov, S. A., Saakyan Yu.M., Puretsky M.V. and others Endoprosthetics of post-traumatic false aneurysm of the subclavian artery//Endovasc. hir. 2018; 5(2): 265–270.
2. Baikov B.V., Zulkarnaev A.B., Yankovoy A.G., Strugaylo E.V. Reconstruction of aneurysmal altered arteriovenous fistula after arrosive bleeding. Clinical observation//Surgery. Journal. named after N.I. Pirogov. 2020;8:107-109. https://doi.org/10.17116/hirurgia2020081107.
3. Baikov B.V., Zulkarnaev A.B., Yankovoy A.G., Strugaylo E.V. Complex reconstruction of arteriovenous fistula for hemodialysis. Surgery. Journal im. N.I. Pirogov. 2021;(1):90-92.
4. Vinogradov R.A., Matusevich V.V., Kazantsev A.N., Sukhoruchkin P. .V. Resection of arteriovenous malformation of the lumbar region//Surgery. Journal im.N.I.Ptrogov.2022;(7):101-105.
5. Gaibov A.D, Sultanov D.D, Sadriev O.N. Diagnostics and principles of surgical treatment of aortic arch branch aneurysms. Cardiology and cardiovascular surgery. 2017; 10(5):58-63. Available from: https://doi. org/10.17116/kardio201710558-63.

6.5. Zayniddin Norman ugli. Algorithmic approach to the choice of surgical treatment of traumatic arterial aneurysms"//J.Europen Science Review. 2018;11-12: 124-130

7. Zayniddin Norman ugli. To the question of classification and prevention yatrogenis damage to vessels//J.Europen Science Review. 2018;11-12:124-130.

8. Kozlov B.N., Kuznetsov M.S., Panfilov D.S., Nasrashvili G.G., Bogdanov Yu.I., Katkov V.A. et al. Disconnection of arteriovenous fistula in a patient with posttraumatic false arteriovenous aneurysm. Cardiology and cardiovascular surgery. 2015; 8 (5): 64–68. https://doi.org/10.17116/kardio20158564-68.

9. Komarov RN, Vinogradov OA, Yasnopolskaya NV, Dzyundzya AN, Nagorny MN. Elimination of post-traumatic arteriovenous shunt between the right common iliac artery and the inferior vena cava. Cardiology and cardiovascular surgery.2016;9(4):81–85. ttps://doi.org/10.17116/kardio20169481-85.

10. Malikov M. Kh., Davlatov A. A., Ibragimov E. K., Kamolov A. N., Karimzade G. D., Makhmadkulova N. A., Khairulloi N., Mirzobekov H. F. Reconstructive surgery of combined injuries to the upper extremities. Avicenna Bulletin. 2018;20(4):410-5. Available from: https://doi.org/10.25005/2074-0581-2018-20-4-410-415.

11. Markov, N. P., Dubose J.J., Scott D. et al. Anatomic distribution and mortality of arterial injury in the wars in Afghanistan and Iraq with comparison to a civilian benchmark // J. Vasc. Surg. 2012; 56(3). 728–736.

12. Nazarov, Kh. N., Gaibov AD, Sadriev ON Surgical tactics for combined osteovascular injuries of the lower extremities // Vestn. Avicenna. 2014; 61(4): 45–49.

13. Novikov Yu.V., Byrikhin N.I., et al. Injuries to the Great Vessels. Clinical Angiology. Manual Vol. 2/Ed. by A.V. Pokrovsky T..2.M:. Medicine, 2004; 555–584.

14. Panfilov D.S., Kozlov B.N., Panfilov S.D., Pryakhin A.S. Treatment of iatrogenic false aneurysms of the femoral arteries// Angiology and vascular surgery 2018; (24)3:19-24.

15. Prasol V.A., Ivanova Yu.V., Pulyaeva I.S., Tkachuk A.Yu., Zarudny O.A., Artamanov R.V. et al. Clinical case of combined aneurysmal lesion of the iliac

and femoral arteries with false posttraumatic aneurysm and arteriovenous anastomosis, deep vein thrombosis. Heart and vessels. 2017;(1):84-90.

16. Repin I.G., Savostyanov K.A., Mizin S.P., Stolyarov A.A., Repin D.I. False aneurysm of the splenic artery as a cause of gastrointestinal bleeding//Surgery. Pirogov Journal. 2017;5: 87-90.

17. Sedov V.M., Karpov S.A., Alferov S.V., Grinev K.M. The phenomenon of ischemic steal in patients with various arteriovenous fistulas for hemodialysis and its surgical correction // Bulletin of Surgery named after I.I. Grekov. 2013;172(6):051-055. https://doi.org/10.24884/0042-4625-2013-172-6-051-055.

18. Sinyavin G.V., Gavrilenko A.V., Kuklin A.V. Surgical treatment of patients with aneurysms of the arteries of the upper and lower extremities//Angiol. i vascular. surg. 2009; 3: 109–112.

19. Khitaryan., Pryadko S.I., Veliev K.S., Alibekov A.Z., Miziev I.A. Treatment of severe forms of venous insufficiency against the background of acquired arteriovenous fistulas//Annals of surgery. 2017;1:36-44.

20. Shumilina M.V., Zandneprovskaya V.V, Sushkova A.V. Iatrogenic vascular injuries // Clinical physiology of blood circulation.2020;17(2):130-141.

21. Almasri J, Alsawas M, Mainou M. Outcomes of vascular access for hemodialysis: A systematic review and meta-analysis//J Vasc Surg. 2016; 64(1):236-243.

22. Baláž P, Rokošný S, Bafrnec J, Whitley A, O'Neill S. Repair of Aneurysmal Arteriovenous Fistulae: A Systematic Review and Meta-analysis. //Eur J. Vasc Endovasc Surg. 2020 Apr; 59(4):614-623.doi: 10.1016/j.ejvs.2019.07.033. Epub 2019 Dec 24.PMID: 31879147.

23. Borger van der Burg, B. L.S., Boudewijn L.S., Hörer T.M. et al.Vascular access training for REVO placement: a feasibility study in a live tissue-simulator hybrid porcine model // J. R. Army Med. Corps. 2019; 165(3) 147–151.

24. Chia C., Pandya G.J., Kamalesh A., Shelar V.G. Splenic Artery psevdoanevrebysm Masquerading as a Pancreatic Cyst-a Diagnostic Challenge//International Surgery.2015; 100:6: 1069-1107.

25. D.Din NU, Berlas F.T, Rehman K.U, Ali G, Salahuddin F, Mumtaz A. Outcomes of Femoral Artery Pseudoaneurysm in Intravenous Drug Abusers Managed at a Tertiary Care Center. Cureus. 2021 Feb 15;13(2):e13350.doi: 10.7759/cureus.13350.PMID: 33643755.

26. Dorigo W., Pulli R., Allessi Innocepti A. A 33-year experience with surgical management of popliteal artery aneurysms// J. Vasc Surg.2015: Vol.62:1176-1182.

27. Finn JP, Lawrence PF. Defining anatomy and blood flow in the threatened limb rising to the challenge with noninvasive imaging//Circ Cardiovasc Imaging.2018;11(5):e007726.PMID:29748313

28. Gallieni M, Hollenbeck M, Inston N. Clinical practice guideline on peri- and postoperative care of arteriovenous fistulas and grafts for haemodialysis in adults. //Nephrol Dial Transplant. 2019; 34(2):1-42. https://doi.org/10.1093/ndt/gfz072.

29. Hachem K., Kfoury J., Tohme J., Chalhoub V. Rupture of an infected radial artery false aneurysm//Can J Anaesth. 2017; 64(1):92-3. Available from: https://doi. org/10.1007/s12630-016-0737-4.

30. Hashimoto H, Fukushima Y, Kumita Sh, Miyamoto M, Takagi G.Prognostic value of lower limb perfusion single photon emissioncomputed tomography computed tomography in patients withlower limb atherosclerotic peripheral artery disease//Jpn J Radiol. 2017; 35(2):68–77. https://doi.org/10.1007/s11604-016-0602-y

31. Huber T.S, Larive B, Imrey P.B, Radeva M.K, Kaufman J.M, Kraiss L.W, Farber A.M, Berceli SA; HFM Study Group. Access-related hand ischemia and the Hemodialysis Fistula Maturation Study//J. Vasc Surg. 2016; 64(4):1050-1058.

32. Majwal T. K., Ismoil A., Alagily R., Invas J.. Renal artery stenosis associated with saccular aneurysms and arteriovenous fistula//Cardiol. -2002; Vol. 14, 7: 411 - 413.

33. Matsumura, Y., Matsumoto J., Kondo H. et al. Fewer REVO complications with smaller devices and partial occlusion: evidence from a multicentre registry in Japan // Emerg.Med.J.2017; 34(12(793–799.

34. Priestley R., Brav P., Bray A., Hunter J. Iatrogenic vertebral arteriovenous fistula treated with a hemobahn stent-graft//Endovasc. Ther. 2003; Vol. 10, 36: 657 - 663.https://doi.org/10.1161/CIRCIMAGING.118.007726

35. Rehman K.U, Berlas M.F, Din N.U, Ali G, Salahuddin F, Mumtaz A. Management of Brachial Artery Pseudoaneurysms in Intravenous Drug Abusers. Cureus. 2020 Dec 27; 12(12):e12315. doi: 10.7759/cureus.12315.PMID: 33520513

36. Ricci M.A., Trevisani G.T.,Pilcher D.B.Vascular complicationis of cardiac catherization//Am.J.Surg.1994; 167: 375-378.

37. Stockinger Z.T., Turner. C.A., Gurney J.M. Abdominal trauma surgery during recent US combat operations from 2002 to 2016//J. Trauma Acute Care Surg. 2018; 85(1):. S122–S128.

38. Schmidli J, Widmer MK, Basile C. Editor's Choice — Vascular Access: 2018 Clinical Practice Guidelines of the European Society for Vascular Surgery (ESVS)//Eur J. Vasc Endovasc Surg. 2018;55(6):757-818. https://doi.org/10.1016/j.ejvs.2018.02.001.

39. Toda R., Yuda T., et al. Surgical repair ofa solitari deep femoralis aneurysm: report of two cases surg//Taday.2000; 30:4 81-483.

40. Turner C.A., Stockinger Z.T., Gurney J.M. Vascular surgery during U.S. combat operations from 2002 to 2016: Analysis of vascular procedures performed to inform military training//J. Trauma Acute Care Surg. 2018; 85(1): S145–S153.

41. Sadata A., Saton T., Ishii A. et al. Large vertebral arteriovenous fistula treated with stent-graft - case report // Neural. Med. Chir. 2003; Vol. 43. 5: 250-253.

42. Surber R., Wermen G. S., Cohnert T. U. et al Recurrent vertebral arteriovenous fistula after surgical repair: treatment with a self-expanding stent-graft//J. Endovasc. Ther. 2003; 10: 49 - 53.

43. Vagdi T., Atav Y., Engin C. Aorta-left renal vein fistula in a woman et al. 7 Heart Inst//J. 2004; 31:435-438.

CHAPTER III. METHODS OF EXAMINING PATIENTS WITH VASCULAR INJURIES AND THEIR CONSEQUENCES

Examination of patients with vascular injuries is carried out in three stages: collection of anamnesis and its analysis; objective examination, including: inspection, palpation and auscultation; use of laboratory, functional and special instrumental methods.

Anamnesis

Collection of anamnesis is an integral part of the clinical examination of a patient with acute vascular injury and its consequences. This occurs during questioning of the patient in case of: wounds and blunt injuries; contusions of the limbs and trunk. In this case, attention is paid to the presence of localization and intensity of pain. The appearance of pain, mainly in the distal parts of the limb, with a discrepancy between their localization and the zone of tissue contusion or bone damage, may be due to vascular injury. Such painful sensations are associated with the development of acute organ ischemia and its degree, especially in the near future after the injury. Damage to blood vessels and existing nerve trunks leads to: numbness, coldness and paresthesia in the distal parts of the limbs; limitation or absence of movement in the joints distal to the injury zone.

An important point in collecting and analyzing anamnesis, in case of vascular injuries and their consequences, is to clarify the issue of the presence of severe bleeding at the scene. Often, you can hear that at the time of injury a fountain of blood was spurting from the wound. Subjective signs of acute blood loss are also complaints of: general weakness, dizziness, headaches, darkening in the eyes, thirst and dry mouth.

Based on a correctly collected anamnesis and its analysis, a preliminary diagnosis is established, which is subsequently confirmed by the results of clinical, functional and instrumental studies.

Objective examination. An objective examination consists of a general examination, palpation, percussion and auscultation.

General examination. Examination of the limb, i.e. determination of skin tone, arterial pulsation, muscle tension, range of motion, etc., must be compared with the opposite limb. Examination is best done in daylight, since artificial light can change skin tone. In this case, the high incidence of acute traumatic disorders of arterial and venous circulation is taken into account.

Examination of the lower limbs is performed from the front and back, if possible, first with the patient standing on a high, hard couch, and then lying down. An idea of the state of blood circulation in the skin is given, first of all, by the color of the skin, especially the distal parts of the limbs. The skin color of a healthy person is light pink. When examining patients with vascular injuries and their consequences, the clinical symptoms are characterized by: pallor, cyanosis, swelling, tremors, lack of limb movement, etc. In case of traumatic injuries to blood vessels and veins, peripheral circulatory disorders in the limbs, in addition to pallor, may also manifest themselves in other changes in the color of the skin: cyanosis, marbling, redness, as well as various combinations. When examining a patient with a vascular injury, it is necessary to pay attention to: blood soaked clothing; wound localization, in the area of the vessel projection. Signs of vascular injury and acute blood loss are sharp local and general pallor, anxiety, dry mouth, a feeling of lack of air, etc. In cases of combined injuries with subsequent traumatic thrombosis, external bleeding may be absent. However, in the area of the contusion, there may be internal skin and subcutaneous hemorrhages, bruises.

Rupture of blood vessels, while maintaining the integrity of the skin, sometimes forms massive interstitial, pulsating hematomas. When examining a victim with vascular injuries, it is necessary to assess: the effectiveness of methods for temporarily stopping bleeding; the duration of the tourniquet application and make sure there are no accompanying injuries to vital organs, such as hematomas, abrasions, limb deformation, etc.

Palpation of vessels. In determining the state of arterial circulation in a limb, palpation of the vessels has clinical and diagnostic value. In each case, the pulse must be determined on all arteries accessible for palpation, sequentially on both

limbs. Thus, it is possible to detect a difference in pulse: the popliteal artery is palpated deep in the popliteal fossa, with the limb bent at the knee joint; The femoral artery is palpated below the inguinal ligament 2 cm inside from its middle, where it is covered only by the broad fascia of the thigh; the external iliac artery is palpated above the inguinal ligament, towards the umbilicus. The palpation method of examination is also used to determine the temperature of the skin, in case of damage to arteries and veins. Normally, the artery wall should be soft, elastic and flexible. The radial artery is located in the lower third of the palmar surface of the forearm, in the middle of the radial groove. The ulnar artery is palpated on the palmar surface of the lower third of the forearm, 2-3 cm above the line of the wrist joint. The brachial artery is palpated on the internal groove of the arm along the medial edge of the biceps muscle and in the area of the elbow joint. The right subclavian artery departs from the innominate artery, the left directly from the aorta. Therefore, it is longer and lies deeper than the right one and is palpated between the clavicle and the 1st rib, in the subclavian fossa. The dorsal artery of the foot passes between the first and second metatarsal bones parallel to the lateral edge of the tendon, the long extensor of the 1st toe. The anterior tibial artery is palpated in front above the ankle joint, in the middle between the malleoli. The posterior tibial artery is palpated between the posteroinferior edge of the medial malleolus and the tendon of the calcaneal joint. **Auscultation of vessels** significantly enriches the diagnosis of vascular disorders.

For the first time, the diagnostic value of auscultation of vessels in vascular damage and their consequences was drawn by V. I. Glinchikov (1930). When listening to peripheral vessels, a stethoscope is usually used, without excessive pressure on the vessels. Otherwise, artificially induced sound phenomena - stenotic noises - can be heard. This method is also used to listen to the carotid, subclavian, brachial and femoral arteries. No sounds are normally heard over large diameter arteries. A rough systolic noise appears over the aneurysm. In the area of arteriovenous aneurysm and fistulas, systolic and diastolic noises of the degree of filling, tension, rhythm frequency, etc. are usually heard. In addition,

changes in the vascular wall are also observed: decreased elasticity; impaired resistance; degree of compaction, etc.

Prehospital treatment

Recent years have seen a sharp increase in the number of injuries involving vascular damage: mortality reaches 15.4-25.5%, amputation - 17.3% (Abushev N.S. 1996; Lovric Z. et al. 1994 and others). In this case, vascular bleeding can be stopped: by finger pressure; applying a pressure bandage; giving the limb an elevated position; maximum flexion in the joints, etc. In clinical practice, a tourniquet is most often used to stop bleeding. Among the various methods of temporarily stopping bleeding, applying a tourniquet is the most reliable.

However, it can entail undesirable consequences. When applying a tourniquet to a limb, complete exsanguination of the distal sections occurs due to compression of: vessels, collaterals, muscle branches and nerve trunks. This may cause dysfunction, persistent angiospasm and unfavorable outcomes of surgical intervention. When removing the tourniquet, tourniquet shock may occur. To date, the maximum permissible time for leaving a tourniquet on the limb has not been established. It is completely safe to apply a tourniquet to a limb for 15-20 minutes. In practice, this requirement is rarely observed. Thus, among practicing doctors, the opinion has taken root about the safety of applying a tourniquet to a limb for 2 hours. According to Yakovlev A.Ya. (1975), the mortality rate among victims when using a tourniquet is significantly higher than among victims who did not have it applied. Compression for 3 hours or more leads to the development of tourniquet shock. In this case, it is necessary to: cover the limb with ice; perform a circular novocaine blockade; take anti-shock measures. In case of stab wounds accompanied by profuse bleeding, a tourniquet should be applied immediately to the site of injury. After the bleeding has stopped, a pressure bandage should be applied to the wound. Based on our own experience, we believe that the time of using a tourniquet as a method of temporarily stopping bleeding in case of arterial and venous wounds should be limited. We are in favor of a wider use of a pressure aseptic bandage. In addition to stopping bleeding at the pre-hospital

stage, immobilization of the limb is of great importance, especially in case of bone and vascular injuries. Comprehensive pain relief plays a major role in improving the general condition of the victims and ensuring their safety during transportation. The main objective is to quickly hospitalize the victims in the nearest surgical department. During transportation, it is advisable to administer: promedol 1-2% - 1 ml, morphine 1% - 1 ml and others. The reasons for late hospitalization are: a late call; the remoteness of the scene from the ambulance station; the need to carry out resuscitation measures in order to bring the victim's condition to a transportable level. It should not be forgotten that 50.1% of patients with injuries die at the scene of the incident.

The most common mistakes at the pre-hospital stage are: late diagnosis and delivery of the patient to a medical facility. At the stage of providing first aid for vascular injuries, improper stopping of bleeding leads to disability or death. Quite often, when providing first aid, a tourniquet is applied ineptly and incorrectly. Unreasonable use of a tourniquet when injuring veins can lead to serious consequences. The time from the moment of applying a tourniquet to applying a tourniquet should not exceed 2 hours, in winter up to 1 hour.

The above facts indicate the need for: continuous improvement of the organization of first medical aid; training of medical personnel in techniques for stopping bleeding and familiarization with resuscitation measures of traffic police officers, workers, machine operators and others.

Treatment of patients in general medical institutions

When providing assistance to patients with traumatic vascular injuries in general medical institutions, the main tasks are to continue the treatment measures initiated at the pre-hospital stage and, as early as possible, call a vascular surgeon or transfer the patient to the vascular department for surgical intervention.

When treating patients with vascular injuries in general medical institutions, it is necessary to reliably, temporarily or permanently stop bleeding and take preventive measures against: progression of tissue ischemia; entry of toxins from the injured limb; intense blood loss; premature purulent complications (Lemenev

V.L. 1998 and others). At the same time, resolve organizational issues related to ensuring the delivery of vascular surgeons or transportation of the patient to specialized departments. The final result of the treatment of patients with vascular injuries largely depends on the timeliness and correctness of these measures and their effectiveness. Often, performing reconstructive operations on vessels becomes impossible or difficult due to the fact that preliminary stopping of bleeding was carried out roughly and insufficiently qualified or an attempt was made to manipulate the vessels without sufficient: knowledge, qualifications and special instruments. Insufficiently qualified surgical treatment of the wound can make it impossible to perform subsequent reconstructive and restorative surgery on the vessels. The main method of reliable temporary stopping of bleeding in medical institutions are: wound tamponade; application of hemostatic clamps; ligature of vessels and temporary prosthetics. Many surgeons still consider ligation of vessels to be one of the effective methods of temporary stopping of bleeding. In many cases, acute ischemic phenomena in the limbs develop, up to gangrene. Also, the disease of the ligated arterial vessel develops.

The frequency of amputation depends on the localization of the ligature. After ligation of the popliteal artery, the amputation rate reaches 42.5%. Errors in general medical institutions, mainly, often occur due to difficulties in diagnosing traumatic vascular injuries. They occur especially often with blunt trauma, contusions and compression. In practice, this is carelessness in ruptures of blood vessels; traumatic thrombosis with blunt trauma, insufficient knowledge of the clinic of combined injuries accompanied by contusion or damage to large vessels, which lead to mortality. One of the most common errors in general medical institutions, when providing assistance to patients with vascular trauma, is observed in the imposition of a vascular suture. Such errors, as a rule, end in amputation of the limb or death.

The elimination of errors in specialized medical institutions, improving treatment results are associated with the emergency use of angiosurgical methods for vascular trauma. This promotes the promotion of modern diagnostic methods

among general practitioners, general surgeons, and traumatologists. And improves their skills in emergency care for vascular injuries. In addition, this is a timely informing of the medical community about the possibilities of specialized surgical treatment methods for patients with vascular injuries. Based on the above, certain conclusions of a negative nature can be made.

The following errors are often made in specialized medical institutions:

diagnostic: late diagnosis, complications after vascular surgery; untimely determination of the viability of an ischemic limb; tactical: failure to take preventive measures in relation to inclusion syndrome; performing reconstructive surgery on vessels in the late stages of ischemia; failure to perform reconstructive surgery for arrosive bleeding; technical: damage to vessels, balloon probes, and other types of deficiencies.

CHAPTER IV. INSTRUMENTAL METHODS OF ASSESSMENT OF THE STATUS OF BLOOD CIRCULATION OF INJURIES OF VESSELS AND CONSEQUENCES

Angiography

Rentgengray examination methods are widely used in the comprehensive examination of patients with acute vascular injuries. In recent years, serial radiography has become increasingly widespread, instead of complex and expensive equipment, including powerful rentgraphy generators, cassettes for serial angiography. In addition, to conduct a serial angiographic study, special equipment is required for manual and automatic supply of contrast agent, with an injection rate of 1-40 ml / s. Single-stage angiography has not lost its significance, due to the simplicity and availability of this study. In acute diseases and injuries of the main arteries and veins, angiography is used to: clarify the diagnosis in clinically unclear situations; determine the localization and extent of the pathological process; assess the state of the vascular bed and collateral blood flow; determine the effectiveness of surgical treatment. Angiographic data on the localization and extent of the lesion, and the state of the vascular bed allow to determine in advance the scope of surgical intervention and establish the degree of

surgical risk. Contraindications to angiographic examination in acute venous obstruction are: increased sensitivity of the patient to iodine radiocontrast agents; venous gangrene; extremely severe general condition of the patient, excluding surgical treatment. Angiographic examination is used at the following stages of surgical treatment.

Before surgery: fractures of long tubular bones or dislocations with suspected injury to an artery or main vein; blunt trauma to a limb; unclear localization of vascular damage.

During surgery: gunshot wounds with massive tissue destruction; damage to several segments of a limb; inconclusive retrograde blood flow below the arterial injury, after revision of the distal segment with a balloon probe, etc.

After surgery: absence of peripheral pulse during arterial restoration; progressive limb ischemia or positive dynamics.

With prolonged angiospasm, widespread, local narrowing of the vessel lumen is observed, up to the complete disappearance of its image on the angiogram.

Expansion of the lumen in a limited area, accumulation of contrast agent outside the vessel shadow is a sign of a false aneurysm or rupture of the artery. In arteriovenous aneurysms, using angiography, it is necessary to establish the exact level and size of the pathological vascular fistula, as well as the presence of arterial collaterals. Many authors believe that angiographic examination is of particular importance in unclear and questionable cases of traumatic aneurysms and arteriovenous fistulas (Fig. 1-4). It allows to determine the size, location and type of aneurysm with the utmost accuracy, and in some cases to make the most rational plan of surgical intervention. In this case, the contrast agent can be injected into the arterial bed in two ways: directly into the aneurysmal sac or into the artery above the aneurysm. However, the introduction of a contrast agent into the cavity of an arterial aneurysm or hematoma is considered dangerous. Since, the increase in pressure in the cavity of an arterial aneurysm can lead to rupture of the sac and cause external or internal bleeding.

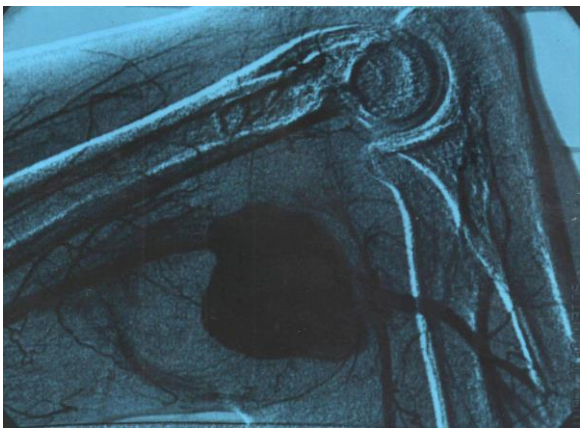


Fig. 1. Angiography. Traumatic aneurysm of the left brachial artery. Filling the distal part of the brachial artery with contrast medium, left.

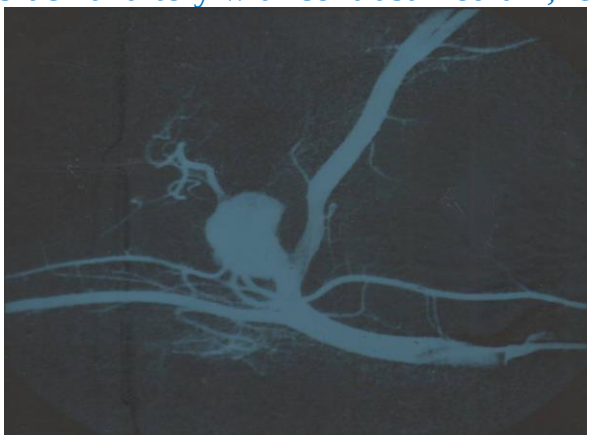


Fig. 2. Angiography. Traumatic aneurysm of the left subclavian artery.

Fig. 3. Angiography. Traumatic aneurysm of the aortic arch.

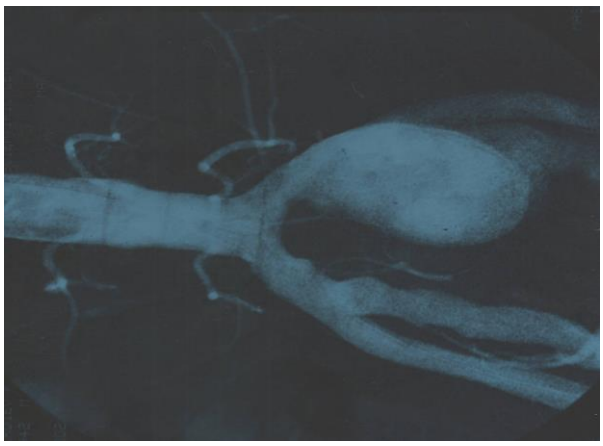


Fig. 4. Angiography. Traumatic aneurysm of the left iliac artery.

Let's dwell on the technique of its implementation

Puncture of the femoral artery is performed in the area of the inguinal fold against the blood flow, almost tangentially to the direction of the artery. The needle entering the lumen of the vessel is felt as a push. After removing the mandrin, with the needle in the correct position, a pulsating stream of scarlet blood appears. For a more convenient puncture of the limb, it is necessary to give a slight rotation from the outside so that the head of the bone lifts the femoral artery. For puncture of the axillary artery, the patient is laid on the table, the arm is abducted and raised above the head. Due to this technique, the armpit is located almost parallel to the plane of the table, which facilitates the examination. The patient's arm should be abducted at least 90C0. The axillary artery is determined by the pulsation at the top of the axillary fossa at the level of the head of the humerus. Then puncture, directing the needle to the center. The Seldinger method is used to obtain safe access to blood vessels and other hollow organs. The method was proposed by Sven Ivar Seldinger (1921-1998), a Swedish radiologist and inventor in the field of angiography.

During an angiographic examination, a catheter is inserted into a vessel using a needle for the dosed administration of a contrast agent. The essence was to deliver the substance to the required location, but at the same time minimally damaging the vessel, especially at the site of the study. Before Sven Seldinger's invention, two methods were used: a catheter on a needle and a catheter through a needle. In the first case, damage to the catheter is possible when passing through tissue.

In the second case, a large needle is needed, which causes much more damage to the vessel at the site of catheterization. The technique consists of first installing a needle, inserting a conductor through it, then removing the needle, and inserting a catheter along the conductor. These studies were performed on 39 patients.

Computer tomography

This X-ray examination method is mainly based on measuring the absorption of X-rays by various anatomical structures of the body. During CT, a narrow beam of X-rays is passed through the object being examined, which illuminates the object. At the exit, they are captured by highly sensitive receiving equipment. These indicators are processed and converted using a computer, which makes it possible to obtain an image of the object being examined on the display. In this process, the object being examined is placed between the emitter and the receiver, and the entire system rotates around the axis of the patient's body, recording the absorption of X-rays at all stages of rotation. As a result, bone and vascular fractures are quite clearly visible. At the same time, it is necessary to remember that during computed tomography, the patient receives a significant dose of X-rays. CT was performed on 2 patients.

Magnetic resonance tomography (MRT)

This method is based on the properties of atoms of individual chemical elements (hydrogen, phosphorus, etc.) that produce resonance in a strong magnetic field. Alternating electromagnetic pulses create a signal that is specific to each tissue. These signals are recorded, processed by a computer, and the image on the screen is converted. Using this method, you can get an anatomical section of the human body in three projections, without exposure to ionizing radiation. This distinguishes this method from computed tomography. At the same time, bones, vessels, and other elements of the body are clearly distinguished. This method is widely used in clinical practice. MRT was performed on 9 patients.

Multispiral computed tomography (MSCT)

MSCT is a method that is used to obtain a clear image of bone structures and soft tissues; small tumors and ruptures with bleeding are clearly visible on the

images. MSCT is used to obtain detailed information about the condition of all organs of the chest, abdominal and pelvic cavity after injuries and strokes. The introduction of contrast agents gives a complete picture of the state of the vascular system and internal organs after the detection of various pathologies. When examining the spine, doctors get a complete picture not only of the state of the vertebrae themselves, but also of the surrounding soft tissues: cartilage, ligaments, tendons, muscles, vessels, nerve roots. Today, MSCT is one of the fastest research methods (up to 5 minutes). Based on MSCT, a high-quality image is obtained using small X-rays (Fig. 5). It should be noted that the slightest pathological changes are clearly defined. MSCT was performed on 10 patients.

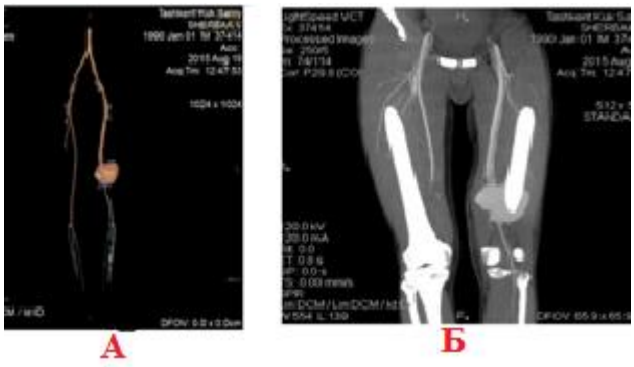


Fig. 5. MSCT angiography. False posttraumatic aneurysm of the left femoral artery and vein.

Based on MSCT, a high-quality image is obtained using small beams. It should be noted that the slightest pathological changes are clearly defined. MSCT was performed on 10 patients.

Ultrasound examination

Ultrasound examination includes ultrasound Dopplerography and duplex scanning with color mapping of blood flow (triplex scanning).

When Dopplerography of blood vessels, sensors with a radiation frequency of 4 MHz and 8 MHz are used. This study allows to confirm the presence of normal, altered blood flow or its absence in venous or arterial vessels, measure regional systolic pressure indices and conduct functional tests. This method is quite simple and is often used in the diagnosis of pathology of arterial lesions, especially in

military field conditions. Triplex scanning uses wide-band sensors: linear (L12-3 kHz), convex (C5-1 kHz) and sector (S 5-1 kHz). This study allows visualization of the vessel itself with an assessment of the structure, nature of the lesion and changes in blood flow, as well as the state of the surrounding tissues. In the veins, it is possible to record: changes in blood flow during the phases of the respiratory cycle; an increase in blood flow when squeezing the leg distal to the segment being studied; the appearance of retrograde blood flow when squeezing the leg proximal to the segment being studied or during the Valsalva maneuver (this applies to both methods, but is better with scanning, since the thrombus can only be stenotic and can be missed with Dopplerography).

Ultrasound allows us to distinguish a fresh growing thrombus from an old one (Fig. 6-10). However, examination of the iliac veins is often complicated by gas accumulation in the intestine. At the same time, the diagnostic accuracy of the method is 95%, sensitivity - 94%. Ultrasound was performed on 39 patients.

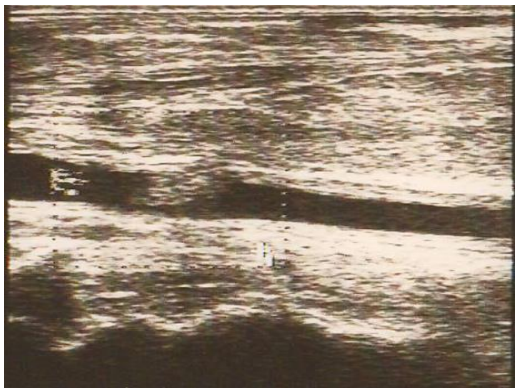


Fig. 6. Ultrasound. Foreign body in the right common carotid artery.

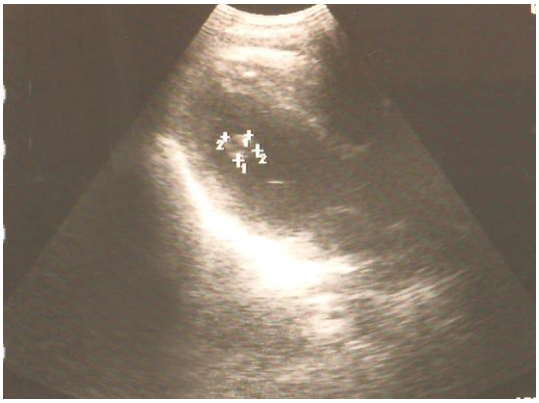


Fig. 7. Ultrasound. Foreign body in the right common carotid artery.

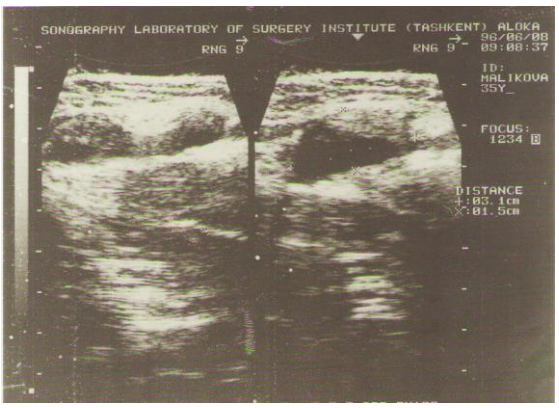


Fig. 8. Ultrasound. Traumatic aneurysm of the right brachial artery.

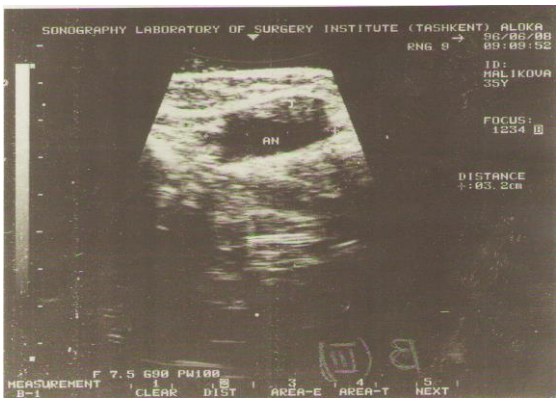


Fig. 9. Ultrasound. Traumatic aneurysm of the right brachial artery.

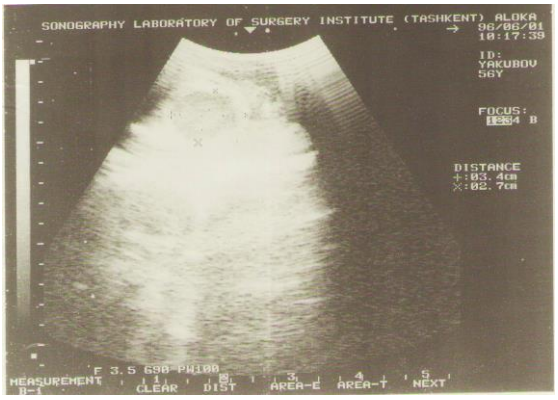


Fig.10. Ultrasound. Traumatic aneurysm of the left brachial artery.

Dopplerography of vessels

This study allows to confirm the presence of venous blood flow. In this case, to register: changes in blood flow during the phases of the respiratory cycle; an increase in blood flow when the leg is compressed distally to the examined segment; the appearance of retrograde blood flow when the leg is compressed proximally to the examined segment. This method is quite simple and is often used in the diagnosis of deep vein thrombosis and venous valve insufficiency.

However, it does not require high qualifications from the researcher. This method was used to examine 12 patients.

CHAPTER V. DIAGNOSIS AND SURGICAL TREATMENT OF TRAUMATIC VASCULAR INJURY

5.1. Clinical signs, causes of traumatic injuries

Recent years have been characterized by a sharp increase in the number of injuries accompanied by damage to the main vessels.

Untimely diagnosis and incorrect tactics of surgical treatment of traumatic vascular injuries lead to death or the development of severe complications. Consequences ending in disability of the victim due to amputation of limbs [Belov Yu.V. 2014; Pokrovsky A.V. 2016].

Injury to the vessels of the upper and lower extremities is one of the severe injuries due to the high frequency of local and general complications, reaching 15.4-25.5% according to various sources. Recent years have been marked by an increase in the number of injuries with damage to the main vessels of the extremities. The frequency of this type of injury has increased by 2-3 times in the last decade. This should attract the special attention of surgeons. The greatest difficulties arise in the treatment of patients admitted at a later stage, against the background of severe combined trauma, accompanied by large blood loss and shock. Mortality reaches 10%.

Vascular injuries at the level of the upper thoracic opening, at the base of the neck and skull are difficult to recognize. This also presents significant difficulties in choosing an approach and finding options for their restoration. Damage to the vessels of the chest and abdominal cavities is accompanied by massive blood loss. At the same time, a huge retroperitoneal hematoma makes it difficult to find damaged vessels. It should be noted that bleeding from vascular injuries can be stopped by: finger pressure; applying a pressure bandage; giving the limb a raised position; maximum flexion in the joints.

To choose a treatment strategy for vascular injury, information about the nature of the injury, its localization, the general condition of the patient, the degree of

ischemia, the presence of concomitant injuries, etc. are of great importance. Surgical treatment of vascular injuries and their consequences often causes significant tactical and technical difficulties. The surgeon must not only carry out therapeutic measures aimed at saving the life of the victim, but also ensure the full function of the damaged organ and labor rehabilitation of patients.

This chapter presents some issues of the clinic, diagnosis and surgical treatment of traumatic vascular injuries. We observed 180 patients. Of these: traumatic and hemorrhagic shock - 36; bone and vascular injuries - 22; iatrogenic injuries - 20 patients. Both sexes aged 10-70 years and older: men - 126 (91.3%), women - 12 (8.6%). Table 1 provides data on gender and age.

Table 1

Distribution of patients by sex and age

Age sick	Including				Total sick (percentage)	P
	Men		Women			
	CG	MG	CГ	MG		
up to 15 years	79(57,2%)	-	1(0,7%)	1(0,7%)	9(6,5%)	>0,05
16-20 years old	9(6,5%)	4(2,8%)	1(0,7%)	-	14(10,4%)	
21-30 years old	42(30,4%)	11(7,9%)	4(2,8%)	-	57(41,3%)	>0,05
31-40 years old	33(23,9%)	4(2,8%)	1(0,7%)	1(0,7%)	39(28,2%)	
41-50 years old	8(5,7%)	3(2,1%)	1(0,7%)	1(0,7%)	13(9,4%)	>0,05
51-60 years old	-	1(0,7%)	2(1,4%)	-	3(2,8%)	
61-70 years and older	-	2(1,4%)	1(0,7%)	-	3(1,4%)	>0,05
Total:	99(71,7%)	25(18,1%)	11(7,5%%)	3(2,1%)	138(100%)	

In this case, as can be seen from the table, vascular injuries were often observed in men, the distribution of vascular injuries by age was from: 16-20 years old - 14 (10.4%); 21-30 years old - 57 (41.3%), 31-40 years old - 39 (28.2%). All traumatic vascular injuries were divided into 2 types: penetrating wounds and blunt injuries. Penetrating injuries are injuries received from firearms and bladed weapons. Blunt injuries are injuries resulting from road accidents and falls from a height, as well as during sports competitions. The causes of vascular injuries to the extremities were penetrating: knife injuries - 45 (32.6%), gunshot wounds - 5 (3.6%). The following complaints are mainly observed in these patients: pain in the area of the injury; presence of a wound (in the projection of the vessels); bleeding from the wound; hematoma in the area of the injury (may be pulsating); signs of limb ischemia (cold, decreased or no sensitivity, no active movement). Here is an example of one of these patients:

Patient K.O. 28 years old, No. 3528. complains of a wound, bleeding, numbness, coldness, general weakness, dizziness and pain in the left shoulder joint. The patient was injured in the field. General condition is average, consciousness is clear, skin is pale. Blood pressure is 100/60 mm Hg. Pulse is 90 beats per minute. Vesicular breathing in the lungs. The liver and spleen are not palpable. Upon examination, there are wounds measuring 2.0 × 2.0, 1.5 × 1.5 cm in size in the left shoulder joint and subclavian region. The edges of the wound are smooth, rounded, bleeding is observed. Movement in the shoulder joint is limited. Severe pain is noted upon palpation.

Diagnosis: gunshot wound of the left shoulder and subclavian region with damage to the axillary and subclavian arteries. The patient underwent emergency surgery. Under intubation anesthesia, an incision was made in the left subclavian and axillary areas. During revision, damage to the axillary and subclavian arteries was established. Autovenous subclavian-axillary bypass was performed on the left and autovenous prosthetics of the left axillary artery were performed. The postoperative course was uneventful. The patient is discharged home under the supervision of a surgeon at the place of residence. Dopplerography was

performed on the patient to study the immediate and remote results. The ABI-1.0 index didnot differ from the healthy arm (ABI-1.1), (Fig. 11-13)

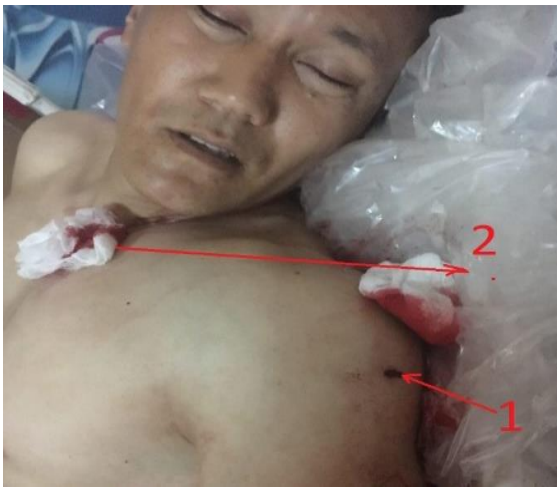


Fig.11. K.O. 28 years old, No. 3528.
Gunshot wound, damage to the axillary artery, left. 1. Entry point of the bullet
2. Exit point of the bullet.

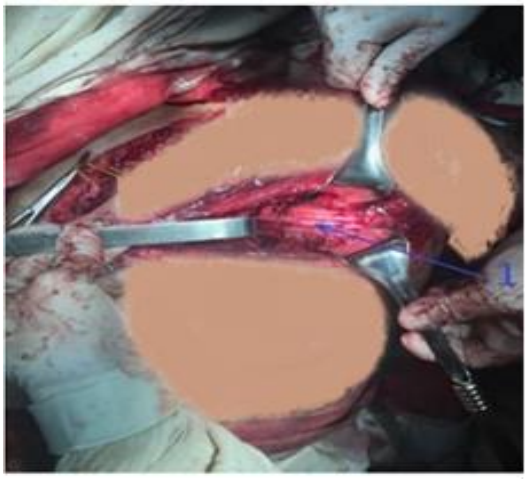


Fig. 12. K.O., 28 years old, No. 3528.

Autovenous subclavian - axillary bypass, left

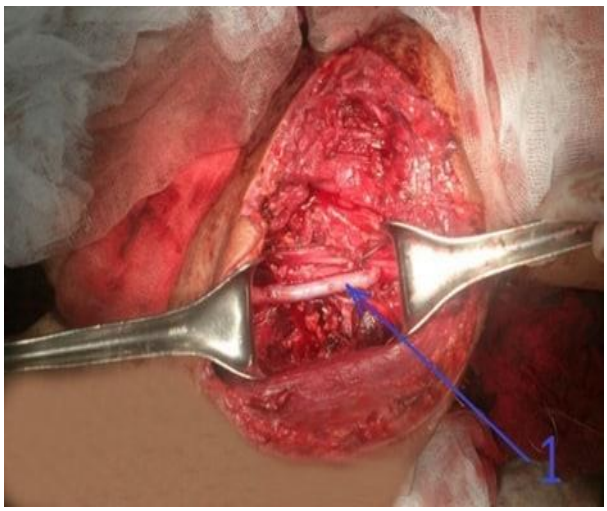


Fig. 13. K.O. 28 years old, No. 3528. Autovenous grafting of the axillary artery, on the right.

Along with the causes, vascular injuries differ in their location.

Thus, injuries differ by their location: femoral - 33 (23.9%), iliac - 5 (3.6%), abdominal aorta - 1 (0.7%), axillary - 4 (2.8%), brachial - 54 (39.1%), ulnar - 11 (7.9%), radial - 6 (4.3%), carotid - 4 (2.8%), external jugular vein - 1 (0.7%), thyrocervical - 1 (0.7%), vertebral - 2 (1.4%), gluteal - 1 (0.7%), occipital - 2

(1.4%), intrapudendal - 1 (0.7%), arteries of the leg - 6 (4.3%), arteries of the neck muscle - 3 (2.1%).

5.2. Diagnosis and tactics of surgical treatment of vascular injuries

When veins are damaged, the following signs should be paid special attention: wound in the projection of the vessel; bleeding from the wound; hematoma in the projection of the injury (may pulsate if the artery is damaged); absence of pulse below the level of injury in case of arterial trauma; signs of acute ischemia (paleness and coldness of the skin of the distal parts of the injured limb, impaired sensitivity and mobility of the limb). When veins are damaged, we recommend that each should be approached individually depending on the patient's condition.

In the work, localization of vascular damage by body parts was distributed as follows: neck and head - 12 (8.6%), trunk - 13 (9.4%), upper limb - 71 (51.4%), lower limb - 42 (30.4%).

The criteria for diagnosing arterial damage and choosing the types of surgical treatment of injuries were based on their localization on the vessels and parts of the body.

It should be noted that ligation of blood vessels is still considered by some surgeons to be one of the most effective ways to temporarily stop bleeding. However, it must be remembered no less that the ligation of the main vessels often leads to the development of acute ischemic phenomena in the limb and up to gangrene. When the main veins are ligated, chronic venous insufficiency develops. Ligation of the arterial trunks often leads to gangrene of the limb and its subsequent amputation. After ligation of the popliteal artery, the amputation rate reaches 42.5%. So, in 138 patients observed by us, vascular operations were performed. Of these: 25 (28.1%) ligation of vessels, while 6 (4.3%) vein ligation. Most often, the ligature is applied to the femoral artery-5 (3.6%). To stop bleeding, surgeons often try to isolate the vessels by expanding the wound channel. Resuming, at the same time, bleeding makes it very difficult to apply hemostatic clamps to the places of alleged damage to the vessels. In this case, part of the vessels and nerve trunks are injured. We consider that when the wound is

localized in the area of the projection of the main vessels to the wound channel, it is directed to the neurovascular bundle.

Along with these types and localization of vascular injuries, we have established the nature and relationship of injuries with other local injuries. Based on the study, we established the localization and nature of injuries, and identified the types of surgical interventions in: axillary, brachial, ulnar and radial arteries. At the same time, in 32 (23%) of the observed patients, vascular injuries were combined with damage to soft and bone tissue.

Patients with multiple vascular injuries were not included in this group. Damage to the iliac-femoral-popliteal arteries was observed in 40 patients. Of these: 33 are femoral, 5 are iliac and 2 are popliteal (Table 2).

Table 2.

The nature of injuries of the iliac-femoral-popliteal arteries

Name of vessels	Other tissues	Type of injury Injuries	Degree of ischemia	Treatment	Shock	Results
Femoral Artery	Knife		IIa-3 IIb-1	Dressing-2 Side artery-1 Lateral vein-4; BV-2 Circular-1 Circulating vein-1 Autovena-7 Autovein vein-1 Extraatomic shunt-1 Amputation-1 Primary debridement -4	2 st-5 3 st-2	Satisfactory-7 Good-13
	Shotgun-2	Vienna-1	II-1	Extraatomic auto-vein-1 Side seam veins-1 Autovena-1		Good-2
	Firearms-2			Primary debridement -1 Palm-1		Good-2

	Other-9	Vienna-4	IIa-3 IIb-1	dressing-3 vein-5 Lateral-1 veins-1 Circular- ny-1 veins-1 Thrombectomy-1 Primary debridement -2	Ist-2 IIst-1	Satisfactory-1 good-8
Iliac artery	Knife-2	-	- IIa-1	Autovena-2		Good-2
	Other-3 (heights)			Autovena-3		Good -2 Satisfactory -1
Popliteal artery	Other-2	Vein-2		Amputation-1 Thrombectomy-1		Satisfactory-1 Good-1
Leg arteries	Other-6	Muscles-2 Vienna-1		Ligation ZBV-2 PHO-1 Autovena-1 Thrombectomy-2		Satisfactory-1 Good-5

Of all the observed patients, 75 patients had injuries to the axillary, brachial, ulnar and radial arteries. In this regard, the patients underwent the following types of surgical interventions: 8 - vascular ligation, including: 3 - venous vessel ligation; 9 - lateral suture was applied; of which: 3 were applied to the vein; 20 - circular suture; 24 - autovenous prosthetics; of which: 1 was applied to the vein; 5 - prosthetics; 8 - primary surgical treatment; amputation - 1. And also simultaneously applied epineural suture (19). The results of the performed reconstructive surgeries are as follows: good - 69; satisfactory - 6; unsatisfactory - 1 patient (Table 3.).

Table 3

The nature of injuries and types of surgical interventions in the subclavian - axillary, brachial, ulnar and radial arteries

Name of vessels	Other tissues	Type of injury Injuries	Degree of ischemia	Treatment	Shock	Results
Subclavian artery	Knife-1			Lateral-1	Shock-II	Good-1
Axillary artery	Other-3	Vienna-1 Nerv-1	IIb-1	Autovena-2 Epineral suture-1		Good -3

				Circular -1 Vein ligation-1		
Brachial artery	Knife-14	Nerv-6 Vienna-3 Muscles-1	IIa-3 III-2	Ligation artery-1 veins-1 Lateral-3 Vienna-1 Circul-8 Autovena-5 Prosthesis-1 Epineural-seam-4	Shock I-2 Shock 11-5 Shock III-2	Satisfactory-1 Good-13
	Other-39	Muscles-1 Nerv-9 Dislocation-1 Vienna-4	Ia-4 Ib-1 IIa-7 IIb-2 IIIa-3	Primary debridement-4 dressing-3 Lateral-2 vein-2 Circus-11 Autovena-16 vein-1 Prosthesis-4 Epineral suture-12 Thrombectomy-4	Shock I-4 Shock II-12 Shock III-2	Satisfactory-3 Good-35 Unsatisfactory-1
Radial artery	Other-5	Nerve-1		Ligation-1 Side seam- Circular-1 Autovena-1 PHO-1 Epineural suture-1	Shock I-1 Shock II-2	Satisfactory-1 Good-4
	Knife-1			Ligation-1		Satisfactory-1
Ulnar artery	Knife-1			Primary debridement -1	Shock II-1	Good-1
	Other-10	Nerv-2 Vienna-1 Tendon-1		Ligation artery-1 vein-2, Side seam-1 PHO-6 Epineural suture-1	II st-2 IIIst-2	Satisfactory-1 Good-9

In our study, based on the analysis of vascular injury parameters in patients with shock, we established the degrees of hemorrhagic shock. We identified 4 degrees of hemorrhagic shock.

Grade 1 hemorrhagic shock was established in 5 (3.6%) patients. Circulating blood volume (CBV) deficit up to 15%. BP above 100 mm Hg. Central venous pressure (CVP) within normal limits. Slight pallor of the skin and increased pulse rate up to 80-90 beats per minute, hemoglobin 90 g / l and more.

Grade 2 hemorrhagic shock was established in 26 (18.4%) patients. CBV deficit up to 30%. Moderate severity of the condition, weakness, dizziness, darkening in the eyes, nausea, lethargy, pallor of the skin are observed. Arterial hypotension up to 80-90 mm. Hg, decreased CBV (below 60 mm Hg), tachycardia up to 110-120 beats per minute, decreased diuresis, hemoglobin up to 80 g / l. and less.

Grade 3 hemorrhagic shock was established in 4 (2.8%) patients. CBV deficit of 30-40%. The condition is severe or very severe, lethargy, confusion, pale skin, cyanosis. BP below 60-70 mm Hg. Tachycardia up to 130-140 beats per minute, weak pulse filling. Oliguria.

Grade 4 hemorrhagic shock was established in 1 (0.7%) patients. CBV deficit is more than 40%. Extreme degree of suppression of all vital functions: consciousness is absent, BP and CVP are not determined on the peripheral arteries. Breathing is shallow and frequent. Hyporeflexia. Anuria. The approximate volume of blood loss can be determined by calculating the shock index.

The circulating blood volume deficit was determined by the value of the shock index using the Algover method (the ratio of the pulse rate to the level of systolic blood pressure), and the shock index was determined by the volume of blood loss (% CBV)(Table.4).

Table 4

Indicators of the Algover shock index

Shock index value	**Circulating blood volume deficit**
0,5	15%
1,0	30%
1,5	50%
2,0	70%

To solve tactical issues in the patient's shock condition, we were guided by the assessment of: the severity of the condition; the nature of the injury and the progression of ischemia. Early reconstructive surgeries in rapidly progressing ischemia and shock simultaneously with anti-shock measures were performed in 36 patients. Severe shock, massive tissue damage and irreversible ischemia were indications for limb amputation in 1 (0.7%) patient with vascular injuries. Our observations show that the feasibility of reconstructive surgeries on vessels is determined not only by the time elapsed since the injury and the degree of ischemic phenomena, but also by objective criteria for assessing the degree of impairment in the injured limb. However, the degree of ischemia is often determined subjectively. Therefore, incorrect interpretation of clinical signs is allowed. To select the optimal treatment method for injury of the main vessels with ischemia, the classification of this condition is of great importance. We often use the classification of Academician of the Russian Academy of Sciences V.S. Savelyev (2002). Evaluation of the degree of ischemia allows us to solve such tactical issues as: in compensated ischemia, emergency surgical intervention is not performed; in uncompensated ischemia, emergency surgical intervention is performed on the integrity of the damaged vessel (within 6 hours); in irreversible ischemia, amputation of the limb is performed. However, even focusing on clinical signs, in accordance with various classifications, it is impossible to predict the fate of the limb. It should be emphasized that great importance is attached to the assessment of a combination of various interrelated factors: time of injury; localization; type and nature of vascular damage; disorders of the anatomical structures of the limb and associated injuries.

In the study, we established the localization of vascular damage by body parts, which is presented in Table No. 3. As can be seen from Table No. 3, the localization of vascular damage by body parts was distributed as follows: neck and head - 12 (8.6%), trunk - 13 (9.4%), upper limb - 71 (51.4%), lower limb - 42

(30.4%). Along with this, the nature and relationship of injuries with other local injuries were established (Fig. 14-17).

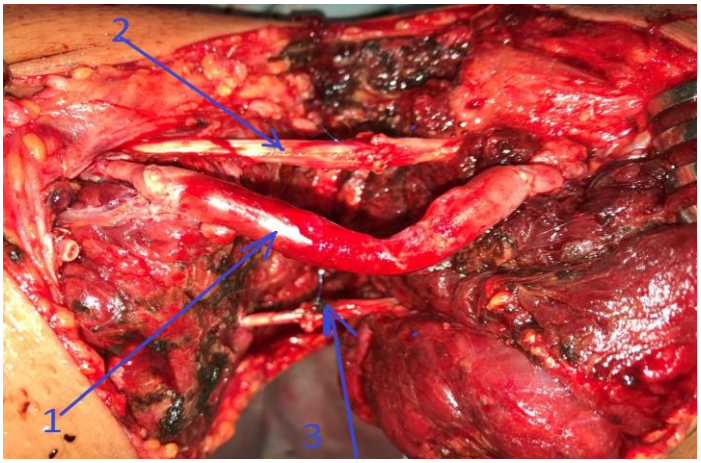


Fig.14. Autovenous grafting of the brachial artery, right. 2. End-to-end restoration of the median nerve. 3. End-to-end restoration of the ulnar nerve.

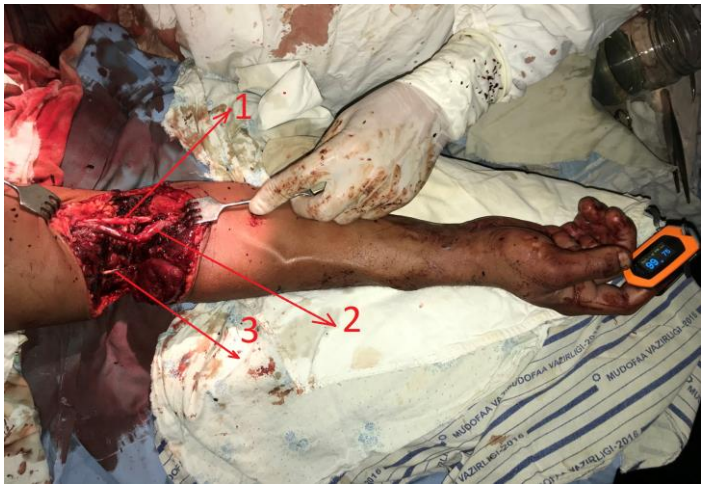


Fig. 15. General view of the limb after restoration of the brachial artery, median and ulnar nerves, on the right.

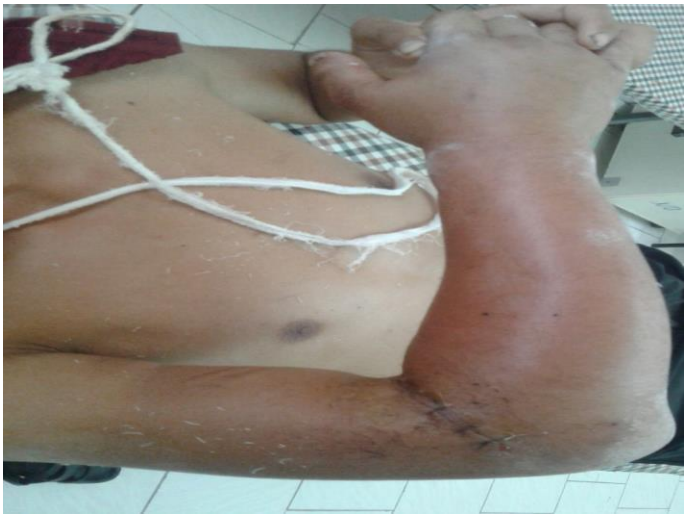


Fig. 16. After recovery after 5 days.

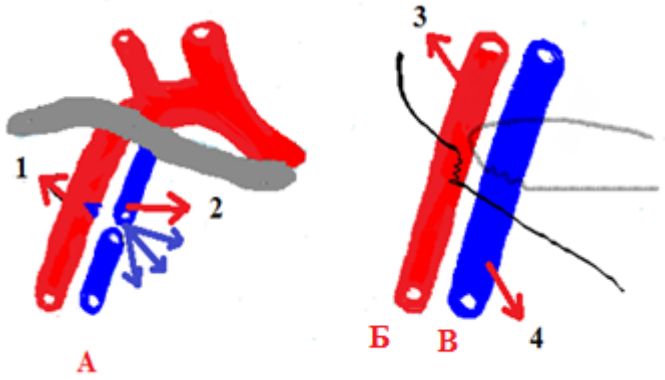


Fig. 17. Traumatic injury to the brachial artery and vein, on the right.

A) 1 - lateral injury to the right brachial artery. 2 - injury to the right brachial vein. B) 3 - lateral suture of the brachial artery, on the right. C) 4 - circular suture of the brachial vein, on the right.

It should be emphasized that the choice of tactics of surgical treatment, when providing specialized care, to patients with vascular injuries should not be of the same type. At the same time, the leading factors in the choice and tactics of surgical treatment are: the general condition of the patient; degree of ischemia; nature of vascular injury; anatomical formations in the limbs and associated injuries. Often, shock occurs with acute blood loss. So, in 45-72% of patients, this was due to damage to the main vessels. At present, there are all possibilities for performing reconstructive and restorative operations on vessels with simultaneous anti-shock measures. However, surgery on the main vessels, against the background of shock, can lead to serious consequences. They are associated with the entry into the general circulation of products of ischemic tissue damage.

To resolve the issue of the possibility of performing reconstructive surgery on the vessels against the background of shock, an objective assessment of the degree of limb ischemia and its progression is necessary. Many researchers diagnosed shock in 20.8% of patients. We found that among those admitted to the clinic in 36 (26%) patients, hemorrhagic and traumatic shock: 5 (3.6%) patients were in extremely severe condition. At the same time, we determined the level of blood loss: 1000-1500 ml - in 6; 1500-2000 ml - at 25; 2500-3000 ml - in 5 patients. Along with this, we have established the degree of shock: the first degree -5 (3.6%); second degree - 27 (19.5%); third degree - 4 (2.8%) patients. At

the same time, in patients, blood pressure ranged from 60/30 to 100/60 mm. rt. Art. and a pulse of 60 to 130 beats per minute.

Depending on the nature and localization of vascular damage, patients with shock were distributed as follows: brachial artery - 17 (12.3%); femoral artery-5 (3.6%); carotid artery-1 (0.7%); occipital artery-1 (0.7%); supraclavicular-1(0.7%); radiation-2 (1.4%); elbow-7(5%); lower leg (tibial artery and vein) -1 (0.7%). We have performed 36 operations of various types on patients with shock after vascular injury: vessel ligature-17; side seam-5. Of these: at the same time, a lateral suture was applied to the venous vessels; circular seam-7; autovenous prosthetics-5; prosthetics-1; extrantomy shunting-1; primary amputation-1 patient. 7 patients had an epineural suture.

Arrosive bleeding was observed in only one patient. In 24 (17.3%) patients, wound healing was primary, in 2 (1.4%) patients, the wounds healed by secondary intention. It should be noted that damage to the vessels of patients was accompanied by various degrees and types of shocks. Laboratory blood tests were performed in 138 patients. Hemoglabin-36-up to 108 g/l in 25 patients. Hematocrit in 14 patients was 20-41, blood coagulation time in 14 patients was from 6-7 to 12.50-13.53. Fibrinogen, in 18 patients from 4440 to 8880 g/l. one patient had very low fibrinogen - 1776 g/l. PTI-68-82.%. In 36 patients, against the background of shock, hemoglobin was from 62 to 109 g/l (in 22 patients). Hematocrit in 6 patients was from 20 to 39%. In 1 patient PTI - 84%. Fibrinogen, in 4 patients from 4210 to 6660 g/l. One patient was low-1776 g/l.

Early reconstructive operations, with rapidly progressing ischemia and shock, were performed simultaneously with anti-shock measures in 36 patients. Severe shock, massive tissue damage and irreversible ischemia were indications for limb amputation in 1 (0.7%) patients with vascular damage.

Our observations show that the expediency of reconstructive operations on the vessels is determined not only by the time elapsed since the injury, but also by the degree of ischemic events (Table 5).

Tables 5.

Dependence of ischemic disorders on localization vascular injury

amaged vessel	Number of patients with ischemia						Total patients	
	I degree		II degree		III degree			
	CG	MG	CG	MG	CG	MG	CG	MG
Iliac artery			1(0,7%)	-	-		1(0,7%)	-
Femoral artery	-	1(0,7%)	-	2(1,4%)			-	3(2,1%)
Axillary artery			1(0,7%)		-	-	1(1,47,9%%)	-
Brachial artery	4(2,8%)	-	6(4,3%)	1(0,7%)	1(0,7%)	1(0,7%)	11	2(1,4%)
Ulnar artery			2(1,4%)				2(1,4%)	-
Total:	4(2,8%	1(0,7%)	10(7,2%)	3(2,1%)	1(0,7%)	1(0,7%)	15(10,8%)	5(3,6%)

Table 3.4 shows that the compensated nature of ischemia is observed with injuries of the extremities: I degree-5 (3.6%); II degree-13 (9.4%); III degree-2 (1.4%); irreversible (amputation) - 1 (0.7%) patients. All other patients recovered limb ischemia.

An important point of the reconstructive operation is the revision of the distal vascular bed in order to remove the thrombus, in order to prevent an unfavorable outcome. Removal of thrombi from the distal vascular bed is performed using a Fogarty balloon probe, which are presented in Table 6.

Tables 6

Terms of performing reconstructive operations in case of traumatic injuries of blood vessels

Damaged vessel	Terms of operations				Total arteries
	Number of patients with ischemia				
	30-3 hours	4-6 hours	7-10 hours	11-15 hours	
Iliac	4(2,8%)			1(0,7%)	5(3,6%)
Femoral	23(16,6%)	6(4,3%)	2(1,4%)	2(1,4%)	33(23,9%)

Popliteal	1(0,7%)	1(0,7%)			2(1,4%)
Leg artery	4(2,8%)			2(1,4%)	6(4,3%)
Axillary	2(1,4%)	1(0,7%)	1(0,7%)		4(2,8%)
Brachial	34(24,6%)	10(7,2%)	7(5%)	3(2.1%)	54(39,3%)
Elbow	10(7,2%)	1(0,7%)			11(7,9%)
Ray	6(4,3%)				6(4,3%)
Gluteal	1(0,7%)				1(0,7%)
Cervical muscle	2(1,4%)		1(0,7%)		3(2,1%)
Abdominal aorta	1(0,7%)				1(0,7%)
Carotid artery	3(2,1%)	1(0,7%)			4(2,8%)
Inside the shameful	1(0,7%)				1(0,7%)
Vertebrate	2(1,4%)				2(1,4%)
External jugular vein	1(0.7%)				1(0,7%)
Thyroid artery		1(0,7%)			1(0,7%)
Occipital	1(0,7%)		1(0,7%)		1(0,7%)
Venous angle and thoracic duct				1(0,7%)	1(0,7%)
Total:	96(69,5%)	21(15,2%)	12(8,6%)	9(6,5%)	138(100%)

One of the most severe complications of acute limb ischemia is the reaction of the body to the inclusion of the ischemic organ into the general circulation. For prevention and treatment, we made the composition of the perfusion solution: broad-spectrum antibiotics (cefuroxome, brolumycin, ciftriaxone) - 1.0; FFP -200 ml; physiological solution-500 ml; papaverine solution - 5 ml; 0.5% solution of novocaine-200 ml; 4% solution of sodium bicarbonate-150 ml; heparin-20000ED; fibrinolysin – 20000 ED; diphenhydramine solution-4 ml. In addition, hemasorption is widely used in practice to combat acute limb ischemia.

The question arises? What is the tactics of surgical treatment of injuries of the vertebral artery in the spinal canal? So the wound of the vertebral artery, in the first segment. Ligation of the vertebral artery, when it is injured in the first segment, is performed from a typical supraclavicular or vertical access. When the artery is exposed on the left, the thoracic lymphatic duct may be ligated. All damaged lymphatic tributaries are ligated. The artery is isolated along its entire length, from its mouth to the entry into the opening of the transverse process of the C6 vertebra, and is ligated.

Operations for injury of the vertebral artery, in the second segment, if it is impossible to ligate the proximal segment of the transected artery, the canal of the transverse processes can be sealed with wax and tamponed with muscles.

Operations for wounds of the vertebral artery, in the third segment, bleeding from the ends of the vertebral artery, can be stopped by tamponing with muscles with deep sutures, closer to the mastoid process of the temporal bone, where the vertebral artery is located most superficially in relation to the skin.

The type of reconstructive operations to provide emergency angiosurgical care to the patient must be selected depending on: the nature and location of the arterial vascular injury; their features in combined injuries; condition of the victim and others. Most often, there are penetrating wounds 45 (32.6%), accompanied by a complete rupture of the vascular wall(Table 7).

Table 7

Comparative analysis of the results of surgical treatment

Damaged vessel	Before 2000 (counter)	Operation	Since 2000-2018 (Basic)	Operation	Total	P
Iliac	5(3,6%)	5	-		5(3,6%)	>0,05
Femoral	20(14,4%)	20	13(9,4%)	13	33(23,9%)	
Popliteal	2(1,4%)	2	1(0,7%)	1	2(1,4%)	
Leg artery	3(6,4%)	3	3(6,4%)	3	6(4,3%%)	
Axillary	3(6,4%)	3	1(0,7%)	1	4(2,8%)	

Brachial	49(35,5%)	49	5(3,6%)	5	54(39,1%)	
Elbow	9(6,5%)	9	2(1,4%)	2	11(7,9%)	
Ray	5(3,6%)	5	1(0,7%)	1	6(4,3%)	
Gluteal	1(0,7%)	1			1(0,7%)	
Cervical muscle	2(1,4%)	2	(0,7%)	1	3(2,1%)	
Abdominal aorta	1(0,7%)	1			1(0,7%)	
Carotid artery	3(4,3%)	3	1(0,7%)	1	4(2,8%)	
Inside the shameful	1(0,7%)	1			1(0,7%)	
Vertebrate	2(1,4%)	2			2(1,4%)	
External jugular veins	1(0,7%)	1			1(0,7%)	
Thyroid arteries	1(0,7%)	1			1(0,7%)	
Occipital	1(0,7%)	1			1(0,7%)	
Venous angle and thoracic duct	1(0,7%)	1			1(0,7%)	
Total:	110(80%)	110(80%)	28(20%)	28(20%)	138(100%)	

Between the CG and MG groups, $p<0.05$ is statistically significant.

In what cases should the damaged vein be ligated: Indications for ligation of vessels; impossibility of restoring a vessel in a wound with severe tissue crushing; danger of exacerbation of infection as a result of manipulations in the wound; presence of a traumatic aneurysm; need for amputation of a limb against the background of anaerobic infection, when the application of a tourniquet is contraindicated; in case of danger of erosive bleeding, for example from the depth of a purulent wound.

In the first group, the following types of operations were performed: ligation of vessels - 25 (18.1%); 25 patients out of 138 who received treatment for

vascular damage, associated with various reasons, where the ligation method was used. Thus, ulnar artery - 1 (0.7%); branch of the external carotid artery - 1 (0.7%); cervicothyroid artery - 1 (0.7%); occipital artery - 1 (0.7%); external jugular vein - 1 (0.7%); branch of the vertebral artery - 1 (0.7%); brachial artery - 3 (2.2%), vascular reconstruction - 1 (0.7%); ischemia compensated by collaterals - 2 (1.4%) patients. Femoral artery - 6 (4.3%), artery reconstruction - 2 (1.4%); ligation of the mouth of the deep femoral artery ligation - 2 (1.4%) patients. Deep femoral vein(DFV) - 1 (0.7%); superficial femoral artery (SFA)-1 (0.7%); - compensated, due to collaterals. For the radial artery - 1 (0.7%); ulnar vein - 1 (0.7%); Anterior tibial artery(ATA) - 1 (0.7%); Posterior tibial artery(PTA)-1 (0.7%); iliac artery - 2 (1.4%) patients underwent vessel ligation. Then the iliac artery was reconstructed. The immediate results of patients are good and satisfactory. Performed: lateral suture - 10 (6.5%); circular suture - 21 (15.2%); autovenous grafting - 45 (32.6%); vascular prosthetics – 3 (2.2%) and others – 34 (26.1%) patients, with $p<0.05$.

Results of vascular injury treatment: good – 114 (82.6%); satisfactory – 23 (16.6%) and amputation – 1 (0.7%).

In case of limb vascular injury, we performed surgical interventions to restore the integrity of 17 venous trunks, which amounted to 12.3% of all vascular reconstruction surgeries. To restore the vessels, the following was performed: circular suture – 2; lateral – 9; autovenous prosthetics – 2 patients.

It should be noted that vein ligation during World War II was performed on 71.3% of the wounded. The high frequency of vein ligation is 80-84%.

It should be emphasized that the application of a ligature to a vein is a serious injury to the vessel walls. Ligature of the main veins was performed in 20 patients. In this case, the patients experienced compensation of venous outflow. Most of the victims experienced the following after vein ligation: pain; swelling; feeling of heaviness; distension of the limb; cramps in the calf muscles.

Results and discussion

In recent years, significant progress has been observed in vascular surgery. This is due to: development of early diagnostic methods; introduction of reconstructive surgeries into clinical practice; optimization of surgical techniques; use of microvascular instruments and new suture materials, which have radically changed the outcome of treatment of patients with vascular injuries.

The effectiveness of treatment of traumatic vascular injuries depends on rationally organized vascular surgical care and timely, correct diagnosis. Undiagnosed traumatic vascular injuries lead to: development of post-traumatic aneurysms; post-traumatic arteriovenous fistulas; gangrene of the extremities; the cause of prolonged suffering, early loss of ability to work and disability, and mortality. However, until now, a significant number of practicing doctors have not sufficiently mastered the methodology of clinical examination of patients with vascular trauma. The main task of the pre-hospital stage and general medical institution, when providing assistance, is to save the patient's life.

Thanks to the use of modern diagnostic methods (ultrasound Doppler, DS, angiography, MSCT, phlebography) and treatment and preventive measures, cases of ischemia in the arms and legs were rare. To eliminate the ischemic condition, we proposed to use a perfusion solution. As a result of its use, serious complications were not observed, while amputation was performed only in one patient.

Treatment result: good - 114 (82.6%); satisfactory - 23 (16.6%) patients, amputation - 1 (0.7%).

These results were obtained by reliable stopping of bleeding; immobilization of the limb; carrying out anti-shock and resuscitation measures. In case of vascular damage (arteries and veins), ultrasound Doppler imaging, DS, angiography, MSCT, phlebography and others are of great diagnostic value. These methods and technologies specified: localization of vascular injuries or their exclusion; nature of damage; degree of development of collateral circulation, which allowed to improve the plan of reconstructive operations. To restore the vascular defect, the following were often used: circular suture; autovenous bypass of vessels;

prevention of severe ischemic disorders of the limb; perfusion therapy, hemosorption and others.

CHAPTER VI. "SURGICAL TREATMENT OF INJURIES TO BONES AND VESSELS OF THE EXTREMITIES

This section of the study is devoted to the study of the features of diagnostics and surgical treatment of bone and vascular injuries. Vascular injuries are considered severe injuries due to the high frequency of their complications and fatal outcomes, reaching, according to various sources, from 15.4 to 25.5%. Bryusov P.S. 1997. The frequency of amputations after combined injury, due to the development of gangrene and crushing of soft tissues, is from 20 to 40%. Gaibov A.D. and others 1999. Lemenev V.L. et al. 2001 observed 48 patients with damage to the main vessels. Of these, 15 (31.25%) patients had bone fractures. In this case, the following were used: intramedullary osteosynthesis 6; plate application-1; skeletal traction-1; external fixation-4; plaster cast-1. Four stages of its implementation are used for effective treatment of combined injuries: wound revision; bleeding control and temporary prosthetics; performing "stable" osteosynthesis; vessel reconstruction and restoration of damaged nerve trunks. Samokhvalov I.M. et al. 2006 observed 130 patients with such wounds. Of these, gunshot fractures of long bones and associated arterial injuries were registered in 41 cases, which is 31.5%.

Difficulties in early diagnosis in 15-60% of cases are associated with rapidly developing gangrene of the limb.

We believe that in case of bone and vascular wounds, the initial stable fixation of fragments makes it possible to determine the true defect between the ends of the vessels and choose the desired option for vascular suture or plastic surgery. The most effective method of temporary or final fixation of tubular bone fragments is intramedullary osteosynthesis. The choice of surgical treatment tactics depends on the individual patient's parameters: the patient's general condition; the nature of the injury; the localization and degree of ischemia.

However, there is no unified classification of bone and vascular injuries and no consensus on the method of treating bone fractures and vascular injuries. Our experience shows that the choice of treatment and diagnostics of bone and vascular injuries must be made individually, depending on the external and internal factors affecting these injuries.

Classification of vasculoskeletal injuries according to:

reasons: road transport; agricultural work; blunt trauma; firearms; falling from height; sports competition and others.

anatomy:

penetrating wounds: separation of the vessel; damage to the vessel wall; vessel defect;

non-penetrating injury: thrombosis; spasm; deformation;

injury mechanism: direct; indirect;

types of fracture: transverse; splintered; oblique;

localization of bone and vascular injuries by areas of the body: thigh; shoulder; collarbone; shin; forearm; neck; spine (thoracic, lumbar) and others;

types of complications: early: thrombosis, ischemia and gangrene;

late: anurism, arteriovenous fistula and others;

On the basis of our proposed classification, in the departments of vascular surgery of medical institutions, they provide assistance for vascular injuries, almost all patients with bone damage.

We observed 22 patients with combined bone and vascular injuries (4 consequences) (mean age 28.62 ± 9.09, $p>0.05$). Upon admission to the clinic, the condition of the patients was as follows: extremely severe-1; heavy-10; moderate - 5 and satisfactory - 6. Among the victims were: 86.3% of men and 3 (13.6%), aged 10-70 years and patients of working age - 70%. Days of hospitalization: 23.27±13.11, $p<0.05$. Until 2000, there were 15 (68.2%) such patients in the CG, and 7 (31.8%) in the CG from 2000-2018, with $p<0.05$. Patients were distributed by age and sex, which are presented in table 8.

Table 8

Distribution of patients by sex and age

Age of patients	Total	Including			
		Men		Women	
		CG	MG	CG	MG
up to 20 years	5(22,7%)	3(13,6%)	2(9%)	-	-
21-30 years old	8(36,3%)	7(31,8%)	1(4,5%)	-	-
31-40 years old	3(13,6%)	3(13,6%)	-	-	-
41-50 years old	2(9%)	1(4,5%)	-	-	1(4,5%)
51 and older	4(18,1%)	-	**2(9%)**	1(4,5%)	1(4,5%)
Total:	**22(100%)**	**14(63,6)**	**5(22,7)**	**1(4,5)**	**2(9,0)**

When receiving patients, urgently, special attention was paid to: general condition; traumatic fracture; artery ruptures; veins, etc. At the same time, the weakening of the pulse and the decrease in pressure on the arteries was due to significant bleeding in the areas of damage to the lower third of the shoulder and the middle third of the leg.

The injuries were mainly of a multiple nature: a crushed fracture of the bones of the lower leg; hip fracture and head injury; fracture of the femur and contusion of the pelvic bones; fracture of the tibia and bruising of the foot; fracture of the bones of the forearm and contusion of the trunk; shoulder fracture and head injury; damage to bones and blood vessels by bullet wounds; damage to bones and blood vessels by shot wounds.

A careful clinical study and angiography, Dopplerography and MSCT revealed in the examined patients, in addition to bone fractures, vascular damage, as well as injuries to the peripheral and main arteries. We analyzed the causes of combined osteovascular injuries and their localization.

In case of road traffic injuries, it is important to trace what led to the injury: a collision with a wheel or a blow to the front of the car. Rail transport injuries are characterized by their own characteristics, including multiple fractures; crushing of blood vessels, up to traumatic amputations. So, in the work on heap-cleaning mechanisms without protective and protective equipment, there were cases of hand tightening. At the same time, the following is taken into account: the nature of the localization of the fracture and injury; violation of local blood circulation

of the injured limb. So, under our supervision there were 22 patients with combined osteovascular injuries. Below is a case history of one patient.

Patient R.O. 14 years old, case number 1319. On April 24, 2017, at 23:00, he was taken to the Bekabad Central District Hospital. The patient was trapped under a train. The general condition is severe, the consciousness is confused, the skin and visible mucous membranes are pale in color. Blood pressure 100/50 mm Hg. Art. Pulse 90 beats per minute. Vesicular breathing in the lungs. The abdomen is soft, pain is noted. The liver and spleen are not palpable. Stool and urination regular. A chest rentgenray was taken. Retgengray showed fractures of the bones of the left clavicle and shoulder. Diagnostic laparotomy was performed with intubation anesthesia. Revision of the abdominal cavity without pathology. Operational wounds are sutured in layers. After that, intermedullary osteosynthesis was performed to the left humerus and a pin was inserted into the clavicle. The volume of contusion and thrombosis of the vessels was 6-7 cm. Therefore, these parts of the vessels were resected, and autovenous prosthetics were performed in the left brachial and subclavian arteries. End-to-end anastomosis, prolene 6/0. The blood flow has been started. There was a distinct pulsation of the radial artery, on the left. The last revision was made on the metatarsus and fingers of the left hand. The bruised - crushed soft tissue of 1-4 fingers of the hand had to be amputated.

Diagnosis: Associated injury. Fracture of the subclavian and humerus bones with bone mixing. Contusion and thrombosis of the subclavian and brachial arteries. Crushed injuries of the fingers of the hand, on the left (Fig. 18-24).

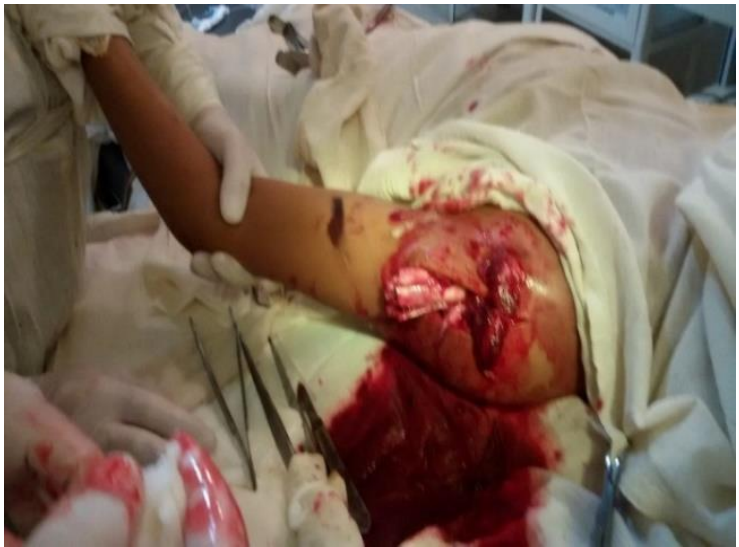


Fig.18. General view of the injury

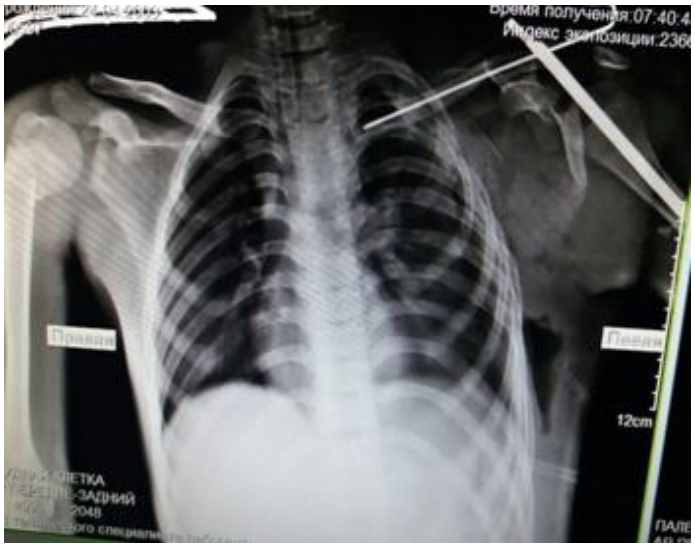


Fig. 19. Fracture of clavicle and humerus, left.
Osteosynthesis of the left clavicle and humerus shoulder area, left.

Fig.20. operational access. Wound of the axillary

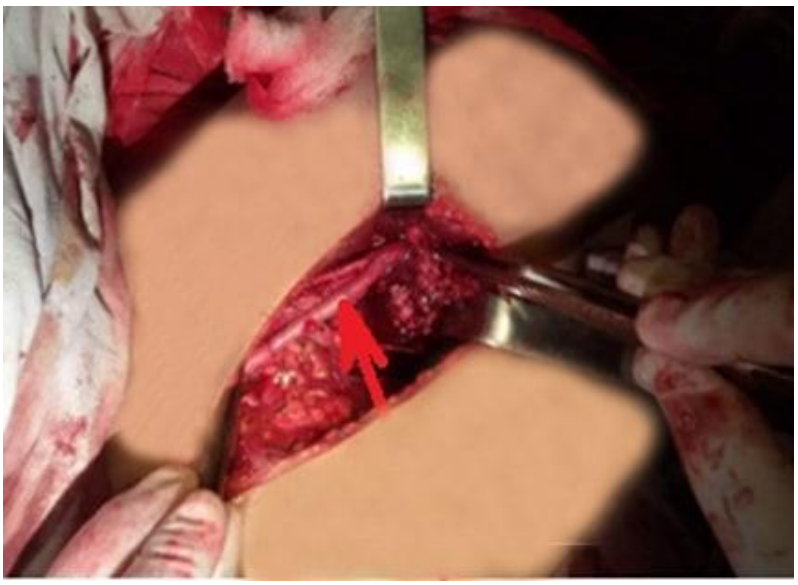


Fig.21. Subclavian-axillary autovenous
prosthetics, left.
artery on the left. The proximal and distal ends of the
axillary artery were mobilized and taken to the ascularclamps.

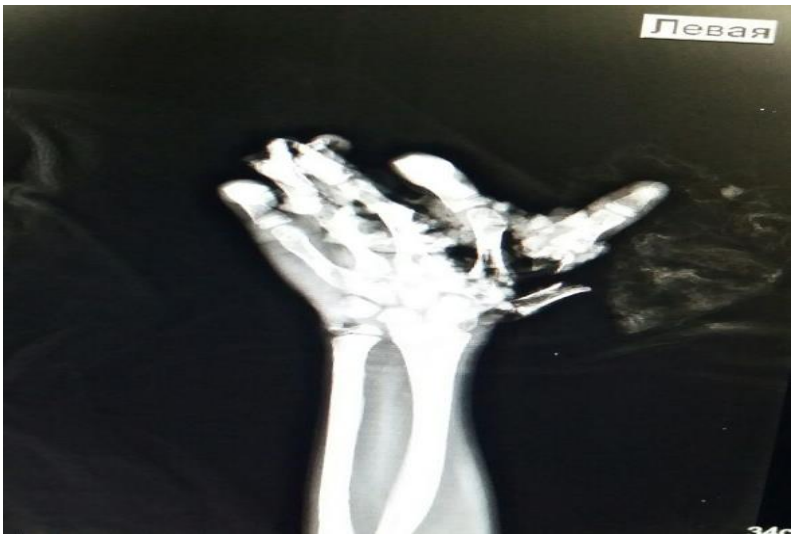


Fig.22.

Rentgengraphy:

of the wound of the left hand

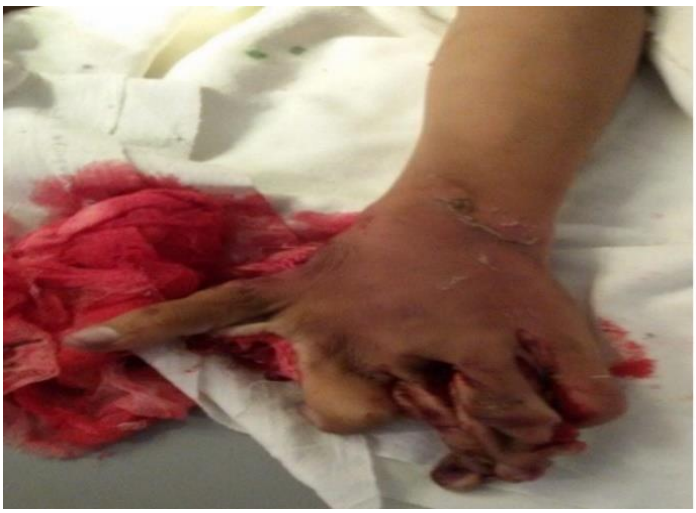
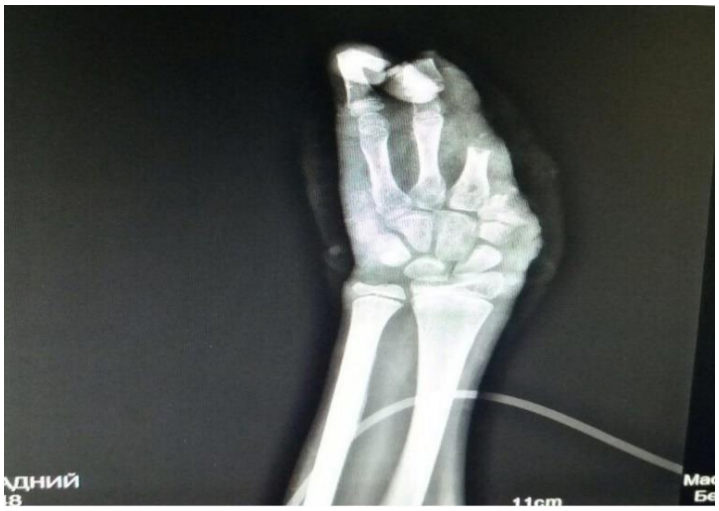


Fig. 23. After primary surgical treatment
racture of the bones of the left hand.



Rice. 24. Radiography after amputation of the left hand.

To study the immediate and long-term results, patients used Doppler imaging. The pulse on the left radial artery of the patient showed a good ankle-brachial index (ABI) -0.9. This indicator differs little from the left radial artery (LPI-1.0).

At the same time, the fractures were: comminuted, transverse and oblique. Of these, three of the observed patients were noted: dislocation and rupture of the elbow joint. As a result of a bone fracture, a false aneurysm developed (Table 9).

Table 9

Nature of the fracture and mechanism of injury

Type of fracture	Number of	Direct	Indirect

	injuries		
Transverse	7(31,8%)	6(27,2%)	1(4,5%)
splintered	10(45,4%)	8(36,3%)	2(9%)
oblique	2(9%)	2(9%)	-
dislocation and joint rupture	3(13,6%)	3(13,6%)	-
Total:	**22(100%)**	**19(86,3%)**	**3(13,6%)**

As a rule, the mechanism and nature of fractures corresponded to classical descriptions. Most oblique fractures, with indirect impact. Transverse and comminuted fractures, with direct impact force. Of particular interest is a brief description of the mechanism of the resulting injury. This gives an idea of how bone fragments can put pressure on soft tissues, c. including to nearby vessels. To this end, we tried to group the observed cases of associated injuries (Table 10).

Table 10

Localization of injuries with combined osteovascular injuries

Localization	Number of patients		Percent %	
	абс	%	cg	мg
Shoulder	7	31,8	5(22,7%)	2(9%)
Subclavian	2	9,0	-	2(9%)
Hips	3	13,6	2(9%)	1(4,5%)
shins	5	22,7	4(18,1%)	1(4,5%)
Iliac	1	4,5	1(4,5%)	-
Elbow dislocation	3	13,6	3(13,6%)	-
Cervical vertebra	1	4,5	1(4,5%)	-

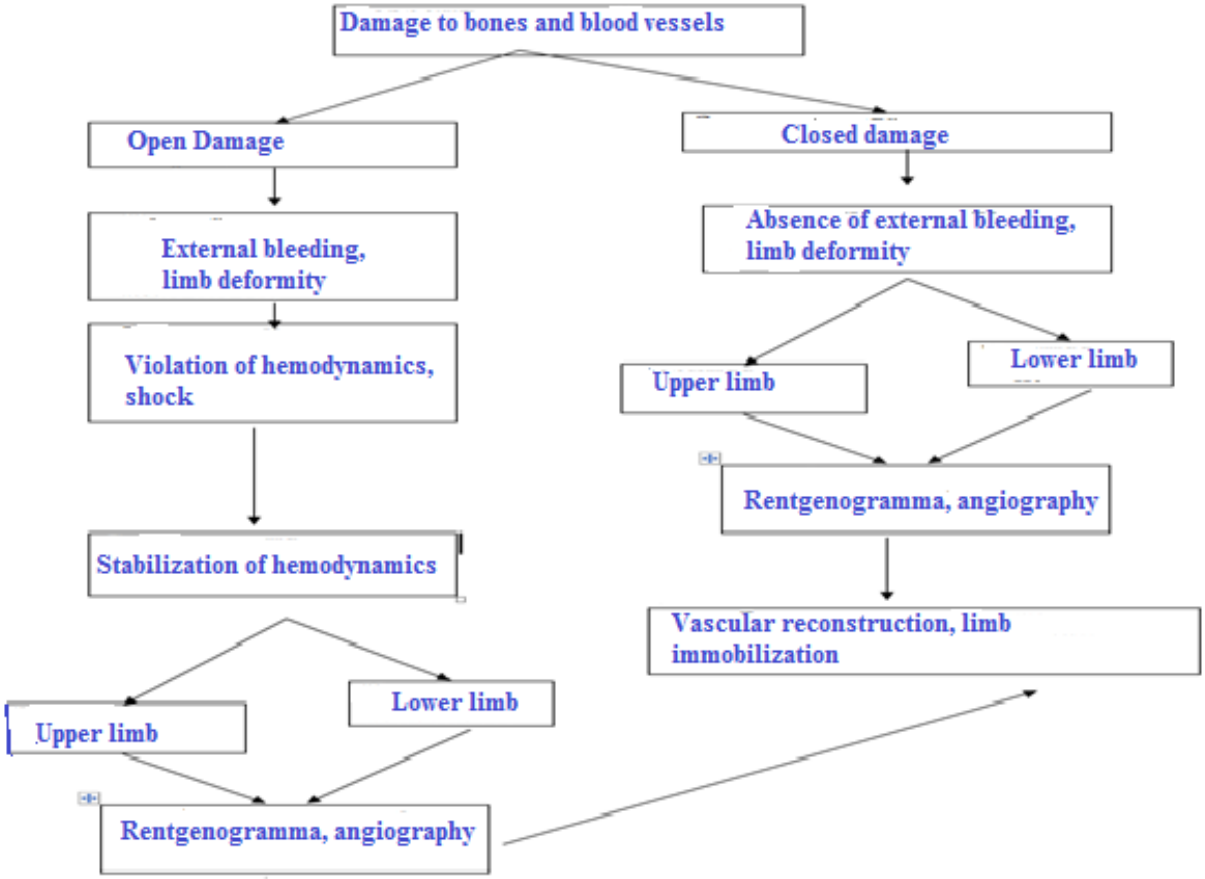
Total:	22	100,0	16(72,7)	6(27,2)

In patients with combined osteovascular injuries, a transverse fracture of the tubular bones occurred as a result of a strong blow almost perpendicular to the surface of the limb.

In the treatment of acute ischemia of the limb, the classification of Academician of the Russian Academy of Sciences V.S. Savelyev is often used. and Zatevakhina I.I. (2002).

Thus, clinical studies of the condition of patients who received combined osteovascular injuries did not reveal any homogeneous symptoms that characterize the signs of an injured vessel. With a fracture of a tubular bone, it is extremely difficult to establish the cause and nature of the violation of normal blood flow. Especially, when diagnosing a bone injury, arteries and veins, errors reach from 30-61.8% [25,124].

According to our observations, in case of osteovascular injuries, the error for 4 patients was (18.1%). Most often, mistakes are made with fractures, dislocations of the lower leg and shoulder. The frequency of amputations after combined trauma, due to the development of gangrene and crushing of soft tissues, ranges from 20 to 40% . According to our observation, this is 5 (22.7%).



In addition, laboratory tests were carried out: hemoglobin, in 11 patients was low 65-99 g/l; blood clotting time-6.50-15; fibrinogen 5320-9990; PTI blood 62-90%. The rest of the parameters were within the normal range. Analyzing research data, accompanying patients and comparing the severity of their condition, when providing first aid before the hospital period, a high frequency of errors during the transportation of the victims was established. All the difficulties occurred in the treatment of victims with combined osteovascular wounds. They are associated with the correction of shock, the normalization of hemodynamics, and on which the fate of the patient mainly depends. Depending on the condition of the patients, the tactical approach to treatment was individual. Conducting a thorough clinical study of patients with concomitant osteovascular injuries, allowed us to make the correct diagnosis. At the same time, we used ultrasound, radiopaque angiography and MSCT.

Based on the above, we tried to describe the algorithmic approach in the language of block diagrams.

The complexity of choosing the optimal volume of surgical intervention depends on the patient's condition, the nature of the injuries and the damaging effect of the traumatic agent.

Many years of experience in the surgical treatment of bone fractures showed instability and a large number of complications during fixation of bone fragments. Based on this, in 3 cases we used osteosynthesis for bone fractures. In 11 wounds with bone fractures without displacement of fragments, it was advisable to apply a plaster cast. Skeletal retraction was performed in 3 patients.

It should be noted that if the objects of the operation are vessels of small diameter, then the lateral suture is irrational, since it leads to a narrowing of the lumen of the vessels (Table 11).

Table 11

The nature of the operation for combined osteovascular wounds

locale-damage-denia	Operations on vessels							Bone surgery		
	Side seam	Circular seam	Autovena	Prosthesis	Spasm resolution	Amputation	Pere knitting	Gypsum	Skeletal retraction	Osteosynthesis
Region shoulder	2(9%)	2(9%)	2(9%)	1(4,5%)	-	1(4,5%)	1(4,5%)	7(31,8%)	-	2(9%)
Region Shin					1(4,5%)	4(18%)			1(4,5%)	
Region Hips		2(9%)	2(9%)						2(9%)	1(4,5%)
Connect chichnaya region	2(9%)							2(9%)		
Suspension doshnaya region			1(4,5%)					1(4,5%)		
cervical region	1(4,5%)							1(4,5%)		
Total:	5(22,7%)	4(18%)	5(22,7%)	1(94,5%)	1(4,5%)	5(22,7%)	1(4,5%)	11(50%)	3(13,6%)	3(13,6%)

With osteovascular injuries, the following types of operations were performed: dressing - 1 (9.1%); side seam - 5 (22.7%); circular suture - 4 (18.1%); autovenous prosthetics - 5 (22.7%); prosthetics - 1 (4.55%) and other types of operations - 6 (27.2%) patients, with $p<0.05$. The results of treatment of patients with vascular and bone injuries are good - 15 patients (68.1%), $p<0.05$; satisfactory - 2 (9%); unsatisfactory - 5 (22.7%) patients, $p<0.05$.

Table 12.

Comparative analysis of the results of operations on localized osseous and vascular injuries with consequences

Damaged vessel	Types of operations until 2000 (CG)						Types of operations from 2000-2018 (MG)					
	Lateral	Circular	Autovein	Prosthesis	Amputation	Spasm	Ligation	Lateral	Circular	Autovein	Amputation	Total
Carotid artery	1(4,5%)	-	-	-	-	-	-	-	-	-	-	1(4,5%)
Subclavian artery	-	-	-	-	-	-	-	2(9%)	-	-	-	2(9%)
Brachial artery	2(9%)	1(4,5%)	2(9%)	1(4,5%)	1(4,5%)	-	1(4,5%)	-	-	1(4,5%)	-	9(40%)
iliac artery	-	-	-	-	-	-	-	-	-	1(4,5%)	-	1(4,5%)
Femoral artery	-	2(9%)	1(4,5%)	-	-	-	-	-	1(4,5%)	-	-	4(18,1%)
Popliteal artery	-	-	-	-	2(9%)	-	-	-	-	-	-	2(9%)
Leg arteries	-	-	-	-	1(4.5%)	1(4,5%)	-	-	-	-	1(4,5%)	3(13,6%)
Total:	3(13,6%)	3(13,6%)	3(13,6%)	1(4,5%)	4(18,1%)	1(4,5%)	1(4,5%)	2(9%%)	1(4.5%)	2(9%)	1(4,5%)	22(100%)

Table 12 presents a comparative analysis of the results by types of operations for damaged vessels and their consequences, between the main control groups of patients. Good results were obtained during reconstructive and restorative operations. At the same time, amputees make up the majority in the CG. Amputee patients before 2000 in limbs: brachial artery-1 (4.5%); popliteal artery - 2 (9%). From 2000-2018, amputation was performed after an injury to the

artery of the leg - in 2 patients. In addition, 4 patients developed a false aneurysm of the artery: femoral-2(Fig.25); subclavian -2. Produced: side seam - 2; circular seam - 1; autovenous prosthetics - 1 patients. The immediate results were good.

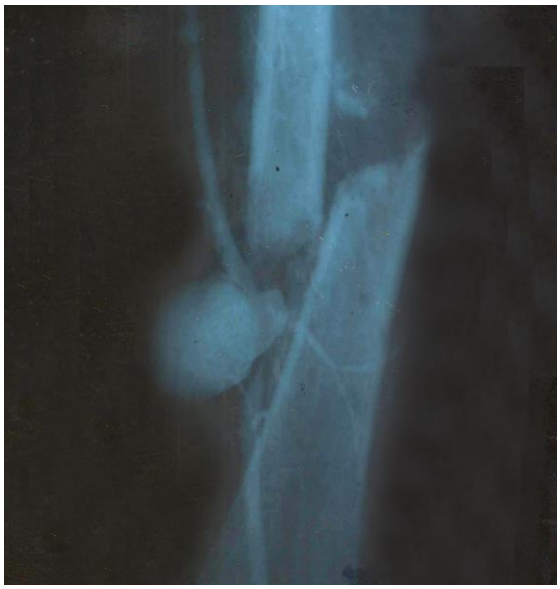


Fig.25. Angiography. Oblique fracture with displacement of bone fragments of the femur, on the right. Posttraumatic aneurysm of the superficial femoral artery, on the right.

Of these, three patients observed had dislocation and rupture of the elbow joint; as a result of the bone fracture, a false aneurysm developed.

As an example, we will provide a case history.

Patient E.Kh., 73, case history №1817, complains of a mass on the left supraclavicular region; numbness in the right upper limb; lack of movement of the fingers of the right hand; general weakness. According to the patient, he suffered an injury 4 months ago, resulting in a fracture of the clavicle, on the right, and ribs. The patient had been receiving treatment for the last 20 days before coming to us, after which the above-mentioned complaints appeared. The patient underwent MSCT and angiography (16.03.2016) and the following conclusion was made: occlusion of the right subclavian vein; stenosis of the right subclavian artery; CT signs of a space-occupying mass above the right subclavian region extending to the right axillary region (Fig. 28). On examination: general condition is satisfactory; normal build; skin is of normal color; peripheral lymph nodes are not enlarged. Vesicular breathing in the lungs on both sides. Percussion

reveals pulmonary sounds above the lungs. Heart sounds are muffled. Heart rate is 80 beats per minute. Blood pressure is 120/80 mm Hg. The abdomen is of normal shape, participates in the act of breathing. On palpation, the abdomen is soft and painful. The liver and spleen are not enlarged. The percussion symptom is negative on both sides. Physiological functions are not impaired. On examination of both, upper and lower extremities, they are of the same perimeter. There is no edema. Pulsation is determined at all landmarks. In the supraclavicular region, on the right, there is a pulsating formation, measuring 10x12 cm, motionless, painless, the skin over the formation is unchanged (Fig. 26). On the right upper limb, finger movement is absent and sensitivity is reduced.

On auscultation, a systolic murmur is heard over the formation. Pulsation is determined at the entire level of both lower extremities. No murmurs are heard over the other main arteries on auscultation. Examination: complete blood count: hemoglobin-113 g/l; erythrocytes-3.8x1012/l; leukocytes-5.7x109/l. Complete urine analysis: protein-0.099%, epithelial units/liter, leukocyte units/liter. Biochemical analysis: sugar-6.8 mmol/l; total bilirubin–10 μmol/l; direct—0; protein-80 g/l. potassium-4.4 mmol/l; sodium-137 mmol/l urea-4.9 mmol/l; creatinine-52 μmol/l. ALT-25 U/l; AST-17 U/l. Coagulogram: plasma tolerance to heparin 6 min 55 sec. PTI 88, fibrinogen 3100 g/l, hematocrit 38%. HbsAg—negative. Anti HCV (hepatitis C) - negative. ECG: Sinus rhythm. HR 90. Horizontal position. EOS - dystrophic manifestations in the myocardium. X-ray: Lung fields without fresh focal-infiltrative shadows. The roots of the lungs are heavy. The dome of the diaphragm and sinuses are free. The heart and aorta are within the limits of age-related changes. EchoCG: EF 69%. EDV 79 ml. ESV 24 ml. SV 55 ml. Severe LVH with systolic overload. Ultrasound: false aneurysm of the subclavian artery, on the right. Dopplerography: on both sides, the blood flow is main, antegrade. The amplitude is preserved.

антеградный. Амплитуда сохранена.

Under intubation anesthesia, at the first stage, endovascular occlusion of the subclavian artery was performed by an incision of the skin of the supraclavicular region on the right above the aneurysm up to 15 cm long (Fig. 27). The false aneurysm was isolated on the anterior wall with sharp and blunt instruments. At this point, the wall of the false aneurysm was opened and isolated, then about 300 g of old blood clots were removed from the aneurysm bed. (Figs. 29-30). During revision, a defect in the anterior wall of the subclavian artery, up to 0.3 cm in diameter, and clavicle fractures were found (Fig. 31). The arterial defect was restored with a lateral suture of 5/0 prolene thread (Fig. 32). The occlusive balloon was removed from the subclavian artery. The suture is airtight. The aneurysm bed was drained through a separate skin incision. Hemostasis, dry. Layer-by-layer suture on the wound. Aseptic dressing.

Fig. 26. General view of a false aneurysm of the right subclavian artery, on the right.

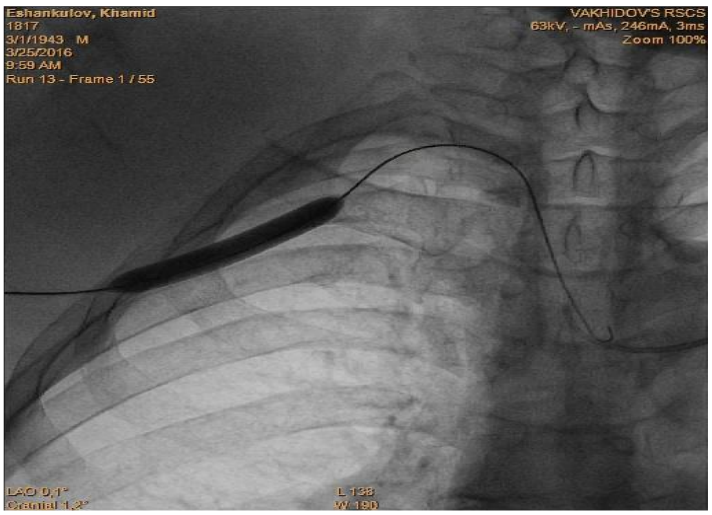


Fig. 27.Rentgenendovascular complete occlusion of the right subclavian artery.

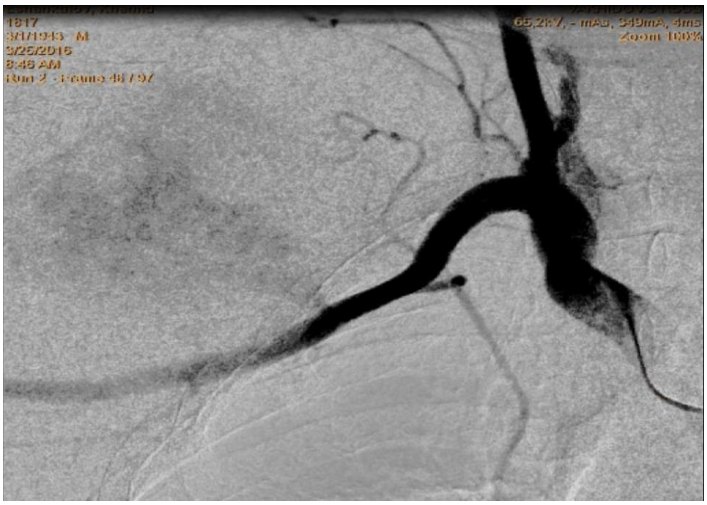


Fig. 28. MSCT of traumatic aneurysm of the subclavian artery, on the right.

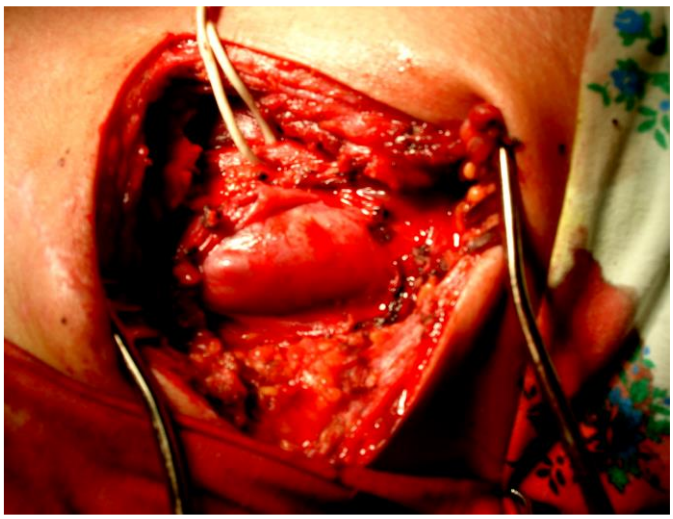


Fig. 29. Traumatic aneurysm of the subclavian artery, right.

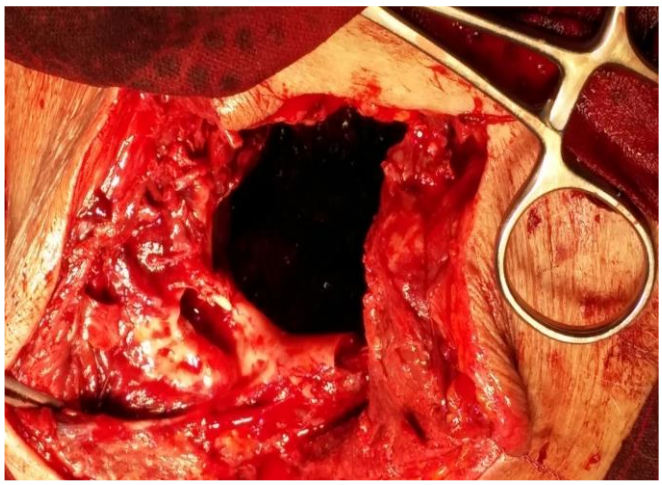


Fig.30. Aneurysm cavity.

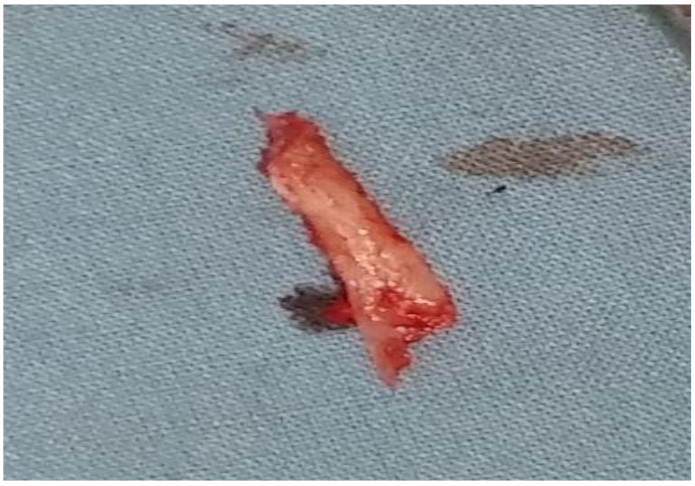


Fig.31. Bone fragment of the right clavicle.

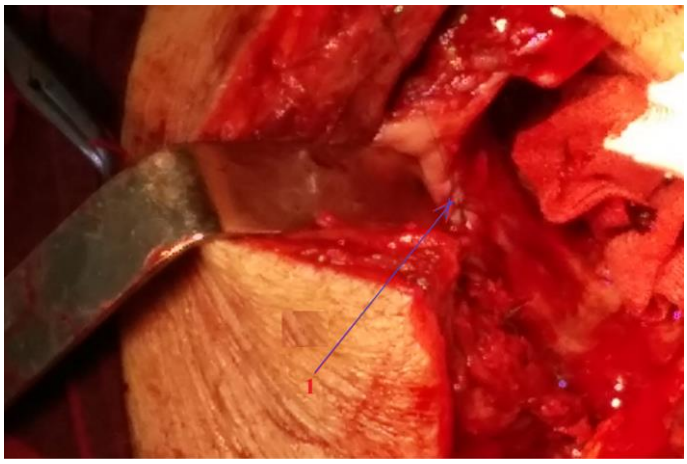


Fig. 32. Lateral suture in the right subclavian artery.

At the same time, on the femoral artery produced: autovenous prosthetics-1; circular seam-1; a lateral suture-2 was applied to the subclavian artery for patients. The immediate and long-term results of sick patients are good (tab. 3.11).

For the prevention of thrombosis and wound infection before, during and in the postoperative period, we prescribed: fresh frozen plasma (FFP from 5 to 15 ml / kg), heparin from 150 to 250 U / kg, aspirin 0.5 2 times a day after meals. In a severe case, the following were prescribed: countercal 300,000 IU or Gordex 20,000 IU 2 times a day and broad-spectrum antibiotics.

Among the adverse outcomes of treatment were: false elbow joint - (1), limb shortening - 2 patients.

Results and its discussion

Based on the analysis of these materials of patients with osteovascular injuries according to the severity of their condition, when providing first aid before inpatient treatment, we have established a high frequency of tactical errors during the transportation of patients. All the difficulties in the surgical treatment of patients with combined osteovascular injuries are associated with the correction of shock and the normalization of hemodynamics, on which the fate of the patient depends. Depending on the condition of each patient, the tactical approach was individual.

The need to restore bone and vascular concomitant injuries is beyond doubt. For, the operation is considered effective only when the integrity of both structures is restored. The complexity of the process in choosing the optimal volume of the operation, depending on: the patient's condition, the nature of the injury; the damaging effect of the traumatic agent, the variety of methods and methods of treatment, as well as the sequence of the stages of the operation in case of combined injuries. However, most authors believe that primary repair of the vascular defect is necessary. We believe that in case of osteovascular injuries, stable fixation of fragments makes it possible: to determine the true defect between the ends of the vessels and to choose the desired variant of the vascular suture or vascular plasty. The final fixation of the fracture of tubular bones by intramedullary osteosynthesis avoids their re-injury. In this case, an important role is played by the correct reposition, fixation of bone fragments and

preservation from the penetration of infections. At the same time, the wounds are drained with a rubber tube for constant washing with antiseptic solutions.

In order to optimize the early diagnosis and treatment of patients with osteovascular injury, we have introduced a diagnostic and treatment algorithm for their treatment based on our developed classification of vascular and bone injuries. In our study, we studied the results of treatment in CG and MG. As a result: CG - amputation of 3 patients, MG - 2 patients. Immediate and long-term results: good - in 15 (68.1%), satisfactory - in 2 (9%); unsatisfactory in 5 (22.7%) patients.

4 patients developed post-traumatic aneurysm: 2 - in the femoral and 2 - in the subclavian arteries. To clarify the immediate and long-term results, these patients underwent a Doppler study. As a result, the established aneurysm of the femoral and subclavian artery is the ABI index - 1.0; long-term results index ABI -1.1.

The best treatment results were obtained by introducing rentgenendovascular temporary vascular occlusion (REVO) and a five-stage aneurysm surgery. After removal of the aneurysm of the subclavian artery, the indicators did not differ from those of a healthy hand. The pulse on the radial arteries of the patients showed a good ABI-1.0.

The tactics of surgical treatment of (bone-vascular) TAA are implemented in stages: stage 1 - drug treatment; stage 2 - retgenendovascular method of balloon occlusion of vessels; Stage 3 - selection of the optimal access to the TAA operation; stage 4 - elimination of traumatic arterial aneurysm and stage 5 - fixation of a bone fracture by osteosynthesis and surgical reconstruction of the main vessels.

For the prevention of thrombosis before, during and in the postoperative period, fresh frozen plasma (FFP) from 5 to 15 mg / kg, heparin from 150 to 250 U / kg, as well as broad-spectrum antibiotics are prescribed.

Chapter VII. IATROGENIC VASCULAR INJURIES AND THEIR CONSEQUENCES

7.1. Causes, nature of the consequences of iatrogenic vascular damage

The intensive use of various medical manipulations for diagnosis and treatment has led to the emergence of so-called iatrogenic (jatros - doctor in Greek) diseases.

It is generally recognized that iatrogenic vascular injuries lead to severe complications requiring surgical intervention. In case of their unfavorable outcomes, difficult moral and legal situations often arise for the attending physicians. The problem of developing modern diagnostics and tactics of surgical treatment of patients with iatrogenic vascular injuries and their complications, as the researchers emphasize, remains one of the topical and debatable tasks of modern vascular surgery.

S.I. Pryadko et al. examined 97 patients with iatrogenic vascular injuries of various nature and localization. Of these, the following were detected: thrombosis - 66.5%, pulsating hematomas and false aneurysms - 24.5%, others - 9% of patients. To restore adequate blood supply to the ischemic pools, emergency or urgent surgical interventions were performed. A total of 97 patients were operated on. Thrombectomy and suturing of the vascular wall defect were performed in 72 (74.3%) patients. Along with them, various types of reconstructive and restorative operations (prosthetics, various types of plastic surgery) were performed in 25 patients. Good results were obtained in 100% of cases. According to other authors (Khamrakulov Z.S. et al. 2000), false iatrogenic aneurysm accounts for 16%. V.G. Gerasimov et al. Describing the experience of treating 113 patients with iatrogenic vascular injuries and their consequences, it is noted that they make up 26.5% of the total number of vascular injuries. Among them, a special place is occupied by iatrogenic injuries received during: general surgical - 63 (50.7%); gynecological - 28 (24.7%); traumatological - 12 (10.6%); oncological - 10 (8.8%) operations. The injuries received during operations by type are: iliac artery and veins - 27 (23.9%); OBV - 30 (26.6%); subclavian veins - 7 (6.2%), arteries -

9 (7.9%); IVC - 7 (6.2%); hepatic artery - 5 (4.4%); popliteal artery and veins - 4 (3.6%); femoral artery - 24 (21.2%). Emergency reconstructive surgeries were performed: lateral suture of arteries and veins - 16 (14.2%), circular suture of the artery 13 (11.6%), autovenous plastic surgery - 21 (18.6%), prosthetic replacement of arteries and veins - 54 (47.8%). Of the total number of patients: primary amputation - 7 (6.1%), mortality - 2 (1.7%) cases. Angiographic studies were performed in 36 (31.2%) patients. The increase in the frequency of this pathology is determined by many factors, mainly those observed when performing a complex of percutaneous diagnostic, minimally invasive, intravascular interventions. Of all iatrogenic complications, pseudoaneurysms occur in more than 60% of cases. Most often, they occur after endovascular interventions on the heart, based on anticoagulant or thrombolytic therapy. Some scientists believe that traditional treatment of iatrogenic false aneurysms is associated with a high risk of developing various types of complications: wound infection, rough scar, pain in the wound area. Some scientists note that false iatrogenic aneurysms develop after coronary angioplasty and stenting, which ranges from 2 to 9%, after angiography from 0.2 to 0.5%.

Risk factors for the development of false iatrogenic aneurysms are observed in patients over 60 years of age, and in female patients with large catheter sizes and anticoagulant therapy. Along with this, the development of false iatrogenic aneurysms is associated with the lack of surgical experience in catheterization of the superficial femoral artery.

Iatrogenic vascular damage is one of the most severe complications of surgical treatment. The frequency of their development reaches 26% of all vascular injuries and does not tend to decrease. Despite the improvement of surgical techniques and the improvement of vascular prostheses, complications still arise after reconstructive vascular surgeries. The optimal method of their treatment is still the surgical method.

The development of surgery has led to a significant expansion of the volume of surgical interventions for various diseases. This was inevitably accompanied

by an increase in the number of iatrogenic vascular injuries. They make up 10 - 24.1% of all vascular injuries. Sometimes, venous bleeding is much more difficult for hemostasis than arterial bleeding. Every surgeon, especially during surgery, must be prepared for the occurrence of such dangerous complications and the adoption of urgent measures to eliminate them.

Bleeding from a damaged vessel should not be applied with hemostatic clamps blindly. In this case, it is advisable to press the vessel with a finger or a shovel, then detect the wound and revise the damaged area. After stopping the bleeding, it is necessary to carefully expand the access to the damaged vessel by mobilizing the central and peripheral ends of the arteries or veins and simultaneously calling a vascular surgeon. We have repeatedly observed the effectiveness of stopping bleeding with finger pressure and tamponade in iatrogenic injuries: vertebral, femoral and other vessels. The causes of bleeding are mainly associated with insufficient performance of angiographic studies and catheterization of arteries and veins. This is observed during manipulations where there is a slight injury or irritation of the inner lining of the vessels - the intima with a catheter, injection needle, etc. Such careless actions lead to superficial, then deep thrombosis, especially to superficial venous thrombosis of the upper and lower extremities. All other injuries are associated with surgical and other procedures.

In almost all surgical operations, damage to one or another large vessel is possible. The use of a Fogart catheter often leads to perforation of arteries in elderly patients with extensive atherosclerosis. Thus, we observed 20 patients with iatrogenic vascular injuries. Until 2000, 11 patients (55%) were admitted to the CG. From 2000-2018, 9 (45%) were received. Days of hospitalization: 15,11 ± 9.64; $p<0,05$.

The mean age of patients was from 37,34 ± 19,87, $p>0,05$. Of these: men - 11 (78.9%), women - 4 (21%). Patient data are presented in Table 13.

Table 13

Distribution of patients by sex and age

Age	Total:		Including			
	Abs	%	Men		Women	
			(CG)	(MG)	(CG)	(MG)
d o 20 years	6	30,0	5(25%)	-	1(5%)	-
21 -30 years old	-	-	-	-	-	-
31-40 years old	2	10,0	-	2(10%)	-	-
41-50 years old	5	25,0	-	3(15%)	-	2(10%)
51-60 and older	7	35,0	3(15%)	**4**	-	-
Total:	20	100,0	8(40,0)	9(45,0)	1(5,0)	2(10,0)

Between the control and main groups of patients 85% of men and 15 and 15% of women treated after iatrogenic injury, $p<0,05$ was observed.

Jatrogenic lesions are more common in arterial vessels than in venous vessels. At the same time, iatrogenic arterial injuries, vessels account for 16 (80%); venous injuries - 4 (20%). The appearance of iatrogenic venous lesions are the consequences of thrombotic complications, with prolonged, intravenous infusions of drugs; venasection, venectomy, etc.

By localization, on arterial and venous vessels, iatrogenic lesions were distributed as follows: iliac artery - 3 patients (5,7%), iliac vein - 2 (10.6%), brachial artery - 2 (10.5%), femoral artery - 10 (50%), subclavian artery - 1 (5,2%), subclavian vein - 2 (10,5%) (Table 4.1.). Particular attention should be paid to the significant increase in the number of iatrogenic injuries associated with angiographic studies and endovascular operations, which is 3,4-24,9% of all false aneurysms, and increases in proportion to the spread of angiographic research methods. Some scientists note that false iatrogenic aneurysms after coronary angioplasty and stenting, which range from 2 to 9%, and after angiography from 0,2 to 0,5% [196].

Based on the analysis of data used methods, we have established the causes of iatrogenic damage to blood vessels. They are presented in table 14.

Table 14

Causes of iatrogenic vascular injury

Causes	Total patients			
	abs.		%	
1. Angiography	(CG)	(MG)	(CG)	(MG)
2. Seldinger angiography	1	2	5,0	10,0
3. Vein catheterization	-	1	-	5,0
4. Apparatus artificial kidney	1	1	5,0	5,0
5. Coronary angiography	3	-	15,0	-
6. Cavovenography (CVG)	-	1	-	5,0
7. Surgical interventions:	-	1	-	5,0
Hernia repair	-	1		5,0
Appendectomy	3	-	15,0	-
Varicoceles	1	-	5,0	-
Transosseous compression-distraction osteosynthesis according to Ilizarov	1	-	5,0	-
Removal of the tumor	-	1		5,0
8. Percutaneous microdiscectomy	-	1		5,0
9. After injection	-	1		5,0
Total:	**10(50,0)**	**10(50,0)**	**50,0**	**50,0**

As the analysis of diagnostics and treatment of diseases shows, the causes of iatrogenic vascular damage are: angiographic examination - 3 (15%); angiography according to Seldinger-1 (5%;) catheterization in the right subclavian vein-2 (10%); connection to the device artificial kidney-3 (15%); cavovenography-1(5%); surgical interventions: herniotomy - 1 (5%), appendectomy - 3 (15%); caronography-1 (5%); varicocele-1 (5%); transosseous

compression-distraction osteosynthesis according to Ilizarov-1 (5%); tumor removal-1(5%); percutaneous microdiscectomy-1(5%) and injection-1(5%). In addition, resection of the stomach; cholecystectomy; bowel resection; strumectomy; mastectomy; gynecological; traumatological; nephrectomy; venectomy; venous section and others.

There were no statistical differences between the CG group and the OG group for the main causes of iatrogenic damage, $p>0.05$.

By us, the consequences of iatrogenic injuries are divided by types of vessels: into: arterial; venous and arteriovenous. The distribution of the consequences of iatrogenic damage by types of localization is presented in Table 15.

Table 15

Distribution by type and localization of the consequences of iatrogenic damage to blood vessels

Name of vessels	Total:		Including			
			abs		%	
	abs	%	(CG)	(MG)	(CG)	(MG)
Iliac artery vein	3 2	15,0 10,0	2(10%) 2(10%)	1(5%) -	10% 10%	5% -
Brachial artery	2	10,0	2(10%)	-	10%	-
Femoral artery	10	50,0	3(15%)	7(35%)	15%	35%
Subclavian artery vein	1 2	5,0 10,0	- 1(5%)	1(5%) 1(5%)	- 5%	5% 5%
Total:	20	100,0	10(50%)	10(50%)	50,0	50,0

According to the types of localization, iatrogenic injuries are more common in the lower part of the body, that is, in the legs. Especially in the femoral artery, it was 10(50%), $p<0.05$.

As a result of iatrogenic vascular injuries, bleeding, thrombosis or its complete rupture with the formation of aneurysms and arterial fistulas occur as consequences. Diagnosis of iatrogenic vascular injuries does not cause any special difficulties. The most common cause of concern is thrombotic complications; forming iatrogenic aneurysms and arteriovenous fistulas. With acute developing occlusion of the main and peripheral arteries, various degrees of ischemia of the distal extremities occur. Rapidly developing thrombosis of the main artery causes acute ischemia, which can result in gangrene of the distal extremities.

7.2. Diagnosis of the consequences of iatrogenic vascular damage

Clinical manifestations and consequences of iatroenous vascular injuries are associated with certain difficulties in diagnosis and treatment.

Therefore, we divided the clinical symptoms as follows: complaints of pain in the area of the aneurysm; tumor-like formation, pulsating; according to the frequency of severe pain in the initial stage.

Symptoms are manifested by: a feeling of pressure arising from; ischemia; imbibition of the surrounding soft tissues and nerve trunks.

So, in 5 patients, there was an increase in pain, with an increase in aneurysm. Along with them, complaints of a different nature associated with ischemic phenomena were noted during localization of iatrogenic aneurysms on the extremities. These complaints include: fatigue; intermittent claudication; general weakness; increased sensitivity to cold factors; convulsive phenomena, mainly in the calf muscles. Complaints of an ischemic nature, as a rule, appear at the initial stage as angiospasm, stenosis or occlusion of the main artery. We noted pain associated with the involvement of the nerve trunk in the pathological process, in the form of damage and compression of it. These pains are of varying intensity and shoot into the limb. Other symptoms of this kind included: paresis; paralysis; hoarseness of voice, with compression of the recurrent vagus nerve. At the same time, the larger the size of the aneurysm, the more it disturbed the patient. Aneurysm of the cervical vessel represented Horner's symptom, which is

associated with damage to the sympathetic trunk. There were complaints associated with compression of the main vein. Therefore, there are violations of the venous outflow, mainly in the distal part of the limbs. Patients complained about: a feeling of fullness and increased venous pattern. In this regard, a well-collected history contributes to the correct diagnosis of iatrogenic vascular damage and the optimal choice of its treatment.

When examining patients with iatrogenic aneurysms, it is not always possible to distinguish the outcome from other vascular lesions. At the same time, in the area of the damaged vessel of the limb, there is a local swelling. In addition, depending on the period of occurrence of iatrogenic aneurysms, they may be formed or unformed. Long-term aneurysms, especially if they are large, are clearly visible on examination. The skin over the swelling is usually normal in color, but redness, infiltration, or thinning of the skin has occasionally been noted. Large, strained aneurysms sometimes cause necrotic changes in the skin.

An indispensable research method is palpation. This method revealed a large percentage of patients with aneurysms. According to the consistency of the aneurysm, they were densely elastic or simply dense. In this case, an important role is played by thrombosis or calcification. The size of the aneurysm ranges from 0.5 to 10 cm in diameter, and is round or oval. Pulsation is absent or weak, this is due to the following reasons: fatigue; calcification of the wall or thrombosis of its cavity. The pulsation of the aneurysm usually catches the systolic tremor over the swelling.

The method of auscultation is one of the key in the diagnosis of iatrogenic aneurysms. At the same time, systolic murmur is often heard. Thrombosis of the aneurysmal sac muffled the systolic murmur to varying degrees, up to its termination. Sometimes, simultaneously with auscultation, the technique of squeezing the proximal part of the artery was used. At the same time, there was a decrease in systolic murmur. This was noted in 1935 by Bogoraz N.A. In addition, for the diagnosis of iatrogenic aneurysm, the determination of pulse and blood pressure plays an important role. With limb injuries, the pulse was

weakened in 5 cases and absent in 3 cases. This is due to the causes of angioiatrogenia and subsequent thrombosis or thromboembolism, in the cavity of the aneurysm. Venous insufficiency, often observed with damage to blood vessels. Among the studied patients, it was observed in 4 cases. Often, venous insufficiency was noted even with large aneurysms. . Its symptoms are: fasting; puffiness; slight enhancement of the subcutaneous venous pattern. Venous insufficiency occurs due to compression of the main veins of the limb by an aneurysm. Changes in blood pressure in patients with iatrogenic aneurysms were mostly normal. However, the study of blood pressure distal to the aneurysm, as well as on the symmetrical side of the healthy limb in patients, showed a decrease in the maximum and minimum pressure within 10-30 mm. rt. Art. in 5 patients. In general, it should be noted that the diagnosis of iatrogenic vascular injury is based on the facts of previous special examination of other diseases carried out during medical procedures. However, for a clear planning of surgical interventions, special research methods are needed that give a clear description: angiography, ultrasound and MSCT.

Of the radiological methods, we used: conventional fluoroscopy, radiography, as well as the radiopaque method of studying the vessel. In addition, we performed angiography in 3 patients. The method through skin puncture of the femoral artery was applied to 3 patients. When analyzing an angiogram, at the beginning, one should pay attention to the state of the proximal part of the artery, usually it is unchanged.

7.3. Selection and optimization of surgical treatment of the consequences of iatrogenic vascular injuries and their classification

The study of this problem shows that the surgical treatment of iatrogenic aneurysm consists in excision of the aneurysm, followed by the imposition of a lateral, circular suture and vessel plasty. After removal of the aneurysm, the following was used: lateral suture in 6 (30%) cases, ligation - 4 (20%), autovenous prosthesis - 1 (10%); prosthetics - 2 (5%) and stent-graft - 1 (7.1%).

In the postoperative period, in 13 (92.8%) patients, wound healing was primary; 1 (7.2%) healing occurred by secondary intention.

For the surgical treatment of iatrogenic aneurysms, we used a number of characteristic operations. Thus, the observational data of 20 patients according to the nature of the operations performed are presented in Table 16

Table 16

Surgical treatment of iatrogenic vascular injuries

The nature of the operation	Number of patients		%	
	(CG)	(MG)	(CG)	(MG)
Side seam	-	6	-	30,0
Circular seam	-	1	-	5,0
Dressing	3	1	15	5,0
Autovenous prosthetics	2	-	10	-
Extraatomic shunting	1	-	5,0	-
homovenous prosthetics	1	-	5,0	-
Z-seam superficial femoral artery	1	-	5,0	-
Operation Palma	2	-	10,0	-
Percutaneous microdiscectomy	-	1	-	5,0
Prosthetics	1	-	5,0	-
Total:	**11**	**9**	**55,0**	**45,0**

Operations performed after iatrogenic injury were statistically insignificant in the CG and MG groups, $p>0.05$.

As an example, consider the following case history.

Patient K.A., 55 years old, case no. 9915 (06.04.2018) was admitted on an emergency basis.

Complaints about the presence of a pulsating formation in the upper third of the thigh of the left lower limb; severe pain; limitation of limb movement and general weakness. Patient considers himself 2 years. In 2016, a puncture of the left femoral artery (angiography) was made. After 1 month, I noticed a pulsating formation. Appealed to medical institutions. In connection with the increase in the disease, he applied (2017) to our clinic, where, after an examination by an angiosurgeon, he was hospitalized, on an emergency basis, for examination and treatment.

General condition at admission, satisfactory. Normal physique. Skin and visible mucous membranes, normal color. Peripheral lymph nodes are not enlarged. In the lungs, vesicular breathing, on both sides, no wheezing. Heart sounds are muffled. AD 140/70 mm. rt. Art. Pulse 80 beats per minute. rhythm. The belly of the usual form, participates in the act of breathing. On palpation, the abdomen is soft, painless in all departments. The liver and spleen are not enlarged. The symptom of effleurage is negative, on both sides. Physiological functions are not violated.

On examination, both lower limbs were of the same size. There are no edema. On the left lower limb, in the upper third of the thigh, a pulsating formation measuring 25x25 cm is palpable. This formation is mobile and painful. There is a wound on the skin, there are no signs of inflammation (redness) (Fig. 33-34). On palpation, systolic trembling is noted. The pulsation at all identification points is determined. On auscultation, a systolic murmur is heard above the aneurysm.

Ultrasound scan revealed an aneurysm in the upper third of the thigh, left lower limb measuring 120x102x130mm. It is 80% filled with blood clots, with a volume of 800 ml. The femoral artery runs along the back, inner side of the aneurysm.

At the level of the small pelvis, the iliac artery is dilated with the formation of an S-type course. In the small pelvis, the transverse section of the iliac artery is sharply expanded to 28-31 mm. with the formation of an S-way. (26.10.2017)

Patient 07.04.2018 MSCT (angiography) was performed. At the same time, a volumetric formation of the proximal part of the left thigh, a possible hematoma, was found. This is an aneurysm of the left common and external iliac artery. The abdominal aorta is deformed and dilated. The same aneurysm was found on the left femoral and left external and common iliac veins.

Examination: Hb- 61.6 g/l; erythrocytes - 4.6x1012/l; CPU - 0.6; leukocytes - 7.7x109 / l. Biochemical an. blood: sugar - 4.9 mmol / l; total bilirubin - 17.4 mmol / l; straight - 3.48; indirect-13.92 mmol/l; AST - 0.24 g/l; ALT-0.6. g/-l. PTI-100%; urea-5.2 mmol/l; urea nitrogen-2.1 mmol/l; creatinine-108 μmol/l; protein - 69.5 g / l. Rentgengraphy: pulmonary fields are reinforced, the cortex is compacted. ECG sinus tachycardia. Myocardial ischemia

Diagnosis: volumetric formation of the proximal ventral left thigh, with a possible hematoma; aneurysms of the left common and external iliac arteries; deformation and expansion of the abdominal aorta; aneurysms of the left femoral, common and external iliac vein.

Under intubation anesthesia, a pararectal access was made according to Pirogov, on the left, as well as access to the retroperitoneal space. (Fig. 35-36) 6 cm. During the revision of the AV, the fistula was not detected. The artery was taken on holders. Further, in the region of the upper third of the left thigh, distally from the formation, superficial femoral artery(SFA) and deep femoral artery (DFA) were isolated and taken on holders. Further, an aneurysmal sac was isolated by a separate skin incision over the formation, using a sharp and blunt way (Fig. 37). Thrombus removed. During the revision, it was established that the false aneurysm was common femoral artery(CFA), on the left. There is a defect with a diameter of 0.6 cm in the common femoral artery. At the same time, flabbiness of the common femoral artery(CFA), was observed and a resection of vessels of 5-6 cm was performed. After that, the reconstruction of the vessels was

carried out in stages. . The anastomosis was imposed by the end-to-end type, with a 6/0 prolene thread. Checked the start of the blood flow, it is normal. The anastomosis is sealed. The pulsation is distinct, on the shunt and superficial femoral artery(SFA). Dry hemostasis. Sutures on the skin. An aseptic bandage was applied. (Fig. 38-40).

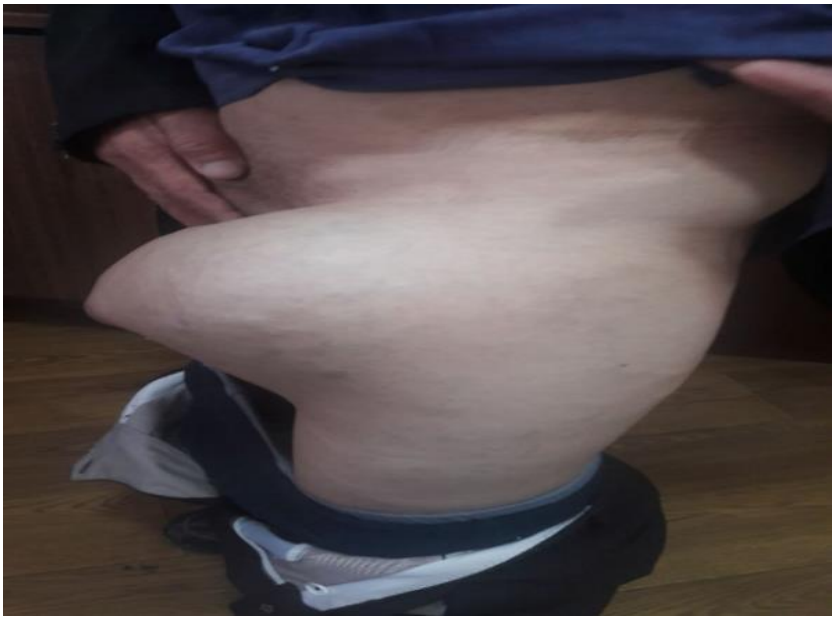


Fig.33. General view of a volumetric formation.

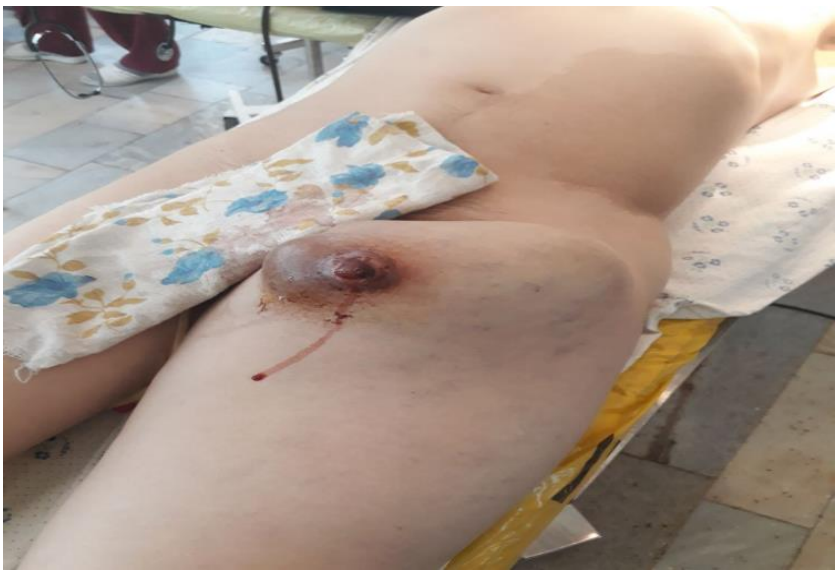


Fig.34. Infection in the upper third of the left thigh.

Fig. 35. Access to surgery for an aneurysm in the left femoral artery.

Fig.36. Isolation of an aneurysm in the left femoral artery.

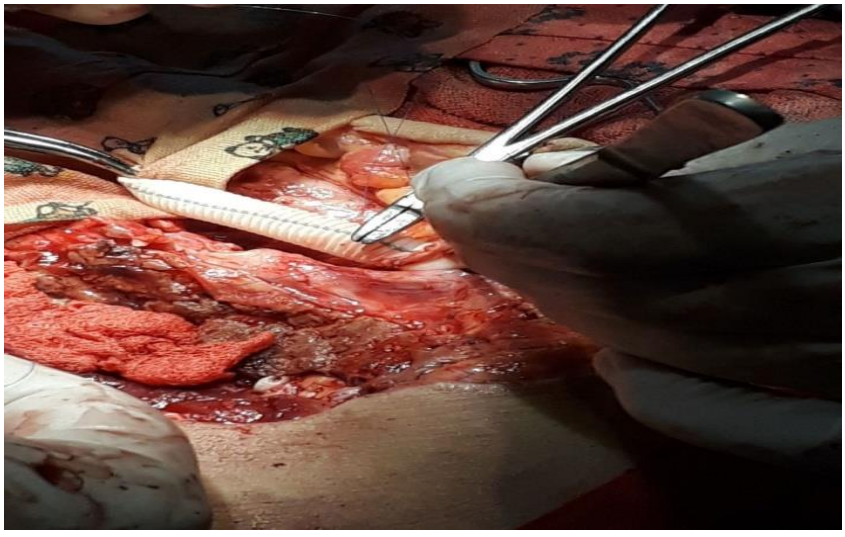


Fig. 37. Measuring the length of the prosthesis.
femoral artery

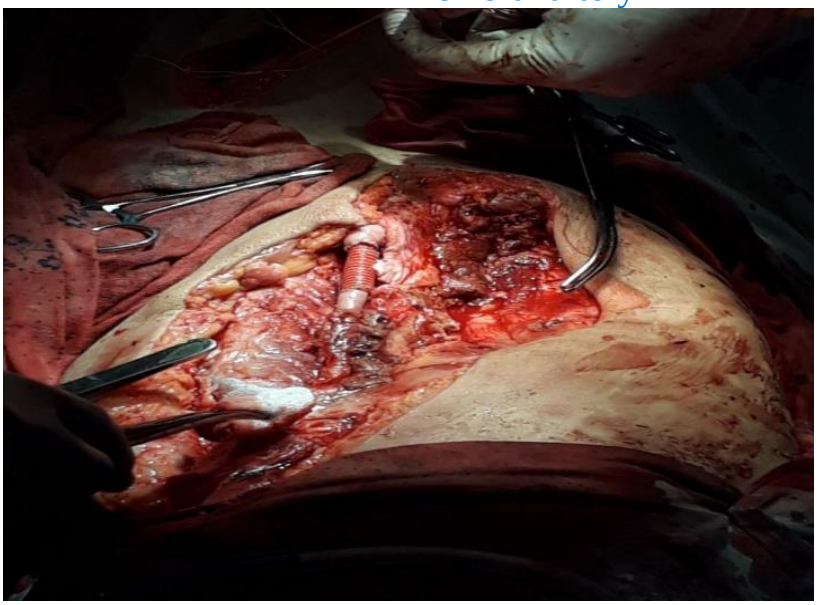


Fig.38. Imposition of a prosthesis in the left

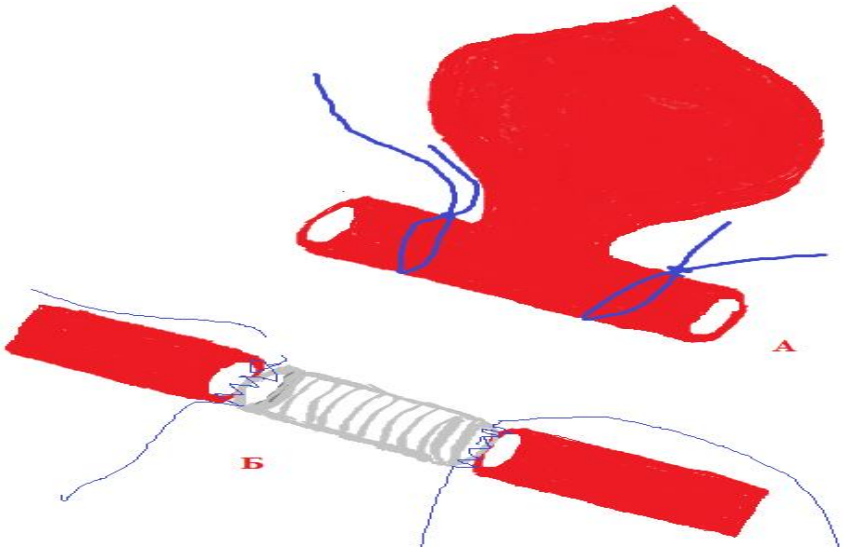


Fig. 39. Scheme of the operation: A – resection aneurysm of the left femoral artery.
B-imposition of a prosthesis in the left femoral artery.

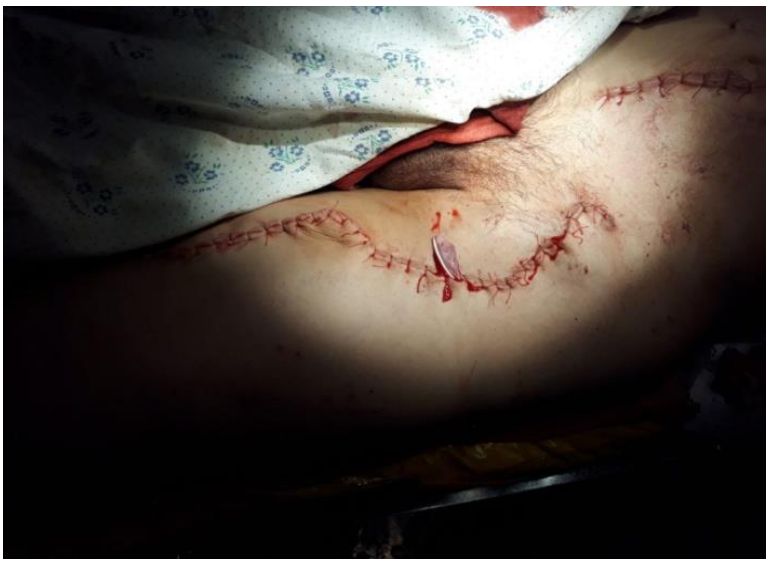


Fig. 40. Postoperative wound, in the left femoral region.

To study the immediate results, the patient underwent dopplerography of the left femoral artery, while the ankle-brachial index (ABI)was -1.0. In the remote period, this indicator of the ABI index is 1.1.

We observed 20 patients with iatrogenic vascular lesions. Of these, 15 patients with iatrogenic aneurysms and one patient with a fistula. Among them: men - 12 (80%), women - 3 (20%).

In the clinic, all patients underwent: general clinical examinations; radiography of the lungs; angiography and ultrasound. We have established the main symptoms of iatrogenic aneurysms: pulsating formation-11; movement restriction-3; pain in the area of education-6; pain throughout the abdomen-1; elephantiasis-1; cooling-3; puffiness-2; general weakness-5; bleeding-1; arrosive bleeding-1. On the basis of clinical indicators, it was established that iatrogenic aneurysms in patients are distributed, depending on the localization and vascular damage:

iliac artery-2; brachial artery-2; femoral artery-8; subclavian artery -3 and abdominal aorta -1.

For early diagnosis and optimization of the tactics of surgical treatment of iatrogenic aneurysms, we used the following methods: angiography-2, identified formations ranging in size from 3x4 to 6.0 cm; Ultrasound examination-5, identified formations ranging in size from 5.3x2.7, 7.0x4.7 to 10x6.0 cm. The

vast majority (10) of patients with iatrogenic aneurysm, we operated on for more than one month from the moment of iatrogenic damage to blood vessels. Currently, ligation of iatrogenic aneurysms is relatively rare (3). It should be noted that reconstructive operations on vessels are widely introduced into practice. In 4 cases out of 13 after ligation, we noted violations of vascular patency. Of all the patients with iatrogenic vascular injuries operated on by us, the lateral suture was applied to 6 patients with the following localizations: subclavian artery (2), femoral (4). Laboratory indicators: Hemoglobin-68-98 g/l; leukocytes - 12.2-19.9 x109/l; erythrocytes - 2.5-3.3 x1012/l; ESR - up to 50. Hematocrit - 24-34%. Blood clotting time - n.4.57 k. 5.25 to n.7 k. 8 minutes. Fibrinogen from 4660 to 6660 g/l.

In those cases when it was impossible to apply a ligature, a lateral suture or a circular suture, we performed plastic surgeries in two cases: autovenous prosthetics and homovenous shunting, and in two cases a synthetic prosthesis was used.

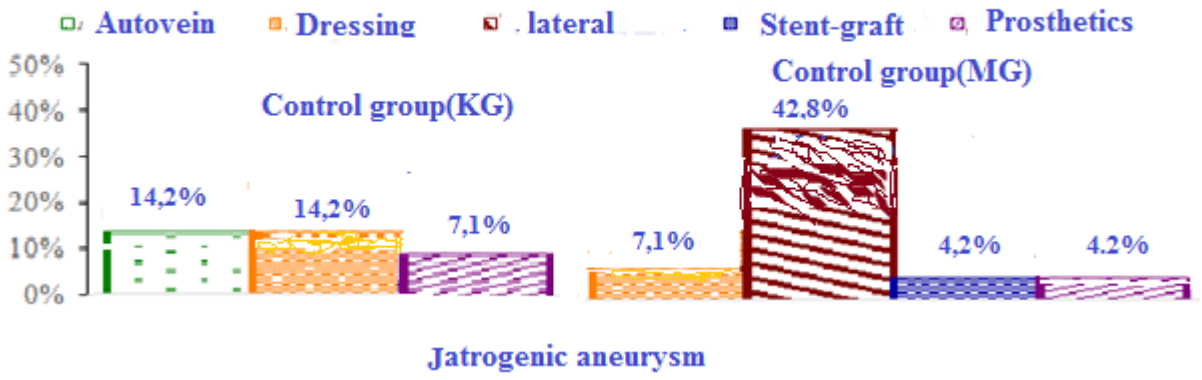


Fig.41. Types of surgical interventions in patients (CG) and (MG).

In the 3rd group, we operated on 20 patients. Of these, 15 patients with iatrogenic aneurysm and one patient with iatrogenic arteriovenous fistula. Among them, 14 patients underwent the following operations: dressing - 3 (21.4%); side seam - 6 (42.8%); autovenous shunting - 2 (10%); prosthetics - 2 (10.00%); 1 – stent graft (5%) (Fig. 4.9). In one patient, the right ureter was intimately soldered by the back wall to the conglamerate. At the same time, it is impossible to mobilize and push it away from the inflamed conglomerate. Therefore,

Laparotomy was performed. The patient underwent revision of the retroperitoneal space. Subsequently, a stent graft was made.

Observed: vascular thrombosis-1 patient; arrosive bleeding - 1 patient. There were no forced amputations or deaths. Two patients refused the operation.

Good treatment results were obtained in 13 (65%) patients, p<0.05. Satisfactory results of treatment were obtained in 7 (35%) patients, with p<0.05 (Table 4.5). The immediate results were evaluated on the basis of angiography, ultrasound and MSCT and objective data (Table 17).

Table 17

Evaluation of immediate results

Research methods	Total:	KG		MG		p
		good	Satisfactory	good	Satisfactory	
Research methods Clinical signs		no	Pain, Swelling, numbness. etc.	no	Pain , swelling, numbness, etc.	
Angiography	9(45%)	3(15%)	4(20%)	2(10%)	-	p<0,05
UZDG	9(45%)	-	3(15%)	6	-	
MSCT	2(20%)	-	-	2	-	
Total:	20(100%)	3(15%)	7(35%)	10(50%)	-	

In further studies, 13 (92.8%) patients had primary wound healing; in 1 (7.1%) patient, healing occurred by secondary intention. Postoperative period, all patients were prescribed broad-spectrum antibiotics and heparin at a dose of 5000 IU for 5 days.

Table 18

Comparative analysis of the results of operations for localization (LA) of jatrogenic aneurysm in the CG nd MG

Damaged vessel	Until 2000 (CG)				From 2000-2018 (MG)					
	Ligation	Circular	Auto vein	Prosthesis	Ligation	Lateral	Circular	Prosthesis	Stent Graft	Total
Subclavian artery	1(7,1%)					2(14,2%)				3(21,4%)
Brachial artery	1(7,1%)									1(7,1%)
Femoral artery			2(14,2%)		1(7,1%)	4(28,5%)		1(7,1%)		8(57,1%)
Iliac artery				1(7,1%)					1(7,1%)	2(14,2%)
Total:	2(14,2)	-	2(14,2)	1(7,1)	1(7,1)	6(42,8)	-	1(4,2)	1(4,2)	14(100%)

Table 18 presents the results of a comparative analysis of patients with iatrogenic aneurysms (CG and MG). At the same time, there is a significant difference between patients operated on before 2000 (CG) and between 2000-2018. (MG), statistically significant p<0,05. As can be seen from Table 4.5, operations to localize JA were 5 (35.7%) patients in the CG, and 9 (64.2%) patients in the CG. Since 2000, the use of the rentgenendovascular method has led to an improvement in the immediate and long-term results of the treatment of patients.

Vessel ligation was performed in 2 patients with JA: subclavian artery-1; shoulder arriere-1. Both patients underwent reconstruction of limb vessels. Long-term results were assessed on the basis of angiography, ultrasound and MSCT and objective data (Table 19).

Table 19

Assessment of long-term results

Research methods	Bcero	CG		MG		p
		good	Satisfactory	good	Satisfactory	
Research methods Clinical signs		no Pain	Swelling, numbness. etc.	no Pain	Swelling, numbness. etc.	
Angiography	6(43,8%)	-	3(21,4%)	2(14.2%)	1(7,2%)	p<0,05
UZDG	7(50%)	-	2(14,2%)	3(21,4%)	2(14.2	

					%)	
MSCT	1(7,2%)	-	-	1(7.2%)	-	
Total:	14(100%)	-	5(35,7%)	6(43,8%)	3(21,4 %)	

As can be seen from the table 19, with a comparative analysis of long-term results in the CG and OG, the difference between the results in the main group is clearly shown. Because the treatment and diagnostic algorithm used by us and the X-ray endovascular method of treatment led to good results. Good results - 43.8% in the main group of MG. Satisfactory results: 35% in the CG and 21.4% in the MG. This means that the proposed method and diagnostic and treatment algorithm for the treatment of JA is very effective.

Radial arterial access (RAA) has gained universal acceptance and is in fact routinely used in both elective and emergency cases. With respect to the latter, the benefits of LAD have been confirmed in large international randomized trials [Babunashvili A.M. et al 2017; Patel A.R et al 2019; Razmadze A. 1999].

In recent years, femoral arterial access (FAA) has received universal recognition and is actually used in both planned and emergency practice. There are works on access through the ulnar artery [Fokin A. A. et al 2016]. In some clinics, brachial arterial access is actively used. In addition, femoral arterial access is used, which is a classic, traditional intervention, including patients with acute myocardial infarction (AMI). The action algorithm scheme is used in all patients who underwent endovascular interventions using dietary supplements.

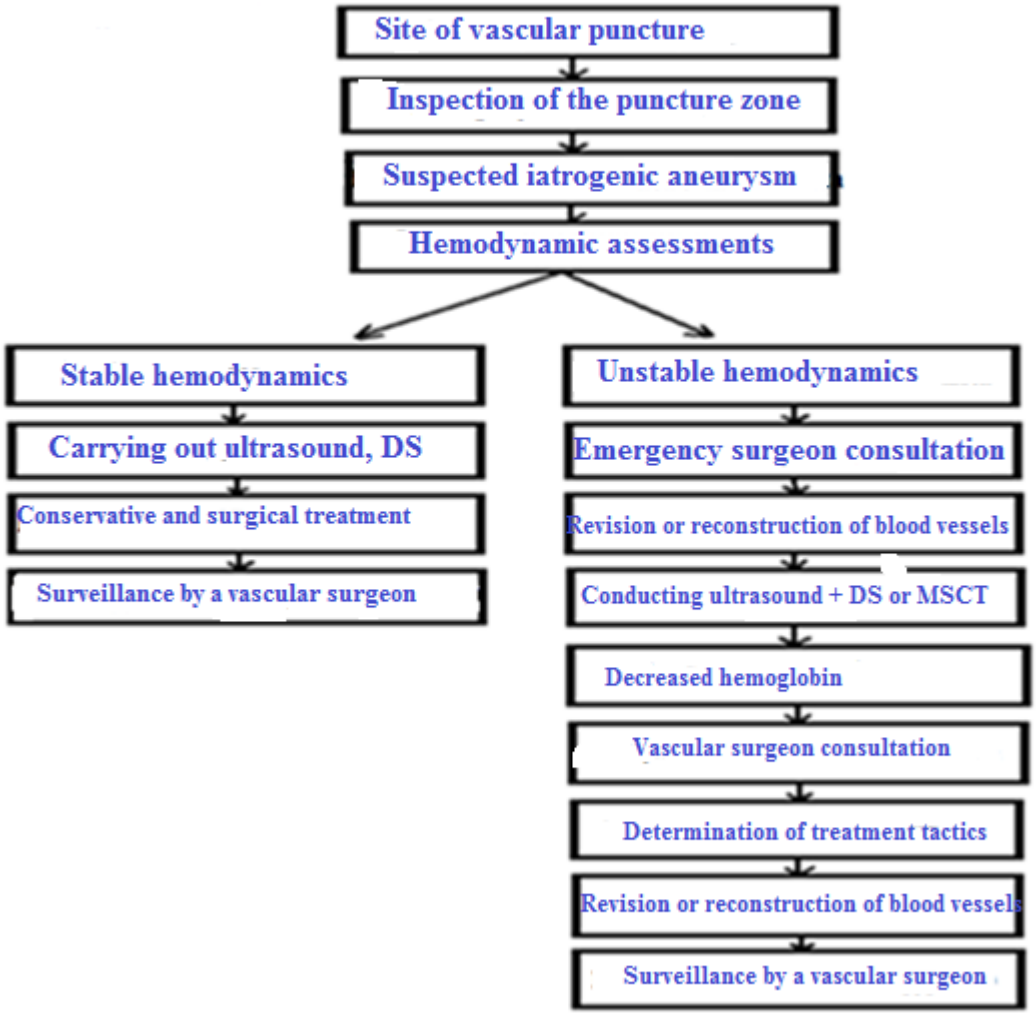
Despite the correct technique of dietary supplements, access is often complicated by iatrogenic false aneurysm of the femoral artery.

The vascular puncture site includes: patient complaints; external examination - pulsating hematoma; false aneurysm; palpation for the presence of a painful or painless formation and its size; auscultation for the presence or absence of systolic murmur in the projection of the femoral artery; examination of the puncture zone; suspected iatrogenic aneurysm. Assessment of hemodynamic parameters according to the stability of hemodynamics; conducting ultrasound +

DS, conservative treatment; control on UZDG+DS. Unstable hemodynamics is also characterized by hypotension - a decrease in blood pressure by 20% of the initial level and other general signs, which requires an emergency consultation of the surgeon and revision of the vessels, as well as ultrasound + DS. If necessary, when conducting MSCT, it is necessary to indicate: the size of the defect; localization of the defect, damage to the wall (anterior, posterior) and the size of the cavity. With a decrease in hemoglobin, it is necessary to consult a vascular surgeon, to determine the tactics of treatment - revision and reconstruction of blood vessels [Komarov R. N., Kurdo S. A. et al. 2011]. and their further monitoring, to vascular surgeons (Fig. 42)

It should be noted that the choice of surgical intervention depends on: the prevalence of the pathological process; localization of concomitant lesions of surrounding tissues. At the same time, the choice of tactics of surgical treatment was always active and independent of the time of occurrence of iatrogenic aneurysm. Therefore, a wait-and-see attitude and treatment is fraught with serious complications, in the form of: thrombosis, rupture in aneurysms, etc. Currently, in domestic and foreign literature, studies on iatrogenic vascular pathology are rather few. Therefore, the creation of a unified classification is an objective necessity that helps to reduce the level of iatrogenic damage. Our experience and foreign research were the basis for the development of a classification of iatrogenic vascular damage.

Fig.42.Algorithm of tactics-therapeutic actions in iatrogenic vascular aneurysms



A useful patent was obtained on the topic(Patent FAP №2510) "**Method for selecting treatment tactics for iatrogenic pseudoaneurysm during endovascular interventions using femoral-arterial access**" to improve the diagnosis and treatment of patients with iatrogenic aneurysms. We present it below:

Method for selecting treatment tactics for iatrogenic pseudoaneurysm during endovascular interventions using femoral-arterial access, including a study of hemodynamic parameters, characterized in that the patient's complaints, examination of the femoral artery (FA) puncture site, palpation of the FA puncture site and determination of pain, auscultation in the FA projection are additionally examined, and then the values of the parameters are assessed in points depending on the severity of the symptoms; and with stable hemodynamics, a score of 1 point is assigned (b), unstable hemodynamics

(decrease by 20%) - 5 points, if the patient complains of discomfort at the site of FA puncture, a score of 1 point is assigned, for moderate pain at the site of FA puncture - 2 points, severe pain at the site of FA puncture - 5 points, if a slight protrusion at the site of FA puncture is detected during external examination, a score of 1 point is assigned, a pulsating hematoma - 5 points; if there is no systolic murmur during auscultation of the FA projection, a score of 1 point is assigned, in the presence of systolic murmur - 5 points; and if the sum of points is equal to 4-5, conservative treatment and observation are recommended, if the sum of points is equal to 20, surgical treatment of iatrogenic pseudoaneurysm of the femoral artery is recommended during endovascular interventions with femoroarterial access.

FOYDALI MODEL

PATENTI

МИНИСТЕРСТВО ЮСТИЦИИ РЕСПУБЛИКИ УЗБЕКИСТАН

№ FAP 2510

Ushbu patent O'zbekiston Respublikasining "Ixtirolar, foydali modellar va sanoat namunalari to'g'risida"gi Qonuniga asosan quyidagi foydali modelga berildi

Son arteryasiga kirgan holda endovaskulyar aralashuvlar vaqtida yatrogen psevdoanevrizmani davolash taktikasini tanlash usuli

Дата подачи заявки: 22.12.2023 Talabnoma raqami: FAP 20230472

Ustivorlik sanasi: 22.12.2023

Patent egasi(lar)i): APTAROV ZAYNIDIN NORMONOVICH

Foydali model muallif(lar)i): APTAROV ZAYNIDIN NORMONOVICH; TINIBEKOV MUXIDDIN XUDAYKULOVICH

Foydali modelga berilgan patent O'zbekiston Respublikasi hududida 22.12.2023-yildan boshlab patentni kuchida saqlab turish uchun patent boji o'z vaqtida to'langandagina 5 yil muddatiga amal qiladi. O'zbekiston Respublikasi Foydali modellar davlat reyestrida 06.06.2024-yilda ro'yxatdan o'tkazildi.

"Method for selecting treatment tactics for iatrogenic pseudoaneurysm during endovascular interventions using femoral-arterial access"

In clinical studies, the group with partial disability included patients after surgical treatment. For them, it was established that a temporary disability was offered a course of drug treatment.

The group of patients with complete disability included patients with iatrogenic injuries and complications: ischemic contracture; trophic ulcer; gangrene, amputation of limbs and extirpation of organs.

In conclusion, it should be noted the high efficiency of reconstructive surgery for iatrogenic aneurysm.

To date, there is no consensus on iatrogenic vascular injuries and there is no single classification. Given the relevance of this problem, we have developed this classification for iatrogenic vascular damage. The classification is based on a number of clinical, etiological, anatomical and topographic criteria. Our proposed classification of iatrogenic vascular injuries is the result of an analysis of the experience of domestic and foreign studies on this issue and our long-term observations of patients with traumatic vascular injuries. It should be emphasized that the development of a unified classification of iatrogenic vascular injury is a difficult task, associated with a variety of options for vascular injury and their complications.

It should be noted that when making a diagnosis of iatrogenic vascular aneurysms, the mechanism and morphology of damage, and the degree of limb ischemia are taken into account. Based on the above data, we proposed the following classification of iatrogenic vascular injuries and their consequences, which is presented in Table 20. Damage to blood vessels and RA differ: by mechanism, depending on: type of intervention; forms of the nature of funds; the timing of the injury; anatomical location; clinical picture; the nature of the consequences of the damage, as well as the causes and outcome. According to the morphology of the damage to the vessel, there are: lateral, penetrating wounds. By the presence of consequences: false aneurysm and TAVF; acute and chronic arterial and venous insufficiency. Vascular injury increases the risk of amputation and death. The proposed classification is of considerable interest for the

diagnosis, tactics and choice of treatment for JA. The classification of iatrogenic vascular injuries and their consequences is very rational and practical in terms of its application in the treatment and damage to the peripheral arteries of the extremities(Table 20).

Table 20

Depending on various criteria, we proposed the following classification

I.Depending on the type of intervention:	II. Depending on the form of the nature of the funds:	III. Depending on the period of occurrence:	IV. By anatomical location:	V. According to the clinical picture:	VI. By the nature of the damage:	VII. By complication:	VIII. Because of:	IX.Exodus:

1. Endovascular 2. Angiographic 3. Angiosurgical 4. General surgical 5.Tarvmatological 6.Oncological 7. Obstetric and gynecological 8. Neurosurgical 9.Therapeutic 10.Ophthalmo-brain teaser 11. Otolaryngological 12.Dental.	1.Puncture 2.Injectable 3.Probing 4.Catheterization 5. Vascular plastics 6. Autovenous prosthetics 7.Prosthetics Vessel ligation 8. Paravasal manipulations 9. Removal of vessels 10. Organ removal 11. Venesection 12. Imposition of the Ilizarov apparatus 13. Overlay needle and pin.	1. Acute (occurring at the time of medical intervention). 2. Remote (arising some time after medical intervention).	1.Head 2. Neck 3. Subclavian region 4. Anterior mediastinum 5. Posterior mediastinum 6. Abdominal cavity 7. Retroperitoneal space 8. Perineum 9. Shoulder 10. Elbow region 11. Forearm 12. Hand 13. Groin area 14. Femoral triangle 15. Thigh 16. Calf area 17. Calf 18. Foot 19. Taz.	1. Bleeding with shock 2.Bleeding without shock 3.Hematomas of various forms of thrombosis 4.Complete vascular occlusion 5. Vessel stenosis with acute and chronic hemodynamic insufficiency	1. Cut; 2. Stab; 3. Torn 4.Mixed	1.Pulsating hematomas 2. Development of a false aneurysm 3.Arteriovenous fistula 4. Mixed clinical forms	1.Insufficient level qualification doctor 2. Insufficiency necessary tools operational and dressing office 3.Late specialized bathroom help sick	1.Recovery leniya 2.Partial loss laborious properties 3. Complete loss laborious properties 4. Death.

Causes of iatrogenic vascular injury:

1. Insufficiency of topographic and anatomical knowledge and skills to determine the location of blood vessels.

2. The appearance of iatrogenic vascular injuries and their consequences is the result of insufficient professional qualifications of a doctor in manipulation and diagnosis.

3. Low level of qualification of nursing staff, especially related to procedural and operational activities.

4. Insufficiency of medical and technological knowledge and skills in the operation and use and application of special medical equipment in the treatment of diseases.

Thus, iatrogenic vascular injuries are the result of low surgical qualification of theoreticians and practitioners of vascular surgery in their diagnosis and treatment.

Therefore, first of all, surgeons and angiosurgeons need to systematically improve the theory and practice of surgical treatment of vascular damage and their consequences. In this regard, timely correct diagnosis and qualified surgical care for patients is the key to successful treatment and recovery.

Results and its discussion

This chapter is dedicated to the study of aneurysm formation and its consequences. Thus, 15 out of 20 patients admitted to the clinic developed iatrogenic aneurysm. Our study differs from others in establishing the types of causes of occurrence, their differences in clinical signs, as well as the use of modern examination methods. In addition, the classification of surgical interventions proposed by us and, on its basis, the developed algorithm for therapeutic-tactical actions and hybrid operations (REVO) had a positive effect on the immediate and long-term results of patients. Differences between patients with CG and MG were statistically significant. Immediate results: good - CG in 3 (15%); MG in 10 (50%); satisfactory - CG in 7 (35%) and MG in 0. Long-term results: good - in the CG - were not observed, and satisfactory - in 5 (35.7%); MG - good in 6 (43.8%); satisfactory - in 3 (21.4%). From the foregoing, it was concluded that the differences in treatment outcomes between CG and MG are statistically significant, $p<0.05$.

The proposed classification of surgical interventions and the developed algorithm of therapeutic and tactical actions and hybrid operations for iatrogenic injuries and vascular aneurysms contribute to effective and safe endovascular operations based on the optimal tactics of surgical treatment.

CHAPTER VIII. DIAGNOSIS, CLINICAL COURSE AND SURGICAL TREATMENT OF TRAUMATIC ARTERIAL ANEURYSM

8.1. Clinical signs and diagnosis of traumatic arterial aneurysms

Surgical treatment of traumatic arterial aneurysm is a pressing issue in vascular surgery. Damage to the main arteries is a severe injury due to the high frequency of local and general complications occurring in 15.4-48.4% of cases. Mechanical damage to vessels can be very different. However, these injuries can be divided into three main groups: penetrating wound; lateral injury; complete transverse rupture. In cases of a narrow wound channel, in the presence of an input and output external opening, they are usually thrombosed. Primary bleeding in the wound channel will continue until the pressure in the formed hematoma is balanced, i.e. in the vascular bed at the site of arterial injury. It should be noted that an aneurysm can be single or double-saccular, depending on the nature of the arterial injury (Fig. 43-a,b,c). Therefore, military surgeons of the I and II World Wars, during the period of liquidation of its consequences, carefully described a variety of traumatic aneurysms.

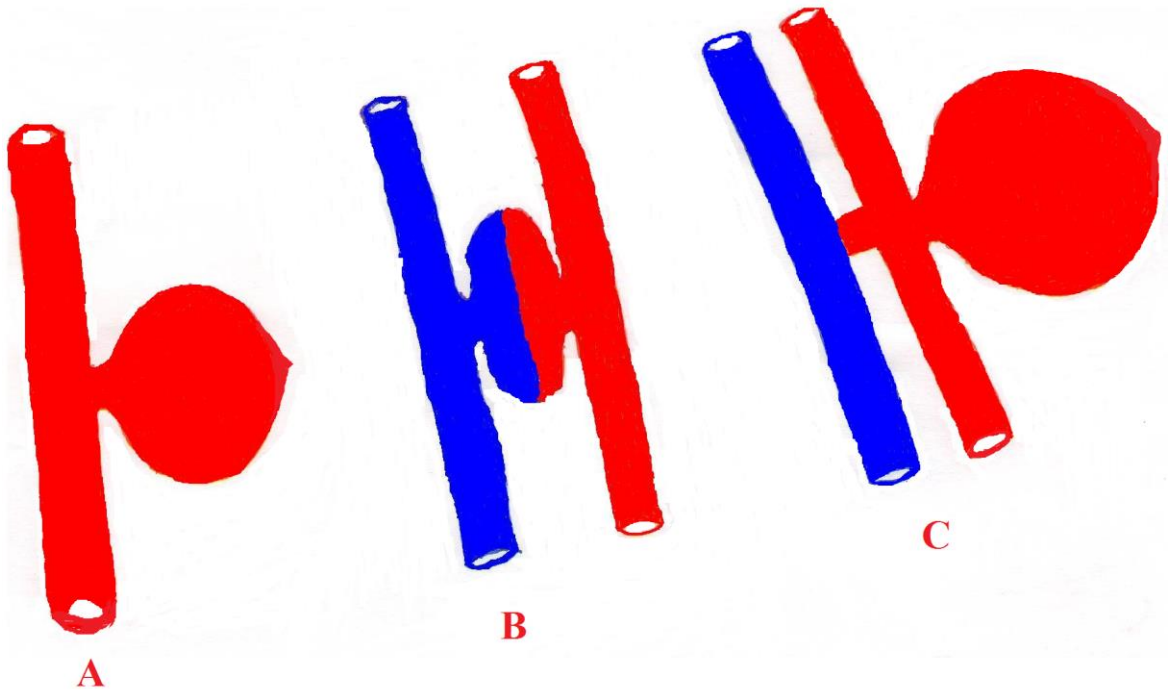


Fig. 43. Scheme. A) Arterial aneurysm. B) Arteriovenous aneurysm.

C) Combined aneurysm.

The formation of a connective tissue sac of an aneurysm from a pulsating hematoma occurs at different times, from several days to several months (Tsygankov V.N. et al. 2016). It should be emphasized that stab, stab-cut wounds with a narrow wound channel, closed thrombi and damage to the subclavian artery can lead to traumatic aneurysms or traumatic arteriovenous fistulas. At the same time, ligation of vessels was the main method and was used to stop bleeding and save the life of the victim, which caused a large percentage of amputations.

Pathomorphological anatomy

Traumatic aneurysms are different, depending on the shape: saccular and fusiform. Small elements are usually found in the vascular wall. With significant sizes, the elements completely disappear and remain only in areas adjacent to the artery. Most of it consists of fibrous tissue. Bulging of the wall or expansion of the arterial segment is accompanied by the formation of fibrous tissue, which strengthens the aneurysmal sac and prevents its rupture. Fibrous membranes are usually uneven. Therefore, they can form on weak areas of the wall. Relative fragility of the aneurysm wall due to inadequate morphological structure, the result of dystrophic changes, perification, lympoidosis, interamural hematomas, which can become a prerequisite for the occurrence of a dissecting aneurysm or rupture.

Pulsating hematomas are early forms of traumatic aneurysms. The aneurysmal sac is formed by a connective tissue sheath, which in a short time can reach a significant thickness of 0,5-2 cm. Some authors believe that the aneurysmal sac is fully formed after 2 months, from which time it can be considered an aneurysm, not a pulsating hematoma. This period is also relative. The formation of the aneurysmal sac cannot be considered completely complete, even several years after the onset of the disease. With aneurysmal expansion of the lumen of the vessel, turbulence of the blood flow occurs. Impaired blood flow and pathological changes in the vascular wall lead to the deposition of blood clots on the wall of the sac. Thrombi are layered, as a result of which the internal diameter of the

aneurysm can reach the normal size of the lumen of the vessel. Mural thrombi, to a certain extent, prevent dissection and rupture of the aneurysm, and even causes embolism of peripheral arteries.

Pathophysiological changes

This pathology is characterized by the development of arterial insufficiency of the limb sections located distal to the aneurysm. Violation of the main blood flow may be complicated by ischemia with the absence of pulsation in the peripheral arteries. In arterial aneurysms, signs of venous outflow disturbance are observed due to compression of the main veins by the aneurysm, as well as neurological symptoms.

In the clinic under our supervision there were 61 patients with traumatic arterial aneurysms (TAA). Upon admission to the clinic, the condition of the patients was as follows: severe-2; moderate 14 and satisfactory-45. The mean age of patients was from 30.43 ± 15.99, p>0,05. Days of hospitalization: 19,14 ± 11,08, p<0,05.

Until 2000, 38 (62.30%) patients were admitted to the CG. From 2000-2018, 23 (37,70%) patients received MG. p<0,05.

We analyzed patients with TAA by age and sex: men - 47 (77%), women - 14 (22.9%) 30,43 ± 15.99, p> 0,05. The data are presented in the table 21.

Table 21

Distribution of patients by gender and age

Age of patients	Including				Number of patients
	Men		Women		
	(CG)	(MG)	(CG)	(MG)	
up to 15 years	5(8,1%)	2(3,2%)	2(3,2%)	2(3,2%)	11(18 %)
16 - 20 years old	1(1,6%)	4(6,5%)	-	1(1,6%)	6(9,8 %)
21 - 30 years old	9(14,7%)	5(8,1%)	1(1,6%)	2(3,2%)	17(28%)
31 - 40 years old	5(8,1%)	5(8,1%)	4(6,5%)	1(1.6%)	15(24,5 %)
41 - 50 years old	3(4,9%)	-	1(1,6%)	-	4(6,5 %)

51-60 years old	4(6,5%)	-	-	-	4(6,5 %)
61-70 years and older	3(4,9%)	1(1,6%)	-	-	4(6,5%)
Total:	**30(45,9%)**	**17(19,6%)**	**8(13,1%)**	**6(9,8%)**	**61(100%)**

The causes of aneurysms were as follows: stab wounds of blood vessels - 29 (47,5%); gunshot wounds of vessels by shot and bullets - 4 (6,5%); blunt vascular injuries - 7 (11,4%); electrical injury-1 (1,6%); car accident-4 (6,5%); aneurysms of the anastomosis - 4 (6,6%) and others - 12 (19,6%).

In medical practice, the diagnosis of traumatic aneurysm does not present a great difficulty, which is revealed by a simple clinical study. However, in this matter, difficulties may arise due to the presence of various options for their manifestation, depending on: localization of aneurysms, concomitant diseases, etiological and other factors. We analyzed the nature of complaints and distributed the patients according to them, in Table 22.

Table 22

Distribution of patients according to the nature of complaints in TAA

Character of complaints in TAA	Number of patients	**%**
Ischemic events	10	16,3
Compression of nerve trunks	3	4,9
Violation of the venous Outflow	7	11,4
Pain in the aneurysm and swelling	41	67,2
Total:	**61**	**100,0**

As can be seen from table 22, in most cases, TAA was observed in sick men of active working age from 15 to 40 years.

We believe that the complaints of patients require quite serious attention, because. often, they, in combination with anamnestic data, factors of local circulatory disorders, make it possible to correctly diagnose. In line with the foregoing, we will consider in detail the following complaints of the patient:

- ischemic disorders of the injured limb: fatigue when walking; increased sensitivity to temperature decrease; (especially in high humidity) shifting lameness; cramps in the muscles of the leg. With prolonged TAA, characteristic complaints in the presence of trauma or even occlusion of the main artery. In the emerging TAA, complaints occur with angiospasms;
- damage to the nerve branches, causing: paresis; paralysis; dysphonia; algia in the limbs.
- compression of a vein by an aneurysm, leading to the following phenomena: stasis; swelling of the distal parts of the limb; strengthening of the venous pattern. At the same time, patients note a feeling of fullness in the affected area.
-local pain, in the TAA area, i.e. at the site of pulsating swelling. Severe pain is noted at the beginning of TAA formation due to ischemic compression and blood imbibition of neighboring tissues, including nerves. These pains subside and may even disappear with a decrease in edema, resorption of the hemorrhagic infiltrate, and organization of the walls of the TAA. Data on the duration of TAA are given in table 23.

Table 23

Duration of traumatic arterial aneurysms

TAA duration	Total patients		including those operated		
			Total:	(CG)	(MG)
up to 5 months	43	70,9%	41(67,2%)	20(35%)	21(36,8%)
up to 1 year	3	4,9%	3(4,9%)	1(1,7%)	2(3,5%)
2-3 years	6	9,8%	6(9,8%)	5(8,7%)	1(1,7%)

4-5 years	1	1,6%	1(1,6%)	1(1,7%)	-
6-9 years old	4	6,5%	3(4,9%)	3(5,2%)	-
up to 10 years and older	4	6,5%	3(4,9%)	3(5,2%)	-
Total:	61	100%	57(93,4%)	33(57,8%)	24(42,1%)

In our study, patients with TAA were identified according to the duration and duration of the existence of traumatic aneurysms. It should be noted that depending on the location and depth of the aneurysm - a symptom of swelling may be absent or determined. The size of the elevation above the skin surface varies within different limits and with different clarity of boundaries. When examining a patient with TAA, of course, postoperative and post-wound scars were found. We paid special attention to the projections of the TAA and the wound channel, in the area of the vascular or neurovascular bundle.

When examining 61 patients with TAA, certain clinical signs were observed. So, during the initial examination, in 61 patients with traumatic arterial aneurysms, the following clinical signs were noted: pain and swelling - 41 (67,2%) patients. Of these: severe pain - 2 (3,2%), moderate - 4 (6,4%), aching - 1 (1,6%), bursting - 1 (1,6%); Along with them, pulsating tumor-like formations were found - 25 (40,9%); cooling-5 (8,2%); general weakness - 13 (21,3%); violation of the sensitivity of the limb - 4 (6,5%). Of these: sharply reduced - 2 (3,2%); thinning, redness, infiltration of the limb - 3 (4,9%); swelling of the distal limbs - 3 (4,9%); movement restriction - 2 (3,2%); systolic murmur over the formation - 20 (32,7%) patients. In addition, coarse target noise-1 was detected; coarse systolic murmur-1 (1,6%); numbness - 7 (11,4%) patients. On palpation, TAA of a round or oval shape, with sizes from 1.5 to 25 cm, were identified, swelling and the phenomenon of vascular pulsation were simultaneously noted in 27 (44,2%) patients. Formation consistency: soft-9 (14,7%); dense - 13 (21,3%) patients. The consistency was often smooth, and thrombosis or calcification was

expressed in an elastic or dense form. Pulsation was caused by systolic blood pressure. The absence or its weakening depended on the degree of thrombosis, calcification, or the thickness of the aneurysmal sac. The absence of pulsation was noted in about a third of patients. With a large window, a large main artery, a symptom of TAA trembling was determined. On palpation examination: swelling of the aneurysm was palpated in 22 (36%) patients. The pulsation phenomenon was positive in 27 (44,2%) patients.

During auscultation over the aneurysm, in 22 (%) patients, a systolic murmur was heard in the aneurysmal sac from blood turbulence. This noise of different strength, sometimes, was not audible, due to thrombosis. When squeezing the adductor artery, the noise disappeared. At the same time, with the old, long-existing, TAA, as a rule, the pulse weakened again, or even its absence.

We believe that noise and pulsation is associated with 4 causes: thrombosis; thromboembolism; stenosis of the outlet end of the injured artery and atherosclerotic plaques that occur in the elderly. One of the symptoms of TAA is venous insufficiency resulting from compression of the main vein by a large aneurysm. Venous insufficiency, respectively, is accompanied by: swelling of the distal part of the limb; pastosity and the presence of a venous pattern.

In our study, venous insufficiency was observed in 7 (11,4%) patients, more often on the legs. TAA, located near the nerve trunks, involved them in the pathological process with cicatricial formation. The neurological status was characterized by neuritis, paresis, paralysis, and causalgia of the limb. Neurological symptoms of a transient nature were observed in 3 (4,9%) patients. Their localization was in the region: shoulder girdle, neck, femoral and popliteal arteries.

Arterial pressure during TAA was observed in: 53 (86,9%) patients were normal; 8 patients - elevated. In the process of research, we have identified a certain asymmetry. When measuring blood pressure distal to the TAA and at the same level in a healthy limb, it showed a lower value by 10-20 mm Hg. Art. than on the affected side. Due to impaired blood flow, due to compression of the artery

by an aneurysm or scar tissue, it was not detected in several patients. From all of the above, it is clear that it is necessary to pay special attention to these signs when examining patients with TAA. This circumstance allows you to quickly establish the diagnosis of the underlying disease and some complications of the aneurysm.

For early diagnosis of traumatic arterial aneurysms, along with clinical examinations, Dopplerography, ultrasound, MSCT and angiography were also used.

Laboratory tests: hemoglobin in 9 patients 76-108 g/l. One patient has a high ESR of 60. Fibrinogen, in 16 (26.2%) patients 3990-8880 g/l. PTI, in 13 (21.3%) patients 62-85%. Differential diagnosis of TAA required the exclusion of the following abnormalities: tumor; abscess; thrombophlebitis; phlegmon and aneurysms of other etiology. In practice, self-healing of TAA has not been observed. The prognosis, as noted by other authors, was always very serious; because complications always threaten. Therefore, operational indications are available for all patients in 100% of cases. Of all the patients in: 4 (6,5%) patients underwent surgery, in an urgent and emergency order (due to rupture of an aneurysm); after 1-2 days, reconstructive operations were performed in 2 (3,5%) patients. The outcome of the autovein operation was favorable in 3 cases. After 1-4 weeks, after the injury and the occurrence of TAA, 4 (6.5%) victims underwent surgery on the large arteries of the limbs. 10 such patients were operated on with favorable results, more than 1 month after the injury. They, respectively, underwent operations on TAA at a later date. The restoration operations performed by us on the TAA "with experience" - six months or more, were accompanied by certain difficulties. They are associated with the development of scar tissue, leading to disturbances in the local architectonics of the neurovascular bundle. At the same time, some of this was observed in younger TAA with the risk of complications, thromboembolic nature.

Summarizing the above, we came to the conclusion that in TAA, the tactics of “postponing” the operation to a later date is fraught with unexpected

complications. Even under conditions of impregnation, thrombosis developed in the soft tissue blood and inflammatory process.

When localizing TAA in non-main or paired arteries, as is customary in practice, we used the imposition of a ligature. It should be emphasized that such patients often developed ligated vessel disease with clear subjective and objective symptoms, characterized by dystrophic phenomena. Complaints of patients are associated with sensations of cold, different intensity of pain, causalgia, articular limitation. In addition, patients were observed: atrophy of the muscles of the limb; the volume of the injured limb; change in skin color: pale or cyanotic and others. Also, it was found: varying degrees of fibro-tendon contractions; intermittent claudication and trophic ulcers. It is appropriate to note that we did not carry out special preparation for the ligature operation, because. the presence of TAA of different prescription caused the development of collaterals, which was also indicated (Novikov Yu.V. et al 2004; Zotov S.P. et al 2011).

Damage to the main arteries is one of the severe injuries, due to the high frequency of local and general complications occurring in 15.4-48.4% of cases.
In addition, we analyzed patients by location with TAA and by body parts. Table 24. the distribution of patients with TAA is presented, depending on its localization and arterial lesions in the part of the body.

Table 24

Localization of traumatic arterial aneurysms by part of the body

Body parts	Localization TAA	Число больных				P
		Total	%	(CG)	(MG)	
Neck and head	Carotid artery - 2 Facial-1 Superior thyroid artery-1 Neck artery-1 Jugular vein-1	6	10,8%	5(8,2%)	1(1,6%)	
Torso	Subclavian - 7 Axillary - 4 Abdominal - 4 Iliac artery-1	16	26,2%	7(11,5%)	9(14,7%)	

Upper end ness	Shoulder - 7 Beam - 7 Elbow - 1	15	24,5%	10(16,3%)	5(8,2%)	>0,05
Lower end ness	Femoral - 17 Popliteal - 4 Shin-3	24	39,3%	15(24,5%)	9(14,8%)	
Total:		**61**	**100%**	**37(60,6%)**	**24(39,4%)**	

The most frequent localization of aneurysm is observed in: femoral artery - 15 (24.5%); radial artery-7 (11.4%); subclavian artery - 7 (11.4%); popliteal artery - 4 (6.5%); brachial artery - 7 (11.4%)(Table 24).

When studying the damaged vessel in the wound channel, an abundant mass of clotted blood was found. Approximately 2 weeks after the injury, a stenosis formed in the aneurysmal sac. After about 2-4 months, the aneurysm became three-layered, like a vessel. At the same time, the outer fibrous layer is usually tightly soldered to neighboring tissues, like a bone. This is usually a tissue or subcutaneous fat layer. The middle layer includes small vessels and proliferating connective tissue cells. The inner layer, as a rule, is compacted fibrin clots. All these 3 layers of the aneurysmal sac gradually pass one to the other, without a sharp border. The thickness of this bag, not everywhere, is the same. If in some places it is thick enough, then in others it is so thin that an aneurysm ruptures. It can be stored for life until the appropriate operation is performed. Layers of long-term aneurysms undergo changes over the years in the direction of the compliance of tear dissection and the possibility of the formation of child aneurysms. So, in the middle layer, elastic and muscle fibers can be found at the neck of the aneurysmal sac. In the outer layer, over the years, coarse connective tissue develops, with abundant vascularization.

The walls of a thin aneurysmal sac are prone to calcification and at the same time become more fragile and fragile. Any false aneurysms, including those of traumatic etiology, are characterized by the occurrence of ischemic phenomena in the distal parts of the affected limb. It manifests itself by reducing the speed of

blood flow in the main artery. Ischemic phenomena are due to the fact that the outlets can be spasmodic or stenotic. This occurs due to cicatricial degeneration, thrombosis or inversion of the intimate inside, into the lumen of the vessel. In this case, occlusion of the output section may also occur. Compression of the outlet is also due to the large size of the aneurysmal sac, which in some cases exerts pressure on the collaterals. Ischemia of the distal arterial bed occurs during the acute period of aneurysm formation, as a result of a reflex spasm of the distal blood flow of the injured limb.

In practice, we were faced with the danger of acutely developing ischemia, which brought the limbs to the brink of gangrene. This occurred with thrombosis of traumatic aneurysms of the popliteal and common femoral arteries, when the main blood flow was blocked. Due to well-defined collaterals, amputation of the limb was not required. However, without reconstructive surgery, the patient retained signs of chronic arterial insufficiency.

Summarizing the above, it should be noted that violations of regional hemodynamics of the main arterial bed occur in the distal ischemia of the injured limb.

The use of various research methods (ultrasound, angiography, MSCT) showed that the presence of aneurysms contribute to the development of collaterals, without compensating for the previous normal blood flow of the main vessels.

8.2. Optimization of surgical treatment of TAA: clinic, choice and the nature f the operations

In the preoperative period, considerable attention is paid to restorative drugs and good nutrition. When using painkillers, preference was given to intubation anesthesia with relaxants and spinal epidural anesthesia. For individual patients, we used controlled hypotension to reduce the tension of the aneurysm (prevention of rupture of the aneurysmal sac) and reduce blood loss. On average, during TAA surgery, blood loss ranged from 500 ml to 1 liter. Therefore, always, in advance before the operation, 2-3 liters of liquid were prepared for one patient. At the same time, cardiovascular agents were used, depending on the patient's condition. The preparatory measures taken made it possible to prevent complications of

hemodynamic disorders. When choosing a surgical approach to the TAA, we used a straight incision in the projection of the main artery. Moreover, this access was quite wide and at the same time ensured a normal postoperative course with restoration of limb function, depending on the location of the TAA (carotid, popliteal, femoral, etc.).

Over the past decades, in angiosurgery, the techniques and methods of operations on the vessels have changed markedly. If necessary, we resorted to sawing bones (clavicles, sternum, etc.)

In practice, we have moved from simpler ligature options with the education of collaterals to more complex and lengthy operations to restore the bloodstream. The timing showed that out of all 57 operations performed by us on TAA, y: 2-6-8 hours; 2 -4.5 hours; 40-3 hours; 3 surgeries lasted 1-2 hours and 10-up to one hour. We have always taken into account that prolonged application of a tourniquet injures muscle, especially nervous tissue, which is fraught with negative consequences for the function of the operated limb. In some cases (sleepy, femoral), the tourniquet, in general, could not be used. Even with carefully thought out and accurate layer-by-layer dissection of tissues, there were collateral veins and arteries of various calibers. Hemostasis, we achieved with the help of a coagulator. In conditions, especially of long-term TAA, the path to an aneurysm, as a rule, was through the meeting of scar tissue and a disturbed topic of the neurovascular bundle.

The aneurysmal sac was opened, and the thrombotic mass was removed from it to prevent soft tissue compression. When inflammatory phenomena were detected, the aneurysmal sac was completely excised. With prolonged TAA, often, nerve trunks are involved in the scar tissue. In such cases, with all precautions, neurolysis was performed to improve the trophism of the surrounding tissues, and hence the postoperative period. After careful fixation, they began to prepare one or another type of restorative operation. All measures were taken to prevent thromboembolism and other complications in the distal part of the artery. In some cases, interoperative angiography has been resorted to,

especially when it was not performed before surgery. Emboli from the distal part of the vessel were found using an electric suction catheter. During the operation, up to 5000 units of heparin were injected into the distal bed. Before layer-by-layer suturing of the wound, we removed non-viable areas of the surrounding tissues. Usually, rubber strips were left to drain hemorrhagic fluid or blood, as sometimes a hematoma forms in this area. All TAA operations by nature are divided into three types: ligature, reconstructive and palliative.

Indications for surgery and terms of surgical intervention

Indications for surgery and terms of surgical intervention in patients with arterial arteriovenous aneurysms are as follows:

- arterial aneurysms are always dangerous, given the possibility of their rupture, embolism, thrombosis of peripheral and main arteries;
- patients with arterial aneurysms, it is necessary to operate as early as possible to avoid irreversible changes in the heart;
- in traumatic aneurysms with signs of an inflammatory reaction of surrounding tissues, infection, surgical intervention should be delayed for 1-2 months until the inflammation disappears;
-treatment of this group of patients should be carried out in specialized departments of vascular surgery;
- the approach and tactics of treatment for each patient should be individual.

General principles of surgical treatment of vascular aneurysms

It must be emphasized that access to the leading and efferent vessels should be wide enough. This is to ensure hemostasis during surgery and with a possible rupture and bleeding. Choosing the optimal access is essential to the success of the entire operation. This requires careful planning for each patient. We consider it expedient to sequentially perform the individual stages of the operation. First, the great vessels, proximal and distal to the aneurysm, should be exposed in order to temporarily compress them. Further, to isolate the vessels, it is necessary to approach carefully and methodically. At this stage, there are significant difficulties associated with cicatricial changes in tissues and a significant

expansion, as well as thinning of the walls of blood vessels. Ligature operations were mainly used for obliteration of the aneurysmal sac. However, of these, 8% of the outcome of this operation ended in amputation or mortality. In case of suppuration, the aneurysm was ligated from both ends and a vascular graft was sutured in the form of a bridge over the included aneurysm.

Indications for surgery and timing of surgical intervention

Treatment of patients with arterial and arteriovenous aneurysms is surgical. Arterial aneurysms are always dangerous due to: rupture, thrombosis and embolism of peripheral vessels. At the same time, they should be operated on earlier to avoid the development of irreversible changes in the heart. They can lead to: death; severe trophic disorders; sharp structural changes in the walls of blood vessels and septic endocarditis.

Self-healing of aneurysms, as a result of its thrombosis, is rare.

In case of an inflammatory reaction of surrounding tissues, infection, and severe impairment of peripheral circulation, surgical intervention can be delayed for 1-2 months until the inflammatory processes disappear.

The approach and tactics of treatment for each patient should be individual.

General principles of surgical treatment of vascular aneurysms

Surgical interventions for aneurysms are among the most complex in vascular surgery. Treatment of this group of patients should be carried out in specialized vascular surgery departments. It should be emphasized that access to the inlet and outlet vessels should be wide enough. This will ensure hemostasis during surgery and in case of possible rupture or bleeding. The choice of optimal access is of decisive importance in achieving the success of the entire operation. For this, careful planning is required for each patient. We consider it appropriate to use the following sequence of individual stages of the operation. First, the main vessels proximal and distal to the aneurysm should be exposed in order to temporarily press them. Then, the vessels should be isolated carefully and methodically. At this stage, significant difficulties associated with cicatricial changes in tissues and significant expansion, as well as thinning of the vessel walls, are encountered.

Ligature operations were mainly used earlier for obliteration of the aneurysmal sac using the Anel, Gunther or their combinations. The Brazdor operation allowed us to slow down the blood flow in the aneurysm using thrombotic masses. Ligation of the aneurysmal sac was also performed using the Vreden-Vardron method. A number of authors note that if the aneurysmal sac is not exported, this is fraught with a number of negative consequences (aneurysm recurrence, suppuration, bleeding). Thus, during the war and post-war years, using only the Gunther-Anel method, only 4.9% of patients had TAA eliminated.

However, in 8% of them, the outcome of this operation ended in amputation or death. As the analysis of some authors' works shows, it led us to the idea that in order to avoid risk, even at the expense of further lifelong limb ischemia, in some cases, the aneurysmal sac was not removed if it did not threaten compression syndrome interoperatively and there was no supuration. In case of suppuration, the aneurysm was ligated from both ends and sutured, in the form of a bridge over the included aneurysm, with a vascular transplant.

In the operation according to the Krishner method, the aneurysmal sac is also not removed, it is isolated for rolling with fascia or some more or less strong synthetic fabric. Sometimes, a metal plate or wire is used, thereby achieving complete or incomplete exclusion of the aneurysmal sac with a thrombotic lining.

The Filagrius operation, which exists in practice to completely remove the TAA, was repeated and described by P. Sapozhnikov (1943) during the Second World War (Fig.44-45).

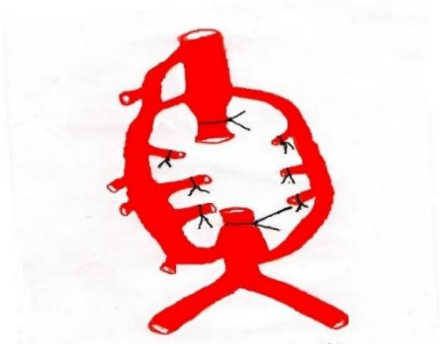


Fig.44. Scheme of the ligature operation according to Filagrius.

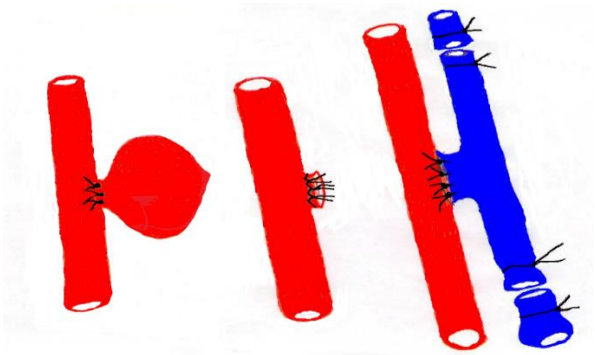


Fig.45. Scheme of operations Sapozhkov S.P. arterial arteriovenous aneurysms

More rarely, for arterial aneurysms, Sapozhkov's restorative operations, the Matas-2 operation are used.

At the same time, sutures were placed on the neck of the aneurysm, and the aneurysm itself was removed. S.P. Shilovtsev, during the war years, similar operations were also performed for every third person with TAA, and the unfavorable outcome reached 9.1%. In other cases, it was possible to prevent infection and recurrence of the aneurysm. The practice of our predecessors offered us a more compromise option, when the aneurysm was partially removed, or even completely preserved. It was dissected, alloyed or the blood flow was restored by a reconstructive and restorative operation. Previously, such operations were carried out along the Antelus (Fig. 46 a, b).

Fig.46. Scheme of operation (a) Antillus, (b) Matas-1 and Matas-2.

The Antillus operation is used for infection of arterial aneurysms. It consists in ligation of the artery below and above the aneurysm, during opening and open plugging of its cavity. The Matas-1 operation (Fig. 46b) is performed when arterial aneurysms are formed. It consists in suturing and ligation of all vessels that open into the aneurysm cavity inside the aneurysmal sac. Operation Matas-2 is indicated for arterial traumatic aneurysms with a small lateral defect in the artery wall. During the war years, such operations were also carried out by S.P. Shilovtsev, with secondary bleeding infection of the aneurysmal sac. At the same time, after the removal of blood clots, she was openly tamponed. Such operations were performed in almost half (47.8%) of the wounded with similar TAA, with a relatively high percentage of adverse outcomes: 5.1% amputation and 10% death. To preserve the collaterals, the Korotkov-Kikitsu technique is useful, when, during the dissection of the aneurysm, the adductor and efferent ends of the artery were ligated, from the inside, and tamponated itself. In practice, the Mates I-II

technique also finds application, when the aneurysmal sac is used for cocapitation, i.e. with plastic material for obliteration and the TAA cavity (Fig. 46b).

In practice, the complete extirpation of TAA was not always used by us, because. its radical removal could cause incidental damage to neighboring arteries, veins, and nerve trunks. After dissection of the aneurysm using suction, blood clots were removed from it. Bleeding from large-diameter collaterals was stopped with a hand. The mouth of the collaterals in the aneurysmal sac was sutured with a traumatic needle. Achieving, by hemostasis, approaching a dry wound. After mobilization of the adductor and efferent ends of the artery, the aneurysm was partially removed, and the rest was used as a plastic material. In total, we performed 57 operations on TAA, of which, in 10 patients, the walls of the aneurysmal sac were partially excised. Patients with TAA used various vascular sutures (lateral, circular). For large defects and diastases that occurred during the operation, a patch (of the 2-popliteal and femoral vein) from an autovein or a synthetic prosthesis was used. When planning recovery operations, the nature and timing of the occurrence of TAA are of some importance, which are given in the following table 25.

Table 25

Comparative analysis of the results of operations with local TAA

Damaged vessel	Before 2000 (Control group)						From 2000-2018 (Main group)						Total:
	Ligation	Lateral	Circular	Autovein	Prosthesis	Denture Patch	Ligation	Lateral	Circular	Autovein	Prosthesis	Denture Patch	
Iliac artery	1												1(1,7%)
Femoral artery	1	1	2	4	3					4			15(26,3 %)
Popliteal artery				1					1	1		1	4(7%)
Leg artery	3						1						4(7%)
			2			1				1		1	5(8,7%)

Axillary													
Brachial artery			3		1			2					6(10,5 %)
Ulnar artery		1											1(1,7%)
Radial artery	3		1				1	1	1				7(12,2 %)
Vertebral artery	1												1(1,7%)
Cervical artery		1											1(1,7%)
Abdominal aorta				1							1		2(3,5%)
Internal jugular vienna			1										1(1,7%)
Subclavian	1			2			3	2					8(14,%)
Facial artery							1						1(1,7%)
Total:	10	3	9	8	4	1	6	5	2	6	1	2	57(100 %)

During the operation, great attention was paid to the fixation and mobilization of the vascular ends of the TAA. After that, then they made the final decision on the choice of tactics for the recovery operation. So, the side suture, we imposed on 6 patients, mainly patients with a long period of traumatic arteriovenous aneurysm. This suture was used in patients with TAA, up to a year old, and only for one with a weekly period. A feature of the use of the lateral suture is the requirement for exceptional care, at all stages, during the reconstruction of blood vessels. During the operation, a continuous eversion suture was used through all layers of the artery. Especially, it concerned the distal segment, so as not to capture intima. This prophylaxis of stenosis and vascular suture was carried out in the transverse direction with minimal wall capture and care so that the thread did not cut through the vessel tissue. Eruption was avoided by reliable mobilization of the TAA vascular ends and flexion of the adjacent joints. All this reduced the tension of the edges of the arterial wall. The formation of a thrombus in the distal part of the artery was prevented by introducing 5000 IU of heparin into it after turning off the blood circulation in the TAA zone. In addition, during the

operation, from time to time, the edges of the artery, in the area of excision of the TAA and the lumen of the vessel were irrigated with a solution of heparin in physical. solution, at the rate of 5000 units per 200 ml of saline. Using the control of redograde and proximal blood flow from the artery, freshly formed blood clots were removed by extrusion. After completion of the operation on the TAA, the pulsation was checked, distal to the segment of the artery. In this case, the pulsation may be absent, due to postoperative spasm of the artery. To resolve it, we used novocaine, papaverine, etc. If the pulsation did not recover, we had to check the condition of the suture and resort to angiography. In the event of a threat, cutting threads or a sharp narrowing of the vessel lumen, we have made a transition to other types of operations.

In those cases when, during the operation, the diastasis of the ends of the vessel was sharply entrained due to a sharp spasm of the artery, we resorted to plastic surgery.

In the reconstructive and restorative operations performed by us on TAA, the transplantation method was used in: 15 cases; moreover, in 5 cases with the use of synthetic agents, in 13 - autovenous prosthetics. One of the first reasons for the use of transplantation was a significant diastasis, when it was practically difficult to mobilize the ends of the artery. With a large defect in the artery wall, an autovenous patch was applied. The technique of autovenous prosthetics with a free segment of the vein was applied to 13 patients with TAA, and the operations were performed after the onset of TAA. In one case up to a month, in the other up to a year. In the third case, for a period of more than 10 years. At the same time, TAA localizations were as follows: external iliac; femoral and popliteal arteries.
Let's look at these points with an example.

So, Patient H. A., 20 years old, case file No. 5734, 10/31/2016. acted as planned.

Complaints of aching pain in the right side of the abdomen and chest with pain radiating to the lumbar region and general weakness. The above complaints, the patient was disturbed during the last month. He was treated at the place of

residence with various diagnoses, without effect. MSCT was performed on an outpatient basis (October 29, 2016): partially thrombosed aneurysm of the suprarenal part of the abdominal aorta (Fig. 47-48).

In 2014, the patient received an electrical injury. Electric shock, as a result of a burn of the anterior abdominal wall and the left upper limb. Other past illnesses, denies. Allergies to drugs and food, denies.

The patient's condition at admission, moderate severity. (heaviness due to pain in the epigastric region). Consciousness is clear, position is passive. Normal build, high nutrition. The skin and visible mucous membranes are clean, of normal color. In the lungs, weakened vesicular breathing on both sides, no wheezing. Heart sounds are muffled, rhythmic. BP120/80 mm Hg, pulse 80 beats per minute. The abdomen is soft, participates in the act of breathing. The liver and spleen are not palpated. Tapping of the lumbar region is painless on both sides. Physiological functions are not violated.

On examination, the abdomen is of normal shape in the umbilical region. Palpation is painful, with deep palpation, pathological formations are not palpable. Pulsation in both feet, distinct. At the remaining identification points, the ripple is determined. Above the projection of the main arteries, there are no noises. Examination: complete blood count: Hb-97g/l; erythrocytes - 3.4x x1012/l; leukocytes - 8.6 x109/l; platelets - 495 thousand. Urinalysis: protein - 0.033; epithelium-0-0-1; leukocytes. 0-0-1. Biochemical blood test: sugar-4.0; bilirubin: total -15 mmol / l; straight-0; protein-72g/l; potassium-5.5; narium-140; urea-6.6; creatinine-57; ALT-15; AST-32. Coagulogram: plasma tolerance to heparin 7 min 40 sec. PTI-78%; fibrinogen-4440 mg%. Hematocrit-38%. ECG: : Sinus rhythm. Heart rate 75. Horizontal position of the EOS. Rentgengraphy: Lung fields without fresh focal-infiltrative opacities. The roots of the lungs are heavy. Domes of the diaphragm and sinuses are free. Heart and aorta of normal shape and size. The dome of the diaphragm (left) is elevated due to pneumatosis of the large intestine. EchoCG: EF 57%. KDO 94ml. KSO 41ml. UO 54ml. Normakinesis. VPS exceptions. The valvular system of the heart is intact.

Under intubation anesthesia, the patient on the right side underwent thoracophrenicolumbotomy along the 8th intercostal space on the left. The organs of the abdominal cavity are retracted, medially. Thoracotomy - the pleural cavity is free, there is no adhesive process. The diaphragm was cut in the tendon part. The medial pedicle of the diaphragm was dissected. During the revision, there is a false aneurysm of the anterior wall of the thoracoabdominal part of the aorta, 12x8x6 cm in size, around a pronounced periprocess, the latter pushes back and squeezes the celiac trunk and SMA from above. Isolation of the aorta with technical difficulties proximal and distal to the aneurysm. The thoracic aorta with a diameter of 2.0 cm was taken on a holder. Below the aneurysm, at the level of the renal arteries, the abdominal aorta was exposed. Clamping of the thoracic aorta and abdominal aorta below the aneurysmal sac, but above the level of origin of the celiac trunk, renal arteries and SMA. Opening the aneurysmal sac, taking blood into the SELSEVER apparatus for retransfusion of autologous blood. With further revision and elimination of the aneurysm of the anterior wall of the aorta, a longitudinal defect 4.5 cm long was found (Fig. 49). Plastic defect of the anterior stack, thoracoabdominal abdominal aorta, is impossible. Since the walls of the aorta, in the area of the defect, are loose and torn. In this regard, it was decided to replace this section of the thorocoabdominal aorta. The thoracic aorta was resected, above the aneurysmal sac, and the site was prepared for proximal anastomosis. The proximal anastomosis was created mainly with the VASKUTEK 18 prosthesis of the end-end type of the thoracic aorta with a 4/0 prolene thread. Further, the abdominal aorta was resected, below the aneurysmal sac and above the celiac trunk. A distal end-to-end anastomosis of the abdominal aorta prosthesis was created, with a 4/0 prolene thread (Fig. 50-51). Start of blood flow, sealed. There is a clear pulsation below the distal anastomosis. Diaphragm sutured. Drainage of the pleural cavity along the midaxillary line, at the level of the 7th intercostal space, on the left of the retroperitoneal space along the midaxillary line. Drainage in the pleural cavity is connected to active aspiration.

The pleural cavity and anterior abdominal wall were sutured. Produced aseptic bandage.

In the postoperative period, the patient underwent multislice computed tomography of the prosthetic thoracic aorta, which is functioning normally. In the late period, the patient underwent multispiral computed tomography of the prosthetic thoracic aorta, while occlusion was not observed and it functions normally.

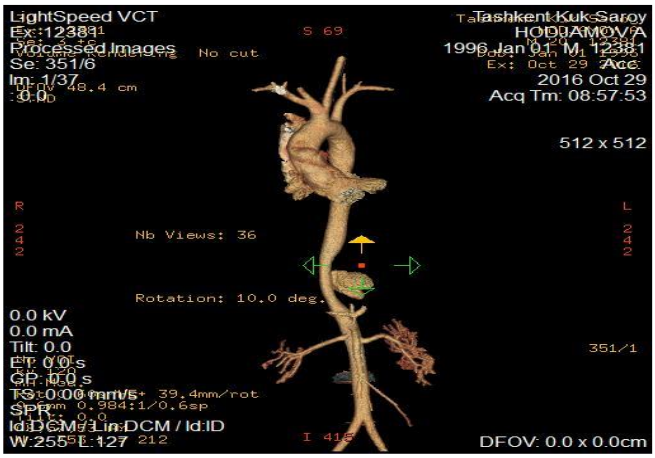


Fig.47. MSCT - Traumatic aneurysm of the thoracoabdominal aorta.

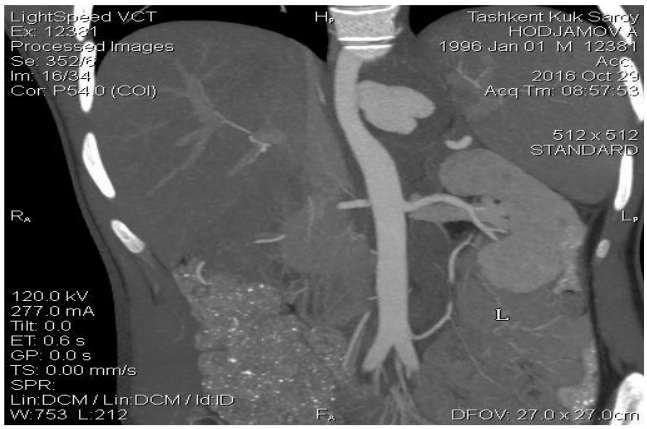


Fig 48. MSCT - Traumatic aneurysm of the thoracoabdominal aorta.

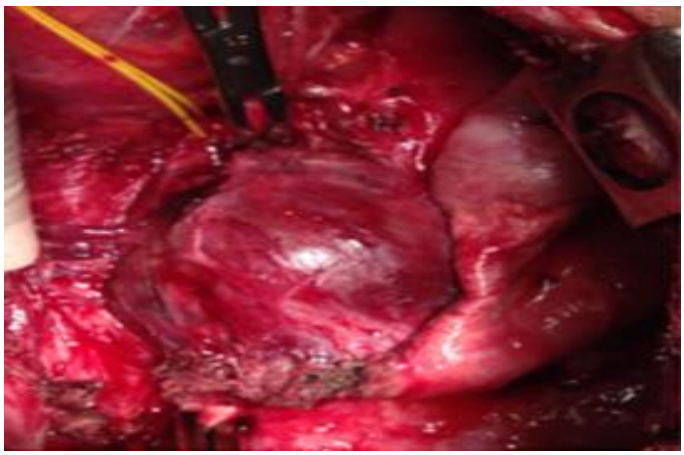


Fig.49. Interoperative photo of thoracoabdominal traumatic aortic aneurysm

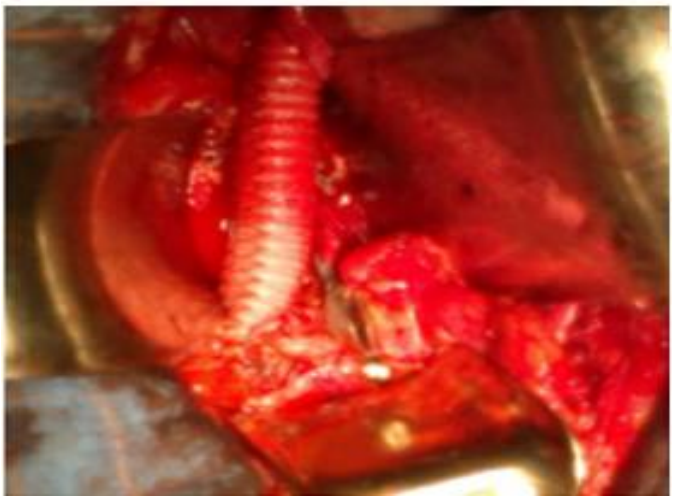


Fig.50. Interoperative-traumatic photo- prosthetics of thoracoabdominal aneurysm

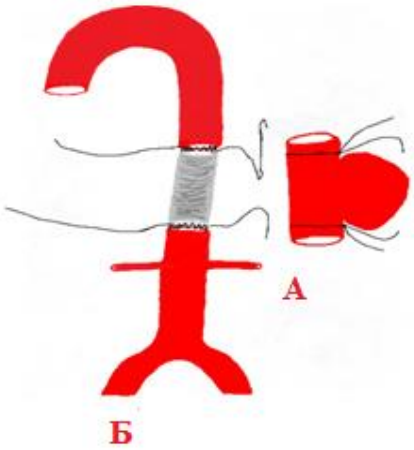


Fig. 51. Scheme of resection and prosthetics of the descending part of the thoracic aorta.

Most angiosurgeons tend to believe that the outcome of operative interventions with TAA is less effective than with operations on TAVF. This can be explained by the fact that ligation often leads to ischemia of the injured limb. Reconstructive surgery for TAA often has such consequences as: thromboembolic phenomena of the distal segment of the main vessel; thrombosis and rupture directly TAA or infection; as well as soft tissue necrosis around the aneurysm. During our work, 57 (93.4%) patients underwent reconstructive and restorative interventions. Of these, 13 (22.8%) patients underwent surgery, in an urgent and emergency order, due to suppuration and aneurysm rupture.

Up to 5 months after the injury and the occurrence of TAA, 41 (71.9%) patients underwent surgical interventions with favorable results. In 3 (5.2%) patients, operations were performed a year after the injury; up to 10 years - 9 (15.7%). During the period of our work, 57 patients (93.4%) were operated on. All of them underwent reconstructive and restorative interventions. Of these, 13 (22.8%) patients underwent surgeries, in an urgent and emergency manner, due to suppuration and rupture of the aneurysm up to 5 months after injury and the occurrence of TAA. 41 (71.9%) patients underwent surgical interventions with favorable results. 3 (5.2%) patients underwent surgery a year after injury, and 9 (15.7%) patients were operated up to 10 years.

Let's consider these points using an example.

Patient D.Sh., 24 years old, case history #3289, was admitted on 08.05.2013. With a diagnosis of post-traumatic aneurysm of the subclavian artery, on the right.

Complaints of a pulsating formation in the neck area, on the right. Lack of appetite, dizziness, dry irritating cough and pronounced general weakness. According to the patient, the formation on the neck appeared a month ago. An ultrasound was performed, which noted ECHO signs of aneurysm of the subclavian artery, on the right. General condition, satisfactory. Consciousness is clear. Skin and visible mucous membranes are clean, pale earthy color. Weakened vesicular breathing in the lungs. Heart sounds are muffled, rhythmic. Blood

pressure on the right upper limb is not determined, the pulse is thready. Blood pressure on the left arm is 110/60 mm Hg. Pulse is 84 beats per minute. The tongue is clean. The abdomen is soft, painless, participates in the act of breathing.

The liver and spleen are at the edges of the costal arch. Stool tends to constipation, diuresis is adequate. In the neck area on the right, a pulsating, nodular formation is palpated: 15x10 cm in size, dense in consistency, irregular in shape and slightly mobile (Fig. 52). Systolic murmur is heard. The pulse in the right upper limb and radial artery is filiform.

Examination: Blood group AB(IV), Rh+. Hb-143g/l; erythrocytes-5.3 x1012/l; leukocytes-6.3 x109/l; platelets-495 thousand units. General urine analysis: specific gravity-1015; protein-0.033. Biochemical analysis: sugar 6.2mmol/l; total bilirubin -11 μmol/l; ALT-29 U/l; AST-33 U/l; protein-82 g/l.; creatinine - 62 μmol/l, urea - 4.7 mmol/l; sodium - 142 mmol/l; potassium - 4.6 mmol/l. Coagulogram: Ht-44%; plasma tolerance to heparin - 15 sec., plasma recalcification time - 92 sec.; thrombotest-5; prothrombin-100%; fibrinogen - 2220 g/l; fibryolytic activity-30.3%. Ultrasound: in the proximal part of the subclavian artery on the right, after the common carotid artery departs from the brachiocephalic trunk, an aneurysm measuring 7x7 cm with thrombotic masses in the lumen is visualized. Blood flow in the subclavian artery and common carotid artery is determined.

Angiography: the ascending aorta and aortic arch are without pathological changes. The brachiocephalic trunk is without pathology. After the departure of the common carotid artery and the vertebral artery on the right, an aneurysmal dilation of the subclavian artery measuring 6x7 cm is noted, in the II segment with thrombotic masses. Blood flow in the center of the aneurysm is determined (Fig. 53).

According to the MSCT data, with the contrast of the vessels, an aneurysmal dilation of the subclavian artery is determined in the second segment, after the departure of the vertebral artery, on the right (Fig. 54). On 28.05.2013, a post-traumatic aneurysm of the subclavian artery was eliminated on the right. Ligation

and suturing of the subclavian artery were performed. The postoperative course is smooth. The wounds heal by primary intention.

Under intubation anesthesia, a median sternotomy was performed (Fig. 55). Wax was applied to the patient's chest. Hemostasis of the wound was performed. The ascending thoracic aorta was isolated with sharp and blunt instruments. The pericardial cavity of the heart was opened and the brachiocephalic trunk, common carotid artery and orifice of the subclavian artery were isolated. A pronounced adhesive process was noted at the level of the orifice of the subclavian artery with aneurysmal expansion of up to 3x3 cm. The arteries were taken on holders. The subclavian artery was clamped. The sternotomy incision of the upper edge was continued towards the supraclavicular region above the aneurysm (up to 10 cm). After that, old blood clots (100 ml) were isolated from the aneurysm. In this case, severe bleeding from the aneurysm cavity was observed. To improve surgical access to the bottom of the aneurysm, the lower third of the sternocleidomastoid muscle was dissected. A catheter was inserted into the distal part of the subclavian artery and the balloon was inflated. During revision of the upper edge of the 2nd segment of the subclavian artery, a defect in the vessel wall was detected. In this case, profuse bleeding was observed and in order to preserve vital signs, the subclavian artery was operatively ligated from the mouth, on the right. At the same time, the distal section of the subclavian artery and its branches were cut and ligated (Fig. 56). Hemostasis of the wound was achieved. The catheter balloon was removed from the subclavian artery, on the right. The pericardial cavity, aneurysm cavity and, by a separate incision, the neck area, on the right were drained. Layer-by-layer suturing of the wound was performed. Sutures were placed on the skin. The immediate and remote results are good.

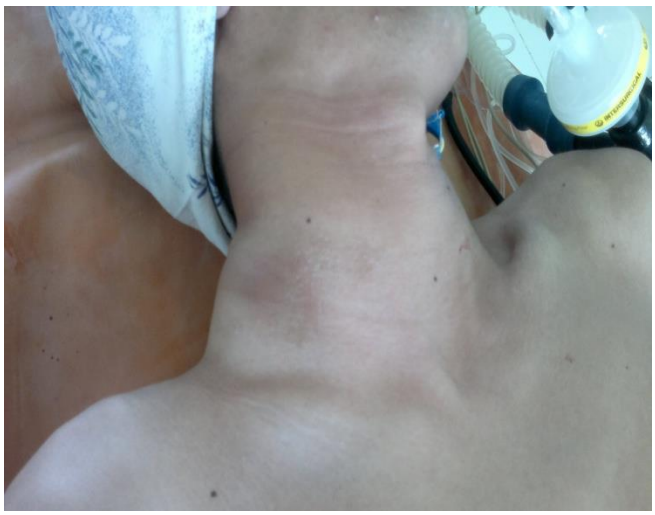


Fig. 52. False aneurysm of the right subclavian artery.

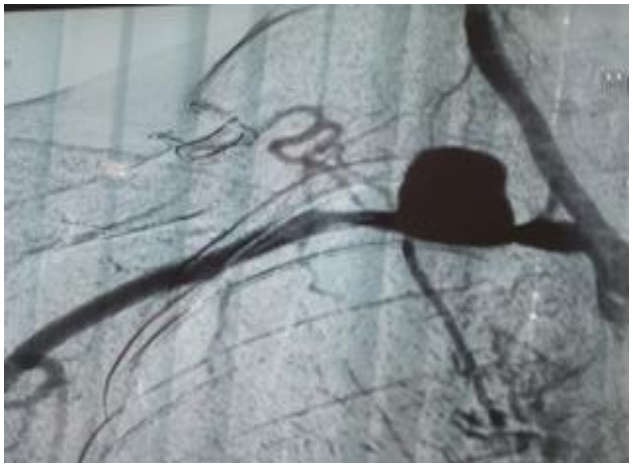


Fig. 53. Angiography of a false aneurysm of the subclavian artery, right.

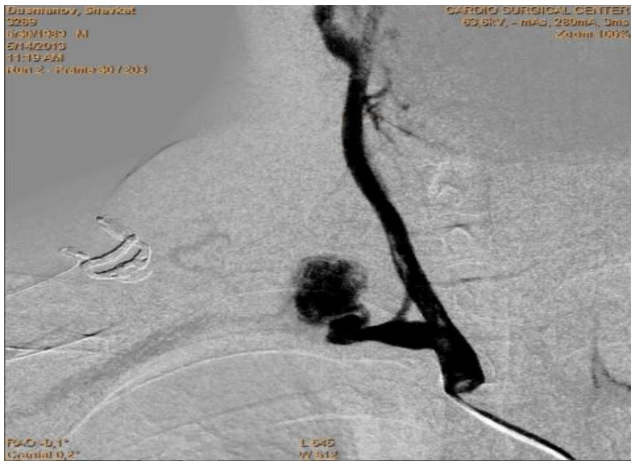


Fig. 54. MSCT: false aneurysm of the subclavian artery, right.

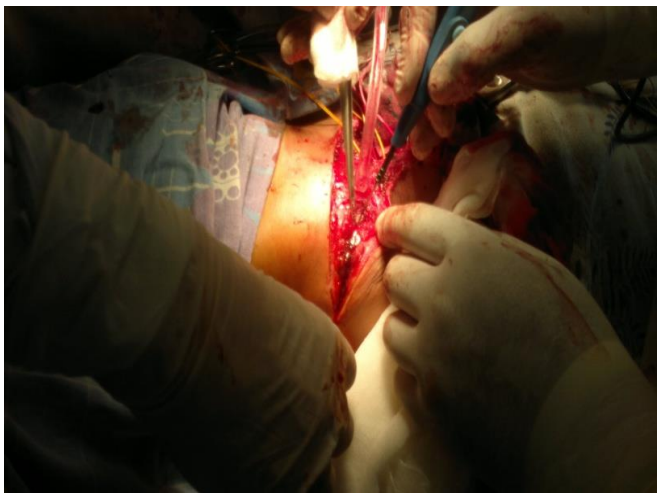


Fig. 55. Access to a false aneurysm, right subclavian artery.

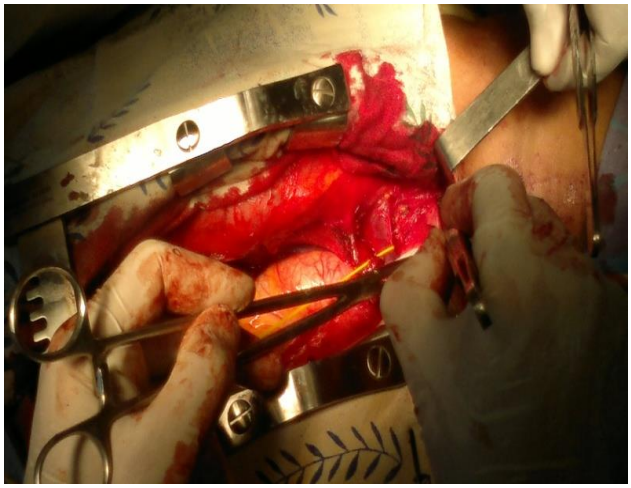


Fig. 56. Interoperative photo of aneurysm elimination in the right subclavian artery.

Under long-term observation, there were 57 operated patients. Observation data are presented in Table 26.

Table 26

Comparative analysis of reconstructive and restorative interventions in TAA by types of surgery in the CG and MG, n=57

Type of operation	(control) From 2000-2018	Before 2000 (main)	Total patients
Vessel ligation	10(17,5%%)	6(10,5%)	16(28%)
Side seam	3(5,2%)	5(8,7%)	8(14%)
Circular seam	9(15,7%)	2(3,5%)	11(19,2%)

Autovenous prosthetics	7(12,2%)	6(8,7%)	13(22,8%)
Prosthetics	4(7%)	1(1,7%)	5(8,7%)
Extraatomic shunt	1(1,7%)	-	1(1,7%)
Popliteal and femoral vein patch	1(1,7%)	2(5,2%)	3(5,2%)
Total:	35(61,4%)	22(38,5%)	57(100%)

Comparative analysis of data between the CG and MG groups shows statistical significance $p<0.05$.

In a comparative analysis of reconstructive and restorative interventions by types of operations, ligation of vessels, circular, autovenous shunts, and others prevail in the CG than in the OG. This circumstance proves the effectiveness of REVO in MG patients.

We have carried out the following types of operations. In the CG performed: dressing - 10 (17.5%); side seam - 3 (5.2%); circular seam - 9 (15.7%); autovenous prosthetics - 7 (12.2%); prosthetics - 4 (7%); extranatomy shunt-1 (1.7%) and vascular defect patch-1 (1.7%). In the OG, the following was performed: ligation-6 (10.5%); side seam - 5 (8.7%); circular seam - 2 (3.5%); autovenous prosthetics - (8.7%); prosthetics - 1 (1.7%), vascular defect patch - 2 (5.2%). patients, with $p<0.05$(Fig.57).

In 2000 (CG) vascular ligation operations were performed for aneurysm of: radial artery-4 (11.4%); femoral artery-1 (2.8%); posterior tibial artery(PTA)-2 (5.7%); anterior tibial artery(ATA) -1(2.8%); axillary artery-1 (2.8%) and vertebral artery-1 (2.8%). arterial wall defect 3 cm in the axillary artery; the presence of retrograde pulsation, infiltrate and defect size of 4 cm STBA; similar cases with PBBA aneurysm; With an aneurysm of the vertebral artery during surgery, there was profuse bleeding. At the same time, under pressure, wax with a mixture of hemostatic sponge was introduced into the wound hole and a zetabular suture was made above them.

From 2000-2018 (MG), operations were performed to ligate the vessels in the following cases of aneurysm: radial artery-1 (4.5%); facial artery-1 (4.5%); Anterior tibial artery (ATA)-1 (4.5%); (infiltration around the aneurysm, hyperemia); subclavian artery aneurysm-3 (13.6%). At the same time, operations were performed on: redness; infiltrates; wall defect up to 4 cm and the collapse of the vessel wall, at the level of the aneurysm. The results of these operations are satisfactory.

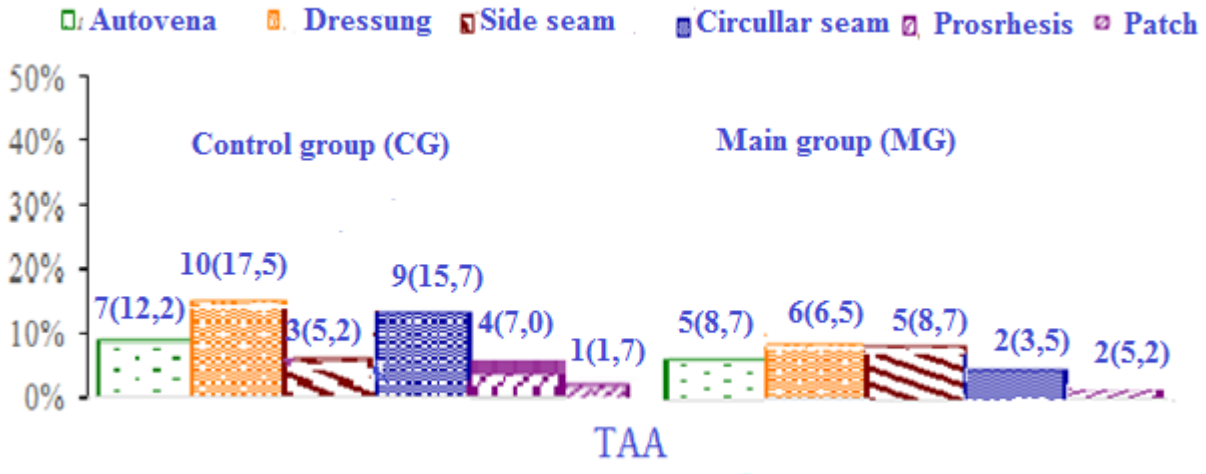


Fig. 57. Types of surgical interventions TAA.

Good results of treatment with TAA, in 51 (89.4%) patients, with $p<0.05$. Satisfactory results of TAA treatment were in 6 (10.5%) patients, $p<0.05$ (table 27).

Table 27

Evaluation of immediate results

Research methods	Total:	CG		MG		p
		good	satisfactory	good	satisfactory	
Clinical signs	57	no	Pain swelling , numbness, etc.	no	Pain numbness, Swelling, etc.	
Angiography	18(31,5 %)	14(24.5 %)	2(3,5%)	2(3,5%)	-	
UZDG	34(59,6	12(21%)	2(3,5%)	18(31,5	2(3,5%)	

	%)			%)		p<0,05
MSCT	5(8,7%)			5(8,7%)		
Total:	57(100%)	26(45,6%)	4(7,0%)	25(43,8%)	2(3,5%)	

Thus, in 48 (84.2%) patients, wound healing was primary, in 9 (15.7%) patients, healing occurred by secondary intention.

In TAA, the length of time since the injury to the vessel is of great importance. Among the observed patients with TAA, the absolute majority - 45 (78.9%). They were operated on for more than one month, from the moment of traumatic damage to the vessels. It should be noted that reconstructive surgery on vessels after 1 year is extremely difficult.

It should be noted that TAA with complications associated with rupture of the aneurysm wall and severe bleeding were observed in 4 (7%) patients. In addition, the patients were found to have: thrombosis - (partial and complete) 19 (33.3%), fresh blood clots in the aneurysm - 1 (1.7%); bursting aneurysm - 2 (3.5%), infected thrombi - 4 (7%); removal of the prosthesis-1 (1.7%).

In 10 (17.5%) patients with TAA due to suppuration; aseptic inflammation and infiltrates in the area of postoperative wounds, recovery was delayed. In 4 (7%) patients, surgical interventions were not performed due to contraindications of their state of health and refusal of patients.

8.3. Long-term results of traumatic arterial aneurysms

In our study, the results of surgical treatment of different periods were analyzed. The most effective treatment for TAA is associated with early diagnosis. In inflammatory processes of the surrounding tissue, autovenous prosthetics or vascular prosthetics were performed. In the vast majority of operated patients, blood flow was restored. Almost all those operated on for TAA did not show any complaints. Limb condition, functional. The skin of all patients is the same in color. Skin turgor was within normal limits. Dermography was the same on both sides. In 2 patients, hypotrophy of the limb was noted due to damage to the nerve trunk. Palpation was examined distal pulse in 20 people. In all, it was clear and practically did not differ from a healthy limb. When

examining all patients by auscultation of the area of operation, vascular noises were not detected.

Along with this, we also studied long-term results in the localization of operations for traumatic arterial aneurysms. These data are presented in table 28.

Table 28

Long-term results on the localization of TAA operations

TAA localization	Total:	Type of operation	Good		Satisfactory	
			(CG)	(NG)	(CG)	(MG)
Vertebrate	1	1-dressing	-	-	1	-
Subclavian	3	2-side 1-dressing	-	2	-	1
Axillary	2	1-autovein 1-side	-	2	-	
Shoulder	3	1-circular *1*-side 1-autovein	1	2		
Radiation	3	1-excision 2-circular	1	2	-	
Femoral	5	1- circular- 4-autovein	-	4	1	
Popliteal	1	1-autovein	-	1		
Total:	18		2(11,1%)	13(72,2%)	2(11,1%)	1(5,5)

As can be seen from table 28, a comparative analysis of the long-term results of CG and MG clearly shows the difference between the results in the main

group. Because the treatment and diagnostic algorithm used by us and the rentgenendovascular method of treatment led to good results. Good results - 11.1% in the CG group and 61.1% in the main OG group. Satisfactory results: 22.2% in the CG and 5.5% in the MG. This means that the proposed method and diagnostic and treatment algorithm for the treatment of TAA is very effective.

Long-term results were assessed on the basis of angiography, ultrasound and MSCT and objective data (table 29.).

Table 29

Evaluation of long-term results

Research methods	Total:	CG		MG		p
		good	satisfactory	good	satisfactory	
Clinical signs	18	no	Pain, swelling, numbness, etc.	no	Pain, swelling, numbness, etc.	
Angiography	2(11,1%)	-	1(5,5%)	-	-	p<0,05
UZDG	12(66,6%)	1(5,5%)		10(55,5%)	1(5.5%)	
MSCT	4(22,2%)	1(5.6%)	1(5,5%)	3(16,6%)	-	
Total:	18(100%)	2(11,1)	2(11,1)	13(72,2)	1(5,5)	

First of all, for effective diagnosis and optimization of the choice of surgical treatment of TAA. The implementation algorithm is traditionally represented by examination and collection of information from the patient.

The examination includes: anamnesis, complaints, external examination;

- palpation - for the presence or absence of a dense, soft, painful, painless formation (the size of the formation);
- auscultation - in the absence of systolic or systole-diastolic noise on the aneurysm projection;

If a pulsatile hematoma is suspected in the presence of a firm, painful mass with a systolic or systolic and diastolic murmur above it, hemodynamic parameters (decreased or increased blood pressure, heart rate, pulse rate, etc.) are evaluated.

At high risk for TAA, hemodynamic instability is associated with "significant" indications: hypertension or hypotension, tachycardia or no tachycardia; a decrease in hemoglobin. At the same time, it is necessary to take into account clinical signs: pallor of the skin, a decrease or increase in the pulse rate on the radial artery.

At low risk of TAA, hemodynamic stability is associated with insignificant signs recorded at normal: blood pressure; heart rate and radial artery pulse. A high risk of cardiovascular disease is associated with ECG changes - dystrophic changes in the myocardium, severe LV with systolic or systolic-diastolic overload. A low risk of cardiovascular events is not observed with ECG changes and dystrophic changes in the myocardium and left ventricle with systolic or systolic-diastolic overload.

Clinical diagnosis of TAA consisted of a number of subjective-objective factors. Among the complaints of patients, the most significant were: ischemic disorders; compression of the nerve trunks by an aneurysm; local and general; a feeling of fullness and fullness in the injured limb; puffiness; stasis and pronounced venous pattern. The study involved 61 patients with TAA. Of these: men - 47 (77%), women - 14 (22.9%), with the timing of the appearance of TAA up to 5 months - 41; up to 1 year-3; 2-3 years-6; 4-5 years-1; 6-9 years old-4; up to 10 years and older-3. Most of the patients were under the age of 30 years.

When examining patients revealed: swelling and local swelling; pathological changes in the skin over swelling. Auscultatory murmur was heard in the aneurysmal sac. We noted a change in the nature of the pulse on the damaged limb from clear to sharp weakened. In the differential diagnosis of TAA, we had to exclude tumors, abscess, thrombophlebitis, phlegmon, aneurysms of other etiologies. Complications included aneurysm rupture and thrombosis. Some

patients required urgent interventions for TAA due to suppuration, aneurysm rupture and bleeding. Our experience of operations on TAA shows that postponing surgery for more than 5 months leads to complications due to the growth of scar tissue, a violation of the architectonics of the neurovascular bundle.

In the preoperative period, considerable attention was paid to restorative treatment. During the operation, more than 2 liters of blood were consumed, as well as three liters of blood substitutes and glucose solution. The time of operations on TAA lasted 3-4 hours - 60%; 1-2h-30%. With prolonged TAA and involvement of the nerve trunk in the process, we performed neurolysis. Up to 5000 units of heparin were injected into the distal bed. During the operation: 10% of the wall of the aneurysmal sac was partially excised.When choosing the treatment for TAA, the time interval from the moment of damage to the vessel is of great importance. When choosing the treatment for TAA, the time interval from the moment of damage to the vessel is of great importance. In the treatment of observed patients with TAA, preference was given to autovenous shunting and direct suture. For an objective assessment of TAA and optimization of the surgical treatment of patients, we developed a diagnostic and treatment algorithm (Fig. 58).

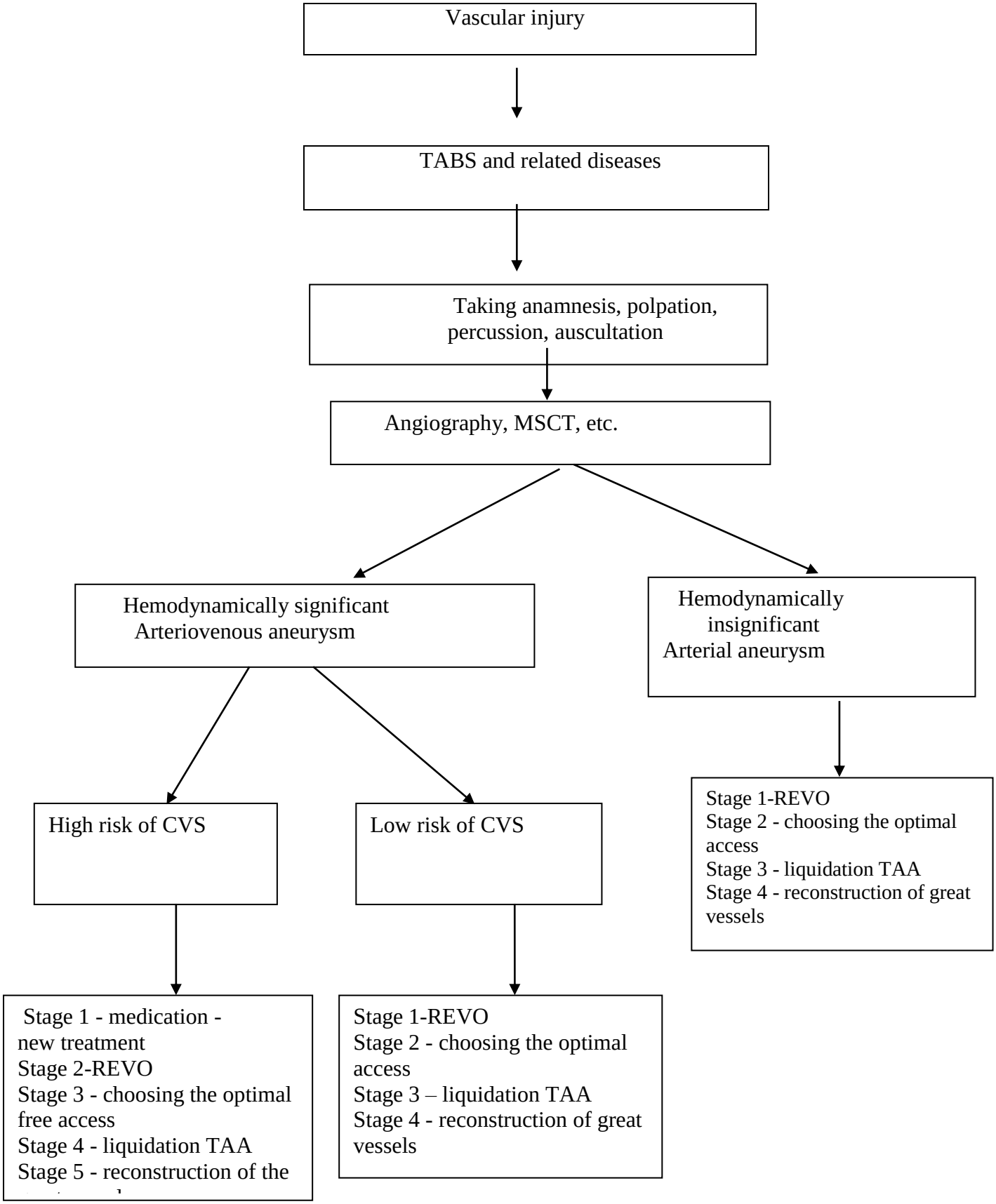


Fig.58. Algorithm for the diagnosis and treatment of traumatic arterial aneurysms.

Discussion and results

In our work, we analyzed the methods of diagnosis and the results of surgical treatment of patients with traumatic injuries of the arteries of the extremities and their consequences, who were treated at the V. Vakhidov Republican Specialized Scientific and Practical Medical Center for Surgery(RSSPMCH). According to the RSSPMCH, for many years, the main cause of TAA was stab wounds, which led to damage to the main vessels.

Our study included 61 patients with TAA. Of these: men - 47 (77%), women - 14 (22.9%), for periods up to 5 months - 41 (72%); 1 year-3; 2-3 years-6(10.5%); 4-5 years-1(1.7%); 6-9 years old-4(7%); 10 years and older - 3 (5.2%). Most of the patients were under the age of 30 years.

Clinical diagnosis of TAA consisted of a number of subjective-objective factors. Among the complaints of patients, the most significant were: ischemic disorders; compression of nerve trunks by aneurysm: local and general; a feeling of fullness and fullness in the injured limb; puffiness; stasis and pronounced venous pattern.

When examining patients revealed: swelling and local swelling; pathological changes in the skin over swelling. Auscultatory hum was heard in the aneurysmal sac. We noted a change in the nature of the pulse on the damaged limb from clear to sharp weakened. The most effective treatment for TAA is their early diagnosis using a diagnostic and treatment algorithm, In the differential diagnosis of TAA, tumors, abscess, thrombophlebitis, phlegmon, and aneurysms of other etiologies were excluded. Complications included aneurysm rupture and thrombosis. Some patients required urgent interventions for TAA due to: suppuration; aneurysm rupture and bleeding. Our experience of operations on TAA shows that postponing surgery for more than 5 months leads to: complications due to the growth of scar tissue; violation of the architectonics of the neurovascular bundle. According to the timing, the number of operations on TAA was: 3-4 h-60%; 1-2h-30%. With prolonged TAA and involvement of the nerve trunk in the process,

we performed neurolysis. Up to 5000 units of heparin were injected into the distal bed.

The immediate and long-term results of treatment of patients with post-traumatic aneurysm (TAA) in the CG and MG were studied. 57 patients were operated on, 4 patients were not operated on for various reasons. The results of treatment of patients: good - CG in 26 (45.6%); OG in 25 (43.8%); satisfactory - CG in 4 (7.0%), MG in 2 (3.5%). The number of good results in CG patients depended on the number of patients treated in the clinic until 2000 (CG). Long-term results were obtained in 18 patients. Good - CG in 2 (11.1%); MG in 13 (72.2%); Satisfactory - CG in 2 (11.1%) and MG in 1 (5.5%), while statistical significance, $p<0.05$. Differences between the CG and MG groups mainly consist in the use of a diagnostic and treatment algorithm and REVO, proposed and used by us in the treatment. The diagnostic and treatment algorithm proposed by us is based on a 5-stage operation: Stage 1 - drug treatment; Stage 2-REVO; Stage 3 - choice of optimal access; Stage 4 - elimination of aneurysm and stage 5 - reconstruction of the main vessels. Good results of treatment with TAA in: 51 (89.4%); satisfactory TAA, in 6 (10.5%) patients, with $p<0.05$.

So, in: 48 (84.2%) patients - wound healing was primary; 9 (15.7%) healing occurred by secondary intention. When choosing the treatment for TAA, the time interval from the moment of damage to the vessel is of great importance. At the same time, we gave preference to autovenous shunting and circular suture.

CHAPTER IX. OPTIMIZATION OF DIAGNOSIS AND SURGICAL TACTICS FOR TRAUMATIC ARTERIOVENOUS FISTULAS

9.1. Diagnosis and clinical features of TAVF

The problem of diagnosis and treatment of arteriovenous fistulas has not yet been finally resolved. This is explained, firstly, by the fact that modern ideas about the pathogenetic bases are not completely clear; secondly, there are no sufficiently clear criteria for early diagnosis, the absence of which creates great difficulties in the timely use of reconstructive operations. Errors in diagnosis and tactics of surgical treatment of traumatic arteriovenous fistulas lead to the use of palliative methods. They subsequently aggravate hemodynamic disorders and worsen cardiohemodynamics.

Pathomorphological anatomy

In long-standing traumatic arteriovenous fistulas, structural changes in the walls of arterial and venous vessels develop due to hemodynamic disturbances. Over time, dilation, lengthening, tortuosity, and dystrophic changes in the wall of the arterial segment located proximal to the fistula occur. The diameter of the artery located distal to the fistula is usually narrowed. These long-standing changes in the leading part of the artery are the cause of venization of the arterial vessels. Due to the increased outflow of venous blood distal to the fistula and increased venous pressure, venous dilation and venous valve insufficiency occur. In long-standing arteriovenous fistulas, trophic ulcers develop.

Pathophysiological changes

In traumatic arteriovenous aneurysms and arteriovenous fistulas, as a result of the discharge of arterial blood through intervascular fistulas into the venous system, disturbances of general hemodynamics occur. The larger the fistula, the more arterial blood rushes into the venous system. Due to arteriovenous discharge, the heart constantly works with increased load, since the volume of circulating blood increases by an amount equal to the volume of blood that is shunted through the arteriovenous fistula. When the working hypertrophy of the heart muscle exceeds a certain critical level, irreversible changes in the heart

occur. Tachycardia, ECG changes, congestion in the pulmonary circulation are also characteristic. During this period, it is necessary to improve the functions and narrowing of the borders of the heart, and degenerative changes in the myocardium can become irreversible. It depends on the state of the heart muscle. In long-term existing arteriovenous fistulas, changes in the pulmonary circulation, pulmonary hypertension, and septic endocarditis may be observed.

Along with them, we studied patients by sex and age, the average age of patients was from 31.27±15.7, p>0.05. Upon admission to the clinic, the condition of the patients was as follows: moderate -2 and satisfactory -28. Information and distribution by sex and age of patients with TAVF are presented in Table 30.

Table 30

Distribution of TAVF patients by sex and age

№	Age	Number of patients		Of them			
		abs	%	Men		Women	
				(CG)	(MG)	(CG)	(MG)
1.	up to 20 years	8	26,6	2	4(13,3)	-	2(6,7)
2.	21-30 years old	10	33,3	5	5(16,6)	-	-
3.	31-40 years old	3	10,0	1	2(6,6)	-	-
4.	41-50 years old	4	13,3	1	3(10,0)	-	-
5.	50 years and older	5	16,6	2	3(10,0)	-	-
6.	Total:	30	100,0	11(33)	17(56,3)		2(6,7%)

As can be seen from this table, there is a significant difference between the control group (CG) and the main group (MG) on the studied problem, which is p<0.05.

In order to effectively address this issue, we have carried out certain studies. So, in the clinic under our supervision there were 30 patients with TAVF, to study the issue of the correctness of the diagnosis and the choice of the optimal tactics of surgical treatment. In this case, first of all, the causes of the occurrence of TAVF are analyzed. According to the causes of TAVF, patients are distributed in Table 6.2. As can be seen from Table 6.1, in most patients 13 (43.3%), the causes of TAVF are piercing-cutting agents (table 31).

Table 31

Distribution of patients by causes of TAVF

№	Causes of TAVF	Number of patients			
		abs		%	
				(CG)	(MG)
1.	Stab-cutting tool	13	43,3	6(20,0)	7(23,3)
2.	Gunshot wounds (bullet, shot)	2	6,6	1(3,3)	1(3,3)
3.	Car accidents	2	6,6	-	2(3,3)
4.	Other	13	43,3	4(13,3)	9(30,0)
5.	Total:	30	100,0	11(36,6)	19(63,3)

In addition, in our study, 30 patients with TAVF were under observation. Days of hospitalization: 19.79 ± 9.34, while $p<0.05$.

Until 2000, 11 (36.67%) patients were admitted to (CG). From 2000-2018, 19 (63.33%) patients were admitted to (MG), with $p<0,05$.

As the analysis of the data in Table 32 shows, a large percentage of patients with TAVF is observed in men - 27 (90%) and 19 (63.3%) are in the most able-bodied age from 20 to 49 years. In addition, we analyzed the data of patients with TAVF on localization and lesions of the arteries, in peacetime. Surgical access to the TAVF provides a wide approach to the fistula, that is, sufficient to restore the subsequent motor function of the operated limb. The incision of the skin and

subcutaneous tissue on the extremities was made in a straight line along the projection of large vessels.

For 3 patients, high technologies were used during the operation. At the same time, rentgenendovascular complete balloon occlusion of arterial vessels was performed. A balloon catheter measuring 6x60 mm was expanded to complete vascular occlusion. At the same time, the pressure in the cylinder is up to 9 atm. at RBP 10 atm. Contrast Unihexol-350-100 ml.

Table 32

Distribution of patients by localization traumatic arteriovenous fistula (TAVF) by body parts

№	Part of the body	Localization of TAVF	Total patients			
			abs	%	%	
					(CG)	(MG)
1.	Neck and head	For the ear - 2 Brow-1 Sleepy outdoor-3 Left half of the face-1 Aortic arches and anonymous vein-1	8	26,6	4(13,3)	4(13,3)
2.	torso	Iliac-2	2	6,6	-	2(6,6)
3.	Upper limb	Shoulder-1 Hand artery-2	3	10,0	1(3,4)	2(6,6)
4.	lower limb	Femoral-10 Popliteal-3 Shin-4	17	56,6	5(16,6)	12(40,0)
5.	Total:		30	100,0	11(36,6)	19(63,4)

In patients who received TAVF, they are more often found in the lower body, that is, on the legs. It is noticed that there is a big difference when comparing the data of patients (CG) and (MG). In practice, the effectiveness of the approach to

patients in (mg) using alternative methods and timely diagnosis has been proven. The difference between (CG) and (MG) was p<0,05.

According to the duration of the existence of TAVF in patients, they were characterized below by the following data, which are presented in table 33.

Table 33

Duration and distribution of patients by age of existence traumatic arteriovenous fistulas

№	Terms of existence	Number of patients			
		abs	%	(CG)	(MG)
1.	up to 1 month	9	30,0	4(13,3)	5(16,7)
2.	from 2 to 6 months	7	23,3	4(13,3)	3(10,0)
3.	up to 12 months	3	10,0	-	3(10,0)
4.	from 2 to 5 years	6	20,0	1(3,3)	5(16.6)
5.	from 6 to 21 years old	3	10,0	-	3(10,0)
6.	Over 30 years	2	6,6	-	2(6,6)
7.	Total:	30	100,0	9(30,0)	21(70,0)

Massive traumatic injuries of wartime vessels and their consequences in the form of long-term TAVF and TAA made it possible for researchers to find out a number of features of the regional arteriovenous discharge and their effect on the general blood circulation. Depending on the caliber of the TAVF, part of the blood from the artery is constantly dumped into the vein.

Venous insufficiency of the distal parts of the limb, (especially the lower ones) does not always occur or is temporary, for the next 2–3 months after the onset of TAVF. It is appropriate to note that so far there is no consensus on the explanation of this phenomenon among researchers. Thus, some researchers believe that at the time of the occurrence of TAVF, the blood from the artery to

the vein enters through the fistulas and moves in two directions: central and peripheral.

Our clinical data on patients with TAVF with chronic regional venous insufficiency, which basically coincide with the data of other authors, allow us to draw some conclusions and suggestions. To confirm them, we conducted a number of studies in the TAVF region and symmetrically on a healthy limb. Measurements of venous pressure in the area of TAVF showed that it is the maximum for the entire line and 3-4 times lower than the arterial one. On the affected distal limb TAVF, the pressure is also lower. At this time, it is higher than on the healthy side.

Directly in the area of TAVF, venous blood was oxygenated only 5-7% less than in the artery. But distal to TAVF compared to the healthy limb, practically no difference was determined. This indicated that there was practically no mixing or reflux of arterial blood in this area.

Blood oxygenation at the proximal levels (in relation to TAVF) of the injured side was approximately 1/3 higher than in the vein of a healthy limb. At higher levels of oxygenation, it was 5-10% higher in the inferior or superior vena cava (depending on the location of the TAVF; in the lower or upper extremity). A direct study of the right ventricle of healthy individuals and patients with TAVF showed that in the latter, despite the almost complete displacement of blood, increased oxygenation was observed.

It is necessary to pay attention to a thorough study of the clinical diagnosis and data of traumatic vascular injuries. In this case, the development of the pathological process is influenced by the "experience" of TAVF, its localization, as well as seizures and some other points. Complaints of patients depend both on the violation of regional, general hemodynamics, and on damage to the nerve trunks.

In the study, we divided patients with TAVF into several types. At the same time, for all, the appearance of local pathological blood circulation, in the area of the fistula, was common. In the lower or upper limbs, it was manifested by the

phenomenon of ischemia. At the same time, subjective sensations were observed in the form of weakness in the affected area of the leg or arm. All patients were characterized by certain disorders of cardiac activity (tachycardia with little physical exertion and even at rest, chest pain, arrhythmia) and rapid onset of fatigue. In 5 patients with TAVF of the vessels of the neck, the following phenomena were observed: external cerebral circulation (dizziness, nausea, headache), complaints of swelling (tumor formation) and protrusion in 14 (46.6%) patients. The phenomenon of pulsation, buzzing and trembling was observed in 15 (50%) patients. At the same time, venous insufficiency of patients, accompanied by the phenomena of edema, especially of the lower extremities, varicose veins. There were 5 such patients (16.6%). Trophic ulcers were noted only on the lower extremities. Of the 30 patients with TAVF, trophic ulcers on the legs were in 1 (3.3%) patient. In a large group of patients 13 (43.3%), complaints are due to pressure and damage to the nerve trunk. At the same time, pains of a different nature were observed: paresthesia; limb paresis; damage to the cranial nerves; Horner's syndrome; complaints, hoarseness. Reports of patients about existing injuries and the presence of a significant degree of scarring on the skin (after trauma and surgery) convinced us that we had a patient with TAVF. The cardiac disorders noted by us in patients with TAVF are known to many surgeons.

Among the traumatic epidemics during the wars, there were many wounded with TAVF. Military physicians paid attention to them and established a close connection between the regional blood circulation that had arisen and violations of cardiac activity. So, a bradycardic symptom of TAVF is described, when it is clamped. A large number of works known from World War II prove that TAVF had a detrimental effect on the cardiovascular system, often leading to a dramatic outcome.

Almost all of the above authors note a violation of heart contractions in patients with TAVF. An increase in the pulse rate up to 90-110 beats per 1 minute was observed in 3 patients, a decrease in the pulse to 60 beats per 1 minute and in

27 remained within the normal range. In order to test the bradycordic phenomenon, we performed temporary clamping of the TAVF or the producing artery. This symptom of Dobrovolsky was better traced in patients with tachycardia, at 90-100 beats per 1 minute. Temporary application of a tourniquet reduced the pulse rate to the norm of 70-72 beats.

On palpation of the chest in the region of the heart, the apex beat in patients with TAVF is usually displaced to the bottom and to the left, which indicates increased work and hypertrophy of the left ventricle. Percussion, in patients in the initial stage of the disease, is determined by the expansion of the boundaries of the heart, to the left. With long-existing TAVF, the right borders-hearts are expanding. As a result, sometimes the heart reaches the size of Cor Bovinum. On fluoroscopy, the waist is smoothed, more often it has a mitral defect configuration, less often aortic. Listening to the heart in patients gave an accent II tone, which is the result of an increase in pressure in a small circle. Typical for most patients is listening to heart murmurs of varying intensity. With "young" TAVF, the murmur is systolic, tender at the apex. Over the years, he was tapped on the other three points of the heart. In the majority of patients (30), systolic murmur was heard at all points, in 12 - at the apex, in 7 - on the 3-fold valve. Simultaneously, with systolic murmur, diastolic murmur was heard in 4 patients. This is noted by a number of authors. They explain the heart murmur in TAVF as an increase in the load on the heart due to the influx of additional blood. As a result, in a patient, the volumetric blood flow velocity gradually leads to dilatation of the ventricular cavities. As the blood flow through the TAVF increased, attachments appeared and the phenomena of right ventricular failure gradually progressed. During systole, the leaflets do not fully close and a systolic murmur occurs. Blood pressure in patients with TAVF tends to have significant combinations. Thus, clamping the fistula area leads to an increase in pressure. Surgical treatment of post-traumatic arteriovenous fistulas and false arterial aneurysms in the postoperative The measurement of arterial pressure on the radial artery of the healthy arm of the patient showed the following results: the

maximum pressure is 110-130 mm Hg-26, 140-200 mm Hg-2, 80-40 mm .rt.st.-y 2.

We compared the blood pressure distal to the TAVF with the level in the healthy limb. On the affected side, in all cases, the pressure was lower (minimum and maximum). At the same time, the pulse pressure on the affected limb was higher. This can be explained by the fact that the development of collaterals in the TAVF region was facilitated by the lowest possible pressure. The minimum arterial pressure in the area of TAVF or proximal in 2 patients showed its increase than on the healthy side. The increase in pulse pressure on the diseased side is associated with the minimum pressure, which remained at the same level. The blood pressure measurements carried out showed that in the initial period there was a slight decrease in it. However, at this stage, blood pressure is somewhat normalized due to the vasoconstruction of the artery and an increase in the volume of circulating blood. The change in pressure in 17 patients with TAVF of long "experience" showed, in dynamics, a slight increase in pressure. Measurement of venous pressure in patients with TAVF (in the supine position) is carried out by the Waldmann apparatus, on the affected and healthy limb. To perform functional phlebodebitometry, you need a tonometer B.A. Waldmann arterial or venous pressure. The catheter inserted into the vein is connected to the tonometer V.A. Waldman. In the horizontal position of the patient, the initial venous pressure is measured. Subsequently, the doctor should focus on a specific, for each patient, level of initial venous pressure. Based on the basal tone of the main veins, the venous pressure ranges from 80 to 120 mm. water. Art.

On the affected side of the TAVF limb, venous pressure fluctuates between 140-480 mm. water. Art. ($p<0.05$) Elevated venous pressure, approximately twice the healthy side of the limb. This indicates damage to the venous valves and increased venous pressure of the limb. It is characterized by a violation of general hemodynamics. In TAVF, the weakening of the left heart extends to both the right atrium and ventricle. When examining the respiratory organs in - 8 patients with TAVF data, congestive rales were determined auscultatively in the lower

parts of the lungs. They had shortness of breath with little physical exertion. Their liver is enlarged due to decompensation of the heart and lungs.

When examining the patient, they paid special attention to post-wound and postoperative scars. At the same time, determining the approximate projection of the wound channel. The following patients were found among the studied patients: tumor-like formation 28 (93.3%). In 9 patients swelling, pulsating. However, swelling in TAVF was noted by good drainage of TAVF. We found that with TAVF with a long history, swelling is detected due to aneurysmal expansion in the area of TAVF. Let's consider these deviations with an example.

Patient Sh.V., 25 years old, and/b No. 5018. At admission, he complained of dizziness and observed pulsating masses in the left thigh, edema and general weakness. On June 20, 2015, the patient received a stab wound to the left thigh.

On examination, pulsating formations were found on the left 12x0.8 cm, swelling in the region of the left thigh; systolic trembling; formation and dense consistency, transmission pulsation is felt; local auscultation, with systole-diastolic murmur. Performed: UZDG - the left femoral artery is not visualized, the pulsation is clear on the right; ankle-brachial index(ABI) - normal; systolic pressure-120 mm Hg. MSCT - the posterior surface of the distal part of the TA, on the left, a defect of the artery and TA up to 4 cm is determined with the formation of a partially thrombosed false aneurysm and a general hematoma, 12.2x8.6 cm in size, extending to the posterior-medial counter of the thigh (Fig. 60-61)

Diagnosis: TAVF of the femoral artery and vein. Intermuscular hematoma of the left thigh.

The patient was in the vascular department of the RSSPMCH and was operated on in a planned manner on 09.09.2015. Elimination of a false aneurysm of the superficial femoral artery, on the left, was carried out. In addition, dissociation of arteriovenous fistulas between the superficial femoral vein and artery was performed. Produced autovenous patch on the superficial femoral vein and

resection of the superficial femoral artery. A femoral-popliteal autovenous bypass was performed, on the left (Fig. 63).

When examining the left thigh, it was found to increase in volume relative to the right. The back surface of the left thigh has a scar after a stab wound (Fig. 59) Pulsation on the arteries of the right lower limb and foot, clear. The pulse on the left lower limb, in the inguinal fold and distally, is not determined. There are old postoperative scars on both thighs, without signs of inflammation (Fig. 64). On the medial surface of the middle third of the left thigh, systolic trembling is determined. At the other identification points, the pulsation is normal. There are no noises above the projection of the main arteries.

Laboratory examination of the patient: hemoglobin - 162 g / l, erythrocytes - 5.5x1012 / l., leukocytes 4.9x109 / l. Biochemical blood test: sugar 6.1 mmol/l, creatinine - 82 μmol/l, urea - 4.7 mmol/l, sodium 145 mmol/l, potassium 5.0 mmol/l, total protein 78 g/l, AST 23 μmol/l, ALT 14 μmol/l, total bilirubin 43 μmol/l; coagulogram: PTI-100%, fibrinogen-2660 mg%, thrombotest V, hematocrit-53%; OAM: rel. density 1030, protein - abs, glucose - abs, ep units in the field of view, leukocytes units in the field of view, erythrocytes unchanged 0-0-1. Electrocardiography - sinus rhythm, heart rate 66-68 beats / min. The position of the electrical axis of the heart, vertical. Renrgengraphy of the chest, without features. Ultrasound Dopplerography of the lower limb: lateral systolic pressure index: on the right - 1.0, on the left - 0.5. Ultrasound examination of the liver: the liver is not enlarged, fine-grained. Intrahepatic bile ducts are not dilated. Choledoch 0.4 cm, porte vein - 1.0 cm.

In the postoperative period (December 12, 2016), the patient underwent selective arteriography with access through the right femoral artery. When contrasting the superficial femoral artery, there is no discharge of blood through the arteries into the femoral vein.

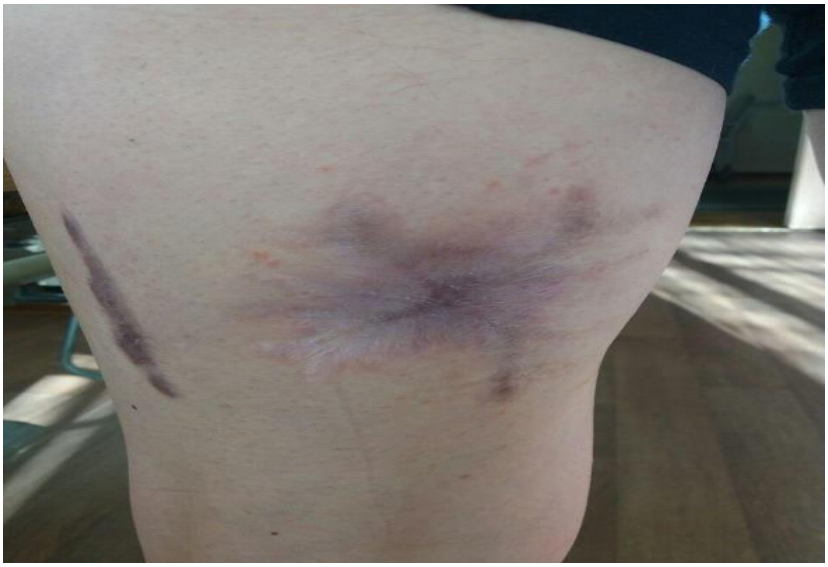


Fig.59. Scheme of TAVF surface
wounds in the region of the thigh, on the left.

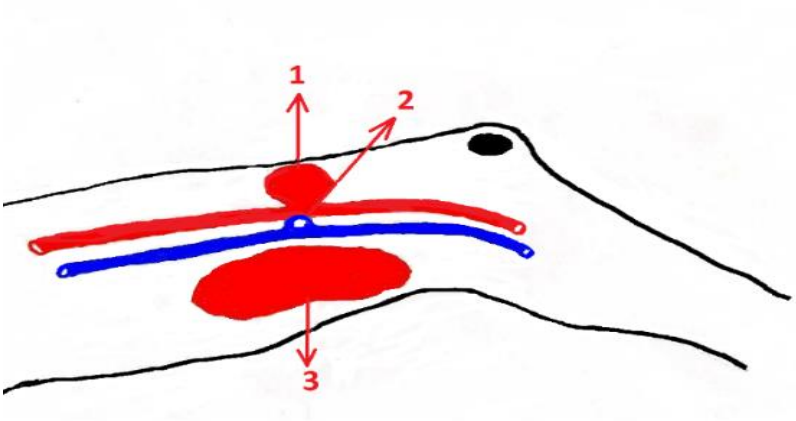


Fig.60. Site of the stab-cut femoral artery and vein, on the left.
1-aneurysm; 2-AVF; 3-extensive hematoma

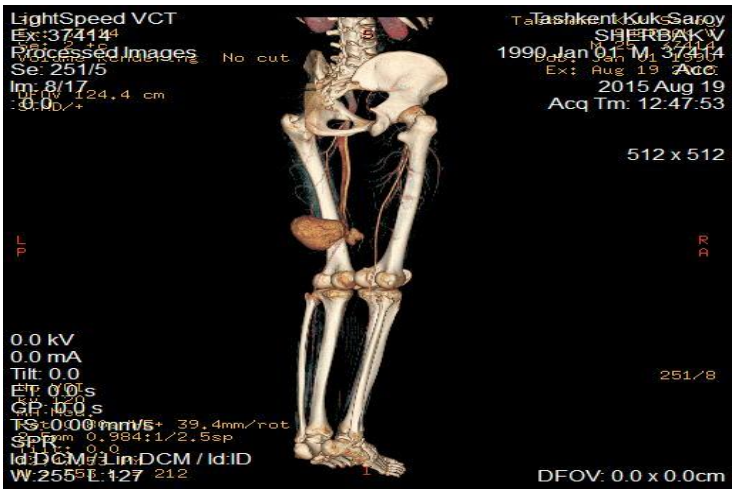


Fig.61. MSCT: TAVF of the superficial between the superficial femoral artery and vein, on the left

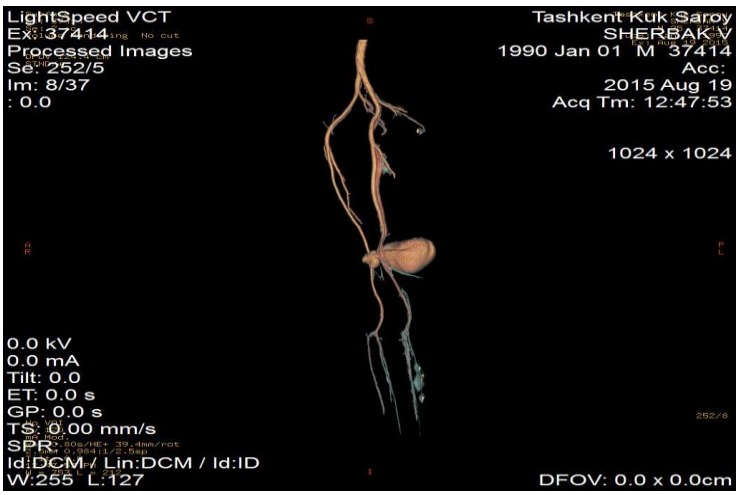


Fig.62. MSCT: Post-traumatic arteriovenous fistula femoral artery and vein, left

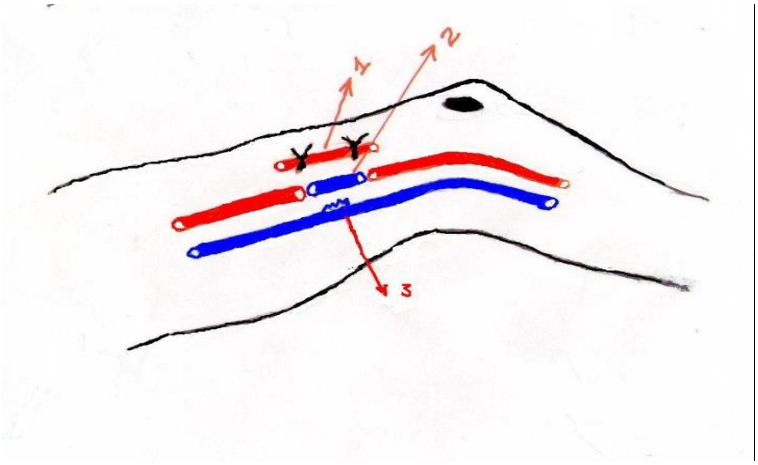


Fig.63. Scheme of applying an autovenous patch to the femoral vein and autovenous shunting of the superficial femoral artery:
 1-aneurysm resection; 2. autovenous shunting;
3. patch the femoral vein.

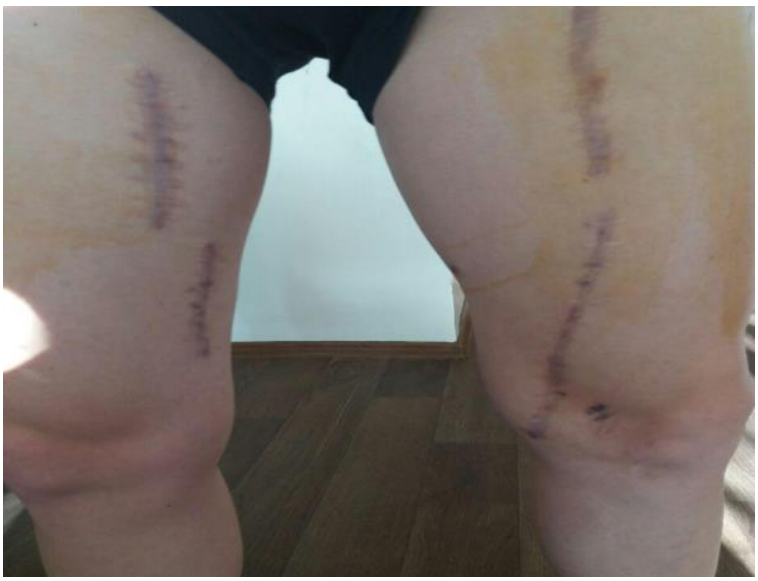


Fig.64. Postoperative scar in the thigh area, on the left.

In the long-term period, the patient underwent multislice computed tomography of the prosthetic section of the superficial femoral artery, on the left, which is functioning normally.

5 patients with TAVF showed signs of venous insufficiency. At the same time, their clear manifestation on the legs was observed, due to varicose veins or increased pattern of saphenous veins. In 3 patients, pulsation was noted in this area. After the operation, regional venous insufficiency decreases in some patients. At the same time, in: 2 patients, the phenomena of lymphastasis with venous insufficiency were observed; 2 patients had lymphastasis on the affected limb. On average, the difference in circumference on the healthy and diseased sides was 5 cm, with a maximum of 10 cm on the thigh. Trophic disorders in the lower leg were observed in 2 patients with TAVF.

On palpation of the TAVF area, in 9 cases it was determined in swelling, including: soft consistency - 4, soft elastic - 3, elastic - 2. The swelling ranged in size from 2x2 cm to 27x30 cm.

Swelling pulsations were observed in: 3 patients; 9 patients, it was combined with systolic-diastolic murmur and trembling (purring). Several patients with TAVF in the lower extremity underwent cuff tests according to Ratner. Applying a cuff above the fistula and creating pressure in it, above the venous and below

the arterial, swelling of the saphenous veins with arching pains distal to the fistula was noticed. Determining the peripheral pulse, in symmetrical areas, in 5 out of 30 patients, a change in the pulse towards a decrease in the affected limb was revealed. In 2 cases, the pulse on the affected side was absent.

During auscultation of the TAVF area, the following was heard: systolic murmur in 5 patients; diastole - systolic murmur and trembling in 28 patients (93.3%). These symptoms are pathognomonic for arteriovenous fistulas, especially those located closer to the surface. When listening to the noise from TAVF, it was found that it spreads more clearly in the proximal direction from the fistula. From the literature data, characteristic symptoms are known in case of combined injuries of blood vessels and nerve trunks.

With a "young" TAVF, nerve damage manifests itself in traumatic neuritis, paralysis, paresthesia, and an increase in skin temperature. Over time, cicatricial changes in the TAVF area cause pressure or atrophy, with the formation of a neuroma. They cause acute local pain to patients. Among our patients, lesions of nearby nerve trunks were observed in 5 (16.6%) cases.

The constant discharge of arterial blood into the venous bed of the affected limb leads to an increase in the saturation of venous blood with oxygen at the level of the fistula, where this value approaches 100%. In the proximal limbs, the saturation of venous blood with oxygen naturally decreases as a result of its dilution with the bulk. In the study of oxygen saturation of venous blood, in symmetrical areas of the affected and healthy limb, in 12 patients there was an increase in its oxygen saturation by 9-29%, compared with the healthy side. With a large discharge of blood, venous blood oxygenation constantly exceeded 90%. Observations of 12 patients showed its saturation with oxygen by 10-20% more compared to the healthy side of the limb. A decrease in the degree of oxygenation of venous blood in the affected limb, compared with the healthy side, indicates an increase in oxygen utilization. It is often observed in venous forms of congenital dysplasia associated with a slowdown in venous blood flow in the affected limb.

Thus, determining the degree of oxygenation of venous blood in the diagnosis of traumatic arteriovenous fistulas is of great practical and differential diagnostic value.

The technique for studying the oxygenation of venous blood showed that its portion from the proximal part contained less oxygen than when the catheter was moved as close as possible to the fistula. At the same time, venous blood practically did not differ from arterial blood. Venotography was performed using a catheter. At the same time, a regularity was revealed that as the catheter approaches the TAVF, venous pressure increases. Removal of the catheter, in the proximal direction, reduced venous pressure, but remained higher than on the healthy side. In order to clarify the diagnosis of TAVF, phlebography was also carried out. The latter was carried out at 3 levels: proximal; distal; directly to the TAVA, as well as in the distal parts of a healthy limb.

Important methods for diagnosing TAVF are radiological, which examined patients: ultrasound-11; UZDG-6; angiography-15; MSCT-10; duplex study-1; EchoCG-1. Following the general methodology, we started with a plain radiograph. With wartime TAVF and shot injuries, fragments and shot were found in the research field. We have established that an arteriovenous fistula of great "experience" is often accompanied by calcification. There were 5 of them in the x-ray with areas of calcification, and calcification was determined directly in the area of TAVF or spread to the venous part of the fistula, in the distal direction. In cases where the fistula was accompanied by a long-term aneurysm, the calcification spread to this area as well.

Clinical investigations and plain radiography usually provide sufficient evidence for the diagnosis of TAVF. In 15 cases, we performed angiography, which made it possible to more clearly determine the state of the proximal and distal branches of the vessels, in the area of the fistula and regional collaterals. These diagnostic studies made it possible to correctly identify and perform surgical intervention on the vessels. In the presence of TAVF in the upper belt, we used selective arteriography. If the TAVF was located in the lower extremity,

then the Seldinger method was used, based on the contrast agent of catheterization. At the same time, it was taken into account that the arterial blood flow quickly dilutes the contrast agent and degrades the quality of the renrgengraphy .

The introduction of low-toxic solutions, at an increased concentration (1.5 ml per kg/weight) as close as possible to TAVF, was safe and gave good vascular contrast in 4 patients. At the same time, the studies were carried out interoperatively using percutaneous function in the main artery of the injured lower limb. Of great interest is the study of the state of the venous bed, with traumatic arteriovenous fistulas. We believe that phlebography is an auxiliary method in the diagnosis of traumatic arteriovenous fistulas, which allows you to clarify the state of the system. At the same time, in pathology, concomitant diseases are detected. Therefore, we did not dwell on this in detail.

Laboratory tests: Hemoglobin, in 2 patients -97-105 g/l. In one patient, ESR is high -26; fibrinogen, in 5 patients - 3550-4440 g/l; PTI 61-85% - in 9 patients.

By studying a series of images in kinematics, we revealed that the contrast agent passed through the fistulas from the artery to the vein within 1-2 s. It is noteworthy that almost all patients, especially those with long-term TAVF, had arterectasia of the adductor site. In other researchers, in addition to the expansion of the artery in the area of TAVF, secondary arterial aneurysms were observed. Moreover, the phenomena of arterial ectasias tended to progress and spread to the aorta itself.

Based on this, we sought to ensure the maximum possible observation of our patients. It should be recognized that an important detail of the angiogram is the knee-shaped lengthening of the adductor artery found in 2 patients. This was used by us during a reconstructive operation, where instead of a synthetic prosthesis, a tortuous section of the artery was used as a plastic material.

In 3 cases, we observed a decrease in the diameter of the artery, a certain part of it, and in 1 patient, occlusion. At the time of the operation, this was confirmed visually. On TAVF angiograms, the degree of development of collaterals is well

defined, especially in the region of the upper third of the thigh. We have identified collaterals between the internal iliac and deep femoral arteries in 3 patients. In all cases, there were TAVF, which suggested the pathognomonicity and interconnectedness of these two conditions. Among all angiograms, there were collaterals, in the form of concomitant small arterial aneurysms (9). The resulting phlebograms were of various contours. Therefore, we divided them into several groups, taking into account the "experience" of the injury.

For "young" TAVF, the transition of the contrast agent with the blood flow from the fistula in the proximal direction is clearly defined. The diameter is practically unchanged and venous capillaries are not traced. The average age of TAVF, determined by the "fluoroscopic" method, reflects the phenomenon of some violation of the venous outflow, due to the expansion of the outlet section of the vein and, of course, the insufficiency of regional venous valves. With long-term existing TAVF, the proximal segment of the vein is sharply expanded. . The phenomena of phlebectasia were found in patients with TAVF, in 6 cases. At the same time, an expansion of the distal part of the vein was found, approximately up to the first canal. In some cases, the reflux of contrast into the superficial veins was determined on the affected lower limb. All patients with TAVF were repeatedly subjected to ECG. With "young" fistulas, functional changes are observed, and with "experience" - degenerative disorders of the myocardium. Cardiac disturbances, including blockade and atrial fibrillation, are not specific symptoms in TAVF. They reflect malnutrition of the myocardium by loads, on one or the other half, and sometimes on the heart as a whole. Cardiac disorders were also detected when determining the pulse rate. Of all patients with TAVF, 21 had a pulse within 70-80 beats 11; 7 pulse within 90-120 beats 11; 2 pulse within 60 beats 11. In the latter case, the phenomena of bradycardia indicate violations of cardiac automatism in patients with TAVF.

Plain radiographs of the chest, in the direct and lateral position, revealed pathological conditions of the heart, which, according to a number of researchers, are very contradictory. Thus, hypertrophy and delatation of the right atrium are

noted, where blood flows from the same nominal left heart through the shortened pathological circle of blood circulation through the fistula. Others note the involvement in this process of both the left and right parts of the heart. In line with the above, we studied radiographs and descriptions of fluoroscopy of the heart and large vessels of 30 patients. We divided all our patients with TAVF into 4 groups (rentgen functional), taking into account the influence of additional pathological circulation of the pulmonary circulation.

In the first group, in 16 patients with "young" TAVF and leading an almost compensatory-normal (before injury) lifestyle, no changes in the heart were found.

In the second group in (6) patients, there were observed: increased lung pattern; expansion of the pulmonary roots and an increase in the left ventricle.

The third group in (1) patients, respectively, had a long "experience" of TAVF. Chest x-rays and rentgen show enlargement of the left and right ventricles and, in some, the left atrium. The pulsation of both ventricles is increased. This indicated an overload of the left ventricle, right heart and overflow of the small circle.

The fourth group included 7 patients. On rentgen, they observed: heart shadows; expanded in both directions, the trunk of the pulmonary artery bulges. The roots of the lungs are hemonised. The amplitude of the ventricular pulsation is extremely increased. Such patients with a long history of TAVF suffered from a significant overload on the heart muscle. We have carried out a number of instrumental studies of patients with TAVF. At the same time, certain patterns were revealed when measuring venous pressure on a healthy limb. With the help of ECG, an increase in heart rate was found in patients with a long "experience" of TAVF. The phenomena of bradycardia and tachycardia in such patients can be attributed to the compensatory activity of the heart in the presence of a pathological circle.

In the initial stages of TAVF, there was no ECG change. In 11 cases, changes in the left ventricle were found. In 8 patients "with experience", the ECG showed

changes in the left side of the heart. Analysis of ECG data in traumatic arteriovenous fistulas, peripheral vessels showed a predominant interest in the pathological process of the left ventricle. As the myocardium is damaged and the left ventricle is overloaded, there are signs of left ventricular myocardial overload, which generally leads to the development of myocardial dystrophic processes.

Cardioradiological changes in patients with TAVF, according to a number of authors, are somewhat contradictory. Our studies of the heart, with TAVF of the lower belt, show minor cardiological changes when they are localized in the popliteal region, and vice versa, with its increase, an increase in the size of the heart is observed, in patients with lesions from the iliac-femoral region.

Thus, when conducting an renrgengraphy examination of the heart and intragastric catheterization, hemodynamic changes were revealed in patients with TAVF, depending on: the "experience" of the fistula, its diameter and localization. Tracing the dynamics of the state of patients with TAVF over a long period of time, we found a number of degenerative phenomena that aggravate their health. Puffiness and hyperpigmentation of the skin of the affected limb was soon supplemented by dermatitis and a trophic ulcer.

Venous aneurysms were detected by us in: 9 patients, with the experience of TAVF: from 5-10 years - 5 patients; 15-25 years - 4 patients; by localization: TAVF 9 patients in the proximal areas - 6 patients. In the upper belt (subclavian vein) -1; lower belt (iliac vein) 2 - patients. With unoperated TAVF, venous aneurysms tend to increase in volume, thrombosis and rupture. This process is aggravated especially in secondary aneurysm, which has a repeated character (Zotov S.P. et al. 2011).

9.2 Optimization of surgical tactics for the treatment of traumatic arteriovenous fistulas

In our study, for patients with TAVF, we determined the surgical intervention, individually, after the mobilization of the adductor and efferent vessels with dissection of the arteriovenous fistula. After the elimination of

TAVF (after about 2-3 years), there was a need for surgical intervention if venous insufficiency continued to persist.

This is due to the insufficiency of communicating veins, which contribute to the slowing down of venous outflow through deep vessels and, as a result, thrombosis. In the study of this problem, we studied the nature and carried out a comparative analysis of reconstructive and restorative operations, according to their types and localizations of TAVF. Data on them are presented in Table 6.5.

Comparative analysis of reconstructive and restorative operations for TAVF by their types and localization. n=30

Until 2000 in (CG) vascular ligation operations were performed with TAVF: PBBA-1; behind the ear artery-1; superciliary artery-1; internal jugular vein-1; carotid artery-1. At the same time, there were observed: redness around the fistula, a rough scar, etc.

From 2000-2018 (MG), operations were performed to ligate the vessels in the following cases of TAVF: the mouth of the deep femoral artery(DFA) of the femoral artery-1;posterior tibial artery(PTA)-2; iliac artery-1, vascular reconstruction; ulnar artery-1; carotid artery-1; occipital vein-1. At the same time, an inflammatory infiltrate was observed; defect and rough scar of the vessel wall, at the level of the fistula. The immediate results of operations are good and satisfactory.

In our practice, surgical treatment of patients with TAVF, septic endocarditis was not observed. So, in the study, 30 patients with TAVF were observed, 2 had: trophic disorders with degenerative changes in local vessels; phenomena of venous congestion and regional hemodynamics. Decompensation of the cardiovascular system was observed in 3 patients. The general blood circulation was disturbed in 14 patients. According to our data, in patients with TAVF with chronic diseases, even in the presence of passive pulmonary hypertension with significant heart damage, an operation was performed to eliminate the fistula. Although the risk, with surgery, is significant. However, the elimination of TAVF in angiosurgical centers, as a rule, gives a favorable outcome.

An analysis of the work and achievements of angiosurgery and our research confirm that the optimization of surgical tactics of treatment according to objective indications and the conduction of reconstructive and restorative operations in TAVF lead to the following positive results:

- the function of the operated limb is restored;
- there is an opportunity for rehabilitation of the patient;
- Chronic cardiovascular insufficiency is prevented.

To optimize the tactics and choice of surgical treatment for TAVF, the time factor is of great importance: the moment of damage to the main vessel; fistula formation; preparation and implementation of restorative surgery. At practical training seminars to improve the skills of surgeons and traumatologists of the district level, it is necessary to pay their attention to the prevention of iatrogenic damage to large vessels.

So, in case of traumatic damage to the vessel with the formation of TAVF, if a reconstructive operation is performed within the first few days, then it must be performed 2-4 months after the development of collaterals. A shorter period of 1-2 weeks for the operation, if the inflammatory reaction subsides in the area of damage. Among our patients with TAVF, the vast majority (9) were operated on more than 1 month after traumatic vascular injury. It is necessary to take into account that reconstructive surgery is performed approximately six months after the occurrence of TAVF and is extremely complex due to significant topographic and anatomical deviations, especially in the area of the vascular-nerve bundle.

Thus, Patient I.V., 47 years old, case No. 34, was admitted on 03.01.2014. Complaints about: the presence of a pulsating formation in the left half of the abdomen, below the navel; pain in the left lower limb and general weakness. During objective examination, the following were revealed: asymmetry due to hypertrophy of the left lower limb, the difference between the left lower third of - 2 cm, the upper third of the leg - 6 cm, the lower third of the thigh 4 cm; the upper third - 4 cm; In the thigh area, on the left, a tumor-like formation measuring 12x13x15 cm (Fig. 65-66). Systole-diastolic thrill and systole-diastolic murmur

are determined above the formation. According to the ultrasound dopplerography data, an expansion of the diameter of the femoral artery and a 2-fold increase in the linear blood flow velocity are noted in the left lower limb. Lower third of the leg: PBA on the right-180, on the left-100, PBA on the right-170, on the left-120; ILSD on the right-1.2, on the left-0.8 (normal 0.9-1.2). Systolic pressure is 140 mm Hg. According to the MSCT data: aneurysms of the common iliac and femoral veins are observed; arteriovenous fistula between the femoral artery and vein (Fig. 67-68). Based on clinical symptoms, ultrasound and CT, the following diagnosis was made: post-traumatic arteriovenous fistula of the femoral artery and vein. Aneurysmal dilation of the iliac and femoral vein, on the left. The patient underwent: disconnection of the ABF between the femoral artery and vein, on the left (Fig. 89-92). between the femoral artery and vein, on the left (Fig. 69-72). An aneurysm of the external iliac vein was eliminated, on the left. The small pelvis was drained. We took into account that the fistula was located at the level of the deep femoral artery, below there is an AV fistula between the GAB and the femoral vein. In this regard, the operation was accompanied by great technical difficulties and GAB was used from the mouth, which was ligated and sutured. When isolating the ABF, there was bleeding in the amount of 500 ml. Blood was collected in the SELSEVER device. In addition, the patients had aneurysmal dilations of the external iliac vein. In this regard, it was decided to ligate it from the mouth. Next, the anterior wall of the aneurysmally dilated external iliac vein was isolated (the dimensions of the external iliac vein are 12x10x10 cm). Resection of the aneurysmal sac with plication of the external iliac vein with a 3/0 prolene thread was performed. When monitoring the iliac vein, it was patent. Control ultrasound Doppler imaging revealed a decrease in the linear velocity of the femoral artery and the absence of systolic-diastolic flow (Fig. 33-74). The patient was discharged in a satisfactory condition, with restoration of active movements in the limbs. An examination was performed a year later, systolic tremor and murmurs are absent.

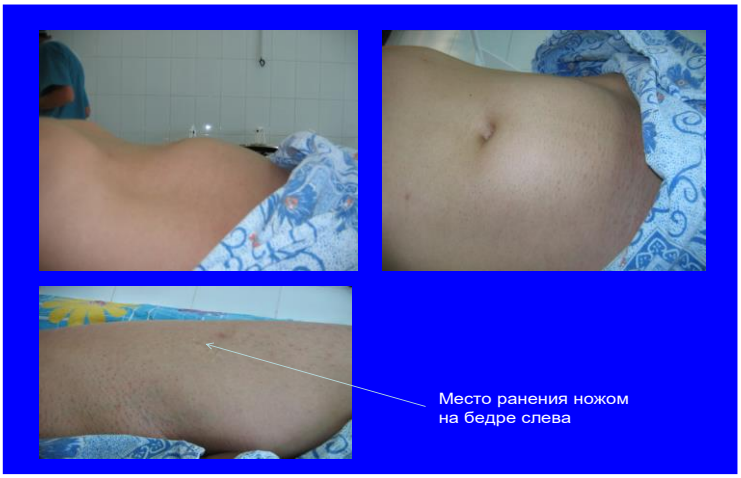


Fig. 65. Patient I.V., 47 years old. Stab wound in the thigh area, on the left

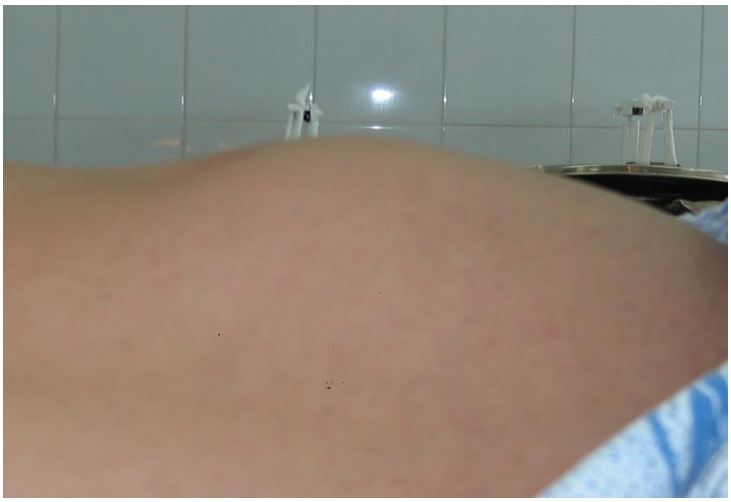


Fig. 66. Patient I., 47 years old. General appearance of the abdomen

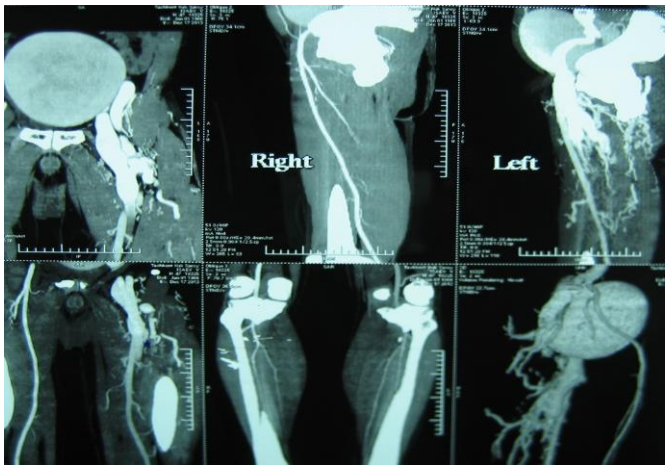


Fig. 67. Patient I., 47 years old. MSCT: Aneurysm of the left common iliac and femoral veins. Arteriovenous fistula between the deep femoral artery and vein

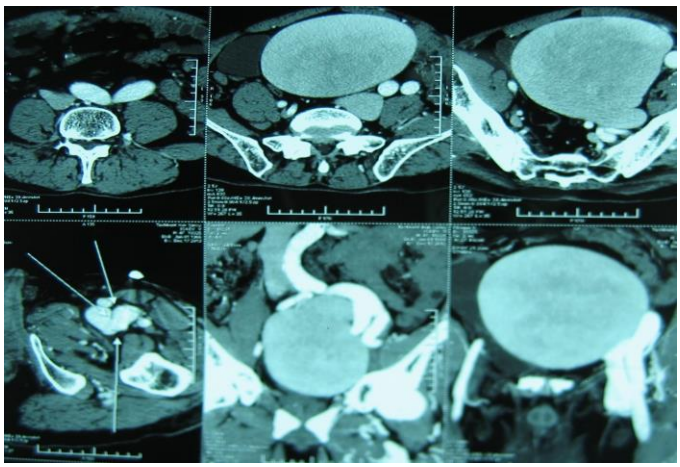


Fig. 68. Patient I., 47 years old. MSCT: Aneurysm of the common and external iliac vein, left

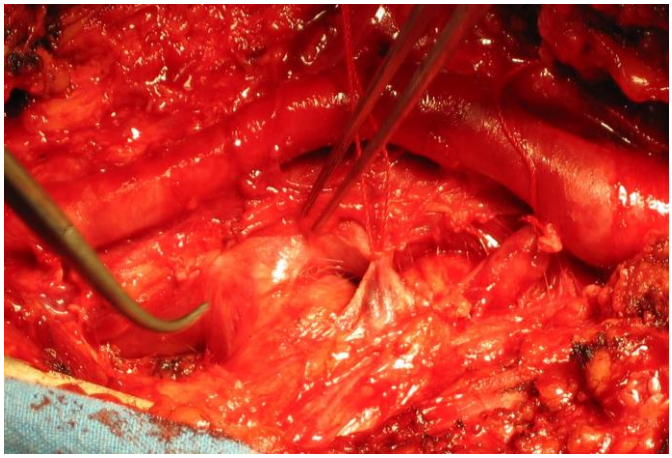


Fig. 69. Patient I., 47 years old. Interoperative photo of an arteriovenous fistula between a deep artery and vein

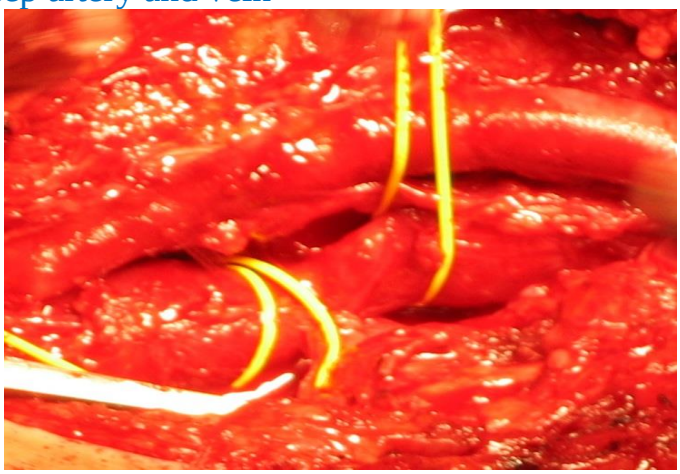


Fig. 70. Interoperative photo of the disconnection of the ABC between the deep femoral artery and vein, left

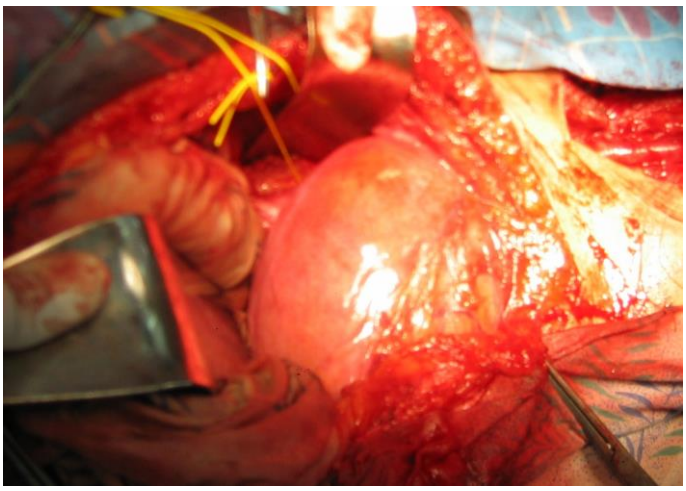


Fig. 71. Patient I., 47 years old. Interoperative photo of aneurysm of the external iliac vein, left

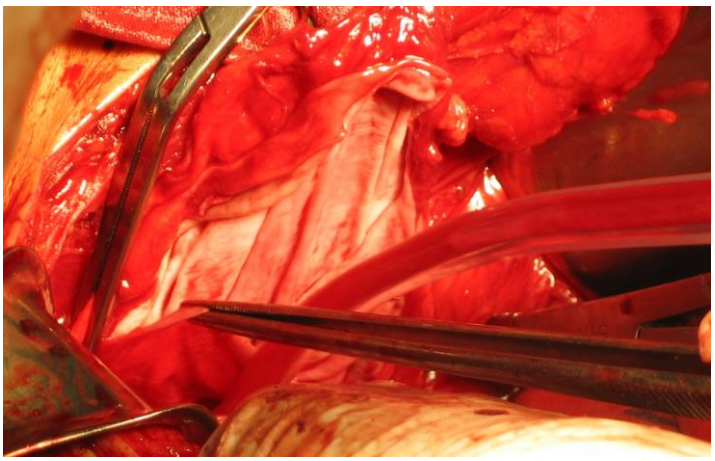


Fig. 72. Interoperative photo of plication of aneurysm of the external iliac vein, left

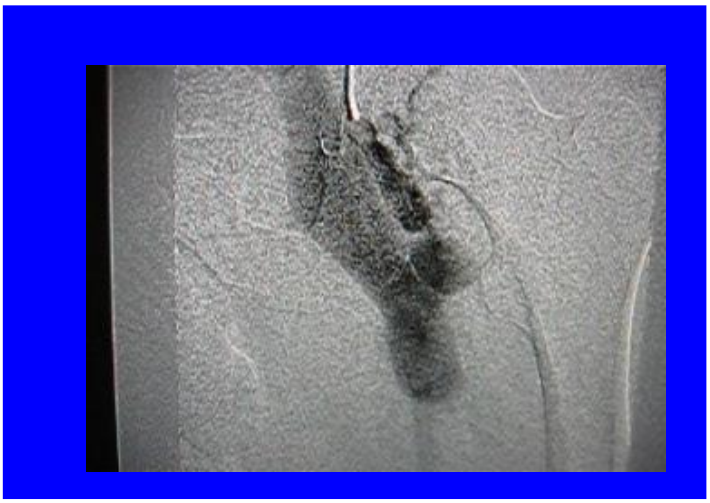


Fig. 73. Postoperative ultrasound of the external and internal iliac artery and vein

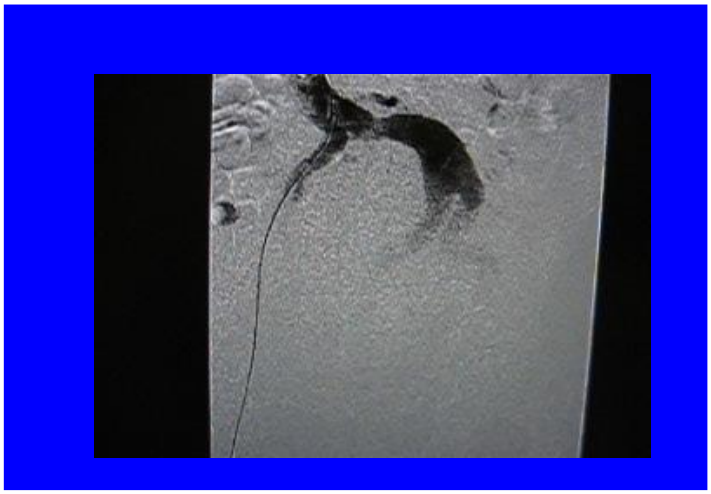


Fig. 74. Postoperative ultrasound of the external and internal iliac artery and vein

It must be taken into account that the reconstructive operation is performed approximately six months after the occurrence of TAVF and is extremely difficult due to significant topographic and anatomical deviations, especially in the area of the neurovascular bundle. Often, cicatricial, local changes: atrophy of the nerve trunk; thromboembolism; accompany TAVF with experience aggravate the outcome of surgery. Usually, the preoperative period includes a restorative treatment of a patient with TAVF. Because at many patients the phenomena of cardiovascular insufficiency are noted. The complex treatment includes: heart remedies (strophanthin 0.025% - 0.5 ml), mildronate 10% -5 ml, levocornitine 10% -5 ml, vitamin hormone therapy and lasting 5-10 days) and painkillers. In the practice of angiosurgery, during operations on TAVF, preference is given to intubation anesthesia with relaxants. The technique of such anesthesia includes: premedication, taking into account the reactivity of the patient (promedol, diphenhydramine, pipolfen). The whole operation is carried out under conditions of 1-2 levels of the surgical stage of anesthesia. The average blood loss during surgery for TAVF is 1.0 liters. (from 300 l to 1 l). Therefore, 1-2 liters of blood supply is needed before the operation. For timely adequate blood transfusion, in order to prevent surgical and postoperative complications.

In addition, blood substitute fluids are needed (rheosarbilac 500-1000 ml; cardiovascular agents, glucose 5% - 1000 ml), other drugs. During the operation,

the following characteristics are important: the amount of blood loss, ECG, hemodynamic data.

Surgical access to the TAVF provides a good approach to the fistula, that is, a fairly wide one, taking into account the restoration of the subsequent motor function of the operated limb. The incision of the skin and subcutaneous tissue on the extremities was made in a straight line along the projection of large vessels. Let us give a detailed presentation of the incision area during the surgical treatment of patients with TAVF. With TAVF of the carotid vessels, the incision was made in front of the masticatory muscle. On the TAVF of the subclavian vessels, the incision was made parallel or semi-vertical to the clavicle. Previously, the sternal end of the clavicle was temporarily dissected. During the operation of 1 patient in the region of the innominate artery, an upper-longitudinal-transverse sternotomy was performed. During operations on the iliac vessels and abdominal branches, longitudinal transperitoneal and extroperitoneal accesses were used.

With TAVF of the popliteal vessels -S - the incision made it possible to lengthen it to the gunter's canal of the thigh or to the vessels of the lower leg. Significant cicatricial changes in the area of TAVF and extensive pathological, topographic and anatomical disorders require a significant time for surgical intervention by an angiosurgeon.

So, the operations were performed within: one and a half hours - 11; up to 2 hours - 11; from 3-6.5 hours or more -8 patients.

After dissection of the soft tissues, we proceeded to mobilize the vessels. It was carried out in layers, by opening the connective tissue case of the holder and taking them into clamps, i.e. separately for arteries and veins. At the end of the reconstructive vascular surgery, we removed the non-viable surrounding tissues. The wound was sutured in layers.

To prevent a hematoma, a counter-opening was left, in the form of an elastic strip, for the outflow of fluid.

Surgical intervention on TAVF, especially long-term "experience", is one of the most difficult in vascular surgery. The phenomena of fibrous periarthritis and

periphlebitis in the fistula area make it difficult to access them and complicate the surgeon's actions in the neurovascular bundle, where topographic and anatomical relationships are observed. A significant network of arterial and venous collaterals, requires readiness of the angiosurgeon for blood loss of varying intensity. During our operations on TAVF, immured nerve trunk was noted in 11 cases. Such operations require careful transfer of blood vessels, in the area of TAVF, on the adductor artery and efferent vein. Angiography was used if necessary. It should be noted that the epicenter of the trembling is usually the projection of the fistula. Among the indications for ligation of TAVF, sufficient is its diameter (no more than 1 cm). To apply a double ligature to the TAVF, as close as possible to the artery and vein, its length must be at least 2 cm. In 2 cases, the fistula was cut between two ligatures.

We performed excisions, or as they are also called, in 16 patients, with fresh and old TAVF.

Indications for the use of the excision method are twofold: the fistula is located between non-main or paired vessels; secondly, the difficulty of doping TAVF.

The practice of angiosurgery confirms the effectiveness of excision in TAVF with a large number of observations. Operations, as far as possible, were performed on a "dry wound" with the blood flow cut off, on the conducting artery and the efferent vein. Depending on the relevant circumstances, reconstructive operations were performed by traditional methods (lateral, circular, autovein, prosthesis). Based on the above and taking into account the relevant circumstances, we performed a lateral suture in 7 (26.1%) patients with TAVF, according to localization. If the defect in the artery was half or more of the diameter of the artery, then the lateral suture was not used, because. this could lead to narrowing of the lumen of the artery. In such cases, a circular suture or autovenous prosthetics was used.

Circular suture on the artery for TAVF was used in 5 (16.6%) cases.

In cases where it was impossible to apply a ligature to the fistula for a lateral or circular suture by TAVF, a plastic-restorative operation was used.

To eliminate TAVF, most angiosurgeons attach great importance to the correction of the main venous blood flow. In practice, due attention was not paid to the restoration of venous blood flow, especially in the lower extremities. Because of this, chronic venous insufficiency often developed during fistula ligation. Thus, the conducted phlebological studies showed that the more venous collaterals in arteriovenous fistulas, the more pronounced venous insufficiency. Often, they remain even after the elimination of TAVF, if due attention is not paid to the correction of venous blood flow. In our study of the problem of TAVF vessels, we took into account all of the above, provisions and experience in their surgical treatment. This is confirmed by the immediate and long-term results of their treatment.

9.3. Immediate and long-term results of surgical treatment TAVF vessels

In our study, out of all 30 operated patients with TAVF, the patency of the main veins was restored in 4 cases, including when applying: ligatures to fistula-12; side seam - 7: circular seam - 5 patients. Surgical intervention for venous aneurysms in TAVF was determined by us, individually, after mobilization of the adductor and efferent vessels and dissection of the arteriovenous fistula. After the elimination of TAVF (after about 2-3 years), the need for surgical intervention arose if venous insufficiency continued to persist.

Our experience confirms that the correction of the main blood flow in the veins should be carried out immediately after the elimination of TAVF. This is due to the insufficiency of communicating veins, which contribute to the slowing down of venous outflow through deep vessels and, as a result, thrombosis. In the study of this problem, we studied the nature of reconstructive and restorative operations by their types. Data on them are presented in Table 34.

Table 34

Comparative analysis of reconstructive and restorative operations for TAVF according to their types of vascular damage, n=30

Damaged vessel	Before 2000 (control)	From 2000-2018 (main)	Total sick

Femoral artery	3(10%)	7(23,3%)	10(33,3%)
Popliteal artery	1(3,3%)	2(6,6%)	3(10%)
Leg arteries	3(10%)	2(6,6%)	5(16,6%)
Brachial artery	1(3,3%)	-	1(3,3%)
Arches of the aorta and innominate vein	-	1(3,3%)	1(3,35)
Iliac artery	-	2(6,6%)	2(6,6%)
Behind the ear artery	1(3,3%)	1(3,3%)	2(6,6%)
Superciliary artery	1(3,3%)	-	-
Ulnar artery	-	2(6,6%)	2(6,6%)
Internal jugular vein		1(3,3%)	1(3,3%)
Carotid artery	1(3,3%)	1(3,3%)	1(3,3%)
Total:	11(35,5%)	19(63,3%)	30(100%)

In a comparative analysis of damage to the vessels of patients, it can be seen from tab. 34 that 11 patients were admitted to the CG before 2000, and 19 patients were admitted to the MG since 2000, $p<0.05$.

We treated each patient individually. During operations performed on patients in the control group, bleeding of 1-1.5 and even 2 liters was observed. Therefore, we have developed a diagnostic and treatment algorithm to prevent bleeding and subsequent complications. Depending on the general condition of each patient, we used a 5-stage treatment. The results of the operation were effective based on the use of rentgenendovascular temporary intravascular occlusion. At the same time, Dopplerography and MSCT were performed after surgery for patients in the main group. The results of Doppler ultrasound indicators of the ankle-brachial index (ABI) 1.0 and 1.2 - the results are good. Angiography was performed mainly for the control group. The results were

satisfactory.

Fig.75. Types of surgical interventions TAVF

As can be seen from this diagram (Fig. 75), the relative differences between CG and MG are clearly visible. At the same time, CG-11 (35.5%) and MG 19 (63.3%) are statistically significant, $p<0.05$. The methods we used and the developed diagnostic and treatment algorithm gave good treatment results. With TAVF, the following types of CG operations were performed: dressing - 5 (16.6%); side seam - 2 (10%); circular seam - 2 (6.6%); autovenous prosthetics - 2 (6.6%). MG: dressing - 7 (23.3%); side seam-5(16.6%); circular seam - 3 (10%); autovenous prosthetics - 1 (3.3%); prosthetics - 1 (3.3%) and patch - 2 (6.6%) patients, $p<0.05$.

Surgical intervention on TAVF, especially with its long existence, requires thorough preparation for a technically complex and with a certain time for its implementation.

When preparing for an operation on TAVF, it is necessary to take into account the likelihood of unexpected blood loss. With TAVF, C, there is always a high risk of arteriovenous bleeding. The use of REVO reduces the trauma of the operation and the risk of bleeding (during the operation). To prevent it, we have identified the adductor and efferent vessels of the fistula according to their mobilization. At the same time, we created drug hypotension and hemostasis during the operation. In 17 patients with TAVF, despite their severe condition with a fistula for a long time, there was no lethal outcome during operations.

Therefore, without weakening attention to surgical intervention (some of them were threatened by myocardial hypoxia), all the forces of the remedy were used to restore the patient's ability to work in the postoperative period. At the same time, it is very important to prevent postoperative complications of organs and systems, primarily cardiovascular. At the same time, the data of the CG and MG of the group of patients with TAVF were analyzed, by types of operations. (Table 35)

Table 35

Comparative analysis of data between control and main between groups of patients with TAVF by types of operations

Type of operation	Before 2000 (control)	From 2000-2018 (main)	Total sick	
Fistula dressing	5(16,6%)	7(23,3)	12(34,4,%)	
Side seam	2(6,6%)	5(16,6%)	7(23,3%)	
Circular seam	2(6,6%)	3(10%)	5(16,6%)	
Autovenous prosthetics	2(6,6%)	1(3,3%)	3(10%)	p<0,05
Prosthetics	-	1(3,3%)	1(3,3%)	
Patch	-	2(6,6%%)	2(6,6%)	
Total:	11(35,5%)	19(63,3%)	30(100%)	

Comparative analysis of the data in CG and MG shows that in terms of the main types of operations, CG prevails over MG. Comparative analysis between groups, CG and MG statistically significant p<0,05. Surgical intervention on TAVF, especially on long-existing ones, despite all the thoroughness of preparation, is technically complex and requires a certain amount of time to perform. For this purpose, we decided to time the duration of operations. Data on

the number of operated patients, depending on the time of the operation, are presented in Table 36.

Tabl 36

Time of the TAVS operation

№	Number of operated patients	Operation time
1	11	1-1,5 hours
2	11	до 2 hours
3	8	3-6,5 hours
4	Total: 30	

In this case, considerable time is spent on isolating the TAVF itself and carefully preparating it from the inflow and outflow vessels, with careful hemostasis. To exclude blood loss, it was necessary to perform appropriate interoperative hemotransfusion. Table 37 shows the average costs of transfused blood in the operations we performed regarding TAVF:

Table 37

Volume of TAVF hemotransfusion

№	Number of patients	Blood transfusion (in ml)
1	1	до 500
2	2	750-1000
3	**Total: 3**	**1500**

When preparing for the operation on TAVF, the probability of unexpected blood loss was always taken into account. To prevent it, we isolated the vessels leading and draining the fistula, mobilized them. At the same time, we created drug-induced hypotension and hemostasis during the operation. In 17 patients with TAVF, despite their severe condition with a fistula of long duration, there was no lethal outcome in the operating room. Therefore, without weakening attention to the surgical intervention (some of them were threatened by myocardial hypoxia),

we directed all our efforts and resources to restoring the patients' ability to work in the postoperative period.

It should be noted that the control of the blood coagulation system was carried out by anticoagulant therapy. It was carried out after a reconstructive operation using an autovein, by suturing the vessels. Intramuscularly, 5000 IU of heparin was administered 4 hours after the operation and then, in the same dosage, six hours later, for 5-7 days (at the same time we check blood clotting). Anticoagulants were not administered to patients in whom a synthetic prosthesis was used after elimination of TAVF. This contributed to the formation of a hematoma around the TAVF. They are contraindicated in the presence of concomitant diseases, in the form of gastric ulcer and duodenal ulcer, etc. In the postoperative period, antibiotics and antiplatelet agents were widely used. In order to prevent deep vein thrombosis in the operated leg, we used elastic bandages and stockings to reduce blood flow through the superficial main veins. Depending on the condition of the operated person, physiotherapeutic procedures and massage are also prescribed in the postoperative period.

In: 27 (90%) patients, wound healing was primary; 3(10%) - secondary tension. The blood flow after the operation was restored in all cases, both in the arterial and venous channels.

Good treatment results in 24 (80%) patients, satisfactory treatment results in 6 (20%) patients, with $p<0.05$ (Table 38).

Table 38

Evaluation of immediate results

Research methods	Total:	KG		MG		p
		good	satisfactory	good	satisfactory	
Clinical signs	30	no	pain, swelling, numbness	no	pain, swelling, numbness	
Angiography	15	6	4	3	2	p<0,05

UZDG	11	1	-	10	-	
MSCT	4	-	-	4	-	
Total:	30	7(23,3 %)	4(13,3%)	17(56,6 %)	2(6,6%)	

Thrombosis was noted in one case. The performed thrombectomy restored the blood flow, with a clear distal pulsation. Before the operation, 11 patients complained of pain in the heart area, a feeling of interruption. After the operation, when they were questioned, they noted a joyful feeling that "now they are not cores" i.e. the disappearance of negative sensations in the region of the heart. In 9 patients, the pulse became rhythmic, its frequency returned to normal. In the first days after the operation, the pulse was quickened and the temperature increased, in 5 patients, after 10-20 days they returned to normal. If rapid breathing was noted in 7 patients with TAVF, then after the fistula was eliminated, only 2 patients. As a result of the medical measures taken, the blood flow of the patients' limbs improved significantly. According to the subjective sensations of the patients, discomfort disappeared, many of whom experienced it for a number of years, all the time. The pulse on the foot was clear, turned pink, the color of the skin on the leg after the operation. This was associated with the phenomenon of venous insufficiency on the limb. We have established signs of vascular damage in patients with TAVF, which are presented as data in Table 39.

Table 39

Signs of limb damage in TAVF

№	Signs of defeat vessels in TAVF	Total	Number of patients before surgery	Number of patients after surgery
1	Venous drawing	1	1	-
2	Tense dilated veins	6	6	-
3	Puffiness of the limb	3	3	-

4	Trophic ulcers	2	2	1
	Total:	12(40,%)	12	1(3,3%)

In addition, we studied the long-term results of the treatment of TAVF, by type of operation. They are presented in table 40.

Table 40

Long-term results of TAVF treatment

№	Type of operation	Total	Treatment results				Follow-up period		
			good		Satisfactory unsatisfactory		1-3 year	4-5 years	6 years or more
			(CG)	(MG)	(CG)	(MG)			
1	Ligature	6	2	3	1	-	1	1	4
2	Side seam	2		2	-	-	1		1
3	Circular seam	1		1	-	-			1
4	Autovena	1		1	-	-	1		
5	Total:	**10**	2(20%)	7(70%)	1(10%)	-	**3**	**1**	**6**

As can be seen from this table 40, when comparing the long-term results of 10 patients in the CG and MG groups, the difference between the results (CG) and (mg) of the main and control groups is clearly visible. Because the treatment and diagnostic algorithm we used and the rentgenendovascular method used led to good results. Good results are 20% in the CG group and 70% in the MG group. Satisfactory results: 10% - CG and not in MG. This means that the method and tactical approach we use is very effective.

Long-term results were assessed as good or satisfactory on the basis of angiography, ultrasound, MSCT and objective clinical data in Table 41.

Table 41

Evaluation of long-term results

Research methods	Total:	KG		MG		P
		good	Satisfactory	good	Satisfactory	
Clinical signs	10	no	Pain, swelling, numbness	no	нет	
Angiography	1		1	-	-	p<0,05
UZDG	7	2	-	5	-	
MSCT	2			2	-	
Total:	10	2(20%)	1(10%)	7(70%)	-	

As can be seen from the table above, all patients were examined after undergoing surgery for TAVF, in the interval from one year to 6 or more, their state of health is good. The pulse distal to the operation site was clearly defined; blood flow was normal. Trophic ulcers were observed in 2 patients. Although the varicose veins remained wide, but the severity of the pattern and tension disappeared. Pulse pressure, when measuring blood pressure, decreased due to an increase in the minimum (when compared with preoperative).

Long-term results after reconstructive and restorative operations were studied in 10 patients. Among operated patients for TAVF, good results - 80%; satisfactory at -20%, unsatisfactory were not observed. Particular attention, when examining long-term results, is paid to the question of the rehabilitation of the working

capacity of persons who have undergone surgery. 2 patients were assigned the 2nd group of disability.

In the remote period, all of them are engaged in physical labor in everyday life.

It should be noted that the immediate and long-term results after the operation mainly show the high efficiency of reconstructive and restorative operations in TAVF, even in patients with "experience". Moreover, the latter, especially, clearly noted the complications of geodynamics: general and regional.

Our experience shows that the earlier a patient is diagnosed with TAVF and the operation is performed, the lower the risk of developing secondary complications. The choice of one or another method of reconstructive-restorative surgery, to the full extent, depends on the individual characteristics and general condition of the patient.

At the same time, a carefully collected history allows you to establish the presence of TAVF. For an objective assessment and treatment of TAVF, we have developed a diagnostic and treatment algorithm for

TAVF. At the beginning of treatment, the patient is examined.

The inspection includes:

- anamnesis, complaints, external expertise;
- palpation - the presence or absence of a dense, soft, painful, painless formation and determination of the size of the formation;
- auscultation - the presence or absence of systolic or systolic-diastolic noise on the projection of the aneurysm;

With a pulsating hematoma of a dense, painful formation with systolic or systolic and diastolic noise above it, hemodynamic parameters are evaluated (decrease or increase in blood pressure, heart rate, pulse rate, etc.).

With a long "experience" of TAVF, hemodynamic instability is associated with "significant" hypertension or hypotension, tachycardia or without it, as well as a decrease in hemoglobin. At the same time, it is necessary to take into account clinical signs: pallor of the skin, a decrease or increase in the pulse rate on the radial artery.

With “fresh” TAVF, hemodynamic stability, “insignificant” signs are recorded at normal arterial pressure, heart rate and pulse of the radial artery. With a high risk of cardiovascular diseases, there are: ECG changes; dystrophic changes in the myocardium; severe LV with systolic or systolic-diastolic overload. At low risk of cardiovascular events, no ECG changes are observed; dystrophic changes in the myocardium and LV with systolic or systolic-diastolic overload (Fig. 76).

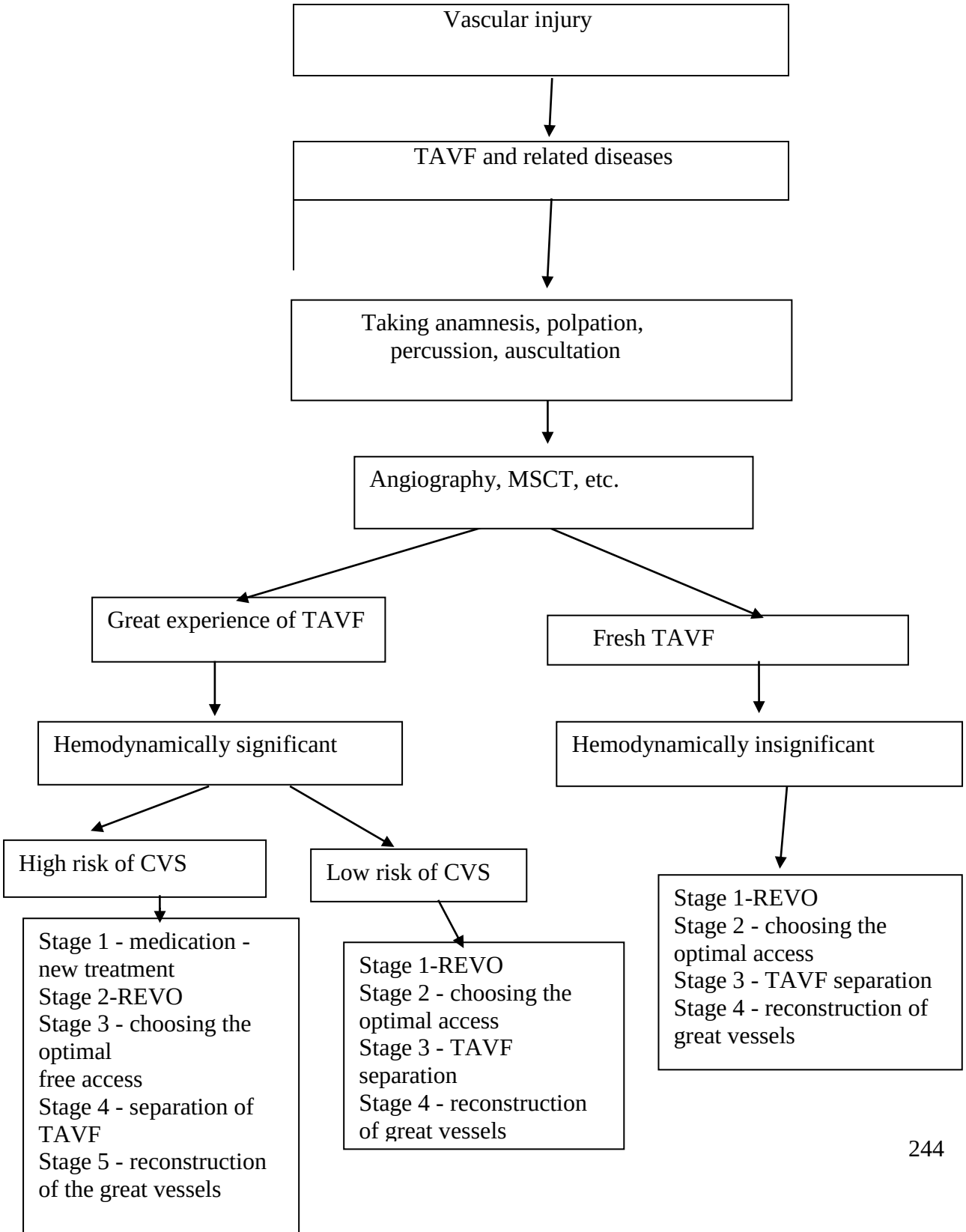
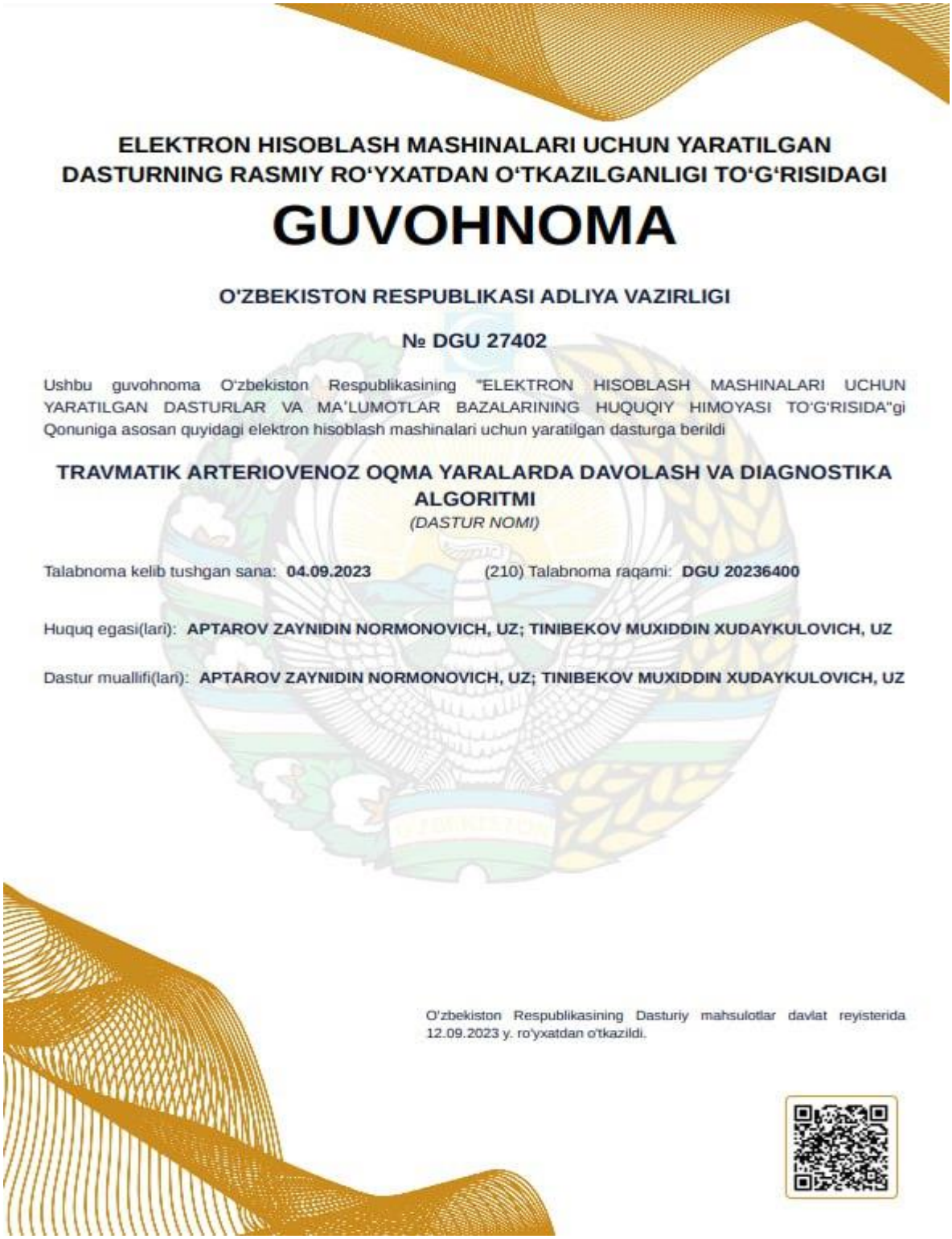


Fig. 76. Algorithm for the diagnosis and treatment of traumatic arteriovenous fistulas.

To improve the diagnosis and treatment of traumatic arteriovenous fistulas, the program No. DGU 27402 was created on the topic "Algorithm of treatment and diagnosis of traumatic arteriovenous fistula wounds". Attached below:



ELEKTRON HISOBLASH MASHINALARI UCHUN YARATILGAN DASTURNING RASMIY RO'YXATDAN O'TKAZILGANLIGI TO'G'RISIDAGI

GUVOHNOMA

O'ZBEKISTON RESPUBLIKASI ADLIYA VAZIRLIGI

№ DGU 27402

Ushbu guvohnoma O'zbekiston Respublikasining "ELEKTRON HISOBLASH MASHINALARI UCHUN YARATILGAN DASTURLAR VA MA'LUMOTLAR BAZALARINING HUQUQIY HIMOYASI TO'G'RISIDA"gi Qonuniga asosan quyidagi elektron hisoblash mashinalari uchun yaratilgan dasturga berildi

TRAVMATIK ARTERIOVENOZ OQMA YARALARDA DAVOLASH VA DIAGNOSTIKA ALGORITMI

(DASTUR NOMI)

Talabnoma kelib tushgan sana: **04.09.2023** (210) Talabnoma raqami: **DGU 20236400**

Huquq egasi(lari): **APTAROV ZAYNIDIN NORMONOVICH, UZ; TINIBEKOV MUXIDDIN XUDAYKULOVICH, UZ**

Dastur muallifi(lari): **APTAROV ZAYNIDIN NORMONOVICH, UZ; TINIBEKOV MUXIDDIN XUDAYKULOVICH, UZ**

O'zbekiston Respublikasining Dasturiy mahsulotlar davlat reyisterida 12.09.2023 y. ro'yxatdan o'tkazildi.

Results and discussion

Solving the problem of traumatic arteriovenous fistulas is an urgent and challenging task. In the clinic, under our supervision, there were 30 patients with TAVF, to study the problem of its correct diagnosis and the choice of the optimal tactics of surgical treatment. At the same time, first of all, we analyzed the causes of the occurrence of TAVF. The causes of TAVF, in the majority of patients 13 (43.3%) are piercing-cutting agents. In the study, we divided them into several types. For all patients, the common is pathological circulation, in the area of the fistula.

At the same time, subjective sensations of patients were observed in the form of weakness in the affected area of the leg or arm. For all patients, a characteristic disorder of cardiac activity (tachycardia with little physical exertion and even at rest, a feeling of chest pain, arrhythmia) and rapid onset of fatigue. In 5 patients with TAVF of the vessels of the neck, the following were observed: disorders of the external cerebral circulation (dizziness, nausea, headache); complaints about their swelling (tumor formation) and protrusion in 14 (46.6%) patients. The phenomenon of pulsation, buzzing and trembling was observed in 15 (50%) patients. At the same time, venous insufficiency in patients was accompanied by edema, especially of the lower extremities and varicose veins. There were 5 such patients (16.6%). Trophic ulcers were noted only on the lower extremities of patients. Of the 30 patients with TAVF, trophic ulcers on the legs were in 1 (3.3%) patient. In a large group of patients 13 (43.3%), complaints are due to pressure and damage to the nerve trunk. At the same time, pains of a different nature were observed: paresthesia; limb paresis; damage to the cranial nerves; Horner's syndrome; hoarseness complaints. We studied radiographs and descriptions of fluoroscopy of the heart and large vessels of 30 patients.

It must be emphasized that not all methods used to eliminate the arteriovenous fistula and aneurysm are effective. Therefore, with combined ABF and aneurysm, the approach to each patient should be individual.

The main task of treating patients with traumatic arteriovenous fistulas and aneurysms is the optimal choice of surgical tactics, methods, types of operations and their sequences. For this purpose, we have developed a diagnostic and treatment algorithm for TAVF. Currently, during operations, REVO (rentgenendovascular balloon occlusion of vessels) is successfully used at the hospital stage: stopping bleeding during surgery and saving the lives of patients with the consequences of vascular injuries. With the joint use of a new diagnostic and treatment algorithm and REVO methods, reliable statistically significant differences in the immediate and long-term results of treatment of patients between CG and MG were obtained. Immediate results in: CG good - 7 (23.3%); MG-17 (56.6%) and CG are satisfactory - 4 (13.3%); MG-2 (6.6%), with $p<0.05$. Long-term results in: CG good-2 (20%); MG-7 (70%) and CG satisfactory -1 (10%); MG- 0., $p<0.05$. The data shows that the results of operations performed by new methods are effective in the main groups (MG).

For this category of patients with TAVF, staged treatment is offered, at: the first stage - drug treatment is performed; the second stage is rengenendovascular temporary complete occlusion of the vessels; the third stage is the choice of optimal access; the fourth stage - dissociation of the arteriovenous fistula and the fifth stage - the reconstruction of the main vessels.

With TAVF, the following types of operations were performed: dressing - 12 (40%); side seam - 7 (23.3%); circular seam - 4 (13.3%); autovenous prosthetics - 2 (6.6%); prosthetics - 1 (3.3%) and others - 4 (13.3%) patients, with $p<0.05$.

In: 27 (90%) patients, wound healing was primary; 3(10%) - secondary tension.

CHAPTER IX. TECHNOLOGY OF USING HYBRID INTERVENTIONS FOR TRAUMATIC INJURIE VESSELS AND THEIR ONSEQUENCES.

10.1. Hybrid interventions for hard-to-reach localizations traumatic injuries of blood vessels and their consequences.

Hybrid trauma interventions are a combination of open and endovascular treatments aimed at temporarily or permanently eliminating the source of bleeding during a single operation.

Hard-to-reach localization is called damage to hard-to-reach vessels. Hard-to-reach localizations of traumatic vascular injuries and their consequences include: subclavian artery in the 1st, 2nd and 3rd segment; arches, thoracic and abdominal aorta and its branches; carotid artery in zones I and III; vertebral artery, arterial bifurcation area, etc.

Bleeding from the area of damage to a large artery is a frequent and very dangerous, life-threatening, consequence of unintentional (external influence) or iatrogenic injury to the vessel. When a vessel is injured in a hard-to-reach localization, a temporary stop of bleeding is a significant difficulty. With proximal source control, if bleeding is accompanied by significant surgical trauma and additional blood loss, they can lead to the death of the patient.

This chapter reviews all such interventions performed by those admitted to our clinic, analyzes the results of their use, and presents studies that can improve the outcomes of treatment of this category of patients in the future.

An analysis of early mortality from injuries shows that the vast majority of victims, in peacetime and wartime, die in the first 30 minutes. This knocks her out of the established concept of the "golden hour". The absence of any methods of temporary intracavitary hemostasis contributes to the advancement of methods (rentgenendovascular surgery) of REC closer to the site of vascular damage. Today, REVO is successfully used at the hospital stage to stop bleeding and save lives in case of vascular damage and its consequences. It should be noted that the introduction of REC is associated with the provision of assistance in case of vascular damage and its consequences.

We have developed a method - REVO, contributed to the revision of approaches to the treatment of vascular lesions and their consequences. This was part of the "scientific and medical revolution" that led to a decrease in the frequency of deaths. At the same time, the evidence base for early vascular interventions in trauma and their consequences is still insufficient. It is limited to retrospective analysis of registries or clinical cases in which the indications for intervention, complications, and even immediate results are not sufficiently substantiated.

We observed 42 patients with hard-to-reach localizations of vascular injuries and their consequences. Information and distribution of patients with hard-to-reach localizations of vascular injuries and their consequences by sex and age, on average, is 33.71 ± 15.59, p> 0.05, which are presented in Table 42

Table 42

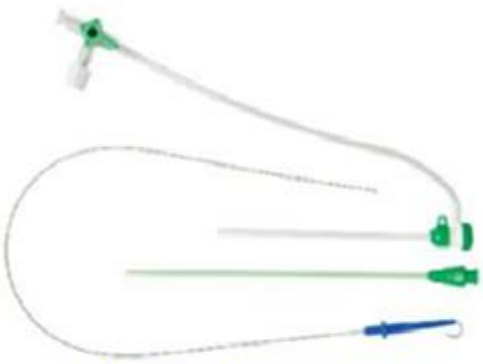
Distribution of patients by sex and age

№	Age	Number of patients		Of them			
		abs	%	Men		Women	
				(CG)	(MG)	(CG)	(MG)
1.	up to 20 years	10	23,8		8	2	
2.	21-30 years old	8	19,0		7	1	
3.	31-40 years old	9	21,4		8	1	
4.	41-50 years old	7	16,6		5	2	
5.	51-60 years old	4	9,5		4	-	
	61 years and older	4	9,5		3	1	
6.	Total:	**42**	**100,0**	**35(83 ,3%)**		**7(16, 6%)**	

Days of hospitalization averaged 15.75 ± 8.32, p<0.05. At the same time, men - 35 (83.3%), women - 7 (16.6%).

During surgical intervention, under local anesthesia of the femoral artery on both sides, introducers 6F were installed (Fig. 77.)

Prelude Femoral Interposers



Introducer femoral prelude

Fig. 77. Types of femoral artery interodes.

Further, rentgenendovascular temporary complete balloon occlusion of arterial vessels was performed. At the same time, a balloon catheter was used (dimensions 6x60 mm); to expand to complete occlusion and vascular patency. Occlusion occurred at a balloon pressure of up to 9 atm with an RBP of 10 atm. Contrast Unigexol-350-100 ml (1 bottle of 100 ml). At the same time, 3 thousand heparin honey was introduced.

Distribution of localization of hard-to-reach vascular injuries and their consequences in Table 43.

Table 43

Localization of hard-to-reach vascular injuries and their consequences by age and gender

№	Age	Number of patients		Of them	
		abs	%	Men	Women
1	up to 20 years	10	23,8	8	2
2	21-30 years old	8	19,0	7	1
3	31-40 years old	9	21,4	8	1
4	41-50 years old	7	16,6	5	2
5	51-60 years old	4	9,5	4	-
6.	61 years and older	4	9,5	3	1

7	Total:	42	100,0	35(83,3%)	7(16,6%)

The distribution of localizations of hard-to-reach vascular injuries and their consequences is as follows: aortic arches and innominate vein-1 (2.3%); thoraco-abdominal aorta-1 (2.3%); vertebral artery-2 (4.7%); subclavian artery - (19%); femoral artery in the area of bifurcation - 20 (47.6%); iliac artery in the area of bifurcation-3 (7.1%); axillary artery at the place of origin of the artery of the shoulder-3 (7.1%) (Table 78). These patients, at the first stage, underwent REVO in the REC department.

Under control, a Grutzeng catheter (size 6x6 mm) was introduced gradually into the damaged vessel. Then, the catheter begins to inflate until the vessel is completely occluded. At the same time, the extravasation of the contrast stops and complete occlusion of the artery (inflow and outflow) occurs. At the same time, the pressure in the balloon reaches 9 atm and the pulse of the peripheral arteries disappears. At the next stage, the patients are transferred to the operating room and the optimal access is selected without exposing the proximal and distal parts of the damaged artery. In addition, retrograde blood flow from the vertebral and thyroid trunk, the internal iliac deep artery of the shoulder and thigh, and the bifurcation of the popliteal artery is stopped.

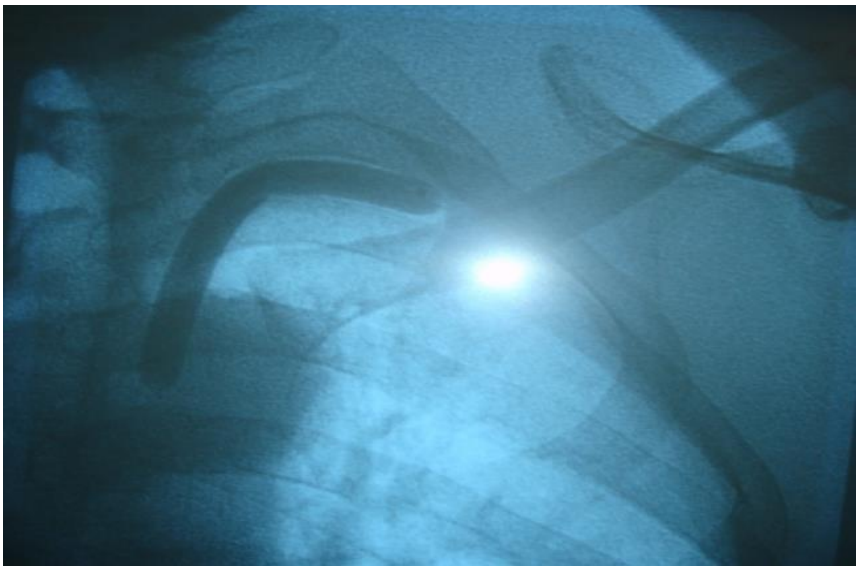


Fig.78. Photograph of puncture access to the femoral artery for REVO in patient I., 52 years old (Disease history DH No. 4042), with JA.

Contraindications are severe atherosclerotic lesions of the iliac-femoral arterial segment.

As a typical example, consider the following case history.

Patient I.E., 52 years old. I / B No. 4042. Complaints at admission to the formation of the left subclavian region and hematoma in it. Considers himself sick for 4 days. After the injury, a tumor-like strained formation appeared in the left supraclavicular region. Traumatic shock was admitted at the place of residence. After recovering from shock and stabilizing hemodynamics, on the fourth day, he was sent to us. According to the patient, 2 years ago he was treated for a tumor of the left supraclavicular region. Produced, selective angiography of the left subclavian artery (Fig. 81). At the same time, a section of the defect in segment 2 of the left subclavian artery was identified. The patient's condition is moderate. Skin and visible mucosa, normal color. In the lungs on both sides, vesicular breathing. Heart sounds are muffled. A/D 130/80 mm. rt. Art. The abdomen is soft and painless. The liver and spleen are not enlarged. Stool and diuresis are normal.

When examining the subclavian region, a tense formation measuring 10x10 cm was found. The formation, imbibed with blood to the gluteal region, is cyanotic (Fig. 79-80). It does not pulsate, a systolic murmur is heard over it. Education, mobile. Examinations: Hb-88 g/l, erythrocytes-3.2, cp-0.8. On ultrasound: a thrombosed formation up to 10x6 cm in size. MSCT revealed a false pulsating hematoma in 2 segments in the left subclavian artery (Fig. 81). Planned operation, opt for hybrid technology. At the same time, at the first stage, it was decided to conduct a balloon catheter in the renrgengraphy of the operating unit for temporary occlusion of a hard-to-reach damaged vessel. After the X-ray procedure, the balloon swells with the disappearance of extravasation of the vessel and pulsation of the radial artery. After that, the patient is transferred to the operating room. At the same time, bleeding from the inflow and outflow arteries, and branches of the subclavian artery, was not observed. Under intubation anesthesia, polyvertical access opened aneurysm. The thrombotic mass was

removed in a volume of 600 ml. Due to the inflammatory process, due to technical difficulties, the proximal and distal subclavian arteries were mobilized and taken to the tourniquet. After that, the balloon was gradually deflated and, under visual control, the catheter was pulled in the proximal direction. At the same time, in the 1st stage, the distal tourniquet was extended and a vascular clamp was applied to the distal subclavian artery. Then, a vessel with an arterial defect was pushed through with the index finger and the balloon catheter was pulled out in the proximal direction. Then, the proximal catheter was pulled out and a vascular clamp was applied. There was no bleeding. Without technical difficulties, a lateral suture was placed on the defect of the subclavian artery, and there was no bleeding.

Due to the inflammatory process, technical difficulties, the subclavian artery was isolated. A lateral suture was placed on the defect of the subclavian artery (Fig.82-83). Grützeng dilator, removed. Bleeding of the artery was not observed. Produced hemostasis. A layer-by-layer suture was applied to the skin. Made aseptic bandage. The wound healed by primary intention (Fig.84). The patient was discharged in a satisfactory condition at the place of residence.

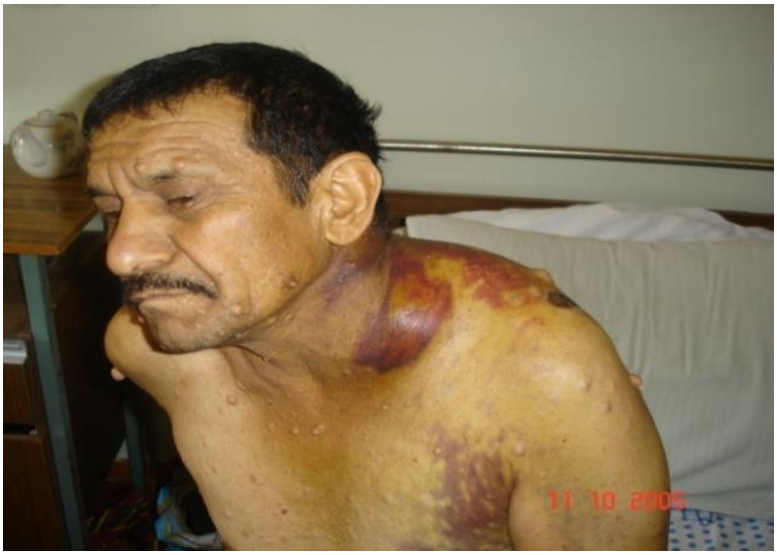


Fig 79.View of the patient after an injury to the subclavian artery, on the left.

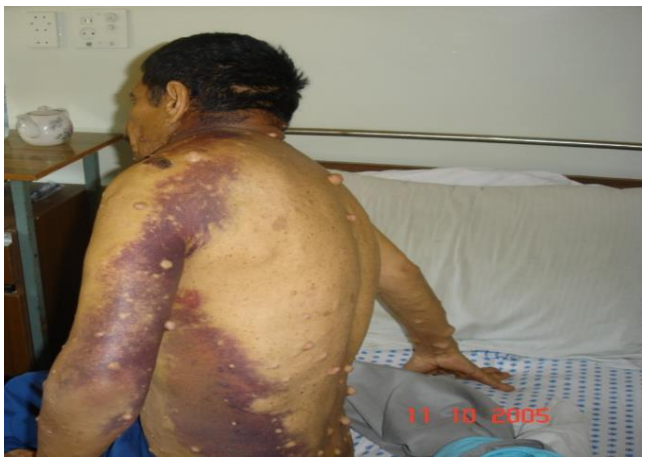


Fig 80. View of the patient after an injury to the subclavian artery, on the left

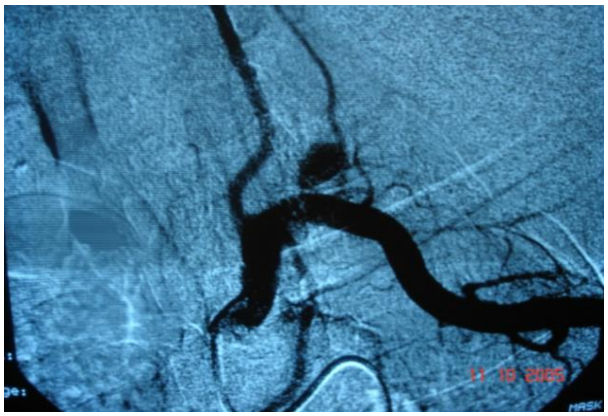


Fig. 81.Angiography of the subclavian artery, left

Fig.82. Scheme of the subclavian artery, lateral suture, left

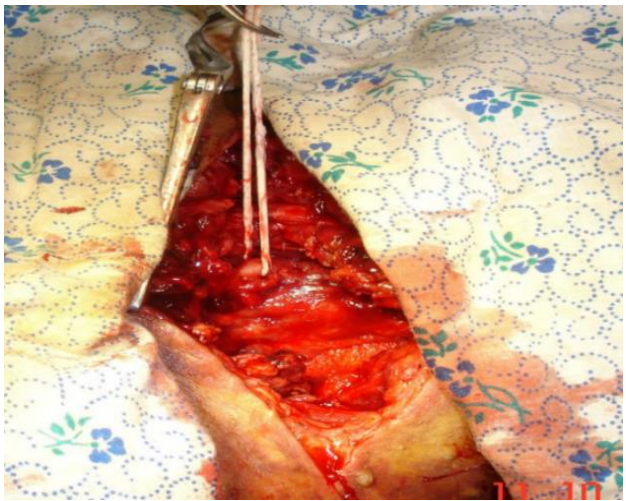


Fig 83. Intraoperative photo: the subclavian artery is taken on the holders of the artery, on the left.

Fig. 84. Semi-vertical access of the operation at the subclavian artery, on the left.

To study the immediate results, the patient underwent Doppler sonography of the left radial artery, ABI index -1.0. We have traced the long-term indicators of the LPI-1.1 index.

It should be noted that despite the simplicity of this method, its incorrect use is accompanied by a number of complications:

1) damage to the artery, due to accidental non-targeted catheterization;

2) displacement of the balloon distally due to increased systemic arterial pressure (BP), in the absence of its support by a long introducer;

3) bleeding from the area of arterial vascular access (AVA).

So, in our practice, when applying a lateral suture, the balloon with the needle was damaged and the bleeding was stopped by finger pressure.

The patient received a stab wound in the chest area. Let's take a look at this moment with an example.

So, Patient K.A., 30 years old and / b No. 5657 10/27/2016. acted as planned.

Complaints about the presence of education, on the neck on the left. She appeared after being stabbed.

Considers himself ill, for the last 9 months. He received a stab wound in the chest area. Examined in Yekaterinburg, February in 2016. The patient on an outpatient basis underwent MSCT and angiography of the thoracic aorta (Fig. 86-88).

The general condition of the patient at admission is satisfactory. The skin and visible mucous membranes are clean, of normal color. Bone-articular system without visible deformations. Auscultatory examination revealed vesicular breathing in the lungs, no wheezing. Heart sounds are clear, rhythmic. BP 120/70 mm Hg on both arms, pulse 74 beats per minute. The belly of the usual form, participates in the act of breathing. On palpation, soft, painless in all departments. Physiological functions are not violated.

On examination, there is a formation on the left side of the neck with dimensions of 5.0 x3.0 cm. On palpation, it is painful and immobile (Fig. 85). The skin, over the formation, is not changed. There is asymmetry of the neck, on the left. On palpation, over the formation, trembling is noted.

The pulsation at all identification points is determined. There are no noises over the main arteries.

Examination of a general analysis of urine and blood. Complete blood count: hemoglobin-164g/l; leukocytes - 6.6 x109/l; erythrocytes-5.3 x1012/l and ESR-11. general urine analysis: protein - negative, epithelium - 0-0-1 / pr. Leukocytes-0-0-1.pr.

Biochemical blood test: glucose - 5.1 mmol / l; Urea-4.3 mmol/l; creatinine 66umol/l; Na+ (sodium) 142; K+4.7 (potassium); total protein 78 g/l.; AST 25 u/l; ALT 37 u/l; total bili. 18 mmol/l; conj.bili. 0. Ht - 44%. PTI-72%. HbsAg - neg. Anti HCV (hepatitis -C) - neg.

X-ray: lung fields without fresh focal and infiltrative shadows. Roots are heavy. Sinuses are free. The heart lies wide on the dome of the diaphragm, enlarged in diameter. The aorta is indurated, dilated, and bulging. ECG sinus rhythm. HR-90. (LVH) hypertrophy of the left stomach, metabolic changes in the myocardium.

Echocardiography EDV 186 ml, ESV 131 ml, SV 115 ml, EF 62%. The patient was examined by a cardiologist and therapy was prescribed.

Diagnosis: Post-traumatic arteriovenous fistula of the aortic arch and innominate vein.

Under intubation anesthesia, in the area of the Scarpovsky triangle, on the right along the Kahn line, a skin incision up to 15 cm long was used to identify the common femoral artery (BOA), the common femoral vein (CFV), and a site for cannulation and AIC connection was prepared. Heparin IV 5 thousand units. Cannulation of the femoral artery followed by cannulation of the femoral vein. The cannula was inserted into a vein 40 cm long to the right atrium. Connection to the AIC through a cannula. After that, the pressure is reduced through the AIC to 70 mm Hg (Fig. 89). Next, a complete median sternotomy was performed. Hemostasis. The ascending and arch of the aorta is highlighted. During the revision, an expansion of the innominate vein with a diameter of up to 4 cm was found. The vein pulsates. In the selected vein there is an adhesive process. With sharp and blunt instruments, with technical difficulties, it was possible to isolate the fistula on the lateral and lower side of the vein. Due to the strong adhesive process, it was not possible to bypass the fistula. Longitudinally, on the fistula of the vein of the lower side, a lateral clamp is applied on the aortic arch. At the same time, the trembling and pulsation in the vein disappeared. Also, clamps were applied to the innominate vein on both sides. The fistula is disconnected. The vein was sutured with a 5/0 Prolene thread. The integrity of the vein was restored. A vascular suture with a thread, prolene 3/0, was also applied to the aorta (Fig. 90). Further, the stump (AVF) of the arteriovenous fistula was sutured with a two-row suture and reinforced with pericardial and periaortal purse-string sutures. The start of the blood flow of the vascular suture is hermetic. Next, carried out a thorough coagulation hemostasis. Sternotomy. The aortovenous fistula was eliminated. The side seam is superimposed on the veins and aortic arches. Drainage of the anterior mediastinum. The edges of the sternum are brought together with metal staples. The wound on the thigh is sutured. Layer-by-

layer suturing of wounds to rubber graduates. Alcohol processing. Aseptic bandage applied.

Post-traumatic arteriovenous fistula of the aortic arch and innominate vein is the most rare complication. Due to the high blood pressure of the aortic arch and innominate vein, to prevent bleeding and other consequences, it is first of all installed on the femoral artery, then the vein - conjunction. The length of the conjugation is 40 cm and is installed up to the right atrium and connected to the apparatus (cardiopulmonary bypass) AIC, while the pressure is kept at 70 mm Hg. This method is rarely used in vascular surgery. It allows you to carry out a quick and high-quality operation.

In the postoperative period, the patient underwent multislice computed tomography; there was no discharge of arterial blood between the aortic arch and the innominate vein. In the long-term period, the patient was repeatedly made multislice computed tomography between the aortic arch and the innominate vein, the discharge of arterial blood was not noted.

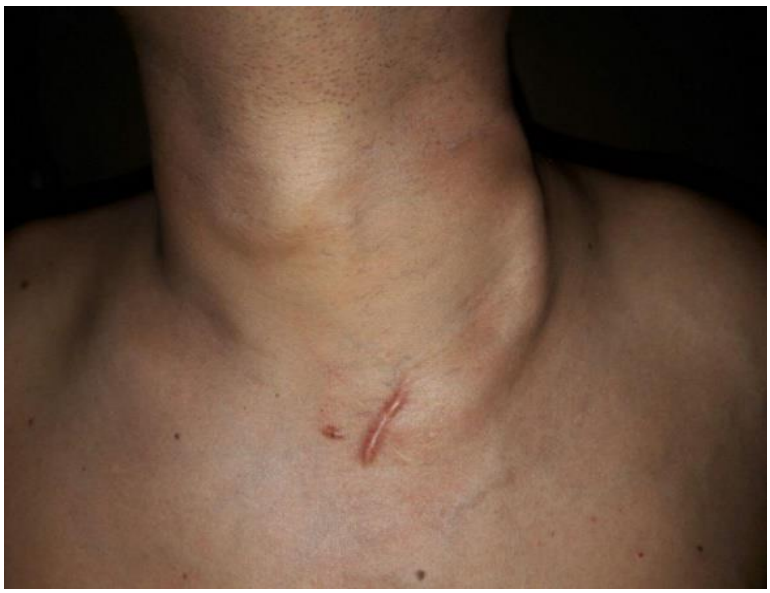


Fig.85. Expansion of the jugular vein

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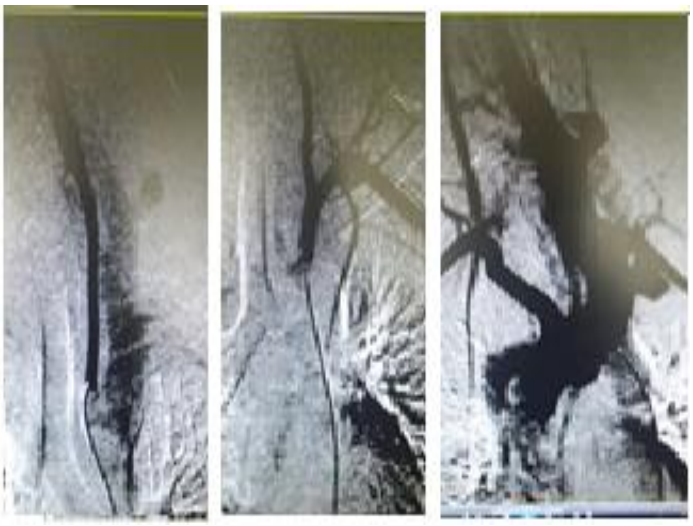

Fig. 86. Angiography of the aortic arch and vein of the neck

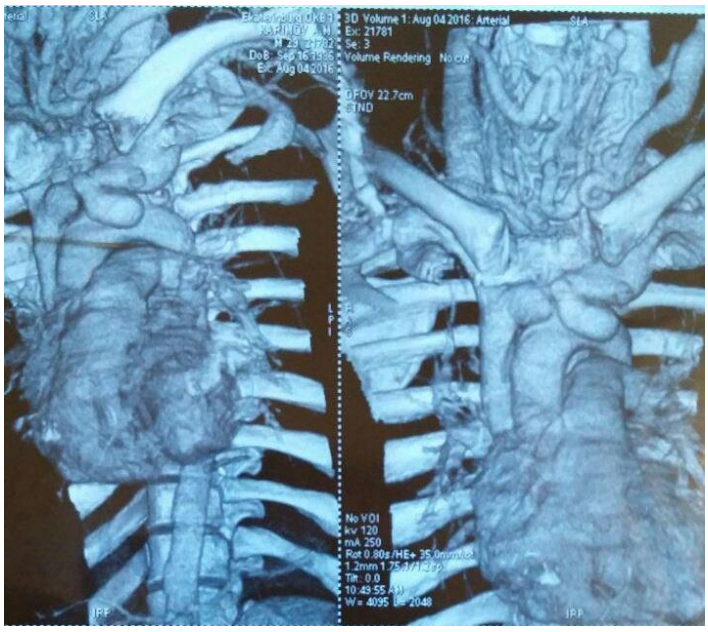

Fig.87. MSCT. TAVF aortic arches and innominate vein

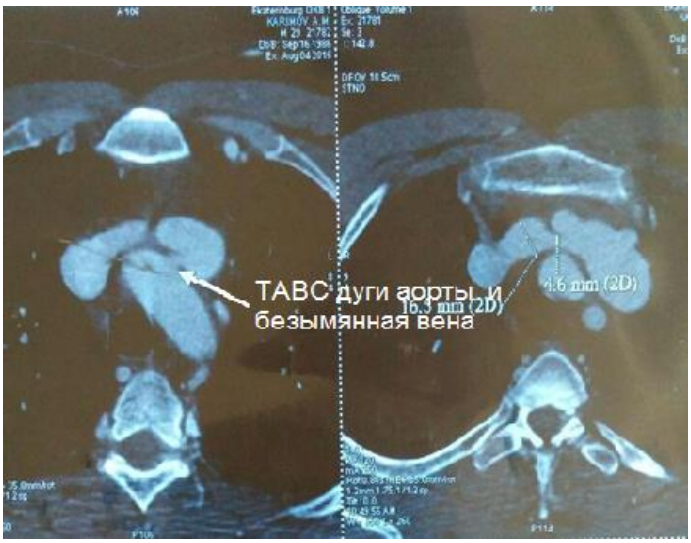

Fig.88. MSCT. TAVF aortic arches and innominate vein

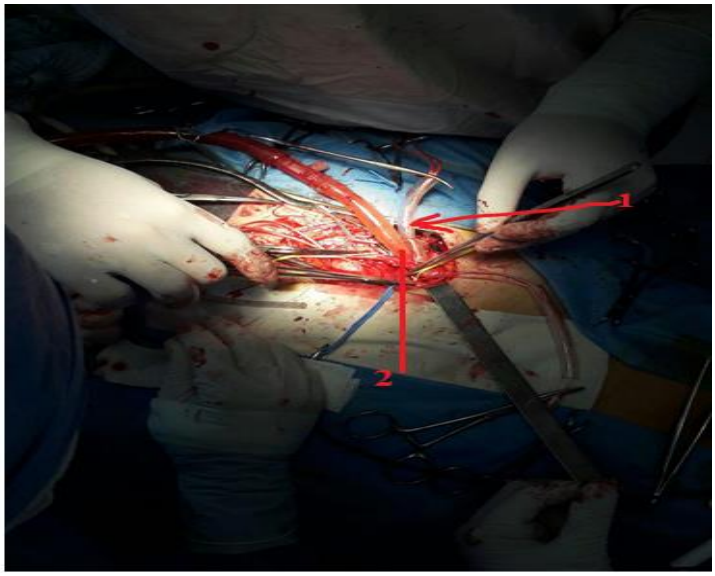

Fig.89. Intraoperative photo. Cannulation of the femoral artery and vein. 1. Cannulation of the femoral artery. 2. Cannulation of the femoral vein to the right atrium.

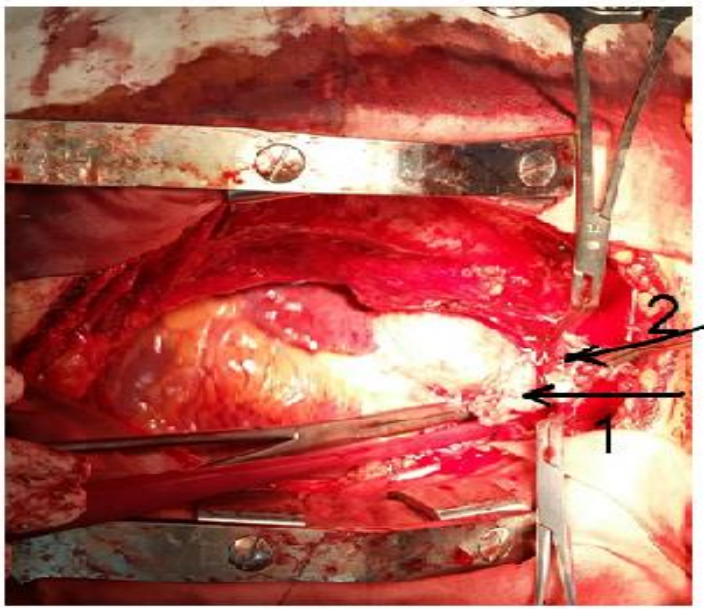

Fig.90. Interoperative photos. TAVF disjunctions on the aortic arch and innominate vein.

10.2. Comparative analysis of the use of hybrid interventions in hard-to-reach localizations of vascular injuries and their consequences

Until 2000, the surgical treatment of vascular injury and its consequences was somewhat different. It was difficult to eliminate an aneurysm in hard-to-reach

localizations of vessels, namely, difficulties in eliminating TAA and TAVF of the subclavian artery. At the same time, T - shaped incision from the sawn clavicle.

However, since 2000, the use of the rentgenendovascular method of temporary vascular occlusion has led to serious changes in medicine, especially in surgery (a method developed at V. Vakhidov RSNPMCH). We used this method for 14 patients between 2000 and 2018.

Our experience in the use of rentgenendovascular temporary vascular occlusion (REVO) shows its effectiveness in the treatment of iatrogenic aneurysms (JA); TAA and TAVF, post-traumatic origin. rentgenendovascular occlusion is based on the introduction of a special balloon catheter into the vessel, temporarily obliterating the lumen of the vessel.

In our study, we divided patients into 2 groups for a comparative analysis of hard-to-reach localizations of vascular injuries and their consequences, the Control group until 2000 (CG) and the main group, from 2000-2018. (MG). Until 2000, YA-7 was treated.; TAA-13; TAVF-8, from 2000-2018 YA-2; TAA-7 and TAVF-5 patients. The difference between these groups (CG) and (MG) is statistically significant $p<0.05$. Comparative analysis data are shown in Table 44.

Table 44

Comparative analysis of hard-to-reach localizations with vascular injury and its consequences

View diseases	Group 1, (N=28) CG	Group 2, (N=14) MG	Total	Level P
TAA	12 (42,86%)	6 (42,86%)	18(42,8%)	p<0,05
TAVF	8 (28,57%)	4 (28,57%)	12(28,5%)	
Iatrogenic aneurysm	7 (25%)	3(10,7%)	10(23,8%)	
Vascular and bone injuries	(0,00%)	2 (14,29%)	2(4,7%)	
Total:	28(66,6%)	15(35,7%)	42(100%)	

Hybrid methods of treatment for vascular injury and its consequences significantly facilitate open surgery and reduce the severity of surgical trauma in case of interoperative blood loss. It is especially suitable for arteries that are

difficult to access by open intervention. For this, a humeral or femoral approach was used.

Table 45

The nature and types of surgical interventions for hard-to-reach localization of vascular injuries and their consequences

Name vessels	dressing	Side saem	Circular	autovein	Prosthesis	Patch	stent graft
Thoracoabdominal aorta					1		
Subclavian	3	5					
Aortic arches and innominate vein		1					
Vertebrate		1		1			
Iliac	1				1		1
Femoral	3	5	4	5	1	2	
Axillary		1		1		1	
Popliteal		2	1			1	
Total:	7(16,6%)	15(38%)	5(12%)	7(16,6%)	3(7,1%)	4(9,5%)	1(2,3%)

We operated on 42 patients, including 14 patients with REVO. Patients made: ligation of blood vessels - 7 (16.6%); side seam - 16 (38%); circular seam - 5 (12%); autovenous prosthetics - 6 (14.2%); prosthetics - 3 (7.1%); stent graft1(2.3%) and patch - 4(9.5%) (Table 45).

The main cause of vascular ligation is reddening of the skin and inflammatory infiltrate around the vascular bundle; the impossibility of applying a vascular suture, due to the friability of the walls of the vessels of the subclavian artery-3; iliac artery-1 vessel wall defect 4 cm, compensated circulation of the limb; femoral artery-3, while the GAB mouth is tied and stitched. In one case, the mouth of the GAB was sutured from the inside, in the other case, due to decompensation of blood circulation, an extranatomic iliofemoral autovenous

shunt was imposed. After ligation of the iliac vessels, autovenous shunting was performed, i.e. an autovenous shunt was placed on the contralateral external iliac artery and the lateral femoral artery. All patients with blood circulation of the extremities are compensated.

A complete presentation of clinical cases of the use of REVO, in case of vascular injury and their consequences in the right subclavian artery, demonstrates the possibilities of minimally invasive surgery, even in difficult conditions with insufficient diagnostics and surgery. In addition, the process of bleeding during surgery was also studied. Differences between groups were also objectively different. These data are presented in the table (table 45)

Table 46

The volume of bleeding by type of disease with their hard-to-reach REVO operations

View diseases	Group 1, (N=27) CG M ±m		Group 2, (N=14) MG M ±m		Total:	p
TAA	12	16,6 л	6	1050 мл	18(42,8%)	<0.05
TAWF	8	17,8 л	4	1750 мл	12(28,5%)	<0.05
Iatrogenic aneurysm	7	10,5 л	3	600мл	10(23,8%)	<0.05
Vascular and bone injuries	-	-	2	400мл	2(4,7%)	<0,05
Total:	27	44,9 л	15	3,8 л	42(100%)	

As can be seen from this table 46, the difference between the frequency of intraoperative bleeding in patients (CG) and (MG) is statistically significant ($p<0.05$) and it was noted that CG is 44.9 l, and MG is 3.8 l. In general, the result of the method we used and the diagnostic and treatment algorithm turned out to be better. Because the less blood is lost during the operation, the more the condition appears during the operation. At the same time, the immediate and long-term results will be good.

Table 47

Immediate results of hybrid interventions for vascular injury and their

consequences in hard-to-reach localizations

Type of operation	Treatment results				
	Good		Satisfactory		Unsatisfactory
	(CG)	(MG)	(CG)	(MG)	
Vessel ligation	4(14,2%)	2(14,2%)	2(7,1%)	1(7,1%)	
Side seam	7(25%)	6(42,8%)	1(3,5%)	-	-
Circular seam	4(14,2%)	3(21,4%)	-	-	-
Autovena	5(17,8%)	-	-	-	-
Prosthesis	1(3,5%)	-	1(3,5%)	-	-
Patch	2(7,1%)	1(7,1%)	1(3,5%)	-	-
stent graft		1(7,1%)	-	-	-
Total:	23(82,1%)	13(93%)	5(17,8%)	1(7%)	-

Immediate results of treatment in group 1 (CG): good - 23 (82.14%); satisfactory - 5 (17.86%)(Table 47). In (MG) group 2: good-13 (93%); satisfactory - 1 (7%), while $p<0.05$ (Fig. 91).

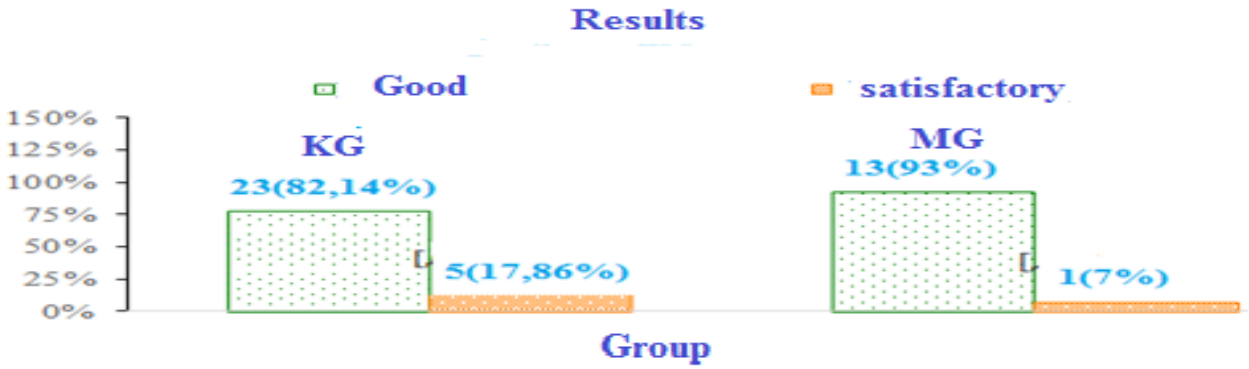

Fig.91. The results of surgical treatment.

In the future: 41-(97.6%) patients - wound healing was primary; 1 (2.3%) - healing by secondary intention.

Table 48

Comparative analysis of the use of REVO in vascular injuries and their Consequences

Diseases	(KG)	(MG)	Total
Subclavian artery	-	8	8(57,1%)
Popliteal artery	-	2	2(14,2%)
Iliac artery	-	3	3(21,4%)
Aortic arches and innominate vein	-	1	1(7.1%)
Total:	-	14	14(100%)

Between groups (CG) and (MG) the results are statistically significant, $p<0.05$. As can be seen from (Table 48): subclavian artery-8 (57.1%); popliteal artery-2 (14.2%); iliac artery-3 (21.4%); aortic arch and innominate vein-1 (7.1%).

At the same time, the long-term results of hybrid interventions in vascular injuries and their consequences, with their hard-to-reach localizations, are presented in (Table 49).

Table 49

Long-term results of treatment

№	Type of operation	Treatment results				
		Good		Satisfactory		Unsatisfactory
		(CG)	(MG)	(CG)	(MG)	
1	Vessel ligature	1(5%)	1(9%)	3(15%)	2(18,2%)	-
2	Side seam	3(15%)	6(54,5%)			
3	Circular seam	4(20%)	1(9%)		-	-
4	Automotive prosthetics	4(20%)	-	1(5%)	-	-
5	Prosthetics	1(5%)	-	1(5%)	-	-
6	Patch	2(10%)	-		-	-
7	Stent graft	-	1(9%)		-	-
	Total:	**15(75%)**	**9(81,8%**	**5(25**	**-**	

			)	%)		

At the same time, REVO was not performed in group 1 (CG), good - 15 (75%); satisfactory - 5 (25%), in group 2 (MG) REVO was performed - treatment results: good - 9 (81.8%; satisfactory - 2 (18.2%) patients, with $p<0.05$ (Fig. 92).

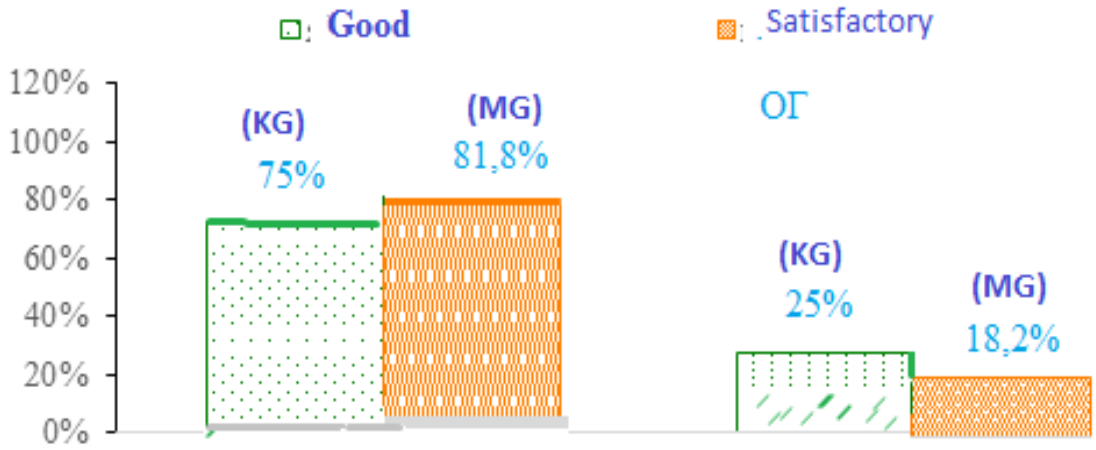

Fig.92. The results of surgical treatment.

Thus, it can be stated that the REVO method is gradually becoming widespread in the treatment of vascular injuries and their consequences, with their hard-to-reach localizations. Obvious advantages make REVO not only one of the ways to combat post-traumatic bleeding, but also a means of temporary stabilization of hemodynamics during the main stage of surgical treatment.

The following advantages of the REVO method should be noted:

- stopping hemodynamic bleeding in hard-to-reach localization of vascular injuries and their consequences and transferring this clinical situation to a stable one;

 reduction of intraoperative blood loss;

 facilitates surgical access and makes it possible without a blood operation and more effective;

 gain in time, with open surgical interventions;

 the possibility of using endovascular methods of treatment based on the basic knowledge and skills of REC.

Results and discussion

In this chapter, the methods of diagnosis and the results of surgical treatment

of patients with traumatic injuries of the arteries of the extremities and their consequences, in their hard-to-reach localizations, are analyzed.

We observed 42 patients with hard-to-reach localizations of vascular injuries and their consequences. Information and distribution of patients by hard-to-reach localizations of vascular injuries and their consequences, by sex and age averages 33.71 ± 15.59, $p<0.05$. Days of hospitalization averaged 15.75 ± 8.32, $p>0.05$. Of these: men - 35 (83.3%) and women - 7 (16? 6%). The main cause of vascular injury is stab wounds. When examining patients revealed: swelling and local swelling; pathological changes in the skin over swelling. Auscultatory hum was heard in the aneurysmal sac. We have established a change in the nature of the pulse on the injured limb, from clear to sharply weakened. The most effective condition for the treatment of vascular injuries and their consequences is their early diagnosis based on a treatment and diagnostic algorithm. When performing REVO, high-quality treatment is extremely important, on which the success of surgical interventions and the effectiveness of using hybrid technology in hard-to-reach vascular injuries and their consequences depend. The effective use of endovascular total vascular occlusion creates favorable conditions for the bloodless and convenient elimination of JA, TAVF and aneurysms by surgical intervention. The results of this treatment method show the effectiveness of various hybrid interventions: stent - graft for iatrogenic TAVF of the iliac artery and REVO. At the same time, REVO and stent-graft were not performed in group 1(CG).

Analysis of the immediate and long-term results of operations in hard-to-reach localizations using hybrid technologies showed differences between CG and MG, and the results were reliable and statistically significant. Immediate results in: CG good - 34 (80.9%); satisfactory - 8 (19%); MG: good-13 (93%); satisfactory - 1 (7%). Long-term results in: CG: good-15 (75%); satisfactory - 5 (25%), MG: good - 9 (81.8%; satisfactory - 2 (18.2%) completed. As can be seen

from the results of the study, the developed diagnostic and treatment algorithm and the use of REVO are the most effective methods of treating injuries vessels and their consequences.

In a further study, in: 41 (97.6%) patients, wound healing was primary; 1 (2.3%) - healing occurred by secondary intention.

CONCLUSION

In recent years, significant progress has been made in vascular surgery. It is associated with: the development of early diagnostic methods; introduction into clinical practice of advanced methods and types of reconstructive and restorative operations; optimization of equipment and technology of surgical interventions; the use of microvascular instruments and new suture materials, which radically changed the outcome of the treatment of patients with vascular injuries and their consequences. We have analyzed the theoretical and practical issues of the clinic, diagnosis and optimization of the choice of methods for the surgical treatment of traumatic vascular injuries and their consequences.

Based on the analysis of the studied materials, we have established methods for early diagnosis and the introduction of optimal methods, methods and types of reconstructive and restorative operations. Recent years have been characterized by a sharp increase in the number of injuries accompanied by damage to the main vessels.

Today, depending on the indications and technical (in a broad sense) possibilities, both ligation of the vessel, exhaustive reconstructive surgery or EP with immediate or delayed revascularization, and covering an increasing area of damage of various localizations, can be applied. The use of selective differentiated tactics in this variant makes it possible to minimize the number of deaths among the victims and those delivered, incl. in the terminal state, as well as the percentage of amputated limbs.

Unfortunately, some severely damaged limbs cannot yet be salvaged. These include: cases of irreversible ischemia and destruction (tears of limbs). Our studies and studies of outstanding domestic predecessors have shown that in case

of an injury accompanied by extremely severe ischemia of the limb with the development of partial contracture, it is possible to save the limb, the function of which in the long-term period will be completely or almost completely restored. The provision on irreversible ischemia, in modern conditions, is no longer a dogma. With the general trend towards an increase in the "energy" of injuries in peacetime and wartime, the overall severity of the condition of the wounded entering the hospital also increases. In such clinical situations, it is impossible not to take into account the hemodynamic status of the patient when making a strategic and tactical decision.

It must be emphasized that untimely diagnosis and the wrong tactics for choosing the surgical treatment of traumatic vascular injuries lead to death, or to the development of severe complications and consequences, ending in the disability of the victim due to amputations of the limbs.

It has been established that the effectiveness of surgical treatment of traumatic vascular injuries depends on rationally organized angiosurgical care and timely correct diagnosis. Inaccurately diagnosed traumatic vascular injuries lead to: the development of post-traumatic aneurysms; the formation of post-traumatic arteriovenous fistulas; gangrene of the extremities; prolonged suffering; early disability and disability, and mortality. Therefore, a practical physician needs to constantly improve the method of clinical examination of patients with vascular injury and their consequences.

The main task of the prehospital stage and the general medical institution is the correct diagnosis and effective surgical treatment. In case of damage to blood vessels (arteries and veins), the following methods are of great diagnostic value; Ultrasound, MSCT, angiography, phlebography and others. With the help of these methods and technologies, the following is clarified: localization of vascular injury or its exclusion; the nature of the damage; degree of development of collateral circulation. This is achieved by: a reliable stop of bleeding; limb immobilization; carrying out anti-shock and resuscitation measures.

It should be emphasized that by analyzing the data obtained during the examination of patients and comparing them with the severity of the condition of patients in the provision of first aid in pre-hospital treatment we have established a high frequency of tactical errors during the treatment and transportation of patients.

So, in line with the above, the question arises, what is the tactics of surgical treatment of injuries of the vertebral artery in the spinal canal in the first segment? it is necessary to perform ligation from a typical supraclavicular or vertical access. When highlighting the artery on the left, it is necessary to ligate the thoracic lymphatic duct. Ligate all damaged lymphatics. The artery is isolated along its entire length from its mouth to the entry into the opening of the transverse process of the C6 vertebra and ligated.

During the operation of the injury of the vertebral artery in the second segment, if it is impossible to ligate the proximal segment of the transected artery, the canal of the transverse processes must be sealed with wax, tamponing with muscles.

Operations for wounding the vertebral artery in the third segment, bleeding from the ends of the vertebral artery, must be stopped by tamponing with muscles with deep sutures closer to the mastoid process of the temporal bone, where the vertebral artery is located most superficially in relation to the skin.

All the difficulties in the treatment of patients with combined osteovascular injuries are associated with the correction of shock and the normalization of hemodynamics. The complexity of choosing the optimal volume of surgery is directly dependent on: the patient's condition; the nature of the injury and the damaging effect of the traumatic agent. With combined injuries, there are a variety of methods and methods of treatment, their consistent use at all stages of operations.

Most researchers believe, and we agree with them, that first of all, primary restoration of the vascular defect is necessary. We believe that in case of osteovascular injuries stable fixation of fragments makes it possible to determine the true defect between the ends of the vessels and choose the desired variant of

the vascular suture or vascular plasty. The final fixation of the fracture of tubular bones by interamodullary osteosynthesis, to avoid their re-injury. To prevent thrombosis, patients were prescribed fresh frozen plasma (FFP) from 5 to 15 mg/kg, heparin from 150 to 250 U/kg, as well as broad-spectrum antibiotics before, during and in the postoperative period to prevent thrombosis.

The tactics of surgical treatment of osteovascular TAA are implemented in stages: stage 1 - drug treatment; stage 2 - rentgenendovascular method of balloon occlusion of vessels; Stage 3 - selection of the optimal access to the TAA operation; Stage 4 - elimination of traumatic arterial aneurysm; Stage 5 - fixation of a bone fracture by osteosynthesis and surgical reconstruction of the main vessels.

The main reason for the appearance of iatrogenic vascular injuries and their consequences is the lack of qualifications of practicing physicians, especially surgical in this problem. This is also associated with insufficient qualifications of nursing staff, especially those associated with procedural and operational-instrumental activities. In addition, this is due to the lack of special medical equipment and optimal technologies for their effective use.

It should be emphasized that the treatment of iatrogenic aneurysm is its excision of the aneurysm, followed by the imposition of a lateral or circular suture or vessel plasty.

The absolute majority of patients with iatrogenic aneurysm, who needed to be operated on in the first months after the moment of iatrogenic damage to blood vessels. It should be noted that the ligation of iatrogenic aneurysms is quite rare. In practice, reconstructive operations on vessels are widely introduced.

To optimize treatment tactics, we have developed a classification of iatrogenic vascular injuries and their consequences, as well as an algorithm for therapeutic and tactical actions in JA.

In practice, surgical treatment of iatrogenic vascular injuries is associated with the work of surgeons. In this regard, first of all, surgeons and angiosurgeons need

to constantly improve theoretical and practical training in the treatment of iatrogenic vascular injuries and their severe consequences.

In our work, we analyzed the methods of diagnosis and the results of surgical treatment of patients with traumatic injuries of the arteries of the extremities and their consequences. According to the RSSPMCH, for many years, the main cause of traumatic arterial aneurysm (TAA) was stab wounds, which led to damage to the main vessels.

Clinical diagnosis of TAA consists of a number of subjective-objective factors. So, according to the complaints of patients, the most significant are: ischemic disorders; compression of the nerve trunks by the aneurysm; local and general characteristics. In addition, there were observed: a feeling of fullness and fullness in the injured limb; accompanying them: swelling, stasis and pronounced venous pattern.

Examination of the patients revealed: edema, local swelling, pathological condition of the skin over the swelling. Auscultatory hum was heard in the aneurysmal sac. We noted a change in the nature of the pulse on the injured limb - from clear to sharply weakened. Based on the data obtained, in the differential diagnosis of TAA, we excluded a tumor, abscess, thrombophlebitis, phlegmon, aneurysms of other etiologies. Complications included aneurysm rupture and thrombosis. At the same time, urgent surgical intervention was performed according to the types of TAA: suppuration; aneurysm rupture and bleeding. Our experience of operations on TAA shows that postponing surgery for more than 5 months leads to complications, the growth of scar tissue and disruption of the architectonics of the neurovascular bundle. In the preoperative period, considerable attention was paid to restorative treatment. During the operation, the blood flow was more than 2 liters. Therefore, it is necessary to have a maximum supply (at least three liters) of blood substitutes and glucose solution. It should be noted that reconstructive surgery on vessels after 1 year is extremely difficult.

It should be noted that, according to our observations, in operated patients with TAA, optimal methods of surgical treatment in reconstructive and restorative

operations on the main vessels showed high efficiency. Experience shows that the best results of operations are obtained when patients with TAA are operated on in the early stages of the onset of traumatic aneurysms with REVO. Taking into account individual characteristics, we gave preference to autovenous prosthetics and direct suture. When preparing for operations, we always proceeded from the general condition of the victim and the localization of the TAA. Based on the generalization of the above, for an objective assessment and treatment, we have developed a treatment and diagnostic algorithm for TAA.

When diagnosing this pathology, first of all, it is necessary to pay attention to the presence of: a tumor-like formation and its size, systolic trembling and noise over the affected area. On the angiogram, there was a decrease in the contrast of the artery, the distal site of discharge into the venous bed through the fistula. The most informative method for the study of post-traumatic arteriovenous fistulas is multislice computed tomography, which allows non-invasive and more accurate assessment of the state of not only the arterial, but also the venous bed.

It must be emphasized that in operational terms, it is not easy to dissociate arteriovenous fistulas. Therefore, with post-traumatic fistulas, an individual approach and a combined method of treating a patient are important.

Summarizing all of the above, for an objective assessment and treatment of TAVF, we have developed a treatment and diagnostic algorithm for TAVF.

In conclusion, it should be noted that for this category of patients, surgical treatment can be implemented in stages: stage 1 - drug treatment; Stage 2 - rentgenendovascular temporary vascular occlusion; Stage 3 - selection of optimal access; stage 4 - elimination of aneurysm and separation of the arteriovenous fistula; Stage 5 - surgical reconstruction of the main vessels. The distribution of patients with hard-to-reach localizations of vascular injuries and their consequences by sex and age averages 33.71 ± 15.59, $p>0.05$.

In hard-to-reach localizations of vascular injuries and their consequences, an assessment of the clinical picture of the disease was taken into account. Hybrid technology based on rentgenendovascular balloon occlusion of the main arteries

creates favorable conditions for surgery. For this purpose, 6F interodes are placed on the femoral arteries. For endovascular occlusion, a 6x60 mm balloon catheter must be used. In this case, occlusion occurs at a pressure in the balloon from 9 to 10 atm. rentgenendovascular methods are highly effective both in identifying the source of bleeding and in its final elimination. The use of hybrid technology for conducting operations gave good and satisfactory results, up to 93-100%.

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TRAUMATIC VASCULAR INJURIES AND THEIR CONSEQUENCES

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брошюра и 3-монографий. Это подтверждается 33 книгами поэтических направленности.