DECISION MAKING IN AVM TREATMENT STRATEGY: TREATMENT BOARD SYSTEM AT TOHOKU UNIVERSITY

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Abstract: Treatment of some large, deep-seated arteriovenous malformations is still a challenge to neurosurgeons. Recent development of non-invasive imaging modalities has increased the chance of finding asymptomatic AVM's, for which evaluation of risk and benefit of treatment is more complicated than in symptomatic cases. Currently there are three major treatment options for AVM: microsurgical removal, radiosurgery, and intravascular embolization. It is not easy task for us neurosurgeons to choose the best single modality or combination of modalities for individual patients, who have different types of onset, neurological deficits, size and location, and social background. After the installation of the Gamma Knife in November 1991, we established an “AVM Treatment Board”. It consists of vascular neurosurgeons, endovascular neurosurgeons, and radio-neurosurgeons, and meetings are twice a month. Every AVM case referred to us is presented to the board, and treatment strategy is selected after a discussion among experts who know the advantages and drawbacks of each treatment modality. This paper describes this board system in detail and emphasizes the importance of gathering expertise in decision making.

Key words: AVM, Embolization, Radiosurgery, Microsurgery, Treatment strategy

INTRODUCTION

Three major treatment options are available to treat AVMs: microsurgical removal, radiosurgery and intravascular embolization. Each modality has its own advantages and disadvantages. It is not an easy task for any one neurosurgeon to understand the advantages and disadvantages of each treatment modality and choose the best single modality or combination of modalities for individual patients, who have different types of onset, neurological deficit, size and location of lesions, and social background. In this paper I discuss our board system for decision making in regard to AVM treatment strategy.

PATIENTS AND METHODS

After the installation of the Gamma Knife at Furukawa Seiryo Hospital in November 1991, we established an “AVM Treatment Board” that meets twice a month. The treatment board consists of specialists in vascular surgery, radiosurgery, and endovascular surgery. Although they are specialized in a single treatment modality at present, all of the members share a common background as board certified neurosurgeons and collaborate in daily clinical activity.

RESULTS

During the past 18 months (January 1996 to June 1997) 86 patients have been registered with the treatment board. Age distribution (fig. 1), type of onset (fig. 2), and Spetzler and Martin grading (fig. 3) are shown in the figures. A single treatment modality was chosen in 61 patients (70.9%) (Table 1). Gamma Knife was chosen in 51 cases (59.3%), surgical removal in 7 cases (8%), and embolization in 3 cases (3.5%). Combined treatment was chosen in 24 patients (27.9%): embolization followed by surgery in 16 cases (18.6%) and embolization followed by radiosurgery in...
7 cases (8%), in 5 of which embolization was used for feeding arteries aneurysms. In one case, there were three independent nidi. In that case, embolization followed by surgery was chosen for the largest nidus, and radiosurgery was chosen for the others. It was decided not to treat the one patient who had a large brain stem AVM.

**ILLUSTRATIVE CASES**

**Case 1 (Fig. 4, 5):** The patient was a 16-year-old boy who was a “karate” champion. He experienced focal seizures on three occasions that led to the diagnosis. Angiography revealed a small AVM in the left frontal lobe. The N20m wave evoked by median nerve stimulation on magnetoencephalography showed that the nidus is on the motor cortex (Fig. 4). Although it...
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was a grade II AVM, the patient refused treatment in view of the paresis as a sequela because he was so enthusiastic about “karate”. We chose radiosurgery to treat this patient. Two years after radiosurgery, there was complete obliteration with no neurological deficit.

**Case 2** (Fig. 6): A 30-year-old male experienced a convulsion associated with a small amount of bleeding from nidus. Mild right foot paresis was present when he referred to us. Angiography showed a grade III AVM involving the motor cortex. We choose embolization followed by radiosurgery to treat the patient. Embolization decreased the volume of the nidus from 26 ml to 4 ml making it suitable for radiosurgery. One year after radiosurgery, complete obliteration of the nidus was confirmed by angiography.

**Case 3** (Fig. 7): A 33-year-old female presented with cerebellar bleeding. Angiography revealed a cerebellar AVM with feeding artery aneurysm. A CT scan showed that the bleeding was from the aneurysm not from the nidus. The AVM was fed by few proper feeders, and so we choose embolization as definitive treatment in this case. The embolization material was released proximal to the aneurysm, and complete obliteration of both aneurysm and nidus was accomplished simultaneously without any new neurological deficits.

**Case 4** (Fig. 8): This 24-year-old female presented with progressive cerebellar signs and symptoms. Angiography showed a huge right hemispheric cerebellar AVM with high flow. Angiography after embolization...
tion showed marked reduction of flow. Complete surgical resection without new neurological deficit was achieved.

**DISCUSSION**

The aim of treating AVMs is prevention of bleeding that may produce neurological deficits in the future. Such symptoms as convulsions, neurological deficit caused by ischemia, headache, and so on, may also improve, but that is a bonus. The recent development of non-invasive imaging modalities has increased the chance of finding asymptomatic or minimally symptomatic AVMs. In our series, one fourth of the AMVs were incidental findings and another fourth were discovered because of infrequent seizures, most of which were controlled with medication. Evaluation of the risks and benefits of treatment in these situations is very complicated and critical.

Microsurgical removal allows immediate elimination of risk of the bleeding in a high percentage of cases of grade I and II AVMs. In contrast, a moderate degree of risk must be accepted in grade III AVMs, and in grade IV and V AVMs, surgical risk is very high even when modern microsurgical techniques are used. There are still so-called grade VI AVMs that are inoperable. In some cases, surgical removal of an incom-
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completely obliterated nidus after radiosurgery can be a treatment option for high-flow and complex AVMs. Endovascular embolization of AVMs is less invasive and can be utilized for large, high-grade AVMs. It can decrease flow in the nidus and facilitate safe surgical removal. On the other hand, the cure rate by embolization alone is still low, and the complication rate is not negligible. Recanalization may occur even with most sophisticated methods and embolization materials. The possibility of inducing bleeding by a sudden change in hemodynamic stress is present. As a pre-radiosurgical method, it may make a nidus smaller and enhance the effectiveness of radiosurgery. In some cases, however, only the core of the nidus is embolized and no benefit is obtained in terms of the volume that needs to be irradiated. Collateralization after embolization obscures the margin of the nidus and makes dose planning difficult.

The greatest advantages of radiosurgery are that it requires the shortest hospital stay and is least invasive. The complete obliteration rate, however, is not as high as with surgical removal. There is a limitation to the size of lesions that can be treated, and some risk of bleeding before complete obliteration is inevitable. Late radiation-induced complications may occur.

We neurosurgeons have the responsibility of accurately informing patients of the natural history of AVMs, and the risks and benefits of each treatment modality to assist decision making by patients. At present, all three treatment modalities for AVM are performed by different experts, who belong to different departments. Rapid progress in technology and sub-specialization makes it impossible for any single surgeon to understand each of the modalities completely. I am convinced that treatment board system is one solution for this predicament (Fig. 9).

Fig. 8 Case 4. Top: enhanced CT scan, MRI and left vertebral angiogram. A huge cerebellar hemispheric AVM is demonstrated. Bottom left: Left vertebral angiogram after embolization. Marked reduction of volume and flow has been accomplished. Bottom middle and right: postoperative MRI and left vertebral angiography. Complete surgical removal without new neurological deficit was accomplished.

Fig. 9 Concept of the AVM treatment board system

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