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*Case Report*

# Successful surgical strategy for ventral thoracic spinal perimedullary spinal arteriovenous fistulas: Case report

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## ABSTRACT

**Background:** Spinal arteriovenous fistulas (AVFs) are vascular lesions that often pose significant surgical challenges. This is particularly true for those located close to the anterior spinal artery. Here, we analyzed the surgical options for treating an anterior perimedullary AVF (pAVFs).

**Case Description:** A 66-year-old male with the right lower extremity weakness was diagnosed with a spinal dural AVF at the L1 level. It was initially treated with open surgery followed by CyberKnife radiosurgery at another institution. Five years later, he presented with a persistent pAVF fistula now involving the T11 level; the major feeder originated on the left at the T7–T8 level (e.g., involving a left-sided "duplicated" anterior spinal artery). Utilizing a three-dimensional (3D) computer tomography (CT) guided approach; he underwent a left-sided posterolateral T10–T12 laminectomy, sufficient to allow for 30–40° of anterior spinal cord rotation. This was performed under neurophysiological monitoring without any significant changes. Surgery included indocyanine green video angiography, temporary feeder clipping, and complete occlusion of the AVF, followed by complete clipping/resection as confirmed on postoperative magnetic resonance imaging.

**Conclusion:** Utilizing a 3D CT image, a ventral pulmonary arteriovenous malformation was excised utilizing a left-sided posterolateral approach allowing for 30–40° of cord rotation.

**Keywords:** Expert computer tomography, Indocyanine green, Perimedullary arteriovenous fistulas, Posterolateral surgical approach, Three-dimensional image

## INTRODUCTION

Spinal perimedullary arteriovenous fistulas (pAVFs) are relatively rare lesions (incidence of 8–19%) that commonly involve the conus medullaris or cauda equina.[1,3,5,2] Type IV pAVF is a challenging vascular lesion. That must be adequately studied angiographically to plan for appropriate resection. These lesions are located on the ventral spinal cord surface and are typically supplied by the anterior spinal artery; they usually drain directly into enlarged venous outflow channels of varying size.[1] Together these factors make treatment challenging. Here, we present a patient with a ventral pAVF originally located at L1 and later at the T11 level that was successfully secondarily treated with microsurgical occlusion/resection.

## CASE DESCRIPTION

A 66-year-old male patient presented with the right lower extremity weakness. On magnetic resonance (MR) and 3D-CT, he has had a spinal dural AVF at the L1 level. Six months after onset of the symptoms, a left L1 feeder was clipped. However, postoperatively, the patient's clinical condition worsened due to a cerebrospinal fluid leak that required secondary corrective surgery (e.g., 1 month after the first surgery). Notably, the routine follow-up angiogram 6 months later, demonstrated a persistent pAVF.

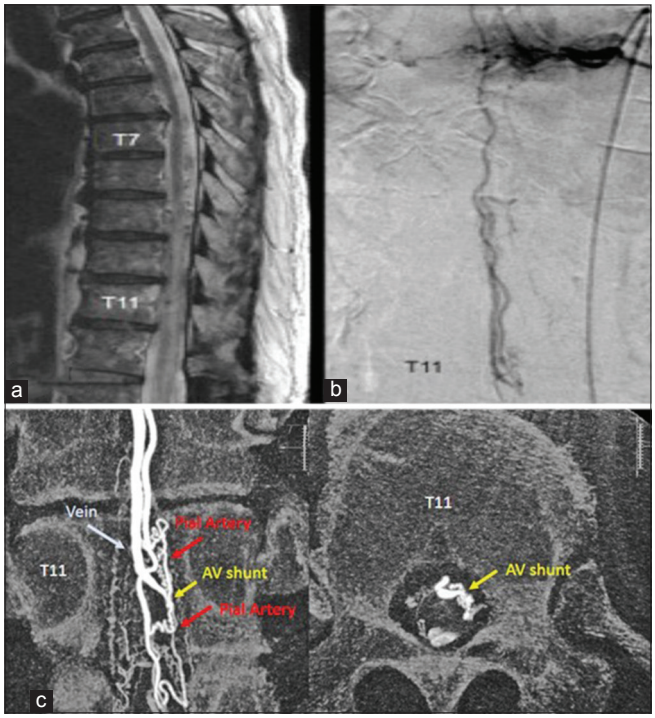


**Figure 1:** (a) Preoperative sagittal T2-weighted magnetic resonance images showing abnormal vessels as a flow void around the spinal cord and intramedullary hyperintensity. (b) T11 angiographic imaging demonstrating the relationship between anterior spinal artery, draining vein, pial artery, and arteriovenous (AV) shunt. (c) Preoperative high-resolution angiography showing anterior spinal artery, pial artery, AV shunt, and draining vein.

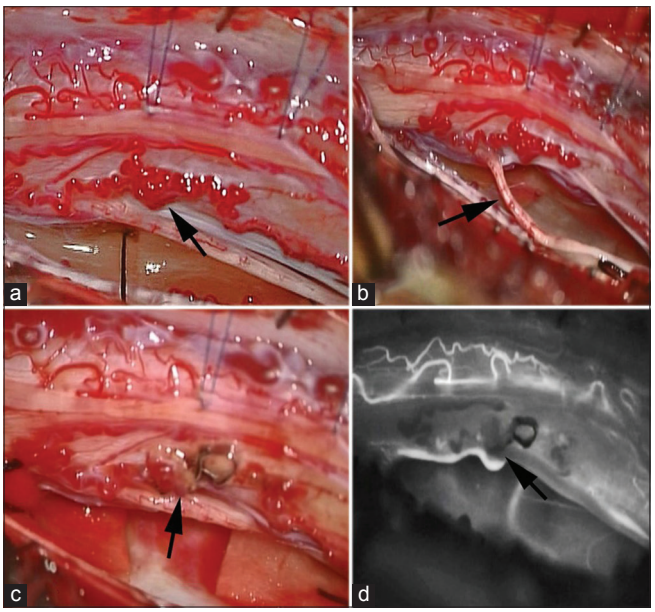


**Figure 3:** (a) Intraoperative arrow image of cord rotation with shunting point and draining vein visible. (b) Intraoperative arrow image showing perimedullary arteriovenous fistula (pAVF) on the ventrolateral surface of the rotated cord with the ipsilateral dentate ligament. (c) Arrow image showing temporary clipping of proximal and distal anterior spinal artery (ASA) feeding the pAVF. (d) Arrow image of complete resection of pAVF and indocyanine green confirmation of the flow in the ASA.

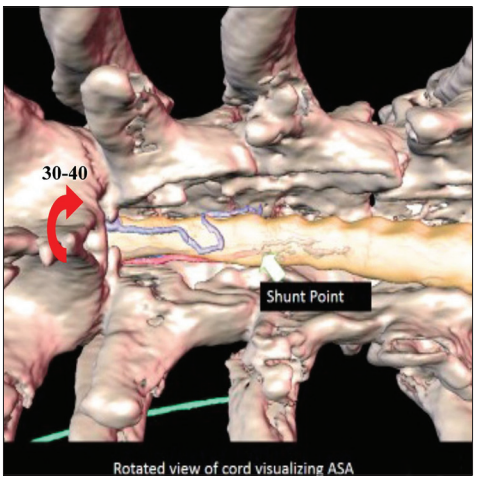


**Figure 2:** Preoperative 3D with an arrow showing images of laminectomy, anteroposterior view, lateral view, and 60° view with the arteriovenous shunt point.

**Figure 4:** Postoperative magnetic resonance imaging demonstrates complete resection of the perimedullary arteriovenous fistula and well preserved anterior spinal artery flow.

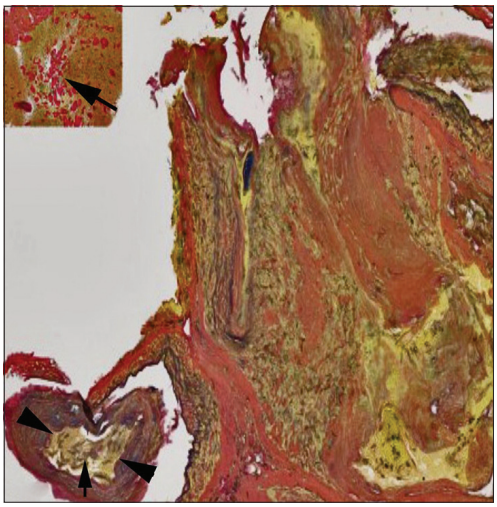

**Figure 5:** Histopathology: Verhoeff Van Gieson stain, arrowhead shows abnormal vascular structures with smooth muscle and elastic fibers inside the blood vessel walls, the latest with variable thickens and vessel caliber, irregular intimal hyperplasia and hyalinized walls. Arrow shows the possible shunting areas.

### Five years later

Five years later, the patient presented with progressive muscle atrophy/paraparesis and urinary incontinence. The ventral thoracic spinal pAVF was now visualized at the T11 level on the MR. Angiographically, it was supplied by the anterior spinal artery [Figure 1a-c]. The patient received CyberKnife treatment in two divided sessions (e.g., a total of 41.1 Gy to the local area and 31 Gy to the marginal area) at the T11 spinal level. Because of his continuing neurological deterioration and persisting perimedullary A-V shunts, he was referred for possible endovascular versus open surgery; the latter open approach was chosen.

### Surgical strategy

Based on the 3D-CT, a posterolateral left-sided T10–T12 laminectomy was performed that could allow for 30–60° of cord rotation to access the ventral AVF [Figure 2].

Notably, motor evoked potentials (MEPs) and somatosensory evoked potentials did not change during and after cord rotation/manipulation. There was a direct arteriovenous connection between the anterior spinal artery (ASA) and a thin-walled abnormal vein, and a duplication of the ASA for the segment harboring the fistula [Figure 3a and b]. Using (indocyanine green [ICG]) videoangiography, temporary clipping showed complete occlusion of the proximal and distal to the origin of the pial arterial feeders [Figure 3c]. The postclipping ICG confirmed the now isolated shunt, and the absence of flow through the fistula; it was then excised [Figure 3d].

### Postoperative MR imaging

The postoperative MR did not show any new or significant intramedullary cord changes. Six months later, it continued to show complete occlusion/resection of the pAVF [Figure 4].

### Histopathology

The histopathological examination confirmed abnormal vascular structures corresponding to the pAVF. The Verhoeff Van Gieson stain showed smooth muscle and elastic fibers inside the blood vessels that had variable wall thickening/caliber that correlated with a pAVF [Figure 5]. Additional findings included; irregular intimal hyperplasia, the hyalinized/hardened wall, and small-thickened blood vessels showing dense intimal proliferation.

## DISCUSSION

### Type of AVF

In this case, MR imaging and angiography demonstrated a Type IV pAVF, subtype I pAVFs. The success rate for permanent pAVF occlusion was previously reported as 98% for open surgery, but a lesser 10–75% for endovascular embolization.[4,6-8] Here, endovascular treatment was not feasible since the anterior spinal artery was the direct feeder. Further, the surgeons determined that this spinal pAVF on the ventrolateral cord surface fed from the ASA could be completely occluded utilizing intraoperative SEP/MEP monitoring to avoid cord injury.

## CONCLUSION

Utilizing preoperative 3D CT planning to estimate the necessary/extent of cord rotation, safe exposure, and excision of a ventrolateral spinal pAVFs was successfully accomplished at the T11 level.

### Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms.

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Nil.

### Conflicts of interest

There are no conflicts of interest.

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