Treatment of Intramedullary Arteriovenous Malformations of the Spinal Cord

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Summary

We retrospectively reviewed our treatment results for spinal intramedullary arteriovenous malformations (AVMs). Fifteen consecutive patients were included in this study.

Five patient underwent particulate embolization. Surgery was performed in ten patients (including two patient who were treated embolization initially). Five patients, at the beginning of our experience, underwent radical excision of the nidus via the posterior myelotomy. Recent five patients underwent interruption of the feeding pedicles on the surface of the spinal cord. Especially when arteriovenous fistulas (AVFs) or aneurysms were demonstrated, accurate obliteration of them were performed. Four patients, including two with residual AVM after the surgery, underwent irradiation therapy.

Anatomically, four AVMs disappeared completely and the other 11 patients have a residual lesions after the treatment. Clinically, three patients improved, six remained unchanged, and six worsened. The causes of neurological deterioration after the treatment were technical complication of embolization in one patient and surgical manipulation in five. There was no patient who experienced hemorrhage during the follow-up period ranged from 6 months to 17 years, with a mean of 7.5 years.

In conclusion, particulate embolization should be considered as the first choice of treatment if feasible. Surgical treatment is indicated for the dangerous anatomical features such as AVFs or aneurysms.

Introduction

Spinal cord arteriovenous malformations (AVM) can be classified into three types: dural arteriovenous fistula (AVF), perimedullary AVF, and intramedullary AVM^{1,2,3}. Dural AVF and perimedullary AVF are very important as curable lesions by embolization, surgery, or combination of them. Our treatment strategy and result of them has been already reported elsewhere^{4,5}. On the other hand, intramedullary AVM still remains at one of the most challenging neurovascular lesions. The purpose of this study is to evaluate angioarchitecture and our treatment results of intramedullary AVMs, and discuss treatment strategy of them.

Material and Methods

Patient Population

Between January 1982 and August 1999, we treated 68 patients with spinal AVMs, 15 (22%) of whom had intramedullary AVMs. The other

Figure 1 37-year-old woman presenting with acute paraparesis caused by hemorrhage. Spinal cord angiography showed an intramedullary arteriovenous malformation fed by the anterior spinal artery with radiculomedullary arteries arising from the right L1 lumbar artery (A) and from the left Th4 intercostal artery (B). An intranidal aneurysm was also demonstrated (arrowhead). She underwent surgical interruption of the feeding arteries and postoperative spinal angiography revealed disappearance of the aneurysm although a residual nidus was still opacified (C, D).

53 patients had dural AVFs (29 patients, 43%) and perimedullary AVFs (24 patients, 35%).

There were eight men and seven women, and their ages ranged from 9 to 42 years (mean 25 years). Nine patients suffered acute aggravation of myelopathy due to hemorrhage and the other six patients experienced gradual worsening of myelopathy.

Angiographical findings

Six lesions were localized in cervical and 11 in thoracolumbar region. Five AVMs were fed by the anterior spinal artery only, and nine by both anterior and posterior spinal arteries. One AVM was fed by the posterior spinal artery only. Aneurysms on sulcocommissural feeding arteries were discovered in two patients and clinical onset of symptoms was due to hemorrhage in both of them (figure 1). AVFs with varix were found in two patients and both regions were located on the surface of the spinal cord. One patient experienced hemorrhage (figure 2) and another patient presented with rapidly progressive myelopathy due to venous hypertension.

Embolization procedure

Embolization was performed in five patients. Embolization via the anterior spinal artery was indicated if feeding arteries were large enough compared with the anterior spinal artery and there were sufficient collateral blood supplies for normal spinal cord above and below the nidus. We used polyvinyl alcohol (PVA) particles as an embolic material in all patients, ranging between 150-250 μ m in size to avoid occlusion of the normal sulcocommissural arteries and anterior spinal artery. Microcatheter was advanced into the feeding artery, and after confirming that there was no normal branch between the catheter tip and nidus into which particles would migrate, PVA particles were injected carefully.

Surgical procedure

Ten patients underwent surgical treatment. In two patients, embolization was performed as a primary treatment, however, it resulted in recanalization or insufficient to stabilize the clinical symptoms, and surgical treatment was re-

Figure 2 33-year-old woman presenting with acute left hemiparesis caused by hemorrhage. Right vertebral angiography, antero-posterior view (A) and lateral view (B), showed an intramedullary arteriovenous malformation fed by the radiculopial artery (arrow) and the radiculomedullary artery (arrowheads). Selective injection of the radiculopial artery demonstrated an arteriovenous fistula (arrowhead) and a varix. Surgical interruption of the fistulous point was performed. Postoperative angiography revealed the significant reduction of the shunted flow and the disappearance of the varix (D, E).

quired. One patient with small AVM situated in the posterior aspect of the conus medullaris underwent surgery, although embolization was also thought to be feasible. In the other seven patients, embolization was not indicated considering their anatomical features.

In five patients, at the beginning of our experience, AVM nidus was removed aggressively via the posterior myelotomy. However, we experienced worsening of the clinical symptoms frequently by this procedure, therefore in the latter five patients, we only performed the interruption of feeding pedicles as close to the nidus as possible and intramedullary nidus was not manipulated. In two patients with AVFs, the fistulous point was defined and interrupted

(figure 2). In two patients with the aneurysms, the sulcocommissural arteries on which there were the aneurysms were interrupted preferentially (figure 1).

Results

Out of five patients who underwent embolization, the AVM nidus was obliterated completely and clinical improvement was also noted in one patient. In one patient the AVM was partially obliterated and the patient remained unchanged. In one patient, although the AVM was partially obliterated, clinical improvement was noted after the embolization. Embolization was repeated four times for the

Figure 3 16-year-old woman presenting with a hemorrhage. Spinal angiography showed an intramedullary arteriovenous malformation fed by the anterior spinal artery with the radiculomedullary artery arising from the left Th8 intercostal artery (A, B). The feeding artery was not large enough and the same anterior spinal artery fed the spinal cord caudal to the nidus. Therefore particulate embolization was thought to be dangerous and she underwent irradiation therapy.

recanalization. Twelve years after the initial symptoms, he experienced the deterioration of the paraparesis and underwent surgery. One patient underwent palliative embolization for the progressive myelopathy, which resulted in the improvement of clinical symptoms. Six months later, he underwent second embolization for the recanalization, however he developed severe paraparesis due to the technical complication, and no further treatment was performed.

In one patient, embolization was performed for the progressive myelopathy, however, the clinical symptoms did not become stable after that and he underwent surgical treatment.

Out of five patients who underwent radical surgical treatment, postoperative angiography revealed complete disappearance of AVM in three patients and residual AVM in two. Clinically, four patients worsened and one remained unchanged after surgery.

Out of five patients who underwent surgical interruption of feeding arteries or AVFs, two patients improved, three remained unchanged, and one worsened. In four patients with AVFs or aneurysms, these anatomical features disappeared after surgery (figures 1, 2).

Four patients, including two patients with residual AVM after the surgery, underwent radiation. However, follow-up period was too short to evaluate its effectiveness.

During the follow-up period ranged from 6 months to 17 years, with a mean of 7.5 years, no patients experienced hemorrhage.

Discussion

Surgical excision of the intramedullary AVM is extremely difficult and accompanies with unacceptably high rate of complications. We now consider radical surgical removal of the intramedullary AVM should not be performed. On the other hand, simple interruption of the feeding pedicles is technically more easy and safe, however, its anatomical result is not satisfactory due to the development of multiple small collateral branches to the AVM. The long-term outcome is also unknown.

Embolization with PVA particles for carefully selected patients is relatively safe and effective treatment^{6,7,8}. Although it is well known that the effect of particulate embolization is not durable and recanalization is unavoidable^{3,8,9}, it should be considered as the first choice of the treatment if feasible. When treating the intramedullary AVM, the most important issue to be concerned is the long-term functional prognosis and not to achieve the complete anatomical cure. Careful following-up is important and repeated embolization is recommended if indicated by significant recanalization or recurrent clinical progression.

Recently, there are several reports that suggest the use of NBCA as an embolic material. Although complete obliteration is still difficult, it offers good and stable clinical results. They suggest that dangerous angioarchitectural features, such as aneurysms or AVFs, should be the target of embolization with glue^{10,11,12,13}.

We agree with them upon the target treatment for AVFs and aneurysms, and recently, we selectively interrupted the shunting point of AVF or the feeding pedicles on which aneurysms existed. Especially, accurate occlusion of

AVF may reduce the abnormal shunt flow significantly and improve the venous hypertension. Selection of therapeutic modalities, surgery or embolization with glue, should be decided in each case by the consultation between neurosurgeons and interventional neuroradiologists.

There are some patients in whom particulate embolization is not indicated due to the anatomical features and dangerous angioarchitecture is not noted (figure 3). What can we do for such cases? Recently we perform irradiation

therapy in selected patients with low flow and small AVM. However, its efficacy still remains unknown.

Conclusions

Complete cure of the spinal AVM remains still difficult. It is important to treat them considering the angioarchitectural features of the lesions and the patient's quality of life even if the treatment incompletely or only transiently obliterates the AVM.

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