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Case Report

"Stent-within-a-Stent" technique for the endovascular treatment of giant aneurysm of basilar artery bifurcation: A case report[☆]

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ABSTRACT

Stents have become very important devices in the treatment of intracranial aneurysms. Flow diverters as high metal coverage stents are developed for hemodynamic treatment of challenging intracranial aneurysms. High level of metal coverage can also be achieved by implementing regular stents telescopically one in another. We present the case of a patient successfully treated for giant aneurysm of basilar artery bifurcation by a "Stent-within-a-Stent" technique. After stent implantation, coil embolization was performed using multiple-sized platinum helical coils. Control angiography performed at the end of the procedure revealed aneurysm occlusion. After 3 years, the patient is fully neurologically recovered, without pyramidal deficit, independently active and able to work.

Introduction

Endovascular stent-assisted coil embolization is a widely used and accepted treatment for intracranial aneurysms. However, when addressing wide-necked, complex, or dissecting aneurysms, which often involve a significant portion of the parent artery, remains challenging. These cases typically require the use of specialized stents to scaffold or bridge the aneurysm neck, sometimes combined with aneurysm flow diverters [1,2]. Coil embolization refers to the filling of the aneurysm with coils, while intracranial stents, a porous

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tubular mesh made of nitinol or other alloys, are implanted in the parent artery [3]. From their introduction in 1997, stents have become crucial devices in the treatment of intracranial aneurysms. Various types of stent have been used since, showing acceptable results in reducing morbidity and mortality [1].

Case report

We present the case of a 35-year-old woman with a history of hypertension, admitted to the Clinic for Neurosurgery, University Clinical center of Serbia for planned endovascular treatment of a neuroradiologically verified giant aneurysm at the bifurcation of the basilar artery and 2 aneurysms on the right internal carotid artery. On admission the patient presented as somnolent, adynamic, markedly bradypsychic with pronounced psycho-organic syndrome. The patient's condition made independent movement difficult and unstable. Neurological examination of cranial nerves revelated bilateral paresis of the upper palate, difficulties in swallowing solid and liquid food, and the presence of diplopia and nystagmus.

The patient's initial complaints began 2 months prior to admission to the emergency department when the patient presented with intense headaches, dizziness and instability. Magnetic resonance imaging (MRI) with gadolinium contrast revealed a 35 mm wide neck partially thrombosed giant aneurysm at the basilar artery bifurcation with a posteriorly oriented fundus (Fig. 1A) exerting significant pressure on the brainstem, particularly on the mesencephalon (Figs. 1B and C), compromising the Sylvian aqueduct with clear signs of hydrocephalus with an enlarged ventricular system and signs of periventricular interstitial edema (Fig. 1D). This diagnosis was confirmed by unenhanced computed tomography (CT) (Fig. 2) and CT-angiography of the circle of Willis (Fig. 3). During hospitalization hydrocephalus progressed, and multidisciplinary team devised a treatment plan, promptly addressing the hydrocephalus with a ventriculoperitoneal shunt.

Three days prior to the procedure, the patient was given antiplatelet therapy with acetylsalicylic acid (Aspirine; UPSA, Ruel Malmaison, France) 100 mg daily, and clopidogrel (Plavix®; Sanofi-Aventis, Longjumeau, France) 75 mg/twice daily. A resistance test to Aspirin and Plavix was performed on the "Verify now" device (Werfen, Barcelona, Spain), which showed an extremely strong response to Plavix (platelet reactivity unit was 7, but therapeutic range is 95-208). Therefore, the therapy was corrected and the patient continued with Aspirin 100 mg daily and Plavix 37.5 mg on the third day.

The endovascular procedure was performed under general anesthesia and right femoral access using a 6F sheath introducer and guiding catheter Chaperon 6F® (MicroVention, Tustin, California, USA) positioned in the left vertebral artery. At the start of the procedure a bolus of 5000 IU of heparin (Polfa Warszawa, Poland) was administered intravenously.

Digital subtraction angiography (DSA) and rotational 3-dimensional digital subtraction angiography (3D DSA) was performed to evaluate the morphology of the aneurysmal sac, aneurysm neck, and parent vessel to determine the proper working projection for stent placement and endovascular coiling (Fig. 4A). Stent diameter and length were chosen based on the angiography findings. The Headway 21 microcatheter® (0.021-inch inner lumen) (MicroVention, Tustin, California, USA) was used for deployment of the LVIS® (MicroVention, Tustin, California, USA, 3.5 × 23/19 mm) and LVIS-Jr® (MicroVention, Tustin, California, USA, 2.5 × 17/13 mm). A Traxcess 0.014-inch microguidewire® (MicroVention, Tustin, California, USA) was placed across the aneurysm neck with the help of 3D roadmap. Before stent deployment, a "Jailed" Echelon 10® (EV3, Plymouth, Minnesota, USA) microcatheter was placed within the aneurysm sac and used as the coil delivery system. A second slightly longer stent (LVIS) was then deployed within the first stent (LVIS-Jr) to minimize the size of the perforations leading to the aneurysm (''Stent-within-a-Stent'' (SWS) technique) (Fig. 4B). Both stents were deployed according to the standard procedure protocol recommended by the manufacturer. After stent implantation, coil embolization was performed using multiple-sized platinum helical coils (MicroVention, Tustin, California, USA). Control angiography performed at the end of the procedure which revealed aneurysm occlusion and good coverage of the aneurysmal neck by the 2 overlapping stents (Fig. 4C). Additionally, endovascular treatment of the aneurysms on the right internal carotid artery was performed (Fig. 5).

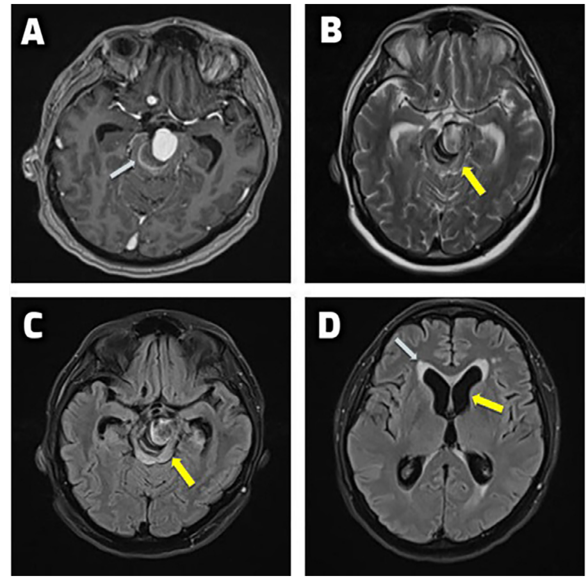

Fig. 1 – (A) MRI of the brain with the application of gadolinium contrast agent showed the existence of a partially thrombosed giant aneurysm of the bifurcation of the basilar artery (white arrow) (B) MRI of the brain (T2W sequence) showed a pronounced compressive effect on the structures of the brainstem (yellow arrow) (C) MRI of the brain (Fluid-attenuated inversion recovery (FLAIR) sequence) showed a pronounced compressive effect on the structures of the brainstem accompanied by surrounding edema (yellow arrow) (D) MRI of the brain (FLAIR sequence) showed a clear signs of hydrocephalus with an enlarged ventricular system (yellow arrow) and signs of periventricular interstitial edema (white arrow).

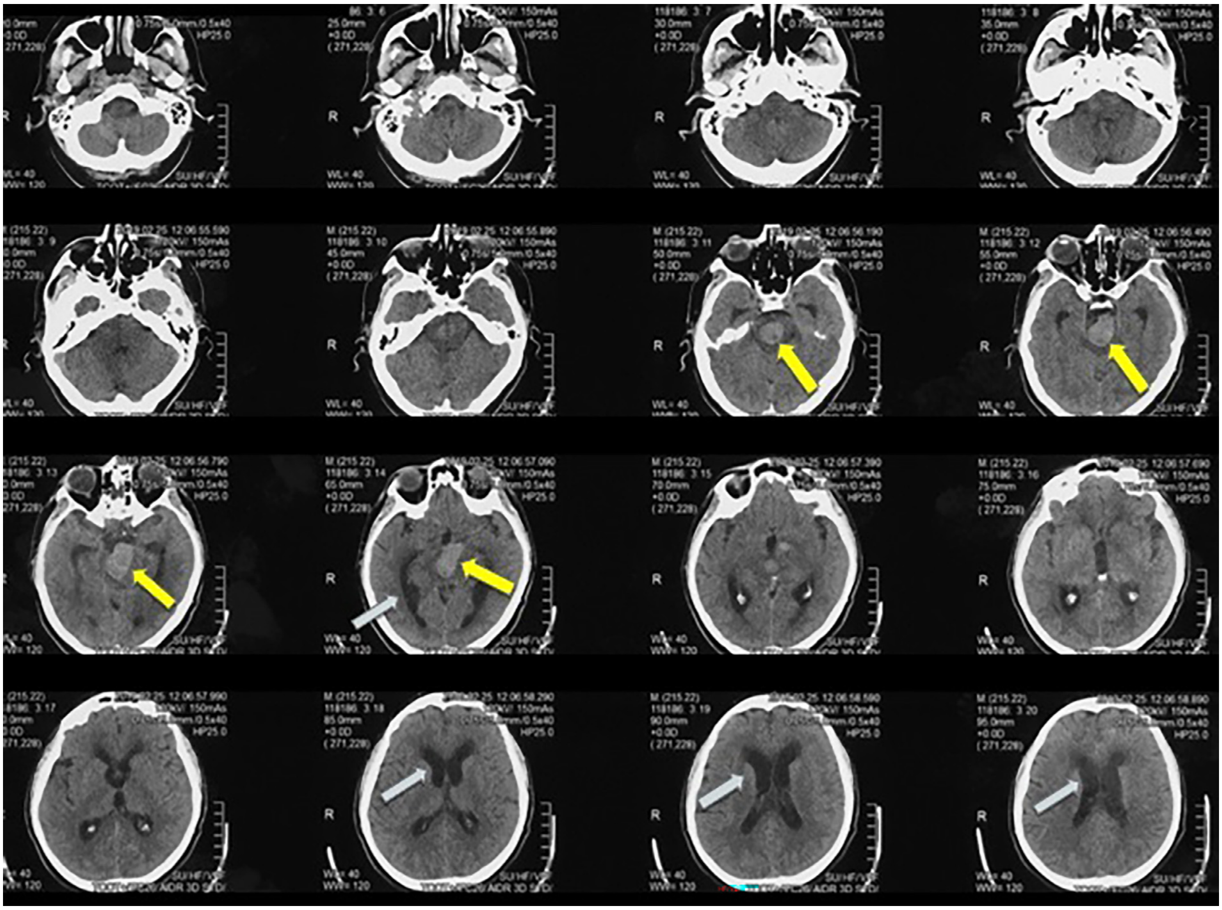

Fig. 2 – Unenhanced CT of the brain showed a hyperdense oval lesion in the interpeduncular cistern with a compressive effect on the brainstem (yellow arrow) and consequent hydrocephalus (white arrow).

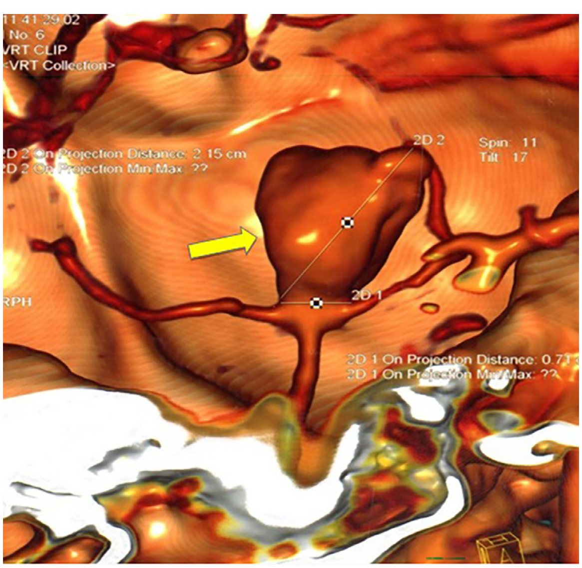

Fig. 3 – CT- angiography of the circle of Willis showed a giant aneurysm of the bifurcation of the basilar artery with a patent portion measuring approximately 22 mm (yellow arrow).

Post-procedure, the patient was monitored in the neurosurgical ICU and later discharged 3 days later in good neurological condition. At 6 months follow-up, the patient was Plavix was excluded from the therapeutic regimen, and the patient continues to be on aspirin monotherapy (100 mg daily). Routine MRIs were conducted 6, 12, 18, and 36 months post-procedure, utilizing a 3-T MRI. Both time-of-flight (TOF) and post-contrast time-resolved angiography with stochastic trajectories (TWIST) MR angiography of the Circle of Willis were performed. The final MRI, conducted 3 years after the procedure, revealed significant improvement: the aneurysm was subtotally excluded from the circulation, with a small residual filling at the neck of approximately 4 mm observed (Fig. 6A). No in-stent stenosis or occlusion of the branch or perforating vessels was detected. This MRI showed a notable decrease in the aneurysm's size compared to the examination a year prior, indicating intrasaccular thrombus in the resorption phase and accompanied by a significant reduction in brainstem edema (Fig. 6B). The clinoid and supraclinoid aneurysms on the right internal carotid artery were completely excluded from the circulation. Three years post-treatment, the patient had fully recovered neurologically, with no pyramidal deficits, capable of independent activity and returning to work, without signs of a psycho-organic syndrome.

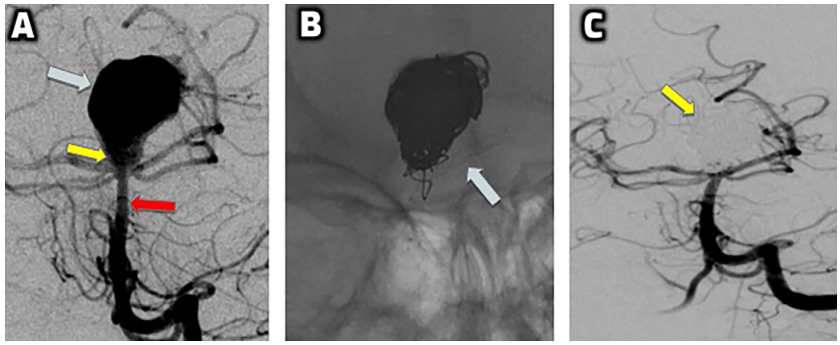

Fig. 4 – (A) Diagnostic DSA revealed the morphology of the aneurysm sac (white arrow), aneurysm neck (yellow arrow) and parent vessel (red arrow) (B) Unsubtracted image showed a good coverage of the aneurysmal neck by the two overlapping stents (“stent-within-a-stent” (SWS) technique) (white arrow) (C) Control DSA showed complete coiling and occlusion of aneurysm of basilar artery bifurcation (yellow arrow).

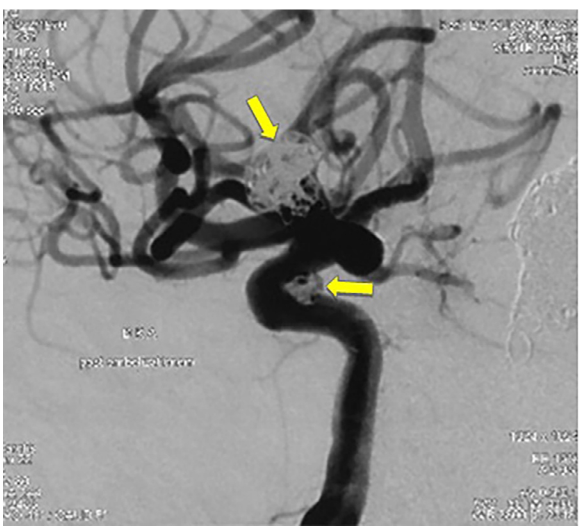

Fig. 5 – DSA showed complete coiling of the aneurysms on the right internal carotid artery (yellow arrow).

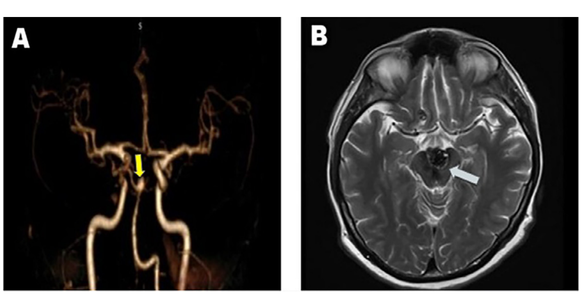

Fig. 6 – (A) The last 3-year follow up MRI of the brain with a postcontrast MR- angiography (TWIST sequence), three years after procedure, showed an aneurysm that is subtotally excluded from the circulation, with a smaller residual filling at its neck of about 4 mm (yellow arrow) (B) MRI of the brain (T2W sequence) showed significant reduction of brainstem edema (white arrow).

Discussion

There are various stent types, braided and laser cut, that can be used to support coils at aneurysm necks; however, some pose visualization challenges and feature a design that may allow coils to protrude into the parent artery due to inadequate apposition or overly large mesh cells [4–8]. Stent placement impacts the arterial wall regionally, leading to neointimal formation characterized by a mix of smooth muscle cell migration and connective tissue matrix, typically occurring within 2 weeks post-implantation [9]. Clinical and experimental evidence has demonstrated that intravascular stent placement in aneurysms can alter the inflow and vortex flow within aneurysms, depending on certain hemodynamic parameters, such as the velocity and direction of flow, the location of the aneurysm, the neck diameter, and the intrinsic characteristics to the stent. These hemodynamic changes can induce the formation of a new flow conduit via the stent that can promote gradual aneurysmal thrombosis with arterial wall reconstruction. Although convincing experimental evidence suggests that stent placement across an aneurysm neck may, by itself, promote intraluminal thrombosis, the role of this phenomenon in clinical practice may be limited by the high porosity of the currently available regular stents compared to flow diverters [9,10].

Commercially available stents like the Enterprise (Cordis Neurovascular®, Miami, Florida, USA), low-profile visualized intraluminal support device (LVIS) ® (MicroVention-Terumo, Tustin, CA, USA) and Pipeline® (Coviden/ev3 Neurovascular, Irvine, CA, USA) offer varying degrees of metal coverage, with the LVIS® stent providing a higher degree of metal coverage (approximately 23%) than the conventional Enterprise (8 %) but somewhat lower than the flow diverter Pipeline® (approximately 30%-35 %) [11,12]. The LVIS® stent, a novel, self-expandable braided stent made of nitinol, offers significant advantages over its counterparts due to its closed cell construction and higher metal coverage, leading to more pronounced reductions in wall shear stress and blood velocity in the aneurysmal sac [13–16].

The double LVIS stent offers greater metal coverage compared to standard flow diverter stents. The efficacy of stenting, whether using a single stent or the SWS technique, is based on the blood flow decrease within the aneurysm. However, it must be noted that overlapping stents increases the amount of foreign body material within the arterial wall and thus increases the risk of arterial occlusion or inflammatory vessel wall reaction, resulting in luminal stenosis due to neointimal hyperplasia.

On the other hand, the placement of overlapping stents and use of double stents are common practice in cardiology and have been shown to be safe [17]. The use of such techniques in neurointerventional procedures, accelerates complete aneurysmal occlusion by promoting intra-aneurysmal thrombosis through significant hemodynamic alterations within the aneurysmal sac. This is achieved by the reduced stent porosity caused by the overlapping stents, which not only may divert more blood away from the aneurysmal sac than a single stent but also further straightening the parent vessel, increasing stent thickness, thus enhancing the overall stent structure's stability. Additionally, increased mesh density promotes endothelial ingrowth Similar studies have also noted the efficacy of double stenting [18–22].

Furthermore, the relationship between stent porosity or the ratio of metal to tissue is another factor associated with neointimal growth and definitive vessel healing. As the porosity decreases or as the stent surface area increases, the risk of subacute thrombosis from excessive neointimal growth also increases [23].

Conclusion

The SWS technique emerges as a feasible and effective reconstructive treatment option for a complex big and giant aneurysms. Given its potential benefits, this method should be considered as a promising alternative therapeutic option to flow diverters in select patients.

Patient consent

Written informed consent to publish this case and use anonymized radiologic material was obtained from the patient.

Radiology case reports

We hereby declare that informed consent from the patient for the submission and publication of the article. "Stent-within-a-Stent" technique for the endovascular treatment of giant aneurysm of basilar artery bifurcation. A case report has been obtained.

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