Cerebral dural arteriovenous fistulas and aneurysms

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Object. The association of aneurysms and cerebral arteriovenous malformations is well established in the literature. Aside from a small number of case reports and small patient series, this association has not been well explored with cerebral dural arteriovenous fistulas (DAVFs). This study was designed to elucidate this relationship in the authors’ own patient cohort with DAVFs.

Methods. Cerebral angiograms of 56 patients with 70 DAVFs were reviewed for the presence of cerebral aneurysms. Background patient demographics, mode of presentation, and DAVF and aneurysm angiographic characteristics were noted.

Results. Twelve patients (21%) had aneurysms in addition to their DAVF. Three patients had multiple aneurysms. Of a total of 15 aneurysms, 5 (33%) occurred on DAVF feeding arteries and 10 (67%) were in remote locations. These patients more commonly presented with hemorrhage (58% vs 20% for those without aneurysms). Aneurysms were associated with DAVFs in any location (feeding artery or remote), but flow-related feeding artery aneurysms were more likely to be associated with Borden Type III DAVFs.

Conclusions. Twenty-one percent of patients with cerebral DAVFs also had aneurysms in this patient cohort. It is thus prudent to perform 6-vessel digital subtraction angiography on patients with DAVFs to rule out potential feeding artery and remote aneurysms. This association may be explained by flow-related phenomena, the initial inciting event leading to DAVF formation, as well as a potential genetic component or predisposition to develop these lesions. (http://thejns.org/doi/abs/10.3171/2011.12.FOCUS11336)

Key words • dural arteriovenous fistula • aneurysm • epidemiology

The association of cerebral AVMs and aneurysms is well established in the literature.\textsuperscript{2,4,8} Recent natural history data have clearly suggested the significance of this association, as AVMs with associated aneurysms are more likely to have hemorrhagic presentation\textsuperscript{9,11} as well as hemorrhage on follow-up.\textsuperscript{2,4} In contrast, the frequency and significance of aneurysms associated with cerebral DAVFs is infrequently addressed, and is limited to case reports and small patient series.\textsuperscript{3,5–7,10} In this report, we review our own patient cohort of cerebral DAVFs and evaluate the association of aneurysms with cerebral DAVFs.

Methods

Fifty-six patients with 70 DAVFs were treated by the neurosurgical or interventional neuroradiology team at Brigham and Women’s Hospital from 2004 to 2011. The cerebral DAVF diagnosis was angiographically confirmed in all patients. In addition to background epidemiological data, we reviewed each angiogram and noted the presence of remote and/or feeding artery aneurysms in association with the DAVF.

Results

Background demographic and treatment information for the entire patient cohort as well as those DAVFs associated with aneurysms is provided in Table 1. Of 56 patients with cerebral DAVFs, 12 had aneurysms (21%; Tables 1 and 2). Patients with DAVFs and associated aneurysms were slightly younger (mean age 49.8 vs 58 years, respectively), with a slightly stronger male predilection (2.0 male-to-female ratio vs 1.2, respectively). Patients with aneurysms had DAVFs in a variety of locations without a clear predisposition for 1 particular location. Approximately two-thirds of the DAVFs in each cohort had cortical venous drainage (Borden Type II or III).\textsuperscript{1} Notably, patients with DAVFs and aneurysms were more likely to have their DAVF treated surgically (75% vs 34%, respectively), and 58% of patients with DAVFs and aneurysms presented with hemorrhage compared with only 20% of patients without aneurysms (Tables 1 and 3).
Of a total of 15 aneurysms, 5 (33%) were located on DA VF feeding arteries (Table 2). Thus, of 70 DA VFS overall, 5 (7%) had feeding artery aneurysms. Four of these aneurysms developed spontaneously and were all associated with Borden Type III fistulas. One aneurysm was an obvious pseudoaneurysm that developed adjacent to a skull base fracture, likely simultaneously with its associated Type I jugular DA VF (Fig. 1). This aneurysm developed on the PMA, whereas the other 4 aneurysms were located on the AICA (2 cases), MMA (1 case), and a distal middle cerebral artery branch (1 case). Two of 5 patients with feeding artery aneurysms presented with hemorrhage (Table 3). In 1 case, subarachnoid hemorrhage was attributed to an AICA feeding artery aneurysm, confirmed intraoperatively (Fig. 2). In another case, a large intraparenchymal hemorrhage with intraventricular extension was attributed to a cortical DA VF as its feeding artery aneurysm was located extradurally on the MMA. In these 2 cases, the DA VFs were treated surgically in an expedient fashion. Two of 3 cases without hemorrhagic presentation were also treated surgically. In 1 case SRS was used, with obliteration of both the DA VF and feeding artery aneurysm observed on the patient’s 2-year follow-up angiogram.

Eight patients were found to have a total of 10 remote aneurysms. Thus, 8 (14%) of 56 patients with DA VFs also had remote aneurysms. Five of these patients presented...
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Fig. 1. Images obtained in a 15-year-old male without significant medical history who presented after a motor vehicle accident. Initial noncontrast axial CT revealed a traumatic subarachnoid hemorrhage (A) as well as a left occipital bone fracture (B, arrow). Digital subtraction angiography was performed 1 week after the incident to rule out vasospasm. Although no vasospasm was noted, a DAVF fed by the posterior meningeal artery with an associated feeding artery pseudoaneurysm (C, arrow) was observed on the left vertebral artery injection.

Fig. 2. Anteroposterior vertebral artery angiogram obtained in a 22-year-old man who presented with a severe headache and mild confusion as a result of a subarachnoid hemorrhage (Hunt and Hess Grade III). The angiogram demonstrates a tentorial DAVF with an AICA feeding artery aneurysm (arrow).

Fig. 3. Digital subtraction angiogram obtained in a 53-year-old woman without a significant medical history who presented with obtundation due to subarachnoid hemorrhage (Hunt and Hess Grade V) from a ruptured basilar apex aneurysm. The aneurysm underwent coil embolization (arrow) and the patient made a remarkable recovery. An anterior fossa DAVF (asterisk) with an ethmoidal feeder (arrowhead) was also noted.

Discussion

The association of aneurysms and cerebral AVMs is well established in the literature. Numerous natural history studies have demonstrated this relationship for approximately 20% of AVMs, with half of associated aneurysms occurring on feeding arteries, one-fourth nidal, and one-fourth remote. In our cohort of 56 patients with 70 DAVFs, we found that 21% of patients had aneurysms as well, approximately one-third on feeding arteries and two-thirds in remote locations. We advocate performing 6-vessel digital subtraction angiography on patients with DAVFs to rule out potential feeding artery and remote aneurysms.

Although DAVFs are considered to be acquired lesions, the finding that 21% of patients have concomitant aneurysms, two-thirds of which are remote (14% of patients overall), suggests a potential genetic component.
or predisposition to developing these lesions as well. In addition to flow-related feeding artery aneurysms, pseudoaneurysms due to trauma may also develop on feeding arteries (Fig. 1). The acquired pathogenesis of these pseudoaneurysms likely occurs concomitant with the development of the DAVF itself. One prior study also found that 13% of patients with DAVFs have remote aneurysms. The authors noted that all 6 patients possessing DAVFs and aneurysms were male, 3 of whom possessed anterior cranial fossa DAVFs while the other 3 had convexity DAVFs. In reviewing the literature, the study reinforced a potential predilection for anterior cranial fossa DAVFs to be associated with remote aneurysms. Although we also demonstrate a male predilection among patients with DAVFs and aneurysms, our cases included DAVFs in a wide variety of locations without a clear predisposition for anterior fossa lesions, although we only had 5 cases of anterior fossa DAVFs in our entire cohort.

We demonstrated that feeding artery aneurysms to DAVFs may be more commonly noted among those with direct cortical venous drainage. This relationship underscores the difficulty of assessing the natural history of such lesions, as most DAVFs with direct cortical venous drainage alone warrant treatment, precluding longitudinal observation of these lesions. Nevertheless, our retrospective analysis demonstrating more common hemorrhagic presentation among patients with DAVFs and aneurysms does reinforce an intuitively more malignant natural history.

**Conclusions**

In this study we demonstrated that approximately 21% of patients with DAVFs also have aneurysms, one-third of which occur on feeding arteries and the remainder in a remote location. Feeding artery aneurysms may develop due to flow-related phenomena or due to the initial inciting event leading to DAVF formation such as trauma. Patients with DAVFs and aneurysms were more likely to present with hemorrhage, were slightly younger, and had a stronger male predilection than those without aneurysms.

**Disclosure**

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

Author contributions to the study and manuscript preparation include the following. Conception and design: all authors. Acquisition of data: Gross, Ropper. Analysis and interpretation of data: all authors. Drafting the article: Gross, Ropper. Critically revising the article: all authors. Reviewed submitted version of manuscript: Du. Approved the final version of the manuscript on behalf of all authors: Du. Study supervision: Du.

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