Case Report

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Borden Type I Sigmoid Sinus Dural Arteriovenous Fistula Presenting as Subarachnoid Hemorrhage from a Feeding Artery Aneurysm of the Anterior Inferior Cerebellar Artery: A Case Report

Borden I 유형의 S상 정맥동 경막 동정맥루의 공급 동맥인 전방 하뇌 소뇌 동맥의 동맥류 파열로 인한 지주막하 출혈: 증례 보고

Myojeong Kim, MD, Sung-Tae Park, MD*

Department of Radiology, Soonchunhyang University Seoul Hospital, Seoul, Korea

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***Corresponding author**
Sung-Tae Park, MD
Department of Radiology, Soonchunhyang University Seoul Hospital, 59 Daesagwan-ro, Yongsan-gu, Seoul 04401, Korea.

Tel 82-2-709-9396
Fax 82-2-709-9396
E-mail stpark@schmc.ac.kr

ORCID iDs
Myojeong Kim
https://orcid.org/0000-0002-2000-2594
Sung-Tae Park
https://orcid.org/0000-0002-3073-1272

Dural arteriovenous fistula is an acquired vascular anomaly that can cause various symptoms. Here, we report a rare case of Borden type I sigmoid sinus dural arteriovenous fistula presenting as subarachnoid hemorrhage. Bleeding occurred from a side-wall aneurysm in the lateral pontomedullary segment of the anterior inferior cerebellar artery, which was a minor pial feeder. Features on imaging modalities, including brain CT, CT angiography, MR imaging/angiography and digital subtraction angiography, are described with a literature review.

Index terms Dural Arteriovenous Fistulas; Subarachnoid Hemorrhage, Spontaneous; Intracranial Aneurysm

INTRODUCTION

Dural arteriovenous fistulas (dAVFs) are vascular abnormalities of the dura mater

that typically involve the dural sinuses, most commonly the transverse and sigmoid sinuses. dAVFs are acquired lesions, often developing after dural sinus thrombosis. Two etiologic hypotheses based around sinus thrombosis have been put forward. The first is that physiologic arteriovenous shunts between meningeal arteries and dural venous sinuses enlarge in response to elevated local venous pressure, resulting in a pathologic shunt. The second is that venous hypertension due to outflow obstruction causes decreased cerebral perfusion and promotes neoangiogenesis (1). dAVFs with ruptured feeding-artery aneurysms are extremely rare and only a few cases have been reported (2-4). Most cases of intracranial hemorrhage in dAVF are likely to occur with cortical venous drainage (Borden types II and III) (1).

We report an unusual case of dAVF presenting as subarachnoid hemorrhage (SAH) from side wall aneurysm of feeding artery and discuss the imaging features with the aid of a literature review.

CASE REPORT

A 71-year-old woman visited emergency room for sudden vertigo and headache for three hours. She stated she had been suffering from right tinnitus. She had no previous medical history. On brain CT, large amount of SAH mainly in right posterior fossa and small amount of intraventricular hemorrhage (IVH) were detected (Fig. 1A, Fisher scale grade 4). Brain CT angiography demonstrates abnormal vascular structure with focal aneurysmal dilatation at right perimedullary cistern (Fig. 1B). Digital subtraction angiography (DSA) showed Borden type I dAVF of right sigmoid sinus supplied by right middle meningeal artery, right occipital artery and cortical branch of anterior inferior cerebellar artery (AICA). Cortical venous reflux was absent (Fig. 1C). Aneurysm on lateral pontomedullary segment (a2) of AICA was considered as the cause of spontaneous SAH (Fig. 1D). As considering DSA is the standard of reference for the diagnosis dAVF, 3 dimensional time-of-flight magnetic resonance angiography (3D TOF MRA) revealed subtle thin transosseous vessel at right occipital cortex, representing dAVF (not shown).

A neurointerventionist tried to occlude aneurysm on right peripheral AICA but failed. Instead, embolization of feeding artery from posterior branch of right middle meningeal artery was done using 0.5 cc of precipitating hydrophobic injectable liquid (PHIL) 25% (Fig. 1E).

On follow-up brain CT and CT angiography, previously noted SAH and IVH were resolved. To prevent further bleeding, clipping of aneurysm and feeding branches from AICA was performed. Hematoma in right posterior fossa was removed and ventriculoperitoneal shunt drainage was done due to hydrocephalus. She no longer complains of headaches, and after discharge she does everyday activities without the help of others.

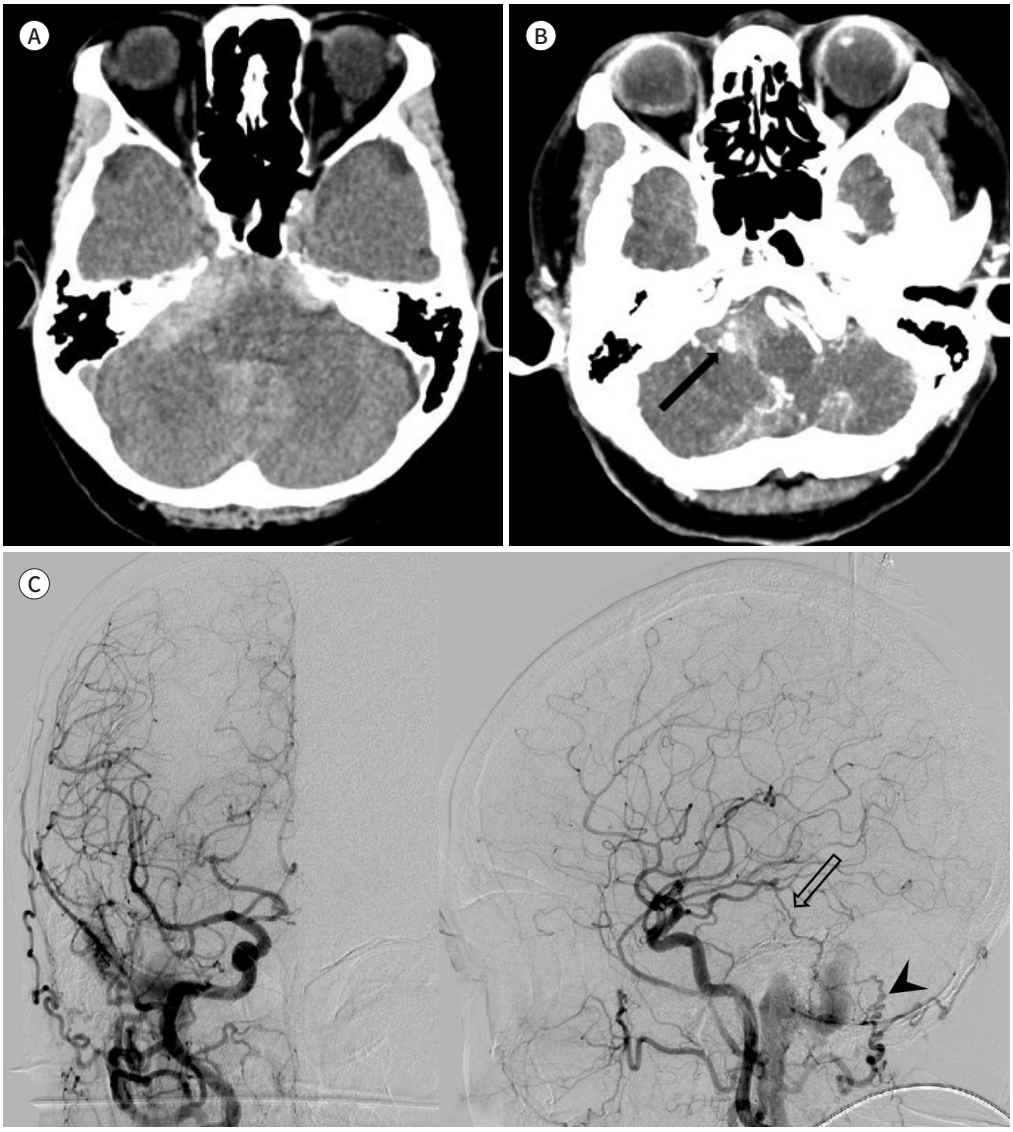
DISCUSSION

Most patients with dAVFs present clinical symptoms in adulthood, ranging from pulsatile tinnitus to intracranial hemorrhage. Pulsatile tinnitus is a common symptom that results from increased blood flow through the dural venous sinuses, particularly in relation to transverse and sigmoid sinus lesions. The risk of intracranial hemorrhage from Borden type I le-

sions is extremely low. The presence of cortical venous drainage (Borden type II and III) is an aggressive feature that places dAVFs in a higher risk category. In these lesions, an annual risk of intracranial hemorrhage of 8.1% has been reported (1). The presence of an aneurysmal dilatation of a draining vein or a venous varix was also a useful predictor of hemorrhage (5).

Although dAVFs are most commonly fed by dural branches of the internal carotid, external carotid, and vertebral arteries, they can also have pial artery supply. Pial arteries lie on the surface of the brain. They then branch into penetrating arteries and parenchymal arterioles

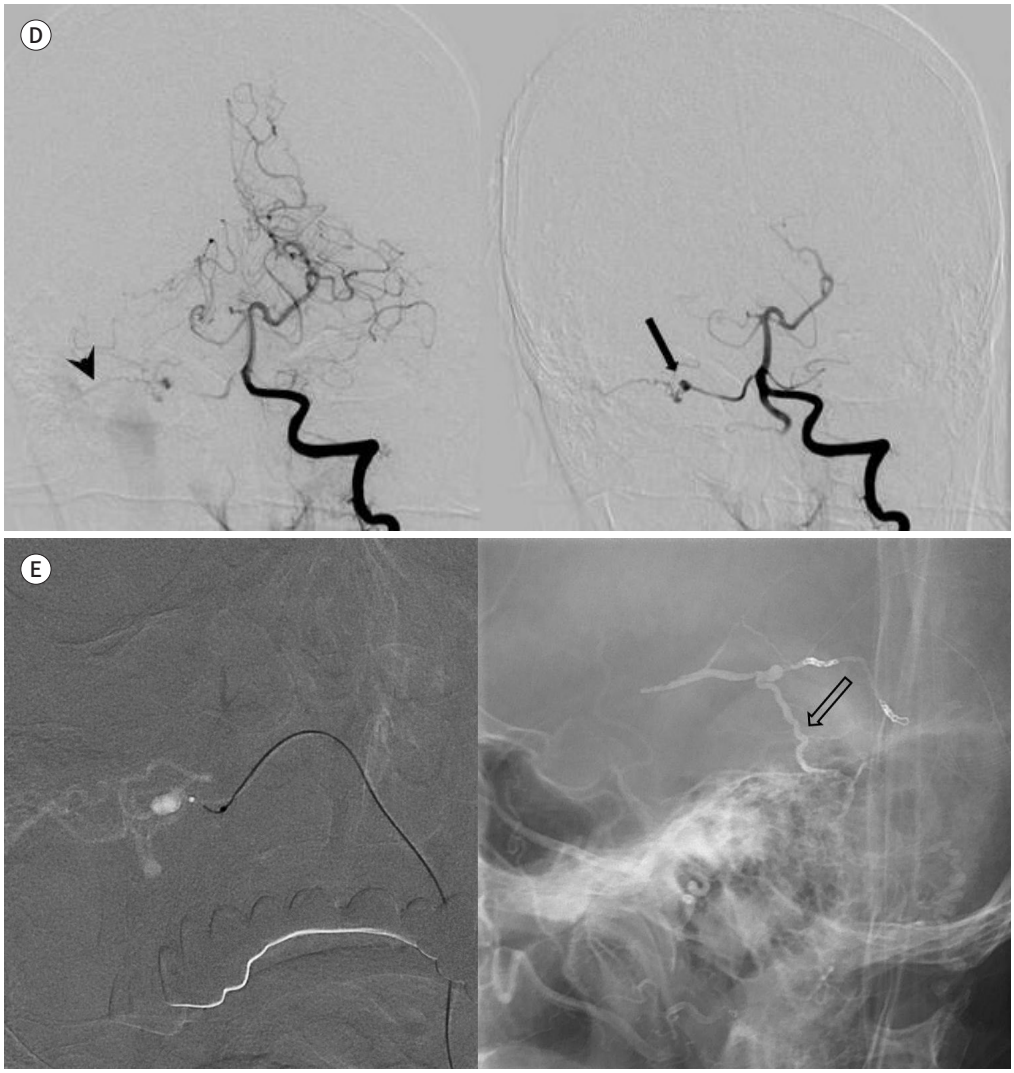
Fig. 1. Borden type I sigmoid sinus dural arteriovenous fistula presenting as subarachnoid hemorrhage in a 71 year-old woman with sudden vertigo and headache.
A. Brain CT demonstrates a large amount of subarachnoid hemorrhage and small amount of intraventricular hemorrhage (Fisher scale grade 4), mainly in the right posterior fossa.
B. Brain CT angiography on the day of admission demonstrates an abnormal vascular structure (arrow) with hematoma at the perimedullary cistern.
C. Right common carotid artery angiography reveals Borden type I dural arteriovenous fistula of the right sigmoid sinus supplied by the middle meningeal artery (arrow) and occipital artery (arrowhead) without the cortical venous reflux.



that lie within and supply the brain parenchyma. The mechanism of pial feeder formation is not well-understood but is believed to be like that of dural feeders, with increased vascular endothelial growth factor secretion from the venous sinus and abnormal angiogenesis (6).

In a single-center cohort study of 56 patients with 70 dAVFs (3), patients with dAVFs and associated aneurysms showed stronger male predilection (2.0 male-to-female ratio vs. 1.2, respectively). 58% of patients with dAVFs and aneurysms presented with hemorrhage compared with only 20% of patients without aneurysms. Of 70 dAVFs, 5 (7%) had feeding artery

Fig. 1. Borden type I sigmoid sinus dural arteriovenous fistula presenting as subarachnoid hemorrhage in a 71 year-old woman with sudden vertigo and headache.
D. Left vertebral artery angiography reveals the dural arteriovenous fistula supplied by the cortical branch of the anterior inferior cerebellar artery (arrowhead). A side-wall aneurysm (arrow) of the lateral pontomedullary segment (a2) of anterior inferior cerebellar artery is considered to be the cause of spontaneous subarachnoid hemorrhage.
E. A roadmap image of the right anterior inferior cerebellar artery was obtained (left), but superselection of the aneurysm failed. Instead, embolization of the feeding artery from the posterior branch of the right middle meningeal artery (arrow) using 0.5 cc of precipitating hydrophobic injectable liquid 25% was performed after coil embolization of the unwanted branch.



aneurysms. Two of the aneurysms were located on AICA, and others were located on distal middle cerebral arterial branch, middle meningeal artery and posterior meningeal artery respectively. Four of these aneurysms were associated with Borden Type III fistulas. Although dAVFs are believed to be acquired lesions, some authors (3) suggested potential genetic component or predisposition to developing these lesions. The origin of dAVF feeding-artery aneurysms is controversial, but the main theory focuses on flow-related stress on the arterial feeders. Flow-related aneurysms are caused by direct high-flow vascular malformations that distally exert hemodynamic stress on the aneurysm wall, and this type of aneurysm formation is often described as true aneurysms or pseudoaneurysms with fragile arterial wall (4).

AICA aneurysms comprise < 1% of all intracranial aneurysms. Most AICA aneurysms are associated with vascular malformations and are commonly seen in feeding arteries with SAH. Although, their association with AVM is well reported, aneurysms of AICA as a feeding artery to dAVF are extremely rare and only few cases are known (2-4). To the best of our knowledge, this is the third case report in which dAVF feeding-AICA aneurysm was manifested as SAH and the second case report in terms of Borden type I dAVF. Gross et al. (3) reviewed cerebral angiograms of 56 patients with dAVFs and revealed only one case of AICA feeding artery aneurysm rupture attributing to SAH (22 years old, male). The AICA feeding-artery aneurysm was confirmed by operation and he had Borden type III dAVF. Kan et al. (2) reported a case of 27-year-old male with unruptured AICA feeding-artery aneurysm supplying a Borden type I transverse-sigmoid dural AVF which was resolved spontaneously with dAVF treatment. Recently, Suzuki et al. (4) presented a case of multiple subarcuate artery aneurysms arising from the AICA as a feeding artery of Borden type I transverse-sigmoid dAVF, which was obliterated using Onyx.

dAVF should be taken into account promptly in the differential diagnosis when unexplained SAH was found (1). dAVF is a treatable disease, but in some cases it is undetectable and eventually leads to irreversible disease because of the diagnostic delay (7). Many brain imaging modalities can help with diagnosis of dAVF. DSA is the standard of reference for the diagnosis dAVF and required for endovascular treatment. TOF MRA enables the visualization of small vessels involved in a fistula at higher spatial resolution. Hyperintense visualization of cerebral venous structures is the most frequent finding in patent fistulas on MRA followed by the hyperintense transosseous vessel sign (8). dAVF with pial arterial supply may be a special type of dAVF that should be considered during endovascular and surgical procedures. Obliterating pial feeding arteries before fistula embolization through dural feeders may decrease the risk of hemorrhage (9).

In conclusion, a rare case of SAH caused by Borden type I dAVF feeding-AICA side wall aneurysm was reported, which was a minor pial feeder. It was successfully treated by clipping of aneurysm.

Author Contributions

Conceptualization, P.S.; data curation, K.M.; investigation, K.M.; project administration, P.S.; resources, P.S.; supervision, P.S.; visualization, all authors; writing—original draft, K.M.; and writing—review & editing, all authors.

Conflicts of Interest

The authors have no potential conflicts of interest to disclose.

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Borden I 유형의 S상 정맥동 경막 동정맥루의 공급 동맥인 전방 하뇌 소뇌 동맥의 동맥류 파열로 인한 지주막하 출혈: 증례 보고

김묘정 · 박성태*

경막 동정맥루는 다양한 증상을 일으킬 수 있는 후천적 혈관 이상이다. Borden I 유형의 S상 정맥동 동정맥 누공이 지주막하 출혈로 나타난 드문 증례를 보고한다. 출혈은 전방 하뇌 소뇌 동맥의 작은 연막 공급 혈관인 측면 연수 교뇌 부분에 있는 측벽 동맥류 파열로 인해 발생하였다. 저자들은 뇌 전산화단층촬영 및 혈관조영술, 자기공명영상 및 혈관조영술 그리고 디지털 감산 혈관조영술을 포함한 영상 소견과 기존의 유사한 증례에 대한 문헌을 검토하고자 한다.

순천향대학교 서울병원 영상의학과