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Case Report

Transvenous embolization of indirect carotid-cavernous fistula via puncture of the cubital vein and distal radial artery

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ABSTRACT

Carotid-cavernous fistula (CCF) is a pathologic communication between carotid arteries and cavernous sinus. The goal of endovascular treatment is to completely interrupt the carotid-cavernous communication with preserving normal blood flow in carotid arteries. Embolization can be performed via transarterial or transvenous access depending on anatomy and angioarchitecture of fistula. In this report, we present a 64-year-old woman with indirect CCF. Effective and safe embolization of indirect CCF was performed using distal radial access for diagnosis and navigation and cubital vein for simultaneous venous access for therapeutic endovascular manipulations, completely avoiding femoral access.

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Introduction

Carotid-cavernous fistula (CCF) is a pathologic communication between carotid arteries and cavernous sinus. Depending on etiology, anatomy and hemodynamics of lesion, CCFs can be classified into several types. According to the type of hemodynamics, CCFs can be divided into high-flow or low-flow fistulas. Depending on etiology, CCFs are post-traumatic and spontaneous. Anatomically, CCFs are classified as direct or indirect. Direct CCFs develop when there is a connection between the internal carotid artery and the cavernous sinus.

Indirect CCFs develop when there is a pathologic connection between branches of the carotid artery and the cavernous sinus [1]. The most common cause of CCFs is trauma, and it is the cause of 75% of all CCFs [2]. Occurrence of spontaneous CCFs reaches up to 30%, they usually occur in middle-aged or elderly women [3] suffering from hypertension.

Most common clinical signs of direct high-flow fistulas are proptosis, chemosis, orbital bruits, and headache [1]. Clinical presentation of indirect low-flow fistulas is less aggressive. Conjunctival redness is often the first clinical manifestation of the disease. Other common clinical signs of low-flow fistulas are arterialization of conjunctival veins,

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chemosis, proptosis, diplopia with ophthalmoparesis, cranial bruit, retro-orbital headache, increased intraocular pressure, and decreased visual acuity [1,4]. Instrumental diagnosis of CCFs begins with noninvasive neurovisualization (MRI or CT angiography). Noninvasive neuroimaging can find indirect signs of the disease, such as cavernous sinus enlargement, proptosis, superior ophthalmic vein dilation. But the gold standard for diagnosing of CCF is cerebral angiography [5].

The goal of treatment is complete interruption of carotid-cavernous communication with preserving the normal blood flow in carotid arteries. Endovascular embolization is the method of choice in treatment of CCF. Embolization can be performed via transarterial or transvenous access depending on anatomy and angioarchitecture of fistula. Transfemoral access is standard for neuroendovascular procedures.

Over the past decade, interventional cardiology has shifted emphasis toward using transradial access. After the publication of several large trials (ie, Radial vs Femoral Access for Coronary Intervention, Radial vs Femoral Randomized Investigation in ST Elevation Acute Coronary Syndrome, etc.), which showed a decrease in the incidence of local complications and even a decrease in mortality during transradial coronary interventions, large European communities in their recommendations indicate transradial access as the first choice for cardiac interventions [6,7]. In contrast to cardiologists, neuroradiologists use radial access less actively and most of them routinely use femoral access. But in some cases, it is not possible to perform transfemoral embolization. Thus, according to

1 study, anatomical features did not allow to perform cerebral angiography via femoral access for ischemic stroke in 5.1% of patients [8]. Under the influence of the experience of cardiologists, there has been an increase in reports of the use of transradial access in neurointerventions.

Transarterial embolization of indirect fistulas can be very challenging and can be associated with complications. In such case, transvenous embolization is used. Usually for transvenous embolization, the femoral vein is punctured first with further catheterization of the cavernous sinus through the inferior petrosus sinus or superior ophthalmic vein.



Fig. 1 – Physical examination before embolization showed exophthalm and right eye redness.

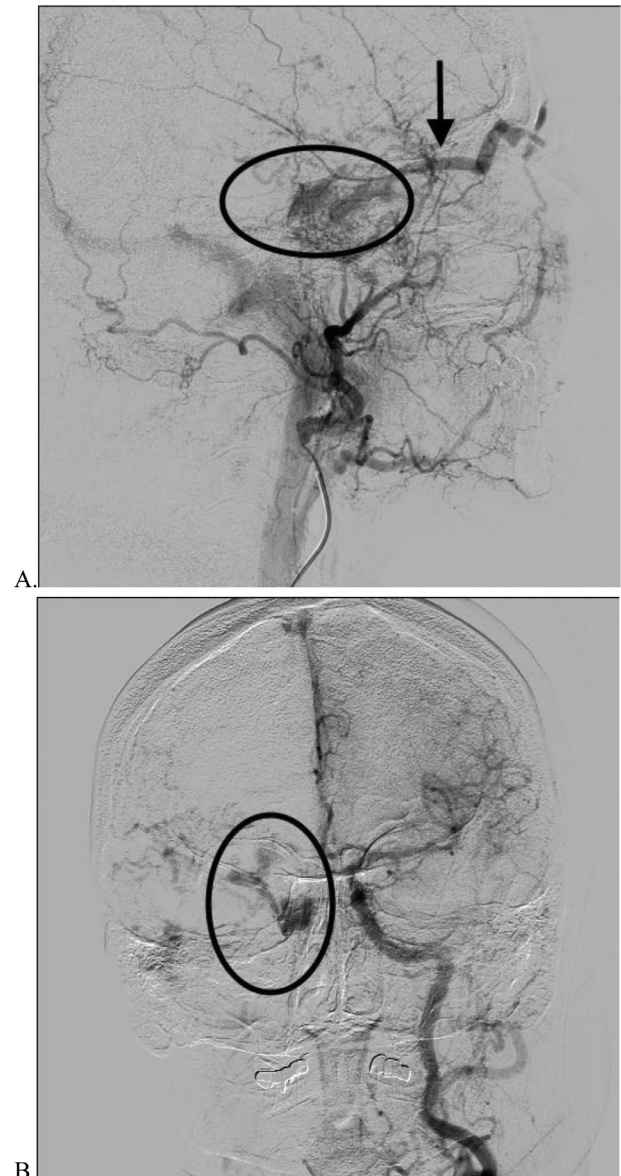


Fig. 2 – Preoperative carotid angiography. (A) Right external carotid artery (ECA) angio showed an indirect dural carotid-cavernous fistula (in the circle). Venous fistula drainage was carried out predominantly through the upper right ophthalmic vein (black arrow). (B) Right common carotid artery angio showed an indirect dural carotid-cavernous fistula (in the circle) filling from the left external carotid artery.

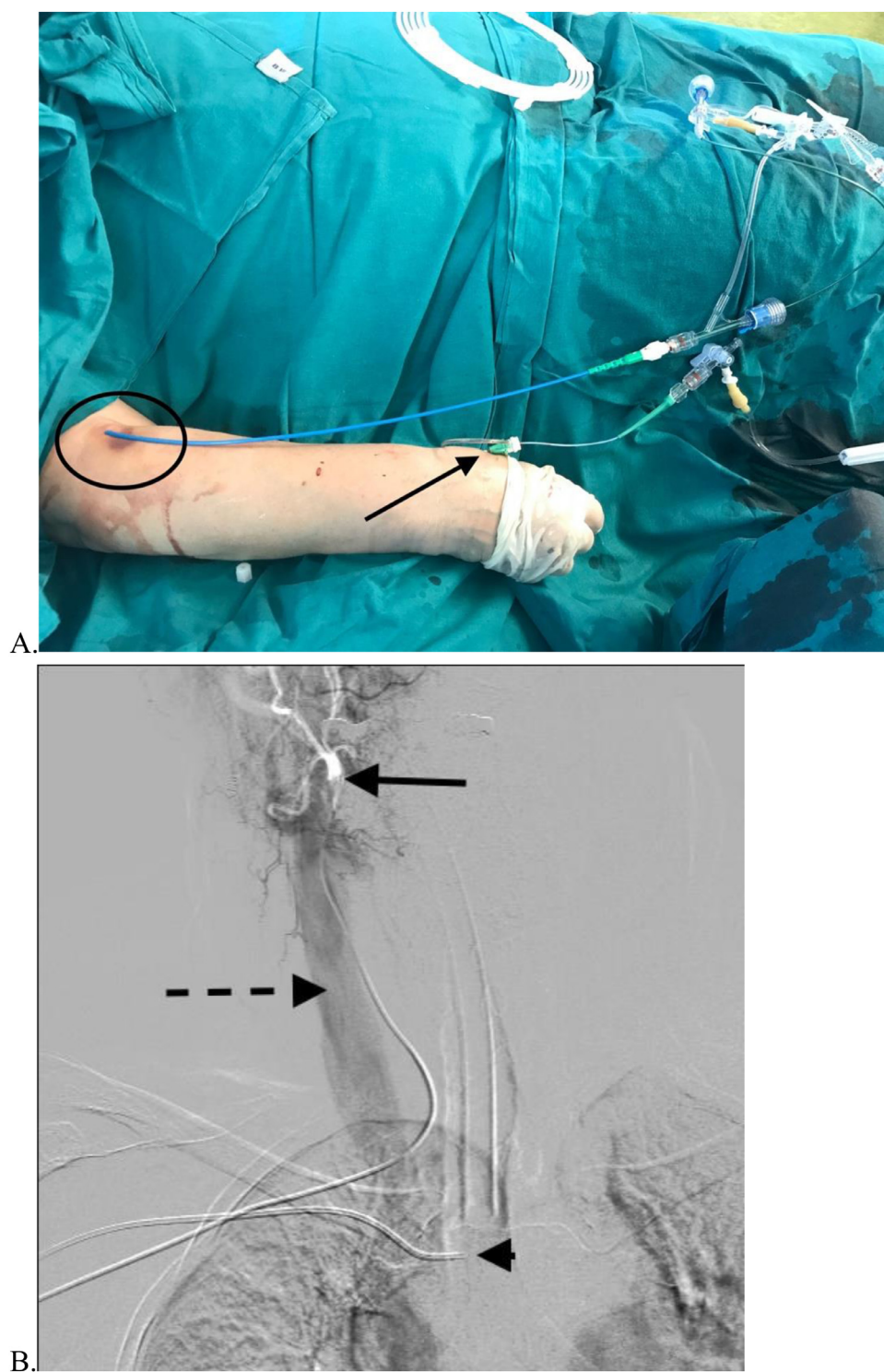


Fig. 3 – Arterial and venous access for embolization. (A). Arterial approach was obtained via introducer placed in distal right radial artery access in the anatomical snuffbox (black arrow). Transvenous approach was obtained via 6-Fr guide-introducer SheathLessPV 6 Fr placed in the cubital vein (in the circle). **(B)** Sim 3 diagnostic catheter was positioned in the right external carotid artery to infuse contrast agent and to perform transarterial navigation in the venous system (black arrow). Guide-introducer SheathLessPV 6 Fr (arrowhead), which was positioned in the cervical region of the right internal jugular vein (dotted arrow).

Embolization itself is usually performed by coils or liquid embolic agents. Transvenous access can also be used for treatment of wide range of neurosurgical diseases such as thrombosis of venous sinuses of the brain, arteriovenous malformation (AVM) of the vein of Galen, dural arteriovenous fistulas, and some AVMs. Transvenous access can be performed via the brachial, internal jugular, and even superior ophthalmic vein [9].

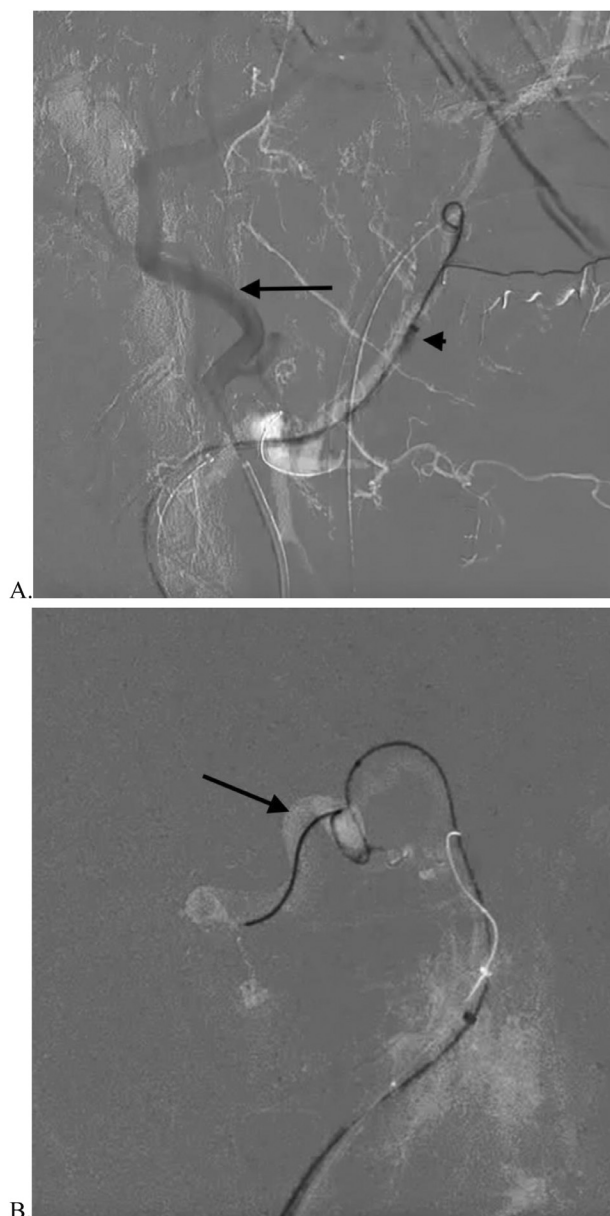


Fig. 4 – Catheterization of the right cavernous sinus. (A) Under the control of subtraction navigation during injection of contrast agent into the right ECA (black arrow), through a common facial vein, a distal access catheter Sofia 5 Fr was positioned in the distal region of the right facial vein (arrowhead). **(B)** Through the superior ophthalmic vein (black arrow), the Headway17 microcatheter was positioned in the cavernous sinus.

Case report

A 64-year-old woman had periodic headaches, pulsation in head, cranial bruits, proptosis, redness of the right eyeball, arterial hypertension 160 mm Hg and higher. Medical history of patient included arterial hypertension, allergic reactions to novocaine and brilliant green. There was no history of trauma. The first manifestation of the disease appeared 5 months before hospitalization, in April 2019, when patient first began to feel a pulsation in her head. About 1 month ago, patient began to notice redness and swelling of right eyeball, more pronounced in the morning. Magnetic resonance imaging (MRI) of the brain showed signs of CCF on the right side.

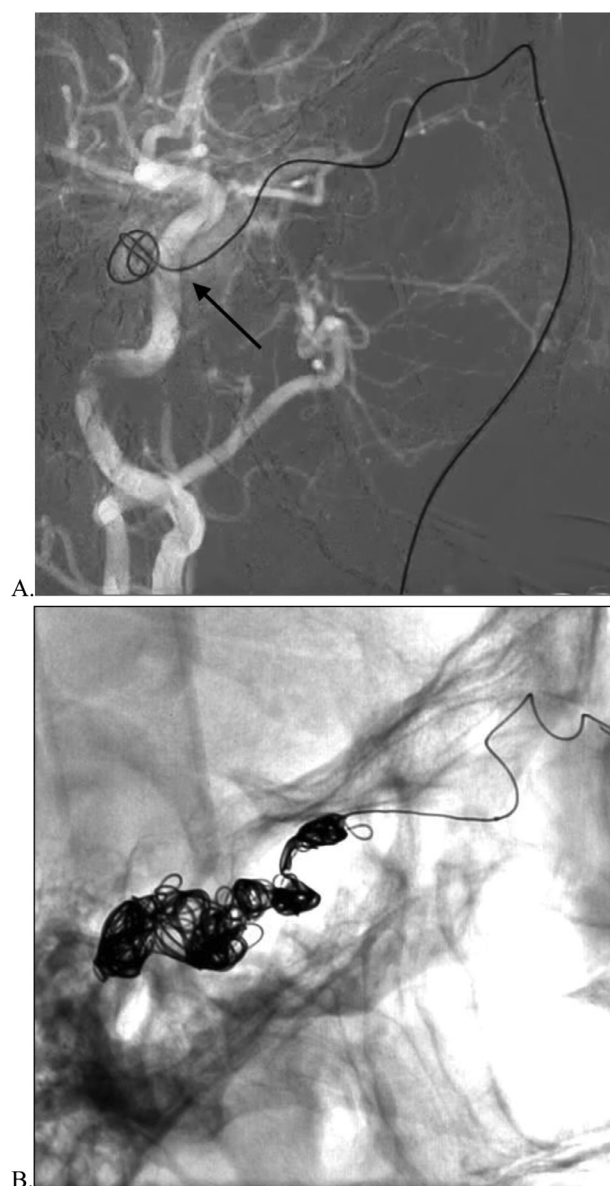


Fig. 5 – Embolization of the right cavernous sinus. (A) Implantation of the first coil in the right cavernous sinus (black arrow). **(B)** Seven detachable microcoils were implanted into the cavernous sinus.

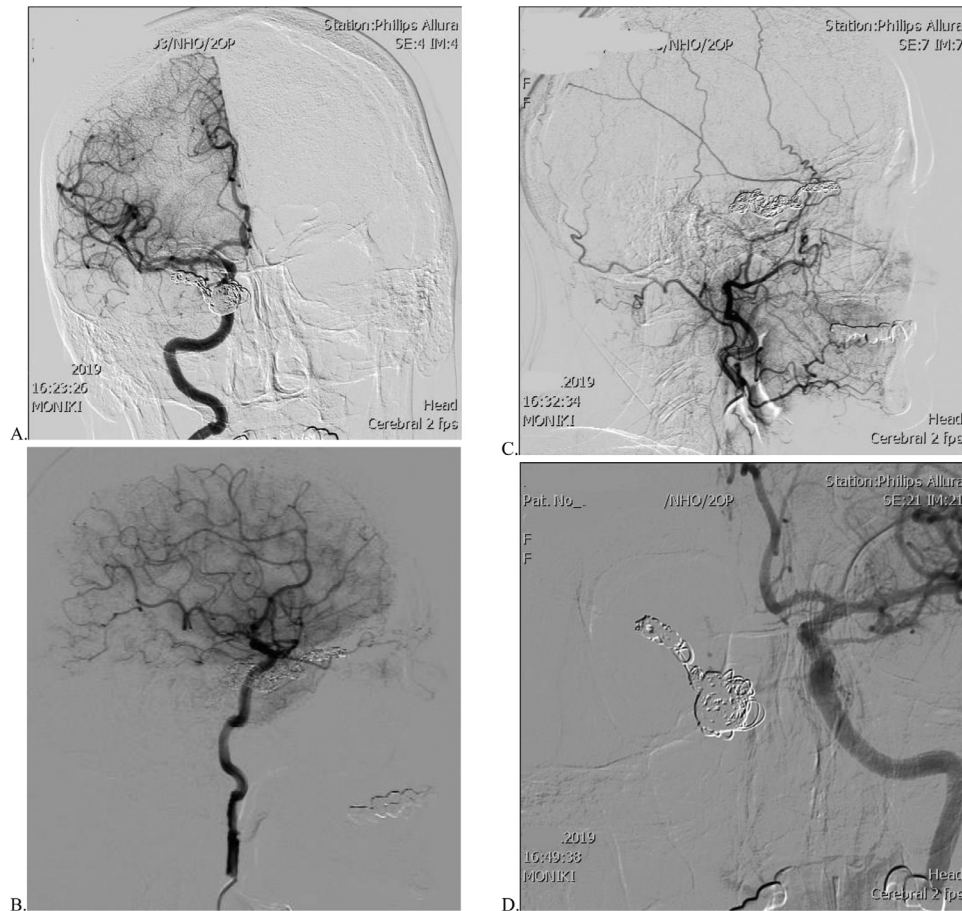


Fig. 6 – On control angiography from the right and left ICA total embolization of CCF was registered. (A) Right internal carotid artery angiography, AP view. (B) Right internal carotid artery angiography, lateral view. (C) Right external carotid artery angiography, lateral view. (D) Left internal carotid artery angiography, AP view.

In September 2019, patient was hospitalized in our clinic for diagnostics and surgical treatment. Physical examination demonstrated that eyes were still not equal, presence of exophthalmos of right eye, right eye redness, movements of the right eyeball were slightly limited (Fig. 1). It was decided to perform angiography with further embolization. Patient was admitted to CathLab of endovascular surgery department. Diagnostic cerebral angiography was performed under local anesthesia. Vascular access was produced via introducer placed in distal right radial artery access in anatomical snuffbox. Catheterization of all cerebral arteries was performed by a Sim 3 diagnostic catheter. Cerebral angiography showed an indirect dural CCF (type C according to the Barrow classification). Pathologic filling of the cavernous sinus in arterial phase was noted with the infusion of contrast agent into right and left external carotid arteries. Venous fistula drainage was carried out predominantly through the upper right ophthalmic vein (Fig. 2). It was decided to continue procedure with endovascular treatment of CCF. Due to indirect nature of CCF and inability to catheterize the cavernous sinus transarterially, it was decided to embolize the cavernous sinus with transvenous access. Patient underwent general anesthesia. Sim 3 diagnostic catheter was positioned in the right external carotid artery, to

infuse contrast agent and perform transarterial navigation in the venous system. Transvenous approach was obtained via 6-Fr guide-introducer SheathLessPV 6 Fr placed in the right cubital vein, which was positioned in cervical region of the right internal jugular vein (Fig. 3). Under control of subtraction navigation during injection of contrast agent into the right external carotid artery through a common facial vein, a distal access catheter Sofia 5 Fr was positioned in the distal region of the right facial vein. Further, through the superior ophthalmic vein (telescopic method), Headway17 microcatheter was positioned in the cavernous sinus (Fig. 4). Seven detachable microcoils (13 mm × 47 cm, 11 mm × 39 cm, 10 mm × 36 cm, 7 mm × 30 cm; 7 mm × 23 cm, 6 mm × 20 cm; and 5 mm × 20 cm) were implanted into the cavernous sinus (Fig. 5). On control angiography from right and left ICA, total embolization of CCF was registered. The cavernous sinus and initial section of the right superior ophthalmic vein were tightly filled with coils; there was a complete interruption of pathologic carotid-cavernous arteriovenous shunt (Fig. 6). Patient was extubated in CathLab, without additional neurologic symptoms and in a stable condition was transferred to neurosurgical department.

Immediately after surgery, patient noted a complete loss of pulsation in head, cranial bruits. On the first day after

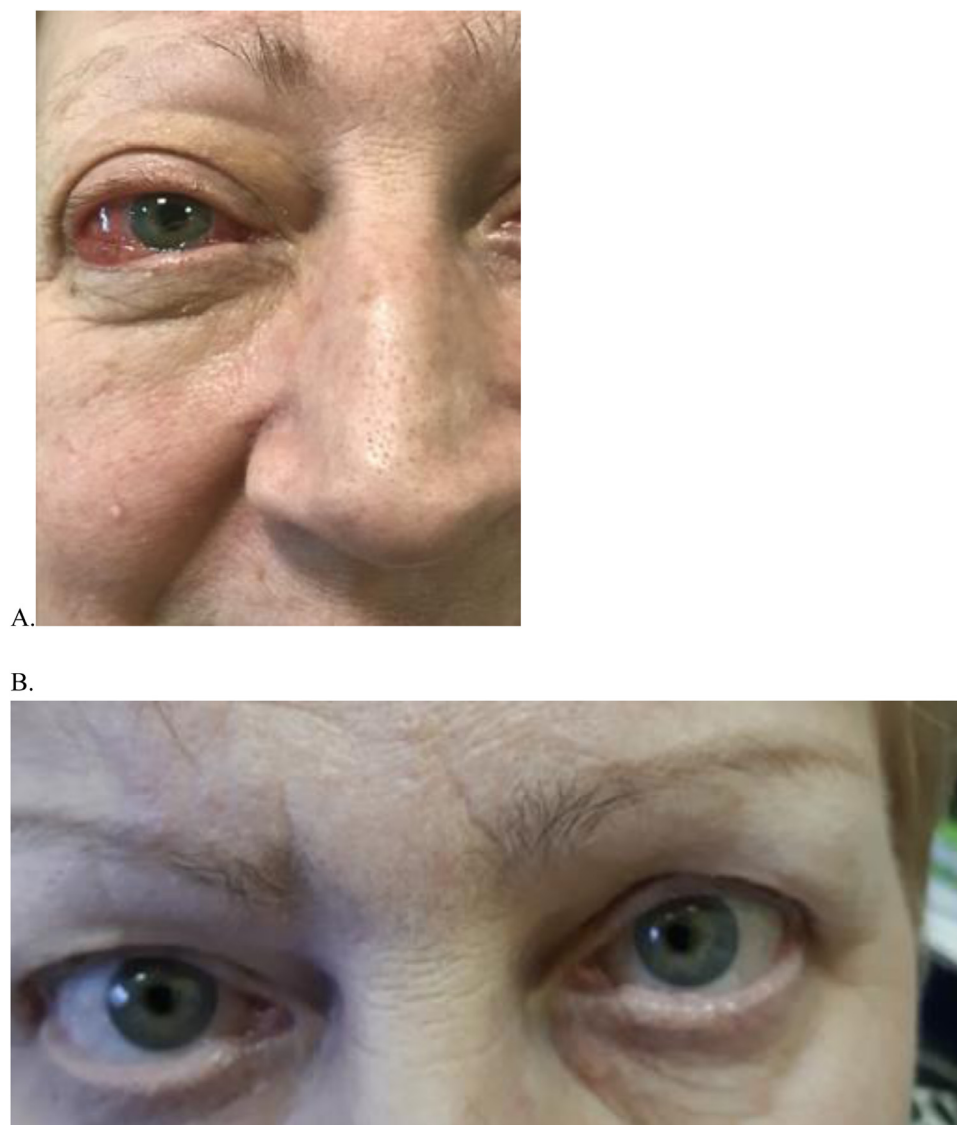


Fig. 7 – (A) Preoperative physical examination. (B) Follow-up examination 6 months after embolization (complete absence of exophthalmos, conjunctival chemosis).

surgery, right eye sclera redness became less significant. However, further growth of exophthalmos, conjunctival chemosis, increased intraocular pressure of the right eye was noted. Patient was consulted by an ophthalmologist. Considering good angiographic result of embolization, persistent absence pulsation in head and cranial bruits, these clinical ophthalmic changes were regarded as a consequence of hemodynamic rearrangement of venous blood flow. In agreement with ophthalmologist, conservative therapy was determined. Conservative therapy showed significant clinical improvement. We associate clinical improvement with an increase in venous collateral blood flow. At the follow-up examination after 6 months, a good clinical result was noted: a complete absence of pulsation in head, cranial bruits, exophthalmos, conjunctival chemosis, there were no signs of an increase in orbital pressure in the right orbit (Fig. 7).

Discussion

Indirect CCFs are difficult for both diagnosis and treatment, since clinical manifestations are not as pronounced as with direct CCF and access to the cavernous sinus is very challenging. The main aim of treatment is to interrupt the pathologic arteriovenous shunt. Surgical treatment of CCF is not very common. Endovascular treatment is the method of choice. Depending on anatomy of lesion, embolization can be performed both transarterially and transvenously. Transfemoral access has traditionally been used to perform all neurointerventional procedures [10]. However, under the influence of cardiologists routinely applying transradial access in their practice, neuroradiologists increasingly began to use transradial access. A series of publications has already appeared

demonstrating safety and effectiveness of transradial cerebral angiography [11]. Moreover, distal radial access is becoming more widespread in clinical practice of an interventional radiologist [12]. This access can be promising even to already reliable standard radial access for such indicators as: lower rate of occlusion, faster hemostasis, minimal risk of hand ischemia, greater comfort for patient and operator, the ability to leave additional arterial access options open for Crossover [13]. However, more studies, especially randomized studies and meta-analyses, are needed to have more evidence in favor of this access. In treatment of indirect CCF, transarterial embolization is often unavailable. Despite the fact that transvenous catheterization of the cavernous sinus is technically more difficult than transarterial catheterization in direct fistulas, sometimes this is the only possible way for treatment [14]. When it is necessary to catheterize the cavernous sinus through an ophthalmic vein, in some cases even direct puncture was used through open surgical access to the ophthalmic vein [9]. But currently, availability of modern catheters, micro-catheters and wires allows us to perform fully endovascular catheterization without open surgical access. In this case, we demonstrate an example of the use of arterial access for diagnosis and navigation, and transvenous access for therapeutic endovascular manipulations. Both arterial and venous accesses were performed through the right upper limb, without femoral access. Arterial access was performed through distal radial access in the area of the anatomical snuff box, venous access was via cubital vein. This technology allowed to perform safe and radical embolization of complex indirect CCF.

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