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DIAGNOSTIC EFFICACY OF MRI IN EVALUATION OF SPINAL CORD TUMORS WITH POSTOPERATIVE HISTOPATHOLOGY AS A GOLD STANDARD.

Dr. Ravi Prakash Saini
MBBS MD Radiodiagnosis, Consultant Radiologist, JD Hospital and Research Center, Reengus Rajasthan.

Abstract
Spinal Cord tumours are relatively uncommon lesions, but the symptoms often are nonspecific and may occur first in the late stage of the disease, early diagnosis by imaging becomes the mainstay of treatment of these lesions.The objective of the study was to assess the diagnostic usefulness of M.R.I. in evaluation and characterization of spinal tumours.

Methodology
The current study is a cross-sectional study carried out in S.M.S. Medical College And Attached group of Hospitals, Jaipur over one year. Total of 34 patients was included in the study. All patients having suspected spinal cord pathology referred from Neurosurgery/ neurology/orthopaedics and medicine department for M.R.I. were included in the study. Sensitivity, specificity, positive predictive value and accuracy of M.R.I. for evaluation of spinal tumours were detected comparing it with histopathology findings.

Results
Out of 34 patients 17 (50%) was intradural extramedullary, 16 (47.6.5%) was intradural intramedullary and 1 (2.94%) was extradural. Among the 40 spinal tumours,M.R.I.diagnosed schwannoma (4), Neurofibroma (5), Astrocytoma (5), Meningioma (4), Ependymoma (9), Myxopapillary ependymoma (2), Hemangioblastoma (2), Dermoid(1), Spinal Lipoma (1) and spinal metastasis (1).Sensitivity, specificity, positive predictive value of the M.R.I. in the diagnosis of spinal tumours were 88.23%, 88.23% and 78.94% respectively.

Conclusion
M.R.I. is the preferred method in the diagnosis of the spinal tumour as it can obtain a more accurate, reliable localisation and qualitative diagnosis based on the specific features of different tumours and being non-invasive it is preferred method of choice.

Introduction

Spinal Cord tumours are relatively uncommon lesions but can cause severe morbidities. The global incidence of spinal cord tumours is 9.28 per 100000 population, among which benign lesions comprise 9.19 while malignant is 0.09.(1) Spinal cord neoplasms represent 0.5% of newly diagnosed tumours and only 5–12% of all tumours of the central nervous system.(2) The clinical symptoms are often nonspecific and include back pain, radicular symptoms, and slowly progressive neurological deficits such as weakness, paraesthesia, gait problems, impotence, and bowel and bladder dysfunctions, to mention the most common. Since the symptoms often are nonspecific and may occur first in the late stage of the disease, early diagnosis by imaging becomes the mainstay of treatment of these lesions.A variety of imaging modalities based on C.T. and M.R.I. are widely available. However, M.R.I. with an accuracyof 85% is superior to C.T. in the diagnosis of spinal lesions. The gold standard for diagnosis of spinal lesions is by biopsy, which is invasive and has various disadvantages.

Internationally numerous studies have been conducted which enumerated different spinal lesions based on imaging findings, but there is a shortage of literature pertaining to spinal lesions form India. The current study was planned to analyse and characterise the M.R. images in patients with spinal cord tumours to classify them based on location. These diagnoses were further confirmed using postoperative histopathology.

Method

The study was an observational cross-sectional study conducted in the Department of Radiodiagnosis and Modern imaging, S.M.S. Medical College And Attached group of Hospitals, Jaipur over a period of 1 year. Approval for conduction of study was obtained from the Institutional Ethics Committee. All patients having suspected spinal cord pathology referred from Neurosurgery/ neurology/ orthopaedics and medicine department for M.R.I.were included in the study. Patients with tumors other than spinal cord and with absolute contraindication of M.R.I. (pace-maker or any kind of metallic implants/prosthesis patients those with claustrophobia) were excluded from the study. A sample size of 34, was calculated using formula 4PQ/e2 assuming PPV of M.R.I. in detecting spinal tumours as 92.3%, a relative allowable error of 10%.

All patients were subjected to M.R.I. spine after detailed clinical examinations. The name, age, sex and clinical history of the patients was noted, and location of the tumour was classified based on their M.R.I. report.The M.R.I. findings were correlated with histopathological findings after surgical management has been taken for histopathological examinations of post operative biopsy sample. M.R. imaging of spine with high resolution T1, T2W and postcontrast images using Gd-DTPA serial sections obtained in the sagittal and axial planes with 5 mm section thickness using a phased array surface coil on a 3.0 Tesla Philips ingenia scanner with strength gradient, in the department of Radio diagnosis.

The pulse sequences on M.R. include:-

1. Axial T1
2. Axial T2
3. Sagittal T1
4. Sagittal T2
5. Postcontrast T1 with Fat Suppression

Data was entered using Microsoft excel and descriptive statistics was used for analysis of data.

Results

Majority of the study participants were male 19 (55.88%) while 15 (44.12%) were females. Their age ranged from 2-69 years with a mean of 34.8+/-18 years. The chief complaints experienced by the participants are enumerated in figure 1. It is observed intradural extramedullary lesions were common (26.47%) in middle age group, Intradural intramedullary lesions were common (38.23%) in younger age group (0-30yrs) while In 60 yrs and above intradural extramedullary were common. The distribution of lesions as per segment of the spinal cord is described in table 1. Most common location for cord tumors was lumbar region followed by cervical region and dorsal region. The diagnosis and localisation of lesions of the cord as interpreted from M.R.I. reports are shown in table 2. Ependymoma were the most commonly seen lesions among patients while metastasis was least common. The associated characteristics of lesions as shown by M.R.I. are enumerated in table 3. We found sensitivity,specificity, positive predictive value (PPV) and accuracy of M.R.I. in diagnosing lesions of the spinal cord is 88.23%, 88.23% and 78.94% respectively when compared with histopathology.

Discussion

The study showed that spinal tumours are more common among male predominantly in the middle age group. Duong et al.(3) reported similar finding in their study on final tumours. Back pain was the most commonly encountered symptom which is in congruence with published literature.(4) All the patients based on their M.R.I. findings were grouped in 3 major categories-Intradural extramedullary lesions, intradural intramedullary lesions, extradural lesions. Blommer et al.(5) classified lesions in a similar way in their study.

Intradural Extramedullary Lesions

In our study four patients had **schwannoma**. On MR imaging, schwannomas (also called as neurilemmoma) appeared intradural extramedullary lesions which were hypo intense on T1WI and hyper intense on T2WI and showed heterogeneous contrast enhancement.

Six patients having **neurofibroma** were in elderly age group (above 50 yrs). On MR imaging neurofibromas appeared intradural extramedullary lesion which were hypo intense on T1WI and hyper intense on T2WI and showing heterogeneous contrast enhancement mostly. Schawannomas and neurofibromas are tumors of the spinal nerve sheath are histologically distinct tumors, but are indistinguishable by imaging(6). Both are composed of Schwann cells. Schawannomas almost always arise from the dorsal sensory roots and form well-encapsulated firm masses that compress adjacent tissue, without invading the involved nerve. (5)(6)Neurofibromas are more complex and are composed of Schwann cells mixed with fibroblasts; they involve the parent nerve. They are unencapsulated, often fusiform, and enlarge within the nerve itself. Intradural schwannomas tends to have signal intensity equal to, or less than, that of the spinal cord on T1-weighted images and mild to marked hyperintensity on T2-weighted images. Focal areas of even greater hyperintensity on T2-weighted images often correspond to cystic portions(7), whereas hypointensity may represent hemorrhage, dense cellularity, or collagen deposition.(8)(9)(10)In our cases, schwannomas demonstrated isointensity or hypointense signal intensity on T1-weighted images, high signal intensity on T2-weighted images, and homogeneous or heterogenous contrast enhancement on Gd-DTPA enhanced images. Neurofibroma showed low signal intensity on T1-weighted images, high signal intensity on T2-weighted images, and variable enhancement on Gd- DTPA contrast images. Schwannomas showed heterogeneous enhancement. These variable enhancements corresponded to focal hemorrhage, focal necrosis, myxoid change, and cystic change on pathologic macroscopic findings. Schwannomas and neurofibromas may be indistinguishable by imaging alone, especially when solitary. However, the target sign is more common in neurofibromas, whereas hemorrhagic changes are more common in schwannomas.

Four patients had **Meningioma**On MR imaging which were isointense to the spinal cord on T1WI and hyperintense on T2WI.Meningiomas showed homogenous contrast enhancement. Spinal cord meningiomas are believed to originate from meningothelial cells near the distal root ganglia. These tumors appear as rounded, sharply marginated masses that are isointense to the spinal cord on T1-weighted images and iso- or hypointense on T2-weighted images. These tumors usually enhance intensely and homogeneously and show dural tail sign in most of the cases(11).The presence of tumor calcification may help to distinguish it from nerve sheath tumors. Differentiation may also be determined by evaluating for neurofibromas that are heterogeneous on T2-weighted images and enhance more intensely than meningiomas do. In our cases, M.R. demonstrated isointense signal on T1-weighted images in all cases and isointense to hyperintense signal intensity on T2-weighted images. All cases demonstrated homogeneous enhancement on Gd-DTPA(12) images and a solid portion on pathologic macroscopic findings.

One case of spinal **lipoma**showed T1 and T2WI hyperintense lesion and showing suppression on STIR images. Intradural lipomas are a subset of spinal lipomas. (13)(14)On MR imaging intradural spinal lipomas are sharply circumscribed masses largely conforming to the dura but distorting the cord. They follow fat signal on all sequences as seen in our case study. These are hyperintense on T.I. and variable signal intensity from hypointense to hyperintense on T2WI. These are hypointense on fat suppression sequences(15).

One patient diagnosed with **spinal dermoid**.which was seen as variable signal intensity on T1, T2WI and fat suppression on STIR images. Dermoids are benign tumors that contain parts of the skin and its appendages. Whereas epidermoids contain only the keratin layer of the skin, dermoids also include skin appendages.Dermoids are well-circumscribed masses. Dermoids commonly display a high signal intensity on nonenhanced T1-weighted sequences. However, hypointense areas owing to sweat gland excretions are common as well. Spinal dermoids tend to have a somewhat heterogeneous signal intensity with concomitant areas of lower and higher signal intensities on T1-weighted sequences. On fat suppression sequences these lesions show decreased signal intensity owing to presence of fatty component. Calcifications may occur.

Intradural Intramedullary Lesions

In our study among 34 patients, in which 18 patients were diagnosed with IDIM. Six patients were diagnosed with**astrocytoma**. On MR imaging astrocytomas appeared intradural intramedullary lesions which were hypointense on T1WI and hyperintense on T2WI and showed heterogenous patchy contrast enhancement. These lesions were associated with extensive syrinx formation, cord oedema and asymmetrical cord expansion. Astrocytomas represent one third of intramedullary gliomas and may occur at any location along the cord. In M.R.I. T1-weighted images demonstrate astrocytomas to be low in signal intensity, with hyperintensity seen on T2-weighted images, and poorly defined margins. Intratumoral cysts within astrocytomas, as well as syringomyelia at one or both ends of the cord associated with astrocytomas, are common. Intratumoral cysts are irregular areas; their contents reflects a signal intensity similar to that of CSF26. A syrinx has parallel walls, and its contents also demonstrates signal intensity similar to that of CSF. Tumoral cysts have rim enhancement following the administration of IV contrast, whereas a syrinx will not enhance. A slight majority of astrocytomas are eccentric within the cord, and axial images demonstrate the asymmetrical expansion of the cord by tumor tissue. Astrocytomas tend to enhance more heterogeneously, although enhancement is highly variable. Enhancement does not define tumor margins.(16).

Nine patients having **Ependymoma**in M.R. imaging appeared as intradural intramedullary lesions which were hypointense on T1WI and hyperintense on T2WI and showed heterogenous but intense contrast enhancement. These lesions were also associated with syrinx formation and cord oedema. Hemosiderin cap sign were seen in most of the cases (8 out of 9 cases).Ependymomas represent 60% of spinal cord neoplasms.Spinal ependymomas appear on M.R.I. as expansile lesions of the cord in the sagittal and axial planes and are slightly hypointense on T1-weighted images and isointense to hyperintense on T2-weighted images. Most cases demonstrate cord edema around the mass, and one third have a hemosiderin ring manifesting as extreme hypointensity at the margins of the lesion on T2-weighted images (cap sign). Cysts are a common feature, more commonly seen at the poles of the lesion, with intratumoral cysts being variable. Syringohydromyelia is also variable. The differentiation of the tumor from the adjacent edema is difficult without the use of IV contrast. The majority of lesions enhance, generally with well-defined margins; this enhancement, in combination with a central location within the cord, has been suggested as a distinguishable feature of cord ependymoma.

One patient had **myxopapillary Ependymoma**. which on M.R. appear as hypo intense on T1WI and hyperintense on T2WI and showed heterogeneous contrast enhancement. Myxopapillary ependymomas of the cauda equina are reasonably characteristic by virtue of their location, usually appearing as an ovoid mass centrally within the spinal canal with nonspecific signal intensities similar to those found elsewhere. Superficial siderosis may accompany the lesion owing to repeated episodes of bleeding, which appears as marked hypo intensity on T2-weighted images in the subarachnoid space. Siderosis is not specific and can be seen with other highly vascular tumors. Gadolinium enhancement is generally in a homogeneous, well-circumscribed pattern.(17)(10).

Two patients were diagnosed with **hemangioblastoma**. On MR imaging hemangioblastoma appeared intradural intramedullary solitary lesions which were hypo intense on T1WI and hyper intense on T2WI and showed intense contrast enhancement in the tumournodule. These tumour nodules were associated with prominent vascular flow voids in the nodule and along the surface of the spinal cord. These lesions were also associated with syrinx formation and cord oedema.Hemangioblastomas are uncommon tumors of the spinal cord, representing 1.6% to 7.2% of spinal cord tumours. The cysts are often high in protein content and are suggestive of prior episodes of haemorrhage. The tumours may arise in the cervical or thoracic cord, usually causing diffuse focal widening of the cord. (18)M.R. images demonstrate an enlarged spinal cord with a variable signal on T1-weighted images and high signal intensity on T2-weighted images with intermixed flow voids.. Gadolinium enhancement is the most useful technique to demonstrate the tumour nidus, which enhances intensely and homogeneously, and it differentiates the lesion from vascular malformations.

Extradural lesions

Only one patient was diagnosed with **extradural metastasis**. On MR imaging, this lesion was hypointense on T1WI, hyperintense on T2WI and showing heterogeneous contrast enhancement. Spin echo (S.E.) T1-weighted sequences distinguish between the high-fat content of unaffected bone marrow and the metastatic lesion. The metastatic lesions alter the usual fat content within the vertebral bodies, thereby causing a decrease in signal intensity on T1-weighted SE images. T2-weighted SE sequences are also helpful because abnormal bone marrow usually demonstrates increased signal intensity on T2-weighted images. In addition, fat saturation techniques offer potential advantages for improving the conspicuousness of bone marrow lesions. T2-weighted, fat-saturated, fast-spin echo (F.S.E.) and STIR sequences have also been used to increase lesion conspicuity.

We found high sensitivity, specificity and positive predictive value of M.R.I. in diagnosis of spinal lesions as compared to histopathological diagnosis, which is congruent with the published literature.(19).

Conclusions

Thus we conclude male are more predisposed to spinal tumours. Backache is a common symptom, and lumbar region is the most commonly affected segmentof the body. Neurofibroma is the most common IDEM tumour, and Ependymomais the most common IDIM tumour. In our study, M.R.I. characteristics were of great value in delineating and differentiating the tumours. In our research diagnostic efficacy of M.R.I. in the evaluation of spinal cord tumours against histopathology as the gold standard was high. Thus MR images are the preoperative modality of choice in the evaluation of spinal cord tumours as it helps in narrowing the differential diagnosis, guides surgical resection and avoid bonyartefacts. Thus M.R.I.is the preferred method in the diagnosis of the spinal tumour as it can obtain a more accurate reliable localisation and qualitative diagnosis based on the specific features of different tumours and be non-invasiveit is preferred method of choice. The current study gives a snapshot of spinal lesions and modes of its diagnosis, although a larger sample size would help to generalise data at the population level.

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Table 1: Spinal segments distributions among patients

Spinal segments	Total cases	Percentage
Cervical	11	32.35%
Dorsal	10	29.41%
Lumbar	13	38.24%
Sacrococcygeal	0	0.00%

Table 2: M.R.I. localisations of various spinal cord tumours.

Tumour	Total case	Location in cord
Schwannoma	4	IDEM
Neurofibroma	5	IDEM
Astrocytoma	5	IDIM
Meningioma	4	IDEM
Ependymoma	9	IDIM
Myxopapillary Ependymoma	2	IDEM
Hemangioblastoma	2	IDIM
Dermoid	1	IDEM
Spinal Lipoma	1	IDEM
Metastasis	1	Extradural

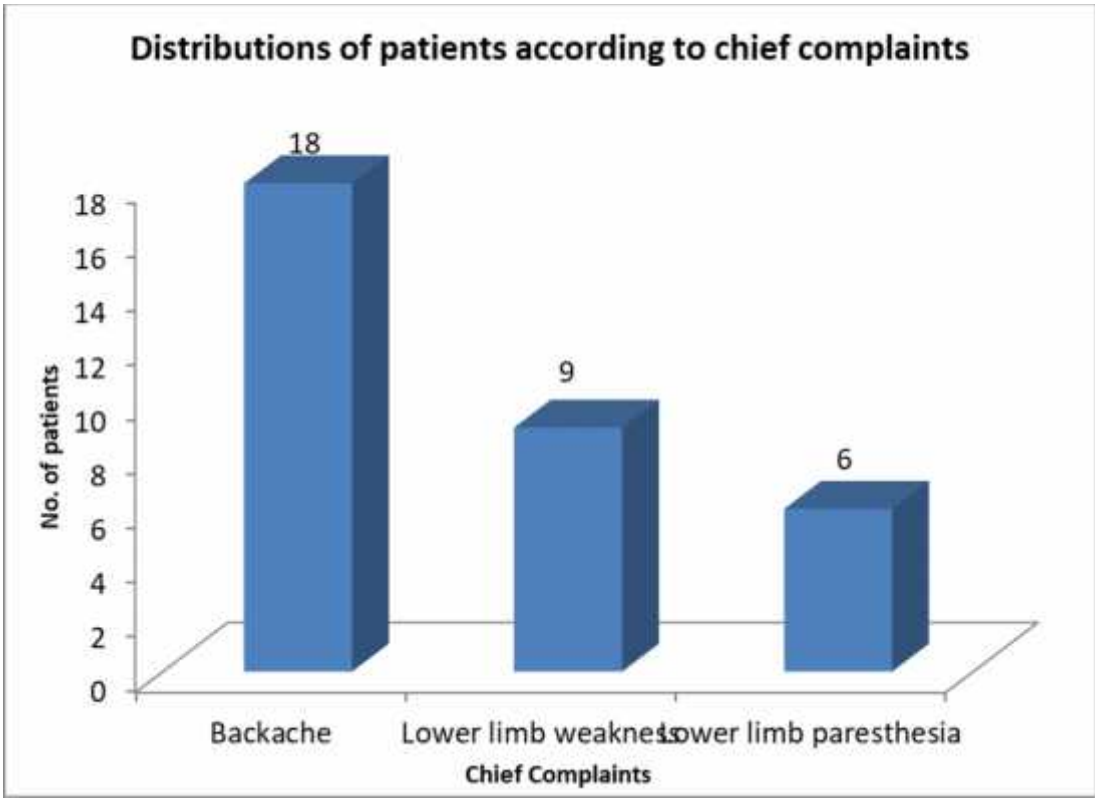
Table 3: Associated M.R.I. characteristics of various spinal tumours

Tumour	Cord oedema	Syrinx	Calcification	Haemorrhage	Flow voids	Fatty comp.
Schwannoma	-	-	-	-	-	-
Neurofibroma	-	-	-	-	-	-
Astrocytoma	+	+	-	-	-	-
Meningioma	-	-	-	-	-	-
Ependymoma	+	+	-	+	-	-
Myxopapillary Ependymoma	-	-	-	+	+	-
Hemangioblastoma	+	+	-	+	+	-
Dermoid	-	-	+	-	-	+
Spinal Lipoma	-	-	-	-	-	+
Metastasis	-	-	-	-	-	-

Table 4: Comparison of M.R.I. and histopathology finding.

Disease finding on M.R.I.	Histopathology	
	Supporting M.R.I. Finding	Does not supporting M.R.I. Finding
Positive	30 (a)	4 (b)
Negative	4 (C)	0 (d)

Figure 1


Distributions of patients according to chief complaints
No. of patients
0
2
4
6
8
10
12
14
16
18
18
9
6
Backache
Lower limb weakness
Lower limb paresthesia
Chief Complaints