Iatrogenic arteriovenous fistula with a saclike widening: alternative means of successful treatment

Szczególny typ jatrogennej przetoki tętniczo-żylnej z tętniakowatym poszerzeniem kanału oraz dostępne metody skutecznego leczenia tego powikłania

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Słowa kluczowe: pseudotętniak jatrogenny, przetoka tętniczo-żylna, iniekcja kleju tkankowego pod kontrolą ultrasonografii.

Abstract

We present 5 cases of iatrogenic arteriovenous fistulas in the unusual form of a channel with a saclike widening. Three of them were treated surgically, while the other 2 were successfully treated with compression of the inflow channel by percutaneous application of tissue glue into the region of the inflow channel and consequent stopping of the blood flow in the arteriovenous fistulas structure. Additional tissue glue application was performed to achieve arteriovenous fistulas sac embolization. This is the first time that such a complication has been treated with a nonsurgical method.

Streszczenie

Przedstawiamy serię 5 przypadków jatrogennej przetoki tętniczo-żylnej w nietypowej formie z workowatym poszerzeniem kanału. Trzech pacjentów było leczonych chirurgicznie, natomiast 2 – skutecznie kompresją napływowej części kanału poprzez przezskórną aplikację kleju tkankowego w okolice kanału, co skutkowało ustaniem przepływu w przetoce. Dodatkowe aplikacje kleju tkankowego wykonano, aby uzyskać embolizację komory poszerzonego kanału. Są to pierwsze opisy przypadków, kiedy tego typu powikłanie było leczone małoinwazyjną metodą.

Introduction

Invasive procedures involving arterial and venous catheterization are associated with the risk of complications [1–3]. Iatrogenic arteriovenous fistula (AVF) is a rare complication with a prevalence estimated at approximately 1.0–1.5% of all percutaneous vascular interventions [2, 4, 5]. Iatrogenic AVF may occur after arterial or venous catheterization [1, 3]. No morphological classification of this complication has been established so far. Our observation reveals 3 distinct forms of AVF morphology:

1) Type I –- a hole connecting both vessels (when they are next to each other),

2) Type II – a connecting channel (when both vessels are at some distance) and

3) Type III – a connecting channel that has widened in a certain section, forming a sac.

Only 4 cases of type III morphological form are described in the literature, and all of them were successfully treated surgically [6–9].

It the current paper we discuss 5 cases of this rare type III AVF, which were diagnosed at our centre in the last 6 years. Furthermore, we introduce a novel method of minimally invasive treatment of this complication that was applied in 2 of these cases.

Type III AVF is unusual because it can closely resemble iatrogenic pseudoaneurysm (psA). Both complications develop due to the lack of stasis at the puncture point of the artery and vein walls with the formation of a pseudo-canal and a sac. In both types, the colour Doppler flow mapping (CFM) image is similar, while in the continuous wave (CW) spectral Doppler, there is high-speed inflow to the sac but with a different spectrum. In cases of psA there are inflow and outflow phases, while in cases of AVF, a constant unidirection-

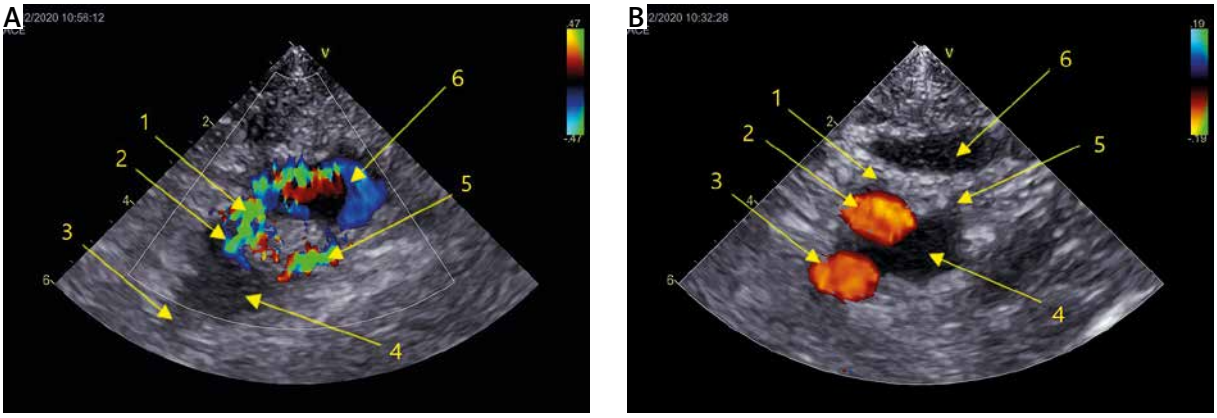

Figure 1. Ultrasound 2-dimensional transverse image with colour Doppler before (**A**) and after (**B**) arteriovenous fistula closure: 1 – inflow fistula channel, 2 – superficial femoral artery, 3 – deep femoral artery, 4 – femoral vein, 5 – outflow fistula channel, 6 – fistula sac

al flow with decreasing velocity is recorded. In addition, the type III AVF has an outflow channel through which a continuous flow is also recorded, but at a lower speed than in the inflow channel. The Doppler spectrum in the inflow channel and the presence of the outflow channel are crucial for the correct diagnosis.

Percutaneous ultrasound-guided thrombin injection (UGTI) is often the first-line treatment for psA [10–12]. If type III AVF is mistaken for psA, the unfortunate injection of thrombin (or any other procoagulant) to the sac of type III AVF may cause its rapid progress into the outflow channel and then into the central venous system where, after its activation, it may cause pulmonary embolism. Such a scenario occurred during psA embolization with concomitant orifice-type AVF (in this case, the inflow gate to psA and the inflow orifice to the AVF were on the opposite sides of the arterial vessel) applying UGTI with 100 UI of thrombin per injection [13]. On the other hand, a case of pulmonary embolism due to a spontaneous thrombus formation in the AVF was also described [14]. Therefore, it is very important to distinguish the morphology between type III AVF and psA.

In the case of saclike widening of the AVF channel, surgery should be considered in all cases, but sometimes concomitant treatment (especially single or dual antiplatelet therapy commonly used in patients undergoing percutaneous vascular interventions) may increase the risk of bleeding complications during surgery.

Case reports

From 2015 to 2021 we screened with ultrasonography approximately 2500 patients and diagnosed 3 cases of type III AVF. Two additional cases were referred from other departments where there was no routine screening for vascular complications following transcatheter interventions. We can thus estimate that type III AVF complicates around 0.12% of transcatheter interventions in our cardiology department.

Case number 1, a 70-year-old patient, was admitted to the hospital with acute coronary syndrome. He received dual antiplatelet therapy with aspirin and ticagrelor and underwent coronary angiography via transfemoral access. Case number 2, a 76-year-old woman with a history of paroxysmal atrial fibrillation, was admitted with myocardial infarction with ST-segment elevation (STEMI) and treated with a percutaneous coronary intervention (PCI) and dual antiplatelet therapy (aspirin + clopidogrel). She additionally received anticoagulation treatment with enoxaparin. In both patients a complication of vessel catheterisation in the form of type III AVF with a saclike widening developed (Figure 1 A). In both cases, the inflow channels to the AVF sacs originated from the right superficial femoral arteries and were over 12 mm in length. They were angled from the vertical plane by around 50–60°. The blood flow velocities in the inflow and outflow channels and the volumes (calculated with the ellipsoid equation) of the ellipsoidal sacs in the middle part of the AVF are presented in Table 1.

In both patients we applied a novel minimally invasive percutaneous treatment method: ultrasound-guided tissue glue injection near the fistula (UGTGINF). In both cases the AVF morphology was favourable: the inflow channels were quite long and sufficiently inclined from the vertical. This allowed the application of tissue glue (Tisseel-Lyo, Baxter Vienna) in the amount of 1.0 ml (500 IU of thrombin and 91 mg of fibrinogen) in one case and 1.2 ml in the other one, to the external region of the inflow channel, with the result of its effective compression and stopping the flow into the AVF sac (Figure 2). After confirmation with CFM and spectral Doppler that no flow was recorded into the AVF sac, for greater efficiency, the embolization of the sac was performed by injection of 2.0 ml of tissue glue into the sac (it was 0.5 ml in the case number 2). There was no recurrence of the AVF in the follow-up ultrasound examinations up to 12 days (Figure 1 B).

Table 1. Detailed information on 5 cases with type III arteriovenous fistula

Sex	Age [years]	Arterial flow velocity [m/s]	Channel length: inflow/outflow [mm]	Sac volume [ml]	Fistula flow velocity: inflow/outflow [m/s]	Treatment
Male	70	0.85	16/18	3.56	4.8/1.3	UGTGINF
Female	76	0.92	15/17	0.35	3.9/1.9	UGTGINF
Female	62	0.9	10/8	2.83	3.7/1.1	Surgery
Male	57	1.01	8/6	4.24	4.1/1.5	Surgery
Male	74	0.9	3/6	0.8	5.5/1.2	Surgery

UGTGINF – ultrasound-guided tissue glue injection near the fistula.

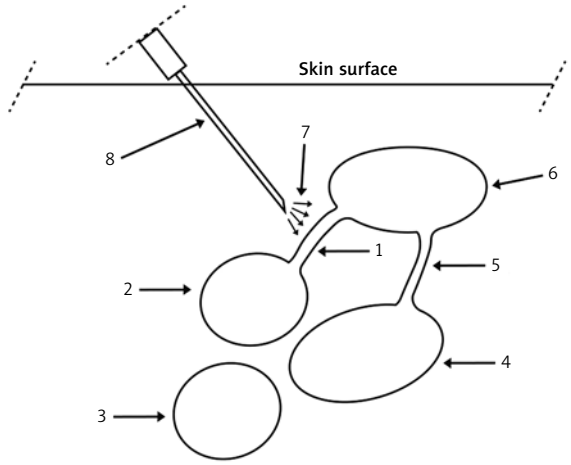

Figure 2. The scheme of arteriovenous fistula treatment by compressing the inflow canal with the use of tissue glue: 1 – inflow fistula channel, 2 – superficial femoral artery, 3 – deep femoral artery, 4 – femoral vein, 5 – outflow fistula channel, 6 – fistula sac, 7 – tissue glue application area, 8 – needle

Cases number 3, 4, and 5 (Table 1) were diagnosed with type III AVF following electrophysiology studies. In all cases the inflow and outflow channels from the AVF ventricle were shorter than in the cases treated with UGTGINF. Moreover, both the inflow and outflow channels were more vertical to the AVF sac (around 80–90° from the vertical plane). Those patients were referred for surgical treatment, which was successful and effective but took more time and required after-discharge rehabilitation, and was therefore also more expensive.

The therapeutic method used in this study has been approved by the Bioethics Committee of the Swietokrzyska Chamber of Physicians in Kielce. Written informed consent for the procedure was obtained from all patients before the treatment.

Conclusions

Type III AVF is a rare complication after arterial or venous catheterization. It is very important to distinguish the morphology between type III AVF and psA. The Doppler spectrum in the inflow channel and the presence of the outflow channel are crucial for the correct diagnosis. In the case of favourable morphology type III AVF may be treated with minimally invasive UGTGINF.

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Conflict of interest

The authors declare no conflict of interest.

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