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HOW I DO IT - VASCULAR NEUROSURGERY - ARTERIOVENOUS MALFORMATION

Cervical spinal arteriovenous fistula with ventral perimedullary venous drainage

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Abstract

Background Spinal arteriovenous fistula (AVF) represents the most common type of spinal vascular lesions and is often associated with progressive neurological dysfunction.

Method Here, we present a unique case of a spinal vascular malformation that does not fit the traditional classification schemes. The patient presented with progressive neurologic deficits resembling partial Brown-Sequard syndrome and was subsequently found to have a lesion resembling type I spinal AVF. However, this intradural fistula drained into the ventral venous plexus rather than dorsal.

Conclusion Recognizing these rare anatomical variants is paramount in achieving successful obliteration and improved functional outcome for patients.

Keywords Spinal fistula · Arteriovenous fistula · Venous plexus · Microsurgery

Abbreviations

AVF	Arteriovenous fistula
CT	Computed tomography
AVM	Arteriovenous malformation
ASA	Anterior spinal artery
MRI	Magnetic resonance imaging
ABF	American British French

This case was reported in the April 2013 issue of *Neurochirurgie* and a reclassification system was proposed to subdivide type I into dorsal and ventral extramedullary lesions [1].

This article is part of the Topical Collection on *Vascular Neurosurgery - Arteriovenous malformation*

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Relevant surgical anatomy

Initial investigation with CT-angiography and MRI revealed a vascular lesion ventral to the C6 spinal cord level (Figs. 1 and 2). Further preoperative characterization of the lesion using spinal angiography confirmed the presence of an arteriovenous fistula, which was confined within the dural root sleeve and supplied by a radiculomeningeal artery with no anterior spinal artery (ASA) involvement (Fig. 3). Given this latter characteristic, the lesion most resembled a type I AVM as an intradural fistula fed by a radiculomeningeal branch of the right vertebral artery. However, it consisted of a drainage into the ventral venous plexus rather than dorsal (Fig. 4). Traditionally, the presence of this ventral drainage would have classified the fistula as type IV AVM, but this was a notable exception since there was no involvement of the spinal artery (Table 1) [3, 4]. Prompt recognition of this unique vascular anatomy was important in deciding the best treatment approach for this patient.

Description of technique

Because the lesion was located within the dural root sleeve, a posterior approach with ipsilateral C5–C7 laminectomy, partial C5–C6 facetectomy, and a durotomy was performed to expose

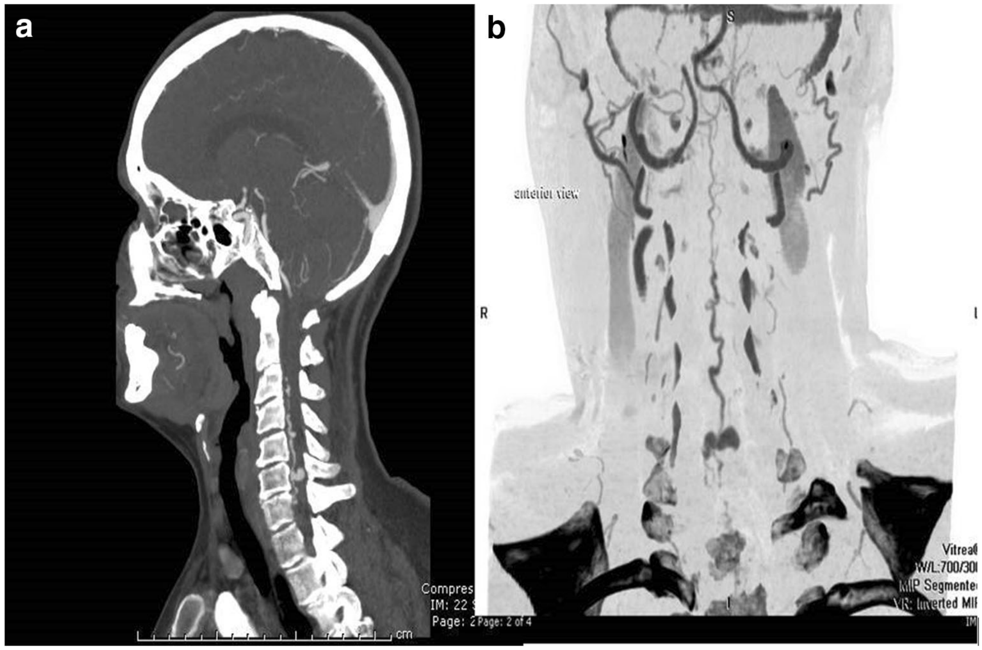

Fig. 1 Sagittal (**a**) and coronal (**b**) reconstructions of admission CT-Angiography displaying dilated vascular structure ventral to the spinal cord with an intranidal aneurysm versus varix

the C7 nerve root. Once the arterialized vein was identified ventral to the spinal cord, Doppler ultrasound assisted in confirming the arterialized flow. A temporary clip was initially placed and the Doppler ultrasound showed absence of arterial flow distal to the clip, again verifying the fistula. After no changes in neuromonitoring were observed with the clip in place for 20 min, a permanent clip was used to occlude the fistula. On postoperative day 1, CT-angiography was obtained demonstrating complete obliteration (Fig. 5). At 6-month follow-up, the patient showed signs of functional recovery.

Indication

The closer resemblance of the fistula to type I AVM argued for a simpler management with surgical disconnection [3, 7]. For intradural AVFs, microsurgical technique offers a more reliable visualization and direct access to the fistula point compared to an endovascular approach, and successful obliteration can be achieved in 94–100% of cases. In comparison, endovascular obliteration is associated with higher risks of treatment failure and recurrence, as well as major complications afterwards [1,

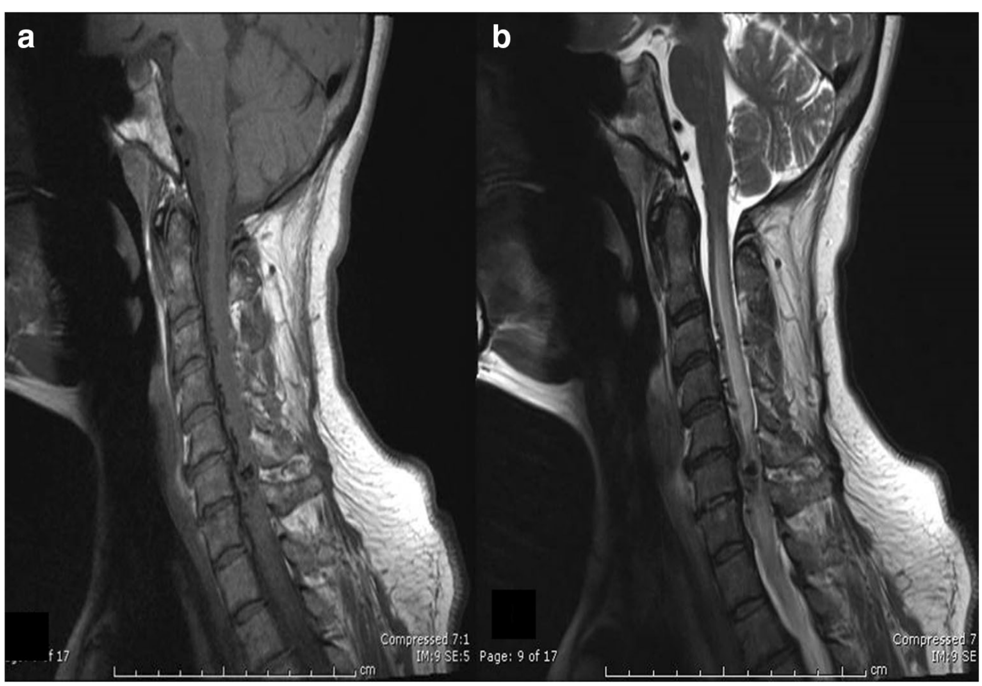

Fig. 2 Sagittal projections of admission MRI. (**a**) T1-weighted image displaying abnormal flow voids ventral to the spinal cord. (**b**) T2-weighted image displaying ventral flow voids and signal change in the spinal cord

Fig. 3 Diagnostic cerebral angiogram. Right vertebral artery injection revealing a dominant feeding artery to the AVF. A radicular artery contributing to the ASA (white arrow) is seen one cervical level above the fistula

4, 5, 8, 9]. As this and previously described cases have demonstrated, a posterior cervical approach with lateral extension allows for adequate exposure and access to lesions located on the ventral/ventrolateral spinal cord [2, 6, 8].

Limitations

Surgical treatment is not without risk, including perioperative blood loss, pseudomeningocele, spinal instability, or new or worsened postoperative neurological deficits. In contrast, although endovascular embolization might confer better short-term outcomes, it is associated with higher recanalization rates and sufficient data on its efficacy is still lacking [3, 4, 7, 8].

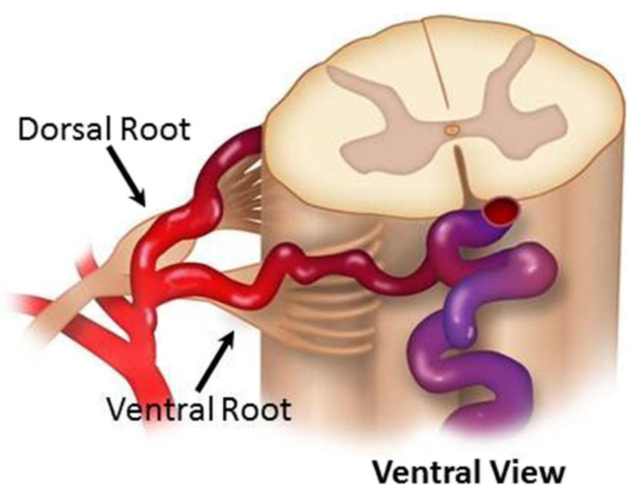

Fig. 4 Spinal AVM consistent with a dural AVF with ventral venous drainage and no involvement of ASA

How to avoid complications

During the procedure, care should be taken to preserve the branches of ASA when occluding the fistula. In addition, there is a possibility of cerebrospinal fluid leak due to the interruption of the dural sleeve, which can be controlled, for instance, using fat graft over the resected area. Each of these intraoperative measures helps to ensure the success of the procedure and minimize the risk of complications [4, 9].

Perioperative considerations

Spinal angiography remains the gold standard for diagnosis of an AVF, which should be obtained preoperatively to identify and accurately delineate its complex vascular anatomy. Postoperative spinal angiogram is important in confirming complete occlusion of the fistula [4, 5]. At subsequent follow-ups, MRI can be useful in assessing signs of recovery, generally seen within 6 months of treatment [9].

Information for patients

It is important for patients to be aware that despite the high rates of complete obliteration of the AVF with surgical intervention, functional outcomes are more variable, in particular, depending on the severity of the initial neurologic impairment. Nevertheless, improved long-term outcomes can be achieved with either stabilization of preoperative symptoms or recovery of previous neurologic dysfunction [4, 8].

Summary

- Dural arteriovenous fistulas represent the vast majority of cases of spinal vascular lesions.
- Spinal AVFs form abnormal communications between the arterial and venous systems and are associated with severe neurological dysfunction.
- The American/British/French and Spetzler classification systems are widely accepted to characterize spinal AVMs.
- Anatomic variants of spinal AV fistulas still exist, adding to the complexity in identifying and managing this condition.

Table 1 Spetzler [5] classification of spinal vascular malformations with corresponding ABF classification based on description of spinal AVM in parentheses

Spetzler classification	Type	Description
Arteriovenous fistulas	Extradural	Abnormal connection between branch of radicular artery and epidural venous plexus
	Intradural	
	Dorsal (type I AVM)	Radicular feeding artery drains into the dorsal venous plexus at the dural nerve root sleeve.
	Ventral (type IV AVM)	Anterior spinal artery drains into ventral venous plexus at the dural nerve root sleeve. Further subclassified A, B, and C, depending on the feeding artery.
Arteriovenous malformations	Extradural-intradural (type III AVM)	Juvenile or metameric AVM. Located along a discrete somite level, involving the skin, muscle, bone, spinal nerves, and spinal cord.
	Intradural	
	Intramedullary (type II AVM)	Located entirely within the spinal cord parenchyma and fed by branches of the anterior and posterior spinal arteries. Subclassified into compact or diffuse.
	Conus medullaris	Lesions that are fed by the anterior and posterior spinal arteries and radicular artery at the level of the conus medullaris or cauda equina.

ABF American British French, *AVM* arteriovenous malformation

- Magnetic resonance imaging or angiography and computed tomography angiography are initial studies that can help in identifying the lesion.
- Spinal angiography remains to be the diagnostic test of choice for spinal vascular lesions.
- For spinal AVFs, surgical repair allows for better obliteration rates than endovascular treatment.
- The success of surgical intervention depends on the location and precise anatomy of the lesion, surgeon's expertise, and preoperative neurological status of the patient.
- Prompt identification and recognition of the anatomic anomalies of spinal AVFs impact the surgical technique and clinical outcome for patients.

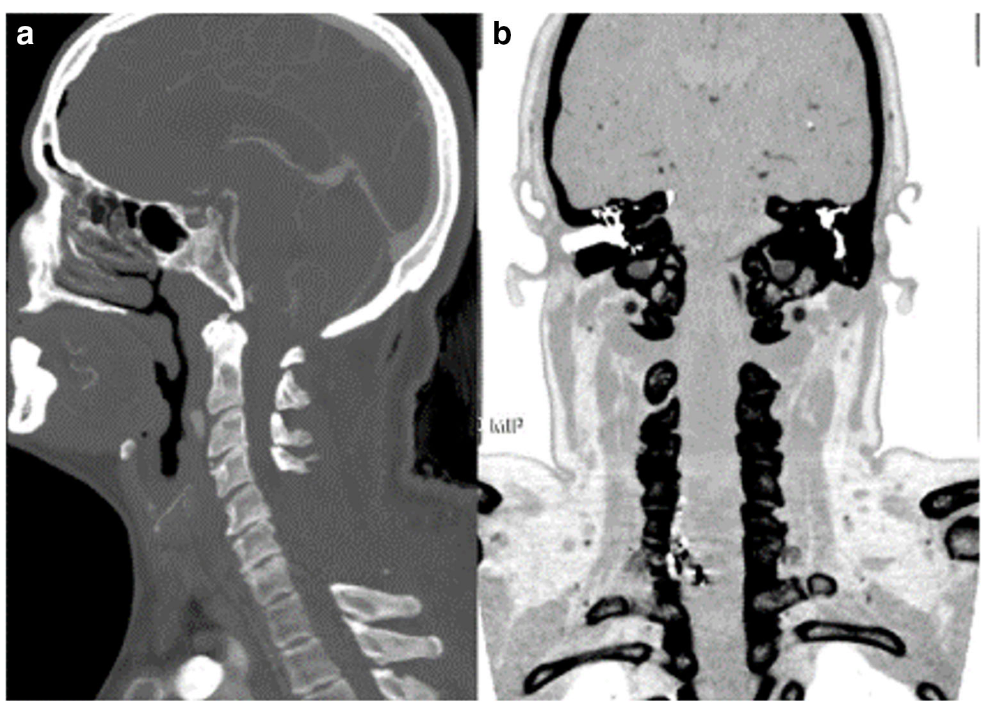

Fig. 5 Postoperative sagittal (**a**) and coronal (**b**) CT-angiography showing no further filling of the fistula

- Modification to the traditional classification scheme should be considered given that a thorough understanding of the anatomy of spinal vascular lesions is paramount in determining approach to treatment.

Patient consent was obtained for use of patient's clinical information, including patient consent to submission of the case report.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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