Cerebellar hemorrhage caused by dural arteriovenous fistula: a review of five cases

KOICHI SATOH, M.D., PH.D., JUNICHIRO SATOMI, M.D., NORIO NAKAJIMA, M.D., SHUNJI MATSUBARA, M.D., PH.D., AND SHINJI NAGAHIRO, M.D., PH.D.
Department of Neurological Surgery, School of Medicine, University of Tokushima, Japan

Object. In this study the authors performed a retrospective analysis of five cases in which the patients (three women and two men) were treated for intracranial dural arteriovenous fistulas (AVFs) associated with cerebellar hemorrhage. On the basis of their findings, the authors evaluated the characteristics of this unusual symptom.

Methods. The dural AVFs were located in the right cavernous sinus in one patient, the left transverse–sincipital sinus in three patients, and the right superior petrosal sinus (SPS) in one patient. All patients presented with severe headache and/or loss of consciousness. Computerized tomography scans revealed a small cerebellar hemorrhage near the fourth ventricle in four cases, and a massive hemispheric cerebellar hemorrhage in the remaining case. The four patients with small hemmorhages underwent ventriculostomy and endovascular treatment; all recovered. The patient suffering from a massive hemorrhage because of a dural AVF in the SPS was treated by suboccipital craniectomy, hematoma evacuation, and removal of the vascular anomaly. This patient remains in a persistent vegetative state. In four cases, results of angiography demonstrated retrograde leptomeningeal venous drainage through the SPS to the anastomotic lateral mesencephalic vein (ALMV) and/or to the vein of the lateral recess of the fourth ventricle (VLR4V). Retrograde leptomeningeal venous drainage to the ALMV and/or VLR4V was responsible for cerebellar hemorrhage in these cases.

Conclusions. Thus, it is important to consider dural AVF in cases in which there is even a small hemorrhage near the fourth ventricle accompanied by intraventricular perforation and a decreased level of consciousness.

KEY WORDS • dural arteriovenous fistula • cerebellar hemorrhage • endovascular treatment
Venous drainage in that patient was through the cortical veins, with a retrograde flow through the torcular herophili and the perimedullary veins from the left jugular bulb.

Illustrative Cases

For illustrative purposes, we selected the following two patients.

Case 2

This 63-year-old woman fell suddenly into a coma and was transported to our institution by ambulance. Upon her arrival, CT scanning results demonstrated acute hydrocephalus and a small hemorrhage in the patient’s left cerebellar dentate nucleus as well as ventricular perforation (Fig. 1B). An emergency ventriculostomy was performed and the patient gradually regained consciousness. An an-

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Age (yrs), Sex</th>
<th>Presenting Symptom</th>
<th>CT Findings</th>
<th>Location of AVFs</th>
<th>Venous Drainage</th>
<th>Surgical Treatment</th>
<th>Endovascular Treatment</th>
<th>AD</th>
<th>Cure</th>
<th>Outcome</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>52, F coma</td>
<td>cerebellar vermis H, IVH, hydrocephalus</td>
<td>rt CS</td>
<td>rt SPS, ALMV, VLR4V</td>
<td>VD</td>
<td>TAE</td>
<td>incomplete cure</td>
<td>mild ataxia</td>
<td></td>
<td></td>
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<tr>
<td>2</td>
<td>63, F coma</td>
<td>lt dentate nucleus H, IVH, hydrocephalus</td>
<td>lt TS-SS</td>
<td>lt SPS, ALMV, VLR4V</td>
<td>VD</td>
<td>TAE</td>
<td>cure</td>
<td>mild ataxia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>65, F coma</td>
<td>cerebellar vermis H, IVH, hydrocephalus</td>
<td>lt TS-SS</td>
<td>lt SPS, VLR4V spinal vein</td>
<td>VD</td>
<td>TAE</td>
<td>cure</td>
<td>no deficit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>49, M headache</td>
<td>lt dentate nucleus H, SAH</td>
<td>lt TS-SS</td>
<td>none</td>
<td>VD</td>
<td>TAE &amp; TVE</td>
<td>cure</td>
<td>no deficit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>74, M coma</td>
<td>rt massive CH</td>
<td>rt SPS</td>
<td>ALMV</td>
<td>VD, excision</td>
<td>none</td>
<td>ND Vegetative state</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* AD = angiographically determined; CH = cerebellar hemorrhage; CS = cavernous sinus; H = hemorrhage; IVH = intraventricular hemorrhage; perimed = perimedullary; TAE = transarterial embolization; TVE = transvenous embolization; VD = ventricular drainage.

Fig. 1. Computerized tomography scans revealing findings in each of the five cases. A: Case 1. A small hemorrhage in the right cerebellar vermis and ventricular perforation. B: Case 2. A small hemorrhage in the left cerebellar dentate nucleus. C: Case 3. A small hemorrhage in the left cerebellar vermis with ventricular perforation. D: Case 4. A small hemorrhage in the left cerebellar dentate nucleus with ventricular perforation. E: Case 5. A massive hemorrhage in the right cerebellar hemisphere observed on a plain CT scan.
giorgram of the left CCA revealed a dural AVF at the TS-SS junction. Retrograde leptomeningeal venous drainage through the petrosal vein was connected to the ALMV (large arrow) and the VLR4V (small arrow).

Case 4

This 49-year-old man heard a small popping sound in his head that was followed by a severe headache. A CT scan obtained upon his admission to the hospital demonstrated a small hemorrhage in the patient’s left cerebellar dentate nucleus as well as ventricular perforation (Fig. 1D). An arteriogram of the left CCA revealed dural AVFs of the left transverse–sigmoid sinus (Fig. 3 left). The dural AVFs could be observed to have multiple retrograde leptomeningeal venous drainage routes including drainage through a perimedullary collateral vein associated with a venous lake (Fig. 3 center). We performed transarterial coil embolization and transvenous coil packing of the transverse and sigmoid sinuses on the left side. The dural AVFs disappeared and, when the patient was discharged, he had no neurological deficits (Fig. 3 right).

Results

The patients in Cases 1, 2, 3, and 5 underwent extraventricular drainage from the anterior horn of the lateral ventricles. Three patients (Cases 1, 2, and 3) gradually improved after ventricular drainage. The patient in Case 5 also underwent surgical removal of the hematoma and coagulation of the abnormal vessels. The patients in Cases 1, 2, 3, and 4 underwent transarterial embolization of branches of the external carotid artery, which supplied the dural AVFs. Embolic agents used to close the fistulas included particle emboli (polyvinyl alcohol), liquid adhesives (N-butyl-2-cyanoacrylate), and platinum wire coils. Transfemoral transvenous embolization was also performed in one patient (Case 4). Three months after treatment, two patients (Cases 3 and 4) had no neurological deficits and two patients (Cases 1 and 2) only had slight cerebellar ataxia. Repeated angiography data revealed complete closure of the dural AVFs in Cases 2, 3, and 4. In the patient in Case 1, who was treated with external carotid artery embolization alone, there was a residual blood supply through the internal carotid artery. This patient refused additional surgery, and 3 months after treatment, manifested mild cerebellar ataxia, although there was no further hemorrhage. Three months after treatment, one patient (Case 5) remained in a persistent vegetative state. In our series, there were no complications during surgery and endovascular treatment.

Discussion

The severity of symptoms in patients with dural AVFs associated with intracranial hemorrhage or venous infarction is affected by the presence of retrograde leptomeningeal venous drainage. Although intracranial hemorrhage occurs in 15 to 20% of patients with dural AVFs located in the transverse–sigmoid sinus, intracranial hemorrhage rarely occurs in patients harboring dural AVFs in the cavernous sinus.

Dural AVFs With Cerebellar Hemorrhage Reported in the Literature

Our search of the literature yielded five reports of cerebellar hemorrhage due to dural AVFs (Table 2).
Computerized tomography studies performed in those patients demonstrated small or medium-sized hematomas surrounding the fourth ventricle, and in one patient a massive hematoma. The dural A VFs were located in the transverse sinus (especially in the torcular herophili) or the SPS. These patients experienced a sudden onset of symptoms; none of them had exhibited prior symptoms of venous infarction.

Venous Drainage and Location of the Hemorrhage

A schematic drawing of the SPS and surrounding sinuses and veins (Fig. 4) shows that the SPS lies between the cavernous sinus and the TS-SS junction. Thus, the SPS can provide a drainage route from transverse and/or sigmoid sinus dural A VFs or cavernous sinus dural A VFs. Retrograde leptomeningeal venous drainage toward the petrosal vein may occur in both types of dural A VFs. Four of our patients (Cases 1, 2, 3, and 5), as well as a patient reported by Nishino, et al., had retrograde leptomeningeal venous drainage toward the ALMV and/or the VLR4V. Hemorrhage occurred at the cerebellar vermis, the dentate nucleus, and surrounding structures of the fourth ventricle. On the other hand, in the other four previously reported cases, venous drainage occurred through the IVVs. The watershed zone between the IVV and the VLR4V is the surrounding structure of the fourth ventricle, in four of the five previously reported cases hemorrhage occurred in this area.

Differential Diagnosis

In many patients hypertensive cerebellar hemorrhage is thought to be caused by bleeding of the dentate nucleus. On CT scans, this is demonstrated as a high-density area in the cerebellar hemisphere, which is in contact with the fourth ventricle. In our patients, the hemorrhage was in contact with the fourth ventricle and arrival at a definitive selection in a differential CT-based diagnosis between hypertensive cerebellar hemorrhage and hemorrhage from a dural AVF was difficult. Although the causes of bleeding among our patients and previously reported patients were different, the lesions were very similar and differed in only two respects: 1) cerebellar hemorrhages from the dural AVFs were shifted slightly to the cerebellar vermis; and 2) all hemorrhages perforated the ventricles. Patients who suffered spontaneous hypertensive hemorrhages smaller than 3 cm were found to have few venous perforations. Cerebellar hemorrhages due to dural AVFs tend to be small, but are accompanied by intraventricular hemorrhage and a severe decrease in the level of consciousness. Therefore, it is important to consider dural AVF in cases in which there is even a small hemorrhage near the fourth ventricle accompanied by intraventricular perforation and a decreased level of consciousness.

Case Management

We performed extraventricular drainage in four of our five patients. Arai and associates and Sakaki, et al., also used ventricular drainage in patients with acute hydrocephalus. To control elevated intracranial pressure in

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**Table 2**

<table>
<thead>
<tr>
<th>Authors</th>
<th>Year</th>
<th>Patient Age, Sex</th>
<th>Presenting Symptoms</th>
<th>Location of AVF</th>
<th>Venous Drainage</th>
<th>Treatment</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malik, et al.,</td>
<td>1984</td>
<td>70 yrs, F</td>
<td>Lt cerebellar vermis H, hydrocephalus</td>
<td>Lt transverse sinus, torcular herophili</td>
<td>Superior cerebellar veins, IVV</td>
<td>Ventriculostomy, hematoma evacuation</td>
<td>Ventriculitis, died</td>
</tr>
<tr>
<td>Sakaki, et al.,</td>
<td>1984</td>
<td>58 yrs, F</td>
<td>massive cerebellar H, IVH</td>
<td>rt transverse sinus</td>
<td>cerebellar &amp; cortical veins w/ varix, IVV</td>
<td>Feeding vessel coagulation conservative</td>
<td>Mild ataxia, AVF remained dead</td>
</tr>
<tr>
<td>Awad, et al.,</td>
<td>1990</td>
<td>78 yrs, F</td>
<td>lt cerebellar peduncle H, SAH</td>
<td>Lt SPS</td>
<td>Superior cerebellar veins, IVV</td>
<td>IVV, rt inf hemispheric vein</td>
<td>Mild hemiparesis, AVF disappeared</td>
</tr>
<tr>
<td>Nishino, et al.,</td>
<td>1991</td>
<td>64 yrs, M</td>
<td>Lt cerebellar H, IVH, SAH, SDH</td>
<td>lt transverse sinus</td>
<td>rt transverse sinus</td>
<td>ALMV, Ant. pons mesencephalic vein, AVM</td>
<td>Ventriculostomy, hemorrhoma evacuation, severe ataxia, mental retardation, AVF remained</td>
</tr>
<tr>
<td>Arai, et al.,</td>
<td>1995</td>
<td>7 days, M</td>
<td>Lt cerebellar H, IVH, SAH, SDH</td>
<td>torcular herophili</td>
<td>Bilateral transverse sinus, SSS, IVV</td>
<td>VP shunt, TAE</td>
<td>AVF remained</td>
</tr>
</tbody>
</table>

*Inf = inferior; SAH = subarachnoid hemorrhage; SDH = subdural hemorrhage; SSS = superior sagittal sinus.

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**Fig. 4.** Schematic drawing of the dural sinuses showing the relationships among the cavernous, transverse, sigmoid, and superior petrosal sinuses. BVR = basal vein of Rosenthal; CS = cavernous sinus; IPS = inferior petrosal sinus; S = sigmoid sinus; SS = straight sinus; T = transverse sinus. Single arrow indicates the VLR4V; double arrow indicates the ALMV.
patients with cerebellar and intraventricular hemorrhage, ventricular drainage should be performed. Dural AVFs have been successfully treated by endovascular occlusion and/or surgical intervention. Endovascular procedures such as transarterial and transvenous embolization are effective in these cases. However, in patients with large hematomas, emergency evacuation of the hematoma and excision of the vascular malformation should be performed. In some cases, clipping of the retrograde venous drainage turned out to be a simple and effective method to deal with dural AVFs.

References


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Address reprint requests to: Koichi Satoh, M.D., Ph.D., Department of Neurological Surgery, School of Medicine, University of Tokushima, 3-18-15 Kuramoto-echo, Tokushima city, Tokushima 770–8503, Japan. email: satoh@clin.med.tokushima-u.ac.jp.