

## Endovascular treatment of an unruptured ophthalmic artery aneurysm with a flow diverter: a case report

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**ABSTRACT**

An unruptured aneurysm is often asymptomatic or present without neurological deficits, causing severe morbidity. However, the potential of this defect to rupture requires proper management. Herein, we report a case of an unruptured saccular aneurysm of the ophthalmic artery with initial clinical seizures. The patient was treated by flow diversion which redirects the blood flow that normally leads to the protrusion of the aneurysm back to the main vessel. Flow diversion is chosen because it is less risky and has a faster recovery time than other treatment options, but it is more expensive than others. Although this technology is not new, there is no report on its implementation in Indonesia. The patient was prescribed antiplatelet treatment for at least 6 months post-treatment, then she showed no sign of seizure or new focal neurological deficits 4 months post-treatment. The patients were expected to undergo digital subtraction angiography evaluation 6 months after flow diversion treatment, but it has not been performed due to the coronavirus disease 2019 pandemic.

**KEYWORDS** aneurysm, computed tomography angiography, digital subtraction angiography, endovascular, ophthalmic artery, seizures

Stroke is the leading cause of death and disability worldwide; indeed, it is estimated to contribute to 11.8% of all deaths globally.<sup>1</sup> The prevalence of stroke in the Indonesian population is 10.9%.<sup>2</sup> Based on its pathology, stroke can be classified as hemorrhagic or ischemic. Hemorrhagic stroke may occur in the cerebral parenchyma or arachnoid space. A subarachnoid aneurysm can be caused by an intracranial aneurysm, which is a weakening of the arterial wall caused by a loss of internal elastic lamina from the tunica intima; such weakening dilates the intracranial artery and produces an aneurysm. An

unruptured aneurysm is often asymptomatic, but its most common symptoms are headache and cranial nerve paresis. Although rare, an unruptured aneurysm could manifest as seizures; therefore, it should be considered during differential diagnosis in patients presenting with seizures.<sup>3</sup> This type of aneurysm must be treated properly because of its potential to rupture, which could lead to subarachnoid bleeding.<sup>4</sup> Aneurysm of the ophthalmic artery is challenging to treat because of the vulnerability of the surrounding structures and the potential effects on patients' quality of vision.<sup>5</sup>

Developments in aneurysm treatment over the last few decades have yielded endovascular treatment as an alternative to microsurgery for the management of an unruptured and ruptured aneurysm.<sup>4</sup> Flow diverter stents with different coiling mechanisms can offer new options for treating unruptured aneurysms.<sup>6</sup> Recent evidence shows that flow diverters result in better occlusion means compared with coiling, as well as fewer neurological complications.<sup>7</sup> This report discusses the implementation of a flow diverter as a therapeutic approach for a rare presentation of an unruptured aneurysm.

## CASE REPORT

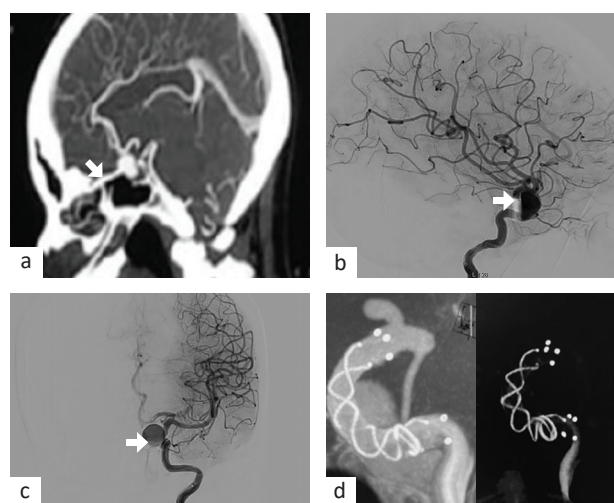
A 51-year-old woman was admitted to the Universitas Indonesia Hospital in February 2020 to undergo flow diverter implantation. She agreed for her case to be reported as a case study. She presented with recurrent seizures 14 months prior to admission (December 2018). The pre-ictal of the first seizure was unknown. During ictal, she felt epigastric discomfort; seconds later, her eyes rolled up, her mouth deviated to the right, and her upper and lower extremities demonstrated rigidity. She was unconscious during the seizure, which lasted for 5 min. Upon regaining consciousness, she appeared normal. She did not take any medication because she had not experienced prior seizures. After the first seizure occurred, she was submitted to a computed tomography (CT) scan. Nine months prior to her visit, she experienced up to five recurrent seizures, the last of which rendered her unconscious. She denied experiencing severe headache, unilateral weakness, unilateral paresthesia, deviated mouth, speech difficulty, or vision or hearing disturbances. She did not experience fever, chronic cough, or weight loss. Patient care at this time was provided by the intensive care unit of a different hospital.

Her non-contrast magnetic resonance imaging (MRI) showed signs of an aneurysm, and her electroencephalography examination was normal. Her CT angiography (CTA) showed an unruptured saccular aneurysm of the ophthalmic segment of the internal carotid artery (C6 segment) measuring  $11 \times 12 \times 14 \text{ mm}^3$  (Figure 1a). These examinations were carried out at the hospital where she received the first treatment.

She was initially planned to undergo coiling. Her digital subtraction angiography (DSA) showed

a saccular aneurysm measuring  $14 \times 13 \text{ mm}^2$  at the ophthalmic region and stenosis in over 50% of the left vertebral artery (Figure 1, b–c). The dome measurement was 14 mm, and the neck diameter was 6 mm; thus, the dome/neck ratio was 2.3. Considering this result, the physician decided not to perform coiling because of the risk of blindness as a complication of the location of the aneurysm at the base of the ophthalmic artery. A major concern was that coiling might occlude the ophthalmic artery or cause coil migration, leading to distal embolization. She was diagnosed with aneurysm, hypertension, and epilepsy.

Her physical, neurological, and laboratory examination, along with chest X-ray, showed no abnormalities. She had acetylsalicylic acid (80 mg qd), candesartan (8 mg qd), and phenytoin (100 mg bid). One week prior to flow diversion, clopidogrel (75 mg qd) was consumed routinely afterwards. The flow-redirecting endoluminal device (FRED) (MicroVention Inc., USA) flow diverter implantation was conducted in February 2020. The flow diverter was installed at the ophthalmic segment of the internal carotid artery (Figure 1d). One day after implantation, she was discharged. Four months post-implantation, she reported no seizure or new neurological deficit. To date, no follow-up with an imaging examination has been conducted due to the coronavirus disease 2019 pandemic.



**Figure 1.** (a) CTA of the patient showing an aneurysm (arrow); (b) lateral DSA of the patient (arrow); (c) anterior-posterior DSA of the patient (arrow); (d) images of a stent flow diverter attached via an endovascular method. CTA=computed tomography angiography; DSA=digital subtraction angiography

## DISCUSSION

A cerebral aneurysm is an abnormal dilatation and weakening of the vessel wall of the cerebral artery. The clinical signs of an aneurysm depend on its status, i.e., ruptured or unruptured. Nearly 10–15% of all unruptured cerebral aneurysms are asymptomatic. Seizure is an uncommon presentation in patients with an unruptured aneurysm. No case report on ophthalmic aneurysms with seizure has yet been published. However, several reports of seizures in aneurysms at the junction of the internal carotid and posterior communicating artery, which is located near the ophthalmic artery, are available. Aneurysms located near the temporal lobe are considered to have an epileptogenic location.<sup>8,9</sup> An unruptured aneurysm in the ophthalmic artery has many indications for treatment. In addition to its epileptogenic location and the possibility of causing visual symptoms, the morphology of large, irregular, and progressive aneurysms can cause rupture.<sup>10</sup>

Brain MRI showed a suspected large aneurysm, and CTA confirmed a medium-sized saccular aneurysm located in the ophthalmic segment of the patient's internal carotid artery. A morphological assessment of the aneurysm was performed to determine the optimal treatment method. DSA was conducted to obtain a better visualization of the aneurysm. Besides its location (saccular, internal carotid artery), the size of the aneurysm was estimated. The dome and neck measurements were 14 and 6 mm, respectively, which translates to a dome/neck ratio of 2.3. DSA appears to be a better technique than CTA for examining the fine details of an aneurysm. DSA clearly visualizes the neck and dome of aneurysms because it is a 3D tool that can view a 360° perspective. Following DSA examination, we found that the aneurysm was located at the proximal region of the ophthalmic artery, which posed some risk of blindness to the patient. Thus, we suggested treatment with a flow diverter.

The management of unruptured aneurysms is available in three main methods: conservative, endovascular, and clipping surgery. Conservative treatment is suggested for an unruptured ophthalmic artery aneurysm with a low risk of rupture. Endovascular treatments for aneurysms include coiling and flow diversion. In some cases, open clipping surgery is warranted.<sup>8</sup> Endovascular treatment is the chosen strategy for moderately sized aneurysms,

such as that presented in this report. Clipping of aneurysms located in the ophthalmic segment is risky because it may result in inadequate vascular supply to the ophthalmic artery due to a lack of collateralization in the ophthalmic segment, leading to complications, such as blindness, rupture, and thrombosis.

The endovascular treatments for the present case were coiling and flow diversion. Flow diversion was considered effective for unruptured aneurysms with complex anatomy, such as fusiform, dissecting, and saccular aneurysms with large necks and low dome-to-neck ratios, located in the internal carotid or vertebrobasilar arteries, which are well known to be challenging to coil or clip. Flow diversion was selected because this technique has few complications and low risk of blindness, although the cost is high.<sup>7</sup> Flow diverters are stent-like devices used endovascularly to manage aneurysms. These devices allow endoluminal flow reconstruction rather than endosaccular filling. They change the parent artery/aneurysm sac interface, alter the in-flow and out-flow, eliminate blood flow to the aneurysm, and induce aneurysm thrombosis. Intracystic thrombosis can occur after device deployment, and subsequent overgrowth could cover the stent reconstructing the parent artery and eliminate the aneurysm.<sup>12</sup> The mechanism by which a flow diverter redirects blood flow from the aneurysm to the main blood vessel is as follows: (1) the installation of fine webs at the neck of the aneurysm can reduce the velocity of blood flow to the defect site; (2) slow blood flow can encourage clot formation in the aneurysm because platelets are activated as they pass through the fine webs of the diverter and then become trapped in the aneurysm; (3) the fine webs of the diverter are eventually covered with a new artery wall layer; (4) the thrombotic aneurysm is reabsorbed over the course of wound healing, then the repaired vessel returns to its normal physiological state.<sup>13</sup>

Recent evidence shows that flow diverters could achieve better occlusion means compared with coiling and have fewer neurological complications and lower risk of death.<sup>3</sup> Previous studies revealed that flow diverters have higher occlusion rates of up to 64% within 6 months and 94% within 3 years post-implantation compared with coiling.<sup>5,14</sup> We performed FRED implantation on the patient and noted no complications, headaches, blurred vision, or neurological deficits following the procedure. Some

complications of flow diverters include stent migration, vessel trauma, thrombosis, and stent restenosis. After we implanted the flow diverter into our patient, we performed DSA to ensure no direct complications.

Dual antiplatelet therapy (DAPT) is the chosen treatment for preventing thromboembolic events (10%) related to endovascular treatment, especially flow diversion, and must be administered to patients for a minimum of 6 months after implantation. In theory, deflecting blood flow via a flow diverter could cause the blood not to be diverted to thrombose and the aneurysm to shrink. However, installing a flow diverter in a blood vessel, which may be perceived by the body as a foreign object, could trigger thrombosis in the device. This complication may be prevented by administering antiplatelets. In the present case, the patient was prescribed DAPT treatment of aspirin and clopidogrel for a minimum of 6 months post-implantation. Prasugrel and ticagrelor could also decrease the risk of platelet resistance, but they are relatively expensive.<sup>15</sup> Candesartan was administered to reduce hypertension to avoid a vessel rupture. Four months post-treatment, the patient reported no seizure or new neurological deficit and was planned to undergo a reevaluation by DSA 6 months after implantation to observe changes in the aneurysm. It could not be concluded that the patient's aneurysm was obliterated, but it was successful in covering the entire neck surface of the aneurysm dome, thereby reducing the risk of rupture.

In conclusion, a flow diversion may be recommended for moderate to large-sized aneurysms located in large arteries. Given its high safety and low risk of sequelae, this endovascular technique is the best choice for aneurysms in locations presenting serious complications that could interfere with patient activities, such as blindness.

#### Conflicts of Interest

The authors affirm no conflict of interest in this study.

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