Neuroimaging of Spinal Tumors

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KEYWORDS

• Tumor • Spine • Intradural

KEY POINTS

- Magnetic resonance (MR) imaging is the method of choice for the detection and evaluation of intradural spinal lesions.
- There are numerous types of intradural-extramedullary masses, but meningioma and schwannoma are the most common tumors.
- Signal intensities, contrast enhancement pattern, and presence of cysts are key imaging findings in differentiation of spinal cord tumors.

Intradural spinal tumors are rare tumors with nonspecific clinical symptoms, usually occurring in the late stage of the disease, which results in delayed diagnosis. Back pain, radicular symptoms, slowly progressive neurologic deficits, or skeletal deformities, such as kyphoscoliosis, are commonly observed in children.

Intramedullary tumors comprise 20% to 30% of all primary intradural spinal tumors. The remaining 70% to 80% of primary intradural tumors are located in the intradural-extramedullary compartment.[1]

Magnetic resonance (MR) imaging is the method of choice for the detection and evaluation of intradural spinal lesions. The imaging protocol should include sagittal and axial T1-weighted and T2-weighted sequences, including contrast-enhanced T1-weighted sequences in the sagittal, axial, and coronal planes. Short time inversion recovery (STIR) should be added for the evaluation of intramedullary cord lesions as well as for the detection of bone abnormalities. Some advanced techniques, such as diffusion-weighted imaging and diffusion tensor imaging (DTI), have recently been described and are increasingly used in the evaluation of spinal lesions.[2]

DTI and fiber tractography are novel techniques with potential usefulness in preoperative diagnosis and postoperative follow-up of spinal cord tumors. These techniques provide more details about the white matter tracts in relation to space-occupying lesions, and thus, may be more sensitive than conventional MRI. Exploiting tractography in these cases has been helpful in predicting the nature of the lesion preoperatively and in planning the surgical intervention.[3]

Myelography and computed tomography (CT)-myelography are less frequently used for intradural spinal lesions. Angiography will be necessary to demonstrate the vascularization of hemangioblastomas (HBs) and presurgical interventions, such as the embolization of hypervascular lesions.[4]

Spinal PET/CT using fludeoxyglucose or 11(C) methionine has been used to evaluate intramedullary lesions, particularly for tumors with high-grade malignancy. Differentiation of tumors

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with low-grade malignancy from non-neoplastic lesions may still prove challenging.[5]

Analysis of the cerebrospinal fluid (CSF) may help to decide among differential diagnoses with an inflammatory etiology.

INTRAMEDULLARY TUMORS

Ependymoma

Ependymoma is the most common primary spinal cord tumor in adults (60% of all primary spinal cord neoplasms), with 39 years of age the mean age of presentation. This is the second most common primary spinal cord tumor in children. Ependymoma is a slowly growing tumor originating from the wall of the ventricles or from ependyma lining the spinal cord central canal. There are 4 histologic ependymoma subtypes: cellular, myxopapillary, clear-cell, and tanycytic. The World Health Organization (WHO) currently classifies ependymomas into 3 grades: grade I tumors include myxopapillary ependymomas and subependymomas, grade II includes classic ependymomas, and grade III includes anaplastic ependymomas.[6] Although these grade classifications may be helpful in treatment decisions, the prognostic value is still controversial.

Ependymoma may be associated with neurofibromatosis type 2 (NF2). In NF2, most ependymomas are WHO grade II, and, rarely, WHO III (anaplastic ependymoma).

Cellular ependymoma are located mostly in the cervical and thoracic spinal cord, with a slight female predilection. They are well defined (may even be encapsulated masses), span up to 4 segments, and have cystic presentations in 50% to 90% of cases. Cysts usually have CSF intensity. The solid portion of the tumor is isointense or mildly hypointense on T1-weighted images (T1WI), hyperintense on T2-weighted images (T2WI) and STIR, and always enhances after contrast administration.[7]

The "cap sign" (hemosiderin on cranial or caudal margin) due to hemorrhage strongly suggests cord ependymoma. Syrinx is also a common finding (**Fig. 1**).

Myxopapillary ependymoma (MPE) is most commonly a tumor of the conus medullare or the filum terminale. It originates from ependymal cells of the filum terminale, and it is classified as a WHO grade I tumor. Ninety percent of all filum terminale tumors are myxopapillary ependymomas, with a male predilection. These tumors present with high-T2, iso or low-T1 signal intensity masses with strong but inhomogeneous enhancement (**Fig. 2**). Scalloping of the vertebral bodies, scoliosis, and enlargement of the neural foramina are additional findings suggestive of myxopapillary ependymoma. Although MPEs are characterized as histologically benign, slow-growing tumors, some patients demonstrate local recurrence or even distant metastasis, more likely occurring in the pediatric population.[8]

Tanycytic ependymoma is a rare subtype of WHO grade II ependymoma. Histologically, these tumors have spindle cells arranged in a fascicular pattern, an absence of ependymal rosettes, and inconspicuous perivascular pseudorosettes.[9] A recently published meta-analysis of all described cases did not find any specific imaging finding. Most commonly, a solid mass with T1 hypointense or isointense signal and T2 hyperintensity, with or without a cystic component with an associated syringomyelic cavity, has been reported.[9]

The best outcomes for spinal ependymomas are achieved with total resection. More specifically, the classic grade II ependymomas may benefit most from aggressive resection, whereas myxopapillary grade I ependymomas did not have clear benefits from total resection.[10]

Astrocytoma

Astrocytoma is an intramedullary infiltrating mass present in 5% to 10% of all central nervous system (CNS) tumors. It is the most common neoplasm in children and the second most common in adults. Astrocytomas are composed of neoplastically transformed astrocytes, which vary from well differentiated to anaplastic. In almost 90% of cases, astrocytomas are low-grade neoplasms. An astrocytoma that extends along the entire length of the spinal cord is termed a "holocord" tumor. These are uncommon, and predominantly seen in children.

Fibrillary astrocytoma (WHO II) is usually seen in the cervical spine, whereas pilocytic astrocytoma (WHO I) is found mostly in the conus medullaris (**Fig. 3**). In 10% to 15% of these cases, high-grade astrocytoma also can occur, mostly anaplastic astrocytoma. The glioneuronal tumor with neuropil-like islands is a newly described variant of the anaplastic astrocytoma (WHO II or III).[11]

Several cases have been reported in the spinal cord, recently also with diffuse meningeal dissemination.[12] Glioblastomas in the spine are uncommon.

Astrocytomas are mostly solid masses extending to multiple vertebral levels. They can show areas of necrotic-cystic degeneration, can have a "cyst with a mural nodule" appearance, or can be completely solid (approximately 40% of the cases). The solid portion of the tumor is isointense or mildly hypointense on T1WI, hyperintense on T2WI and T2*GE,