

Original article:

Role of MRI in evaluation of bone marrow changes in non-traumatic spine in various diseases

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Abstract:

Objective: This cross-sectional observational study aimed to evaluate the prevalence, characteristics, and distribution of non-traumatic spinal pathologies using magnetic resonance imaging (MRI). The study also aimed to assess the signal characteristics and enhancement patterns of infiltrative disorders and focal bone marrow abnormalities.

Methods: A total of 100 patients with clinical suspicion of axial skeleton pathology were included in the study. MRI of the spine was performed, and routine assessments, additional imaging methods, and informed consent were obtained. The study population consisted of both admitted and outpatient cases from various departments. Data on clinical history, radiological and hematological findings, and treatment strategies were collected and analyzed.

Results: Among the 100 cases studied, degenerative disorders were the most prevalent (60%), followed by infiltration disorders (16%) and reconversion disorders (11%). Modic changes were observed in 29.4% of cases, with type II being the most common. Metastasis to the vertebrae was associated with primary malignancies such as prostate (30.7%) and breast (30.7%) cancers. Signal intensities and enhancement patterns varied in infiltrative disorders, and focal edema was the most common focal bone marrow disorder (60%).

Conclusion: This study provides insights into the prevalence, characteristics, and distribution of non-traumatic spinal pathologies using MRI. Degenerative disorders were the most common, while Modic changes and metastasis to the vertebrae were also observed. MRI demonstrated its value in diagnosing and characterizing infiltrative disorders and focal bone marrow abnormalities. These findings contribute to the understanding and management of non-traumatic spinal pathologies and highlight the significance of MRI as a valuable diagnostic tool.

Keywords: MRI, spinal pathologies, bone marrow, degenerative disorders, Modic changes, infiltrative disorders, metastasis, focal edema.

Introduction:

Magnetic Resonance Imaging (MRI) has revolutionized the field of diagnostic imaging, providing detailed and non-invasive visualization of various anatomical structures within the human body. While MRI is commonly associated with the evaluation of soft tissues, it also plays a crucial role in assessing bone marrow changes in non-traumatic spine conditions.

Bone marrow, a specialized tissue found within the central cavities of bones, is involved in hematopoiesis and the storage of fat. Changes in bone marrow can occur due to a wide range of diseases, including hematological disorders, infectious processes, metabolic conditions, and neoplastic diseases. These changes can significantly impact the overall health and function of the spine. (1,2) MRI offers unique advantages in the evaluation of bone marrow pathology in the spine. It provides excellent soft tissue contrast, multiplanar imaging capabilities, and the ability to differentiate between various tissue types within the bone marrow. With the use of specific pulse sequences, such as T1-weighted, T2-weighted, and fat-suppressed sequences, MRI can accurately characterize different bone marrow abnormalities, including fatty infiltration, edema, fibrosis, infection, and malignancy.(3,4,5)

Moreover, MRI allows for the assessment of bone marrow changes not only in the vertebral bodies but also in the posterior elements, such as the pedicles, laminae, and facets. This comprehensive evaluation aids in the detection and localization of pathology, guiding appropriate treatment strategies.(6,7)

Material and methods:

A cross-sectional observational study of total 100 patients who came to Radiology department from OPD or Casualty or admitted mainly in surgery, medicine , emergency department and pediatrics of Bapuji hospital/Chigateri general hospital with clinical suspicion of non traumatic pathology involving the axial skeleton underwent imaging study. MRI of spine was done on an elective basis. Prior institutional ethics committee clearance and approval of the JJM Medical College were obtained for the study.

Routine assessments (like history taking, physical examination, related blood tests) were aimed at all patients, while additional imaging methods (x-ray spine or x-ray / CT chest and abdomen in patients with primary at other identified location) were also performed using a risk-benefit-based management algorithm.

Informed consent was obtained from the subjects for inclusion of their MR images in the study.

INCLUSION CRITERIA:

- Clinical suspected marrow pathology involving the axial skeleton.
- Biochemical examination suggestive of derranged haematological profile / Ineffective haematopoiesis/Metabolic disorders.
- In patients with known primary malignancy presented with backache.
- In patients with backache radiating to extremities without any previous significant past history.

EXCLUSION CRITERIA:

- Patients not consenting for the study and the patients who are claustrophobic
- Intracranial aneurysm clips (Unless the referring doctor is confident that it is made of non-ferromagnetic material such as titanium)
- Intra-orbital pieces of metal
- Any implants that are electrically, magnetically or mechanically powered
- including cardiac pacemakers, biostimulators, neurostimulators,
- Cochlear implants and hearing aids
- Pregnancy (Risk Vs benefit ratio to be assessed).

Results:

A total 100 number of patients with non-traumatic pathology of spine referred mainly from surgical, medicine , pediatric and emergency department were included in the study . Among them 22 were admitted patients and 78 were from out patient department. Various pathologies of spine were diagnosed in these patients based on history, clinical suspicion, correlation with radiological and hematological findings and treated accordingly.

Out of n=100 cases studied for various spinal pathologies, maximum cases (n=60) were degenerative followed by infiltration disorders (n=16), next was reconversion disorders (n=11). There were only 3 cases of depletion disorder and was no case with deposition disorder.

1) Prevalence of Modic changes

In our study of various spinal pathologies, out of n=60 cases of degenerative disorders of spine 17 patients showed various Modic changes as follows. Type II was the most common finding. None of the cases had type III modic change in our study group.

Sr no	Modic changes	No of patients(Percentage)
1	I	5(29.4%)
3	II	12(70.6%)
5	III	0(0%)

2) Site of primary in patients with metastasis- Out of 13 patients with metastasis to vertebrae, distributions of primaries were as follows.

Sr no	Primary site	Number of patients
1	Unknown	2(15.3%)
2	Prostate	4(30.7%)
3	Breast	4(30.7%)
4	Lung	2(15.3%)
5	Kidney	1(0.07%)

3) Signal characteristic and enhancement pattern - Signal intensity of vertebral bone marrow in various infiltrative disorders were compared with that of paraspinal muscles and intervertebral disc. Lesions show various signal intensities and enhancement patterns as tabulated below.

Sr no	MRI	No of patient
1	T1	
	Hypointense	14
	Isointense	2

	hyperintense	0
2	T2 Hypointense	0
	Isointense	6
	hyperintense	10
3	STIR Hypointense	0
	Isointense	6
	hyperintense	10
4	Post enhancement contrast	11
5	Diffusion restriction	14
6	Signal drop in outphase	2

4) Classification of Depletion disorders

Only 3 cases of depletion disorders are found in our study. Various depletion disorders can be classified in to depletion disorders secondary to radiotherapy, chemotherapy, idiopathic and depletion disorders with fibrosis (myelofibrosis), aplastic anaemia and tabulated below.

Sr no	Depletion disorders	No of patients
1	Unknown cause	1(33.33%)
2	Myelofibrosis	1(33.33%)
3	Aplastic anaemia	1(33.33%)
4	Secondary to chemo or radiotherapy	0(0%)

5) Distribution of focal disorders of Bone marrow -

Various focal bone marrow disorders in spine are focal edema, ischemia. Distributions ofwhich are as follows

Sr no	Focal disorders of bone marrow	No of patients
1	Focal oedema	6(60%)
2	Focal lesions	4(40%)

6) Causes of focal oedema

Causes of focal oedema in spine are ischemia, tumour, infection and trauma. Excluding trauma, prevalence of causes of other focal bone marrow is as follows.

Sr. no	Causes of focal oedema(other than trauma)	No of patients
1	Ische mia	0
2	Tumo ur	0
3	Infecti on	6

7) Signal characteristic and enhancement pattern

Signal intensities of vertebral bone marrow with focal oedema were compared with that of paraspinal muscles and intervertebral disc. Lesions showing various signal intensities and enhancement patterns as tabulated below.

Sr no	MRI	No of patient
1	T1	5
	Hypointense	1
	Isointense hyperintense	4
2	T2	0
	Hypointense	1
	Isointense hyperintense	9
3	STIR	0
	Hypointense	1
	Isointense hyperintense	9
4	Post contrast enhancement	4
5	Signal drop on out phase	4

CASE 1: INFILTRATION OF SPINAL BONE MARROW BY LYMPHOMA

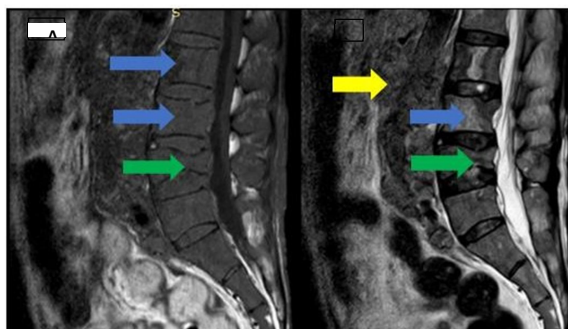


Image A : T1 sagittal Cervical Spine , **Image B** : T2 Sagittal Dorsal Spine

There are multiple ill-defined T1 hypointense, T2 hyperintense lesions noted at multiple vertebral levels (Blue arrow) . we can also see wedge collapse with fluid sign noted in L4 vertebral body (green arrow) – s/o osteoporotic fracture . In the FOV we can see there are multiple enlarged retroperitoneal lymphnodes (yellow arrow) which are T1 iso-hypointense and T2 iso – hyperintense to the intervertebral discs.

CASE 2: INFILTRATION OF SPINAL BONE MARROW BY CARCINOMA LUNG

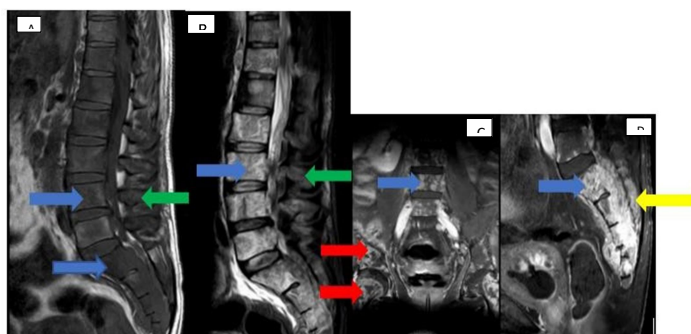


Image A : T1 sagittal Lumbar Spine, **Image B** : STIR Sagittal Lumbar Spine , **Image C** :

Post contrast T1 Fat sat lumbar spine coronal , **Image D** : Post contrast T1 Fat sat sacrum

Sagittal In this K/c/o Carcinoma Lung , there is diffuse infiltration of Lumbar , sacral vertebral bodies, pelvis and bilateral femur . Appears as heterogenous T1 hypointensities , STIR hyperintense and showing heterogenous postcontrast enhancement noted in sacrum and lumbar vertebral bodies (blue arrow) , posterior elements (green arrow) , adjacent soft tissue (yellow arrow) and pelvis and bilateral femur (red arrow)

Discussion:

The present study aimed to investigate the prevalence and characteristics of non-traumatic spinal pathologies using MRI imaging. A total of 100 patients with suspected axial skeleton pathology were included in the study, referred mainly from surgical, medicine, pediatric, and emergency departments. The study population consisted of both admitted patients and those from the outpatient department.

The results of the study revealed that degenerative disorders were the most prevalent spinal pathologies, accounting for the majority of cases (60 out of 100). Infiltration disorders were the second most common, with

16 cases, followed by reconversion disorders with 11 cases. Depletion disorders were observed in only three cases, while no cases of deposition disorders were found.

Among the degenerative disorders, Modic changes were identified in 17 out of 60 cases. Type II Modic changes were the most common finding, while no cases of type III Modic changes were observed. This information provides valuable insights into the prevalence and distribution of different types of Modic changes in non-traumatic spinal pathologies.

Metastasis to the vertebrae was found in 13 patients, with the primary site being unknown in two cases. Prostate and breast cancers accounted for the majority of cases, followed by lung and kidney cancers. These findings highlight the importance of considering metastatic disease as a potential cause of spinal pathologies, particularly in patients with a history of primary malignancies.

The signal characteristics and enhancement patterns of infiltrative disorders were evaluated. Various signal intensities and enhancement patterns were observed, indicating the diverse nature of these disorders. Additionally, focal bone marrow disorders were investigated, with focal edema being the most common, followed by focal lesions. In cases of focal edema, infection was the predominant cause identified, while ischemia and tumor-related causes were not observed in this study.

The study also examined the classification of depletion disorders, which included cases of myelofibrosis, aplastic anemia, and idiopathic causes. The low number of cases in this category suggests that depletion disorders are less common in non-traumatic spinal pathologies.

The results of this study provide valuable information regarding the prevalence, distribution, and characteristics of various spinal pathologies using MRI imaging. This knowledge can aid in the accurate diagnosis and appropriate management of patients with non-traumatic spinal disorders. Understanding the specific patterns of Modic changes, metastatic involvement, and infiltrative disorders contributes to the comprehensive evaluation and treatment of patients presenting with axial skeleton pathology.

It is important to note that this study has certain limitations. The sample size was relatively small, and the study was conducted at a single institution. Further research with larger sample sizes and multi-center collaborations would enhance the generalizability and validity of these findings. Additionally, long-term follow-up studies are necessary to assess the clinical outcomes and treatment responses in patients with different spinal pathologies. Overall, the findings of this study contribute to the growing body of knowledge on non-traumatic spinal disorders and support the use of MRI as an effective diagnostic tool in this context.

Conclusion:

In conclusion, this study highlights the prevalence and characteristics of non-traumatic spinal pathologies using MRI imaging. The findings emphasize the high occurrence of degenerative disorders, followed by infiltration and reconversion disorders. Modic changes, particularly type II, were frequently observed. Metastasis to the vertebrae was most commonly associated with prostate and breast cancers. The study also revealed diverse signal intensities and enhancement patterns in infiltrative disorders, with focal edema being the most common focal bone marrow disorder. This study contributes valuable insights into the understanding, diagnosis, and management of non-traumatic spinal pathologies, emphasizing the importance of MRI as a diagnostic tool in this context.

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