ENDOVASCULAR ARTERIALIZATION OF DEEP CRURAL AND PEDAL VEINS IN A PATIENT WITH CRITICAL LOWER LIMB ISCHAEMIA

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Described in the article is a clinical case report regarding complete endovascular arterialization of deep crural and pedal veins in a male patient with accompanying pathology and impossibility of intraluminal restoration of the arterial bed. Peculiarities of the presented case report consisted in creation of an arteriovenous anastomosis in the upper third of the crus using an endovascular technique. During treatment, a repeat intervention was required, i. e., balloon angioplasty of veins and implantation of an additional stent graft due to reocclusion of veins because of long-term local treatment of wounds and cytostatic therapy for background diseases (chronic myeloleukaemia and rheumatoid arthritis). The performed treatment resulted in a clear trend towards healing of the wounds on the foot and limb salvage.

Key words: *arterialization, lower limb critical ischaemia, atherosclerosis, amputation, stent graft.*

INTRODUCTION

Arterialization of deep veins of lower limbs was used in patients with critical ischaemia of lower limbs in atherosclerosis with accompanying diabetes mellitus, as well as thrombanginitis as a method of revascularization for severe lesions of arteries of the crus and foot before the advent of endovascular methods of revascularization [1].

Methods of endovascular restoration of the lumen of arteries significantly enhanced the capabilities of vascular surgery and made it possible to restore completely occluded arteries of the crus and foot with reconstruction of the arterial arch. Along with it, classical arterialization of the venous bed was often abandoned in favour of more efficient methods of treatment. The results of limb salvage in such operations were significantly better, the limb salvage rate increased, with no requirement for an extraanatomic variant of treatment. However, according to authors, with gaining experience in interventions on arteries of the distal bed as well as increased severity of lesions (with increased age of patients and their survival), the following concussion was made: up to 20% of patients are resistant to traditional endovascular methods of restoring blood flow, with the presence of pronounced microangiopathy and high degree of calcinosis of arteries of the crus and foot [2, 3]. In this connection attention of the surgical society was again paid to methods of arterializations of the venous bed.

Arterialization as a method of revascularization in patients with severe lesions passed in its development several stages – from experiments on redirecting the switching the blood flow from the femoral artery to the femoral vein without destruction of the valvular system before the development of the special system with ultrasound guidance in order to create an anastomosis of the artery and vein on the crus using an endovascular method [4, 5]. Assessing the results of first operations it became clear that reversing blood flow required mechanical destruction of all valves of the venous system along the bloodstream. A.V. Pokrovsky, et al., in their studies demonstrated that more effective were arterializations of the deep vein system of the foot and complete destruction of pedal valves up to the venous arch of the foot [6, 7]. A.V. Gavrilenko, et al. made a suggestion that the remote results of arterialization for patency of the construction may be better in a series of cases than if perforating veins are not ligated [8].

As for endovascular arterializations, accidental

formation of an arteriovenous anastomosis is considered to be a commonly occurring iatrogenic complication of endovascular interventions, as a rule, with neither clinical symptoms nor negative consequences for the patient. But targeted creation of such an anastomosis requires special skills and instruments.

Our clinical case report describes the use of the technique of completely endovascular arterialization of the deep veins of the crus and foot using the standard endovascular instruments, with the achievement of the clinical affect sufficient for wound healing in a situation when intraluminal restoration of arteries is impossible.

Clinical case

A 67-year-old male patient P. diagnosed as having lower limb artery atherosclerosis with a distal form of arterial lesions – occlusion of arteries of the right crus and foot, as well as with an indolent necrotic wound on the big toe of the right foot after opening of a felon, followed by resection of the distal phalanx of the big toe of the right foot and carried out local treatment (Fig. 1).

On examination by a vascular surgeon, based on the clinical data and the results of instrumental study, the patient was diagnosed with chronic ischaemia threatened by limb loss WIfI 2-3-1, thus a high risk for extremity loss. Besides, the patient had for a long time suffered from chronic myeloleukaemia and rheumatoid arthritis, receiving constant antitumor and hormonal therapy – methylprednisolone 4 mg daily and imatinib 600 mg daily. At the moment of the operation the patient was in stable remission of these diseases.

The patient had 4 weeks prior to admission undergone at a vascular centre an attempt of roentgen-endovascular conduit revascularization of arteries of the crus, however due to extremely pronounced arterial calcification, recanalization of any crural artery had failed.

On admission, the patient presented complaints, besides a wound on the big toe, of rest and night severe pain in the right foot, disturbing the night sleep. At examination, the foot was of pale cyanotic colour, cold to touch, with no oedema. From the great toe the distal phalanx was removed – in this zone was a necrotic wound with a small amount of purulent discharge. Arterial pulsation on the foot was not determined, with duplex scanning demonstrating poor collateral blood flow on foot arteries. Blood tests showed no leukocytes, but the level of haemoglobin of 82 g/l corresponded to moderate severity anaemia regarded as a manifestation of the underlying disease on the background of cytostatic therapy. Anaemia represented additional risks in case of the development of haemorrhage during intervention and was a risk

Fig. 1. Appearance of the wound on the foot: view from the rear of the foot (A), view from the sole (B)

Fig. 2. Ultrasound-guided puncture of the posterior tibial vein

factor complicating the course of the wound process on the foot. Besides, permanent cytostatic therapy taken by the patient prevented the normal course of the process of wound healing on the foot.

A decision was made to attempt repeat revascularization on the right lower extremity in order to save it from high amputation, with impossibility of carrying out arterial recanalization – performing endovascular arterialization of deep veins of the crus and foot. In numerous attempts of conductive recanalization of crural arteries using various-rigidity conduits with support of balloon

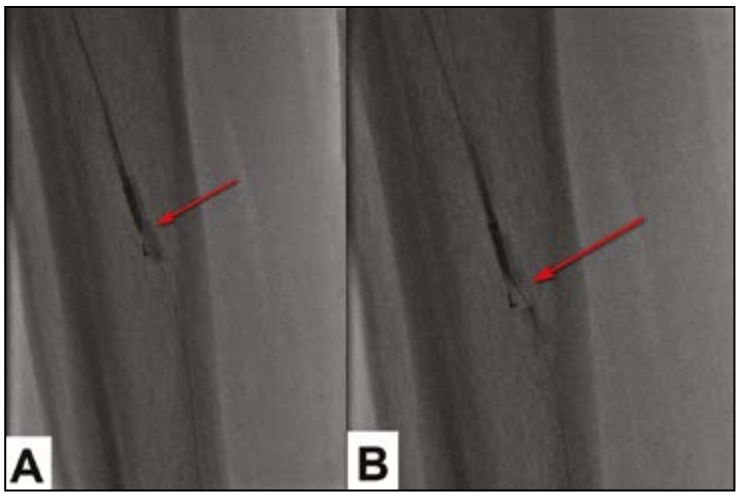

Fig. 3. Moment of puncture of the balloon catheter (arrow-indicated) present in the PTV (A) and insertion of the guidewire (arrow-indicated) from the PTA to PTV (B)

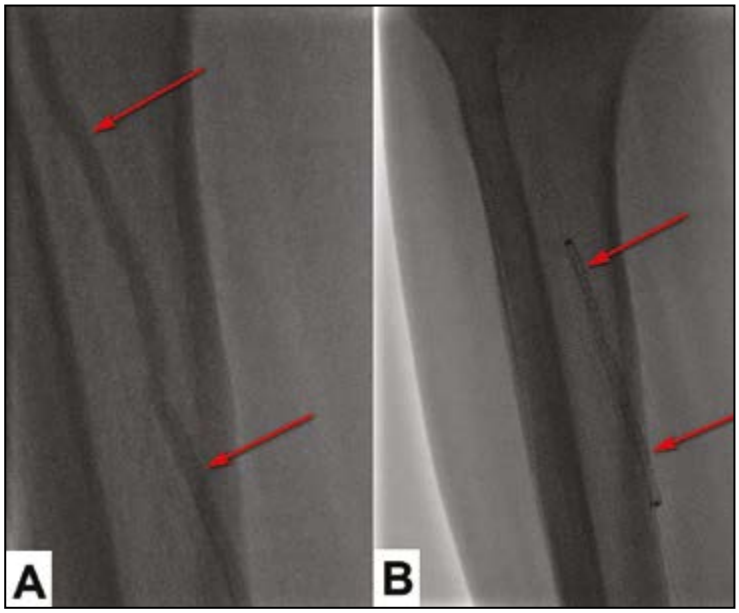

Fig. 4. Predilatation of arteriovenous fistula with a balloon catheter (A – arrows indicating the balloon catheter); implanted stent graft from the PTA to PTV (B – arrows indicating the stent graft)

catheters and microcatheters it became clear that the degree of arterial calcification really did not allow us to perform recanalization of arteries. Such high degree of arterial calcification could be associated with long-term taking of methylprednisolone by the patient. Intraoperatively it was decided to perform arterializations in several stages.

The first stage consisted in an ultrasound-guided approach to the posterior tibial vein (PTV) (Fig. 2), with a 5F introducer inserted into the PTV. Through the introducer along the blood flow inserted was a conduit along which – a coronary balloon catheter sized 3.5 x 20 mm, followed by its indeflation under the pressure of up to 4 mm Hg (Fig. 3). Then the filled with contrast medium balloon catheter was a reference point for venous puncture.

The second stage consisted in using a re-entry device Outback LTD (Cordis, USA) to puncture the balloon catheter from the side of the initial portion of the posterior tibial artery (PTA), with rupture of the balloon catheter indicative of inserting the re-entry device needle into the lumen of the vein, with a coronary guidewire being inserted along the needle into the lumen of the balloon catheter (Fig. 3). The balloon catheter was removed from the vein lumen, the guidewire inserted to the level of the introducer and below into the veins of the foot. The introducer was removed from the vein, followed by compression haemostasis.

The third stage consisted in performing predilatation of the arteriovenous anastomosis (PTA – PTV in the upper third of the crus) using another balloon catheter sized 3 x 80 mm, followed by implantation of a Fluency stent graft (BD, USA) sized 5 x 100 mm (Fig. 4).

The fourth stage consisted in inserting the coronary guidewire via the venous valves and venous arch of the foot, followed by a 4 x 80 mm balloon catheter used to perform stagewise dilatation of the catheter segment to 6 atmospheres in the veins of the crus and foot in order to destroy venous valves (Fig. 5).

The control angiograms demonstrated spasm of the venous system of the foot not relieved by administration of spasmolytic solutions. The intervention was completed with closure of the vascular access by an Angioseal VIP device (Terumo, Japan).

In the postoperative period the patient received Ca-channels inhibitors (amlodipine) in a minimal dose to cope with venous spasms, performing infusion of a 0.9% sodium chloride solution and spasmolytic solution (drotaverine hydrochloride) intravenously in drips.

The next morning, we noted significant warming of the foot, with the major blood flow along the PTV. According to the findings of duplex ultrasonic scanning the stent graft of the PTV distal to the stent graft, as well the veins of the foot were patent with major blood flow all along the line.

The patient was prescribed triple antithrombotic therapy – acetylsalicylic acid 100 mg daily, clopidogrel 75 mg daily, rivaroxaban 20 mg daily. The wound of the foot was topically treated, with certain positive dynamics in the form of a decreased amount

of wound discharge, appearance of hyperaemia and an inflammatory shaft along the edge of the wound.

However, after 2 months the patient had cold foot and occlusion of the stent graft and PTV. Angiography of the crus and foot was performed confirming occlusion of the *the implanted* stent graft and the vein.

We performed conductive recanalization of the occlusion followed by balloon angioplasty using a 3 x 120 mm catheter with restoration of the lumen of the veins of the crus and foot, as well as the foot venous arch below the previously implanted graft we inserted yet another stent graft Fluency 5 x 80 m for partial closure of the perforating branches on the crus (Fig. 6).

The postoperative period after redo repeat intervention was followed by warming of the foot, more pronounced positive dynamics of the wound process on the big toe (Fig. 7).

During the postoperative follow up, the patient adhered to the same regimen of antithrombotic therapy, however anticancer therapy was corrected – decreased doses of methylprednizolone to 2 mg daily and imatinib to 400 mg daily, with a clear trend towards wound healing on the foot.

DISCUSSION

The technique of arterialization of the crural and foot veins significantly enlarged the possibilities of revascularization when direct revascularization of the zone of lesion on the foot is impossible. In the absolute majority of cases for this purpose open arterializations was used. R. Ferrarezi et al. also described experience with hybrid (open and endovascular) arterializations of blood flow [9].

Endovascular revascularization, as a whole, expands opportunities for treatment of patients, allowing in failure of the classical approach to immediately in the roentgen operating room to switch to an extraanatomical variant. However, there are no specialized systems for carrying out such operations in Russia [10].

Unconditionally, the technique of performing endovascular intervention in order to arterialize crural and pedal veins requires discussion.

First, the more distal to the foot the anastomosis was applied the less is the length of the venous segment on the way of blood flow, consequently there are fewer perforant branches and collateral veins on which there comes early venous return of arterial blood and more haemodynamic pressure in the area of the wound. Besides, on the way of blood flow there are fewer venous valves creating a potential obstacle and theoretically being a substrate for of occlusion in the venous system.

Fig. 5. The moment of destruction of the valves of veins of the foot by a balloon catheter (arrow)

Secondly, destruction of the valvular apparatus on the way of retrograde blood flow is a necessary condition for successful functioning of the construction. In open surgery for this purpose there are specialized valvulotomes but their use in endovascular surgery is restricted limited by peculiarities of arterial access. Within the framework of a specialized set of instruments for arterializations (Limflow, France), a special valvulotome is used. Also for valvulotomy some authors suggest cutting balloon catheters. They could have been used in our case, but we resorted to a simpler method of destroying the valves – i.e., a balloon catheter

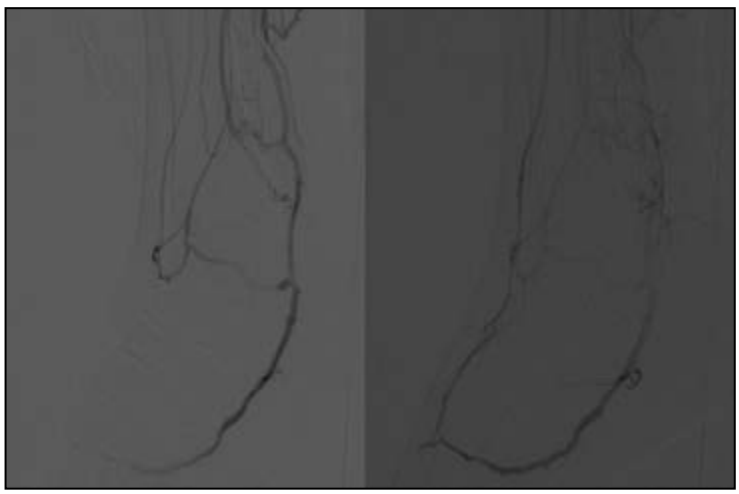

Fig. 6. Final angiograms of the foot after repeat arterialization of deep veins of the crus and foot

Fig. 7. Appearance of the wounds 14 days after repeat endovascular intervention

of enlarged diameter in relation to the vein.

Veins are prone to angiospasm, as well as arteries are, and in the described case due to performing balloon angioplasty of veins, we encountered a situation when angiospasm was so disseminated and protracted that superselective administration of spasmolytic agents was ineffective.

In some cases in arterializations of the blood flow they perform ligation of perforant veins in order to increase velocity of blood flow along the arterializated venous system. In our case report we attempted to perform closure of communicating veins in the proximal segment in the course of the first procedure of arterialization. However, in repeat intervention we closed the major part of communicating branches with the help of a second stent graft.

Based on our experience gained in this clinical case and literature data, it may be concluded that, if possible, it is necessary to use more protracted stent grafts (to the level of the ankle) or to apply an arteriovenous anastomosis as distal as possible. In this case it is provided greater efficacy of the primary intervention.

Thirdly, there are no explicit recommendations on postoperative follow up of patients, from the point of view of antithrombotic therapy and postoperative management of the wound. In the presented clinical case there was used one of the therapeutic regimen of following after carrying out venous stenting. Later experience with similar interventions would undoubtedly make it possible to work out the most efficient therapeutic regimens.

The patient's taking drugs for treatment of accompanying diseases – rheumatoid arthritis and chronic myeloleukaemia – created additional complications for treatment and wound healing, thus requiring to decrease the dosage of cytostatic drugs to minimal in order to increase efficacy of treatment of wounds and prevent infectious complications of the wound process in the postoperative period.

In a series of cases of revascularization in treatment of patients with critical ischaemia of lower limbs, repeat interventions may be required. Unconditionally, it is important to avoid them and to try to gain complete wound healing after the first revascularization. In the given case, a redo intervention made it possible to undertake appropriate actions in order to increase efficacy of venous blood flow and create the possibility for wound healing on the foot.

CONCLUSIONS

This clinical case report demonstrated capabilities of roentgenoendovascular surgery for arterializations of the veins of the crus and foot to obtain a clinical effect on relieving lower limb critical ischaemia and wound healing. Whereas previously such effects were achievable only with the help of open surgery methods, currently it is possible to perform such interventions completely using a minimally invasive technique. Gaining experience with such interventions will make it possible to more clearly formulate the indications for arterialization, will make the technique more advanced, rapid and unified, as well as will make it possible to work out an optimal algorithm for postoperative follow up of patients.

Conflict of interest: none declared.

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