A Case of Postoperative Transverse Sinus Dural Arteriovenous Fistula Treated with Selective Sinus Packing: Usefulness of Quadriaxial Catheter System

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Objective: A case in which an isolated sinus type dural arteriovenous fistula (AVF) that newly occurred in the transverse sinus after tumor resection by craniotomy was occluded by selective transvenous embolization (TVE) is reported.

Case Presentation: A 50-year-old woman had undergone resection of meningioma of the middle cranial fossa by craniotomy 50 months before. Tinnitus appeared 17 months after surgery, and exhaustive examination showed a dural AVF that appeared de novo in the transverse sinus occluded on the right sigmoid sinus side. The patient noted a heavy feeling of the head 50 months after surgery, and re-examination showed that the fistula became an isolated sinus type due to occlusion also on the confluence of sinus side with exacerbation of cortical venous reflux. After evaluation of the shunt point, the occluded areas were recanalized via the femoral vein by a quadriaxial catheter system using a 6 Fr guiding sheath, a 6 Fr guiding catheter, a 4.2 Fr catheter, and a microcatheter, and selective coil embolization was performed, resulting in disappearance of the shunt.

Conclusion: The occluded areas could be recanalized safely due to preoperative evaluation and the use of a quadriaxial catheter system and consequently, selective coil embolization became possible.

Keywords ▶ postoperative, transverse sinus dural arteriovenous fistula, selective sinus packing, quadriaxial catheter system

Introduction

Dural arteriovenous fistula (AVF) is an acquired disorder of unknown cause, but infection, sinus thrombosis, and trauma have been suggested as its causes.\(^1,2\) It has also been reported to have occurred after craniotomy.\(^3,4\) Also, dural AVF arising in the transverse-sigmoid sinus becomes complicated by outflow tract obstruction as it advances, and symptoms are rapidly exacerbated to present aggressive features, requiring urgent treatment.\(^1,5-7\) However, in this stage, treatment is often difficult because of obstruction of the transvenous access route.\(^2\) Here, we report a case in which a quadriaxial catheter system was useful for recanalization of the occluded transvenous access route, which led to selective coil embolization.

Case Presentation

The patient was a 50-year-old woman with tinnitus and a heavy feeling of the head. Before 50 months, she was examined due to dizziness, was found to have meningioma of the right middle cranial fossa, and underwent resection of the tumor by a right frontotemporal craniotomy (Fig. 1). The pathological diagnosis was psammomatous meningioma. After surgery, she was discharged...
without neurological deficits and was followed up as an outpatient. She had an uneventful course without recurrence until she noted tinnitus about 17 months after surgery, and as head MRI revealed confluence of abnormal blood vessels from around the right transverse sinus to the jugular foramen and dilatation of the occipital artery (OA) (Fig. 2), we performed cerebral angiography, suspecting dural AVF of the right transverse sinus. On right external carotid arteriography, a dural AVF was visualized in the right transverse sinus, which was fed primarily not only by the right OA, but also by vessels including the right middle meningeal artery (MMA) and right ascending pharyngeal artery (APA). The drainage route was the right transverse sinus, the right sigmoid sinus side was occluded, and cortical venous reflux (CVR) was partially observed (Fig. 2). The fistula was Borden type II and Lalwani grade 3,5,8) but as the patient refused surgical treatment at that time, she was observed.

History of present illness: The patient noted a mild but gradually exacerbating heavy feeling of the head from several weeks before the visit. Since head MRI (performed 50 months after surgery) showed exacerbation of CVR and mild edematous change in the surrounding brain parenchyma (Fig. 3), she was admitted for close examination.

Neuroradiological findings: On right external carotid arteriography, the dural AVF of the right transverse sinus with the right OA as the primary feeding vessel and vessels including the right MMA and right APA as minor feeding vessels showed no marked change compared with the state 17 months after surgery. However, as the right transverse sinus was occluded at a site further inside the shunt, it was drained through a route via the vein of Labbé, and CVR was exacerbated (Fig. 3). The Borden type was III, and Lalwani grade was 4. On selective 3D cerebral angiography from the right external carotid artery, the shunt point appeared to converge on the isolated transverse sinus (Fig. 3).

Intracranial endovascular treatment: Under general anesthesia, an angiographic 4 Fr catheter was placed transbrachially in the right external carotid artery, and transvenous embolization (TVE) was carried out. By the transfemoral venous approach, a system consisting of a 6 Fr FUBUKI guiding sheath (Asahi Intecc, Aichi, Japan), a 6 Fr Cerulean DD6 (Medikit, Tokyo, Japan), and a 4.2 Fr FUBUKI (Asahi Intecc) was navigated to a point immediately before the occluded area, and the occluded area was recanalized using a 0.035" Radifocus Shapeable Guidewire (Terumo, Tokyo, Japan). In addition, the same Radifocus Shapeable Guidewire was also advanced through the septum of the sinus near the shunt, and a Neurodeo 10 (Medico’s Hirata, Osaka, Japan) was quadriaxially delivered to the shunt site under guidance with a Neuroute-14 (Medico’s Hirata). From this site, the sinus pouch was selectively packed and occluded using various detachable coils (12 coils, 182 cm in total) (Movie 1; This is available online.). This resulted in complete disappearance of the shunt (Fig. 4). Tinnitus and the heavy feeling of the head were resolved, and the patient was discharged, being capable of unassisted ambulation, 3 days after surgery. No recurrence has been noted for half a year after surgery.

Discussion

According to our review, 16 patients diagnosed with dural AVF after craniotomy have been reported, and the site of the lesion was the transverse-sigmoid sinus in 10 patients (Table 1). The adjacency of the scalp and muscle to the dura mater after craniotomy, intraprocedural damage or separation of veins or sinuses, and change in the intracranial pressure have been suggested as causes of dural AVF occurring after craniotomy, but these speculations are inconsistent with the occurrence of lesions at sites distant from the scalp.
from the surgical field in a majority of patients. In our patient, also, no change was observed on follow-up MRI until 17 months after surgery, and the lesion was somewhat distant from the area of surgical manipulation, so the surgical manipulation is unlikely to have been the direct cause of the lesion. However, there is a possibility that the dural
AVF occurred due to events during the postoperative course such as thrombus formation in the area from temporal cortical veins to the tentorial sinus, which had been displaced by the meningioma.\textsuperscript{21,22}

Next, particularly, in the transverse-sigmoid sinus, sinuses around the shunt are often occluded.\textsuperscript{5} If both the proximal and distal sides of the shunted area are occluded, and all blood begins to flow toward the cortex (isolated sinus), aggressive features such as venous infarction and hemorrhage are likely to appear, requiring urgent treatment. In addition, if areas around the shunt are occluded, transvenous access routes are closed, and treatment becomes difficult.\textsuperscript{1,5–7} In this event, the first-line treatment is transvenous recanalization of the occluded area using a hard guidewire, but this is often difficult.\textsuperscript{5} If this procedure is impossible, alternatives including direct sinus packing by a small

**Table 1** Summary of reports of dural AVF that appeared after direct surgery

<table>
<thead>
<tr>
<th>Author (Year)</th>
<th>Age/Sex</th>
<th>Postoperative period</th>
<th>Surgical site</th>
<th>Fistulous point</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miura (1975)$^9$</td>
<td>60M</td>
<td>24 months</td>
<td>Lt. frontal craniotomy</td>
<td>Lt. transverse-sigmoid sinus</td>
</tr>
<tr>
<td>Mizukawa (1978)$^{10}$</td>
<td>61F</td>
<td>27 months</td>
<td>Lt. temporal craniotomy</td>
<td>Lt. transverse-sigmoid sinus</td>
</tr>
<tr>
<td>Bliz (1978)$^9$</td>
<td>67M</td>
<td>32 months</td>
<td>Lt. frontal craniotomy</td>
<td>Lt. transverse-sigmoid sinus</td>
</tr>
<tr>
<td>Watari (1984)$^9$</td>
<td>57F</td>
<td>5 months</td>
<td>Rt. frontal craniotomy</td>
<td>Lt. transverse-sigmoid sinus</td>
</tr>
<tr>
<td>Watanabe (1984)$^{12}$</td>
<td>62M</td>
<td>6 months</td>
<td>Rt. frontotemporal craniotomy</td>
<td>Rt. cavernous sinus</td>
</tr>
<tr>
<td>Mizukawa (1978)$^{10}$</td>
<td>46F</td>
<td>4 months</td>
<td>Rt. suboccipital craniotomy</td>
<td>Lt. superior petrosal sinus</td>
</tr>
<tr>
<td>Nabors (1987)$^{13}$</td>
<td>58M</td>
<td>4 months</td>
<td>Rt. parietal craniotomy</td>
<td>Lt. sigmoid sinus</td>
</tr>
<tr>
<td>Ugrinovski (1989)$^9$</td>
<td>69M</td>
<td>4 months</td>
<td>Rt. suboccipital craniotomy</td>
<td>Rt. sigmoid sinus</td>
</tr>
<tr>
<td>Sasaki (1995)$^9$</td>
<td>47F</td>
<td>5 months</td>
<td>Rt. transpetrosal transcranial craniotomy</td>
<td>Lt. transverse-sigmoid sinus</td>
</tr>
<tr>
<td>Igase (1996)$^9$</td>
<td>59M</td>
<td>9 months</td>
<td>Rt. suboccipital craniotomy</td>
<td>Lt. transverse-sigmoid sinus</td>
</tr>
<tr>
<td>Hashimoto (1998)$^9$</td>
<td>57F</td>
<td>12 months</td>
<td>Bifrontal craniotomy</td>
<td>Lt. inferior vermian vein</td>
</tr>
<tr>
<td>Ohno (1998)$^9$</td>
<td>52M</td>
<td>17 months</td>
<td>Rt. suboccipital craniotomy</td>
<td>Lt. pterion</td>
</tr>
<tr>
<td>Amen (2006)$^9$</td>
<td>72M</td>
<td>17 months</td>
<td>Rt. transpetrosal transcranial craniotomy</td>
<td>Lt. transverse-sigmoid sinus</td>
</tr>
<tr>
<td>Murakami (2005)$^9$</td>
<td>47F</td>
<td>17 months</td>
<td>Rt. suboccipital craniotomy</td>
<td>Rt. sigmoid sinus</td>
</tr>
<tr>
<td>Sadahiro (2014)$^9$</td>
<td>59M</td>
<td>17 months</td>
<td>Rt. suboccipital craniotomy</td>
<td>Lt. superior petrosal sinus</td>
</tr>
<tr>
<td>Yamaki (2014)$^9$</td>
<td>47F</td>
<td>17 months</td>
<td>Lt. frontotemporal craniotomy</td>
<td>Lt. inferior vermian vein</td>
</tr>
<tr>
<td>Ngerageza (2016)$^9$</td>
<td>52M</td>
<td>17 months</td>
<td>Lt. suboccipital craniotomy</td>
<td>Lt. pterion</td>
</tr>
</tbody>
</table>

AVF: arteriovenous fistula; Bil: bilateral; F: female; Lt: left; M: male; Rt: right
A 4 Fr angiographic catheter was placed in the right external carotid artery by the transbrachial approach (TBA), and transvenous embolization was performed. A system consisting of a 6 Fr FUBUKI guiding sheath (Asahi Intecc, Aichi, Japan), a 6 Fr Cerulean DD6 (Medikit, Tokyo, Japan), and a 4.2 Fr FUBUKI (Asahi Intecc, Aichi, Japan) was navigated to a point immediately before the site of occlusion by the transfemoral vein approach (TFvA), and the occluded area was recanalized using a 0.035” Radifocus Shapeable Guidewire (Terumo, Tokyo, Japan). In addition, the same Radifoxus Shapeable Guidewire was advanced through the septum of the sinus near the shunt, and a Neurodeo 10 was delivered to the shunted area under guidance with a Neuroute-14 (Medico’s Hirata, Osaka, Japan). From this site, the sinus pouch was occluded by selective packing using a total of 12 coils (182 cm) consisting of DELTAMAXX-18 (Codman, Raynham, MA, USA), Target XL (Stryker, Kalamazoo, MI, USA), and VFC•HydroFill (Terumo, Tokyo, Japan). (This movie is available online.)

In our patient, the angle of the confluence of sinus was steep (Movie 1). Therefore, if the 4.2 Fr FUBUKI had not been navigated to the site of occlusion after stabilization across the confluence of sinus using an elaborately steam-shaped 6 Fr FUBUKI guiding sheath, penetration of the occluded area and the septum of the sinus near the shunt using a 0.035” Radifocus Shapeable Guidewire would have been extremely difficult and dangerous because extra forces would have been exerted to the veins of the access route to these sites.

Since only the simple technique using a single microcatheter is possible with the quadriaxial catheter system used in our patient, the option of the use of the double catheter technique is lost for situations such as the presence of shunts at multiple sites.

Recently, reports of radical transarterial embolization using Onyx, which is still in the clinical trial stage in Japan but is already in practical use in Western countries, have increased, apparently with favorable results.27,28 Although the principles of endovascular treatment for dural AVF with an isolated sinus may change in the future, embolization with preservation of the vein of Labbé by the transarterial technique using Onyx would have been difficult in our patient, and TVE with preservation of the vein of Labbé is considered to have been a reasonable choice.

**Conclusion**

In a patient with right transverse dural AVF that appeared after tumor resection by craniotomy, progressed thereafter, and became an isolated sinus type AVF, we could perform selective embolization of the shunt point due to preoperative evaluation and the greater support and manipulability obtained by the use of a quadriaxial catheter system compared with the conventional triple coaxial catheter system.

**Disclosure Statement**

The first author and coauthors have no conflicts of interest.
References


