Resection of the transverse sinuses and confluence of sinuses for treatment of multiple dural arteriovenous fistulas

Case report

ETTORE Fiumara, M.D., SILVANA TUMBILO, M.D., MARIA LUISA BELLOMONTE, M.D., PAOLINO SAVATTERI, M.D., FRANCESCA FINAZZO, M.D., AND FABIO LA GATTUTA, M.D.

Departments of Neurosurgery and Radiology, Villa Sofia Hospital, Palermo, Italy

Dural arteriovenous fistulas (DAVFs) occurring simultaneously at two or more separate locations are not frequent. In fact, the incidence of multiple DAVFs is 7 to 8% of all DAVFs. Patients harboring multiple DAVFs have a higher incidence of hemorrhage, venous infarction, and neurological deficits due to a greater frequency of leptomeningeal venous drainage. To the authors’ knowledge only a few cases of DAVFs involving both transverse sinuses (TSs) have been reported. These patients underwent various combined treatments (transarterial embolization, transvenous obliteration, surgical isolation, resection, and radiosurgery). Treatments performed that do not include resection of the involved sinuses do not always guarantee a cure. The authors present a patient who harbored multiple DAVFs of the TSs, both distally occluded with secondary reflux into the superior sagittal sinus (SSS), the straight sinus, the deep venous system, and the leptomeningeal veins of both hemispheres. An en bloc removal of the portions including the fistulas of the TSs, the confluence of sinuses, and the distal parts of the SSS, and straight sinus allowed for the patient to be cured. The fact is emphasized that despite the progress of endovascular treatment and radiosurgery this kind of DAVF must be surgically treated. The operation may be complex and dangerous.

KEY WORDS • cerebral arteriovenous malformation • dural arteriovenous fistula • intracranial pressure • surgical treatment • transverse sinus

In the present paper we report on a patient who was surgically treated for multiple DAVFs that involved the left and right TSs, close to the CoS, which were both occluded. We emphasize the peculiarity of our case and the absolute necessity to treat this kind of lesion aggressively.

Case Report

History. This 29-year-old woman presented with a 1-year history of headache and progressive visual impairment. In another hospital 9 months before admission, she underwent transarterial and transvenous endovascular treatment of DAVFs of both TSs, because the left TS was occluded. Guglielmi Detachable Coil and platinum coil embolization was performed by retrograde catheterization of the right TS, which was permeable. At that time vision in her right eye was 10/100 and 90/100 in her left. Despite this treatment, symptoms of high ICP persisted and her vision worsened. The patient was referred to our department for further evaluation and treatment.

Examination and Operation. Neurological examination revealed slight decreases in mental performances with a minimal state examination score of 24/30, blindness in right eye, a decrease in vision (30/100) in the left eye, and chronic papilledema. A lumbar puncture revealed a CSF pressure of 80 cm H₂O. No cerebral alteration was seen on magnetic resonance imaging.
Bilateral internal CA, ECA, and VA angiographies demonstrated two DA VFs that involved one of the middle portions of the left TS and the other the proximal portion of the right TS, close to the CoS. The left TS fistula was supplied by the transosseous branch of the left OA and the posterior meningeal branch of the right VA, precociously going across the midline; this artery, after crossing again the midline along the posteroinferior wall of the CoS, constituted the only supplier of the right TS fistula. The DA VFs directly drained into the TSs, both distally occluded, with secondary reflux into the SSS, SS, the deep venous system, and the leptomeningeal veins of both hemispheres; remarkable venous drainage that had developed from DA VFs through the diploë of the bone were seen (Fig. 1). Therefore, on the basis of Borden classification we considered both DA VFs to be Type II.

An attempt at preoperative transarterial embolization of the DAVF failed. A malleable lumbar spinal needle was placed for perioperative drainage of CSF. The patient was placed prone and surgical ligation of the left OA, identified by Doppler ultrasonography, near the mastoid was made. A middle occipital skin incision was used and a suboccipital craniectomy was performed, exposing the TSs and the CoS. During this procedure the intradiploic coils were removed and a venous drain, which had produced communication of an intradiploic venous lake and the posterior wall of the left TS, was coagulated. A thin bilateral parietoccipital craniotomy extending to the suboccipital craniectomy was performed. Approximately 50 ml of CSF was withdrawn through the lumbar needle. Two dural incisions were made parallel to the long axis of both TSs, one superior to and the other inferior to the sinuses and to the beginning of lateral walls of the CoS. Secondary dural incisions above and below the tentorium allowed the exposition of the occipital lobes and the cerebellum. The posterior meningeal branch of the right VA was identified beside the falx cerebelli and coagulated. Retraction of the occipital lobes and the superior cerebellum was accomplished. The tentorium was incised bilaterally up to the SS walls. The falx cerebelli and the falx cerebri in proximity of falx–tentorium junction were also cut. In this manner the CoS, the TSs, the distal portions of the SSS, and the SS were isolated. Using hemostats, clips, and curved scissors, an en bloc removal of the portions of both TSs, including the DAVFs, the CoS, the distal part of the SSS, and the SS (a few millimeters from the CoS) was achieved. The hemostats applied on the residual portions of the sinuses were removed after their holes were closed with a running suture; closure then was made. During the entire procedure, due to the rich dural vascularization and the venous drainage that developed from the DAVFs through the diploë of the bone, there was conspicuous blood loss, which required the transfusion of 1600 ml of blood. The hemorrhage was slow and controllable; rapid serious blood loss did not occur because of early obliteration of the arterial supply and the scanty exposition of the skull and of transdiploic venous drainage (the occipital skin incision made in the middle and the bilateral thin parietoccipital craniotomy performed).

Postoperative Course. Apart from transitory deterioration in her visual fields, the postoperative course was uneventful and her headache was reduced. One month later no DAVF
was seen on control angiography. The patient underwent lumbar peritoneal shunt placement because her ICP, even when reduced, remained high (30 cm H₂O). At the 18-month follow-up, the patient remained blind, but the vision in the left eye was 70/100. Six-vessel angiography did not show any DAVF (Fig. 2). At the 30-month follow-up, the neurological deficits were unchanged; the patient refused angiography.

Discussion

With the exception of bilateral cavernous sinus fistulas, DAVFs simultaneously occurring at two or more separate locations are regarded as infrequent with isolated reports in the literature. Barnwell, et al., reported on seven patients harboring multiple DAVFs in their series of 105. van Dijk, et al., reported on 20 patients with multiple DAVFs in a group of 284. The incidence of multiple DAVFs is considered to be 7 to 8% of all DAVFs. Although some hypotheses on the cause of the multiple DAVFs have been formulated, the pathogenesis remains unknown. The presenting symptoms are not different from those of the solitary DAVF, although patients with multiple DAVFs have a higher incidence of hemorrhage, venous infarction, and neurological deficits, owing to a higher frequency of leptomeningeal venous drainage. In fact, in the van Dijk series, 84% of patients had leptomeningeal venous drainage compared with 46% of patients with solitary fistulas, 89% of patients with multiple DAVFs presented with hemorrhage or neurological deficit, and the incidence of hemorrhage in patients with multiple DAVFs is three times higher than in those with a solitary DAVF. The percentage of cases in which patients who harbor multiple DAVFs must be treated is higher than that of those with solitary DAVFs. Different modalities of therapy have been used to treat DAVFs: surgery, intraarterial intravenous embolization, and radiosurgery. When treatment is undertaken it should be radical because partial obliteration of the DAVF almost invariably is the cause of acquisition of an arterial supply from the leptomeningeal vessels, which makes successive therapy more difficult. Barnwell, et al., and Van Dijk, et al., defined multiple DAVFs that were distinct anatomically in relation to locations of the fistula, feeding arteries, and venous drainage. Alternately, Barnwell, et al., considered the DAVFs to be multiple when they drained into distinct leptomeningeal veins. In our case the location of the fistula was the middle portion of the left TS and the second DA VF was located in the proximal portion of right TS. The feeding arteries of left TS fistula were the left OA and the posterior meningeal branch of right V A; this latter constituted the only arterial supply of the right TS fistula. The venous drainage, owing to occlusion of both TSs distally to the nidus, was the same for both fistulas. On the basis of definitions given by the aforementioned authors the DAVFs of our case could not be defined as multiple. Nevertheless, although keeping in mind that it may be a mistake to extrapolate concepts applicable to all DAVFs on the basis of only one case, we maintain that DAVFs may be defined as multiple only in relation to locations, regardless of consideration arterial supply and venous drainage. Indeed the peculiarity of our case does not rest in the fact that the DAVFs may be defined as multiple, but in fact that the DAVFs were located in both TSs, which were distally occluded. This constituted the difficulty in their treatment.

To our knowledge only a few cases of DAVFs involving both the TSs have been reported (Table 1). From analysis of the cases shown in Table 1 (which also lists our case), it is evident that the majority of patients harboring DAVFs of both TSs presented with infarct, hemorrhage, or neurological deficit; this confirms the gravity and the risks of this kind of lesion. Surgical obliteration or isolation of involved sinuses does not always guarantee cure. The patient reported on by Lucas, et al., underwent transarterial embolization and surgical obliteration of the DAVFs with clinical cure but residual supply. The second patient reported on by Goto, et al., had residual fistula after transarterial and transvenous embolization and surgical isolation of involved sinuses; in this patient complete cure was accomplished only after resection of the involved sinuses. Moreover, the case reported by Goto, et al., is the only case treated by resection of both TSs and CoS other than our own.

Our patient presented with a 1-year history of headache and progressive visual impairment due to high ICP (30 cm H₂O). Angiography revealed two fistulas directly draining into the TSs, both distally occluded, with secondary reflux into the SSS, the SS, the deep venous system, and the leptomeningeal veins of both hemispheres; therefore, both DAVFs can be considered to be Borden Type II. Without doubt a lesion of this type must be treated. Why did we choose excision of both TSs and CoS? Transvenous endovascular embolization produces cure in 55 to 80% of cases with a 10% rate of transient complications and a permanent complication rate of 5%. In our patient this method was impossible to utilize because both TSs were occluded; moreover, recanalization or direct packing of sinuses that have reflux into SSS, SS, and leptomeningeal veins can be more hazardous and less efficacious than resection. Ra-

Fig. 2. Six-vessel angiography obtained 18 months after surgery, confirming the absence of the DAVFs. Arterial phase of the right VA angiography in anteroposterior (upper left) and in lateral (upper right) views. Venous phase of right VA angiography obtained in the lateral view (lower left). Left ECA angiography obtained in the frontal view (lower right). Note the disappearance of the transdiploic venous drainage.
Resection of transverse sinuses and confluence of sinuses for DAVFs

**TABLE 1**

<table>
<thead>
<tr>
<th>Authors &amp; Year</th>
<th>Age (yrs), Sex</th>
<th>Clinical Presentation</th>
<th>Location of DAVF</th>
<th>Borden Type</th>
<th>Involved Sinus</th>
<th>Treatment</th>
<th>Angiography/FU</th>
<th>Neurol/FU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barnwell, et al., 1991</td>
<td>49, M</td>
<td>headache, bruise</td>
<td>Lt TS</td>
<td>II</td>
<td>occluded</td>
<td>transarterial + surgical obliteration</td>
<td>cure/only postop</td>
<td>cure/2 yrs</td>
</tr>
<tr>
<td>Lucas, et al., 1997</td>
<td>54, M</td>
<td>tinnitus</td>
<td>Lt TS</td>
<td>I</td>
<td>patent</td>
<td>transarterial embol</td>
<td>residual supply/10 mos</td>
<td>cure/2 yrs</td>
</tr>
<tr>
<td>Goto, et al., 1999</td>
<td>42, M</td>
<td>left cerebral infarct</td>
<td>Lt TS</td>
<td>I</td>
<td>occluded patent</td>
<td>transarterial + surgical obliteration</td>
<td>cure/2 yrs</td>
<td></td>
</tr>
<tr>
<td>59, M</td>
<td>mental deterioration, ICH</td>
<td>Lt TS</td>
<td>II</td>
<td>stenotic</td>
<td>1st treatment: transarterial + surgical obliteration + isolation + radiosurgery 2nd treatment: resection of TSs &amp; CoS</td>
<td>residual AVF cure/5 yrs</td>
<td>slight dementia/5 yrs</td>
<td></td>
</tr>
<tr>
<td>62, F</td>
<td>mental deterioration, SAH</td>
<td>Lt TS</td>
<td>II</td>
<td>occluded</td>
<td>transarterial + surgical isolation of TSs</td>
<td>cure/2 yrs</td>
<td>slight dementia/2 yrs</td>
<td></td>
</tr>
<tr>
<td>van Dijk, et al., 2002</td>
<td>64, NR</td>
<td>neurodeficit</td>
<td>Lt TS</td>
<td>II</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td></td>
</tr>
<tr>
<td>present case</td>
<td>29, F</td>
<td>mental &amp; visual deficits</td>
<td>Lt TS</td>
<td>II</td>
<td>occluded</td>
<td>resection of TSs &amp; CoS</td>
<td>cure/1.5 yrs</td>
<td>improved visual deficit/2.5 yrs</td>
</tr>
</tbody>
</table>

* Embol = embolization; FU = follow up; ICH = intracerebral hemorrhage; NR = not reported; neur = neurological; SAH = subarachnoid hemorrhage.

On the basis of the excellent result achieved in our patient we suggest treating this type of lesion with an en bloc resection of both TSs and the CoS. We believe this holds true as well if the surgical procedure is complex and dangerous.

**References**

bolization of dural fistulas involving the transverse and sigmoid sinuses. AJNR 10:385–392, 1989

Manuscript received May 19, 2003.
Accepted in final form September 29, 2003.
Address reprint requests to: Ettore Fiumara, M.D., Via Pietro Scaglione No. 12, 91011 Alcamo (TP) Italy, email: fgabriele@tin.it.