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*Michał Przyszlak, Tomasz Jargiełło, Maciej Szajner, Małgorzata Szczebo-Trojanowska

Endovascular Treatment of Extracranial Internal Carotid Artery Aneurysms

Wewnątrznaczyniowe leczenie zewnątrzczaszkowych tętniaków tętnicy szyjnej wewnętrznej

Department of Interventional Radiology and Neuroradiology, Medical University of Lublin
Head of the Department: prof. Małgorzata Szczerbo-Trojanowska

S u m m a r y

Introduction. The purpose of this article is to present endovascular treatment options for extradural ICA aneurysms and evaluate their usefulness based on treatment success rate and complications.

Materials and methods. We have treated 52 patients with extradural aneurysms, both true and false aneurysms, of the internal carotid artery (ICA) since 1999. Our techniques involved: stenting with bare and covered stents, primary coiling, remodeling with stent or balloon, ICA trapping and parental artery occlusion. Each procedure was performed after successful Balloon Test Occlusion (BTO).

Results. Endovascular treatment was successful in all cases. Two patients had a TIA one month after primary coiling and one patient had a major stroke after parental artery occlusion.

Conclusions. Our experience with extradural carotid aneurysms management shows that endovascular treatment of those lesions is both safe and efficient and should be considered a primary treatment option. However, good results depend heavily on proper choice of endovascular equipment and technique.

Key words: aneurysm, carotid, endovascular treatment

S t r e s z c z e n i e

Wstęp. Celem poniższego artykułu jest prezentacja wewnątrznaczyniowych metod leczenia zewnątrzoponowych tętniaków tętnicy szyjnej wewnętrznej oraz ich ocena pod kątem stopnia wyleczenia i występowania powikłań.

Materiały i metody. Od 1999 roku do dziś, w naszym zakładzie, 52 pacjentów było leczonych z powodu zewnątrzoponowych tętniaków (zarówno tętniaków prawdziwych, jak i rzekomych) tętnicy szyjnej wewnętrznej. Nasze metody obejmowały: stentowanie (stenty zwykłe, stenty pokrywane), implantacje odczepialnych spiral platynowych (czasem przy użyciu technik remodellingu z balonem lub stentem), zamykanie tętnicy macierzystej tętniaka. Każdą procedurę poprzedzała próba Matas'a.

Wyniki. Leczenie wewnątrznaczyniowe spowodowało pełne wyłączenie tętniaka z krążenia we wszystkich 52 przypadkach. Dwóch pacjentów miało epizod TIA około miesiąca po zabiegu (zamknięcie tętniaka odczepialnymi spiralami platynowymi). U jednego pacjenta wystąpił udar dokonany po terapeutycznym zamknięciu tętnicy szyjnej wewnętrznej.

Wnioski. Nasze ponad 10-letnie doświadczenie w leczeniu zewnątrzoponowych tętniaków tętnicy szyjnej wewnętrznej pokazuje, że leczenie wewnątrznaczyniowe jest bezpieczne i skuteczne. Jednakże dobre rezultaty zależą od wybrania odpowiedniej techniki wewnątrznaczyniowej.

Słowa kluczowe: tętniak, tętnica szyjna, leczenie wewnątrznaczyniowe

INTRODUCTION

Extradural internal carotid artery aneurysms are very rare. They are significantly less common than the intracranial aneurysms. Their incidence is still not established at this point. They also differ in clinical presentation. Symptoms include distal embolism (60%), a pulsatile mass on the neck, murmur, Horner's syndrome, headaches, tinnitus, vertigo and local mass effect. The most common location for extradural aneurysms is the ICA (Internal Carotid Artery), or less frequently, the VA (Vertebral Artery). In some very rare cases extradural aneurysms form on the ECA (External Carotid Artery) or it's branches. There is no single cause for extradural aneurysm formation. Typically those lesions can be secondary to atherosclerosis, vessel wall defects, trauma, infection, radiation, or special flow conditions. Sometimes there are no obvious underlying conditions and the etiology is unknown. The vast majority of extradural aneurysms interventional neuroradiologists and neurosurgeons encounter, are located in the cavernous

segment of the ICA (1). The anatomy of this location poses a major challenge for surgical treatment, wheras the endovascular approach in reaching aneurysms of these locations is relatively easy and safe.

According to one of the most comprehensive books for neuroradiologists, the Surgical Neuroangiography, the most common cause of extradural aneurysms is trauma. Authors also acknowledge that in the past, infectious aneurysms were much more frequent, but now are very rare. Finally, there are reports of false aneurysms after failed attempt to place a central line (1). In our department, we have been treating extradural ICA aneurysms since 1999. To this day we have treated 52 lesions of this kind. The purpose of this study is to demonstrate and evaluate the current endovascular treatment options employed in these cases.

MATERIAL AND METHODS

Since 1999 we have treated 52 extradural aneurysms in 52 patients (27 female, 25 male) with mean age of 36 years. Aneurysms varied in etiology, location, morphology and clinical presentation. Of 52 lesions, 24 where due to atherosclerosis, 19 were traumatic, 1 was infectious and the rest 8 were not connected to any underlying condition, therefore were considered to be of congenital/developmental origin.

The clinical of the aneurysm were: symptoms TIA in case 8, mass effect in 23, dysphagia in 2 and a pulsatile mass on the neck in 2 patients. Aneurysms varied in size with the mean diameter of 28 mm (range 5-56 mm).

Patients were qualified for endovascular treatment based on Doppler Ultrasound, CT-Angio or Digital Subtraction Angiography (DSA)

Before each procedure a Balloon Test Occlusion (BTO) was performed to assess efficiency of the circle of Willis. Under local anesthesia with 2% Lignocaine two 5Fr sheaths were introduced – one into each femoral artery, giving us access to the aorta with all of it's branches. A 5Fr Headhunter catheter was introduced and navigated to the ICA on the opposite side to the lesion. Using the second arterial access via the femoral artery a balloon was navigated through aorta and cervical vessels, and positioned in the aneurysms parental artery. Patients were given 5000 IU of heparin and aneurysms parental artery was occluded with the balloon. Contrast medium was then injected through the catheter placed on the other side. This showed if the collateral circulation through anterior communicating artery (AcomA) is sufficient according to neuroradiologic criteria (based mostly on the symmetrical filling of the cortical veins of both hemispheres). At the same time, each patients neurological status was examined. Should any neurological deficits or additional symptoms appear, the BTO would be terminated and patient disqualified from endovascular treatment (2).

All patients included in this study had sufficient blood circulation during BTO therefore were the candidates for the endovascular treatment.

All patients were treated under local anesthesia with 2% lignocaine. In each case via femoral arterial access an intraarterial sheath was introduced and a cerebral angiography was performed using 5Fr Headhunter catheter. After visualizing the aneurysm on the DSA, a "working projection" was established. It had to show the aneurysmal neck, dome and surrounding vessels anatomy.

Various methods were used to exclude an aneurysm from the circulation.

In primary coiling we have used platinum Detachable Guglielmi Coils (GDC) which were introduced to the aneurysmal sac through microcatheters (fig. 1).

Fig. 1. Internal carotid artery angiography, lateral projection. Internal carotid artery aneurysm before and after embolization with platinum detachable coils (GDC).

They form a soft metallic filling of the aneurysm and block the blood flow into the sac. In the long term they also cause aneurysmal sac thrombosis and endothelial proliferation (3).

Balloon assisted coiling is a relatively new method. Balloon positioned at the level of aneurysmal neck was blocking the blood flow from entering the aneurysm, which makes coiling safer. In case of aneurysmal wall perforation, the bleeding will not occur. Balloon protected coils from "falling out" of the aneurysm. This makes the procedure safer and enables better packing of the platinum coils in the aneurysmal sac (4, 5).

Stent assisted coiling is a procedure similar to the balloon assisted coiling, recommended for aneurysms with a very wide neck. Stent placed at the level of aneurysms neck kept coils in the aneurysmal sac and allowed for its denser packing (6-9).

Parental Artery Occlusion (PAO) is a method which leads to occlusion of the artery from which the aneurysm is originating. Using detachable coils the artery was oc-

cluded below the aneurysms origin, this blocked the flow into the aneurysm and caused thrombosis. This technique is useful if the aneurysms are very large and other endovascular treatment methods can't be used. "Trapping" technique is a variant of the PAO treatment. If it was possible to safely navigate the catheter to the distal part of the ICA passing through the aneurysm, coils were implanted in parental artery above and below the aneurysms origin (10, 11).

Stent implantation. This technique is very effective in cervical part of the ICA. Stent was implanted over the aneurysms origin and reduced the flow into the aneurysm causing its thrombosis. Covered stent were also used. They effectively blocked the blood flow into the aneurysm the very moment of their implantation (fig. 2) (12).

Fig. 2. Common carotid artery angiography, lateral projection. Internal carotid artery aneurysm before and after covered stent placement.

Our follow-up protocols consisted of Doppler Ultrasound examination the day after procedure, DSA after 6 months and a CT-ANGIO one year later. Should any of our follow-up examinations discover, insufficient occlusion of the aneurysm or in-stent stenosis or any unexpected outcome, second endovascular procedure was performed, and the follow-up protocol was restarted.

Doppler Ultrasound was helpful in evaluating patency of the stent, early intraaneurysmal thrombosis and changes in the blood flow.

We considered a six-month period to be long enough for the hemodynamic adjustments to become well established. If the DSA outcome was good, which was defined by the reconstruction of the arterial wall and no aneurysmal blood flow, we considered the procedure to be successful, and further DSA examinations to be unnecessary.

After 12 months, patients had a CT-ANGIO control examination.

RESULTS

26 patients underwent covered stent implantation, 10 underwent balloon-asisted coiling, 7 underwent primary coiling, 5 underwent stent-assisted coiling and 4 underwent parental artery occlusion. All 52 patients were successfully treated.

At the end of each procedure no intraaneurysmal blood flow was observed. Complications were registered in 3 cases. Two patients suffered a TIA one month after primary coiling and one patient developed a major stroke 3 days after parental artery occlusion.

On a 6 month follow-up DSA examination all aneurysms were occluded. On the CT-angio follow-up examination performed 18 months after treatment aneurysms did not recanalise in all 52 cases (100%).

DISCUSSION

Aneurysms of the extradural arteries are very rare and no specific guidelines for treatment have been established so far. A brief review of literature shows that most authors encounter mainly posttraumatic aneurysms of extradural region (1, 12). In their article about 24 aneurysms treated with covered stent, Isil Saatci et al., found this method to be safe (no complications during procedure or afterwards) and effective (100% occlusion rate and ICA reconstruction in each case) (12). Similiar results were reported by Redekop et al. in their article about treatment of traumatic aneurysms and arteriovenous fistulas with covered stents (13).

Interventional neuroradiology techniques are minimally invasive and offer many advantages over classical open surgery approach. The obvious advantage is the relatively easy access to the lesion. Because we don't have to deal with anatomical structures outside of the arteries (bones, nerves, ligaments, etc.), endovascular procedures are less complicated and has lower compilation rare. The main differentiating factor between neurosurgical and interventional radiology treatment is the invasiveness of the procedure and possible complication rate. Nowadays we have an ever-growing arsenal of dedicated devices at our disposal. Actually it wouldn't be an exaggeration to say that interventional radiology procedures are getting safer and more accessible every year (12). The equipment used for endovascular treatment is also constantly improved by the manufacturers. This progress is well mirrored in our study showing changes and evolution of methods used during more than a decade. The first aneurysms were given the primary coiling treatment. Then, special balloons were introduced which made coiling safer by keeping the coils inside the sac during the procedure. However some wide-necked aneurysms still required a constant support for the coils. Treatment of those aneurysms became possible with introduction of special stents that support the coils with their tightly packed mesh. More recently the covered stent has become an

option and additional coiling of the aneurysm is not required. It just blocks the flow into the aneurysm and reconstructs the arterial anatomy. Most of the aneurysms we encounter below cavernous sinus, were treated with the covered stents.

For the intracavernous aneurysms we used the parental artery occlusion option. Recently a special stent the flow-diverter was developed. Regarding characteristic this stent should be placed between classic and covered one. It achieves the flow-diverting effect of the covered stent without actually being covered. It relies on a dense metallic mesh, that is dense enough to reduce aneurysmal flow activities and thromboses the aneurysm, but not dense enough to block the blood flow into branches of the parent artery. This type of stent provide also a scaffold and stimulate growth of endothelium across the aneurysm neck.

Treatment of aneurysms with flow diverters is efficacious with low morbidity and mortality. The main complications are delayed aneurysm ruptures and in- stent thrombosis or stenosis (14).

The concept of parent vessel reconstruction is quickly advancing however this newly developed device still needs more clinical long-term follow-up. Varing endovascular treatment alternatives currently are available for the management of extracranial aneurysms, however an appropriate case selection is crucial for successful results.

CONCLUSIONS

Endovascular treatment of aneurysms originating from the extradural segments of the ICA, due to its satisfying long-term results and low rate of complications, should be considered as primary treatment.

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Address/adres:
*Michał Przyszlak
Department of Interventional Radiology and Neuroradiology,
Medical University of Lublin
ul. Jaczewskiego 8, 20-954 Lublin
tel.: +48 (81) 724-41-54
e-mail: ewamak@mri.am.lublin.pl