Anterolateral transthoracic transvertebral resection of an intramedullary spinal arteriovenous malformation

Case report

FRED C. WILLIAMS, JR., M.D., JOSEPH M. ZABRAMSKI, M.D., ROBERT F. SPEITZLER, M.D., AND HAROLD L. REKATE, M.D.

Division of Neurological Surgery, Barrow Neurological Institute, Phoenix, Arizona

The case is reported of a 16-year-old girl with an anterior thoracic spinal cord arteriovenous malformation (AVM) who presented with subarachnoid hemorrhage and sudden change in lower-extremity strength. Spinal angiography revealed a Type II (glomerous) intramedullary AVM at the T7-8 level fed by multiple branches of the anterior spinal artery. The AVM was successfully resected using an anterolateral transthoracic approach. The details of this approach and its use for surgery of anterior thoracic spine lesions are described.

KEY WORDS • anterolateral transthoracic approach • thoracic spine • spinal arteriovenous malformation • surgical approach

Less than a quarter of a century ago, the outlook for patients with spinal arteriovenous malformations (AVM's) seemed bleak. Better understanding of the pathophysiology of these lesions and rapid advances in diagnostic and therapeutic modalities have dramatically improved the prognosis of patients affected by these lesions. Spinal AVM's located over the dorsal surface of the spinal cord and those involving the dural root sleeve can be readily approached and eliminated with minimal morbidity and mortality. However, the management of lesions over the ventral surface of the spinal cord remains problematic. Current treatment for these lesions has concentrated on transfemoral embolic therapy, but recent reports suggest that embolization may provide limited long-term benefits. This report details the use of an anterolateral transthoracic approach for the resection of a ventrally located Type II (glomerous) spinal AVM and reviews the related literature.

Case Report

This 16-year-old Native American girl was transferred to our institution after the sudden onset of headache, back pain, nausea, and vomiting. Her medical history was remarkable for the acute onset of paraplegia at 10 years of age; the episode had resolved spontaneously within 24 to 48 hours. At that time, she had been evaluated only with standard x-ray films of the spine which had been reported to the family as normal.

Examination. On admission to our institution, the patient had mild meningismus and a slight weakness (graded 4/5) of the right lower extremity. Her reflexes were symmetrical and brisk, and her toes were downgoing bilaterally to plantar stimulation. The remainder of the examination was normal.

A computerized tomography scan of the head was normal. Lumbar puncture revealed grossly bloody xanthochromic cerebrospinal fluid (CSF). Four-vessel cerebral angiography, including cervical views during the vertebral artery injections, was normal. High-resolution magnetic resonance (MR) imaging of the thoracic and lumbar spine revealed a thin band of increased signal intensity anterior to the spinal cord from T3-4 through T8-9 on T1-weighted images (Fig. 1). Cerebrospinal fluid present over the dorsal spinal cord at these levels suggested that the spinal cord was not compressed. The MR findings, the evidence of subarachnoid hemorrhage on lumbar puncture, and the normal cerebral angiogram were thought to be diagnostic of a spinal AVM. The patient underwent selective spinal angiography, which revealed a Type II (glomerous) spinal AVM over the ventral surface of the spinal cord at the T-8 level (Fig. 2). The AVM was fed by branches of the anterior spinal artery that, in turn, arose from the intercostal artery at the T-9 level.
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Transfemoral endovascular embolization of the lesion was ruled out because the feeding branches to the AVM originated from the anterior spinal artery. After further review, it was elected to attempt complete surgical resection of the AVM using a right-sided anterolateral transthoracic approach.

Operation. After the induction of general endotracheal anesthesia, the patient was placed in the left lateral decubitus position. A right lateral thoracotomy was performed with resection of the midportion of the eighth rib. The T-8 neurovascular bundle was followed medially to the neural foramen by an extrapleural dissection. A double-barreled endotracheal tube* allowed selective deflation of the right lung which improved the exposure. Subperiosteal dissection was used to expose the right anterolateral aspect of the body, transverse process, and pedicle of T-8. The medial portion of the eighth rib was resected using subperiosteal technique along with the transverse process of T-8.

With the aid of an operating microscope and a high-speed air drill,† a partial right anterolateral corpectomy of the inferior third of the body of T-7 and of the superior half of the body of T-8 was performed to expose the central and right lateral aspects of the spinal canal (Fig. 3 upper left). The posterior longitudinal ligament was removed using a small Kerrison rongeur. A midline ventral dural incision was performed, and lateral incisions were made to create an H-shaped opening. The dural leaflets were reflected laterally and secured with tacking sutures.

* Bronco-Cath manufactured by Mallinckrodt Critical Care, Glens Falls, New York.
† Air drill manufactured by Midas Rex Institute, Inc., Fort Worth, Texas.

The malformation, which was a true glomus-type intramedullary AVM, was visualized on the ventral cord surface (Fig. 3 upper left). The large radicular branch from the right intercostal artery at the T-9 level was readily apparent and gave rise to the anterior spinal artery as demonstrated by angiography. Three feeding vessels in turn arose from the anterior spinal artery to supply the AVM. A large venous aneurysm (Fig. 3 upper left), partially buried within the spinal cord substance and surrounded by hemosiderin-stained tissue, suggested that it was the source of previous hemorrhages.

Removal of the malformation was initiated by cauterizing and dividing the feeding vessels which supplied the malformation. Microvascular dissection was continued in the glotic plane surrounding the nidus of the AVM and the associated venous aneurysms. All remaining feeding vessels were carefully coagulated and divided before the draining venous pedicle was sacrificed (Fig. 3 upper right).

A watertight dural closure was obtained with the aid of a lyophilized (Tutoplast) graft. The resected portions of the eighth rib were trimmed, divided into three segments, and used as bone-graft struts to span the area of the partial corpectomy (Fig. 3 lower). The parietal pleura was sutured over the bone defect, and the remainder of the closure was performed in a standard fashion including placement of a chest tube. A spinal lumbar subarachnoid drain was placed after the procedure, and the CSF drainage was continued for 3 days. The lumbar drain and a right-sided chest tube were
removal on the 3rd postoperative day. The patient awoke from surgery neurologically unchanged. Postoperative angiography revealed no evidence of residual AVM (Fig. 2 right).

Postoperative Course. At the patient's 6- and 12-month follow-up visits, she had no deficits and was leading a full, active life without restrictions. Follow-up spinal films at 1 year revealed normal bone alignment (Fig. 4). The patient, who is graduating from high school, is reportedly an excellent volleyball player and is considering trying out for a professional beach volleyball team.

Discussion

Less than 25 years ago, Houdart, et al.,\textsuperscript{14} reported that "the total ablation of a vascular malformation of the spinal cord is often not possible . . . [it] can only be reasonably undertaken if the position of the abnormal vessels is purely extra-spinal and posterior." The introduction of the operating microscope, advances in anesthesia, and an improved understanding of the pathophysiology of these lesions have markedly reduced the risks of operative resection.

Yaşargil\textsuperscript{25-27} was one of the first neurosurgeons to emphasize the operability of spinal AVM's when microoperative technique was combined with meticulous use of bipolar coagulation. As early as 1969, he reported excellent results in patients undergoing total resection of spinal AVM's.\textsuperscript{25,26} In 1975, he reported on a series of 11 patients with cervical spinal AVM's which were completely excised.\textsuperscript{27} All 11 patients had significant clinical improvement in neurological function, which was described in six as dramatic. There was one delayed death in the perioperative period secondary to meningitis.

More recently, Ommaya\textsuperscript{18} reviewed the total microsurgical resection of spinal AVM's in 64 patients and found that 78% improved, 19% remained unchanged, and only 3% were made worse. We have treated 35 patients with spinal AVM's, including 12 with intraspinal glomus-type AVM's, in whom there were no deaths and only one case of neurological deterioration after surgical resection (unpublished data).

Despite these improvements, the management of ventral spinal cord AVM's has remained fraught with problems. Exposure difficulties have permitted limited surgical access, particularly in the mid- to upper-tho-

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**Fig. 3.** Intraoperative photographs showing an anterolateral transthoracic transvertebral exposure of the ventral spinal cord surface. *Upper Left:* With the dura open and retracted, the anterior spinal cord surface is well visualized, exposing the arteriovenous malformation (straight arrow) and a large venous aneurysm (curved arrow). Several small branches arising from the anterior spinal artery and feeding the malformation can be identified. *Upper Right:* The malformation has been completely resected. The main trunk of the anterior spinal artery as it curves sharply to descend over the anterior cord surface and a large ascending branch (arrow) are preserved. *Lower:* The resected portion of the eighth rib has been divided into three segments and used to fill the bone defect.

**Fig. 4.** X-ray film, lateral view, of the thoracic spine 1 1/2 years after surgery (arrow indicates T-8 level).
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racic spine. The anterolateral transthoracic transvertebral approach, first described by Hodgson and Stock, is useful for the treatment of Pot’s disease, provides excellent exposure to this area. Subsequent reports have described its use for the treatment of metastatic disease and osteomyelitis, as well as for the decompression of herniated thoracic discs and traumatic lesions producing anterior compression. In addition, we have identified two reported cases where this approach was used in the treatment of ventrally located spinal AVM’s: in 1982 Raynor and Weiner reported a case at the T-8 level, and in 1986 Heros et al., reported a case at the T3-4 level.

Transfemoral embolic obliteration is an alternative to surgery for the treatment of spinal cord AVM’s which has seen increasing clinical use during the last two decades. The use of glue, small-particle embolization, and various sclerotic mixtures has been reported in both the surgical and radiographic literature. While transfemoral embolization can clearly produce acute obliteration of many of these lesions, its long-term effectiveness has recently been brought into serious question by two reports. In 1989, Hall, et al., reported the results of follow-up angiography in six patients with spinal AVM’s treated by embolization. Despite complete angiographic obliteration of lesions at the time of embolization, recurrent symptoms occurred in two and 8 months in two of three patients with dural AVM’s and within 2 months in two of three patients with glomus AVM’s. Spinal angiography revealed recanalization of the spinal AVM’s in five of the six patients. In a review of the management of dural AVM’s at the Mayo Clinic, Morgan and Marsh reported that follow-up angiography demonstrated recurrence of the spinal AVM in 11 of 13 patients whose symptoms occurred after the lesion had been successfully obliterated by embolization. In the present case, embolization was considered to be contraindicated since the feeders for the AVM arose as branches from the anterior spinal artery (Fig. 2). Endovascular treatment would have thus carried an unacceptably high risk of ischemic injury to the spinal cord.

Conclusions

Surgical resection-obliteration remains the “gold standard” for the treatment of spinal cord AVM’s. The majority of these lesions can be approached dorsally via laminectomy; however, for those rare lesions that involve the ventral surface of the cord, a variety of surgical approaches have been devised that can provide exposure. The anterolateral transthoracic exposure offers a safe, effective approach to the ventral spinal canal for the resection of anteriorly located lesions in the thoracic region.

References


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Address for Dr. Williams: Section of Neurosurgery, University of Arizona, Tucson, Arizona.
Address reprint requests to: Joseph M. Zabramski, M.D., Editorial Office, Barrow Neurological Institute, 350 West Thomas Road, Phoenix, Arizona 85013-4496.