Case Consult

A case of dural arteriovenous fistula with retrograde intracranial venous flow

Alexandros L. Georgiadis, MD[1]; Giuseppe Lanzino, MD[2]; Nazli Janjua, MD[3]; Jawad F. Kirmani, MD[4]; Adnan I. Qureshi, MD[1]

[1]Zeenat Qureshi Stroke Research Center, University of Minnesota
[2]Illinois Neurological Institute, University of Illinois College of Medicine at Peoria
[3]Department of Neurology, Long Island College Hospital
[4]Department of Neurology, University of Medicine and Dentistry of New Jersey

Abstract

Presentation: Dural arteriovenous fistulae are relatively rare lesions which can present a variety of different symptoms ranging from tinnitus to devastating intracranial hemorrhage. For those fistulae that require treatment, therapy is available in a wide range of options. We describe the case of a 60-year old patient who presented with a right occipital lesion presumably secondary to a dural arteriovenous fistula of the right transverse-sigmoid junction. The patient underwent successful endovascular treatment of the fistula.

Discussion: The participants in our discussion present their thoughts on how to evaluate and when and how to treat dural arteriovenous fistulae.

Key words: Dural arteriovenous fistula, coil embolization, endovascular treatment, sinus thrombosis.

J Vasc Interv Neurol 2008; 1(1):9-13

Abbreviations, in the order used in this report.

MRI:	magnetic resonance imaging
MR:	magnetic resonance
DAVF:	dural arteriovenous fistula
ECA:	external carotid artery
AV:	arteriovenous

Commercial products, in the order referenced in this report.

Envoy®	Cordis Corp, Miami Lakes, Florida, USA
Prowler® Plus	Cordis Corp, Miami Lakes, Florida, USA
Onyx®	Micro Therapeutics, Inc., Irvine California, USA

Correspondent: *Alexandros L. Georgiadis, MD; Zeenat Qureshi Stroke Research Center; Department of Neurology; University of Minnesota; 420 Delaware St. SE; Minneapolis, MN 55455; USA; alg1971@gmail.com*

Presentation

Dr. Georgiadis: A 60 year old man presented with confusion while driving. He had no significant past medical history. Neurological examination revealed a dense left homonymous hemianopsia without any other deficits.

MRI showed a right occipital lobe infarct (Figure 1). The MR-angiogram was suspicious for fistulous connections to the right transverse sinus (Figure 2) and the patient was therefore referred to our center for further work-up.

The patient underwent a 6-vessel diagnostic cerebral angiogram that revealed a dural arteriovenous fistula (DAVF) with multiple right external carotid artery (ECA) branches feeding directly into the right transverse sinus (Figure 3). The right sigmoid sinus and internal jugular vein were occluded. The DAVF exhibited retrograde flow into the right transverse sinus and into occipital cortical veins and was accordingly classified as Type IIa+b according to the Cognard classification1. Although it was not clear that the patients' lesion was caused by the DAVF, the probability of future symptoms for Type IIa+b DAVFs is in the range of 40%.[1,2] After further review of additional angiographic features of the lesion and discussion with the patient, the decision was made to proceed with endovascular treatment.

The procedure was performed under general anesthesia. A 5-French sheath was placed in the left common femoral artery and a 5-French Davis catheter was advanced into the right ECA. Subsequently, a 6-French sheath was placed in the right common femoral vein and a 6-French *Envoy-MPC* guide-catheter was advanced into the proximal segment of the left internal jugular vein. Next, a 2.3-French *Prowler Plus* microcatheter was advanced through the guide-catheter into the right transverse sinus via the left sigmoid and transverse sinuses (Figure 4). Guglielmi detachable coils with size ranging from 2 mm x 4 cm to 6 mm x 20 cm were deployed serially. Right ECA injections were performed after each coil deployment to assess flow into the right transverse sinus. Complete obliteration of the right transverse sinus was achieved after 31 coils were placed (Figure 5), at which point the procedure was terminated.

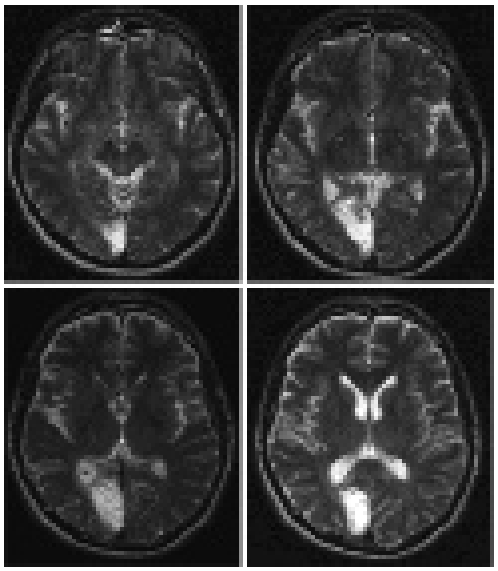

Figure 1. These T2-weighted images show a right occipital infarction that seems to correspond to posterior cerebral artery territory.

The patient tolerated the procedure very well. Neurological examination for the 24 hours following the procedure that he remained in the hospital was normal with the exception of his persisting left homonymous hemianopsia. MRI performed prior to discharge revealed an asymptomatic right hemispheric cerebellar hemorrhage (Figure 6). The timing of the asymptomatic hemorrhage was unclear.

The patient was seen again for follow up 2 months later. He had had no new symptoms. Repeat angiogram showed persisting obliteration of the right transverse sinus (Figure 7).

Discussion

Dr. Georgiadis: What is known about the pathogenesis of DAVFs, and do you believe that the fistula caused the patient's lesion?

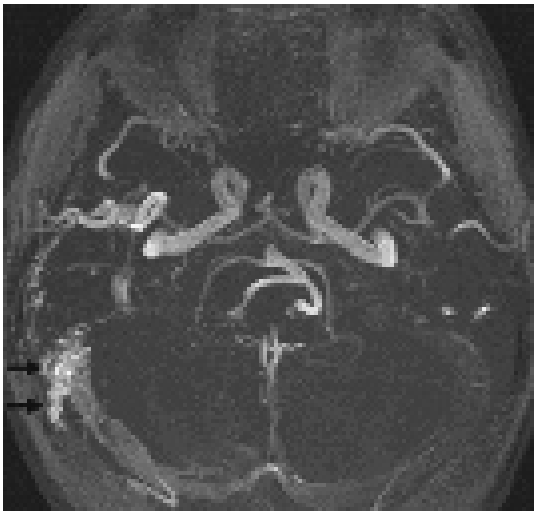

Figure 2. On this MR-angiogram, part of the venous phase is visualized. The arrows point at abnormal-appearing blood vessels that raised a suspicion of a transverse sinus DAVF.

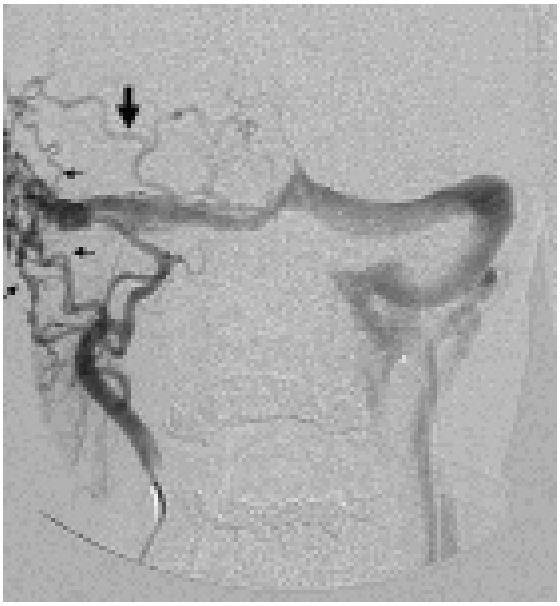

Figure 3. Right external carotid artery injection from the original diagnostic angiogram. The small arrows point at abnormal vessels that originate from the external carotid artery and feed directly into the right transverse sinus. The right sigmoid sinus and the right internal jugular vein exhibit no flow. The right transverse sinus fills in retrograde fashion into the left transverse sinus. The large arrow points at occipital cortical veins that also fill in retrograde fashion.

Dr. Lanzino: This is a classic dural AV-fistula of the transverse-sigmoid junction and we know that these are related to sinus thrombosis.[3-6] There have been earlier studies in the 1970s that documented de-novo formation of an AV-fistula in patients with sinus thrombosis. Recent experimental studies have postulated that the development is related to local release of vascular growth factors.[6,7] Whether we have formation of new vessels or re-opening of pre-existing AV-shunts is still a matter of debate. The fistula seems to be fed primarily from branches of the ascending pharyngeal and occipital arteries which commonly vascularize the dura and the wall of the sinuses. So the pathophysiology is fairly obvious.

The second question is more intriguing and difficult to answer. The patient has a DAVF in the occipital area with some "dangerous" features such as the retrograde drainage through occipital veins. At the same time the patient has a vascular event in the occipital lobe. I would tend to believe that somehow the two events are related even though as you said, MRI seems to show an ischemic stroke that follows the arterial distribution. How the stroke is connected to the presence of the DAVF is a matter of speculation.

Where there any abnormalities of the right posterior cerebral artery on your angiogram?

Dr. Qureshi: Both posterior cerebral arteries appeared normal.

Dr. Lanzino: So inspite of the arterial-looking distribution, I would wonder if this could be a venous infarct. Also, did you do a diffusion-MRI? It could be that the T2-changes that we saw were related to the altered hemodynamics, i.e. they could represent cerebral edema and not ischemia.

Dr. Qureshi: The MRI was obtained ten days after symptom onset because the patient did not seek medical attention earlier, and at that time diffusion MRI was negative.

I agree that there is clearly an association between sinus

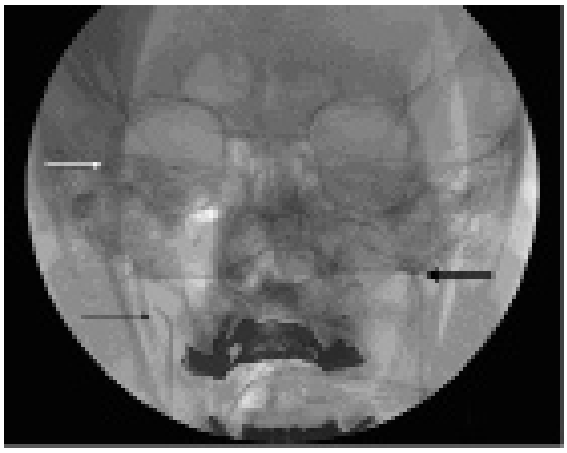

Figure 4. Unsubtracted image obtained prior to coil embolization of the right transverse sinus.The thin black arrow points at the tip of the diagnostic catheter in the right external carotid artery. The thick black arrow points at the tip of the guide catheter in the left proximal internal jugular vein. The white arrow indicates the position of the tip of the microcatheter inside the right transverse sinus.

thrombosis and the development of DAVFs.

If the formation of DAVFs was secondary to opening of pre-existing channels, which would be pressure-dependent, you would expect to see this occurring in the acute phase of sinus thrombosis. The fact that this phenomenon is not seen in the acute phase of sinus thrombosis supports the theory of angiogenesis through the release of vasoactive factors over a period of time.

When we were discussing this case we felt that we could not exclude that the DAVF was related to the patient's lesion. The stroke appeared to be arterial in distribution but there was engorgement of the draining veins suggesting venous hypertension in the occipital region.

Dr. Georgiadis: Do you think that elaborate classification schemes such as those by Borden[8] or Cognard[1] are necessary?

Dr. Lanzino: These classifications are often quite complex and difficult to remember. To me they are not that useful. I look at the factors that interest me and there are mainly two. The first factor is: is there any connection to the dural sinus? Some AV fistulas do not have a connection with the sinus and that is very important from a therapeutic point of view because such DAVFs are easily treated surgically. DAVFs with sinus involvement are usually more suited for endovascular treatment.

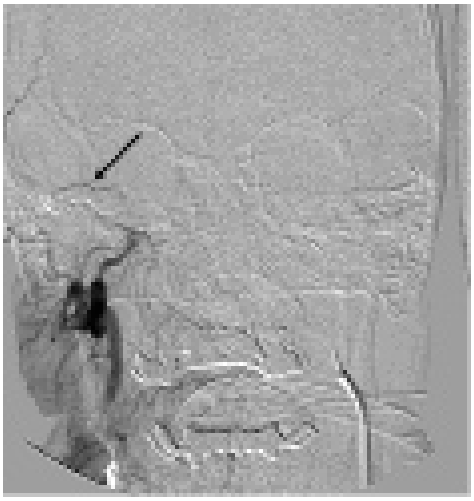

Figure 5. Right ECA injection after deployment of 31 coils. There is no filling of the transverse sinus. The arrow points at the coil mass.

The other issue relates to cortical venous drainage. We know that retrograde cortical venous drainage is associated with a more aggressive clinical behavior which should prompt treatment. So these are the two factors that I look at when making therapeutic decisions.

In terms of whether this specific DAVF required treatment, I believe that it did. We had a lesion with aggressive angiographic features; i.e., the retrograde cortical venous drainage and also I would consider this fistula symptomatic.

Dr. Qureshi: I think that also in our minds, the retrograde cortical venous filling was decisive since it suggested the presence of venous engorgement and possibly also of venous hypertension. Based on that, the chance of bleeding in the future was high.

Dr. Georgiadis: How would you treat this lesion?

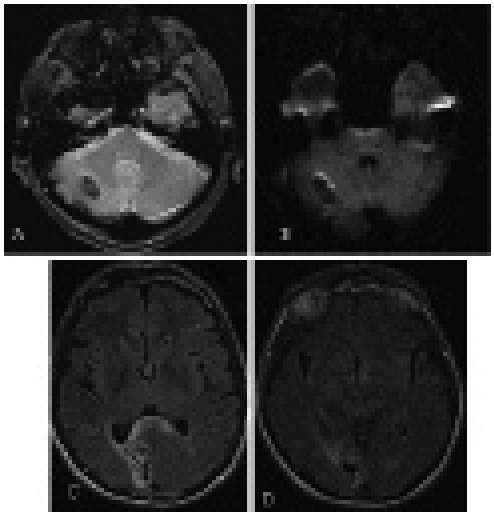

Figure 6. This MRI was obtained one day after embolization. **A:** Gradient echo MRI. **B:** Diffusion-weighted MRI. A small hemorrhagic lesion of the right cerebellar hemisphere is depicted. **C and D:** FLAIR MRI shows the unchanged right occipital stroke.

Dr. Lanzino: For a fistula that has involvement of the sinus, the preferred treatment is through the endovascular route. When you consider endovascular treatment it is very important to study not only the angiographic picture but also to study the dynamic images. In this case you see that there is not only retrograde cortical venous drainage, but also drainage from the right transverse sinus into the left transverse sinus. That suggests that the pressure in the right transverse sinus is such that it has already lost its primary function of venous drainage. Therefore you should be able to safely obliterate that sinus. I also looked at the oblique view very carefully to identify the vein of Labbé. The sinus can be safely obliterated distal to the entry point of the vein of Labbé. In case the vein of Labbé fills in retrograde fashion, it is not important that its entry point be spared.

Once you have studied the angiogram you have two options. One is to approach the lesion from the arterial side and

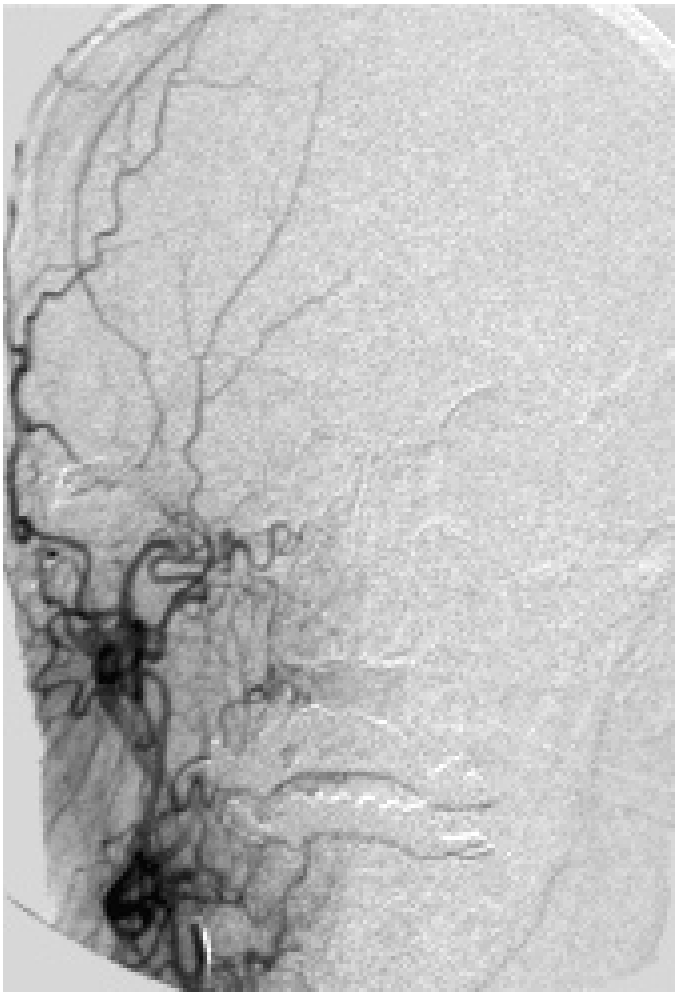

Figure 7. Right ECA injection at 2 month follow-up shows again no connection between ECA branches and the right transverse sinus.

the other is to approach it via the venous side. Approaching it from the arterial side was done particularly in the past. It is helpful as a palliative measure. We often treat patients with intractable tinnitus who however have no dangerous angiographic findings. We embolize the arterial feeders with the idea of palliating their symptoms. Quite often the patients do experience symptomatic improvement. This is an easy and fairly safe method if you embolize the ECA distal to any potential connections to the posterior circulation or the internal carotid artery.

The preferred way of treating this specific fistula is through the venous side with obliteration of the sinus.[9-13] The arterial approach could be helpful in this case as a way to slow down the fistula before treating from the venous side. My preferred method of treatment is with coils because I feel more comfortable with coils and I think they are safer and easier to control.

Newer embolic agents such as *Onyx* might in the future become the preferred way of treatment.[14]

Dr. Qureshi: We felt that if we treated from the arterial side only we would not get complete obliteration because the feeders were too numerous and because of the tendency towards neovascularization which means that if you shut down the arterial feeders only, new feeders develop over time.

Also of note, the right transverse sinus is occluded distally so the question came up, could we open up that occlusion even though it is chronic? There are data showing that if you open up the sinus you might cause favorable flow redistribution.[15] However, we felt that the occlusion was too long so that we would be probably unable to revascularize the entire occluded segment.

We decided to proceed with obliteration of the transverse sinus. We looked carefully to locate the vein of Labbé and we found no temporal vein that was actually draining through the transverse sinus.

Dr. Georgiadis: What is the risk of a complication such as intracranial hypertension after successful treatment?

Dr. Lanzino: The risk of developing intracranial hypertension in this patient is low because the contralateral transverse sinus is patent and large and should be able to handle the flow after you have re-established normal venous outflow patterns.

Dr. Georgiadis: What is the chance of recurrence? How long would you follow the patient?

Dr. Lanzino: I would perform a repeat study in a few months to rule out recurrence; however, you got such a good result that recurrence is unlikely. Some people might even question the need for any additional follow-up angiography. Of course that would change if the patient developed symptoms that could be referable to the fistula.

Dr. Qureshi: The only other thing I would mention was that we were concerned about the drainage of the cerebellum, but it appeared at least angiographically that most of the drainage was into the torcula and not into the transverse sinus.

We performed the 2-month follow-up study to make sure that there were no new fistulous connections, because DAVFs can sometimes recur.

Dr. Lanzino: It would be interesting to repeat an MRI to see if there is any resolution of the lesion; i.e., if this was just edema and not a stroke.

Dr. Qureshi: We did an MRI the day after the procedure looking for immediate effects of the procedure. At that time there was no resolution of the lesion.

What we did find on the MRI was an asymptomatic intracerebral hemorrhage in the cerebellum.

Dr. Lanzino: I was going to comment on this, because in a similar case a patient of mine suffered a small hemorrhagic infarction of the brainstem a week after the procedure.

I think that even though we are usually concerned about the vein of Labbé and supratentorial drainage, infratentorial veins might also be affected by our treatment, even though we would not expect the sinus to be functional.

Dr. Qureshi: We could not be sure about the age of the hemorrhage because it was asymptomatic and unfortunately T1-weighted images were not obtained. We do not know if that was related to the fistula itself or to our treatment. The patient continues to be asymptomatic after the treatment.

References

1. Cognard C, Gobin YP, Pierot L, Bailly AL, Houdart E, Casasco A, Chiras J, Merland JJ. Cerebral dural arteriovenous fistulas: Clinical and angiographic correlation with a revised classification of venous drainage. Radiology 1995; 194:671-680.
2. Davies MA, TerBrugge K, Willinsky R, Coyne T, Saleh J, Wallace MC. The validity of classification for the clinical presentation of intracranial dural arteriovenous fistulas. J Neurosurg 1996;

85:830-837.
3. Sakaki T, Morimoto T, Nakase H, Kakizaki T, Nagata K. Dural arteriovenous fistula of the posterior fossa developing after surgical occlusion of the sigmoid sinus. Report of five cases. J Neurosurg 1996; 84:113-118.
4. Preter M, Tzourio C, Ameri A, Bousser MG. Long-term prognosis in cerebral venous thrombosis. Follow-up of 77 patients. Stroke 1996; 27:243-246.
5. Pierot L, Chiras J, Duyckaerts C, Jason M, Martin N. Intracranial dural arteriovenous fistulas and sinus thrombosis. Report of five cases. J Neuroradiol 1993; 20:9-18.
6. Uranishi R, Nakase H, Sakaki T. Expression of angiogenic growth factors in dural arteriovenous fistula. J Neurosurg 1999; 91:781-786.
7. Lawton MT, Jacobowitz R, Spetzler RF. Redefined role of angiogenesis in the pathogenesis of dural arteriovenous malformations. J Neurosurg 1997; 87:267-274.
8. Borden JA, Wu JK, Shucart WA. A proposed classification for spinal and cranial dural arteriovenous fistulous malformations and implications for treatment. J Neurosurg 1995; 82:166-179.
9. Klisch J, Huppertz HJ, Spetzger U, Hetzel A, Seeger W, Shumacher M. Transvenous treatment of carotid cavernous and dural arteriovenous fistulae: results for 31 patients and review of the literature. Neurosurgery 2003; 53:836-856.
10. Roy D, Raymond J. The role of transvenous embolization in the treatment of intracranial dural arteriovenous fistulas. Neurosurgery 1997; 40:1133-1141.
11. Lin J, Elwood PW, Fraser KW. Venous ligation of dural arteriovenous fistulae. Br J Neurosurg 2003; 17:239-243
12. Terada T, Kinoshita Y, Yokote H, Tsuura M, Tanaka Y, Itakura T, Ryujin Y, Hayashi S, Minamikawa J. Clinical use of mechanical detachable coils for dural arteriovenous fistula. Am J Neuroradiol 1996; 17:1343-1348.
13. Urtasun F, Biondi A, Casaco A, Houdart E, Caputo N, Aymard A, Merland JJ. Cerebral dural arteriovenous fistulas: percutaneous transvenous embolization. Radiology 1996; 199:209-217.
14. Rezende MT, Piotin M, Mounayer C, Spelle L, Abud DG, Moret J. Dural arteriovenous fistula of the lesser sphenoid wing region treated with Onyx: Technical note. Neuroradiology 2006; 48:130-134.
15. Murphy KJ, Gailloud P, Venbrux A, Deramond H, Hanley D, Rigamonti D. Endovascular treatment of a grade IV transverse sinus dural arteriovenous fistula by sinus recanalization, angioplasty, and stent placement: technical case report. Neurosurgery 2000; 46:497-500.