Successful management of an anterior thoracic Type IV spinal arteriovenous malformation with two associated aneurysms utilizing vertebrectomy

Technical Note

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Anteriorly located Type IV thoracic arteriovenous malformations (AVMs) are difficult to treat surgically. Although high-flow fistula subtypes are amenable to treatment using endovascular techniques, low-flow fistulas should be treated surgically. There are few reports discussing the diagnosis, behavior, and treatment of these spinal fistulas due to their low incidence. Posterior surgical approaches to Type IV spinal AVMs reported in the literature have been associated with high morbidity rates or aborted procedures. The authors report the successful management of a T-12 Type IV spinal AVM with an emphasis on approach, interoperative angiography, and the use of modern instrumentation. To the authors’ knowledge, this is also the first reported case of multiple arterial-side aneurysms in a Type IV AVM of the anterior spinal artery. (DOI: 10.3171/SPI/2008/9/7/067)

KEY WORDS • arteriovenous malformation • perimedullary fistula • spinal aneurysm • vertebrectomy

Typically, the surgical treatment of spinal AVMs has largely consisted of laminectomy and other posterior techniques. In this paper we present the case of a Type IV AVM with 2 associated aneurysms treated using an anterior approach.

Illustrative Case

This 47-year-old man with a history of hypertension presented to a different hospital with acute onset of low-back pain, bilateral lower extremity weakness, and urinary incontinence. A magnetic resonance image revealed an intradural hematoma with flow voids at the T-11 vertebral level (Fig. 1). Upon transfer to our institution, the patient had 2/5 muscle strength in the iliopsoas bilaterally (according to the manual muscle test), 4/5 strength distally, diminished rectal tone, diminished proprioception in both legs, and an incomplete T-10 sensory level. A spinal angiogram demonstrated an anterior thoracic pial AVF supplied by 2 small sulcocommissural branches of the left T-12 radicomedullary artery, each with an associated arterial aneurysm (Fig. 2). Due to the technical difficulty of reaching these distal medullary branches and the potential for reflux of glue into the ASA, surgery was believed to be the preferred treatment modality.

Operative Technique

Although the lesion had a right paracentral location, the thoracic surgery team believed that a right-sided approach at the T-10 and T-11 levels would be partially obstructed by the liver. As a result, the patient was placed in a right lateral decubitus position and underwent a left thoracotomy. The pleura was dissected away from the vertebral bodies of T-10 and T-11, followed by complete corpectomies of T10–11 with a high-speed air drill until the PLL was exposed. Critical to the approach was the isolation and preservation of the T-12 segmental artery (of Adamkiewicz). An incision was made in the PLL with a preserved medial attachment, creating a window to the dura. The dura was incised, flapped inferiorly, and secured with 4-0 silk sutures. This exposure resulted in wide visualization of the fistulous connections and associated aneurysms (Fig. 2). The fistulous connection was identified, coagulated using bipolar cautery, and then cut with microscissors. Afterward, the 2 aneurysm domes were sequentially shrunk using bipolar cautery.

Abbreviations used in this paper: ASA = anterior spinal artery; AVF = arteriovenous fistula; AVM = arteriovenous malformation; PLL = posterior longitudinal ligament.
The dural opening and the PLL were separately reapproximated and each was closed in a watertight fashion. To allow for satisfactory angiographic visualization a radiolucent polyetheretherketone cage (Medtronic Inc.) was placed and the patient underwent a spinal angiogram. The angiogram demonstrated complete obliteration of the lesion, after which the patient was returned to the operating room for definitive stabilization (Fig. 3). Through the same thoracotomy incision, the vertebrectomy site was visualized and a titanium plate/screw construct was inserted. The thoracic surgery team then performed the closure in a standard fashion. In the recovery room the patient was noted to be at his preoperative neurological baseline. Upon discharge 3 weeks later, the patient had 4/5 strength in his right iliopsoas, but was otherwise at full strength in his legs. In addition, he had regained proprioceptive sensation and complete control of his bladder function. Most recently, at his 1-year clinic visit, the patient was noted to be at full strength in all muscle groups with no residual sensory deficit.
Vertebrectomy for Type IV spinal arteriovenous malformation

Fig. 3. Coronal computed tomography image showing the spinal reconstruction.

Discussion

Type IV spinal AVMs, or perimedullary AVFs, are distinguished from other spinal AVMs by their intradural extramedullary location and are supplied by branches of the spinal arteries. Type I AVMs are dural fistulas occurring near the spinal root sleeve, Type II (glomus) AVMs are intramedullary AVMs, and Type III (juvenile) AVMs are intramedullary, but can expand into the extradural space involving multiple feeding arteries. Type IV spinal AVMs are usually subtyped as A, B, or C (or I, II, and III), depending on their size, number of arterial feeders, and blood flow.

The treatment options for Type IV spinal AVMs are surgery, endovascular embolization, or a combination of both. In general, embolization can be difficult in simple perimedullary AVFs requiring catheterization of small caliber feeding vessels associated with the fistula. Also, embolization can lead to recanalization rates of as high as 83%, making surgery the preferred treatment modality whenever possible. Thus, embolization is usually reserved for treating large, higher-flow perimedullary AVFs with greater venous congestion.

Our patient presented with an anterior thoracic Type IV spinal AVM above the conus. A purely posterior approach (a laminectomy) has inherent problems with visualization resulting in probable manipulation of the spinal cord. Mourier and colleagues in their series of 35 patients with Type IV spinal AVMs recognized the difficulty of approaching anterior cord lesions through a laminectomy, and therefore performed embolization in such patients. In a series of 8 patients reported by Barrow and colleagues, 2 of 3 patients with anterior spinal cord perimedullary AVFs approached via laminectomy had postoperative complications, including diminished lower extremity motor function and cerebrospinal fluid leakage. The worsening of lower extremity function was believed to be due to the manipulation of the conus. Djindjian and associates could not locate the fistula in 1 patient in a series of 3 patients with anteriorly located perimedullary AVFs.

The posterolateral approaches, which include the lateral extracavitary, costotransversectomy, and transpedicular approaches, have been successfully utilized to treat a wide variety of anteriorly located diseases including tumors, herniated discs, infections, and vascular malformations. Although these approaches may have ultimately proven adequate in the present case given that the fistula was para-central, it was believed that the manipulation of more centrally located aneurysms associated with sulcocommisural arterial branches to this fistula necessitated an even greater level of care and, therefore, a more purely anterior approach. If the lesion was simply a fistula in isolation, we would have given much stronger consideration to using a posterolateral approach.

There are 3 case reports discussing thoracotomy for spinal AVMs (2 intramedullary AVMs and 1 Type IV spinal AVM). In all 3 cases, the surgeons performed partial vertebrectomies and in 2 of the 3 cases there were symptomatic partial occlusions of the ASA postoperatively. Our patient underwent complete vertebrectomies, which provided excellent visualization of the fistula, aneurysms, and adjacent spinal cord. These procedures allowed for safe manipulation of the 2 small arterial branches with aneurysms, and ultimate coagulation of the fistulous connection and aneurysm domes.

The utilization of a 2-part procedure in this case is controversial. Extensive discussion was undertaken with the endovascular team, who were of the opinion that intraoperative spinal angiography would be difficult to perform and possibly inadequate for visualizing small caliber vessels associated with this lesion. As a result, a radiolucent cage was placed and definitive fixation was performed after demonstrating radiographic obliteration of the fistula with formal spinal angiography. Undeniably, the reliance on a 2-part procedure along with the inherent risks of a thoracotomy could have been avoided had a posterolateral approach been selected. Given the concomitant presence of aneurysms from 2 small perforating arterial branches and an anteriorly located fistula, however, a wide anterior exposure was deemed necessary. Additionally, the 2-part anterior approach offers another opportunity to treat any residual disease noted during postoperative angiography.

Conclusions

Whenever possible, Type IV spinal AVMs should be treated surgically. Vertebrectomy maximizes exposure of the fistula, which is of particular importance when the disease is complex, as it was in this case. Either intraoperative or interoperative angiography (in the angiography suite after the placement of a radiolucent cage) should be performed to rule out residual disease.
References

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