Cavernous angiomas of the spinal cord

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Five cases of histologically verified cavernous angiomas of the spinal cord are reported. Acute lower-extremity sensory disturbance was the initial symptom in four patients, and one presented with weakness of the hand. Progressive neurological deficit occurred in all patients, but the clinical course and outcome were extremely variable. Myelography revealed an intramedullary lesion in two cases but was completely normal in three; magnetic resonance imaging was diagnostic in these patients. Subtotal removal was accomplished in two cases, and myelotomy and biopsy were carried out in three. Four of the cavernous angiomas were located in the cervicothoracic region, whereas one was found in the thoracolumbar cord. All of the patients exhibited characteristic gross and microscopic features as well as hemosiderin-laden macrophages indicating remote hemorrhage. The diagnostic, therapeutic, and prognostic implications of this rare condition are discussed.

KEY WORDS: cavernous angioma, spinal cord, magnetic resonance imaging

Cavernous angiomas are uncommon vascular malformations of the central nervous system that are characterized by hemorrhage, seizures, or focal neurological deficit. Although generally found in the cerebral hemispheres, they may affect any part of the neuraxis. In the spine, cavernous angiomas usually originate in the vertebrae, with occasional direct extension into the extradural space. Purely extradural lesions have been reported, but intramedullary cavernous angiomas are extremely rare. In this report we describe five cases of cavernous angioma of the spinal cord and discuss the clinical, radiological, and pathological features of this condition.

Summary of Cases

This series consists of two men and three women ranging in age from 33 to 51 years. Acute lower-extremity sensory disturbance was the initial symptom in four patients, two of whom had associated pain. The other patient presented with sudden weakness of the hand. Progressive paraplegia occurred in three cases, and progressive lower-extremity hypesthesia and a Brown-Séquard syndrome developed in the remaining two cases. Deterioration of the neurological deficit was variable but often occurred in a stepwise fashion, with symptoms and signs present for up to 9 years before diagnosis. The differential diagnosis in these cases was transverse myelitis, multiple sclerosis, spinal cord tumor, or Foix-Alajouanine syndrome. Cerebrospinal fluid (CSF) analysis was not helpful in establishing the diagnosis. Myelotomy and biopsy were carried out in three cases and partial removal was accomplished in two. The clinical course and outcome were extremely variable. The clinical features of these five cases are summarized in Table 1.

Myelography revealed an intramedullary lesion in two cases but was completely normal on multiple examinations in three cases. Magnetic resonance (MR) imaging was diagnostic in these three instances. The radiographic features are outlined in Table 2.

The macroscopic findings were similar in each case, showing well-circumscribed, dark blue-brown, intramedullary mulberry-shaped lesions with surrounding gliosis and hemosiderin staining. The lesions varied in length from 1 to 3 cm. Despite almost complete replacement of cord parenchyma by the cavernoma, expansion of the spinal cord was usually not significant. No abnormal vessels or bleeding was seen. On sectioning, there were multiple cysts filled with old blood with dense fibrous stroma and occasional calcification. All cases exhibited characteristic microscopic findings of thin-walled sinusoidal spaces lined with a single layer of endothelium, lacking elastic or muscularis layers and without any intervening nervous tissue. Hemosiderin-laden macrophages indicating remote hemorrhage...
TABLE 1
Clinical features in five cases of cavernous angioma of the spinal cord

<table>
<thead>
<tr>
<th>Case</th>
<th>Age (yrs), Sex</th>
<th>Location of Lesion</th>
<th>Initial Symptom</th>
<th>Clinical Course</th>
<th>Duration of Symptoms</th>
<th>Type of Operation</th>
<th>Outcome &amp; Follow-Up Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>34, M</td>
<td>T2-3</td>
<td>painful thoracic hyperesthesia</td>
<td>progressive lower-extremity hypesthesia</td>
<td>1 wk</td>
<td>myelotomy, biopsy</td>
<td>active &amp; ambulatory</td>
</tr>
<tr>
<td>2</td>
<td>33, F</td>
<td>C6-7</td>
<td>acute Lt-hand weakness</td>
<td>progressive Brown-Séquard syndrome</td>
<td>3 mos</td>
<td>subtotal removal</td>
<td>non-ambulatory</td>
</tr>
<tr>
<td>3</td>
<td>51, F</td>
<td>T2-3</td>
<td>bilat lower-extremity hypesthesia</td>
<td>rapidly progressive paraplegia</td>
<td>3 yrs</td>
<td>subtotal removal</td>
<td>unchanged</td>
</tr>
<tr>
<td>4</td>
<td>41, F</td>
<td>T2-3</td>
<td>bilat lower-extremity hypesthesia</td>
<td>mild paraparesis, bladder disturbance</td>
<td>11 yrs</td>
<td>myelotomy, biopsy</td>
<td>unchanged</td>
</tr>
<tr>
<td>5</td>
<td>48, M</td>
<td>T11-12</td>
<td>acute painful lower-extremity hypesthesia</td>
<td>progressive paraparesis</td>
<td>5 yrs</td>
<td>myelotomy, biopsy</td>
<td>increased paraparesis, bladder disturbance</td>
</tr>
</tbody>
</table>

TABLE 2
Radiological findings in five cases of cavernous angioma of the spinal cord*

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Myelography</th>
<th>Computed Tomography</th>
<th>Angiography</th>
<th>MR Imaging</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>intramedullary lesion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>intramedullary lesion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>negative × 3 negative</td>
<td></td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>negative syringomyelic cavity</td>
<td></td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>negative × 6 enhancing intramedullary lesion</td>
<td></td>
<td>+</td>
<td></td>
</tr>
</tbody>
</table>

*MR = magnetic resonance; + = diagnostic for the cavernous angioma.

were present in all cases. The pathological features are summarized in Table 3.

The five cases are presented below.

Case Reports

Case 1
This 34-year-old male physician noted acute interscapular pain followed by numbness in his left foot and leg 2 days before admission. Initial examination revealed bilateral hyperesthesia at T1–3 and a left hemisensory deficit below T-2, although vibration and position sense were intact. Muscle bulk, power, and tone were normal, with 3+ deep-tendon reflexes bilaterally and flexor plantar responses. Myelography was performed and suggested an intramedullary lesion in the upper thoracic cord. At operation there was mild segmental enlargement of the cord with blue-black discoloration appearing through the dorsal root entry zone on the right. Myelotomy disclosed multiple cystic cavities with fibrous walls and containing old blood. There were no abnormal vessels and no active bleeding. Histopathological analysis of tissue obtained at myelotomy and biopsy revealed a cavernous angioma.

The patient made an excellent recovery from his surgery and remains very active 15 years later, with only minor numbness in the left foot and leg.

Case 2
This healthy 33-year-old woman experienced acute left-hand weakness 3 months prior to admission. Over the subsequent weeks the weakness progressed into a partial Brown-Séquard syndrome. Bladder and bowel function remained normal. Upon examination, a left hemiparesis with hyperreflexia and a left Babinski response were noted, and below C-8 there was right hemisensory loss to pain and temperature. Myelography revealed a slight enlargement of the lower cervical cord. At surgery, a dark blue-brown intramedullary lesion was detected consisting of multiple cystic cavities containing old blood. Myelotomy was performed with subtotal removal of the lesion, which on pathological analysis was revealed to be a cavernous angioma. Although there was transient neurological worsening, the patient remained essentially unchanged and ambulatory until 11 years postoperatively, when she was lost to follow-up evaluation.

Case 3
This 51-year-old woman noted the gradual onset of numbness of her right foot which progressed to involve the entire right lower extremity and then the left. Complete myelography was normal on two occasions, and it was thought that the patient had a spinal cord astrocytoma or demyelinating disease.

Sudden progression in her sensory deficit 9 months later, associated with a T-2 sensory level, paraplegia, and bladder dysfunction, prompted repeat myelography with computerized tomography (CT) scanning. These studies were normal except for the appearance of a C6–7 posterior osteophyte. Discectomy and osteophyte removal at C6–7 was performed without benefit, and the patient remained paraplegic with a T-2 sensory level. Three years later, MR imaging revealed a multicystic intramedullary lesion in the upper thoracic cord.

At operation, the cord was noted to be of normal caliber but almost completely replaced by a dark blue mulberry-shaped lesion consisting of multiple cysts with
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TABLE 3
Pathological features in five cases of cavernous angioma of the spinal cord*

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Lesion Location</th>
<th>Size (cm)</th>
<th>Cord Expansion</th>
<th>Abnormal Vascularity</th>
<th>Gliosis</th>
<th>Calcification</th>
<th>Hemosiderin-Laden Macrophages</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>T2-3, intramedullary</td>
<td>1.5 x 1 x 1</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>2</td>
<td>C6-7, intramedullary</td>
<td>2.5 x 1 x 1</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>3</td>
<td>T2-3, intramedullary</td>
<td>2.5 x 1 x 1</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>4</td>
<td>T2-3, intramedullary</td>
<td>3 x 1 x 0.5</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>5</td>
<td>T11-12, intra-/extramedullary</td>
<td>3 x 1 x 1</td>
<td>±</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
</tbody>
</table>

* + = present; - = absent; ± = could not be determined.

fibrous walls and containing old blood (Fig. 1). There were no abnormal vessels or active bleeding, and subtotal removal was carried out. Pathological analysis revealed a cavernous angioma. The patient’s condition was unchanged 1 year postoperatively.

Case 4

This 41-year-old woman noted the gradual onset of left groin numbness, which progressed over 9 years to involve the entire left side below the costal margin and the right side below her waist. There was mild leg weakness bilaterally. Myelography was normal initially; however, subsequent CT with myelography revealed syringomyelia, and a syringosubarachnoid shunt was placed with some improvement. The recurrence of her symptoms over 1 year, along with development of new paresthesiae in both hands, prompted referral to the Montreal Neurological Institute.

On examination, muscle bulk and power were normal bilaterally, but there was marked hyperreflexia with bilateral Babinski signs and ankle clonus. There was a suspended sensory loss on the right side between T-1 and T-5, and a more complete sensory deficit to all modalities below T-4 on the left side. Magnetic resonance imaging revealed a 3-cm long multicystic intramedullary lesion at T-2 with syringomyelic cavities extending above and below the lesion.

At surgery, numerous blue-black nodules were seen through the cord surface, with surrounding yellow discoloration. Myelotomy disclosed multiple cysts with fibrous capsules containing old blood. There were no abnormal vessels. Pathological analysis revealed a cavernous angioma. Only a biopsy of the lesion was carried out, and the patient was unchanged postoperatively and at follow-up examination 1 year later. She then noted an increase in numbness and stiffness of the lower extremities and increased difficulty in walking which prompted repeat MR imaging. There was essentially no change in the appearance of the hemangioma and no detectable syrinx. She was given 3953 cGy of radiotherapy to the upper thoracic spine over a 33-day period. It is still too early to evaluate the effect of this treatment, during which her condition has remained stable.

Case 5

This 48-year-old man experienced transient acute right lower-extremity weakness lasting 1 hour. Cranial CT scans revealed an enhancing left internal capsule lesion that was believed to represent a vascular anomaly; however, cerebral angiography was negative. Two years later, he experienced the first of three similar
episodes consisting of acute low-back pain and lower-extremity numbness and weakness. Myelography performed after each episode was completely normal, although the CSF was xanthochromic on one occasion. Progressive paraparesis with sensory deficit in both legs and bladder dysfunction prompted reinvestigation, including an early MR image which was reported as normal. Continued deterioration over the subsequent 2 years led to his referral to our institute.

On examination, there was marked spastic paraparesis with bilateral hyperreflexia, ankle clonus, and Babinski responses. Sensation to pinprick and light touch and proprioception were diminished with left L-1 and right L-2 sensory levels. Computerized tomography with myelography revealed slight enlargement of the conus medullaris, with a small extramedullary component at T-11 anterolaterally on the left. Lumbar CT with intravenous contrast material showed enhancement of the lesion (Fig. 2). Magnetic resonance imaging demonstrated a well-defined multicystic intramedullary lesion at T11–12 (Fig. 3 left), but selective spinal angiography was normal (Fig. 3 right).

At operation, a dark blue intramedullary lesion with a small exophytic component was seen. The lesion consisted of multiple cysts with fibrous stroma containing old liquefied blood. There were no abnormal vessels and no bleeding except for minimal oozing from the periphery of the lesion. The lesion itself appeared to replace the spinal cord rather than expand it, and only a subtotal removal was carried out. Pathologically, the lesion was determined to be a cavernous angioma. Postoperatively, the patient experienced some worsening of his paraplegia and bladder dysfunction. His condition is essentially unchanged 1 year after surgery.

Discussion

Cavernous angiomas, or cavernomas, are uncommon vascular malformations that may affect any part of the neuraxis but are generally seen intracranially. While cavernous angiomas have been estimated to represent 5% to 12% of all spinal vascular anomalies,2 most arise within the vertebral bodies with occasional extension into the extradural space.7 Purely extradural lesions have been reported,18,19 but intramedullary cavernous angiomas are very rare and only a handful of poorly documented reports exist.1,3,4,8–12,14,15,17,20,22,25,28,29

Symptomatic cavernous angiomas of the spinal cord tend to develop between the third and sixth decade of life and range in size from a few millimeters to several centimeters. Grossly, they appear as well-circumscribed multilobulated lesions, dark blue or brown in color, and are usually seen through the discolored cord substance (Fig. 1). There are no abnormal leptomeningeal vessels. Cavernous angiomas are composed of multiple cysts containing old blood with dense fibrous walls and occasional calcification. Histopathologically, they are indistinguishable from cerebral cavernous angiomas.13

Cavernous angiomas can occur along the entire spinal cord and, although usually solitary, may be associated with cavernous angiomas in other organ systems28 or in other parts of the central nervous system.12 They may be multilobulated and extend into the extradural space or be associated with a syrinx. Purely extradural intradural lesions have been reported.10

Clinically, cavernous angiomas of the spinal cord may be asymptomatic, being found incidentally at autopsy in patients with multiple cavernous angiomas.12,28 Subarachnoid hemorrhage10,26 and hematomyelia11,20,25 have been described but, in general, the presentation is...
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one of progressive paraparesis and sensory loss frequently associated with pain, and is difficult to distinguish from chronic progressive radiculomyelopathy or Foix-Alajouanine syndrome. This disorder is associated with an extremely variable clinical course and unpredictable outcome. Occasional good results have been reported many years after diagnosis; however, progressive paraparesis appears to be more common.

Symptoms may be present for many years before diagnosis, which can be extremely difficult. Analysis of the CSF may reveal slightly elevated protein levels and, rarely, xanthochromia. Myelography may be completely normal, even on several occasions, demonstrating no enlargement of the cord. Computerized tomography with myelography can be more revealing. As with intracranial cavernomas, CT through the affected levels following administration of intravenous contrast agents may reveal an enhancing area. Cavernous angiomas are angiographically occult and spinal angiography will usually be completely normal (Fig. 3 right). Magnetic resonance imaging is diagnostic and reveals a well-defined intramedullary lesion of predominantly low-intensity signal admixed with smaller areas of high-intensity signal (Fig. 3 left). The high-intensity signals may represent old clot or hemosiderin within the lesion. This appearance is quite characteristic and is identical to that of intracranial cavernous angiomas.

Optimal therapy is unknown. A purely extramedullary cavernous angioma has been removed with good results, and an uncomplicated removal of a densely calcified intramedullary cavernous angioma or "hemangioma calcificans" has been reported. In general, complete removal is difficult, and usually only myelotomy and biopsy are performed. Subtotal removal may be associated with improvement or stabilization of symptoms or with continued progressive deterioration. External irradiation has been proposed as potentially useful in the treatment of cavernous angiomas of the brain and extradural spinal lesions but this is unproven. It may have a role in the management of patients with progressive paraplegia after partial removal of a spinal cord cavernoma.

While generally considered to be vascular hamartomas and not true tumors, cavernous angiomas may be associated with glial neoplasia and can be induced by the polyoma virus in mice. In the spinal cord, cavernomas may enlarge by internal hemorrhage or proliferation at the outer edge. In certain cases, there is no enlargement of the cord size, suggesting that these lesions are indeed very slow-growing and may be associated with cord atrophy.

Intramedullary cavernous angiomas may mimic other progressive disorders of the spinal cord, both clinically and radiologically. Diagnosis is extremely difficult and MR appears to be the most sensitive imaging modality available. A characteristic gross appearance is associated with histopathological features of a cavernous angioma. Complete surgical removal is rarely possible except for extramedullary lesions, and despite various modes of therapy the clinical outcome is variable, ranging from stabilization and improvement to progressive deterioration.

References

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