Fatal intracranial hemorrhage after balloon occlusion of an extracranial vertebral arteriovenous fistula

Case report

TAKESHI KONDOH, M.D., NORIHIKO TAMAKI, M.D., NAOYA TAKEDA, M.D., TOORU SUYAMA, M.D., SHIZUO OI, M.D., AND SATOSHI MATSUMOTO, M.D.

Department of Neurosurgery, Kobe University School of Medicine, Kobe, Japan

A patient is presented who developed a fatal hemorrhage immediately after balloon occlusion of an extracranial vertebral arteriovenous fistula. The fistula was associated with marked retrograde flow not only from the contralateral vertebral artery but also from the carotid artery system through the posterior communicating artery and the basilar artery. The bleeding appeared to be caused by acute hemodynamic effects following abrupt occlusion of the long-standing fistula. A gradual staged occlusion or trapping procedure should be considered for the treatment of such vertebral arteriovenous fistulae.

KEY WORDS arteriovenous fistula vertebral artery internal jugular vein intravascular occlusion

VERTEBRAL arteriovenous fistulae represent an uncommon and challenging neurosurgical problem. Since the development of the intravascular balloon technique, occlusion with a detachable balloon is considered a simple and safe method for treating some types of arteriovenous fistulae. The authors were therefore prompted to report a case of vertebral arteriovenous fistula in which catastrophic hemorrhage occurred immediately after balloon occlusion of the fistula.

Case Report

This 41-year-old man was admitted on May 27, 1987, because of a pulse-synchronized buzzing noise over the left retroauricular region. He had been struck in the neck with a wooden bar 11 years before and had noted a rushing noise in the left side of his head on the following day. This had progressed to a constant loud, roaring sound.

Examination. On admission, a loud bruit was detected on the left side of the patient's neck, face, and eye with its maximum intensity at the left mastoid process. No wound, scar, or definite neurological deficit was found. On selective angiography, a left vertebral injection showed a high-flow arteriovenous fistula at the C-1 level (Fig. 1), with blood flowing into the internal jugular vein. Right vertebral angiography revealed marked retrograde flow through the distal segment of the left vertebral artery to the fistula (Fig. 2). Both vertebral arteries were obviously enlarged. Minor flow to the fistula from both internal carotid arteries

![Fig. 1. Left vertebral angiogram showing a large arteriovenous fistula at the C-1 level. The vertebral artery is markedly enlarged.](image-url)
T. Kondoh, et al.

FIG. 2. Right vertebral angiogram showing retrograde flow through the distal segment of the left vertebral artery to the fistula. The left posterior inferior cerebellar artery is not visualized.

and a branch of the left occipital artery was observed on the selective carotid artery injections. Stump pressure was measured when the left vertebral artery was occluded proximally with a balloon. The distal mean arterial pressure dropped 59%, from 98 to 58 mm Hg.

Embolization. Direct balloon occlusion of the fistula was attempted via the left vertebral artery. On June 19, a Debrun detachable balloon was passed via a transfemoral approach into the left vertebral artery and was floated up into the fistula. At this time the murmur ceased completely and blood pressure was 98/65 mm Hg. Injection of metrizamide through the introducing catheter revealed patency of the left vertebral artery and no filling of the fistula (Fig. 3). Thirty minutes after occlusion of the fistula, the patient suddenly complained of severe headache and immediately became deeply comatose, followed by respiratory arrest. Repeat angiography showed that the balloon was in the correct place but that the left vertebral artery was not filling. Computerized tomography revealed diffuse multifocal hemorrhages of the brain stem and left thalamus, associated with subarachnoid hemorrhage in the basal cistern and intraventricular hemorrhage (Fig. 4). Auditory brain-stem evoked potential testing showed no response. The patient died on June 29.

Discussion

Arteriovenous fistulae involving the vertebral artery are fairly uncommon. Embolization with polyvinyl alcohol foam or a metallic coil has been reported. In cases with high blood flow or a large fistula, incomplete thrombosis may result in pulmonary emboli. Recently, intravascular balloon occlusion techniques have been used to close fistulae with or without a subsequent operative procedure. A Fogarty balloon catheter has often been used intraoperatively to control bleeding, but this may require sacrificing the vertebral artery. Whichever procedure is selected, surgical or endovascular, the goal of treating a vertebral arteriovenous fistula is complete occlusion of the shunt with preservation of normal patency of the parent vertebral artery.

Up to the present, 37 cases of vertebral arteriovenous fistula occluded with detachable balloons have been described. The lesions at or above the C-1 level are the most difficult to treat surgically because: 1) the injured artery is often covered by arterialized venous plexus or a false aneurysm; 2) the vertebral artery is encased in the foramina transversaria, and proximal control is difficult; and 3) a suboccipital craniectomy and intradural approach are necessary for distal control of the vertebral artery. The risk of massive uncontrollable hemorrhage has been pointed out and, in some cases, several operations have been required for fistula occlusion.

Embolization with polyvinyl alcohol foam or a metallic coil has been reported. In cases with high blood flow or a large fistula, incomplete thrombosis may result in pulmonary emboli. Recently, intravascular balloon occlusion techniques have been used to close fistulae with or without a subsequent operative procedure. A Fogarty balloon catheter has often been used intraoperatively to control bleeding, but this may require sacrificing the vertebral artery. Whichever procedure is selected, surgical or endovascular, the goal of treating a vertebral arteriovenous fistula is complete occlusion of the shunt with preservation of normal patency of the parent vertebral artery.

Up to the present, 37 cases of vertebral arteriovenous fistula occluded with detachable balloons have been reported. Of these, 29 cases (78%) were treated with preservation of the parent vertebral artery. Most frequent complications were brain-stem infarctions. Hemorrhagic complications due to hemodynamic changes have not been reported. In 47 cases of vertebral arteriovenous fistula in the literature, the angiographic findings were described in detail. The fistulae can be classified into three groups based on the hemodynamic picture (Fig. 5):
Intracranial hemorrhage after vertebral AV fistula occlusion

Type 1, with flow from the parent vertebral artery only, was found in 25 cases (53%); Type 2, with steal from the contralateral vertebral artery, was present in 17 cases (36%); and Type 3, with steal from the carotid arteries as well as the contralateral vertebral artery (as in our case), was present in only five cases (11%). In long-standing Type 3 fistulae, hemodynamic stability may be maintained by maximally dilated, nonautoregulating small vessels of the vertebrobasilar system. Failure of autoregulation, called the “normal-pressure breakthrough phenomenon,” is well known in cases of large arteriovenous malformations after abrupt occlusion of the fistula. Blood may be redirected into these abnormally dilated vessels with a high perfusion pressure. Hemorrhage from a similar etiology has been reported after carotid endarterectomy to treat severe carotid stenosis. Halbach, et al., reported reversible ischemic signs, vertigo, severe headache, and quadriparesis immediately after occlusion of vertebral arteriovenous fistulae. They treated the condition with staged or slow occlusion of the fistula, followed by complete occlusion without any neurological deficit. In our case, massive multifocal bleeding occurred suddenly without any ischemic signs.

Abrupt occlusion using a detachable balloon appears desirable for Type 1 and 2 fistulae, but in a Type 3 fistula, with flow from the other vertebral artery and steal from the carotid arteries, abrupt occlusion carries some risk. To prevent a hyperperfusion syndrome, careful evaluation of the hemodynamic changes attendant upon occlusion of a long-standing arteriovenous fistula is required. Perioperative hypertension must be avoided, and a gradual staged occlusion or intravascular trapping procedure should be considered.

Fig. 4. Computerized tomography scans showing diffuse multifocal hemorrhage of the brain stem and left thalamus, associated with thick subarachnoid hemorrhage in the basal cistern and intraventricular hemorrhage.

Fig. 5. Diagrams showing the three types of vertebral arteriovenous fistula: Type 1 (left) was present in 25 cases (53%); Type 2 (center) was present in 17 cases (36%); and Type 3 (right) was present in five cases (11%). For a description see text.
References


Manuscript received January 22, 1988.
Address reprint requests to: Takeshi Kondoh, M.D., Department of Neurosurgery, Kobe University School of Medicine, S-1 Kusunoki-cho 7 Chome, Chuo-ku, 650 Kobe, Japan.