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Radiodiagnosis

MRI Evaluation of Compressive Myelopathy

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Abstract **Original Research Article**

An observational study of 100 patients was conducted on Siemens 1.5 T MAGNETOM Avanto MRI machine for evaluating the various causes of compressive myelopathy, characterizing spinal cord compressive lesions based on MRI findings and to classify the lesions based on location into extradural/intradural compartments. Routine sequences used were T1W and T2W (axial and sagittal), STIR (coronal) and myelosequence (sagittal). Spinal cord compression can occur due to various pathologies both intradural and extradural. Most cases have cord signal changes representing edema/myelopathy. Most common causes are degenerative disc changes, infections and trauma. Identification of theses causes early and effectively has a great influence on the outcome of the disease and patient morbidity as most of these causes if recognized early are easily manageable. MRI because of its high soft tissue contrast has a great advantage over other modalities like CT and plain radiography in identifying these causes precisely and with greater efficiency. MRI is also helpful not only in identifying the primary pathologies but also various complications occurring secondary to them which can be prevented if diagnosed early.

Keywords: Magnetic Resonance Imaging, Intradural, extradural, soft tissue contrast, degenerative disc changes, infections, trauma.

INTRODUCTION

Compressive Myelopathy is the term used to describe the spinal cord compression from outside or within the cords itself due to multiple etiologies [1].Various causes of include post-traumatic compression by fracture fragments/displaced vertebra/ abscess in the epidural space/ herniated discs/ space-occupying lesions (both intradural and extradural).Although the first investigation in a case of trauma is radiograph, many cases are negative for spinal injury. Therefore all patients who are clinically suspected to have spinal injury and plain film negative should undergo MRI for further evaluation. For evaluation of soft tissue injuries, ligaments, Intervertebral discs, evaluation of spinal cord hemorrhage, edema and differentiation of edema from hemorrhage which has a prognostic value. In cases of spinal trauma MRI demonstrates the relationship of fractured/subluxed vertebral bodies to the cord and highlights significant stenosis. The signal abnormalities within the cord can be identified, helping to localize and define the degree of trauma [2].The role of MRI is to distinguish compressive from non-compressive myelopathy. Once compressive lesions have been excluded, non-compressive causes of acute myelopathy that are intrinsic to the cord are considered primarily vascular, inflammatory and infectious etiologies [3]. Many spinal cord diseases are reversible if recognized early stage [4], thus, they are one of the most common of neurologic emergencies. Hence for successful outcome knowledge presenting features of common spinal cord diseases and anatomy is essential.

MATERIAL AND METHODS

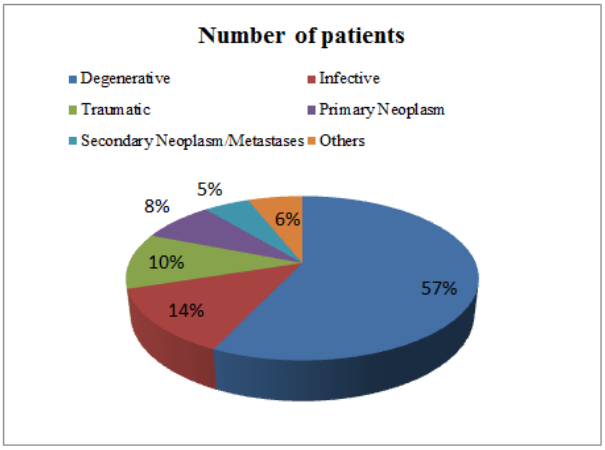
This observational study was conducted in the Department of Radiodiagnosis, Dr D Y Patil Medical College and research center, Pimpri Pune, for duration of two years. We studied hundred patients who came to our department with suspicion of compressive myelopathy. Patients with intramedullary pathologies were excluded. The patients were evaluated in 1.5 T Siemens MAGNETON Avanto MRI machine with T1WI & T2WI (axial & sagittal), STIR (coronal) myelosequence (sagittal) and whole spine T2WI sagittal. Whenever needed contrast was used and precontrast T1W fat saturated images (axial & sagittal) and post contrast T1W fat saturated (axial & sagittal) images were obtained.

OBSERVATIONS AND RESULTS

Majority of the patients who had degenerative changes, tuberculosis/infectious, post traumatic and primary neoplasms of the spine belong to young and middle age groups (12-50 years). Patients with secondary neoplasms like metastases belonged to older age groups (>50 years). Other cases which included rheumatoid arthritis, Chiari malformation, vertebral osteoblastoma, spinal subarachnoid hemorrhage, epidural lipomatosis and extramedullary hematopoisis did not belong to any specific age groups.

Table-1: Causes of compressive myelopathy

MR diagnosis	Number of patients (n=30)	%
Degenerative	57	57
Infective	14	14
Traumatic	10	10
Primary neoplasm	8	8
Secondary Neoplasm/Metastases	5	5
Others	6	6

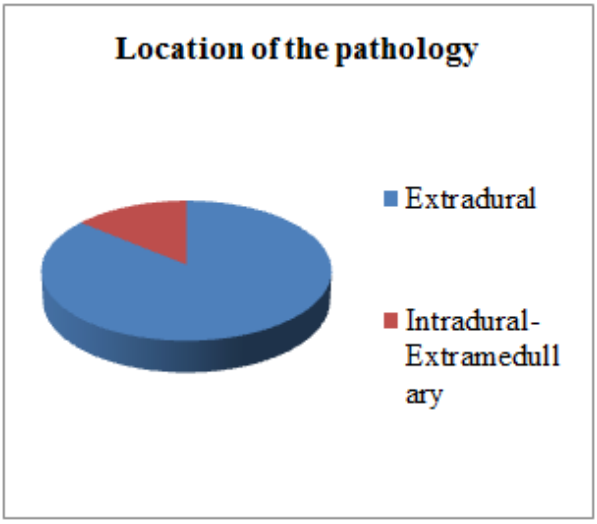


Graph-1: Causes of compressive myelopathy

Most common cause for compressive myelopathy in our study was degenerative spinal disease (57%), spinal infection (14%) followed by trauma (10%).

Table-2: Location of pathology

Compartment	Number of patients	%
Extradural	86	86
Intradural-Extramedullary	14	14
Total	100	100

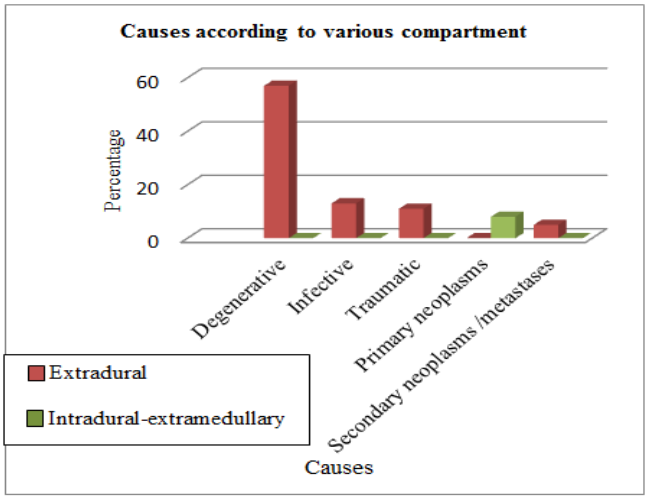


Graph-2: Location of the pathology

Extradural compressive lesions (86%) are the most common cause for compressive myelopathy.

Table-3: Causes according to various compartment

Causes	Number of patients (n=100)	Extradural (n=86)	Intradural-Extramedullary (n=14)
Degenerative	57	57	0
Infective	14	14	0
Traumatic	10	10	0
Primary neoplasms	8	0	8
Secondary neoplasms /metastases	5	5	0
Others	6	5	1

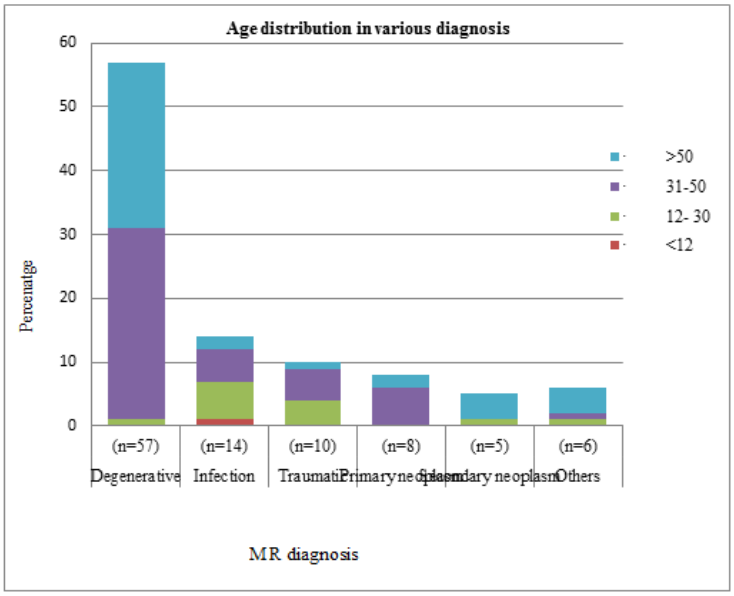


Graph-3: Causes according to various compartment

Degenerative spinal disease, spinal injuries and infection are the common causes for extradural compression while Primary neoplasms are more common in intradural compartment in our study.

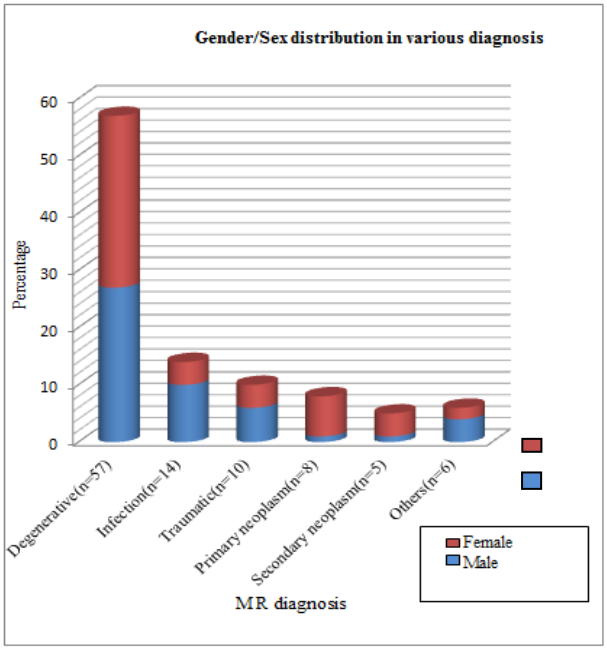
Table-4: Age, gender and compartmental distribution in various diagnoses

	Degenerative (n=57)	Infection (n=14)	Traumatic (n=10)	Primary neoplasm (n=8)	Secondary neoplasm (n=5)	Others (n=6)
Age in years						
• <12	0 (0 %)	1 (7 %)	0 (0 %)	0 (0 %)	0 (0 %)	0 (0 %)
• 2- 30	1 (1.7 %)	6 (42.8 %)	4 (40 %)	0 (0 %)	1 (20 %)	1 (16.6 %)
• 31-50	30 (52.6 %)	5 (35.7 %)	5 (50 %)	6 (75 %)	0 (0 %)	1 (16.6 %)
• >50	26 (45 %)	2 (14.2 %)	1 (10 %)	2 (25 %)	4 (80 %)	4 (66.66 %)
Gender						
• Male	27 (47.3 %)	10 (71.4 %)	6 (60 %)	1 (12.5 %)	1 (20 %)	4 (66.6 %)
• Female	30 (52.7 %)	4 (28.6 %)	4 (40 %)	7 (87.5 %)	4 (80 %)	2(33.3 %)
Compartment						
• Extradural	57 (100 %)	14 (100 %)	10 (100 %)	0 (0 %)	5 (100 %)	5 (80 %)
• Intradural	0 (0 %)	0 (0 %)	0 (0 %)	8 (100 %)	0 (0 %)	1 (20 %)



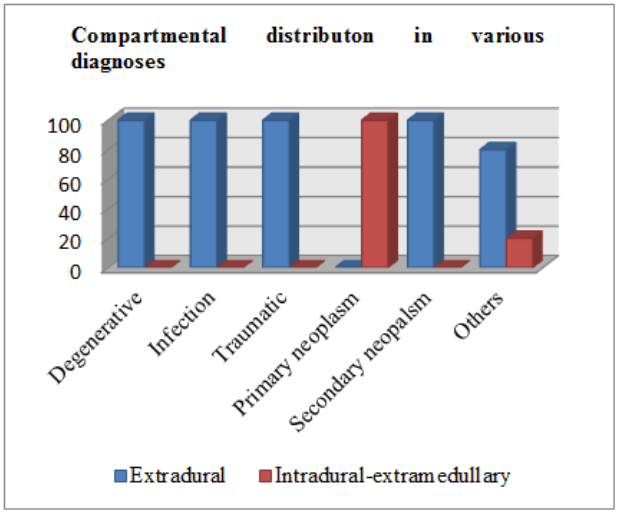
Graph-4: Age distribution in various diagnoses

Majority of patients of degenerative disease (98.3%) are aged 31-50 and >50 years, spinal injury (90%) are aged 12-3o and 31-50 years, primary neoplasm (75%) are young adults/ middle age group (31-50 years). While Majority of patients of spinal infection (78.5%) are aged between 12 to 50 years and secondary neoplasm (80%) are older age group (>50 years).



Graph-5: Gender/Sex distribution in various diagnoses

Most of the degenerative disease (52%), primary neoplasm (60%) and secondary/ metastasis (60%) are more common in female population, while spinal injury (84.6%) and spinal infection/TB (57.1%) occur in male population

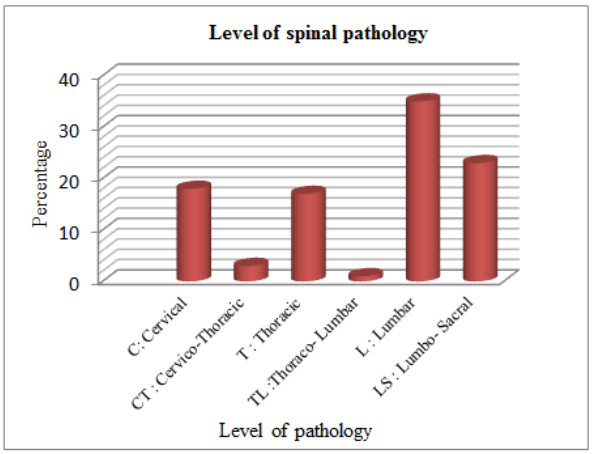


Graph-6: Compartmental distribution in various diagnoses

All of degenerative disease, most of spinal infection, injury, and secondary neoplasm involve extradural compartment while most of primary neoplasm involves intradural compartment.

Table-5: Level of spinal pathology

Level of pathology	Number of patients (n=100)	%
C: Cervical	18	18
CT : Cervico-Thoracic	3	3
T : Thoracic	17	17
TL :Thoraco- Lumbar	1	1
L : Lumbar	35	35
LS : Lumbo- Sacral	23	23
LC : Lumbar + Cervical	3	3

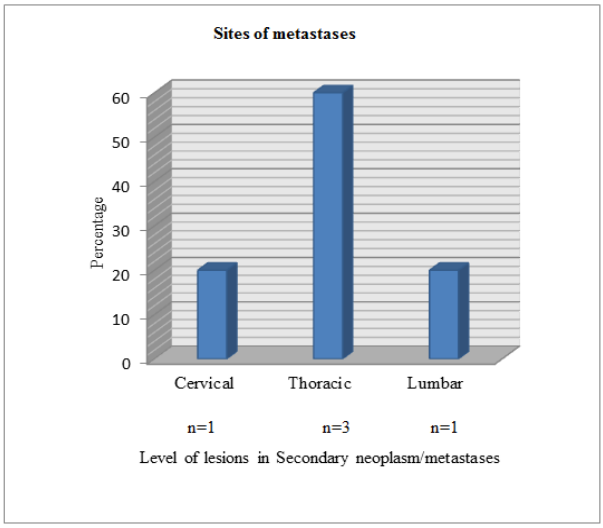


Graph-7: Level of spinal pathology

In our study, the common site involved is the spine was lumbar and lumbo-sacral.

Table-6: Site of metastases

Levels of lesions in Secondary neoplasm/metastases	Number of patients	%
Cervical	1	20
Thoracic	3	60
Lumbar	1	20

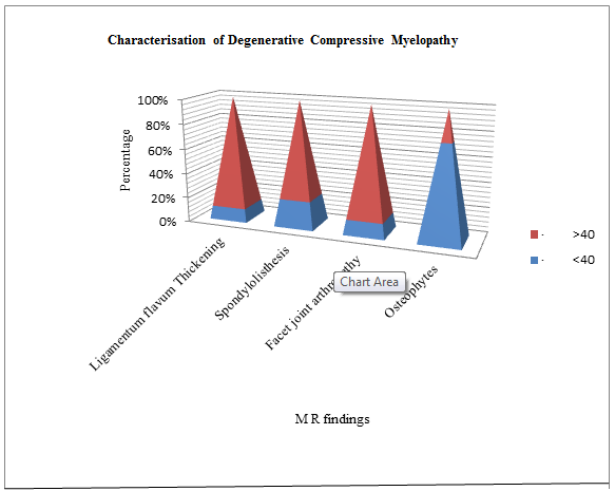


Graph-8: Site of metastases

Thoracic region is the most common site for spinal metastases.

Table-8: Characterization of Degenerative Compressive Myelopathy

	Ligamentum flavum Thickening (n=37)	Spondylolisthesis (n=9)	Facet joint arthropathy (n=33)	Osteophytes (n=57)
Age in years				
• <40	4	2	4	43
• >40	33	7	29	14



Graph-9: Characterization of Degenerative Compressive Myelopathy

All cases had osteophytes and while ligamentum flavum hypertrophy, Spondylolisthesis and facet joint arthropathy are more common in patients aged > 40 years.

MRI is very useful in detecting degenerative disease, spinal trauma, and extradural lesions such as metastases, epidural abscess, and infective spondylitis with epidural soft tissue component.

DISCUSSION

MRI has the ability to show the spine and spinal cord with greater sensitivity and specificity than myelography and CT in cases of trauma, neoplastic, congenital, & degenerative disorder. MRI has the advantage as it provides direct visualization of the spinal cord. Also, MRI has the ability of multiplanar imaging of cross-sectional anatomy, greater soft tissue details, and no radiation exposure and non – invasiveness.

In our study comprising of 100 cases of compressive myelopathy, we found various different etiologies of compression. Among them 57 cases were of degenerative changes, cases were of infectious spondylitis, 10 cases were post traumatic compressive myelopathy, 8 cases comprising of primary neoplasms, 5 cases of metastases and 1 case of Rheumatoid arthritis, epidural lipomatosis, spinal subarachnoid hemorrhage, extramedullary hematopoisis, Chiari malformation and vertebral Osteoblastoma.

These findings were similar to the study conducted by Vishal Kasotiya *et al*.[5] which showed degenerative changes as the most common non traumatic cause of compressive myelopathy and Navya *et al*. [4] which showed degenerative changes as the most common cause of compressive myelopathy.

In our study, out of 57 cases of degenerative changes causing compressive myelopathy all the patients had osteophytes which is consistent with study conducted by Vishal Kasotiya *et al*. [5], and 46 patients had cord changes i.e., intramedullary high signal intensity on T2 weighted images. Also Navya *et al*. [4] showed 32 out of 33 patients had cord changes. In our study, we had 14 cases of Potts spine, Out of these 9 cases involved thoracic region and 5 involved lumbar regions. These findings were in concordance with studies conducted by Roos DEA *et al*. [6].

X ray was abnormal in all the cases. On MRI there was destruction of the vertebral body, pre and para vertebral collection. Intra osseous abscess with rim enhancement, Epidural component with T1 hypointense signal and T2 and FLAIR hyperintense signal with rim enhancement causing compression was seen in all cases. Cord edema as hyperintense signal was also noted in all abscess.

In our study, we had 10 cases of traumatic compressive myelopathy out of which the level of spinal injuries were thoracic (7), cervical (1) and lumbar (2), which are consistent with the studies conducted by Kerslake *et al*. [7] and Navya *et al*. [4]. MRI demonstrated spinal cord abnormalities like cord compression and abnormal cord signal intensities. This finding was seen in all cases. Spinal cord compressions in these cases were due to fracture of vertebral body with retropulsed fracture fragments and epidural hematoma in 8 cases and 3 cases showed vertebral body subluxation.

In our study, all patients of traumatic compressive myelopathy had MRI finding of showed focal hypointensity on T1W and hyperintensity on T2W images and STIR images at the level of cord compression which is suggestive of cord edema/contusion. These findings of signal changes are comparable with studies done previously by Hackney *et al*. [8]. The cord signal intensity has the prognostic implication where patient with cord edema recovered

completely or partially and patient hemorrhage in cord had poor prognosis. This has also been shown by studies done by Hackney *et al*. [8], Flanders *et al*. [9] and Kulkarni *et al*. [10].

MRI depicted not only the spinal cord changes in our patients but also the relationship of subluxed/dislocated vertebral bodies to that of cord, posterior elements fracture (6 patients), ligamentous disruption (6 patients) and epidural hematoma (7 patients).The advantage of MRI in demonstrating all these characteristics in spinal injury is shown by many studies done by Kulkarni *et al*. [10].

In our study we had 8 cases of primary neoplasms, all were intradural and extramedullary. These findings are comparable with the studies done by Cormick PC *et al*. [11], which said that 2/3rd of intradural tumors are extramedullary. All these case had MRI findings of compressive myelopathy.

In our study, among these 8 cases of intradural extramedullary primary neoplasms, there were 6 cases were of meningioma and 2cases were of nerve sheath tumor. Many studies done by Matsumoto S *et al*.[12], Gezen F *et al*.[13] and Souweidane MM *et al*.[14] stated the signal characteristic of meningioma as iso intense to the cord on T1W and T2W images with intense homogeneous enhancement on post contrast. These findings are similar to the findings of our study in all cases which showed hypointense signal on T1W and iso-hyperintensity on T2W images and intense homogeneous enhancement on post contrast.

In our study, out of 4 cases 3 cases of meningioma were seen in women aged between their fourth and fifth decades and in the thoracic region. This is in concordance with the study conducted by Souweidane MM *et al*. [14], which stated that women, usually between their fourth and fifth decades, account for approximately 80% of patients with spinal meningiomas with lesion located in the thoracic region in majority of the cases. Nerve sheath tumors were iso-to- hypointense on T1WI and hyperintense on T2WI and showed intense enhancement on post contrast. One case showed extension into the neural foramina. Studies done by Dorsi *et al*. [15] and Matsumoto *et al*. [12] showed that on T1WI the signal varied from hypo to isointense to the cord and on T2WI they are hyperintense in signal and also may show decreased signal in the central portion consistent with necrosis and showed marked enhancement which was heterogeneous.

In our study of 100 cases, we had 5 cases of metastases as a cause of compressive myelopathy. In our study, all the cases of metastases had multiplicity of lesions which is comparable to the study done by Vishal Kasotiya *et al.* [5] in which 78% of cases of metastases had more than one lesion which include vertebral masses in addition to those compressing the cord. Also our study showed that thoracic region was the most common level for the metastases which is comparable to the study done by Livingston *et al*. [8],Vishal Kasotiya *et al*. [5].

In our study, most patients with degenerative changes of spine were females which is consistent with the study done by Vishal Kasotiya *et al*. [5], primary and secondary neoplasm were more common in females while study conducted by Navya *et al*. [4] showed that these pathologies were more common in males.

We had 1 case of rheumatoid arthritis of the cervical spine as a cause of compressive myelopathy. MRI showed atlanto-axial dislocation, with spinal canal stenosis. Also hyperintense bone marrow signal. Significant posterior ligament hypertrophy was noted along with peri odontoid synovitis which was hypointense on T1W and hyperintense on T2W and STIR. Cord abnormal signals suggestive of edema were also noted. These findings are comparable with the study done by J A Naravaez[16] which stated that cervical spine involvement is relatively common in Rheumatoid arthritis with finds of posterior ligament hypertrophy, canal stenosis and atlanto axial subluxation.

We had 1 case of extramedullary hematopoisis as a cause of compressive myelopathy. MRI showed soft tissue mass which hypointense on T1W and iso to hyperintense on T2W was causing spinal cord compression. These imaging findings were consistent with study done by Shuhei Ito *et al*. [17].

We had 1 case of spinal epidural lipomatosis as a cause of compressive myelopathy. In our study the level of pathology was at lumbar spine which is comparable with Chatzidakis *et al*. [6, 5] which concluded that lumbar and thoracic spine was the most common region. MRI showed T1W hyperintense adipose tissue causing spinal cord compression. The dural sac showed polygonal shape in the lumbar region which on subsequent section shows classical inverted 'Y' sign. This finding is comparable to the study done by Chatzidakis *et al*. [18].

We had 1 case of vertebral body osteoblastoma involving the vertebral body and posterior elements as a cause of compressive myelopathy. MRI showed a well-defined destructive solid lesion in the vertebral body which was hypointense on T1W and hyperintense on T2W with heterogeneous contrast enhancement causing spinal cord compression. These findings are similar to study done by Argyriou, Andreas A. *et al*.[19] which showed involvement of vertebral body and posterior elements.

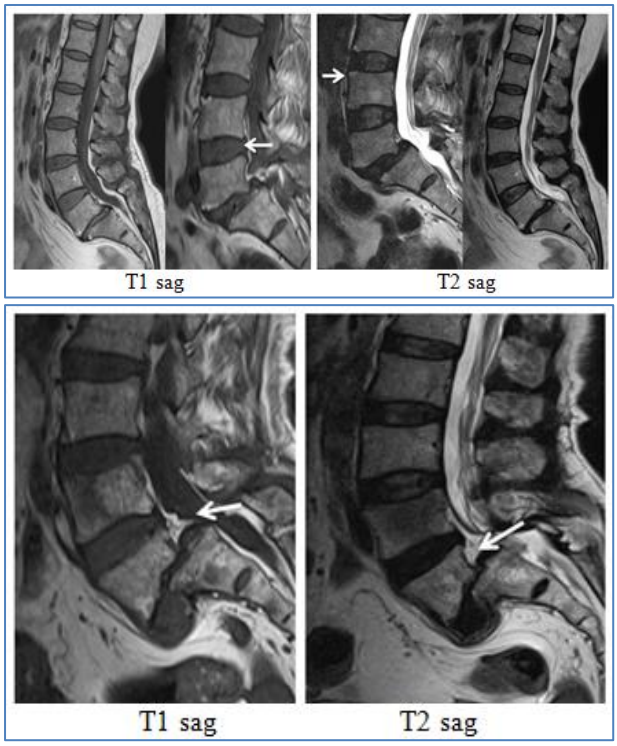
We had 1 case of spinal subarachnoid hemorrhage as a cause of compressive myelopathy.

MRI showed T1 hyperintense subarachnoid hemorrhage compressing the spinal cord similar to study done by Toshinari Kawasaki *et al*. [20].

We had 1 case of Chiari 1 malformation as a cause of compressive myelopathy. Sagittal MRI showed CMJ showing 7 mm tonsillar herniation with effacement of subarachnoid space by the indentation of dens. Cord hyperintense signal were also noted. All these findings are comparable to study done by Hadley DM *et al*. [21] which stated that Chiari 1 malformations is characterized by displacement of deformed cerebellar tonsils more than 5 mm caudally through the foramen magnum. The brainstem and IVth ventricle retain a relatively normal position although the IVth ventricle may be small and slightly distorted.

CASE GALLERY

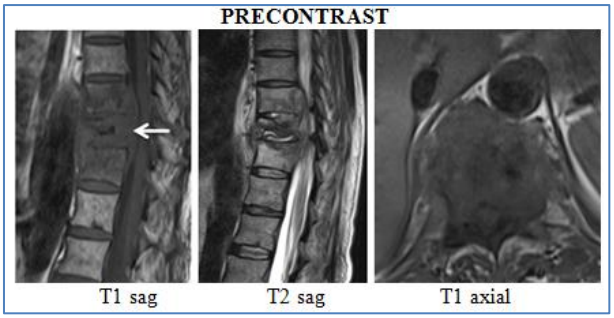
Disc desiccation and osteophytes



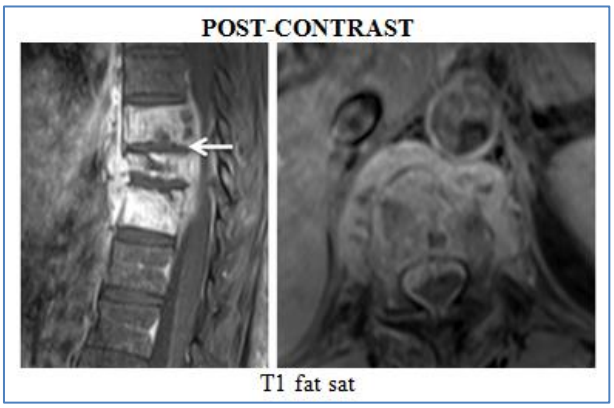
Case-1: Degenerative disease

T1 sag and T2 sag images of lower lumbar spine showing degenerative changes of disc desiccation and osteophytes (arrows).

T1 sag and T2 sag images showing grade 2 Spondylolisthesis (arrows)

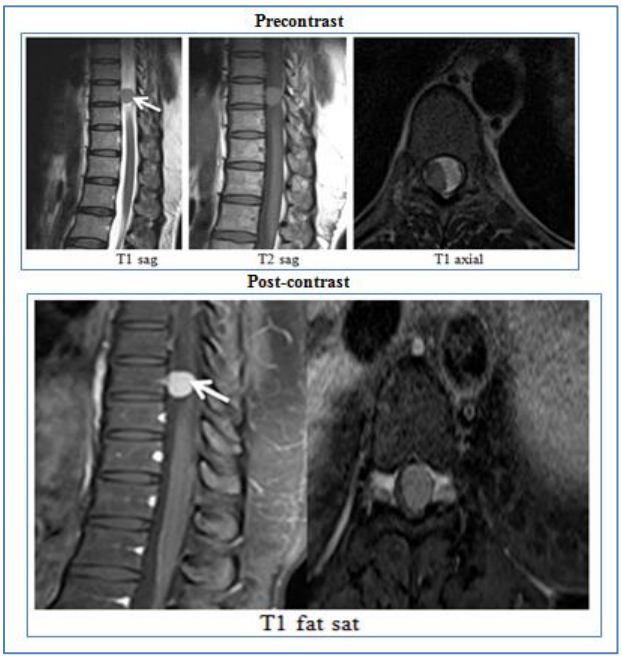


Case-2: potts spine with abscess



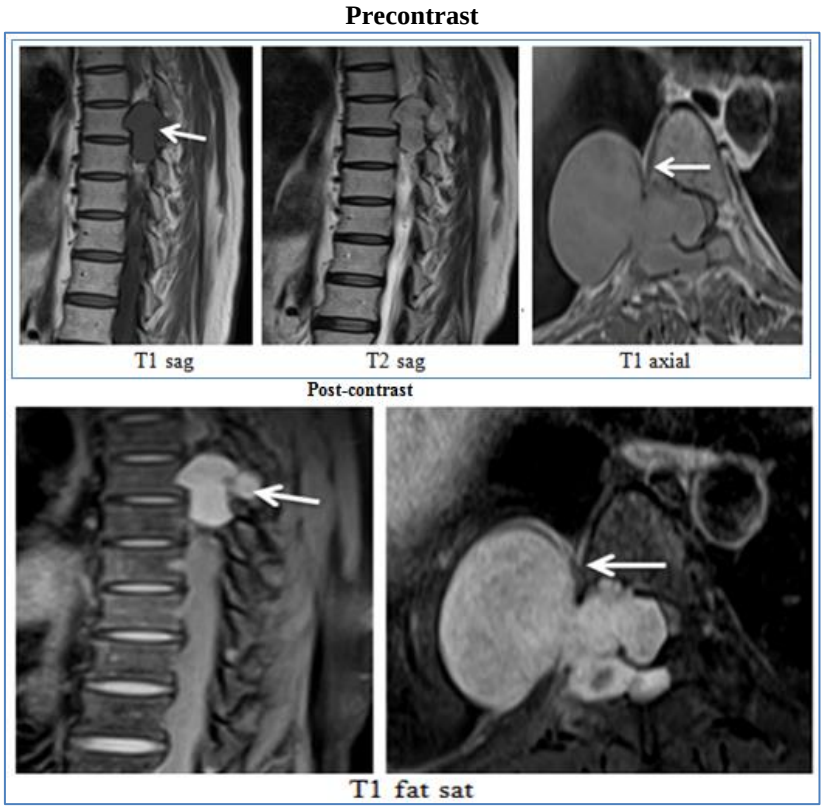
Case-2: Potts spine with abscess

Sagittal and axial pre and post contrast images showing altered bone marrow signal with destruction of vertebral bodies and rim enhancing epidural, subligamentous collection in the dorsal spine (arrows).



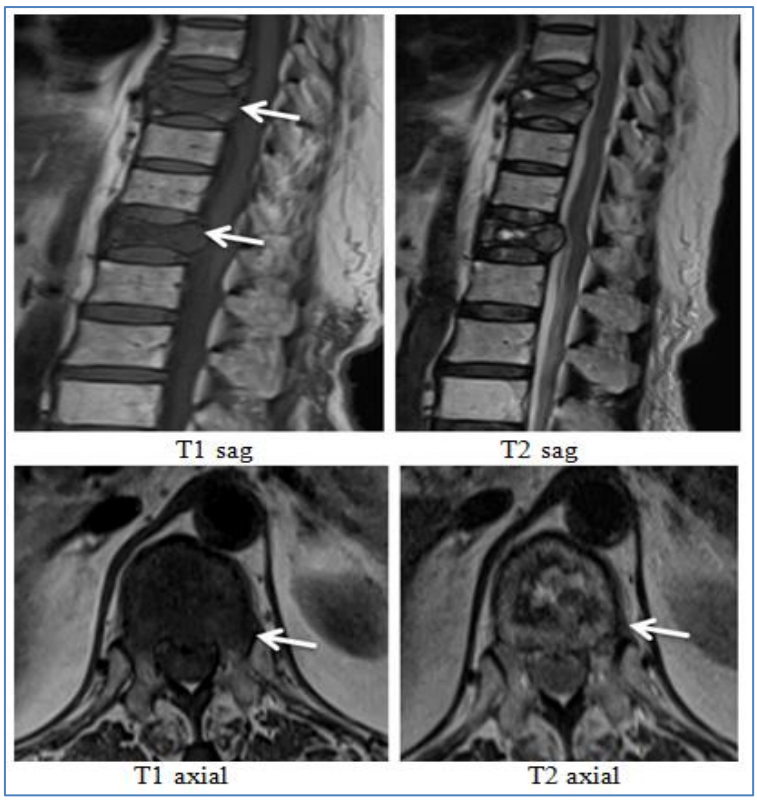
Case-3: Meningioma

Sagittal and axial pre and post contrast images showing Intradural extramedullary lesion, iso to hypointense on T1W and hyperintense on T2W with homogeneous post contrast enhancement at the dorsal spine level (arrows).



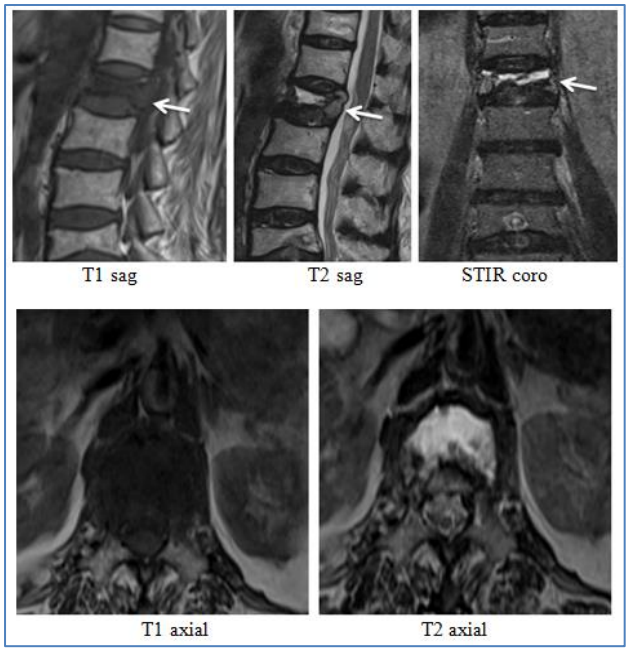
Case-4: Nerve sheath tumour (schwannoma) with extension into neural foramina

Sagittal and axial pre and post contrast images showing Intradural extramedullary lesion, iso to hypointense on T1W and T2W with homogeneous post contrast enhancement and extension into the neural foramina at the dorsal spine level (arrows).



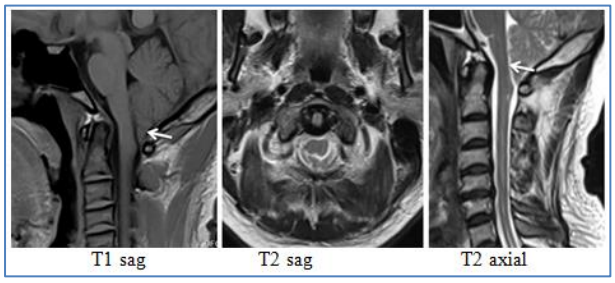
Case-5: multiple vertebral mets

Sagittal and axial images showing reduced vertebral body heights and altered bone marrow signal at the dorsal spine level with epidural soft tissue component causing compression of the spinal cord (arrows).



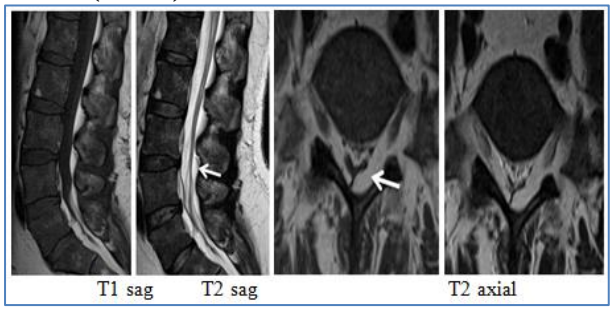
Case-6: vertebral fracture

Sagittal axial and coronal images showing reduced vertebral body height due to compression and altered bone marrow signal at the dorsal spine level with retropulsed fracture fragment component causing compression of the spinal cord (arrows)



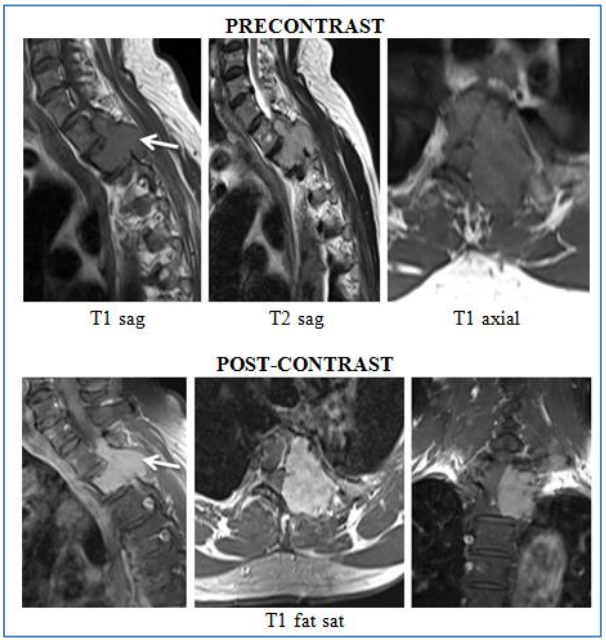
Case7: chiari 1 malformation

Sagittal and axial images showing peg shaped low lying cerebellar tonsils causing compression of the upper cervical cord which is showing hyperintense cord oedema (arrows).



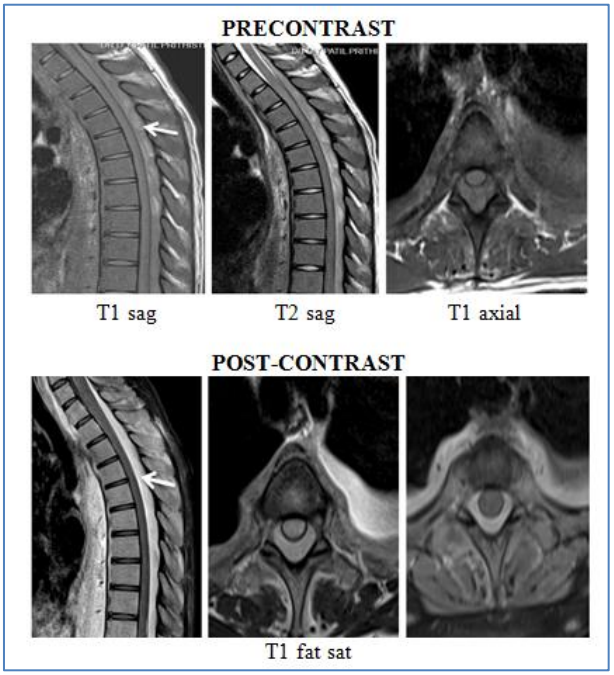
Case-8: epidural lipomatosis

Sagittal and axial images showing T1 and T2 hyperintense signal epidural fat causing compression of the spinal cord in the lumbo-sacral level. Characteristic "Y" sign is seen (arrows)



Case-9: osteoblastoma

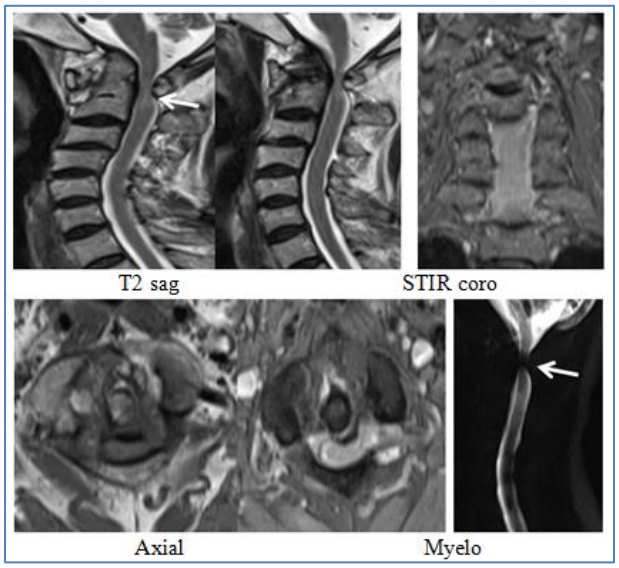
Sagittal and axial images showing an expansile lytic lesion arising from the body and pedicle of the dorsal vertebra and extending into the spinal canal and causing compression of the spinal cord. On contrast there is near homogeneous enhancement (arrows).



Case-10: extramedullary haematopoiesis

Sagittal and axial pre and post contrast images shoeing T1 isointense and T2 hyperintense epidural

lesion at the cervico-dorsal level causing compression of the spinal cord. On contrast there is homogeneous enhancement.



Case-11: Rheumatoid arthritis with spinal canal stenosis

Sagittal, axial and coronal images showing deformity at the atlanto-axial level causing severe spinal canal stenosis and compression of the cervical 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 degenerative changes, cord edema/contusion and integrity of the intervertebral discs and ligaments. MRI is very sensitive and considered the imaging modality of choice to detect and characterize the spinal tumors and spinal infections. The final diagnosis still relies on biopsy and histopathological examination. Till date, MRI is the only modality which can image the changes in spinal cord directly.

In my study with the help of MRI I was able to successfully characterize the changes of degenerative changes, identify the most common pathological changes in degenerative disc disease, characterize the spinal tumor based on location into Extradural / Intradural and assess the integrity of spinal cord, intervertebral discs and ligament after acute spinal trauma. Also I was able to diagnose rare causes of compressive myelopathy like Rheumatoid arthritis, Chiari 1 malformation, Spinal epidural lipomatosis, Vertebral Osteoblastoma, Spinal subarachnoid hemorrhages and extramedullary hematopoisis along with their associated changes which are difficult to diagnose on other imaging modalities. 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.

Limitations of the study

Histopathological correlation could not be done due to various reasons. Sample size and duration of study were limited.

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