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Technique

Use of frameless stereotactic computed tomography venography for intraoperative localization of dural arterial venous fistulas: case report

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Abstract

Background: The following technical case report illustrates the use of multiple imaging modalities including 3D CTV with frameless stereotactic navigation for intraoperative planning and localization for surgical obliteration of a cranial dAVF with leptomeningeal drainage.

Case Description: This 65-year-old man presented with an asymptomatic occipital dAVF with leptomeningeal drainage. In addition to cerebral angiography, a CTV with 3D reconstruction was performed, which provided excellent visualization of the dAVF and clarified its pattern of drainage. The dAVF was supplied by a middle meningeal artery branch that drained into an occipital cortical vein, which then retrograde filled the vein of Labbé. Frameless stereotactic navigation with the imported CTV images was used to plan the craniotomy and to localize the leptomeningeal draining vein and vein of Labbé. The draining vein of the fistula was successfully ligated and divided while preserving flow in the vein of Labbé. Postoperative angiogram demonstrated complete obliteration of the dAVF.

Conclusion: Integration of a 3D reconstructed CTV with conventional angiographic information optimized our surgical understanding of the spatial anatomy of this dAVF and its pattern of venous drainage. Applying the CTV with frameless stereotaxy allowed for safe obliteration of the dAVF while preserving the vein of Labbé.

Keywords: Dural arteriovenous fistula; Frameless stereotactic navigation; Computed tomography venogram

1. Introduction

For the neurosurgeon, frameless stereotactic navigation has become an essential operative tool in resecting intracranial tumors [1,4]. However, use in cerebrovascular surgery has been less common and confined to unusual aneurysms and some AVMs [3,5-9]. Reports of the use of frameless stereotactic navigation for dural arterial venous fistulas (dAVFs) are even less common. For some dAVFs, it can be difficult to transpose conventional 2-dimensional cerebral arteriography into a cognitive surgical understanding of adjacent critical structures. Recent advances in CT arteriography and venography have improved the covisualization of vascular and cranial structures [2]. These computer images can be rotated in 3 dimensions to optimize the visualization of critical structures and can assist in the design of craniotomies. Yet, even with the use of these images, there remains an element of cognitive translation in the operative room. By combining 3D CT angiography with frameless stereotactic navigation, the precise location of vascular structures can easily be translated from preoperative

Abbreviations: AVM, arteriovenous malformation; CT, computed tomography; CTV, computed tomography venography; 3D, 3-dimensional; dAVF, dural arteriovenous fistula; 3D CTV, 3-dimensional computed tomography venography; DV, draining vein; IV, intravenous; TS, transverse sinus.

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plans to intraoperative locations. This can improve localization of aberrant vascular structures and potentially prevent surgical complications.

In this report, we describe a method using frameless stereotactic navigation in conjunction with 3D CTV for the surgical treatment of a cranial dAVF with leptomeningeal drainage. The 3D CTV clarified the pattern of drainage of the dAVF. Combining this with frameless stereotactic navigation allowed for optimal intraoperative planning, accurate localization, and safe obliteration of the dAVF while preserving the vein of Labbé and TS.

2. Case report

This 65-year-old right-handed white man who developed symptoms of amaurosis fugax had a workup that included a 4-vessel cerebral angiogram that demonstrated greater than 90% carotid stenosis. He subsequently underwent successful balloon-assisted angioplasty and placement of a carotid stent. The angiogram also demonstrated a left occipital dAVF with leptomeningeal drainage. The dAVF was supplied primarily by a hypertrophied left middle meningeal artery branch, which drained into an occipital cortical vein just above the TS. The cortical vein then drained into the vein of Labbé with retrograde flow and anterograde flow down the TS (Fig. 1).

Although the patient was asymptomatic, we recommended treatment of the dAVF because the retrograde flow into the vein of Labbé presented a high risk of hemorrhage for the patient [2]. A transvenous route to embolize the fistula was contemplated; however, because of the tortuosity of the vein of Labbé at the transverse-sigmoid junction, we felt that the venous outflow of the fistula would be difficult to access and obliterate safely without occluding the vein of Labbé. Therefore, a direct surgical obliteration of the leptomeningeal draining vein with preservation of the vein of Labbé was planned.

On the day of surgery, fiducial markers were placed on the patient's scalp and a frameless stereotactic CT with IV contrast was obtained using a protocol designed for CT venography. Three-dimensional reconstructions of the CT venogram were obtained preoperatively using TeraRecon software v1.5.2 (TeraRecon, San Mateo, Calif). These images provided clear visualization of the spatial anatomy of the dAVF and its pattern of venous drainage (Fig. 2). The location to ligate the venous outflow (occipital cortical vein) at the point of the dural fistula was selected preoperatively based on these images and in combination with the

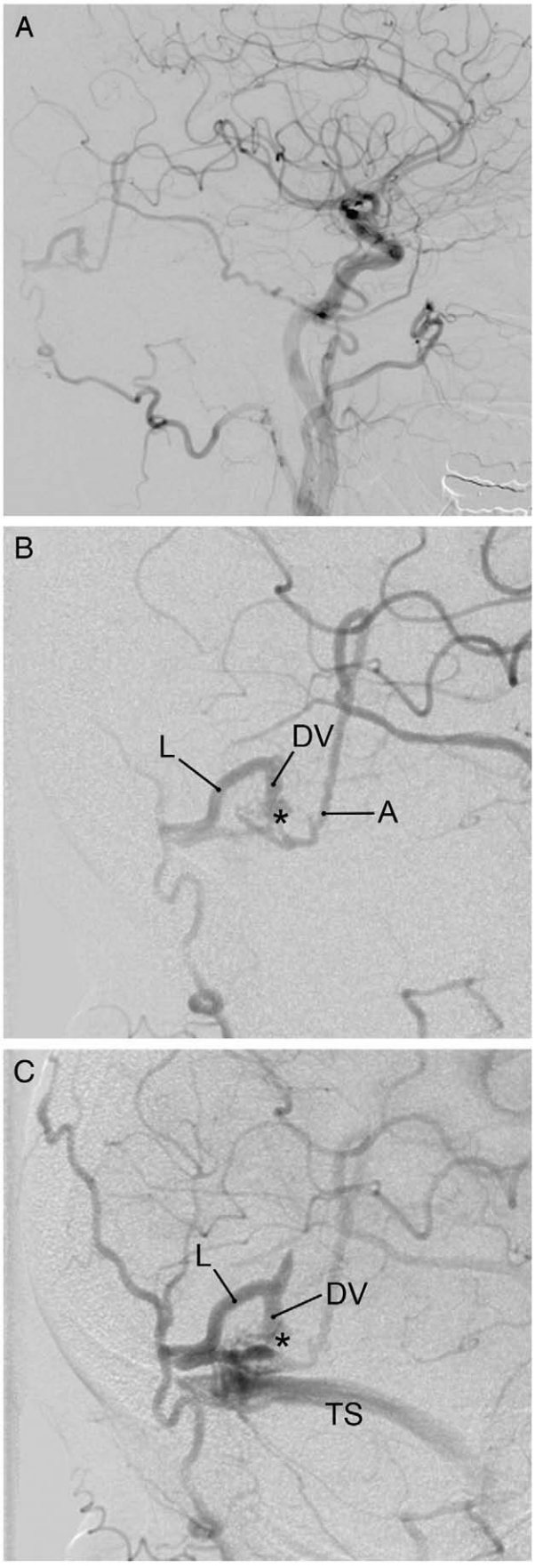

Fig. 1. Lateral common carotid digital subtraction angiogram (A: mid-arterial phase; B: mid-arterial phase zoomed in view; C: late arterial phase zoomed in view) shows a dAVF (asterisk), supplied by a branch from the middle meningeal artery (A). The venous outflow of the dAVF drains through a cortical DV which then flows into the vein of Labbé with some retrograde filling. There is also anterograde flow down the TS. L indicates vein of Labbé.