Use of balloon occlusion and substances to protect ischemic brain during resection of posterior fossa AVM

Case report

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The successful resection of a large posterior fossa arteriovenous malformation (AVM) is reported. A balloon catheter was used for temporary intraoperative occlusion of the basilar artery and feeding vessels of the AVM. Prior to occlusion of these arteries, newly tested substances to protect the ischemic brain were administered to prolong occlusion time. Resection of the AVM was completed without complication, and the patient returned to normal life. This is a useful intraoperative procedure for the resection of AVM's considered inoperable by conventional approaches.

KEY WORDS arteriovenous malformation posterior fossa temporary occlusion ischemia chemical brain protection

Large arteriovenous malformations (AVM's) situated in the posterior fossa are difficult and sometimes very hazardous to resect.1,4,7,19 Total removal of these AVM's is especially complicated when the nidus is located close to the brain stem. Another difficult aspect is controlling the feeding arteries when they are deeply situated. We usually attempt temporary occlusion of the feeding arteries prior to approaching an AVM,12 but they are frequently difficult or even impossible to reach.

Recently, we successfully resected a large posterior fossa AVM utilizing a balloon catheter for intraoperative temporary occlusion of the basilar artery and other arterial feeders to the AVM. To prolong the safe occlusion time of these arteries, the patient was given newly developed substances to protect the ischemic brain.10 The patient's clinical history and hospital course are presented to demonstrate the usefulness of this method for resection of surgically difficult AVM's.

Case Report

This 14-year-old girl experienced the sudden onset of a headache, followed by vertigo, tinnitus, nausea, and vomiting on September 30, 1983. A computerized tomography scan disclosed subarachnoid hemorrhage with ventricular rupture and a left cerebellar hemorrhage (Fig. 1). She was admitted to our clinic 1 week later.

Examination. Neurological examination showed no deficit except for left cerebellar signs. Conventional and superselective angiography showed a large left cerebellopontine angle AVM fed by a duplicated left superior cerebellar artery and a left anterior inferior cerebellar artery (AICA) (Fig. 2A, B, and C). The superior anterior part of the nidus was mainly fed by the duplicated left superior cerebellar artery and the inferior posterior portion was fed by the left AICA.

Before surgery, the patient was given 500 ml of 20% mannitol, 300 mg of vitamin E, and 50 mg of dexamethasone.10 Immediately after that a 15-minute tolerance test of balloon occlusion of the basilar artery was carried out under local anesthesia. No neurological dysfunction or disturbance in the brain-stem auditory evoked potentials (BAEP's) was noted (Fig. 3).

Operation. On November 14, 1983, two Silastic non-detachable balloon catheters were introduced through a No. 8 French thin-walled catheter via the left femoral artery. One balloon was inserted into the left AICA and the other into the basilar artery where the duplicated left superior cerebellar artery originated (Fig. 4). The BAEP's were monitored continuously and intraoperative angiography was performed. The operation
was carried out via a unilateral suboccipital approach. Just before the basilar artery was occluded, the patient was given 500 ml of 20% mannitol, 300 mg of vitamin E, and 50 mg of dexamethasone intravenously over 30 minutes, followed by 800 ml of perfluorochemicals (20% Fluosol-DA) to prolong temporary arterial occlusion time. The balloon catheters were then inflated to occlude the AICA for 26 minutes and the basilar artery (where the duplicated left superior cerebellar artery originated) for 46 minutes. The AVM was totally resected without troublesome hemorrhage. The BAEP’s showed no change throughout the operation.

Postoperative Course. The postoperative course was uneventful, and angiography confirmed total resection of the AVM (Fig. 2D). The patient returned home with no additional neurological deficits and, 10 months after the operation, was doing well at school.

Discussion

For the surgical treatment of this large posterior fossa AVM, we used two currently developing methods: intravascular balloon catheter occlusion and substances that protect the ischemic brain. With this technique, which combines temporary occlusion of the feeding arteries by a balloon catheter with surgical resection of the AVM, an operative approach can be selected based on the location and the extent of the nidus regardless of the difficulty of access to the feeding arteries.

Recent progress in balloon catheter technique has extended its clinical application to the treatment of intracranial AVM’s. This technique can now be employed in superselective angiography and in tolerance tests of temporary occlusion. Arteries feeding AVM’s can be embolized by detachable balloon catheter. Kerber introduced a calibrated-leak balloon and used it to embolize an AVM with cyanoacrylates. However, some problems still exist, including the difficulty in manipulating the balloon into the nidus and the potential risk of vessel rupture and polymerization between the balloon and the vessel. If further progress is to be made in the embolization technique as a therapeutic method, it is mandatory to develop safer and more definitive liquid embolizing materials.

Recently, preoperative detachable balloon occlusion was reported as an adjunct to treatment of AVM’s. However, the detaching mechanism of commercially available detachable balloon catheters of the traction type may cause vascular injury. Moreover, there are some feeding vessels into which it is impossible to introduce balloons. With our technique, feeding or parent arteries that perfuse the critical area can be occluded temporarily. This technique can be applied to cases of AVM’s difficult to resect surgically.
Another factor that lead to favorable results in this case is the development of methods for prolonging the occlusion time possible in cerebral arteries. We first used these methods in a patient with an aneurysm who underwent prolonged temporary clipping of a major cerebral artery after the administration of 20% mannitol. Since then, we have conducted a series of experimental and clinical investigations to determine the protective effect of mannitol. On the basis of these studies, we now believe that the administration of mannitol allows safe prolongation of vascular occlusion. In recent experimental and clinical studies, we have found a more effective method which consists of using 20% mannitol, vitamin E, dexamethasone, and perfluorochemicals ("Sendai cocktail"). The protective effect of the combined administration of these substances was demonstrated in experimental studies of produced severe ischemia (10% cerebral blood flow for 1 hour). Recently, we have shown by chemiluminescence methods that the 20% mannitol, vitamin E, and glucocorticoid combination probably acts as free radical scavengers. We have developed many clinical applications using these concepts, including its therapeutic use for acute brain infarction.

With this adjunct to the surgical treatment of AVM's, the feeding arteries can be occluded temporarily, massive hemorrhage can be avoided, damage to the brain can be minimized, and a safe operation can be completed. This method is a useful intraoperative procedure, and will make it possible to resect AVM's considered inoperable by conventional approaches.

References

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