Basilar artery dissection: an early postoperative complication of aneurysm clipping

Case report

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Recurrent subarachnoid hemorrhage (SAH) in the early period following successful clipping of a cerebral aneurysm is unusual. The authors report a unique case of distal basilar artery dissection and fatal SAH on the 6th day postoperatively. It is concluded that this complication was related to vascular trauma inflicted by repositioning the aneurysm clips during a seemingly uneventful procedure for a basilar artery tip aneurysm.

KEY WORDS: cerebral aneurysm • aneurysm clip • subarachnoid hemorrhage • surgical complication

The management of ruptured cerebral aneurysms is associated with a wide range of possible complications. Preoperative, intraoperative, and postoperative phases of treatment each present unique and overlapping problems that must be recognized promptly and treated expeditiously to ensure a favorable outcome. The ideal "management" of complications, however, is prevention. Fundamental to prevention is a basic awareness of all potential problems that may arise.

The most common causes of morbidity and mortality in patients surviving subarachnoid hemorrhage (SAH) are vasospasm and rebleeding. The incidence of cerebral vasospasm is 34%, and its etiology, prevention, and treatment have been the subject of intense investigation. Rebleeding is a complication that can occur in all phases of surgical care. Unsecured aneurysms rebleed with a frequency of 50% within the first 6 months of initial hemorrhage. Intraoperative hemorrhage has been reported to occur in 19% of cases. Wide fluctuations in cerebral perfusion pressure and surgical manipulation during aneurysm dissection and clipping have been identified as causes of hemorrhage during the operative period. Recurrent hemorrhage remains a significant, although uncommon, risk during the postoperative period, both early and late. Its causes include clip failure, the presence of multiple aneurysms, and incomplete neck occlusion. We describe a previously unreported cause of early postoperative hemorrhage subsequent to the successful clipping of a basilar artery tip aneurysm.

Case Report

This 34-year-old right-handed woman suffered a coma-producing SAH. She was intubated at the scene of the ictus and transferred to the hospital. On arrival, her Glasgow Coma Scale score was 7. Over the ensuing 24 hours, she rapidly improved to a state of being alert and oriented without neurological deficit. Computerized tomography (CT) of the head revealed diffuse SAH, and angiography showed a 12-mm basilar artery bifurcation aneurysm (Fig. 1). Fifteen days after SAH, the patient was transferred to our institution.

Examination. The patient was alert but confused, and had mild weakness of the left hand. The only significant medical history was 15 years of essential hypertension. On the 16th day after SAH, she was brought to the operating room for aneurysm clipping.

Operation. A standard right subtemporal approach was used. Exposure of the aneurysm was straightforward. Clip placement proved awkward because the aneurysm neck was bulbous, incorporating the proximal right posterior cerebral artery, and the aneurysm projected posteriorly. A Sugita temporary clip was placed on the basilar artery proximal to the superior cerebellar
arteries. Then, a Sugita fenestrated clip (shortened to 5 mm) was applied, with the right posterior cerebral artery encircled by the fenestration. Despite a number of attempts, the initial positioning of the Sugita fenestrated clip failed because the bulbous neck caused the clip blades to slide off the aneurysm and onto the distal basilar artery. A second clip was then placed further distally on the neck and the initial clip removed. A total of three fenestrated clips in tandem were used to secure the aneurysm. The final configuration provided complete occlusion of the aneurysmal neck and spared the distal basilar, posterior cerebral, and superior cerebellar arteries, as well as all visualized perforating vessels. Throughout the procedure, there was no change in the heart rate, blood pressure, or somatosensory evoked potentials.

**Postoperative Course.** On the 1st day postoperatively, the patient was mildly disoriented with a right third nerve palsy, but was otherwise well. Angiography on Day 5 revealed satisfactory clipping of the aneurysm. Postoperative recovery was uneventful until the evening of Day 6, when she experienced a sudden loss of consciousness with the immediate development of decerebrate posturing and fixed, dilated pupils. An emergency CT scan revealed a large interpeduncular SAH with intraventricular hemorrhage. Despite intubation, hyperventilation, osmotic diuresis, and ventriculostomy, the patient did not recover. She was declared dead on Day 7.

**Fig. 1.** Preoperative angiogram, anteroposterior projection, revealing a 12-mm basilar artery bifurcation aneurysm. The aneurysm projected posteriorly on the lateral view.

**Fig. 2.** Postmortem photograph of the clipped basilar artery tip aneurysm, dorsal view. The clip blades completely occlude the aneurysmal neck and leave no residual sac. All major branches and perforating vessels were spared by the clipping.

**Autopsy Findings.** Postmortem examination of the circle of Willis revealed complete occlusion of the aneurysmal neck by the aneurysm clips (Fig. 2). Inspection of the distal basilar artery revealed a small transverse tear on the ventral surface. It was located at the point of initial clip placement, approximately 2 mm proximal to the location of the final permanent aneurysm clips. This tear was well distal to the site of the temporary clip placement.

Microscopic examination of the aneurysm showed the typical loss of internal elastic lamina and media. The aneurysm was not atherosclerotic, and did not contain thrombus. Examination of the distal basilar artery revealed a ragged rent through the ventral wall. A segment of relatively normal vascular architecture was present between the neck of the aneurysm and the site of vascular rupture. The intima of this segment was slightly thickened, but the internal elastic lamina looked normal. The media was mildly attenuated. Arterial dissection was evident, with thrombus extending from the intravascular space, dissecting proximally into the media, and finally rupturing into the subarachnoid space (Fig. 3). The presence of thrombus not only extending through the wall but also dissecting into the media confirmed that the tear in the artery was not an artifact of postmortem dissection. The segment of structurally normal blood vessel wall between the aneurysm and the site of rupture was pathological evidence that the origin of the fatal hemorrhage was through the basilar artery and not the residual aneurysmal neck. Based on the pathological findings, it was concluded that a fatal dissection and rupture had occurred through the distal basilar artery at the presumed site of initial permanent clip application.
Basilar artery dissection

Fig. 3. Photomicrograph (left) and schematic drawing (right) of a midline longitudinal section through the distal basilar artery bifurcation aneurysm. Left: The aneurysmal wall shows the typical loss of media and internal elastic lamina (arrowhead). The site of clip placement is clearly evident (straight black arrow). A segment of relatively normal vascular wall (curved black arrow) is present between the aneurysmal neck and the site of rupture (open arrow). Thrombus extends from the basilar artery lumen through the vascular tear, dissecting proximally into the media of the artery (two-headed white arrow). Movat’s stain, × 36.

Discussion

Early postoperative hemorrhage following successful aneurysm clipping is a rare event. A small number of factors have been associated with this unusual occurrence. The initial use of aneurysm clips was followed by a few reports of clips that slipped due to inappropriate occlusion forces or fractured, leading to fatal hemorrhage.2,4,11,14 The clips that are now manufactured have an extremely low rate of failure. This improvement is the result of extensive research that has optimized the minimum occlusion forces, metallurgical variables, biocompatibility, and corrosion resistance.5 Yaşargil17 reported no complications due to clip failure in his series of 1500 aneurysm cases.

Aneurysm clips may slip not only because of inherent mechanical failings, but also as a consequence of the size and pathological state of an aneurysmal neck. A large, atherosclerotic neck is prone to difficulties at the time of clipping and also postoperatively when, in combination with continuous pulsatile forces, it may cause clip migration.1 Incomplete occlusion of the aneurysmal neck may occur inadvertently, due to incomplete dissection, and unavoidably in cases where anatomical and pathological circumstances preclude both complete neck obliteration and parent artery preservation. Drake and Vanderlinden1 have reported on the hazard of the incompletely clipped aneurysm, citing complications in 11 of 25 cases including recurrent hemorrhage and aneurysm enlargement. A later study12 described 19 patients with incompletely clipped aneurysms. Although the residual neck averaged only 2 mm in size, 15 patients experienced recurrent hemorrhage. Yaşargil18 also reported 10 cases of incomplete neck occlusion, all of which rebled within 2 to 4 weeks.

The presence of multiple aneurysms can also contribute to postoperative hemorrhage. Identifying the responsible aneurysm may be difficult when SAH occurs in a patient harboring multiple aneurysms. If an incidental aneurysm is mistakenly identified as the responsible lesion, the truly culpable aneurysm may escape definitive treatment, leading to postoperative disaster.

In this report, we describe an unexpected early postoperative hemorrhage caused by rupture of the basilar artery, just proximal to an adequately clipped aneurysm. Pathological examination of a longitudinal section through the basilar artery leaves no doubt that the arterial tear was an in vivo event and that the site of hemorrhage was through the basilar wall proximal to the neck of the aneurysm, at the presumed site of initial clip placement. We believe that the relatively high closing force of the permanent clips damaged the basilar artery at the point of application, leading to fatal dissection on the 6th day postoperatively. There is theoretical support for this hypothesis. It is known that the parent artery feeding an aneurysm is not an architecturally normal vessel. Microscopic examination of the artery just proximal to an aneurysm may reveal thickening of the intima, fragmentation and degeneration of the internal elastic lamina, fibrosis and attenuation of the media, and thinning of the adventitia.13,16 Cerebral vessels that are chronically exposed to hypertension suffer further damage, including progressive degeneration of the media. Experimental evidence has established that aneurysm clips can cause severe vascular damage. Typically, the endothelium is fractured, the internal elastic lamina disrupted, and smooth muscle destroyed.5,7,8 Aneurysm clips produce the greatest shear forces on the endothelium and internal elastic lamina.

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situatet closest to the clip’s fulcrum. These traumatic events can be minimized by reducing the occlusion forces of the clip blades. Serrated aneurysm clips, such as the Sugita type, are particularly damaging. The serrations decrease the surface area of the blades in contact with the vessel wall. For a given clip force, the smaller surface area imparts a greater stress on the artery, causing greater damage. Repeated damage inflicted by an aneurysm clip on a pathologically abnormal artery may predictably result in a vessel vulnerable to dissection and rupture. We propose that this was the mechanism of hemorrhage in our patient. The unequivocal findings at autopsy and the theoretical considerations described above support our pathophysiological hypothesis. This case illustrates that repeated repositioning of a permanent clip has the potential to result in serious vascular injury. Although clearly not a common complication, an awareness of this danger should factor into any decision to adjust or reapply an aneurysm clip.

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References


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