

# MRI Evaluation of Different Spectrum of Spinal Tumors

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## **Abstract:**

### **Background:**

A spinal tumor is an abnormal mass of tissue within or surrounding the spinal cord and spinal column, can cause significant morbidity and can be associated with mortality as well. Accounts for approximately 15% of cranio-spinal tumours. MRI is the essential procedure of choice for the work up of all spinal tumors and plays an integral role in evaluation and improving anatomic delineation and early diagnosis of spinal tumors and also plays an important role in follow-up and to monitor response to treatment.

### **Aims and objectives :**

1. To study the role magnetic resonance imaging (MRI) for the evaluation of spinal tumors.
2. To classify the spinal tumours into extradural, intradural extramedullary and intradural intramedullary compartments.
3. To review the differential magnetic resonance imaging (MRI) features of various spinal tumors.

### **Materials and Methods:**

The patients who were found to have spinal tumors on undergoing MRI of spine for the evaluation of back pain and neurological symptoms were included in the study. The patients with other causes for symptoms were excluded from the study.

## **INTRODUCTION:**

A spinal tumor is an abnormal mass of tissue within or surrounding the spinal cord and spinal column.<sup>1</sup> Intraspinous tumours may originate from the spinal cord, filum terminale, nerve roots, meninges, intraspinal vessels, sympathetic chain, or vertebrae. They can be benign or malignant, primary or secondary, and may result in serious morbidity. Intraspinous tumours are relatively uncommon lesions. However, these lesions can cause significant morbidity and can be associated with mortality as well. In establishing the differential diagnosis for a spinal lesion, location is the most important feature.<sup>1</sup>

Spinal tumors may be referred to by the area of the spine or compartment of the spine in which they occur. The basic areas are cervical, thoracic, lumbar, and sacral regions.

The MRI images of 35 patients were studied and following characteristics were evaluated: Location, shape, extent, component characteristics, signal intensities on different MRI sequences and enhancement patterns of the lesions, the lesions were classified into extradural, intradural extra-medullary, intra-medullary and correlated with histopathology.

### **Results:**

Out of 35 tumours studied, 10 cases (28.5%) were localized into extradural, 17 cases(48.5%) into intradural extramedullary and 8 cases(23%) into intramedullary compartments. Nerve sheath tumors were contributed to majority of the cases (10 cases, 28.5%) , followed by meningioma (6 cases, 17%). Hemangioma, ependymoma, astrocytoma, metastasis, lipoma, myxopapillary ependymoma, chordoma, sacrococcygeal teratoma and multiple myeloma formed the rest.

### **Conclusion:**

1. MRI is the modality of choice for the evaluation of spinal tumors.
2. The differential MRI findings are helpful in the classifying different tumors and narrow down the diagnosis.

**Key words:** Compartment classification, magnetic resonance imaging, Spinal tumours

Additionally, they are also classified into 3 main categories according to their location with respect to the dural sac and spinal cord: extradural; intradural-extramedullary; or intramedullary. Lesions can occasionally compromise more than one compartment.<sup>1</sup>

Today, MR is always considered the procedure of choice for the workup of all spinal tumors.<sup>2-6</sup>

It permits high-resolution imaging of not only the osseous structures but also the soft-tissue structures in multiple orthogonal planes through the use of varying pulse sequences. MR imaging plays an integral role in evaluation and improving anatomic delineation and early diagnosis of spinal tumors.<sup>1</sup>

Routine MR sequences to be acquired are sagittal and axial unenhanced T1- and T2-weighted images, sagittal STIR, coronal T2 weighted images and contrast-enhanced axial and sagittal T1-weighted images.

Contrast-enhanced images can be important for tumor detection, delineation, characterization, and grading. They help differentiate the tumor from the spinal cord, nerve roots, or thecal sac as well as from peri-tumoral edema or cysts. They are also crucial to ensure correct staging and treatment planning. MRI also plays an important role in follow-up and to monitor response to treatment.<sup>7</sup> Hence MRI has virtually replaced all other modalities while evaluating spinal tumors.

#### **DISCUSSION:**

Spinal tumors should virtually always initially be assessed by the radiologist asking “within what compartment is the lesion situated?” that is, is it extradural, intradural extramedullary, or intramedullary.<sup>8</sup>

#### **Compartmental Classification**

Tumors in the spine can be localized into one of three compartments: extradural, intradural-extramedullary, and intramedullary. Lesions in each of these compartments have common characteristic appearances that help to identify the compartment in which the tumor is located. Once the lesion is localized, a differential diagnosis can be developed based on the tumors that commonly occur in that compartment. Some lesions have characteristic magnetic resonance imaging or radiographic features that may allow for a definitive diagnosis based on imaging studies alone.<sup>9-12</sup>

**Extradural tumours (Fig 1):** The tumours located external to the dural layer and cause impingement on the thecal sac. With progressive increase in size of the mass, the subarachnoid space is at the interface of the mass & the cord gets obliterated with extrinsic cord compression.<sup>8</sup>

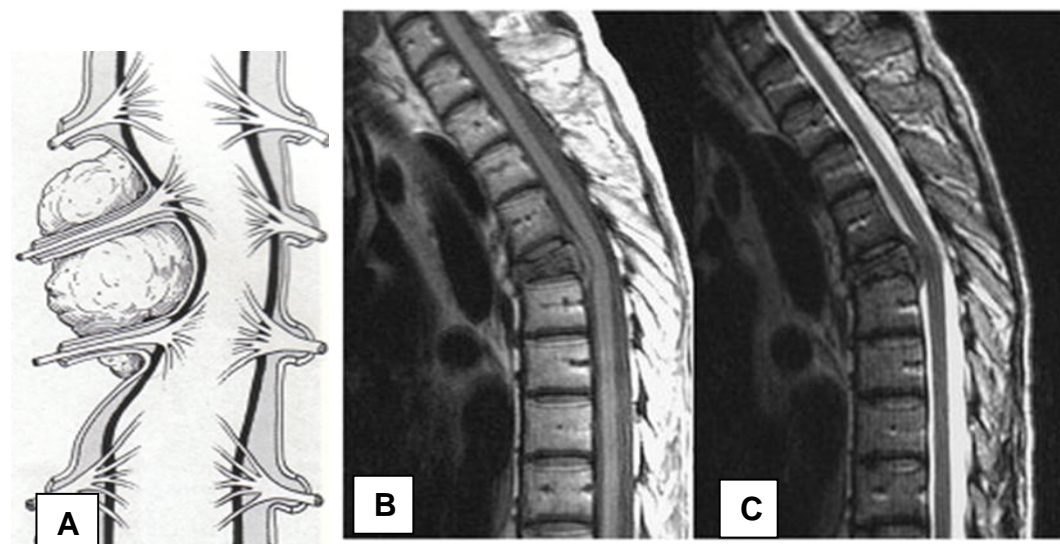
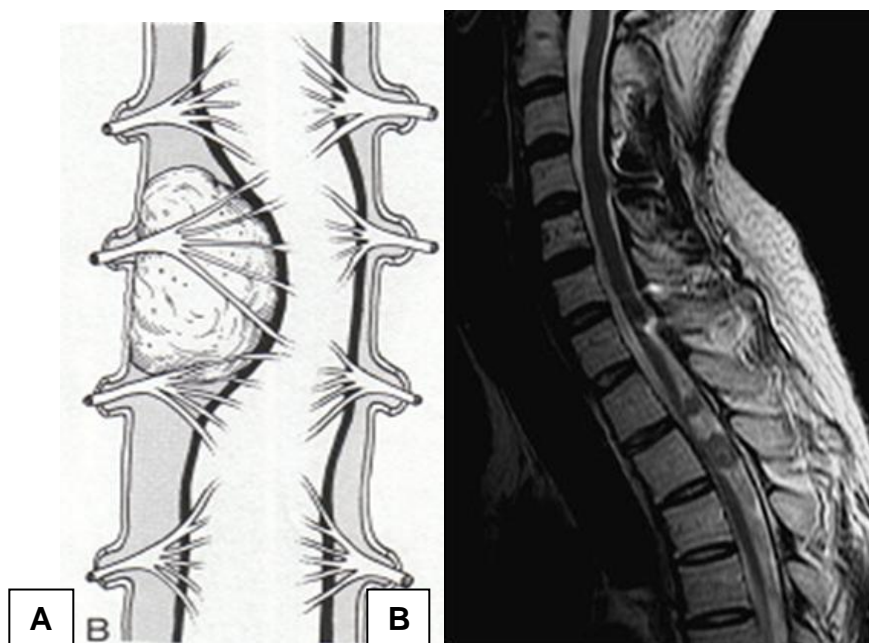


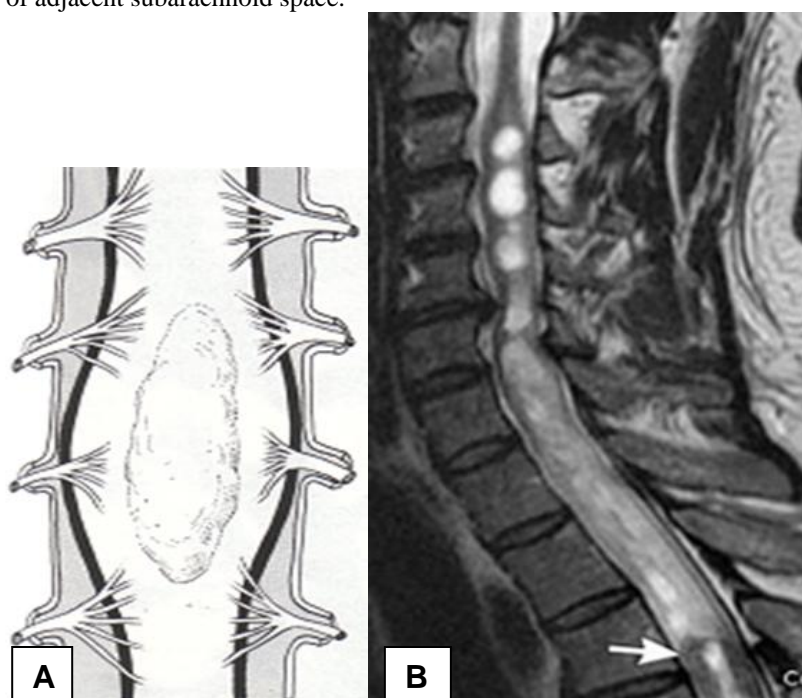
Fig No 1 : Schematic(A) and sagittal T1WI (B) and T2WI(C) MR images showing MRI features of extradural spinal tumors (Courtesy : myradnotes.wordpress.com and Atlas, Scott W et al. Magnetic Resonance Imaging of the Brain and Spine:4th Edition,2009)

**Intradural extramedullary tumours(Fig 2):** The tumours located in the subarachnoid space between the dura and spinal cord. They will be seen as intradural filling defect outlined by sharp meniscus of CSF with enlarged ipsilateral subarachnoid space up to mass and cause deviation of the spinal cord away from the mass.<sup>8</sup>



**Fig No 2 : Schematic(A) and sagittal T2WI MR images(B) showing MRI features Intradural extramedullary spinal tumors** (Courtesy : myradnotes.wordpress.com and Atlas, Scott W et al. Magnetic Resonance Imaging of the Brain and Spine:4th Edition,2009)

**Intradural intramedullary tumours( Fig 3):** The tumours located within the spinal cord and cause cord expansion – essential imaging criteria or focal or diffuse multi-segmental smoothly enlargement of the cord with gradual effacement of adjacent subarachnoid space.<sup>8</sup>



**Fig No 3 : Schematic(A) and sagittal T2WI MR images(B) showing MRI features Intramedullary spinal tumors** (Courtesy : myradnotes.wordpress.com and Atlas, Scott W et al. Magnetic Resonance Imaging of the Brain and Spine:4th Edition,2009)

#### **EXTRADURAL TUMORS**

Extradural tumors commonly arise from the

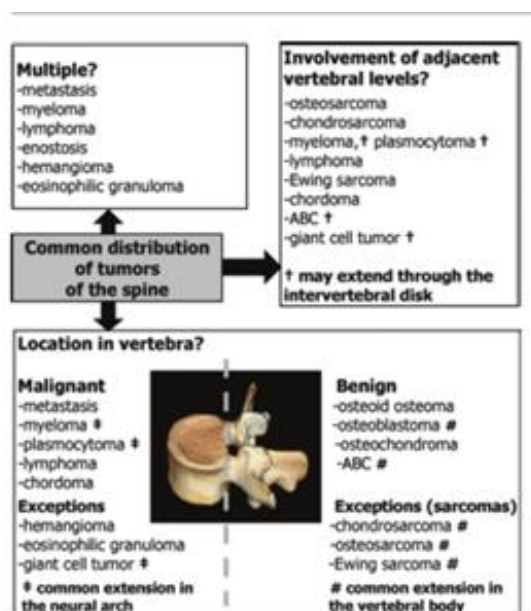
bone but can also develop in the soft tissues near the spine but outside of the spinal cord, (Fig no-4).

Differential diagnosis depends upon the site of origin and distribution of the tumors.<sup>9,12</sup> Given the degree of osseous involvement, Conventional radiographs and computed tomography scans are often necessary for the full evaluation of these lesions  
MRI is useful to assess the soft-tissue and cartilaginous

components and the extent of tumour impingement on the neural elements. Extradural tumors can be divided into primary lesions and metastatic disease, primary lesions can be subdivided further into benign and malignant tumors.<sup>9</sup>(Table no- 1)

**Table No 1 : Extradural tumors**

Benign tumours	Malignant tumors:
Hemangioma, Osteoblastoma, osteoid osteoma, Osteochondroma, Giant cell tumour, Aneurysmal bone cyst, Eosinophilic granuloma, Chordoma, Sacrococcygeal teratoma	Multiple myeloma, Plasmocytoma, Ewing’s Sarcoma, Osteosarcoma, Chondrosarcoma,



**Fig No-4 : Site of origin and Distribution of extradural spinal tumors(courtesy: Rodallec et al Diagnostic Imaging of Solitary Tumors of the Spine: What to Do and Say: RadioGraphics 2008; 28:1019–1041 )**

**Vertebral Hemangioma (Fig no-5) :**

It is a benign vascular tumor and most common benign tumour of spine.<sup>1</sup> These lesions can be solitary (66%) or multiple (34%).<sup>13</sup> Most commonly occur in the thoracic region(60%). Most occur in the vertebral body and about 10% extend into the posterior

elements.<sup>8</sup> MR is extremely sensitive in the detection of hemangiomas. These are hyperintense on both T1-weighted and T2-weighted images.<sup>8,14</sup> This high signal reflects the adipose tissue in these lesions rather than a hemorrhagic component.

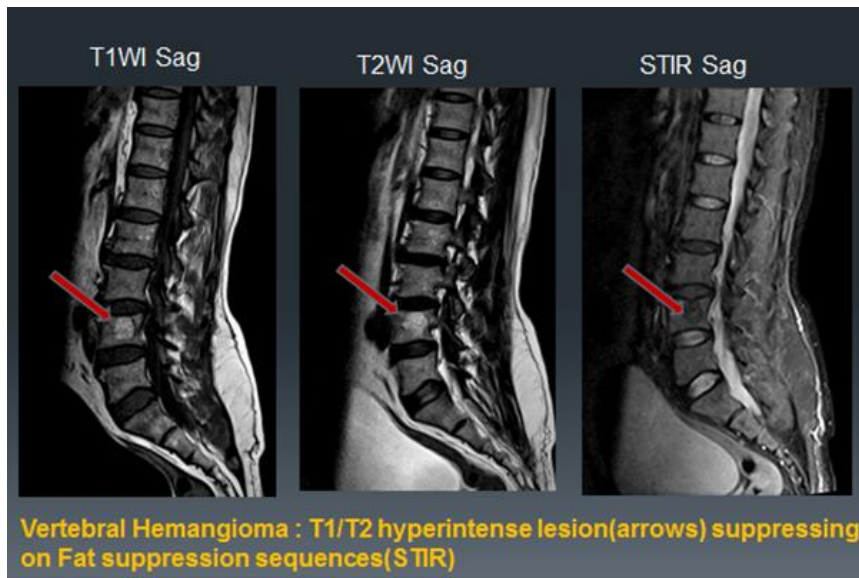


Fig No-5 : Vertebral Hemangioma

**Chordoma** (Fig no-6):

They arise from remnants of the notochord.<sup>15</sup> 50% arise in the sacrum, 35% in the clivus, and 15% in the vertebrae.<sup>16,17</sup>

On MRI, 75% of chordomas are isointense to cord on T1-weighted images and 25% are hypointense.

The lesions are high signal on T2-weighted images.<sup>18</sup> 75% of cases show internal septations and a surrounding capsule of low signal intensity. Areas of hemorrhage and cystic changes can be seen. Prominent postcontrast enhancement is seen.<sup>19</sup>

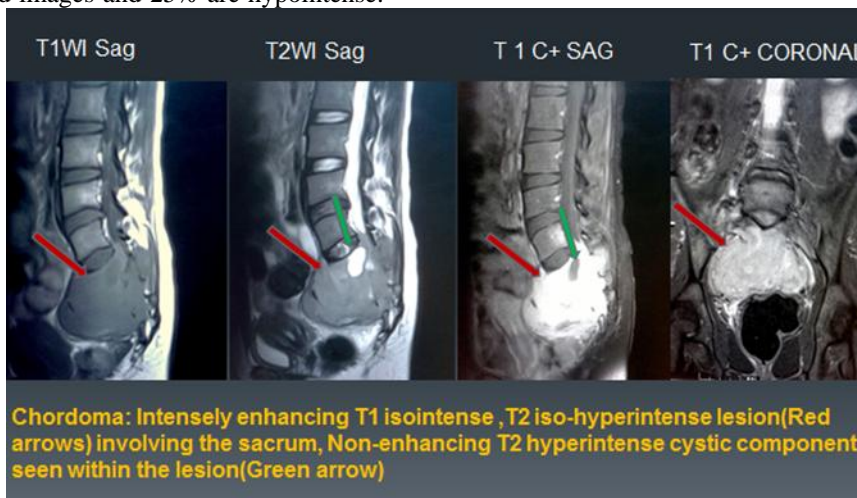


Fig No- 6 : Chordoma involving the sacrum

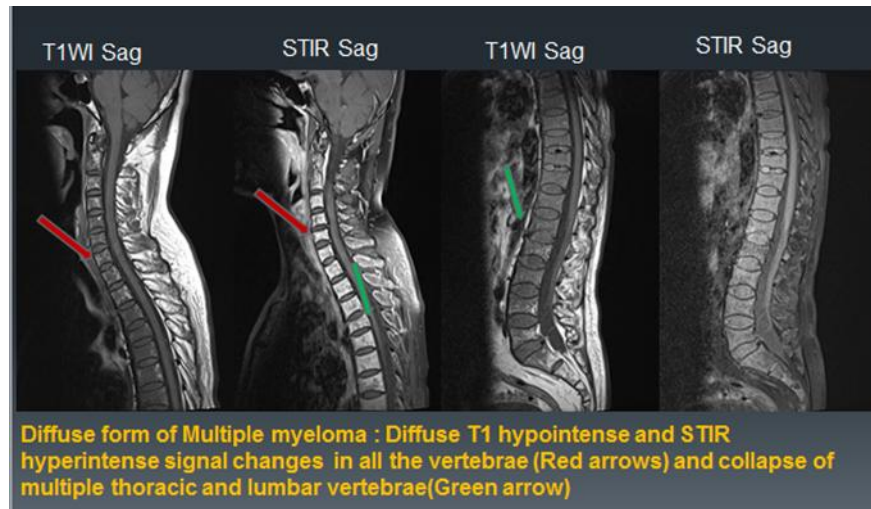
**Multiple myeloma** (Fig no-7):

Most frequent primary malignant tumour of the spine.<sup>1</sup> Multiple myeloma represents a clonal B-lymphocyte neoplasm of terminally differentiated plasma cells.<sup>20</sup> The myeloma cells displace normal hematopoiesis in the bone marrow, resulting in anemia, leukopenia, and thrombocytopenia. Myeloma causes osseous destruction of first the bone marrow and then

the bone itself.

MRI reveals five different infiltration patterns.<sup>21</sup>

1. A normal-looking bone marrow signal (28%).
2. Focal myeloma infiltration (30%).
3. Diffuse bone marrow infiltration (28%).
4. A combined focal and diffuse infiltration pattern (11%).
5. Salt-and-pepper pattern (3%).



**Fig No-7 : Multiple Myeloma**

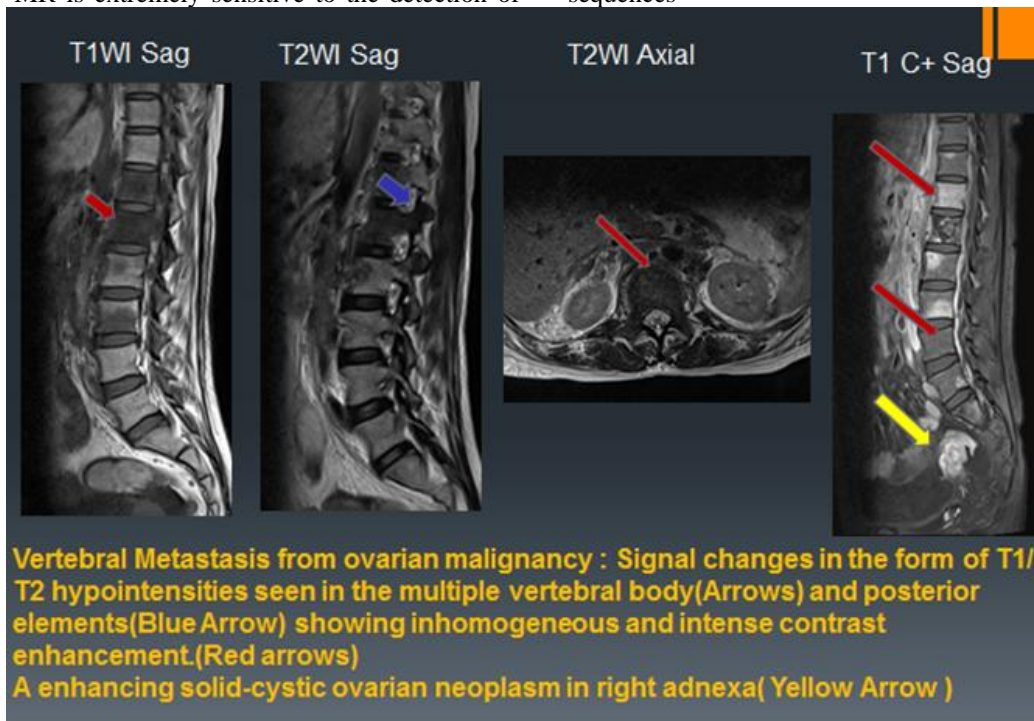
**Metastasis (Fig No-8):**

The spine is the second-most-common location for metastatic disease to the CNS in patients with malignancies, after the brain.<sup>22</sup> Myeloma, breast carcinoma, prostate carcinoma, lung carcinoma, and lymphoma are often metastasize to vertebral bodies.<sup>8</sup> Multiple lesions are commonly seen. Most frequent in the thoracic spine followed by the lumbar spine. Most lesions are osteolytic; osteoblastic metastasis occur frequently with prostate and breast primaries.<sup>1</sup>

MR is extremely sensitive to the detection of

metastasis in the vertebral bodies or extradural space.<sup>8</sup> Impingement on the thecal sac is well delineated on MR.

On unenhanced T1-weighted images, appears as low intense lesions. Rarely, metastatic lesions are hemorrhagic and appear of high signal intensity on T1-weighted images. On T2-weighted images, they may have a varied appearance and may be hypointense, isointense, or hyperintense. Marked sclerotic metastasis are hypointense on both T1-weighted and T2-weighted sequences



**Fig No-8: Vertebral metastasis from Ovarian neoplasm**

**INTRA-DURAL                      EXTRA-MEDULLARY  
TUMOURS**

Tumours in the intradural extramedullary space can be primary and secondary diseases.

Primary tumors, such as meningiomas and nerve sheath tumours, generally are well seen on noncontrast MR images.<sup>23</sup> These tumors tend to be compact and to stand out against the lower intensity surrounding CSF on T1-weighted sequences. On T2-weighted sequences, contrast is reversed and the tumors often appear of lower signal intensity against the high intensity of CSF.<sup>8</sup>

Secondary tumors include lepto-meningeal drop metastasis from the primary brain tumours.<sup>1,8</sup>

**Nerve Sheath Tumours ( Fig no-9 & 10):**

Include neurofibroma and schwannoma that arise from Schwann cells of nerve sheaths.<sup>24</sup> Schwannomas are generally solitary, do not envelop the

adjacent nerve root which usually is the dorsal sensory root and clinically are not typical of neurofibromatosis.<sup>8,25,26</sup>

Neurofibromas are frequently are multiple, envelop the dorsal sensory root and usually are associated with neurofibromatosis, even when single.<sup>8,24,25,27</sup>

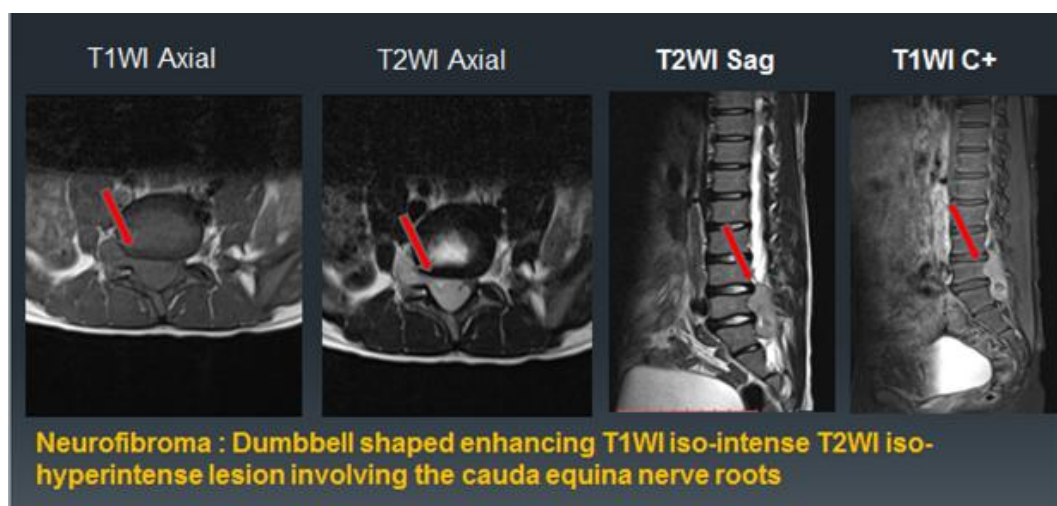
Nerve sheath tumors are the most common intraspinal lesion, representing 16% to 30% of all intraspinal masses.<sup>8</sup> Most common location is cervical region, followed by the lumbar and thoracic regions.<sup>28</sup>

On MRI, Nerve sheath tumors are hyperintense on T1 and T2-weighted images.<sup>29,30</sup> They frequently show central areas of decreased signal intensity on T2 WI which may represent denser areas of collagen and Schwann cells.

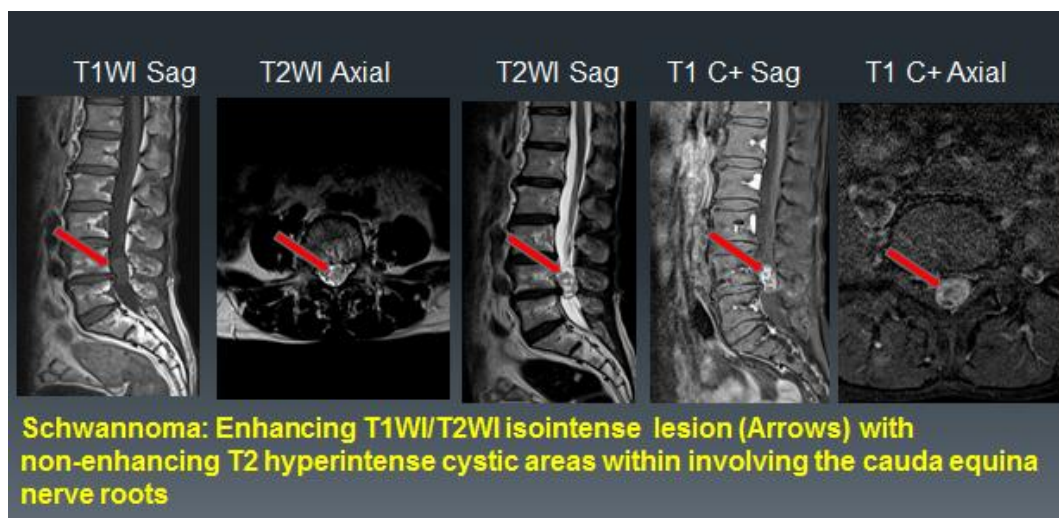
MRI can differentiate plexiform neurofibromas from malignant nerve sheath tumors. On MR, both benign and malignant lesions show inhomogeneity.<sup>31</sup>

**Table No 2 : Benign and Malignant nerve sheath tumours<sup>31</sup>**

	<b>BENIGN PLEXIFORM NEUROFIBROMA</b>	<b>MALIGNANT NERVE SHEATH TUMOUR</b>
<b>Margins</b>	Smooth	Irregular and infiltrative
<b>Central area of low signal intensity on t2-wi</b>	Frequent	Less frequent
<b>Size</b>	Smaller	Larger



**Fig No-9 : Dumbbell shaped neurofibroma in the lumbo-sacral region**



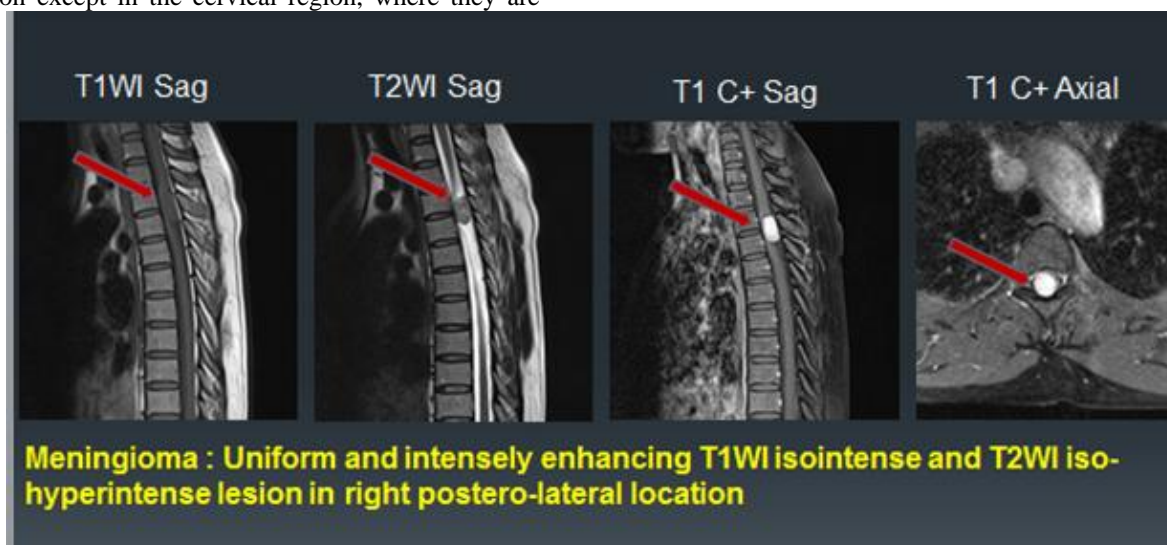
**Fig No-10 : schwannoma in the lumbo-sacral region**

**Meningioma (Fig no-11):**

Meningiomas are common in adults.<sup>32-34</sup> with 60% to 80% seen in females.<sup>32</sup> Meningiomas in the spine tend to be encapsulated and are attached to the dura. They do not invade the spinal cord but displace it. They are usually posterolateral in location except in the cervical region, where they are

more likely to be anterior.

On MRI, in T1-weighted images, are hypointense to isointense to the spinal cord, in T2-weighted images, are slightly hyperintense to the spinal cord. On contrast administration, they enhance immediately, intensely, and homogeneously.<sup>8</sup>



**Fig No-11 : meningioma in the thoracic region**

**Spinal Leptomeningeal metastasis (Fig No-12):**

Both primary intracranial neoplasms and systemic tumors may spread to the CSF. Primary intracranial neoplasms are the most common, especially in the pediatric population.

Contrast-enhanced MR scans are very sensitive to the detection of subarachnoid tumor in the spine.<sup>8</sup> In some cases, tumor may coat the cord or the

nerve roots, resulting in a fine layer of enhancement overlying all the structures. In other cases, tumor growth may be very local rather than diffuse, resulting in the appearance of multiple nodules in the subarachnoid space. Finally, in severe cases, enhancement of the entire thecal sac may be seen as a result of tumor permeating all of the CSF space.



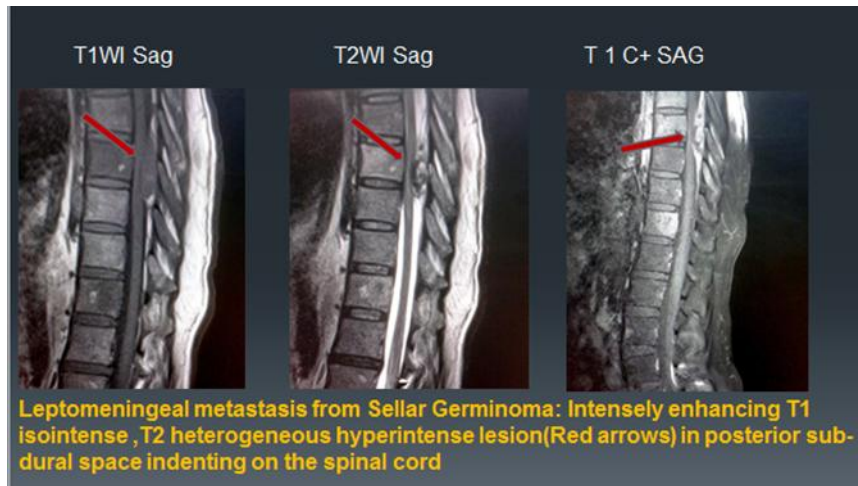


Fig No-12 : Leptomeningeal metastasis from intracranial Germinoma

### INTRAMEDULLARY TUMORS

Intramedullary tumors arise from the parenchyma of the spinal cord or nerve root and account for approximately 16% to 25% of spinal neoplasms.<sup>9</sup>

Gliomas are the most common tumor occurring in this compartment (90% of intramedullary

tumors). In adults, ependymomas are more common than astrocytomas, but in children this order is reversed and astrocytomas are more common. Many lesions may be associated with syringomyelia or cyst-like cavities within the spinal cord.<sup>9</sup>

Table No. 3 : Intramedullary Spinal cord tumours

Common	Less common
Ependymomas Myxopapillary ependymoma Astrocytomas Pilocytic astrocytoma Anaplastic astrocytoma Hemangioblastoma	Subependymoma, Ganglioglioma, Paraganglioma, Metastasis, Lymphoma, PNET, Neurocytoma, Oligodendroglioma, Mixed glioma, Glioblastoma multiforme

#### Astrocytoma(Fig no-13):

Astrocytomas are especially more common in children and second most common in adults. They represent more than 50% of intramedullary mass lesions in children.<sup>8</sup> Astrocytomas most often are located in the thoracic cord and cervical cord.

On MRI, they are typically eccentrically located within the posterior spinal cord and cause fusiform expansion of the cord, are diffusely infiltrative and several spine segments are involved. Cystic

components are present in 30%, Cysts can be either intratumoral or rostral and caudal. Cysts are either neoplastic or non-neoplastic. On T1-weighted images, these lesions appear of low signal intensity, On T2-weighted images, these lesions and the associated edema appear of high signal intensity. After contrast administration, these lesions almost always enhance.<sup>8</sup> Cyst show high signal on T2 weighted images and neoplastic cysts show peripheral rim like enhancement.

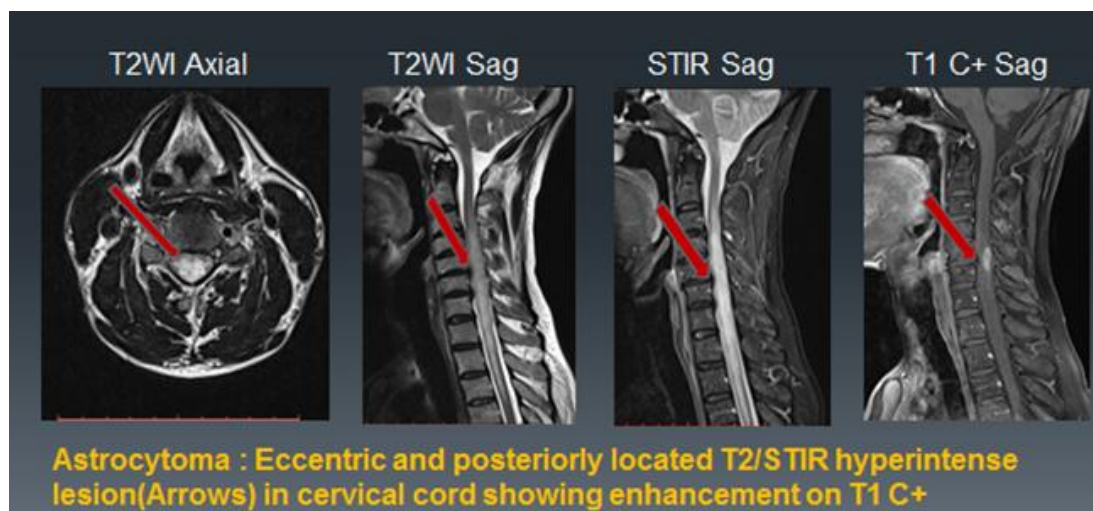


Fig No-13 : Astrocytoma in the Cervical Region

**ependymoma** (Fig No-14 & 15):

It is the most common primary cord tumor of the lower spinal cord, conus medullaris, and filum terminale<sup>34</sup> and is the most common intramedullary tumors in adults.

MRI:<sup>1,8</sup> They tend to be well circumscribed and centrally located in the cord, hypointense or isointense with the cord on T1-weighted images and typically heterogeneous on T2-weighted images. Areas of

hemorrhage may appear of varying intensity on both sequences. Hemosiderin deposition is encountered frequently, particularly at the superior and inferior borders of the tumor, and appears as mildly hypointense on T1-weighted images and markedly hypointense on T2-weighted images. Areas of hypercellularity are seen commonly as regional hypointensity within the bulk of a relatively hyperintense lesion on T2-weighted images. After the administration of contrast, ependymomas tend to enhance intensely but irregularly.



Fig No-14 : Ependymoma in the Lower Thoracic Region

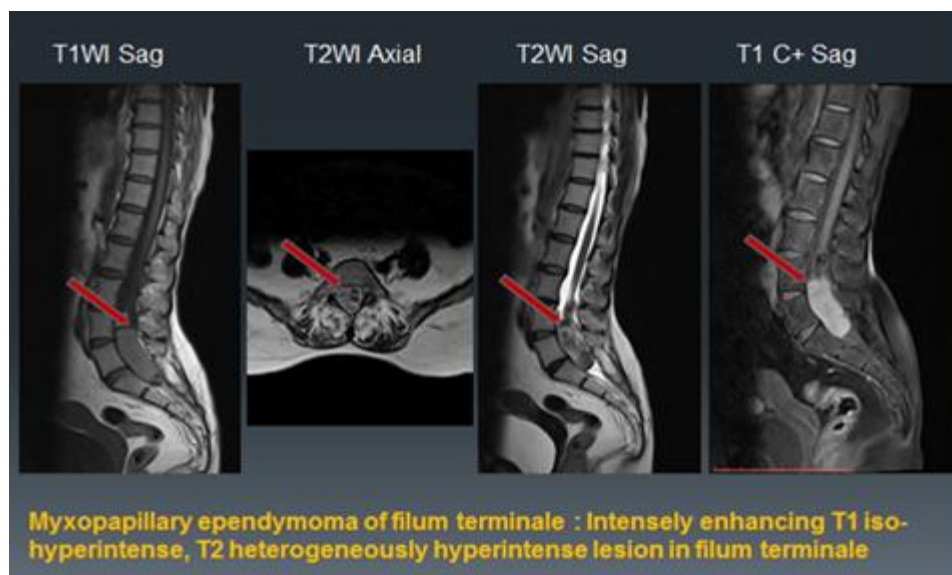


Fig No-15 : Myxopapillary Ependymoma in the Filum Terminale

**Lipoma** (Fig no-16):

Lipoma is the most common developmental intradural mass lesion. Spinal lipomas are most often

located in the lumbosacral region and are commonly associated with spinal malformations. On MRI, in that they parallel fat in signal intensity.<sup>8</sup>

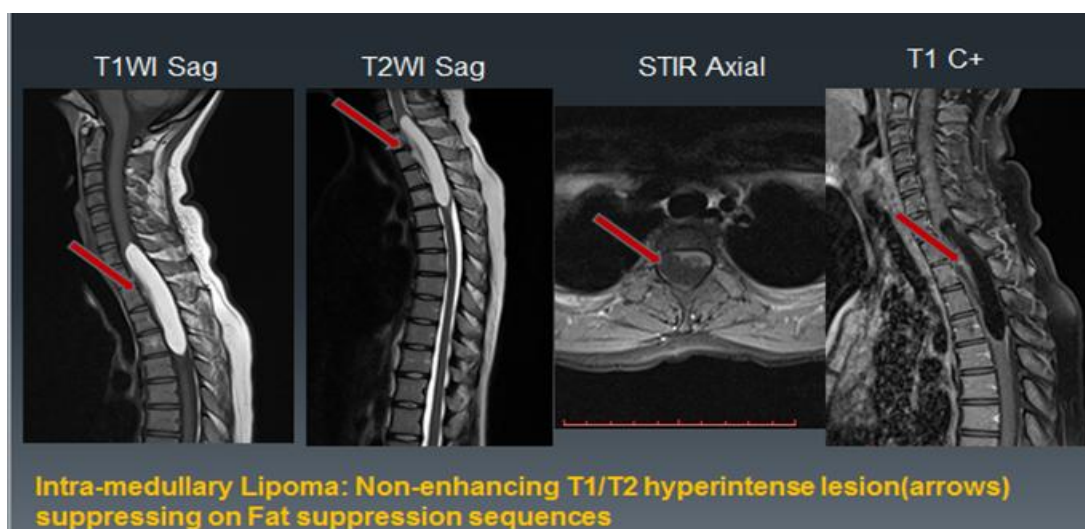


Fig No-16 : Intramedullary Lipoma in the Cervico-Thoracic Region

**CONCLUSION**

Spinal tumors accounts for approximately 15% of cranio-spinal tumours and can cause significant morbidity and can be associated with mortality as well. MRI is helpful to classify the tumours into different compartments and narrow down the differential diagnosis so MRI is the essential procedure of choice for the work up of all spinal tumors and plays an integral role in evaluation and improving anatomic delineation and early diagnosis of spinal tumors and also plays an important role in follow-up and to monitor response to treatment.

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