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One-Stage Clipping of Mirror-Image Middle Cerebral Artery Aneurysms and a Basilar Apex Aneurysm: A Case Report and Literature Review

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Abstract

Multiple intracranial aneurysms are present in 30% of patients with aneurysms, and in our clinical experience, bilateral mirror-image aneurysms occur in 5% of patients. Embolization in wide-necked aneurysms is rarely seen and it is extremely uncommon for a patient to have both a pair of mirror-image wide-necked aneurysms in the anterior circulation and a basilar-tip wide-necked aneurysm. In this case report, we present a patient with a pair of mirror-image wide-necked middle cerebral artery aneurysms as well as a wide-necked basilar-tip aneurysm that was surgically clipped. We further discuss the significance of this rare occurrence.

Keywords: Cavernous sinus; Aneurysm; Middle cerebral artery; Basilar artery

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Introduction

Aneurysm, a common intracranial cerebrovascular disease, has a prevalence rate ranging from 3.8% to 8.3% [1], an incidence rate of 3% to 5%, and a mortality rate of up to 30% for the initial hemorrhage [2]. Currently, there are two main treatment methods for aneurysms: Endovascular interventional embolization and surgical clipping, each having its own advantages and disadvantages [3]. The former is minimally invasive and time-saving, while the latter is more invasive but less likely to recur. Middle cerebral artery aneurysms are among the most common intracranial aneurysms. Surgical clipping of ipsilateral middle cerebral artery aneurysms is common, while surgical clipping of contralateral middle cerebral artery aneurysms is rare. Though there are published literatures on the clipping of contralateral middle cerebral artery aneurysms both domestically and internationally [4,5], there is currently no expert consensus or guideline recommendation on the matter. Basal aneurysms, being deeper in location and surrounded by more complex structures, are challenging to deal with and require advanced techniques [6]. Aneurysms can be classified into narrow-necked and wide-necked aneurysms based on whether the neck diameter exceeds 4 mm or the dome-to-neck ratio is less than 2 mm [7]. Interventional embolization of wide-necked aneurysms requires the assistance of stents and is less likely to achieve complete embolization. Moreover, it carries the risk of postoperative cerebral infarction and hemorrhage [8,9]. Conversely, surgical clipping of wide-necked aneurysms offers advantages such as the ability to completely clip the aneurysm under direct visualization and a lower incidence of long-term complications [10].

The pterional approach is commonly used for surgical treatment of anterior circulation aneurysms [11]. For basilar artery aneurysms, the anterior sub-temporal approach or the frontotemporal orbitozygomatic approach [12] are often employed, where the pterional approach or the lateral supraorbital approach is also adopted occasionally. Multiple intracranial aneurysms constitute 30% of all intracranial aneurysms, with mirror aneurysms comprising 5% of all cerebral aneurysm cases [13]. Staged surgery can be performed for bilateral anterior circulation aneurysms, although studies have explored simultaneous treatment with a single incision [14]. For unilateral anterior circulation aneurysms and basilar artery aneurysms, single-stage complete clipping of all aneurysms has been reported [15-17]. However, when aneurysms occur concurrently on both sides of the anterior circulation and the basilar artery apex, complete clipping of multiple aneurysms in a single operation using a single surgical approach becomes challenging. The trans-temporal trans-zygomatic transcavernous approach is a complex skull base surgical technique that offers complete lateral wall exposure of the cavernous sinus [18]. This approach, an extension of the Dolenc approach [19,20], involves dural opening in the skull base, enabling shorter contralateral surgical distances

and comprehensive exposure of the basilar artery apex. It provides the potential to simultaneously clip bilateral anterior circulation aneurysms and basilar artery aneurysms. Our hospital's neurosurgery department has refined this surgical approach in 2022 and achieved successful outcomes in numerous cases! We have successfully employed the trans-temporal trans-zygomatic transcavernous approach to clip bilateral middle cerebral artery aneurysms and wide-necked basilar artery aneurysms, resulting in a successful operation and favorable prognosis.

Case Presentation

A 61-year-old Chinese female patient presented at the First Affiliated Hospital of Xinxiang Medical University with a 15-day history of dizziness. The dizziness occurred without obvious triggers and was described as a sensation of spinning around. It would subside after 2 h of rest and was related to changes in body position, especially when turning the head to the left. The patient did not experience headache, nausea, or vomiting. Motor function, speech, and bladder/bowel control were normal. The patient had a 10-year history of hypertension and diabetes, both managed with regular oral medication.

During the neurological examination, the patient was awake, alert, and had a normal gait without any signs of ataxia. No abnormal eye movements or other pathological findings were observed. Routine blood tests did not reveal any abnormalities.

Computed Tomographic Angiography (CTA) showed multiple intracranial aneurysms (Figure 1): 1. Right middle cerebral artery M1 bifurcation aneurysm with a 4 mm neck, 3 mm height, regular shape, and pointing in the same direction as M1; 2. Left middle cerebral artery bifurcation aneurysm with a 3.5 mm neck, 3 mm height, regular shape, and pointing in the same direction as M1; 3. Basilar artery wide-necked aneurysm with an 8 mm neck, 12 mm width, 10 mm height, multiple protrusions on the surface, and the tip pointing towards the interpeduncular fossa.

After 7 days of symptomatic treatment, the patient's dizziness completely resolved. In terms of aneurysm treatment, the family opted for surgical clipping of the aneurysms and requested complete clipping of all 3 aneurysms in a single stage. Following thorough preoperative preparation and discussion, the surgical plan was formulated and explained to the patient and their family. They were informed of the associated risks and signed the informed consent. Subsequently, "multiple aneurysms clipping through pretemporal trans-zygomatic transcavernous sinus approach" was performed, and the operation was successful. Postoperatively, the patient was transferred to the Neurosurgical Intensive Care Unit (NSICU). On the first day after the operation, the patient was alert, with normal language and limb movement. A CTA scan was conducted (Figure 2), and the patient was then transferred to the general ward. The patient was discharged 10 days later, and follow-up has been conducted for over 6 months, revealing no new symptoms or signs.

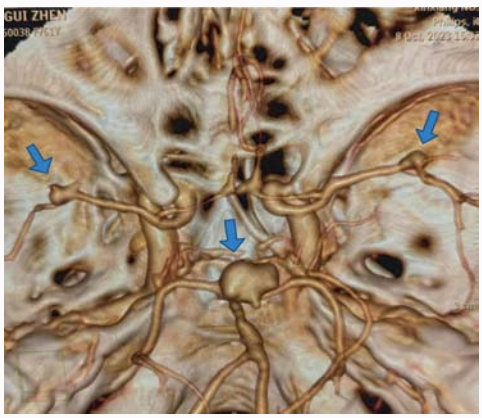

Figure 1: Preoperative CTA, arrow pointing to aneurysm.

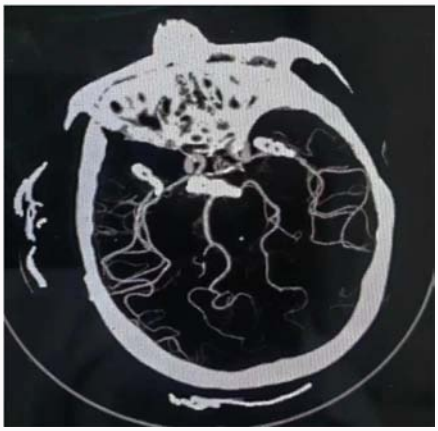

Figure 2: Postoperative CTA, aneurysm clipped, vessel patency.

Discussion

The pterional approach is the commonly utilized surgical approach for anterior circulation aneurysms [21], followed by the lateral supraorbital approach [22], supraorbital keyhole approach [23], and median frontal flap approach of the coronary flap [24]. Among anterior circulation aneurysms, the most common types are anterior communicating aneurysms, posterior communicating aneurysms, and middle cerebral artery aneurysms. The pterional approach is sufficient for clipping these conventional aneurysms. The lateral supraorbital approach, supraorbital keyhole approach, or pterional keyhole approach are also employed for the management of saccular aneurysms originating from these sites to minimize brain injury and achieve a better prognosis. In cases where aneurysms originate behind the A2 segment of the anterior cerebral artery, the median frontal flap approach of the coronary flap can be employed.

For basilar artery apex aneurysms, the commonly used surgical approaches are the anterior sub-temporal approach, Fronto-orbito-zygomatic approach [25,26], and occasionally the pterional approach and lateral supraorbital approach [27]. Basilar artery aneurysms are deeper in location and have a more complex surrounding structure. The hypothalamus, which is a vital center of life, lies above it. Behind the basilar artery is the cerebral peduncle, which controls limb movements. The posterior inferior edge of the basilar artery is home to small central perforating vessels that control consciousness. Any errors during the operation can have catastrophic consequences for the patient. The conventional surgical approaches mentioned above are difficult to fully expose the structure of the basilar artery apex during the operation, particularly the contralateral posterior cerebral artery, contralateral superior cerebellar artery, and posterior perforating artery. After clipping the aneurysm, it is easy to cause vascular stenosis or even occlusion of the contralateral vessels, particularly the posterior perforators. This can lead to postoperative coma, and MRI examinations often reveal thalamic infarction.

In the treatment of bilateral middle cerebral artery aneurysms, staged treatment is commonly employed [28], or interventional embolization may be considered [29]. In staged treatment, the bleeding aneurysm is first clipped, and the contralateral aneurysm is treated electively, or both aneurysms are managed simultaneously in a single operation [30-33]. For bilateral mirror-image middle cerebral artery aneurysms, due to the influence of M1 length and operator limitations, studies have explored both staged treatment and simultaneous treatment [34]. When treating contralateral middle cerebral artery aneurysms, there is a relatively heavy frontal lobe elevation, which may potentially damage the bilateral olfactory nerves. Thus, a thorough preoperative evaluation considering patient preferences and the surgeon's experience is essential. In this case, the contralateral middle cerebral artery aneurysm was successfully clipped during the operation, and the bilateral olfactory nerves remained intact, with the patient exhibiting a normal sense of smell postoperatively.

The current treatment options for wide-necked aneurysms pose challenges in interventional therapy. Typically, stent assistance is necessary, with the stent being placed in the normal parent artery cavity [35]. However, this approach requires postoperative antiplatelet therapy, which can lead to bleeding complications [36]. Moreover, the stent can lead to intimal hyperplasia, resulting in long-term parent artery occlusion and related ischemic complications [37]. Furthermore, incomplete embolization of wide-necked aneurysms can cause intra-aneurysmal hemodynamic changes, leading to mismatched inflow and outflow channels and subsequent aneurysm rupture shortly after embolization. Even with the use of the Woven EndoBridge (WEB) for wide-necked bifurcated aneurysms, there is still a reported recurrence rate of approximately 10% in the literature [38,39]. While interventional therapy is currently the preferred treatment for aneurysms, microsurgical clipping remains an important tool for contemporary cerebrovascular neurosurgeons, especially for wide-necked aneurysms [40]. Surgical clipping allows for direct vision during the procedure [40], making it easier to completely clip the aneurysm, protect the parent artery, and minimize long-term complications. In this particular case, the basilar aneurysm had a wide neck measuring 8 mm, and it was successfully clipped during the surgery. The parent artery remained unobstructed and free of stenosis.

The transtemporal trans-zygomatic transcavernous approach is a highly intricate surgical technique for skull base procedures. It serves as an essential method for accessing the lateral wall of the cavernous sinus and the entire dural wall of the middle cranial fossa. This approach is an expansion and extension of the Dolenc approach [41,42]. The surgical procedure associated with this approach is complex, time-consuming, and demanding, requiring surgeons to possess significant skills in skull base surgery. Earlier, Kriszti AF from the United States implemented this surgical approach for basilar aneurysm treatment [43,44]. By using this technique, the basilar artery tip structure is exposed, resulting in a wide and clear visual field and a shallow surgical field. This not only provides visibility of the ipsilateral vascular structure but also offers a clear view of the contralateral vascular structure. In the treatment of basilar aneurysms, a clear visual field, distinct structures, and precise surgical clipping of the aneurysm facilitate complete clipping while safeguarding surrounding structures. Additionally, due to the protection provided by the dura to the brain lobes, the risk of cerebral cortex injury is minimal, reducing the likelihood of postoperative epileptic sequelae. Moreover, cutting the dura at the skull base shortens the distance for contralateral operations. With the implementation of this surgical approach, successful clipping of both the wide-neck basilar aneurysm and the contralateral middle cerebral artery aneurysm was achieved.

Conclusion

The pretemporal trans-zygomatic transcavernous approach proves to be a safe method for effectively clipping aneurysms located above or in close proximity to the ipsilateral anterior and posterior circulation Willis rings. This approach is also suitable for wide-necked basilar aneurysms and contralateral middle cerebral artery aneurysms. The trans-pretemporal trans-zygomatic transcavernous approach is particularly beneficial in treating complex cerebrovascular diseases at the skull base. However, it is important to note that this surgical technique is characterized by its complexity, time-consuming nature, and demanding requirements. On the other hand, it offers a spacious and clear visual field, excellent controllability, and positive patient prognoses as advantages.

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