NEWER advances in flat-panel detector technology have led to the development of angiography suites outfitted with rotational volume cone-beam CT as well as routine fluoroscopy and digital subtraction angiography. Rotational angiographic CT is useful in detecting complications during interventional neuroradiological procedures, such as a rupture during aneurysm coil embolization, without the delay of transferring a patient to the CT scanner. This imaging modality has been used during other interventional procedures to better understand angiographically demonstrated anatomy and to guide therapy. We describe the use of this technique in a patient with a dAVF in the region of the petrous ridge who had presented with subarachnoid hemorrhage. Computed tomography angiography following the intravenous administration of contrast did not definitively reveal the site of the fistula because of poor contrast opacification in the tiny feeding vessels, which were beyond the resolution of the CT scanner. To determine the optimal surgical pathway—subtemporal versus suboccipital—the precise location of the fistula was required. Thus, we performed selective microcatheterization of the feeding vessel coupled with dynamic CT by using the rotational capability of an angiography machine equipped with flat-panel detector technology.

**Illustrative Case**

**History and Examination.** This 54-year-old woman experienced an acute pancranial headache with associated nausea and vomiting 7 days prior to neurosurgical presentation. An initial unenhanced CT study performed in the emergency department showed a focal area of increased density in the right cerebellopontine angle cistern (Fig. 1A). Cerebrospinal fluid obtained from a lumbar puncture was clear, without evidence of xanthochromia. A catheter angiogram revealed a Type I dAVF in the region of the petrous ridge supplied predominantly by petrosal branches of the MMA (Fig. 1B).
Because of the very small size of the multiple feeding vessels, surgical exploration was favored over endovascular therapy. As the exact site of the fistula, especially with respect to the tentorial attachment, was crucial in choosing the best surgical approach, we decided to use the cone-beam volume CT capability of the angiography suite (DynaCT, Siemens Medical Solutions) after selective microcatheterization of the MMA.

**Imaging Technique.** Based on the previously obtained catheter angiogram, the fistula was predominantly supplied by the petrosal branches of the MMA. A Renegade Hi-Flo microcatheter (Boston Scientific) with an inner diameter of 0.027 in and a burst pressure rating of 800 psi was used to selectively catheterize the MMA. Test injections were performed at various injection rates (1–1.3 ml/second) to determine the most acceptable flow rate providing adequate opacification of the feeding vessels and draining vein. A biplane flat-panel detector angiography unit (AXIOM Artis FD Biplane Angiosuite, Siemens Medical Solutions) was used for volume acquisition with the following parameters: 20-second rotations at 0.4° increments and a 512 × 512–matrix at no magnification for a total angle of 217°. Undiluted contrast was injected through the microcatheter at a rate of 1 ml/second for a total duration of 22 seconds during the rotational acquisition, with a 2-second x-ray delay. Images were reconstructed on a commercially available workstation (Leonardo, Siemens Medical Solutions). The time from acquisition to 3D rendering was ~4 minutes, and interactive postprocessing took 10 minutes.

Final reconstructed images were viewed in an intermediate window level to best visualize the bone and the contrast distinctly and to minimize the cone-beam artifact around the edges of the contrast-filled vessels. The images were reconstructed in the coronal and sagittal planes (Fig. 2A and B), and thick multiplanar reformatted images were also obtained in an oblique coronal plane (Fig. 2C). All images had an acceptable quality. The images visualized a dAVF below the tentorial attachment, warranting a suboccipital surgical pathway.

**Operation.** During surgery multiple tiny feeding vessels were noted to supply the fistula below the tentorium, with drainage into the petrosal vein. The vessels were co-
agulated and divided, resulting in a change in the color of the petrosal vein from red to blue.

Postoperative Course. The postoperative control angiography demonstrated complete obliteration of the dAVF (Fig. IC). The patient’s recovery was unremarkable with no neurological deficit, and she resumed all former activities by the 3-month follow-up.

Discussion

Multidetector CT angiography has been used in the evaluation of patients with intracranial dAVFs. In cases with tiny feeding vessels, however, the intravenous administration of contrast may lead to nonopacification and indeterminate localization of the fistula. Advances in flat-panel detector technology have allowed cone-beam volume CT in the angiographic suite with improved imaging characteristics including enhanced spatial resolution, less image distortion, and higher efficiency compared with non–flat-panel acquisitions. There have been other reports of rotational digital subtraction angiography techniques following selective microcatheterization to enhance understanding of arteriovenous malformation vascular anatomy. We opted to combine the use of a microcatheter-directed injection to better visualize the feeding vessels, fistula, and draining veins, free of overlapping uninvolved vessels. The volume acquisition of DynaCT provided information on the relationship between the fistula and adjacent bone and soft tissue structures, which allowed us to select the suboccipital surgical approach to the fistula.

Conclusions

We were successful in determining the precise site of the dAVF, which was crucial in deciding on the optimal surgical approach. Although such a procedure is not routine, selective microcatheter use with cone-beam volume CT acquisition may be useful in patients in whom anatomical localization has not been possible using conventional techniques.

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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