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Role of Magnetic Resonance Imaging in Evaluation of Compressive Myelopathy

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Author Details

Dr. Ambry Garg[1] and Dr. Devinder Kumar Gupta*[2]

Authors Affiliations

[1]Senior resident, Department of Radiodiagnosis, Kalpana Chawla Government Medical College, Karnal Haryana, India

[2]Senior Resident, Dept of Orthopedics, Kalpana Chawla Government Medical College, Karnal Haryana, India

Corresponding Author*
Dr. Devinder kumar gupta

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Abstract: Introduction: Myelopathy describes any neurologic deficit related to the spinal cord. Myelopathy is usually due to compression of the spinal cord by osteophyte or extruded disk material in the cervical spine. MRI should be used as the imaging modality of choice for evaluation of the spinal cord after injury. CT and plain radiography should be used to assess the bony anatomy of the spine in patients with Spinal Cord Injury (SCI). MR imaging has become the technique of choice in the assessment of lesions of the spine and spinal cord. MR imaging provides accurate localization of intramedullary, intraduralextramedullary, and extradural tumors. Ependymomas and low-grade astrocytomas are the most common intramedullary tumors. Malignant spinal cord compression is one of the most dreaded complications of cancer. Materials and Methods: The study was conducted on 40 patients who were referred from various departments of Rajindra hospital Patiala and other hospitals to MRI centre in department of Radiodiagnosis, GMC and RHP. Case selection-40 patients, who were clinically suspected as cases of compressive myelopahy, were investigated with MRI and analysed statistically. Results: In our present study of 40 cases of compressive myelopathy different causes for compression were trauma (45%), infectious causes (35%), primary neoplasms (10%) and secondary neoplasms (10%). In our study, the most common site of trauma was thoracic spine (55.5%) and then the cervical (33.3%) and lumbar spine (11.1%). In our study cord changes in the form of edema or contusion in the patients of traumatic spine injury were noted in 72.2% of cases. The most common changes were cord contusion and cord hemorrhage. Among the non-traumatic pathologies, cord changes were observed in 37.7% of cases of spinal infection/TB, in 75% cases of metastases and in all the cases of primary neoplasms of spinal cord. Conclusion: MRI is the definitive modality in assessing soft tissues of the spine and spinal cord abnormalities. It is the best modality to evaluate cord edema / contusion and integrity of the intervertebral discs and ligaments. MRIis very sensitive and considered the imagingmodality of choice to detect and characterize the spinal tumors and spinal infections.

Keywords: Magnetic Resonance Imaging, tuberculosis spine, compressive myelopathy.

INTRODUCTION

Myelopathy describes any neurologic deficit related to the spinal cord. Myelopathy is usually due to compression of the spinal cord by osteophyte or extruded disk material in the cervical spine. [1]

MRI should be used as the imaging modality of choice for evaluation of the spinal cord after injury. CT and plain radiography should be used to assess the bony anatomy of the spine in patients with Spinal Cord Injury(SCI)). [2]

MR imaging has become the technique of choice in the assessment of lesions of the spine and spinal cord. MR imaging provides accurate localization of intramedullary, intraduralextramedullary, and extradural tumors. Ependymomas and low-grade astrocytomas are the most common intramedullary tumors (Tomura, N. 2000).

Malignant spinal cord compression is one of the most dreaded complications of cancer (Yalamanchii, M., & Lesser, G.J.2003).

Deficiencies of vitamin B12, folate, copper, and vitamin E may result in characteristic clinical, electrodiagnostic, and imaging features. Prompt recognition and treatment is critical to limit permanent neurologic impairment (Goodman, B.P. 2015).

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TUBERCULOSIS-

MRI characteristics in spinal TB are as follows:

- Vertebral body endplate involvements appear as heterogeneously enhancing endplate irregularity on post-contrast sequences.
- Vertebral lesions appear hypointense on T1W images, hyperintense on T2W images and shows heterogeneous enhancement on postcontrast T1W images.
- Marrow edema appears as hyperintense areas on T2W and STIR images.
- Intervertebral disc involvement appears hypointense on T1W and hyperintense on T2W images and shows heterogeneous enhancement on post-contrast T1W images.
- Prevertebral, paravertebral and psoas abscesses appear as heterogeneous lesion with peripheral enhancement and central non-enhancing hypointense areas on post-contrast T1W images. The level, extent and size of abscess can be well delineated on
- MRI

Granulation tissue appears heterogeneously enhancing soft tissue on post-contrast T1W images. The granulation tissues and epidural abscess can cause narrowing of thecal sac or compression of spinal cord causing neurological complications (Ansari, S.*et al.,* 2013).

A B C

Fig-1

A Contrast-enhanced T1-weighted sagittal magnetic resonance image showing destruction of L2 and L3 vertebral bodies with intraosseous and epidural abscess resulting in spinal canal stenosis
B T2-weighted coronal MR image showing collapse of L1 vertebral body with irregularity of superior end plate of L2 along with bilateral psoas abscesses
C Contrast-enhanced T1-weighted axial MR image showing bilateral psoas abscesses

Metastatic Spinal Cord Compression

Metastases to the spine can involve the bone, epidural space, leptomeninges, and spinal cord. The spine is the third most common site for metastatic disease, following the lung and the liver (Witham, T. F.*et al.,* 2006) and the most common osseous site (Klimo Jr, P., & Schmidt, M. H. 2004).

Common tumors with a high rate of metastasis to bone include tumors of the breast (72%), prostate (84%), thyroid (50%), lung (31%), kidney (37%), and pancreas (33%). Together, these account for more than 80% of primary tumors in patients presenting with metastases (Alcalay, M.*et al.,* 1995; &Brage, M. E., & Simon, M. A. 1992).

Enhancement and extensive edema for lesion size (often ≥3 segments) are typical for intramedullary spinal cord -metastasis. Presence of cystic change/hemorrhage makes intramedullary spinal cord metastasis unlikely. Evidence for other CNS or spinal (non-spinal cord) metastases and the primary tumor/non-CNS metastases are common. The prevalence of other CNS or spinal (non-spinal cord) metastases in those with multiple intramedullary spinal cord metastases is especially high (Rykken, J. B.*et al.,* 2013).

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Fig-2 Figure imaging of spinal metastatic disease (Chadwick, D. J.*et al.,* 1991)

Spinal Tumors

Spine tumors are historically classified as (1) extradural, (2) intraduralextramedullary, and (3) intradural intramedullary (Samartzis, D.*et al.,* 2015).

Intradural Extramedullay Lesions/Neoplasms

Spinal cord meningiomas are believed to originate from meningothelial cells near the distal root ganglia. Most of meningiomas are intraduralextramedullary, and only 5% are extradural. 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 (Chung, J. Y.*et al.,* 2008).

Spinal paragangliomas are seen as Intraduralextramedullarycaudaequina mass. These are well encapsulated masses that are iso intense with cord on T1andisoto hyper intense on T2W scans (Duffau, H.*et al.,* 2000).

Schwannomas on T1W1 vary from hypo to isointense. On T2W1 they are hyperintense in signal. Neurofibromas are iso to hypointense compared to spinal cord on T1W1 and hyperintense on T1W1. A target appearance with a hyperintense rim and hypointensecentre is often seen on T2W1 and contrast enhanced T2W1(Rothwell, C.I.*et al.,* 1989).

Trauma

Magnetic resonance imaging (MRI) is the technique of choice for the imaging of the spinal cord. The typical SCI lesion on MRI is spindle shaped, containing an epicenter of hemorrhage surrounded by a halo of edema; the latter has a greater rostral-caudal extent than the central hemorrhage (Flanders, A.E., & Schwartz, E.D.2009).

Radiographic signs of instability include widening of the interspinous and interlaminar distance, translation of more than 2mm, kyphosis of more than 20 degrees, dislocation, height loss of more than 50%, and articular process fractures. However, fractures may be unstable in the absence of these signs. Unrecognized supraspinous ligament disruption contributes to this instability. This structure is best evaluated by MR examination. Confirmation of posterior ligamentous disruption occurring in conjunction with the burst fracture leads to reevaluation of the presumed mechanism of injury (Petersilge, C., & Emery, S.1996).

The advent of magnetic resonance imaging (MRI) has made it possible to accurately characterize the underlying SCI even when radiographs and computerized tomography (CT) scan are normal. MRI, with superior tissue characterization, provides the best evaluation of soft tissue pathology and is essentially the only direct evaluation of the spinal cord and nerve roots. Several types of traumatic spinal cord lesions can be found: intramedullary hemorrhage, spinal cord contusion/edema, extrinsic compression by a bone fragment or a traumatic disc herniation, and even complete transection of the cord (Magu, S.*et al.,* 2015).

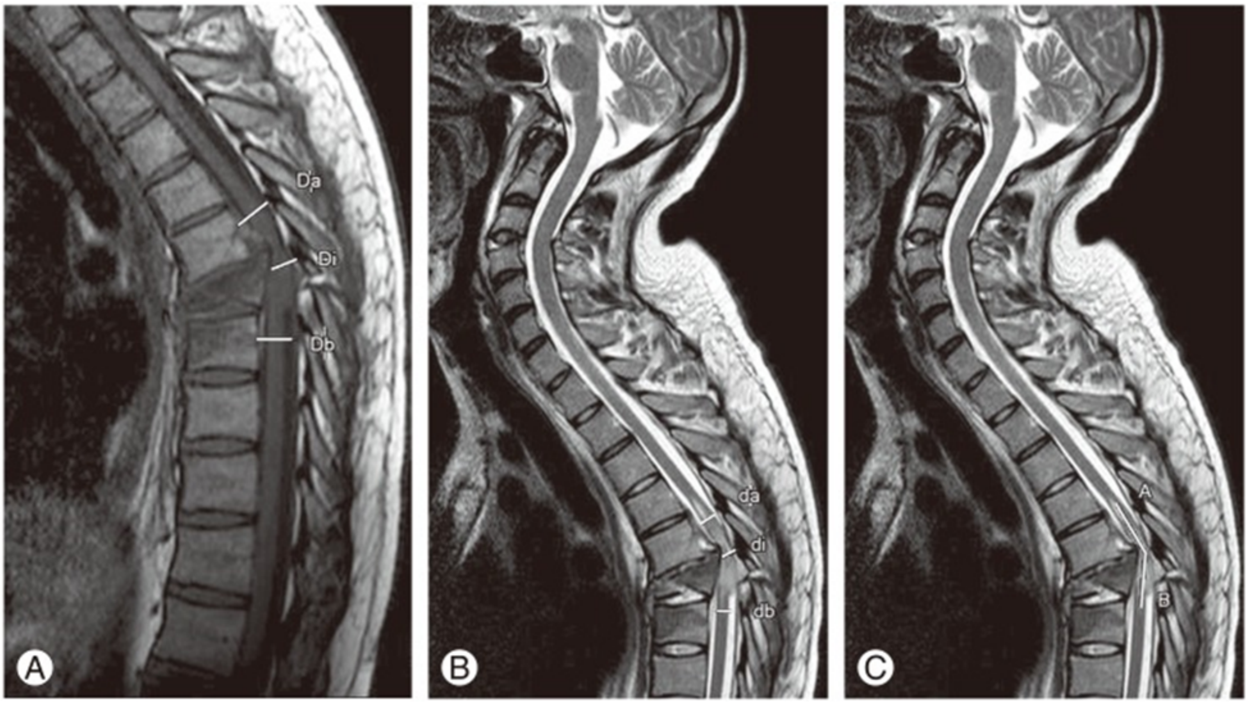

Fig-3

A) Mean canal compromise calculation on T1-weighted image (T1WI). Da and Db are canal diameter one segment above and below the injury level respectively and Di is the canal diameter at injury level

B) Mean spinal cord compression calculation on T2WI. da and db are the cord diameter one segment and above and below the injury level respectively and di is the cord diameter at injury level

C) Lesion length measurement on T2WI. Altered signal from cord is seen between Point A and B

AIMS AND OBJECTIVES

1. To evaluate various causes of compressive myelopathy.
2. To evaluate MR characterization of spinal cord compressive lesions.
3. To assess associated pathologies, neurological deficit and complications with compressive myelopathies.
4. To classify the lesions based on location into extradural/intradural compartments.

MATERIALS AND METHODS

The study was conducted on patients who were referred from various departments of Rajindra hospital Patiala and other hospitals to MRI centre in department of Radiodiagnosis, GMC and RHP.

Methods of Collection of Data

The study was a prospective study done on 40 patients referred for MRI scan to the department of Radiodiagnosis, RHP.

Case selection-40 patients, who were clinically suspected as cases of compressive myelopahy, were investigated with MRI and analysed statistically.

A complete history of the patients was taken with particular reference to motor and sensory symptoms.

Patient Preparation

The procedure was briefly explained to the patient and consent was taken. Detailed history for contraindication of MRI was specifically taken.

Equipment

SIEMENS 1.5 TESLA1 MRI superconducting magnet. Standard surface coils and body coils for cervical, thoracic and lumbar spine for acquisition of images.

Sequences-

Conventional spin echo sequences T1WI, T2WI, STIR sag, T1WI, T2WI axial and post contrast T2 axial, s0ag and coronal.

TECHNIQUE

Patients were examined with MRI scan in the supine position with proper positioning and immobilization of the body. Standard surface coils were used for acquisition of images.

The MRI images wereanalysed based on location (cervical, thoracic, lumbar), segment of the spinal cord involvement, grading of injury. In cases of trauma, site and level of injury, vertebral fracture, ligamentous injury, presence /absence of haematoma to classify intraspinal subdural/extradural haematoma. Neoplasms were classified on the basis of appearance into benign/malignant, based on location into extradural, intraduralextramedullary.

Discussion

The ability of MRI to show the spine and spinal cord with greater sensitivity and specificity than myelography and CT is well established for trauma, neoplastic, congenital, and degenerative disorder. MRI is the only currently available technique that provides direct visualization of the spinal cord. This has become the modality of choice to image spine and spinal cord pathologies because of its ability to depict cross sectional anatomy in multiple planes without ionizing radiation, Exquisite soft tissue delineation and noninvasiveness.

Etiology of Compressive Myeolpathy-

In our present study of 40 cases of compressive myelopathy different causes for compression were trauma (45%), infectious causes (35%), primary neoplasms (10%) and secondary neoplasms (10%). Similar pattern was seen in studies by various other authors also.

Kumar S *et al.,* (2020) concluded the causes of compressive myelopathy as traumatic (43.3%), infective (23.3%), primary (16.7%) and secondary neoplasms/metastases (16.7%).

Level of Lesion

In our study, the most common site of trauma was thoracic spine (55.5%) and then the cervical (33.3%) and lumbar spine (11.1%). This was in comparison to the studies done by NK Kadam *et al.,* who observed the thoracic spine (66.6%) to be the most common site involved in trauma and N Sindhu *et al.,* observed thoracic spine involvement in 55.6% cases of traumatic spinal injury. These results are comparable to our study (Kadam, N.K., & Gehlot, K.2015; &Sindhu, N.*et al.,* 2017).

The most common site of TB that lead to compressive myelopathy was thoracic spine (64.2%), cervical spine (34.7%)

Cord Changes

In our study cord changes in the form of edema or contusion in the patients of traumatic spine injury were noted in 72.2% of cases. The most common changes were cord contusion and cord hemorrhage

B.G, Leypoid *et al.,* (2008) also demonstrated cord edema in 100% of patients and cord hemorrhage in 67% of patients in a retrospective analysis of 48 patients with clinically complete cervical spine injury.

Cord Changes in Nontraumatic Pathology-

Among the non-traumatic pathologies, cord changes were observed in 37.7% of cases of spinal infection/TB, in 75% cases of metastases and in all the cases of primary neoplasms of spinal cord. V.Sarthchand *et al.,* (2016) reported the cord changes in 46.6% of cases in his study (Sarathchand, V.*et al.,* 2016).

Characteristics of Traumatic Spinal Cord On MRI-

MRI depicts not only the spinal cord changes but also the relationship of subluxated/ dislocated vertebral bodies to the cord, posterior element fracture, ligamentous disruption and soft tissue injuries. In our study half cases comprised of stable fractures while other half had unstable fractures. 50% of the cases had fracture of posterior elements and 50% of the cases had ligamentous injury. We observed epidural hematoma to be the cause of spinal cord compression in 83% of the cases of spinal injury.

This is in comparision to the study by N Sindhu who reported stable fractures in 33%, unstable 67%, posterior element fracture in 67% and ligamentous injury in 67% of the cases (Sindhu, N.*et al.,* 2017). Epidural hematoma/ soft tissue component was seen in 78% of the cases.

Characterisation of Non-Traumatic Spinal Cord Compression by MRI

In our study among 22 cases of nontraumatic compressive myelopathy posterior elements were involved in 3 (16.6%) cases of TB and 4 (100%) cases of metastases.

Epidural soft tissue component was seen in all the cases of spinal TB and metastases.

Pre/paravertebral collections were seen in 9(64.3) of cases of spinal TB and in 2(50%) cases of metastases.

Metastases/ Secondary Neoplasms-

In our study, most common primary tumors with spinal metastases causing spinal cord compression were carcinoma prostate (50%), lung/lymphoma (25%) and breast (25%).

Similar pattern was seen in study done by M Lubdha *et al.,* (2011) with primaries metastasizing to spine as tumors of the breast (72%), prostate (84%), thyroid (50%), lung (31%), kidney (37%), and pancreas (33%).

Multiplicity of the Lesions-

In our study, we observed multiplicity of the lesions in patients of TB was seen in 35.7% and in patients with metastases was seen in 75% of the cases.

Primary Neoplasms

In our study 4 (10%) cases of primary neoplasms were associated with compressive myelopathy among these 2 cases (50%)were intraduralextramedullry- Meningioma (25%), schwanomma (25%) and 2cases were intmedullary in location-ependymoma (25%) and dermoid (25%). Cord changes were seen in all the cases.

CONCLUSION

MRI is the definitive modality in assessing soft tissues of the spine and spinal cord abnormalities. It is the best modality to evaluate cord edema / contusion and integrity of the intervertebral discs and ligaments. MRIis very sensitive and considered the imagingmodality of choice to detect and characterize the spinal tumors and spinal infections. The final diagnosis still relies on biopsy and histopathological examination. Tilldate, MRI is the only modality to directly image the spinal cord.

In my study with the help of MRI I could successfully characterize thespinal tumor based on the location into Extrdural / Intradural and asses the integrity of spinal cord, intervertebral discs and ligament after acute spunal trauma. So in the end I can conclude that MRI is very definitive, sensitive, accurate, though costly but very specific, noninvasive, radiation free modality for evaluation of compressive myelopathy.

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