Multiphase CT Angiography for Evaluation and Diagnosis of Complex Spinal Dural Arteriovenous Fistula

Sudharsan Srinivasan, Zachary M. Wilseck, Joseph R. Linzey, Neeraj Chaudhary, Ashok Srinivasan, Aditya S. Pandey

Keywords: Multiphase computed tomography angiography, Arteriovenous fistula, Spinal vascular malformation, Spinal dural AVF

doi:10.1017/cjn.2020.94 Can J Neurol Sci. 2020; 47: 681–682

Spinal dural arteriovenous fistula (AVF) accounts for the majority of spinal vascular malformations (70%) and can lead to venous congestion with neurological injury.[1,2] Spinal angiography is the gold standard for diagnosis. We present a case of tortuous, ectatic aorta with significant atherosclerosis preventing completion of successful spinal angiogram. Utilization of delayed multiphase computed tomography angiography (CTA) in patients with difficult to access vasculature provides a novel diagnostic and pre-therapeutic planning test for spinal dural AVF.

The patient was an 85-year-old man with a 3-month history of bilateral lower extremity weakness and gait instability and found to have holocord edema on his thoracic MRI concerning for spinal dural AVF. On initial presentation, EMG demonstrated evidence of a distal, symmetric polyneuropathy in the bilateral lower extremities and a left-sided common peroneal neuropathy at the fibular head with axonal denervation. Two weeks later, the patient was admitted for frequent falls during exertion. He was also noted to have increased urinary frequency, decreased lower extremity sensation, and urinary incontinence. Medical history was pertinent for left-leg deep venous thromboembolism, hypertension, and hyperlipidemia.

MRI of his thoracic spine showed intramedullary T2 hyperintense signal throughout the thoracic spinal cord and adjacent dilated perimedullary veins. This finding was initially concerning for dural AVF. The patient underwent incomplete spinal angiography, which failed to identify a fistulous connection. Follow-up, high-resolution T2 FIESTA (Fast Imaging Employing Steady-state Acquisition) MRI of the spine redemonstrated the dilated perimedullary vascularity on the posterior surface of the spinal cord and holocord edema; however, the fistulous connection was still not apparent. A second spinal angiography focused on the lower lumbar, internal iliac, and subclavian arterial branches without identification of a spinal vascular abnormality. Finally, multiphase CTA was conducted, focused on the thoracic level. The second phase was delayed 30 seconds after the first phase to allow for better opacification of the segmental arterial system (Figures 1 and 2). This led to clear visualization of the spinal dural AVF emanating from a radiculomedullary branch of the left T6 segmental artery (Figure 3). Subsequent thoracic laminectomy for AVF ligation was performed without complications.

Multiphase, rapid dynamic CTA assists in overcoming some resolution limitations of non-invasive imaging, mainly high spatial resolution, hemodynamic visualization of the spinal vascular malformation, and broader survey of fistulous connection possibilities.[3] The accuracy of multidetector CTA for determining level of fistulous connection has previously been compared and validated in other image-acquisition techniques, such as digital subtraction angiography (DSA).[4] DSA provides a gold standard for recognizing type, level, and site of spinal vascular malformations; however, it may require general anesthesia and has risks inherently associated with invasive endovascular procedures.[5] Multiphase CTA of the spine offers a non-invasive method of identifying the fistulous site and planning treatment. While in the past, it has been concluded that time-resolved

Figure 1: *Axial CTA with 30-second delayed acquisition demonstrates improved opacification of the segmental artery (black arrows) arising from the descending thoracic aorta feeding the spinal dural AVF.*

From the School of Medicine, University of Michigan, Ann Arbor, MI, USA (SS); Department of Radiology, University of Michigan, Ann Arbor, MI, USA (ZMW, NC, AS); and Department of Neurosurgery, University of Michigan, Ann Arbor, MI, USA (JRL, ASP)

Received February 1, 2020. Date of Acceptance May 7, 2020.

Correspondence to: Aditya S. Pandey, Department of Neurosurgery, University of Michigan, 1500 E. Medical Center Drive, 3552 Taubman Center, Ann Arbor, MI 48109-5338, USA. Email: adityap@med.umich.edu

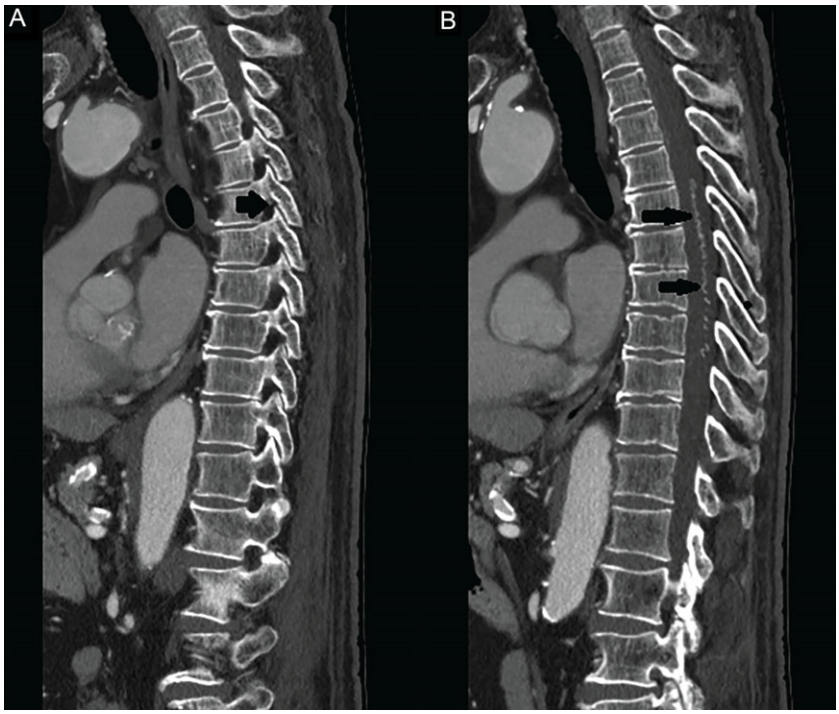

Figure 2: *Sagittal delayed acquisition CTAs demonstrate (A) an enlarged segmental artery in the T5–6 intervertebral foramen (black arrow) and (B) the draining vein of the known spinal dural AVF (arrows).*

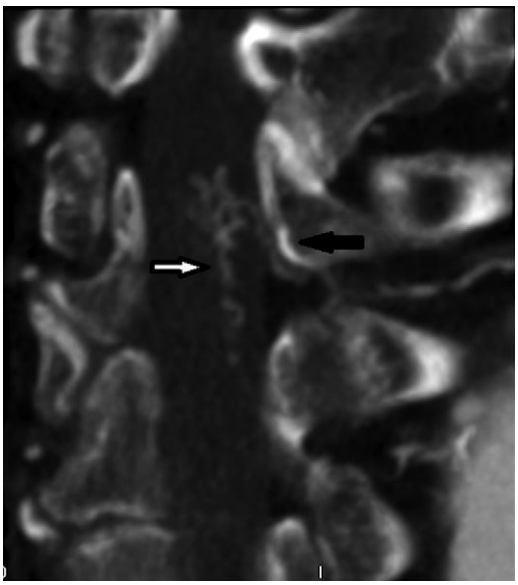

Figure 3: *Three-dimensional reconstruction of the delayed acquisition CTA demonstrates the feeding segmental artery (black arrow) and the draining vein (white arrow) of the spinal dural AVF.*

imaging could perhaps be utilized as a screening tool for spinal vascular malformations; this case exemplifies circumstances in which multiphase CTA could provide greater screening benefit than catheter-based spinal angiography.[6]

Conflicts of Interest

None.

Statement of Authorship

AS, ASP, and NC contributed to conception and design. All authors were involved in data collection and interpretation, article revision, and review of the submitted version. SS, ZMW, JRL, and ASP drafted the article, and ASP supervised the work and approved the final manuscript on behalf of all authors.

References

1. Eddleman CS, Jeong H, Cashen TA, et al. Advanced noninvasive imaging of spinal vascular malformations. Neurosurg Focus 2009;26:E9.
2. Merland JJ, Riche MC, Chiras J. Intraspinal extramedullary arteriovenous fistulae draining into the medullary veins. J Neuroradiol 1980;7:271–320.
3. Sharma AK, Westesson PL. Preoperative evaluation of spinal vascular malformation by MR angiography: how reliable is the technique: case report and review of literature. Clin Neurol Neurosurg 2008; 110:521–24.
4. Schaat TJ, Salzman KL, Stevens EA. Sacral origin of a spinal dural arteriovenous fistula: case report and review. Spine (Phila Pa 1976) 2002;27:893–97.
5. Amarouche M, Hart JL, Siddiqui A, Hampton T, Walsh DC. Time-Resolved contrast-enhanced MR angiography of spinal vascular malformations. AJNR Am J Neuroradiol 2015;36:417–22.
6. Ali S, Cashen TA, Carroll TJ, et al. Time-Resolved spinal MR angiography: initial clinical experience in the evaluation of spinal arteriovenous shunts. AJNR Am J Neuroradiol 2007;28: 1806–10.

https://doi.org/10.1017/cjn.2020.94 Published online by Cambridge University Press