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Post-Traumatic Pseudoaneurysm of Femoral Artery Associated with Arteriovenous Fistula in a 32-Year-Old Male Patient (Clinical Observation)

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ABSTRACT The presented clinical case demonstrates the hybrid imaging SPECT/CT-angiography solutions in the diagnosis of post-traumatic femoral artery pseudoaneurysm combined with arteriovenous fistula. The presented case shows the effective use of CT and radionuclide medicine which allowed detailed of blood flow and tissue perfusion of lower extremities as well as an outcome of surgical treatment to be evaluated.

Keywords: post-traumatic arteriovenous fistula, pseudoaneurysm, CT-angiography of lower extremities, SPECT/CT

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AVF – arteriovenous fistula
CT-angiography – computed tomography and angiography
MIP – maximum intensify projection
SPECT/CT – single photon emission computed tomography
VRT – volume rendering technique

INTRODUCTION

Arteriovenous fistula (AVF) is an abnormal connection between the arterial and venous systems. They can occur in any area of the body, be single or multiple, congenital or acquired (for example, as a result of trauma). Human anatomy involves the location of arteries and veins in close proximity to each other. In case of injury, this contributes to the combined damage to the artery wall and vein. With minor wall defects, the arteriovenous connection may spontaneously close. In certain situations, the communication between the artery and vein persists, turning into 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 vein [1]. In addition, damage to the walls of blood vessels with an outflow of blood into the paravasal structures can lead to the formation of false aneurysms. Large AVFs can cause hemodynamic changes due to shunting blood flow from an arterial vessel (with high resistance) to a venous vessel (with lower resistance). A variety of complications that develop during the long-term existence of AVF dictates the need for timely and comprehensive diagnostics for the further selection of the optimal treatment method for AVF and the prevention of a whole cascade of hemodynamic and trophic disorders.

Clinical case

A 32-year-old male patient N. was admitted to the N.V. Sklifosovsky Research Institute for Emergency Medicine with complaints of bursting pain in the lower third of the left thigh, swelling of the left lower limb, intensifying after physical exertion. Over the last few years he noted rises in blood pressure up to 170/90 mm Hg. Upon examination, an increase in the volume of the left lower leg with skin induration, the presence of varicose saphenous veins at the level of the lower leg and knee area attracted attention . On the anteromedial surface of the lower third of the left thigh, an area of expanded pulsation was determined, with pronounced systolic murmur; on the posteromedial surface, a dense volume formation 9x6x6 cm in size was palpated.

From the anamnesis, it is known about a knife wound to the lower third of the left thigh 12 years ago, then the initial surgical treatment of the wound was performed. Later, the patient was not examined, did not seek medical help. Over time, pain in the lower extremity occurred and began to increase, cyanosis and tightening of the skin of the left tibia appeared, and varicose veins of the saphenous veins of the left tibia formed. The last few months the patient have been worried about swelling of the left leg after exercise and weakness in the limbs during exercise.

Upon admission, the data of laboratory tests were within normal limits, an ultrasound examination of arteries and veins, computed tomography angiography (CT-angiography) and three-phase limb scintigraphy with ^{99m}Tc-pirfotech on a SPECT/CT hybrid apparatus were performed, combined with an X-ray computer tomograph.

Ultrasound of the arteries and veins of the lower extremities determined the dilation of the common iliac arteries and veins on the left, conglomerate from the arteries and veins, communicating with the popliteal vein in the left popliteal region, and varicose expansion of branches of the left great saphenous vein.

According to the CT-angiography, a contrast of venous vessels from the level of the inferior vena cava to the popliteal vein in the arterial phase of the scan was noted. At the level of the pelvis and thigh, dilation of the iliac arteries and veins was detected (the maximum diameter of the external iliac artery is 26 mm, the external iliac vein is 42 mm), and dilation of the distal inferior vena cava was revealed (Fig. 1). The fistula between the distal parts of the femoral artery and vein (at the border with the popliteal) was visualized. In the lower third of the thigh, a false aneurysm was determined at the AVF level in the structure of the short head of the biceps muscle with the presence of an aneurysmal sac with blood flow in it and calcification at the level of the upper pole.

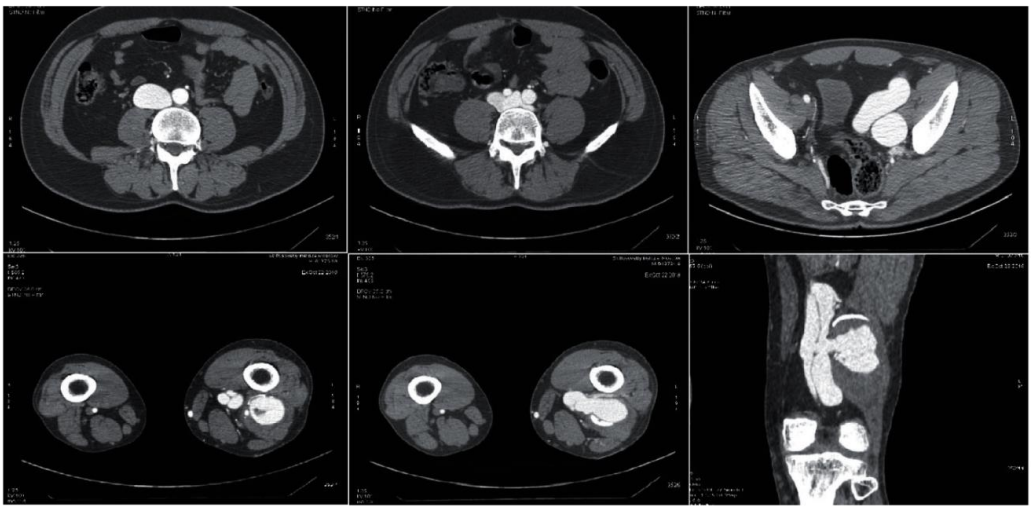

Fig. 1. CT-angiography of lower extremities: axial images and coronal reconstruction. Arterio-venous fistula at the level of distal left femoral artery is observed. Moreover, there is a large pseudoaneurysm of soft tissues in the lower third of the left thigh communicating with femoral artery via femoral vein

To assess the state of the microvasculature of the limb and determine the degree of tissue ischemia, three-phase scintigraphy was performed with ^{99m}Tc-pirfotech. The 1st phase (main blood flow) revealed a significant dilation of the femoral artery along its entire length with aneurysm in the distal section was determined; in the 2nd and 3rd phases (tissue and bone) the tissue blood flow of the left lower limb was preserved with slight swelling of the tissues of the left thigh and lower leg, insignificant infiltrative changes in the muscles of the lower leg and thigh due to microcirculatory disturbances were observed against the background of the altered venous outflow. Foci of necrosis, areas of lack of blood supply, signs of ischemia were not detected. A moderate increase in the accumulation of the radiopharmaceutical in the region of the knee joint (in the area of the expanded venous network, according to the CT-angiography) and in the area of the false aneurysm in the form of two foci was determined (Fig. 2).

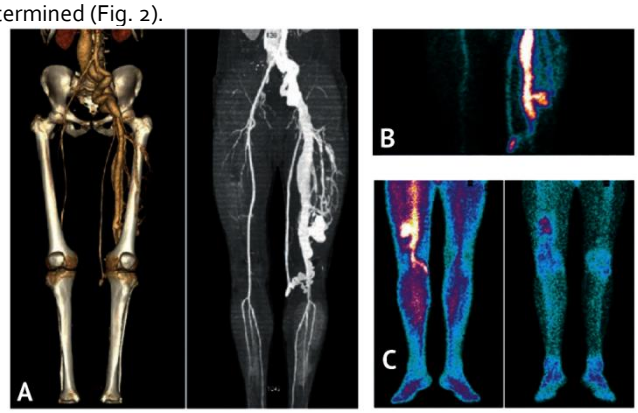

Fig. 2. Hybrid examination: A — CT-angiography of lower extremities: VRT and MIP (anterior projection). Dilated vasculature within the soft tissues of the left thigh, left iliac and femoral arteries and veins, as well as vena cava inferior and cavity of pseudoaneurysm filled with the contrast agent; B — radionuclide angiography (anterior projection): dilated femoral artery and pseudoaneurysm of distal femoral third; C — scintigraphy in soft tissue-phase and bone-phase (posterior projection): microcirculation disorder seen as increased radiotracer uptake in the region of knee joint and focal radiotracer accumulation in the cavity of the pseudoaneurysm

Due to the growing complaints of pain and swelling of the left lower limb and to prevent trophic and cardiovascular disorders, the patient underwent a planned open operation to dissociate AVF.

A follow-up examination (CT and three-phase scintigraphy with ^{99m}Tc-pirfoteh) was carried out on the 7th day after the operation. According to the CT-angiography: no previously detected flow of arterial contrasted blood into the venous system; on the left, the lumen of the arteries (from the level of the common iliac artery to the level of the aneurysm) remained widened; there was no contrast of the cavity of the false aneurysm. A decrease in the diameter of the dilated veins was noted mostly at the level of the preoperative maximum expansion of the external iliac vein with a diameter of 30 mm (previously 40 mm). There was postoperative soft tissue edema at the level of the middle and lower third of the thigh and in the knee area on the left (Fig. 3).

Fig. 3. CT-angiography of lower extremities before (left image) and after (right image) surgical separation of arterio-venous fistula, VRT (posterior projection)

The three-phase scintigraphy in the 1st phase (main blood flow): when examined in dynamics — arterial blood flow was not impaired, the cavity of the aneurysm was not visualized; in the 2nd and 3rd phases (tissue and bone) there was an increase in edema of the tissues of the left thigh with a decrease in edema of the tissues of the lower leg; An increased accumulation of radiopharmaceutical in the region of the knee joint continued, with a tendency to aggravate changes caused by an increase in venous outflow from the distal parts of the left lower limb (Fig. 4).

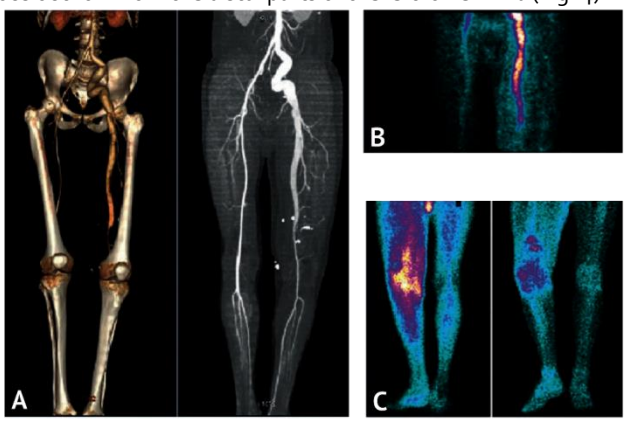

Fig. 4. Hybrid examination on day 7 after surgical treatment: A — CT-angiography of lower extremities: VRT and MIP (anterior projection); B — radionuclide angiography (anterior projection): unaltered arterial blood flow, pseudoaneurysm cavity is not detected; C — scintigraphy in soft tissue-phase and bone-phase (posterior projection): increasing of perfusion disorder in the region of knee joint due to recovery of venous outflow from distal region of the lower extremity

The patient was discharged on the 10th day after surgery with a significant regression of edema of the left lower limb and the absence of pain.

DISCUSSION

The formation of post-traumatic AVF and pseudo-aneurysms is a consequence of inadequate vascular revision during the initial surgical intervention in the early diagnosis of trauma [2, 3]. It often takes more than one year from the time of injury to the the diagnosis and treatment aimed at correcting secondary manifestations, which does not bring the proper result [4].

A false aneurysm is a connective tissue cavity located outside the vessel, but communicating with its lumen. The formation of such a cavity is the result of the formation of a hematoma in the tissues [5]. A few days after the outpouring of blood, a fibrinous sac begins to form, and 2-3 weeks later the hematoma wall tightly binds to the surrounding structures with the newly formed connective tissue. By the 2nd – 3rd month, a dense wall forms, which inner surface is not covered by endothelium. In addition to the risk of hemorrhage, pseudoaneurysms in combination with AVF are dangerous for arterial embolism and the development of acute ischemia of the distal limb segments or venous embolism with a clinical picture of pulmonary embolism, since the aneurysm sac contains thrombotic masses. In some cases, aneurysm may be complicated by acute deep vein thrombosis of the lower extremities [6]. Pseudo-aneurysms manifest themselves as a tumor-like formation with possible edema and pain (due to compression of the surrounding structures and ischemia of the distal parts) [2, 3].

The formation of AVF creates the conditions for a pulsating, highly resistant blood flow in a vein with a simultaneous drop in peripheral resistance in arterial vessels, followed by a compensatory increase in stroke volume and cardiac output. In case of damage to large vessels, this pathogenetic link leads to decompensation of cardiac activity, which can regress after elimination of

the anastomosis. Another consequence of the discharge of blood from the arterial system is a decrease in blood flow to the limb, which can lead to the emergence or worsening of the symptoms of its ischemia [7]. Due to the increased blood flow to the right heart, pulmonary congestion develops, which leads to chronic pulmonary hypertension. The reflux of arterial blood also leads to the development of venous hypertension with the formation of valvular insufficiency, pathological vertical reflux and, as a consequence, varicose transformation of superficial veins, and subsequently to the occurrence of trophic disorders, including edema, pigmentation, sclerosis and ulceration [8]. Arterialization of the outlet venous segment causes proliferation of the endothelium and muscle fibers, an increase in the diameter of the vessel, which creates additional difficulties for surgical reconstruction [6].

Traditionally, minimally invasive research methods, such as ultrasound, CT, magnetic resonance angiography or invasive angiography, are used to diagnose AVFs [9]. However, these research methods, providing an assessment of blood flow in the main vessels, do not provide sufficient information about the state of the microvasculature. In contrast, three-phase scintigraphy with ^{99m}Tc-pirfotech allows us to evaluate tissue blood flow, detect ischemia, infiltrative and necrotic changes [10]. In this clinical case, the patient had symptoms indicating secondary trophic and hemodynamic complications after trauma. The use of a hybrid diagnostic method (scintigraphy and CT) allowed some problems to be resolved simultaneously. The CT-angiography method revealed changes in the vascular bed, made it possible to determine the topographic relationship of blood vessels and surrounding structures, the presence of reflux of contrasted arterial blood into the venous system, to visualize the anastomosis and cavity of pseudo-aneurysm, to verify the absence of thrombosis and embolism requiring urgent surgical treatment. Three-phase scintigraphy with ^{99m}Tc-pirfotech confirmed the absence of lower limb tissue ischemia, which allowed the patient to be operated on as planned, limiting the amount of surgical intervention by separation of the arterial and venous channels. MRI could also help in obtaining data on the state of soft tissues and the diagnosis of ischemic changes. However, in this study, lower limb scintigraphy supplementing CT-angiography with an assessment of tissue blood flow in a single hybrid study appeared to be sufficient and comprehensive. The postoperative monitoring by a hybrid method with an increase postoperative edema allowed to verify the absence of bypass flow paths, as well as exclude the presence of postoperative complications, such as arterial thrombosis, ischemic at stated failures of the lower limb at the level of the microvasculature.

CONCLUSION

This clinical example demonstrated the advantages and effectiveness of using the hybrid method (SPECT/CT) in the study of the main and tissue blood flow and paravasal anatomical structures of the lower extremities for the diagnosis of arteriovenous fistula and its complications, as well as evaluating the results of surgical treatment.

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