Brainstem Arteriovenous Malformation with a Pedicle Aneurysm Treated by Endovascular Surgery and Proton-beam Radiosurgery

—Case Report—

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Abstract

A 39-year-old male presented with a small pontine hemorrhage and subarachnoid hemorrhage. Angiography showed a small left pontine arteriovenous malformation (AVM) associated with a small aneurysm on the pedicle feeding the AVM. The pedicle aneurysm was occluded by microcoils. The AVM was then treated by proton-beam radiosurgery. Follow-up angiography 2 years later revealed that the AVM had disappeared completely without neurological deficit. The combination of embolization and proton-beam radiosurgery was curative in this patient with a pontine AVM associated with an aneurysm on the feeding artery, showing that these techniques can be used to treat inoperable vascular lesions safely.

Key words: arteriovenous malformation, aneurysm, embolization, stereotactic radiosurgery, proton beam, brain stem

Introduction

Treatment of brainstem arteriovenous malformations (AVMs) is still challenging despite the recent advances in microsurgery, endovascular surgery, and stereotactic radiosurgery. An aneurysm arising from the midcourse of a pedicle feeding an AVM is an important source of hemorrhage, and should be targeted for early selective treatment to diminish the risk of hemorrhage.1-3,5,7,8,10) Pedicle aneurysms are likely to cause recurrent hemorrhage from ruptured AVMs if untreated.10)

We describe a case of a ruptured brainstem AVM associated with a small pedicle aneurysm which was treated successfully by endovascular embolization of the aneurysm followed by proton-beam radiosurgery.

Case Report

A 39-year-old male was admitted to another hospital due to mild headache which had persisted for a night and gait disturbance. He had previously been healthy. Neurological examination was normal except for slight weakness of the right leg. Computed tomography (CT) of the brain showed a small hemorrhage in the left pons and subarachnoid hemorrhage in the left cerebellopontine angle cistern (Fig. 1). He was transferred to our hospital.

Left vertebral arteriography showed a small AVM of 7 mm maximum diameter located in the left pons (Fig. 2). Superselective angiography revealed that this AVM was fed by a small artery arising directly from the distal portion of the basilar artery (Fig. 3). In addition, a small aneurysm was visualized arising from the pedicle artery feeding the AVM (Figs. 2 and 3).

Treatment with stereotactic proton-beam radiosur-
gery was planned, because open surgery or embolization of the nidus was considered hazardous. Therefore, the pedicle carrying the aneurysm was occluded with microcoils to prevent bleeding from the aneurysm. A 6-F guiding catheter was placed in the right vertebral artery through a 6-F femoral sheath. A Tracker-18 (Target Therapeutics, Fremont, Cal., U.S.A.) microcatheter was navigated into the feeding artery. Provocative testing with 15 mg of amytal injected intra-arterially showed no neurological deterioration. Two straight, fibered, 5 mm microcoils and five 2 mm microcoils (Target Therapeutics) were placed into the feeding artery through the microcatheter (Fig. 4). Angiography following coil placement showed no opacification of the aneurysm and a remarkable decrease of the shunt flow (Fig. 5).

He was then treated with stereotactic proton-beam radiosurgery. His head was fixed in a stereotactic frame. The outline of the target and the direction of the proton beam were determined based on postcontrast CT scans. He was irradiated by four portals of...
proton beam in a single fraction, generated by a 250-
MeV synchrotron at the High Energy Physics In-
stitute (Tsukuba, Ibaraki). The total irradiation
dose was 19 Gy. Figure 6 shows the dose distribu-
tion curves.

Follow-up angiography showed that the shunt
flow had decreased further after 1 year and had disap-
peared completely after 2 years (Fig. 7). There were
no complications or neurological deficits.

Discussion

Total surgical extirpation of a ruptured AVM is the
treatment of choice to avoid further hemorrhage, but
was hazardous in our patient because of the
brainstem location. An alternative therapy for in-
operable AVMs is stereotactic radiosurgery using the
gamma knife, linear accelerator, or proton beam. We
have treated such patients with stereotactic
bragg-peak proton-beam therapy since 1990 in our in-
sitution. Proton-beam therapy for brain AVM
achieved total AVM obliteration in 22%, near total
obliteration in 29%, reduced size in 36%, and no sig-
nificant change in 13% of patients examined by an-
giography 2 years after therapy. In contrast, gam-
ma knife radiosurgery had obliterated 79.2–84.1%
of lesions at 2 years on a follow-up angiogram. Proton-beam therapy is apparently less effective than the gamma knife, but proton-beam therapy has been used for both small and large lesions, while the majority of lesions treated by gamma knife have been small (usually <3.0 cm average diameter). The advantage of proton-beam therapy is its unique dose distribution in brain tissue. Bragg-peak ionization theoretically allows little or no potential injury to adjacent vital structures because of the focused peak of particle delivery at a predetermined depth. In our patient, the AVM was located on the surface of the brainstem just above an eloquent area. Therefore, we planned to focus the proton beam peak at the AVM to protect adjacent brainstem area.

Radiosurgery requires a long latent period between irradiation and obliteration, which sometimes exceeds 2 years. The patient remains at risk of hemorrhage during this period. Therefore, we embolized the aneurysm with microcoils prior to radiosurgery, to prevent the rupture of the aneurysm during this latent period. Endovascular treatment of this kind of aneurysm is best performed with N-butyl cyanoacrylate or coils. We selected microcoils to minimize the risk of migration which could cause tragic results in the brainstem.

The combination of embolization and proton-beam radiosurgery was curative in this patient with a pontine AVM associated with an aneurysm on the feeding artery, showing that these techniques can be used to treat inoperable vascular lesions safely.

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