Case Report

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Delayed destabilization and rupture of a giant anterior circulation aneurysm following flow-diverter placement: A case report

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Abstract:
Flow-diverting stents have been increasingly utilized for the treatment of intracranial aneurysms, especially when there are factors that go against coil embolization, such as wide neck and large aneurysm size. However, its use does not guarantee success, especially in giant lesions, and failure to obtain aneurysmal obliteration can result in long-term instability of the aneurysmal wall, leading to aneurysmal growth and late rupture. We present the case of a 65-year-old woman who suffered from a late aneurysmal dilation and rupture, 2 years and 4 months after flow-diverting treatment of a giant ophthalmic segment aneurysm. Although not fully understood, the pathophysiology of this phenomenon has one necessary factor: incomplete aneurysmal obliteration. When this scenario is present, two main factors take place: the augmentation of intrasaccular blood flow after stent delivery and the local inflammation caused by partial thrombus formation and the presence of the stent itself. To prevent this complication, complete aneurysmal obliteration must be assured, and the use of combined techniques is encouraged.

Keywords:
Aneurysm, flow-diverting stents, late rupture

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Introduction

Flow-diverting stents (FDSs) have been increasingly utilized for the treatment of intracranial aneurysms (IA). They have gained notoriety in the treatment of complex, giant, and/or wide-necked IA, many of which, in the past, required open surgery for proper management. However, despite the favorable outcomes achieved with the correct use of these devices, local hemodynamic alterations induced by their presence can occasionally result in long-term instability of the aneurysmal wall, leading to aneurysmal growth and late rupture, a serious complication with catastrophic consequences.[1-3] Here, we present the case of a patient who experienced a rupture of her IA years after treatment with a FDS.

Case Report

A 65-year-old woman who had been complaining of right-sided pulsatile tinnitus for years underwent a contrast-enhanced magnetic resonance imaging (MRI) of the brain for investigation. This revealed the presence of a large supraclinoid right internal carotid artery (ICA) aneurysm, measuring approximately 16 mm × 13 mm × 12 mm. The patient was referred to our center, where a digital subtraction angiography was performed. It was determined to be an ICA aneurysm of the ophthalmic segment, measuring 17 mm × 14 mm, with

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a neck width of 5.5 mm [Figure 1]. After a discussion with the team and the patient, it was decided to use an FDS without associated treatment. The procedure was done under general anesthesia, and preparation 7 days before the procedure with dual antiplatelet therapy with 300 mg/day of acetylsalicylic acid (ASA) and 75 mg/day of clopidogrel was made. Using femoral access with an 8 French introducer, a 6 French Infinity sheath (Stryker, Fremont CA) was navigated to the level of the right internal carotid cervical, followed by a Catalyst 5 French guide catheter (Stryker, Fremont CA) and an Excelsior XT 27 microcatheter (Stryker, Fremont CA) assisted by a Transend 0.014" microguide wire (Stryker, Fremont CA), and a 5 mm × 20 mm Surpass Evolve stent (Stryker Neurovascular, Fremont, California) was deployed covering the entire neck of the aneurysm [Figure 2]. No complications occurred during the procedure. The patient underwent an MRI 3 months postprocedure, which revealed a small amount of blood flow within the aneurysm interior, as well as small aneurysmal growth (17 mm × 12 mm × 16 mm). Angiographic follow-up was performed 6 months postprocedure and demonstrated a significant reduction in the aneurysm blood flow; however, there was persistent flow at the aneurysmal neck [Figure 3]. At this point, clopidogrel was discontinued, and only aspirin was continued for 12 months.

The patient lost neurological outpatient follow-up until, 2 years and 4 months after the treatment, she began to experience confusion, headache, and drowsiness. A new MRI revealed significant aneurysmal growth associated with the presence of a right frontal hematoma and intense subcortical frontal edema [Figure 4a and b]. The patient was then hospitalized and subsequently transferred to our center. After a discussion with the multidisciplinary team of neurosurgery and interventional neuroradiology, it was decided to perform trapping of the right ICA, which was completed without complications following a successful occlusion test [Figure 4c]. The patient continues with outpatient follow-up and, fortunately, does not exhibit any neurological deficits. A late follow-up MRI revealed aneurysmal size reduction and partial resolution of cerebral edema [Figure 4d].

Discussion

The treatment of giant aneurysms is always challenging. With the improvement of endovascular techniques and devices, such as FDSs, nonsurgical treatment has been gaining traction for the treatment of this condition. However, it is not free from failures or complications, especially when used in isolation. Incomplete aneurysmal obliteration after the use of an FDS can lead to severe

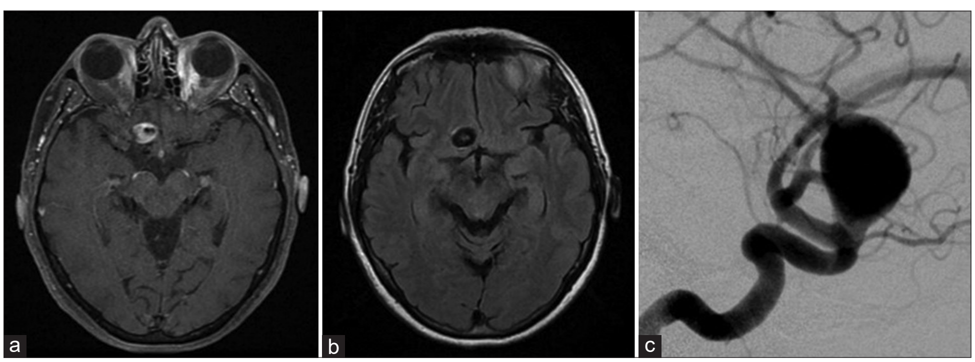

Figure 1: Diagnosis of the aneurysm. (a and b) Axial magnetic resonance image with and without paramagnetic contrast, respectively, showing an aneurysm in the anterior circulation measuring 16 mm × 13 mm × 12 mm. (c) Digital subtraction angiography, lateral view, confirming the presence of a giant ophthalmic segment aneurysm with a wide neck (5.5 mm), measuring 17 mm × 14 mm

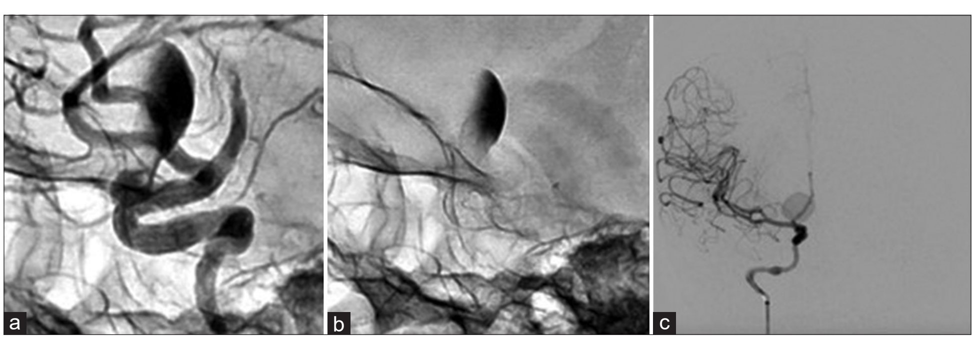

Figure 2: Digital substraction angiography (DSA) showing the initial treatment of the aneurysm with a flow-diverting stent. (a) Work incidence (contralateral view) showing the immediate angiographic image after stent placement. (b) Shows the stent adequate positioning after placement and contrast retention inside the aneurysm. (c) Anterior view showing aneurysmal opacification

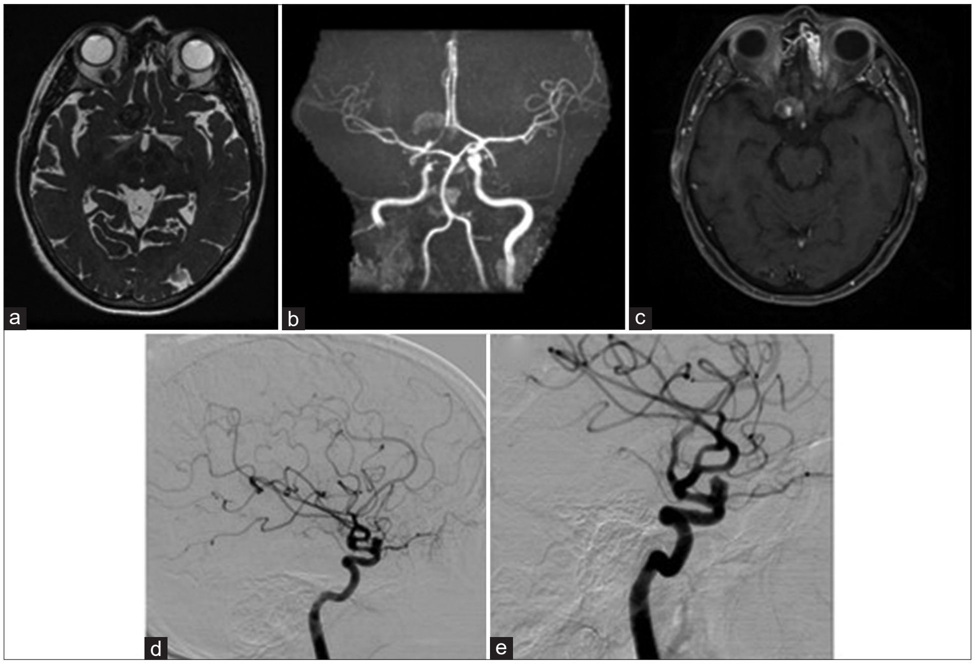

Figure 3: First postprocedure follow-up imaging. (a) Magnetic resonance imaging (MRI) in the T2 sequence showing aneurysmal thrombosis. (b) MRI angiogram showing persistence of intra-aneurysmal blood flow. (c) T1 sequence with contrast showing a small amount of intra-aneurysmal blood flow. (d and e) digital substraction angiography (DSA) control 6 months after flow-diverter placement showing reduction of aneurysm size with persistence blood flow in the aneurysm's neck

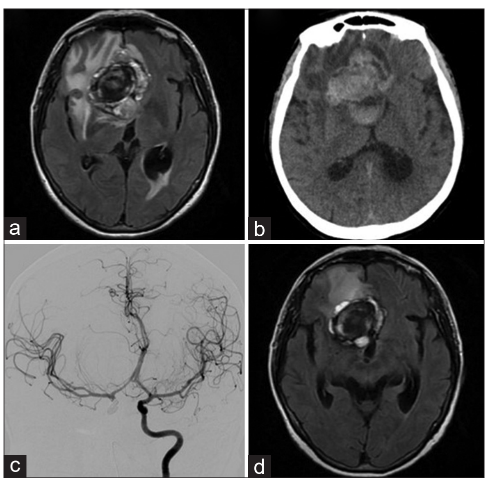

Figure 4: (a) Axial magnetic resonance imaging (MRI) in the T2 sequence featuring an important dilation of the aneurysm, as well as an intraparenchymal hemorrhage with surrounding white matter edema. (b) Axial non-contrast tomography showing intraparenchymal hematoma. (c) digital substraction angiography (DSA) in the anterior view. Immediate posttrapping of the right internal carotid artery showing adequate blood flow through the anterior circulation. (d) Axial T2 flair MRI presenting aneurysmal stability and partial resolution of the cerebral edema and hemorrhage reabsorption

consequences, such as wall destabilization and late aneurysmal rupture.[1-3] The pathophysiology of this occurrence is not yet fully understood, but two main factors have been identified.

Initially, the implantation of a flow-diverting device leads to an increase in intra-aneurysmal pressure,[4] a fact that has been clearly demonstrated through computational hemodynamic analysis. In patients where aneurysmal obliteration is not achieved, this may be the most relevant mechanism in ruptures that occur shortly after the procedure.

Furthermore, it is known that thrombus formation within the aneurysm is crucial for its healing. However, when residual flow is present, this scarring process contributes to the late rupture of the aneurysm. It has been observed that, in some patients, a cascade of local inflammation can lead to autolysis of the aneurysmal wall,[5-7] leading to its weakening and resulting in progressive dilatation of the lesion until rupture occurs, as seen in our patient.[7,8]

Analyzing the data available in the literature regarding the pathophysiology of aneurysmal wall destabilization and subsequent rupture following the implantation of flow diverters, it can be inferred that the increase in local blood flow and intrasaccular pressure are relevant factors in early rupture, while local inflammation and consequent aneurysmal destabilization and dilation are involved in late ruptures. In any case, this complication only occurs when there is no complete obliteration of the lesion, indicating that its prevention lies in the complete closure of the aneurysm neck.

Therefore, when residual aneurysmal blood flow is detected, additional treatment options should be considered. Employing multiple overlapping FDSs can provide greater coverage and further restrict aneurysmal blood flow, creating a more favorable thrombotic environment for occlusion. However, this approach carries increased risks, as additional endovascular interventions raise the likelihood of complications, as demonstrated by Chalouhi *et al*.[9] in their statistical analysis. Alternatively, surgical intervention offers a promising success rate, nonetheless, it is associated with other significant considerations, such as extended recovery times, the need for optimal aneurysm positioning, and a higher potential for complications. Thus, the decision must weigh both the benefits and the inherent risks of each treatment pathway.

As a side note, we would like to point out that despite the fact that pulsatile tinnitus (which usually indicates central hemodynamic abnormalities, such as nonlaminar blood flow sound being transmitted to the inner ear or local causes such as high displacement or a dehiscent jugular bulb[10,11]) can be caused by IA-as demonstrated by a few reported cases, specifically involving aneurysms in the petrous segment of the ICA.[12] In our case, the pulsatile tinnitus reported by the patient did not seem to hold a significant correlation to her aneurysm. Nonetheless, it was its presence that led to investigation and the accidental finding of the lesion.

It should be kept in mind that the use of FDSs alone for the treatment of giant aneurysms may prove inadequate in many cases, as demonstrated by Hou *et al*.[1] in their literature review. Therefore, the use of combined techniques – such as aneurysmal embolization with coils preceding the deployment of the flow diverter – can increase the success rate of endovascular treatment and is recommended for the treatment of giant lesions. It is worth noting that the impact of many interventions is still not fully established in this context, and decisions are to be made on a case-by-case basis.

Conclusion

Despite the clear contribution of FDSs in the treatment of IA, they should be used cautiously in the treatment of giant lesions, given the number of reported cases of postprocedural rupture. Endovascular techniques, like any other intervention, yield excellent results only when appropriately indicated. Therefore, a thorough evaluation of the lesion and available therapies is essential in managing patients with complex aneurysms. We suggest that large or giant aneurysms, when indicated for endovascular treatment, should always be approached using combined techniques. However, it must be acknowledged that there are not enough studies for definitive therapeutic guidance, and the final approach should be personalized.

Author contributions

Each author made significant individual contributions to this manuscript. Martio AE: Development and writing of the article; approval of the final version of the manuscript. Scaravonatto SL: Development and writing of the article; approval of the final version of the manuscript. Vanzin JR: Main physician responsible for the patient's surgical care and main surgeon; review of the manuscript's intellectual content; approval of the final version of the manuscript. Manzato LB: Physician responsible for the patient's care, auxiliary surgeon; writing of the article; approval of the final version of the manuscript. Perini F: Physician responsible for the patient's care, auxiliary surgeon; writing of the article; approval of the final version of the manuscript.

Ethical policy and institutional review board statement

The study was conducted in accordance with the declaration of Helsinki.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given her consent for her images and other clinical information to be reported in the journal. The patient understands that her name and initials will not be published and due efforts will be made to conceal her identity, but anonymity cannot be guaranteed.

Data availability statement

All data generated or analyzed during this study are included in this published article.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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