Posterior Circulation Aneurysms: Clip or Coil?

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Both surgical and endovascular therapies can be safe and effective in treating posterior circulation aneurysms; however, there are stronger propensities to treat certain posterior circulation aneurysms by one method or the other based on the different risk profiles of open and endovascular modalities, particularly in perforator-rich and prebulbar locations.

Although the majority of posterior circulation aneurysms are saccular aneurysms, there are higher rates of dissecting pseudoaneurysms and fusiform aneurysms in this vascular territory.

When planning treatment for posterior circulation aneurysms, one should consider the accessibility of the lesion as well as relationship of the aneurysm to the perforating vessels, to the posterior clinoid process, and the necessity/safety of dual antiplatelet therapy, particularly in patients with ruptured aneurysms and hydrocephalus.

Posterior circulation aneurysms include aneurysms of the vertebral artery (VA), vertebrobasilar (VB) junction, basilar bifurcation, posterior inferior cerebellar artery (PICA), anterior inferior cerebellar artery (AICA), superior cerebellar artery (SCA) and posterior cerebral artery (PCA). They differ from their anterior circulation counterparts because of their less accessible deep locations and propensity for complex morphology.

Since the posterior circulation originates anterior to the brainstem and supplies the surrounding highly eloquent area, complications are more devastating, making treatment of these lesions exceedingly more difficult than that for aneurysms in the anterior circulation.

Although the potential for neurologic complications applies to both endovascular and open treatments, the current treatment paradigm has shifted away from microsurgery toward endovascular therapy. During the past decade, this trend has been fueled by increasing experience and studies such as the International Subarachnoid Aneurysm (ISAT) and the International Study of Unruptured Intracranial Aneurysms (ISUIA) trials that reported higher morbidity rates associated with clipping than coiling for posterior circulation aneurysms.

Nonetheless, an indiscriminate use of algorithms or protocols for patient selection is unwise. All aneurysms should be evaluated by a multidisciplinary team of specialists with both advanced microsurgical and endovascular expertise so that the final treatment plan is tailored based on unique aneurysm and patient characteristics.

In this chapter, I will highlight the nuances of selection of surgical and endovascular treatments for posterior circulation aneurysms. Many of the concepts are further explored in the chapter titled: Anterior Circulation Aneurysms: Should we Clip or Coil?

Basilar Artery Bifurcation Aneurysms: The Case for Clip Ligation

Clip Ligation of basilar bifurcation aneurysms is technically challenging as these lesions are relatively inaccessible and their manipulation is associated with a high risk of thalamoperforator infarction. The basilar apex is reached via three anatomic trajectories, including the opticocarotid, carotid-oculomotor, and rarely supracarotid triangles. Microsurgery is compromised by an inadequate identification of the thalamoperforators and suboptimal proximal vascular control.

Moreover, the direction of aneurysm dome projection and the location of the bifurcation in relation to the posterior clinoid process complicate adequate surgical access. Superior and posterior-projecting aneurysms obscure the perforators behind the distal neck, whereas anterior-projecting aneurysms hide the contralateral SCA and the PCA. The perforators are easier to dissect and protect in anterior-projecting aneurysms because they diverge from the aneurysm dome.

On the other hand, the posterior-projecting aneurysms displace and compress the perforators into the back wall of the aneurysm neck, making these variants the most difficult to treat surgically.

Surgical access depends on the vertical position of the basilar apex in relation to the posterior clinoid. High-riding basilar bifurcations are obscured by the ICA, requiring additional rostral neurovascular manipulation to view the aneurysm neck, but proximal control is readily visualized. The perforators also have a more inferior orientation, which facilitates their dissection away from the neck.

The posterior clinoid process obscures the low-riding basilar bifurcations, preventing reliable proximal control. Furthermore, the perforators travel in a more vertical orientation in this vascular configuration, impeding their mobilization and dissection. Depending on the relative position of the basilar tip to the edge of the tentorium and the posterior clinoid, a subtemporal approach can be advantages.

Proximal PCA (P1) aneurysms are similar to SCA aneurysms in terms of their surgical exposure. They are laterally oriented and easily exposed through a transsylvian corridor, but unlike SCA aneurysms, the surgical view is tangential to the thalamoperforators arising from the posterior communicating artery (PCoA) or P1 segment that are often adherent to the aneurysm dome or neck.

Distal PCA aneurysms are fortunately rare, difficult to expose, and should be evaluated individually. Although distal PCA aneurysms can be accessed through a subtemporal approach, there is frequent morbidity associated with poor visibility and extensive temporal lobe retraction.

Case Example 1

A 43-year-old woman presented with Hunt & Hess grade IV subarachnoid hemorrhage secondary to rupture of a basilar tip aneurysm. After discussion with the endovascular team, the patient underwent microsurgical clipping because of the aneurysm’s wide neck .

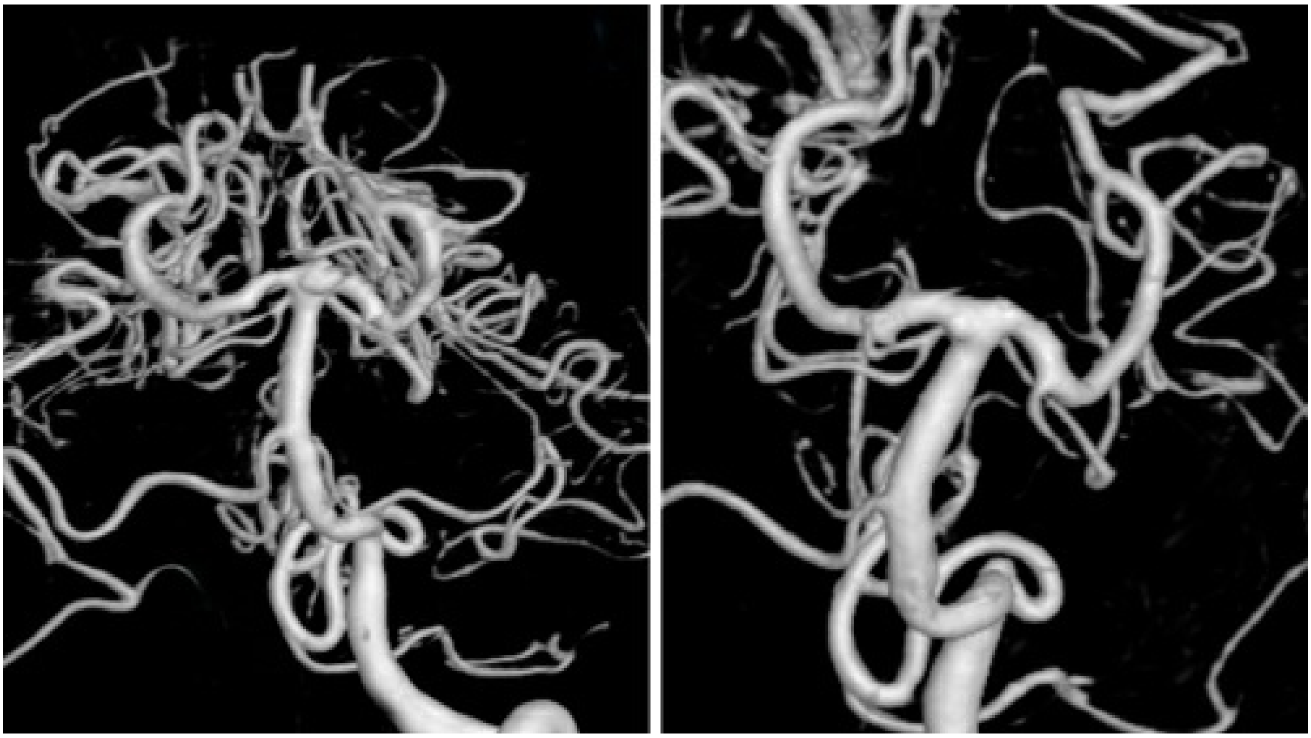

Figure 1: Three-dimensional (3D) reconstruction of the digital subtraction angiography (DSA) shows an anteriorly-projecting high-riding basilar bifurcation aneurysm with a wide neck (left).

Postoperative imaging reveals complete obliteration of the aneurysm (right).

Basilar Artery Bifurcation Aneurysms: The Case for Endovascular Intervention

These aneurysms preferably undergo endovascular treatment given the limited safe exposure of the interpeduncular cisterns and the need for risky manipulation of the thalamoperforating vessels.

Endovascular treatment of these lesions is also not straightforward. Basilar apex aneurysms often are wide-necked and involve the origin of one or both of the P1 segments. If the aneurysm projects posteriorly or is well below the dorsum sella, endovascular treatment is clearly favored over clipping. Flow diversion, although used successfully in some cases, should be avoided in the perforator-rich basilar apex if at all possible. Coiling with balloon or stent assistance is successful and safe.

The most advantageous stent configuration that leads to reconstruction of the parent bifurcation and aids in embolization of the aneurysm is a stent placed from one P1 to the other via the PCoA. Unfortunately, in many patients, the PCoA is not amenable to this maneuver.

Other possible stent configurations include “shelving” a single P1 to basilar stent, Y-stenting with one stent out of each P1, and T-stenting from P1 to P1 via the PCoA. The shelving technique is technically most straightforward, but it may not adequately narrow the neck of the aneurysm to protect the unstented P1. Y-stent and T-stent configurations are more protective of the P1s, but these are more complex maneuvers which require significant experience and skill. Balloon-assisted coiling may be performed with a balloon from P1 to basilar or from P1 to P1 across the PCoA.

Primary basilar artery or trunk aneurysms often are either dissecting pseudoaneurysms or aneurysms related to basilar artery fenestrations. Both of these entities can be treated endovascularly by means of stent reconstruction. Again, flow-diverters should be reserved for extraordinary circumstances because of the perforator-rich nature of the basilar trunk. Although an attempt at coiling is prudent for fenestration aneurysms, double-stenting (a stent within a stent) techniques are a reasonable option for dissecting pseudoaneurysms.

Case Example 2

A 75-year-old man presented with a transient ischemic attack and was incidentally found to have a basilar tip aneurysm. The aneurysm was coiled by means of stent assistance. Older patients benefit best from an endovascular approach.

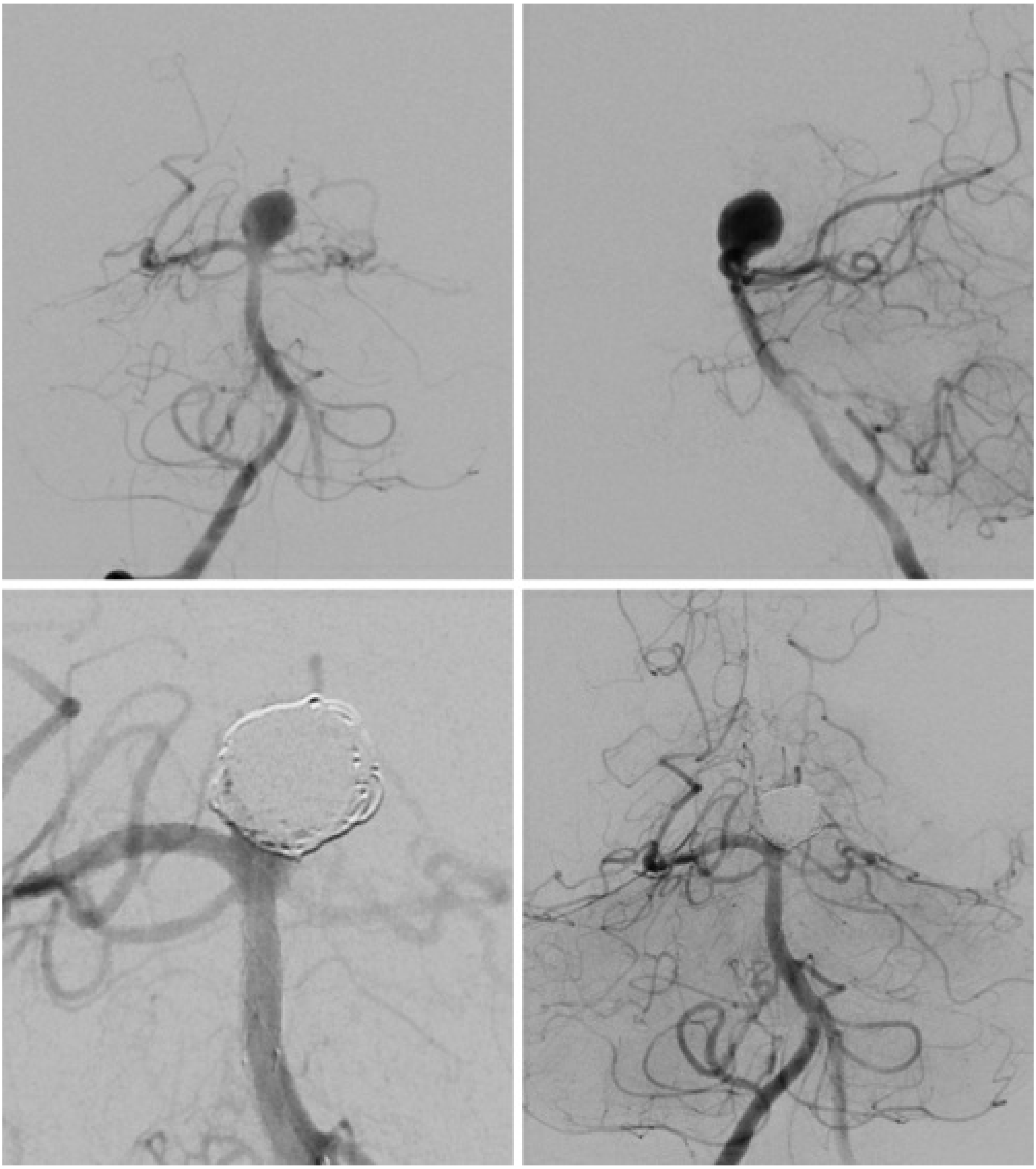

Figure 2: The basilar bifurcation aneurysm is demonstrated on AP and lateral angiography (top row). Postprocedural imaging reveals Raymond grade 3 embolization (bottom row).

Case Example 3

A 70-year-old woman presented with a mid-side wall basilar artery aneurysm, which was found during diagnostic tests for a previous MCA stroke. The patient underwent endovascular stent-assisted coiling.

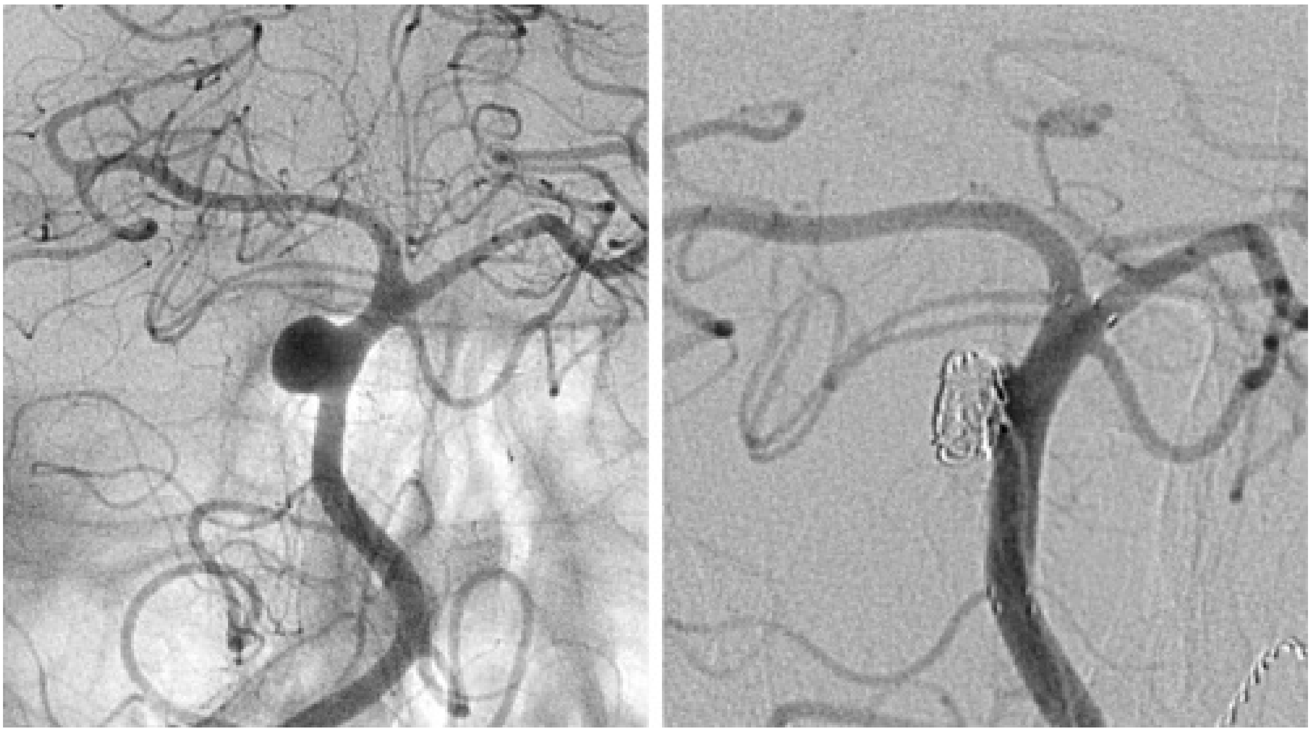

Figure 3: DSA of the posterior circulation shows a dissecting basilar artery aneurysm. The postoperative angiography shows Raymond grade 3 obliteration. There is no good surgical option available for this lesion.

PICA Aneurysms: The Case for Clipping

Microsurgery continues to have a primary role in the treatment of PICA and distal AICA aneurysms. The small caliber PICA and AICA typically arise from the neck of the aneurysm and embolization can place these small caliber vessels at risk.

These lesions are readily accessible through a lateral suboccipital or extended retrosigmoid approache, especially at the distal vascular locations where there are few branching vessels and proximal control is easily possible with minimal dissection.

Although proximal PICA aneurysms are more technically challenging, the lower cranial nerves and traversing perforators can be safely protected or circumvented. Temporary occlusion is also well tolerated for revascularization procedures when the parent vessel cannot be saved.

Case Example 4

A 39-year-old woman presented with Hunt & Hess grade II subarachnoid hemorrhage (SAH) secondary to a left PICA-origin aneurysm rupture. The patient underwent clip obliteration of the aneurysm via a left lateral suboccipital approach. Postoperative angiography confirmed total obliteration of the aneurysm.

Figure 4: Angiography shows an aneurysm at the origin of the

PICA (top row). The small caliber and therefore vulnerable PICA emerges from the neck of the aneurysm. Postoperative angiogram confirms complete obliteration of the aneurysm via two clips (bottom row).

Case Example 5

70 year-old male presented with a ruptured PICA aneurysm. Endosvascular attempts were unsuccessful due to tortuosity of proximal PICA. Clip ligation allowed complete exclusion of the aneurysm.

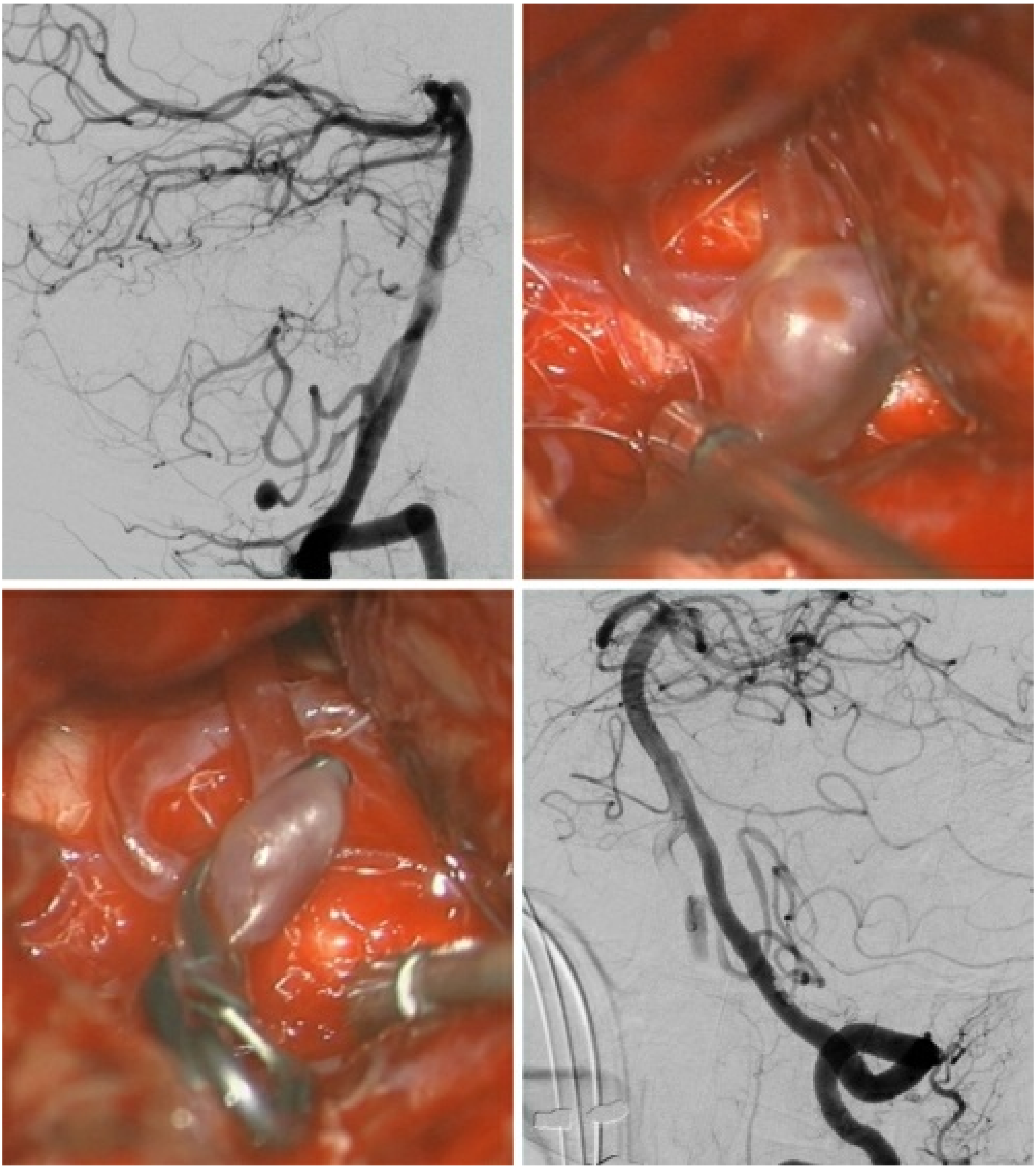

Figure 5: This distal PICA aneurysm (left upper image) was inaccessible for endovascular intervention. Clip ligation (right upper and left lower images) excluded the wide-based aneurysm while preserving the PICA (right lower image).

PICA Aneurysms: The Case for Coiling

The designation of PICA aneurysms includes PICA-origin aneurysms and distal PICA aneurysms. There is an obvious overlap between the vertebral artery dissecting pseudoaneurysms and PICA-origin aneurysms, but this section will be limited to a discussion of saccular aneurysms of the PICA origin.

Aneurysms arising at the PICA origin can arise primarily from the VA or the PICA itself. The PICA origin is often incorporated in the aneurysm neck. Preserving the PICA origin in these cases may be more straightforward by means of clipping; however, when the PICA origin is in a position that can be easily preserved with endovascular techniques, coiling/stenting/flow-diverting can provide a durable, safe, and well-tolerated treatment.

VA aneurysms are most often associated with the PICA origin. Aneurysms of the VA that are not associated with this branch are often dissecting pseudoaneurysms arising immediately distal to the beginning of the V4 segment as the artery traverses the dura. Double stenting (a stent within a stent) technique may be performed with or without the addition of coils to tackle these pseudoaneurysms. This region is relatively perforator free, and flow diverting stents have been used safely and successfully for VA aneurysms.

Distal PICA aneurysms are often more easily clip ligated. Another consideration is the reciprocal overlap between the blood supply from the PICA, SCA, and AICA, which allows, in some selecte cases, sacrifice of the PICA without any adverse effects.

Case Example 6

A 52-year-old woman harbored both a basilar apex and a PICA aneurysm. She underwent primary coil embolization for both aneurysms. The PICA aneurysm required balloon assist to pin the microcatheter against kick-out.

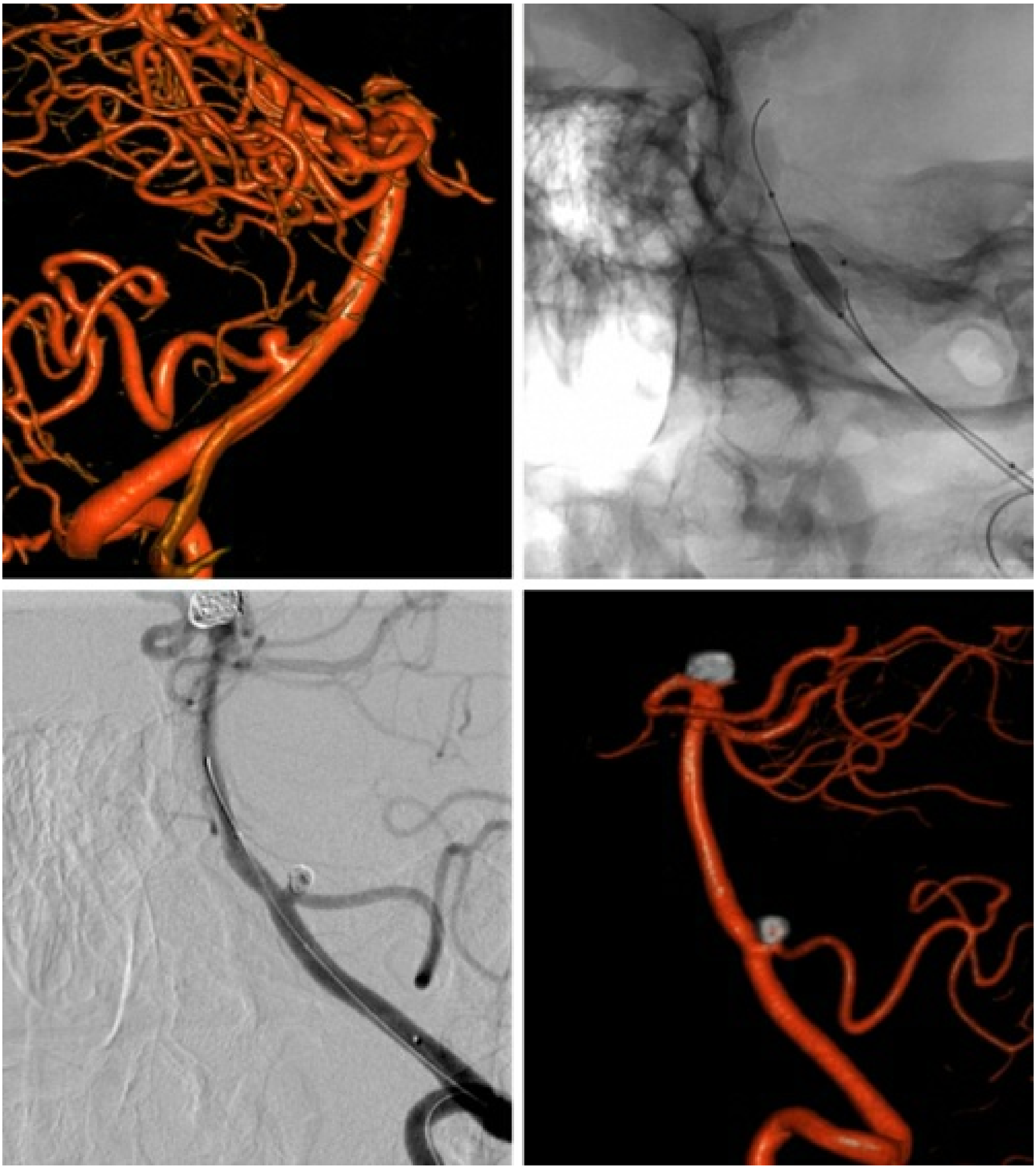

Figure 6: Three-dimensional reconstruction of the rather small and wide-necked PICA aneurysm that was treated with primary coiling is included (left upper corner). Due to the unfavorable working angles and small aneurysm, kickout of the microcatheter was avoided by stabilizing the microcatheter using a balloon in the VA (right upper corner). Final favorable result of a stable coil packet is apparent (lower panels).

Case Example 7

During diagnostic tests for headaches, a 56-year-old man was found to have a dissecting aneurysm at the origin of the PICA. Endovascular treatment was rendered via a pipeline device. After the procedure, angiography demonstrated good apposition to the vessel wall, stagnation within the dome of the aneurysm with incomplete sac filling, and persistent filling of the PICA.

Figure 7: A right VA angiogram demonstrates a dissecting aneurysm at the PICA origin (top row). Three-dimensional

reconstruction of the Dyna CT shows good compression of the device at the level of the aneurysm (left lower image). A postoperative angiogram confirms obliteration of the aneurysm (right lower image).

Superior Cerebellar Artery Aneurysms: The Case for Clip Ligation

Superior cerebellar artery (SCA) aneurysms are much more suited for microsurgical intervention than basilar apex aneurysms because their necks are anatomically barren of brainstem perforators. These critical thalamoperforators neither arise from the axilla of the PCA nor the shoulder of the SCA. Additionally, SCA aneurysms are laterally projecting, which improves their visualization through a transsylvian approach.

These unique anatomic advantages allow the neck of an SCA aneurysm to be safely exposed without extensive microdissection or risk of perforator infarction. Although there are no high-riding SCA aneurysms, low-riding SCA aneurysms are more difficult to expose surgically and may require a posterior clinoidectomy or dorsum sella resection. Overall, SCA aneurysms are relatively approachable with a low perforator risk.

Case Example 8

A 55-year-old man was incidentally found to have a basilar apex and left SCA aneurysm. He underwent an orbitozygomatic craniotomy for clipping of the left SCA aneurysm followed by stent-assisted coiling of the basilar apex aneurysm.

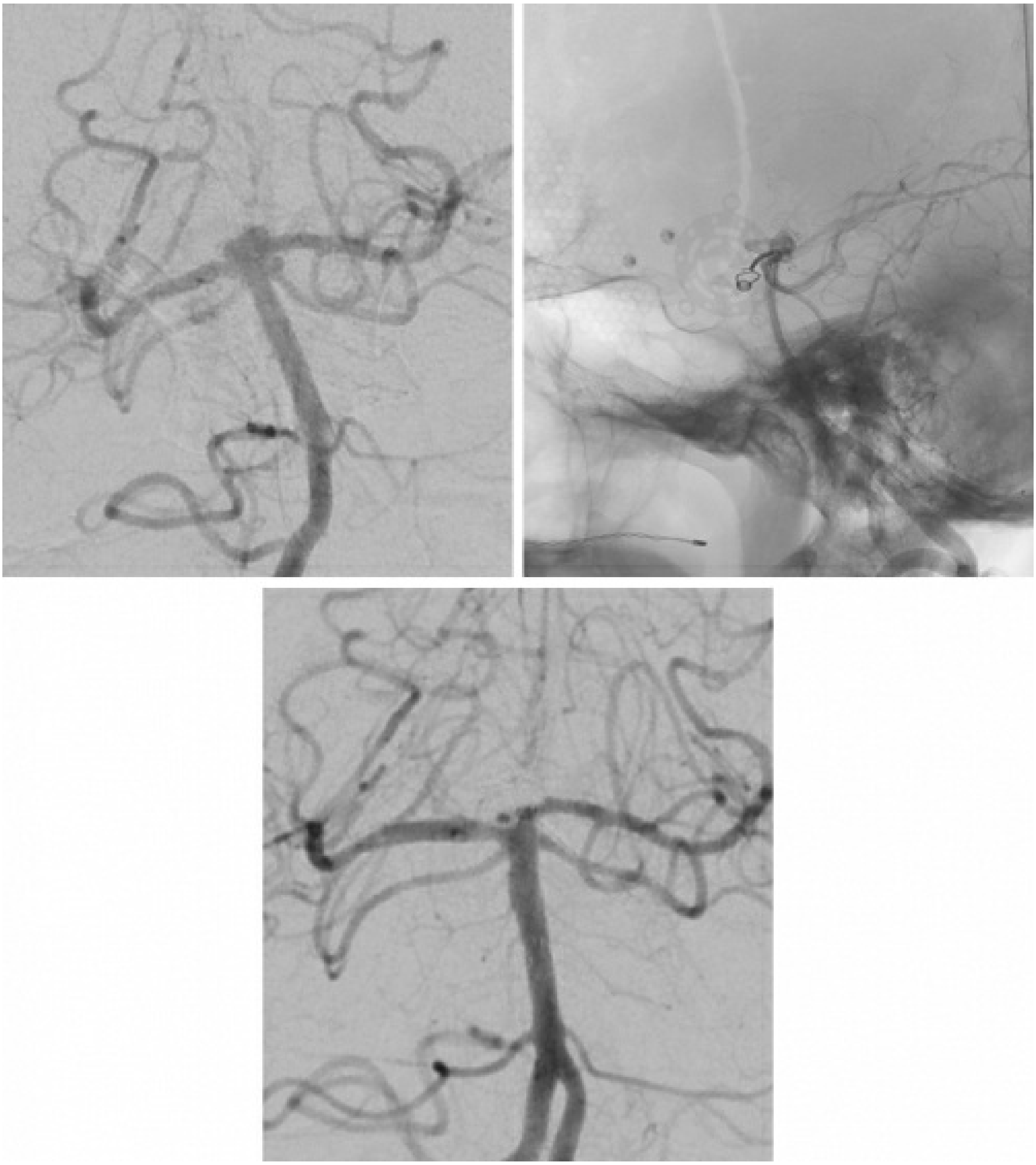

Figure 8: A basilar apex and left SCA aneurysm are shown (left upper corner). The bone window on the right reveals the high-riding basilar apex that was not readily accessible during microsurgical clip ligation of the SCA aneurysm (right upper corner). Postoperative angiogram demonstrates successful obliteration of the SCA and basilar apex aneurysms (bottom image).

Superior Cerebellar Artery Aneurysms: The Case for

Endovascular Intervention

The small size of most SCA aneurysms and the size discrepancy between the SCA and the basilar artery make primary coiling and balloon- or stent-assisted coiling difficult. AICA aneurysms pose the same challenges and may be treated more effectively with open surgery if accessible. On the other hand, subtotal but protective coiling may be a reasonable option for elderly patients with other medical problems.

Case Example 9

A 70-year-old woman presented with transient ischemic attacks and was found to have a left SCA aneurysm. The patient underwent coil embolization. Magnetic resonance angiography 2 years after treatment revealed no recurrence.

Figure 9: A left SCA aneurysm is evident (left). Angiogram after coiling demonstrates obliteration of the aneurysm with preservation of the normal vasculature (right).

Posterior Circulation Aneurysms with Dissecting, Giant, or Complex Morphology

Complex aneurysms encompass a myriad of subtypes, including giant, multilobulated, dissecting, serpentine, fusiform, and broad necked. Aneurysms with a broad base, intraluminal thrombus, distal location, or efferent artery origins are poor endovascular candidates because they are often incompletely occluded and require multiple retreatment procedures.

Surgery, on the other hand, is technically challenging and equally fraught with peril; however, accessible aneurysms with available proximal control should undergo microsurgery. Such is the case with PICA aneurysms which are more frequently complex, yet remain microsurgically accessible and manageable.

One the other hand, vertebral artery aneurysms are more often dissecting variants that lack a surgically clippable neck. These lesions are more prone to intraoperative rupture and vascular control is not readily attainable.

In the posterior circulation, surgical treatment of large, dissecting, or fusiform aneurysms often requires high morbidity adjuncts such as hypothermic circulatory arrest, extensive skull base exposures, and prolonged temporary clipping. These factors cause surgery to become less favorable in comparison to endovascular alternatives. Nonetheless, surgery may have a role in rapidly deteriorating patients with thrombotic aneurysms compressing the brainstem.

Flow diversion may be an option for select dissecting or fusiform aneurysms. Perforator infarcts are a dreaded complication of flow diversion, causing many interventionalists to avoid flow diversion in the perforator-rich basilar artery, basilar apex, and vertebrobasilar junction territories. The exact risk profile of flow diversion in this region remains largely unestablished.

Case Example 10

A 62-year-old man initially underwent coil occlusion of his right VA for treatment of a 2.5-cm giant vertebrobasilar junction (VBJ) aneurysm. The aneurysm increased in size over time and caused further brainstem compression. Subsequently, the patient underwent clip reconstruction under hypothermic circulatory arrest. The patient's modified Rankin score improved from 5 to 3 in 6 months, and to 2 at 1 year after treatment.

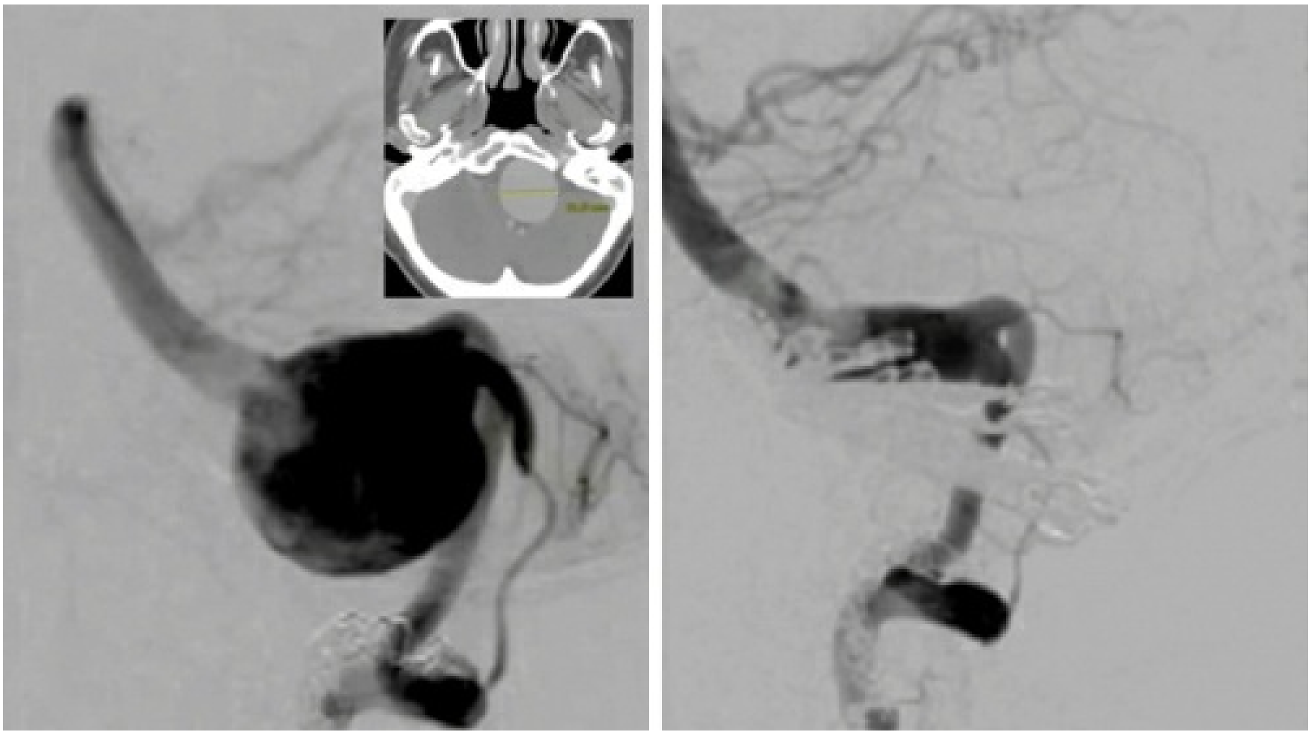

Figure 10: An axial CT (inset) demonstrates brainstem compression secondary to a giant vertebrobasilar junction aneurysm (left). The aneurysm was decompressed and clip reconstruction accomplished (right).

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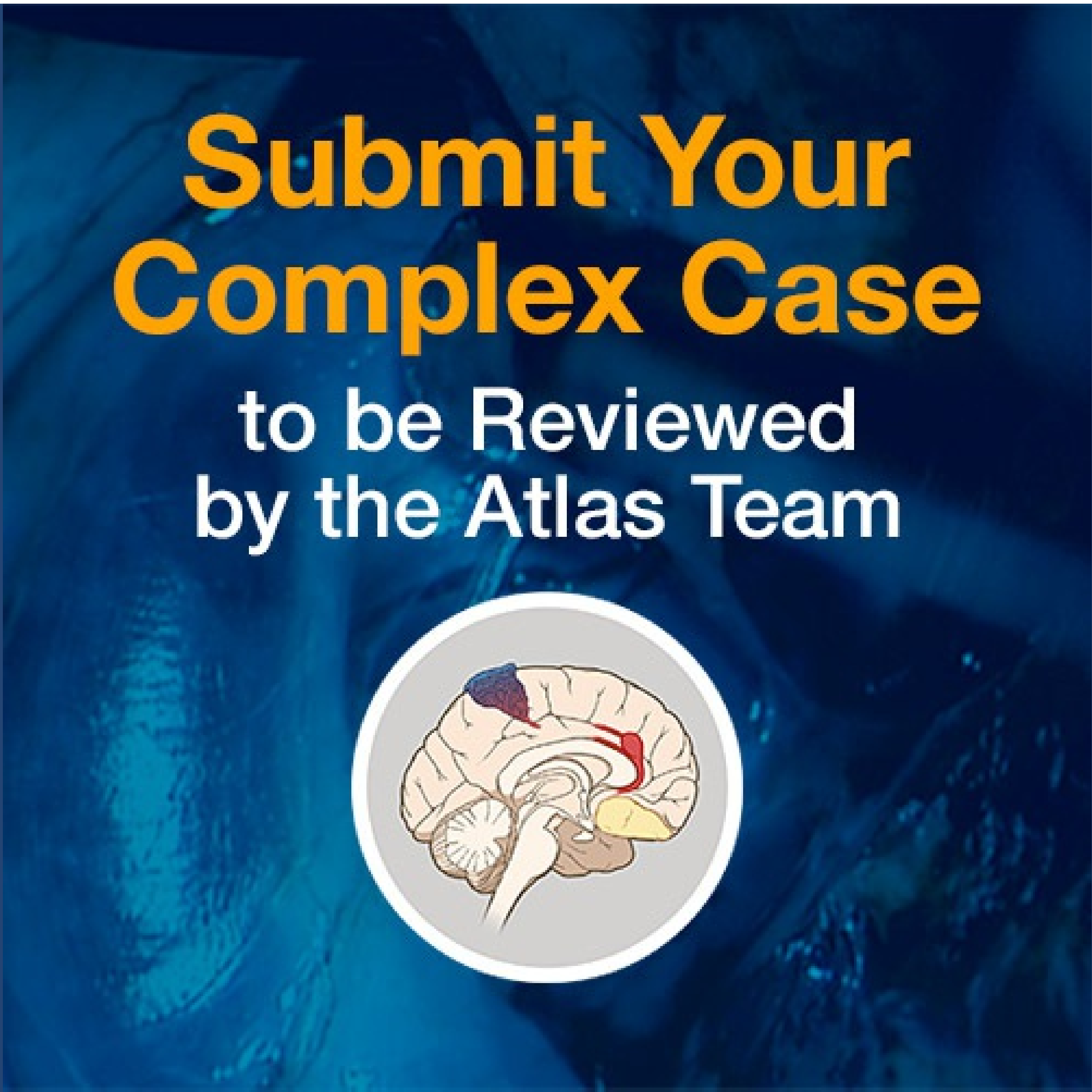
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