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Classification, Characterisation and Spectrum of Spinal Tumors: An Observational Magnetic Resonance Imaging Study / Review of Current Insights

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ABSTRACT

INTRODUCTION

A spinal tumor is an abnormal growth of tissue that develops in or near the spinal cord or within the bones and discs of the spine. Spinal tumors can be benign or malignant and can cause significant morbidity and even mortality in some cases. Magnetic Resonance Imaging(MRI) permits high spatial resolution in multiple orthogonal planes with the use of varying pulse sequences in detecting not only osseous structures but also soft tissue components. The reliability and accuracy of preoperative diagnosis of spinal tumors has dramatically increased with the advent of MRI.

Aim of this study is to put emphasis on the utility of MRI in early detection and compartmental classification of spinal tumors. This study also endeavors to precisely characterize, delineate anatomically and review differential diagnosis of spinal tumors.

MATERIALS AND METHODS

An observational study of 42 patients with spinal tumor was carried out in the department of Radio-diagnosis, NKP SIMS Nagpur. These patients were assessed and following variables were evaluated: age, gender, location and extent of various spinal cord tumors.

RESULTS

In this observational study, we discussed MRI findings of various spinal tumors with other variables. Out of 42 tumors evaluated,23 cases (54.7%) were found in extradural, 13 cases (30.9%) in intradural extra medullary and 6 cases (14.2%) in intradural intramedullary compartments respectively.

CONCLUSION

In summary, MRI provides explicit characterization of spinal tumors. However, MRI findings need to be correlated with other variables like age, gender, location and presentation to arrive at close differential diagnosis to funnel treatment planning.

Keywords: MRI, Spinal tumor, intradural extra medullary, intradural intramedullary, extradural

INTRODUCTION

Out of all neoplasm of central nervous system, spinal tumors are rare and compromise 10-15% of cases(1)(2).Spinal tumors can cause long term morbidity and even mortality. MRI provides a high-resolution contrast with multi-planar images to precisely characterize the spinal tumors. With the availability of multiple tissue component specific sequences, more accurate diagnosis is made possible.

In most of cases, aetiology of spinal tumors is unknown(2). However, some tumors may be attributed to genetic factors. In immunocompromised patients, spinal lymphomas are common.

Spinal tumors are broadly categorize on the basis of anatomic location as – cervical, thoracic, lumbar and sacral. Further additionally, tumors can be classified on the basis of compartment involved with respect to the dural sac and spinal cord as: extradural; intradural-extra medullary; or intramedullary(3). Most common are found in extradural (55-60%), followed by intradural extra medullary(25-30%) and intradural intramedullary(5-10%) compartments respectively(4).

Extradural tumors originate outside the dural sac. They are derived from either cells covering the nerve roots or vertebrae (most common)(1). The most important finding on MRI is the compression of thecal sac away from the lesion(3)(5).

Intradural-extra medullary tumors originate from arachnoid cells (meningioma), in the nerve roots which are extending outside the spinal cord (Schwanoma and neurofibromas), or sometimes at the base of cord (filum terminal) ependymoma(6). Most of Intradural-extra medullary lesions are primary. These lesions lie inside the medullary cavity but outside the dural sac(7). Displacement of spinal cord to the opposite side of thecal sac with widening of the cerebrospinal fluid space are the findings appreciated on MRI.

Intradural Intramedullary tumors originate within the cord parenchyma, most commonly in the cervical region. It causes widening of the spinal cord. Ependymoma and astrocytoma are the two most common types. In adults, ependymoma are common and in paediatric population astrocytoma are common(8)(9).

MRI is the imaging technique to differentiate tumour mass from the spinal cord, nerve roots or thecal sac. Modern MRI sequences like diffusion weighted imaging (DWI) and post gadolinium (Gd) study helps in distinguishing haemorrhage, necrosis, solid or cystic components of the tumour. It can also differentiate between oedema from peritumoral cysts(10).

Regional location of spinal tumors is very important for further evaluation of its extensions into adjacent soft tissues, osseous structures and neurovascular elements. Relationship of cervical spinal tumors with supra aortic trunks can be depicted by MR angiography. In case of thoracic tumors, relationship with pleura, mediastinal structures and ribs is imperative to establish. With respect to lumbar and sacral spinal neoplasms, relationship with retroperitoneum and sacroiliac joints are vital(6)(10).

MRI is the only imaging modality that provide direct visualization of the changes in the ligaments and intervertebral discs in cases of spinal tumors.

In our study we focused on characteristics of different spinal tumors on MRI with their extra spinal extensions(11). We also meditate upon demographics of various spinal tumors with review on differential diagnosis(9).

MATERIALS AND METHODS:

A total of 42 patients were taken up for this hospital based observational study. A 1.5 Tesla GE MR Scanner was used and combination of pulse sequences were used to acquire images in axial, sagittal and coronal planes.

MR Imaging of spine was performed with 1.5 Tesla MR Scanner in the axial, coronal and sagittal planes using a combination of pulse sequences. The study was performed with patient in supine position. Patient was instructed to perform quiet breathing to avoid motion artefacts. Acquisition of sagittal T1-weighted (T1W) and T2 –weighted (T2W) fast spin echo sequence, sagittal and coronal Short Tau Inversion Recovery(STIR) sequences, and axial TIW and T2W fast spin echo images and axial Gradient Recalled Echo (GRE) sequences was done. Pre-contrast images were followed by post contrast images with intravenous administration of 0.1mmol/kg of body weight of Gadolinium.

Sagittal images were kept 5.0 mm thick with a 0.5 mm slice gap. The field of view (FOV) of the area of interest was at 24 cm in cervical spine and at 32 cm in lumbosacral spine. However, in the dorso-lumbar spine, a large FOV was needed (34/36 cm).

T2-weighted image was obtained using a single FSE acquisition using a split echo train, resulting in an intermediate T2WIs sequence. For the short TEeff image, an echo train of three with two excitations was used, whereas for the long TEeff image an echo train of 15-30 with single excitation was used. For every sequence, 256- 448 steps were followed in both the frequency and phase axes. Axial images were obtained using FSE or gradient-echo (GRE)

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pulse sequences. Other technical parameters included were 16° flip angle, minimum TR/TE, 224 × 320 matrix and two excitations in T1WI and one excitation in T2WIs. The TE used was up to 100 m/s in T2WIs and less than 15 m/s in T1WI in order to minimize unwanted susceptibility effects that might give an impression of bony stenosis or haemorrhage.

INCLUSION CRITERIA:

In this study we included patients who were found to have spinal tumors on undergoing MRI over the period of 20 months (May 2017-January 2019) and underwent MRI spine in the department of radio diagnosis at NKP SIMS Nagpur.

EXCLUSION CRITERIA:

Patients with sustained trauma to spine.

Contraindications for MRI like non- cooperation, in situ metallic implants, pacemakers and claustrophobia were excluded from the study.

RESULTS:

In our study, 42 cases with spinal tumors were evaluated. Of these 31 cases (73.8 %) were males and 11 cases (26.2%) were females with ages ranging from 24 to 77 years (mean age 52 years). MRI examination revealed, maximum number of lesions in thoracic region 22 cases (52.3%), followed by lumbar region 14 cases (33.3%) and cervical region 6 cases (14.3%).

The most common tumor found in our study was haemangioma 12 cases (28.5%), followed by metastasis 9 cases (21.4%) and meningioma 8 cases (19.0%). Schwannomas (11.9%), ependymoma (9.5%), astrocytoma (4.7%) and osteoid osteoma (4.7%) formed the rest of the spinal tumors respectively. Pain was the most common presenting symptom in 22 cases (52.3%) followed by motor deficits in 10 cases (23.8%). Rest 10 cases (23.8%) were found incidentally with no significant clinical correlation.

Out of total cases, 12 cases (28.5%) shows multilevel involvement while 30 cases (71.4%) were limited to single level involvement.

DISCUSSION

Our study was carried out with a sample size of 42 patients who underwent MRI spine for detection and evaluation of spinal tumors.

Out of 42 patients, 31 were males and 11 were females. The most common tumor found in our study was haemangioma (28.5%)(12). Patnaik S. found the similar results in 2016. Vertebral body is the most common site for haemangiomas in spinal cord (10). On MRI, it shows hyperintense signal on both T1WI and T2WI. These lesions show typical hypointense signal on fat saturation images and shows enhancement on post contrast study. Transverse section of CT scan shows typical "polka-dot" pattern. Depending on the presentation, two categories are classified: benign form, asymptomatic lesions and aggressive form, causing compression on the spinal cord. Aggressive lesions can cause pressure symptoms by invading into the epidural space. Decompressive surgery is the usual mode of treatment in painful haemangiomas(13).

Metastasis was the second most common tumor found in our study accounting for 21.4%. Prior history of primary tumor is valuable to suggest this diagnosis. Thoracic is the most common region of spine involved in spinal metastasis followed by lumbar region. Osteoblastic metastasis most commonly caused by prostatic carcinoma in males and breast carcinoma in females. Lung, thyroid, kidneys and colon are the usual primary sites for osteoclastic metastasis. On MRI, metastatic lesions appear hypointense on T1WI and mix signal intensity on T2WI. Typically, they show marked enhancement on post contrast sequences.

Nerve sheath tumors (meningiomas and schwanommas) are the most common intradural extra medullary neoplasm found in our study accounting for 19% and 11.9% respectively.

Meningiomas are WHO grade I neoplasms. Thoracic spine is the most commonly involved region with peak incidence at fifth to sixth decade(14). They show iso- to hypo signal on T1WI and mildly hyperintense on T2WI. Strong and homogenous enhancement is noted on post gadolinium scans(13). Meningiomas are dural based tumours with common presentation in fifth to sixth decade. In most of the cases, solitary lesions are present, however multiple meningiomas are also seen in approximately 3% cases of neurofibromatosis -2.

Schwannomas are usually solitary, whereas multiple lesions are found in children with NF-2. Dorsal sensory neural roots are typically involved. On MR

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imaging, they appear iso- to hypo intense on T1WI, hyperintense on T2WI with cystic components within.

Most common intramedullary tumours in adults are ependymomas, whereas astrocytomas compromises majority of cases in paediatric population. Percentage distribution of spinal ependymomas and astrocytomas were 9.5% and 4.7% respectively in our study. Samartzis D and Gillis CC et.al found similar results in 2015.

Spinal ependymoma compromises 9.5% of the total number of cases in our study. Ependymomas shows peak incidence at fourth to fifth decade. Sensory symptoms are frequently observed because of the involvement of spinothalamic tract due to central location of tumour within the spinal cord. Motor problems appear later in the course of disease. Ependymomas are classified as WHO grade II with benign indolent course. Various histological subtypes have been described: clear cell, papillary, cellular and tanycytic. They are usually well defined which allows complete resection of lesion. On MRI, lesions appear hypointense on T1WI and hyperintense on T2WI. On post contrast study, it shows vivid enhancement.

Spinal astrocytomas compromises the most common tumour group in children. Pilocytic variety is the most common subtype. On the contradiction with ependymomas, astrocytomas shows aggressive behaviour in the form of infiltration into the surrounding structures. Because of the poor characterisation of boundaries, complete resection is not possible. Thoracic region is the most common site of involvement. On MRI, mix intensity areas are seen suggestive of necrosis and cystic degeneration. Solid component appears iso-to hypo intense on T1WI and hyperintense on T2WI. Variable pattern of enhancement of the solid component is seen on post contrast study.

CONCLUSION

MRI is excellent modality to diagnose and categorise various spinal tumors. Our study evaluated the utility of MRI in demonstrating soft tissue extensions, marrow infiltration and involvement of neural elements. Haemangioma was found to be the most common spinal tumor followed by metastasis in our study. Extradural compartment was the most commonly involved compartment in our study. Out of total cases, 12 cases were found to have multilevel involvement and 30 cases were found to be involving the single spinal level.

MRI proved to be the best diagnostic tool for compartmental classification and component characterisation of the spinal tumors. Apart from this, other subtle entities like soft tissue involvement in paravertebral region, marrow infiltration, intraspinal and extra spinal extensions were precisely demonstrated.

Further, MRI Multiplanar imaging with high contrast resolution aids in biopsy localisation, staging of tumor and surgical planning.

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Table1: Various spinal tumors on MRI seen in our study

MRI FINDINGS:	NO OF PATIENTS:	PERCENTAGE DISTRIBUTION:
Hemangioma	12	28.5%
Metastasis	9	21.4%
Meningiomas	8	19.0%
Schwannomas	5	11.9%
Ependymomas	4	9.5%
Astrocytomas	2	4.7%
Osteoid osteoma	2	4.7%

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Figure1:

Compartmental classification of spinal tumors Schematic representation of intradural intramedullary, intradural extra medullary and extradural extra medullary lesions.

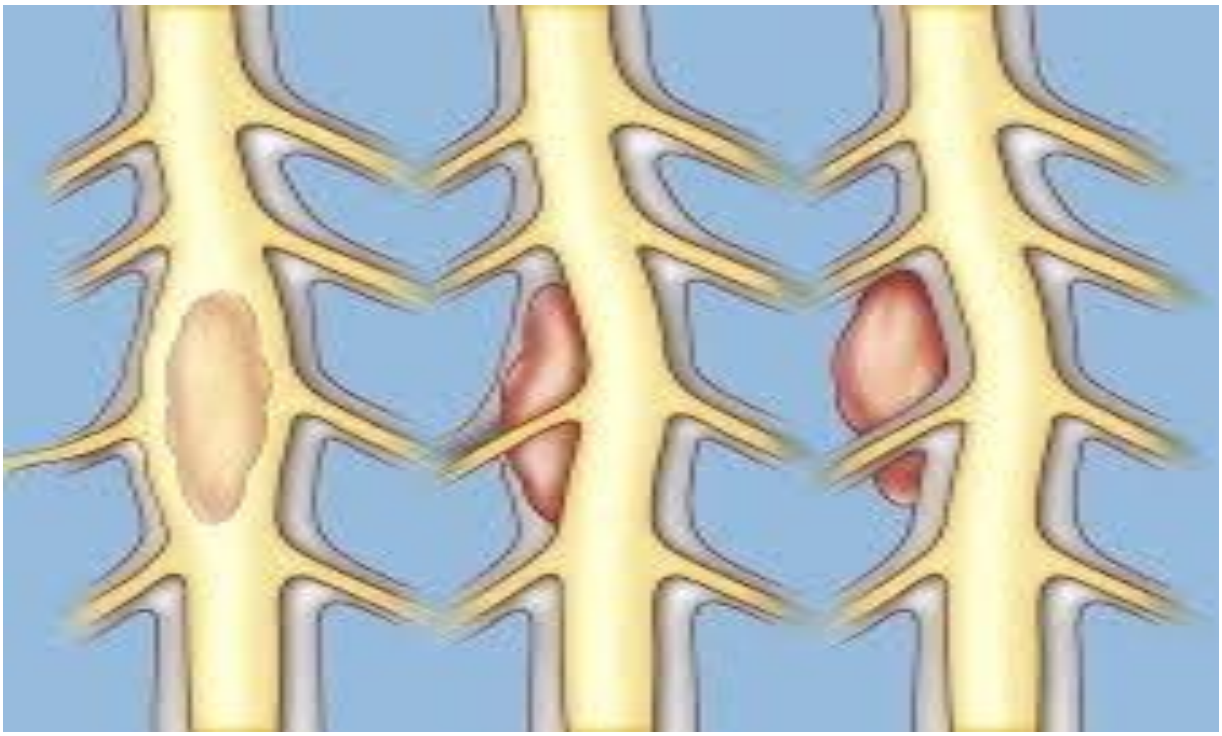

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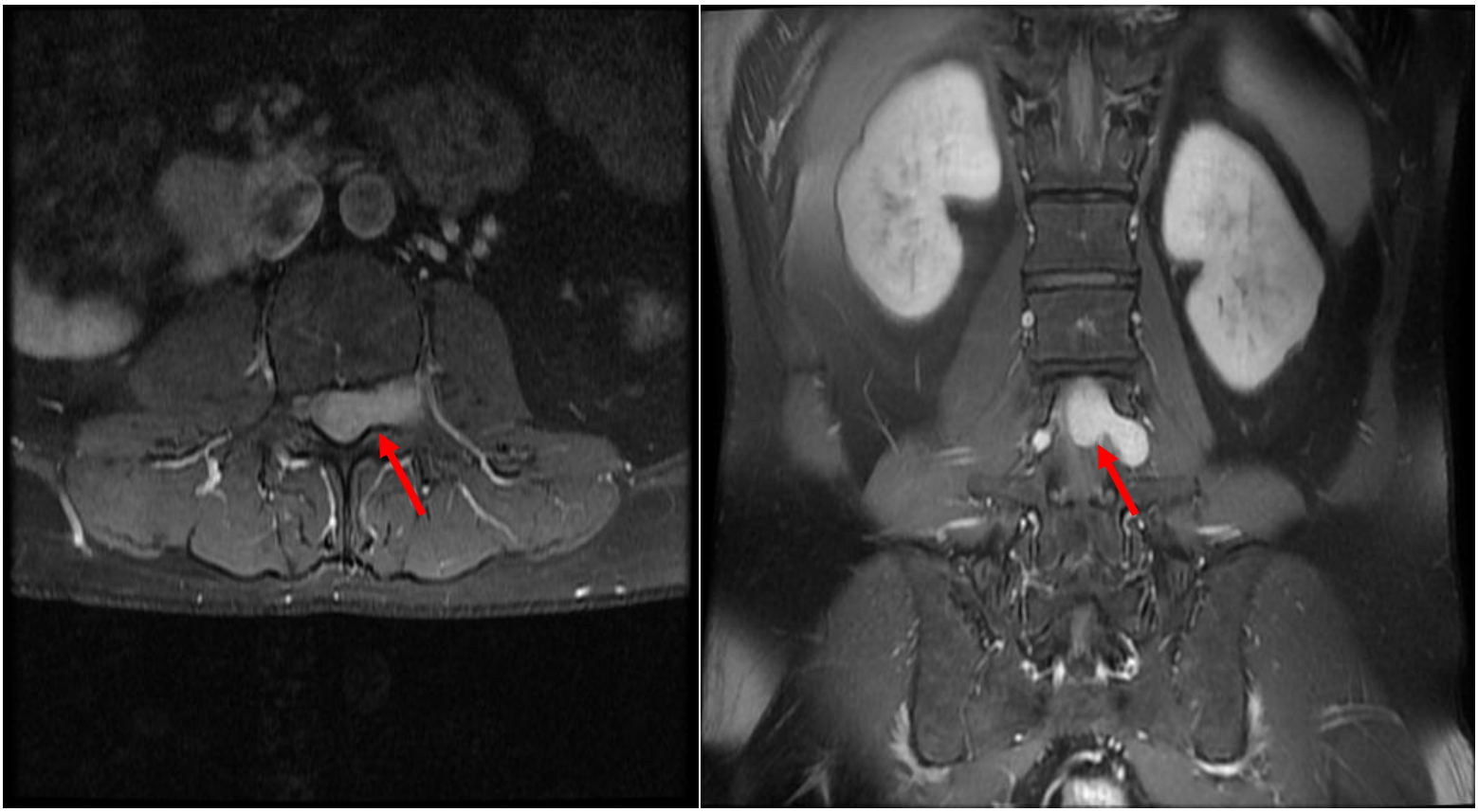
Figure2:
A 38 years old male with complaints of neck pain. Figure (a) SAGITTAL T2 (b) SAGITTAL STIR shows mixed signal intensity lesion is noted in the intradural intramedullary compartment extending from C4-C7 vertebral levels with hemorrahagic cap sign suggestive of spinal tumor-Ependymoma. Also there is associated syrinx formation extending from C2-T3 vertebral levels



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