Three-dimensional computed tomography angiography in presurgical planning for treatment of infratentorial dural arteriovenous fistulas

Technical note

Sergio Paolini, M.D., Giuseppe Lanzino, M.D., Claudio Colonnese, M.D., Eugenio Venditti, M.D., Giampaolo Cantore, M.D., and Vincenzo Esposito, M.D.

Dural arteriovenous fistulas (DAVFs) with pure leptomeningeal drainage may be cured by simple interruption of their venous side. This report illustrates the cases of 3 patients undergoing surgery for fistulas classified as Borden Type III, involving the posterior cranial fossa. Preoperatively, the surgical anatomy of these lesions was investigated with 3D reformating of multislice CT angiography, in addition to conventional angiography. Reformatted images clarified the surgical anatomy of the malformation. Reconstructing both the osseous and the vascular structures and simulating the surgical orientation allowed localization of the dural takeoff point of the DAVF’s drainage, showing its relationship with osseous landmarks. Precise localization of the DAVF’s drainage may help in choosing the most direct and effective approach to treat the malformation. The reported cases could be treated with a standard retrosigmoid exposure, avoiding the need for more complex cranial base approaches. (DOI: 10.3171/2008.4.17515)

Key Words • cranial base • dural arteriovenous fistula • surgery • three-dimensional computed tomography angiography • venous drainage

**Case 1**

**History and Examination.** This 48-year-old man was admitted after subacute onset of severe tetraparesis, dyspnea, dysphagia, and sphincter paralysis. On MR imaging, T2-weighted sequences showed hyperintensity within the medulla oblongata, with flow voids surrounding the bulbomedullary surface (Fig. 1A). Conventional angiography disclosed an early shunt between a tentorial branch of the ECA and an intracranial vein crossing the posterior fossa, down to the level of the foramen magnum, eventually bifurcating into a posterior and an anterior longitudinal spinal vein (Fig. 1B). Dural sinuses were...
not recruited by the shunt. A CT angiography study with 3D images (reconstructed without subtracting the bone and rotated to simulate a posterior perspective) showed the DAVF’s draining vein arising from the petrous surface between the IAM and the superior petrosal sinus and running inferiorly through the CPA (Fig. 1C).

Operation. A standard retrosigmoid approach was used. As anticipated based on the CT angiogram, the arterialized vein was seen emerging from the posterior surface of the petrous bone just above the IAM (Fig. 1D). The vessel was secured with an aneurysm clip as it entered the subarachnoid space. Within 1 minute, the vein turned blue.

Postoperative Course. On postoperative angiography, the fistula was no longer visible (Fig. 1E). Two months after surgery, the patient experienced significant motor...
recovery of the upper limb strength but only minimal improvement of the paraparesis.

Case 2

History and Examination. This 46-year-old man presented with a 10-day history of burning dysesthesia in the left hemiface and with peripheral left facial palsy. An admission CT scan disclosed a complex vascular lesion in the left CPA, with an ectatic structure compressing the brainstem (Fig. 2A). An MR imaging study confirmed this finding. Conventional angiography showed a DAVF fed by external and internal carotid artery branches. The lesion drained intradurally through a single vein, which dilated into a large varix before emptying into the galecnic venous system (Fig. 2B). Three-dimensional CT angiography reconstructions confirmed a single draining vein and localized its intradural takeoff point along the inferior surface of the tentorium. A postdilation stenosis was also evident (Fig. 2C).

Operation and Postoperative Course. Via a standard retrosigmoid approach, the proximal portion of the draining vein was readily identified beneath the tentorium (Fig. 2D). After closing the vessel with 2 aneurysm clips, the remaining part of the venous compartment collapsed and became pale (Fig. 2E). After surgery, the facial nerve function improved. Postoperative angiography showed resolution of the malformation (Fig. 2F).

Case 3

History and Examination. This 58-year-old man was evaluated because of a long-standing history of rightsided, continuous facial pain, which had become more intense in the few months preceding evaluation. Results of MR angiography suggested the presence of an arteriovenous malformation. A conventional cerebral angiogram revealed the lesion to be a DAVF fed by tentorial branches of the meningohipophyseal trunk and dural branches of the occipital artery (Fig. 3A). The venous drainage was
through the petrosal vein into the lateral mesencephalic vein, basal vein, and into the vein of Galen (Fig. 3A). Three-dimensional CT angiography clearly visualized the point of fistulization right along the superior petrosal sinus posterior and superior to the IAM (Fig. 3B).

**Operation and Postoperative Course.** The lesion was approached via a standard retrosigmoid approach. The large draining vein was identified as it emerged from the dura mater (Fig. 3C), and it was closed with 2 permanent aneurysm clips. Postoperative cerebral angiograms confirmed obliteration of the fistula (Fig. 3D). The patient noted immediate resolution of his facial pain and made an uneventful recovery.

**Discussion**

Borden Type III fistulas can be permanently cured by simple interruption of their leptomeningeal drainage. Surgical disconnection can usually be achieved without difficulties once the proper site of fistulization is identified. Therefore, correct exposure of the vein itself represents the key step of the procedure. This issue is even more relevant for lesions involving the posterior cranial fossa, an area in which minor modifications of a working perspective often correspond to different surgical approaches. Accordingly, different types of cranial base approaches have been used to treat posterior fossa DAVFs. Nevertheless, the presurgical criteria leading to the choice of a specific approach have not always been detailed. Conventional neuroimages as well as the surgeon’s personal experience were probably the main factors affecting the decision-making process.

Catheter angiography is essential to understanding the flow dynamics of the malformation and to ascertain its fistulous nature and the number of draining veins. However, precise topographical localization of the DAVF’s drainage and its relationship with the skull base is not always immediately apparent on conventional angiograms alone. Noninvasive techniques like MR imaging and CT-based angiography are used with increasing frequency to improve diagnosis of intracranial DAVFs. Renner and colleagues reported the use of MR angiography to localize a tentorial DAVF. This technique might suffer 2 limitations that could potentially compromise the accuracy of surgical planning: 1) the bidimensional nature of MR angiography images and 2) the suboptimal visualization of bone landmarks adjacent to the draining vein. Intraoperative neuronavigation is an appealing adjunct to preoperative imaging planning. A recent report, however, found it to be beneficial only for small, superficial DAVFs. Localization of deep-seated lesions was less accurate due to brain shift and brain retraction. Three-dimensional rotational angiography has also been described as a localizing tool in the surgery of spinal DAVFs, but its use in intracranial fistulas has not been investigated.

In our 3 patients, reformatted CT angiography proved to be a straightforward procedure. Because it is entirely based on data post-processing, it may easily integrate a standard spiral CT study. To highlight the surgical anatomy of the malformation, the key step of the procedure is including both the vascular and the bone anatomy in the reconstruction. In this way, a properly rotated reconstruction may effectively simulate a surgical perspective. In the cases we describe here, this method localized the surgical target infratentorially, immediately above the IAM, which is an area normally exposed by a standard retrosigmoid approach. This was valuable information because it ruled out the need for more complex cranial base approaches. Based on this experience, we believe that 3D CT angiography should be used in addition to conventional angiography as part of the routine presurgical workup of these lesions.

**Disclaimer**

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

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Address correspondence to: Sergio Paolini, M.D., Department of Neurosurgery, Via G. A. Sartorio, 44–00147 Rome, Italy. email: spa02@yahoo.com.