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Research Paper

MRI Evaluation of Intermedullary 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 mortality. Accounts for approximately 15% of cranio-spinal tumours. MRI has become the modality ofchoice for spinal cord lesions as it provides anatomic delineation. It alsoprovides image of compartments and is able to access the presence ofenhancement, cystic change and blood product.*
Aims and objectives :
1. To study the magnetic resonance appearance of various neoplasm of spinal cord.
2. To calculate the sensitivity and specificity of MRI in mass lesions.
Materials and Methods:
During the period from April 2017 to October 2018 a prospective study of 25 patients was carried out. The study group consisted of patients from different parts of India. Patients diagnosed or suspicious of having spinal cord lesions referred for MRI were studied.
Each patients following details were taken and documented: Name, Age, Sex, Medication history, Fever, History of spinal cord trauma, Malignancies or other diseases, Clinical symptoms (backache, numbness, tingling, bladder- bowel incontinence, fever)., Clinical signs, Clinical diagnosis.
Different MRI sequences were taken for each patient. Histo-pathological examination was obtained in patients of spinal cord tumors.Spinal DSA was done in patients of vascular malformation.
Inclusion Criteria were taken as: All patients who have given their consent,Patients presenting with spine deficit such as spinal trauma and benign versus malignant lesions, Suspected cases of spinal cord injuries/lesions. Presenting with new deficits, Known Patients with neoplastic progression of the benign lesions previously diagnosed on CT (Computer Tomography)/MRI (Magnetic Resonance Imaging).
Exclusion Criteria were taken as: All the patients with contradiction to MRI scan, like patients with cardiac pacemakers, metallic implants and cochlear implants, Lack of consent from patient , clinical or ethical committees and critically ill patients who are unable to co-operate in magnetic resonance imaging procedure, Patients with claustrophobia.
Statistical analysis
Data was entered in Microsoft office excel worksheet.
Results
This study contained total 25 patients with spinal cord neoplasm. Outof them 17 had primary cord tumors, 4 vascular malformations and 4 had metastasis to cord.
Primary spinal cord Tumor
In this study out of 17 patients of intramedullary tumors number ofEpendymomas were 6, number of Astrocytomas was 5,hemangioblastoma were 2, Primitive Neuroectodermal tumor was 1,arachnoid cyst was 1, Ganglioglioma was 1, Dermoid was 1.
Conclusion:
1. MRI is the modality of choice for the evaluation of spinal tumors.
2. MRI is accurate specific and non-invasive technique for diagnosis of spinal cord neoplasm and to study extent and characterization of thelesions.
3. The sensitivity and specificity for the mass lesions in this study cameout to be 0.67 and 0.75 respectively.
KEY WORDS: *Compartment classification, magnetic resonance imaging, Spinal tumours dural sac and spinal cord: extradural; intradural- extramedullary; or intramedullary.*

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I. INTRODUCTION:

A spinal tumor is an abnormal mass of tissue within or surrounding the spinal cord and spinal column. Intraspinal 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. Intraspinal 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. 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. Lesions can occasionally compromise more than one compartment.

The high and worldwide appeal of MRI has also ensured development ofequipment that are now clinically applicable to man with great benefit inassessments of all path physiological states cost and time effectively. MRI has been playing an increasingly important role in the management of spinal trauma patients. With the advent of different MRI sequencesone can optimally visualize various aspects of spinal cord tumor.

Magnetic resonance imaging (MRI) is a noninvasive medical test andUnlike. As the name suggests MRI uses a powerful magnetic field, radio frequency pulses and a computer to produce detailed pictures of organs, soft tissues, bone and virtually all other internal body structures. It permits high-resolution imaging of not only the osseous structures but also the soft-tissue structuresin 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.1 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. MR images are based on proton density and proton relaxation dynamics. These vary according to the tissue under examination, as there physicaland chemical properties need to be reflected, therefore helping inevaluating various tissues using different sequences.(1)

MRI is widely used in hospitals and clinics for Medical diagnosis, Staging of disease, Follow-ups without exposing the body to ionizing radiationMR images can then be used in multiple ways like examination on acomputer monitor, transmitted electronically, printed or copied to a CD oruploaded to a digital cloud server.MRI scans are capable of producing varying chemical and physical data, in addition to highly sensitive spatial images. The sustained increase in
demand for MRI within the healthcare industry is slowly leading to cost
effectiveness and timely diagnosis(2).

II. DISCUSSION:

Primary Neoplasms Of Spinal Cord

Spinal cord Ependymoma

Ependymomas have origin from ependymal cell lining the central canal and are located centrally within the cord. Sensory symptoms are more because of close proximity to the spinothalamic tracts. These ependymoma in the pediatric population represent 30% of pediatric intramedullary spinal neoplasms and have second most common occurrence. Usually they occur sporadically but may be associated with neurofibromatosis type 2.

Most of theses ependymomas are well demarcated and compress the adjacent cord rather than infiltrating it and histologically benign.

1.On MRI, ependymomas appear typically as central wellcircumscribed iso to hypointense lesions on T1-weighted images and as iso to hyperintense on T2-weighted images. Most of these
lesions are compressive in nature therefore a cleavage plane may be seen. Contrast enhancement is variable and may be homogeneous or heterogeneous, but some degree of enhancement always seen. On T2W images a ―cap sign‖ appearing as a rim of low signal along the border of the neoplasm is seen and it represents hemosiderin deposition due to hemorrhage.

2. Ependymomas usually have polar cysts, but intra-tumoral cysts are less common. CSF dissemination is mainly associated with highergrade tumors. The prognosis for patients with spinal ependymoma depends on the tumor grade, degree of resection, and presence or absence of CSF dissemination (3,4).

In this study total 6 patients had spinal cord ependymomas of total 17 patient with cord tumors (35.30%) comprising most common intramedullary tumor.

In this study tumor margins were well defined in 4patient and poorly defined in the rest of them. All the tumors were hyperintense on T2W1. Cord expansion was symmetrical in all patients. Intratumoral cyst was present in 3 patients. On intravenous contrast administration, enhancement was present in all patients. 4(66.66%) patient showed homogenous enhancements whereas 2 (33.33%) patient showed heterogeneous enhancements.

Differential diagnoses of spinal cord Ependymoma are:
- Poorly demarcated tumor, eccentric location with in spinal cord with asymmetrical cord expansion favors Astrocytoma over Ependymoma. Hemorrhage and cyst formation is less common in Astrocytoma compared to ependymomas. Astrocytoma more commonly show inhomogeneous enhancement on contrast administration, while Ependymoma generally enhance homogenously
- Irregularly patchy hypointense area with presence of flow voids favor hemangioblastomas
- Old age patients clinical history (known case of primary tumor)and presence of leptomeningeal enhancement are helpful to differentiate spinal cord metastasis from Ependymoma
- Small filum terminale Ependymoma should be differentiated from schonnoma, ganglioma and paraganglioma.
- Large destructive myxopapillary Ependymoma can be confused with aneurismal bone cyst, chordoma and giant cell tumor.

Ependydomas

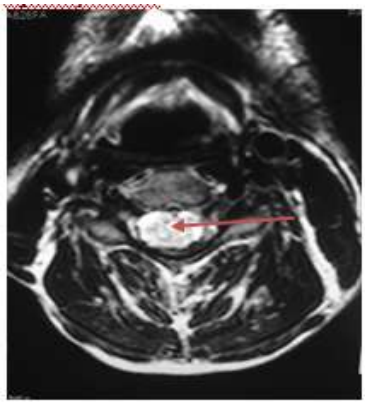

Image 1 (a)

Image 1 (a & b). (a) T2W axial (b) T2W saggital (⟶) lesion

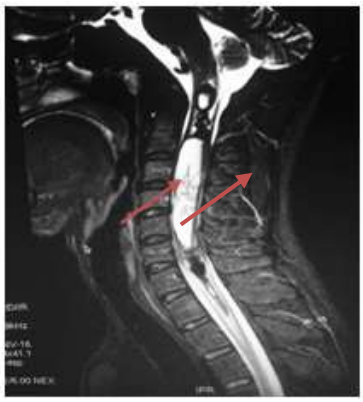

Image 1 (b)

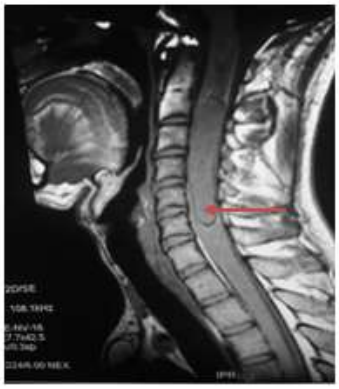

Image 2 (c)

Image 2 (c & d). (c) T1W sagittal (d) T1W saggital- Gd (

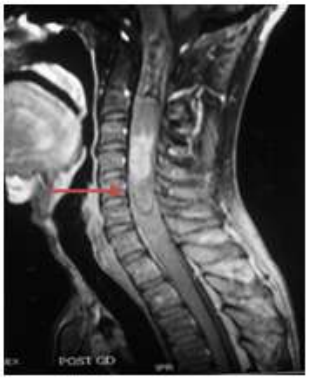

Image 2 (d)

Myxopapillary Ependymomas.

Lobulated, soft, sausage-shape mass in filum terminale that is isointense relative to cord on T1WI and hyperintense on T2WI. Hyperintensity on both T1WI and T2WI may be noted occasionally, a finding that reflect mucin content or hemorrhage. (6)

Spinal Cord Astrocytoma:

Astrocytomas of the spinal cord are rare tumors arising from astrocytes in the spinal cord. Most of theses spinal cord astrocytomas are benign, low-grade tumors that are mainly diagnosed with magnetic resonance imaging. These astrocytomas usually cause cord expansion and is associated with cysts and a variable enhancement pattern.(7) Patients usually present with symptoms at or below the level of the spinal cord tumor. The most common signs and symptoms of spinal cord tumors include back pain, numbness and paresthesias, unilateral or bilateral weakness, ataxia, bowel or bladder dysfunction, spasticity, and gait difficulties. The extent of the tumor mass, the enhancement pattern of the tumor, and the presence of associated tumoral cysts and syringeal cavities are well visualized on MRI. (8)

1.The spinal cord usually expands at the level of involvement. This feature helps in differentiating spinal cord tumors from non-neoplastic diseases, like inflammatory or demyelinating processes.
2.T1- and T2-weighted images demonstrate the extent of tumor, the solid and cystic components of the tumor, spinal cord edema, reactive cysts, and syringeal cavities. Spinal cord tumors are typically isointense or hypointense on T1-weighted images and hyperintense on T2-weighted images(9). T1-weighted, gadolinium-enhanced MRI scans add information for characterizing the enhancement pattern of the tumor by distinguishing between enhancing and non-enhancingcomponents of tumor and by distinguishing between tumoral and reactive cysts. Astrocytomas of the spinal cord vary in size and length, with 7 vertebral body segments being the average length. Tumoral enhancement is variable, and some astrocytomas are completely nonenhancing.

3. The tumor margins may be well defined or indistinct.

Tumoral cysts are a common finding, and reactive cysts may be observed at the tumoral poles. Drop metastases (i.e., intradural extramedullary spinal metastases that arise from intracranial lesions) in the subarachnoid space are most commonly seen with high grade astrocytomas but can occasionally occur with low-grade astrocytomas. (4)

This study included 5 patients with cord Astrocytoma, comprising 2nd most common spinal cord tumor after Ependymoma. Out of 5 patienttumor margin was well defined in 3patient (60%)
Poorly defined in 2 patient (40%) Tumor was eccentric with asymmetric cord expansion in 4 patient while symmetrical cord expansion was present in 1patient
Intra-tumoral cyst was present in 4patient All tumors were hypointense in T1W1 and hyperintense in T2W1 On intravenous contrast administration in patchy enhancement was
present in 1 patient, heterogeneous enhancement in 3 while absent in 1 patient.

Astrocytoma

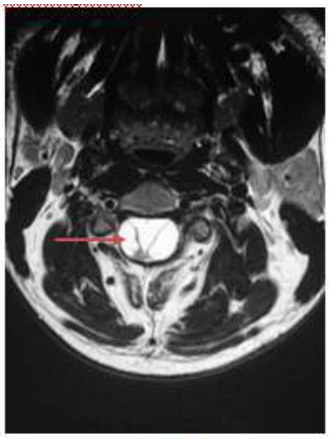

Image 3 (a)

Image 3 (a & b). (a) T2W axial (b) T2W sagittal (c & d) (c) T1W sagittal (d) T1W sagittal - Gd

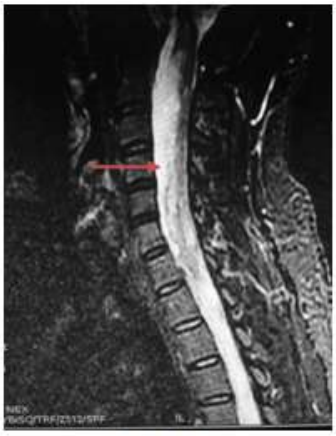

Image 3 (b)

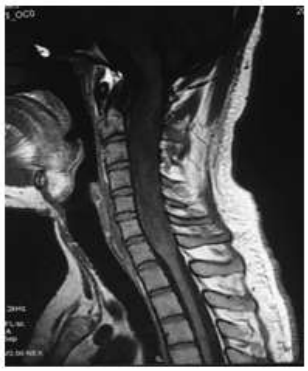

Image 3 (c)

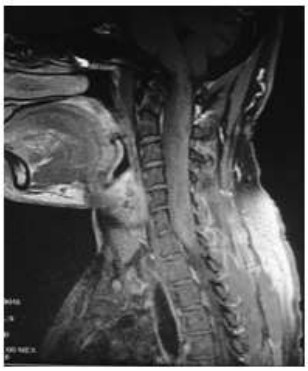

Image 3 (d)

Spinal Cord Hemangioblastoma

Hemangioblastomas are benign vascular tumors that are seen primarily in the cerebellum and spinal cord. Spinal cord hemangioblastoma accounts for approximately 3% of all intramedullary spinal tumors. These tumors occur more commonly as sporadic isolated lesions in 70-80% of cases rather than as multiple lesions in the cerebellum and retina as part of the von Hippel–Lindau disease. Hemangioblastomas may lead to significant neurologic deficits. (10,11)

Hemangioblastomas are a rare tumor and their most common location is in the posterior cranial fossa . The second most common location is the spinal cord. Sporadic hemangioblastomas occurmuch later in life, have less neurological deficit, and have a better prognosis than their Von-Hippel Lindau counterparts. Patients with Von-Hippel Lindau syndromeare at higher risk of recurrence and requiring lifelong follow up and surveillance.

1.Gadolinium enhanced MRI is the primary diagnostic imaging modality for hemangioblastomas of the spine. These tumors are mainly found on the dorsal aspect of the cervical and thoracic spinal cord and appear as cystic lesions with mural nodules. On T1-weighted images they are seen as homogenously enhancing tumor with a rostral-caudal cyst along with serpentine signal voids on the dorsal surface of the spinal cord. On T2-weighted images these lesions

demonstrate the extent of the associated edema and cyst formation. Gadolinium enhanced MRIs may highlight a mural nodule within the cyst wall.

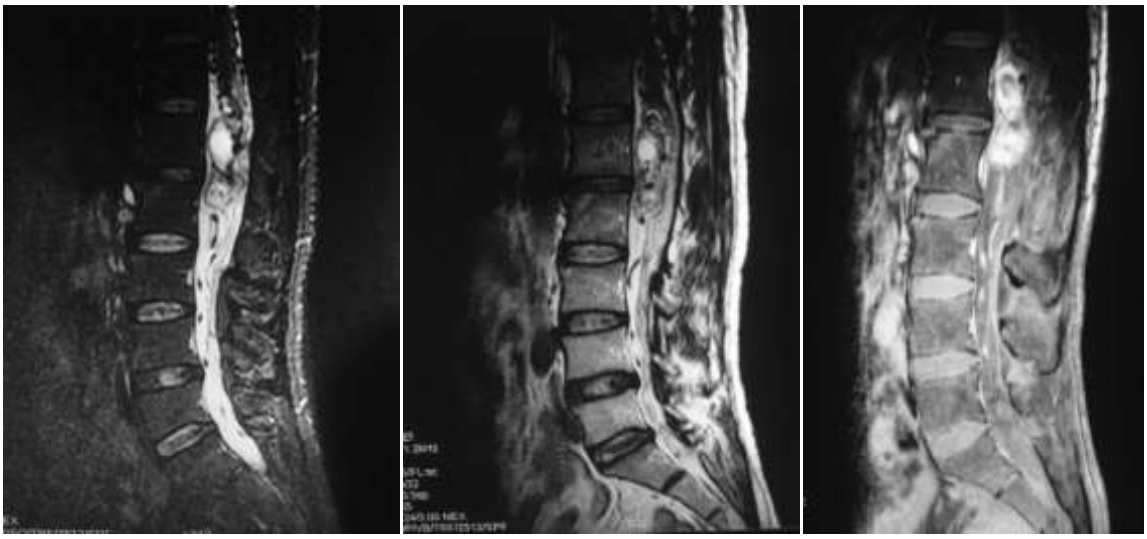

Image 4a (T2W Sagittal) Image 4b (STIR Sagittal) Image 4c (T1WSagittal Gd)

Image 4 (a,b,c)

Spinal Cord Ganglioglioma

Gangliogliomas are rare primary tumors o0f central nervous system with very rare involvement of spinal cord which is composed of a mixture of neoplastic mature neuronal elements and glial elements. Cervical cord is most common site, with rare involvement of conus. Children are commonly affected.

1. MR appearance of ganglioglioma is variable most commonly appearing as a circumscribed solid or mixed solid and cystic mass involving a long segment of the cord with T1 hypointensity and T2 hyperintensity. Variable enhancement patterns are seen ranging from minimal to marked, and may be solid, rim, or nodular. Surrounding cord edema and syringomyelia and peritumoral cysts is seen associated with reactive scoliosis.

Spinal Cord Paraganglioma

Spinal cord paragangliomas are rare benign lesions of neuroendocrine origin, usually arise in carotid body and glomus-jugulare. Spinal canal paragangliomas are rare mainly found in cauda equina and filum terminale with the peak incidence in 50-60 years of age.

1. Lesion appears isointense on T1W images and hyperintense on T2W sequences and show enhancement after Gadolinium administration. Similar features are also seen in other lesions for e.g. ependymoma, schwannomas, meningiomas, dermoid tumours or lipomas.

2. Scintigraphy with I-MIBG helps in localizing these extra-adrenal paragangliomas.

Spinal Cord Metastasis

Intramedullary spinal cord metastasis is uncommon. Small cell lung cancer is the most common primary tumor that metastise to spinal cord, however other tumors that metastise to spinal cord includes breast, kidney, colorectal, cervical, ovarian cancers.

1. MR imaging features of intramedullary metastases appear as a solitarylesion, involving mainly the thoracic spinal cord, located eccentrically within the cord, causing expansion of cord appearing hyperintense on T2 and isointense on T1 relative to cord along with perilesional edema. On postcontrast imaging they enhance homogenously.

In this study there are 4 patients of spinal cord metastasis(19.04% of total spinal cord neoplasm).

Primary tumor was carcinoma breast in 1patient and lung carcinoma in 3 patients.

Cord expansion was present in 3patient All 4 patients showed homogenous enhancement.

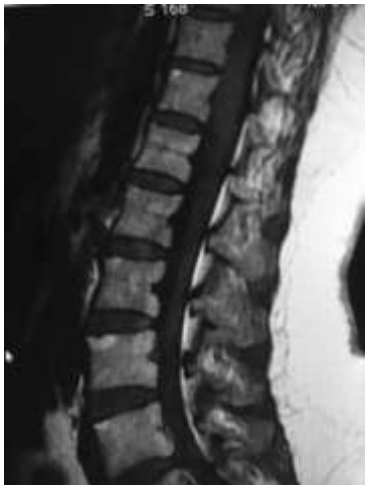

Image 5a (T1W Sagittal)

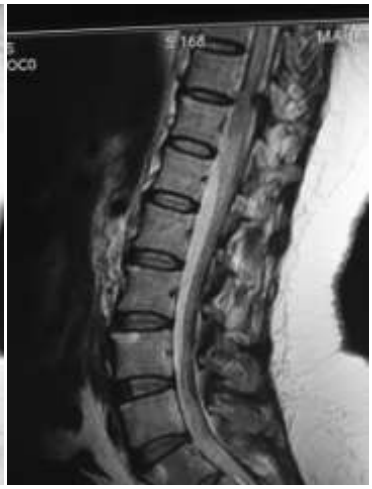

Image 5b (T2 Sagittal)

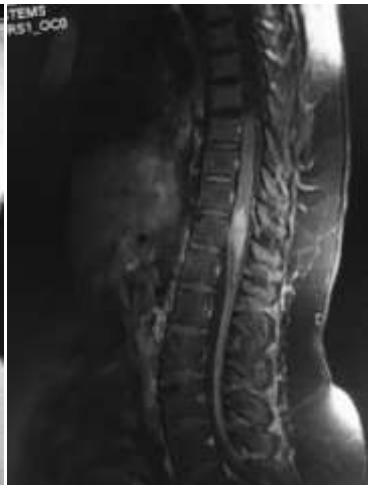

Image 5c (T1WSagittal Gd)

Table 1. Spinal Cord neoplasms

SPINAL CORD NEOPLASM		**No. of patients**	**Percentage**
Spinal cord primary tumor	Ependymoma	6	28.5%
	Astrocytoma	5	23.8%
	Hemangioblastoma	2	9.5%
	PNET	1	4.7%
	Arachnoid cyst	1	4.7%
	Ganglioglioma	1	4.7%
	Dermoid	1	4.7%
Spinal cord metastasis		4	19.04%
		21	100%

Table 2. Enhancement Characteristics in Neoplasms

Enhancement characteristics						
Lesions			Enhancement present			
			homo	Hetero	patchy	absent
Spinal cord primary tumor	Ependymoma	6	4	2	0	0
	%	100%	66.6%	33.3%	0	0
	Astrocytoma	5	0	3	1	1
	%	100%	0	60%	20%	20%
	Hemangioblastoma	2	0	1	1	0
	%	100%	0	50%	50%	0
	PNET	1	0	1	0	0
	%	100%	0	100%	0	0
	Arachnoid cyst	1	0	0	0	1
	%	100%	0	0	0	100%
	Ganglioglioma	1	0	0	1	0
	%	100%	0	0	100%	0
	Dermoid	1	0	1	0	0
	%	100%	0	100%	0	0
Spinal cord metastasis		4	4	0	0	0
%		100%	100%	0	0	0

Table 3. Primary Lesions in Spinal Cord metastasis

Primary lesions in SC metastasis		
Primary lesions	No of pt.	Percentage
CA breast	1	25%
CA lung	3	75%
Total	4	100%

Table 4. Level of Spinal cord involvement in Neoplasms

level of SC involvement in Neoplasms					
	cervical	dorsal	dorso-lumbar	cervico-dorsal	Total
ependymoma	4	1	1	0	6
%	0.66	0.16	0.16	0%	100%
astrocytoma	1	2	2	0	5
%	20%	40%	40%	0%	100%
metastasis	1	0	1	2	4
%	25%	0%	25%	50%	100%

Table 5. Sensitivity and Specificity

DIAGNOSED IN MRI	HAS THE DISEASE ACCORDING TO HISTOPATH	
	DISEASE	**NO DISEASE**
POSITIVE	**16 (TP*)**	**8(FP**)**
NEGATIVE	**8(FN[#])**	**25(TN[##])**
SENSITIVITY	**0.66**	
SPECIFICITY	**0.75**	

* True positive
** False Positive
[#] False Negative
[##]True Negative

III. CONCLUSION:

Spinal tumors can cause sincere morbidity and can be associated with mortality as well. MRI is helpful to classify the tumours and narrow down the differential diagnosis. MRI also 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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