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Original Research Paper

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INCIDENTALLY DETECTED BONE MARROW RECONVERSION IN A LARGE PROSPECTIVE ADULT COHORT ON ROUTINE MRI LUMBAR SPINE: UNMASKING THE UNDERLYING ETIOLOGY

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ABSTRACT

PURPOSE: The purpose of this study was to evaluate the incidence and various etiologies of the incidentally detected abnormal bone marrow signal changes of reconversion on routine lumbar MRI spine examinations and to determine the prevalence of subsequent oncologic and non-oncologic diagnosis.

MATERIAL AND METHODS: MR images of the lumbar spine of 998 --------patients with lower back pain obtained between July 2015 and December 2016 were analyzed prospectively. Two readers reviewed the MRI studies were reviewed for for bone marrow signal changes of the vertebrae for marrow reconversion. The patients with marrow reconversion changes in lumbar spine were checked for Vitamin D levels, reviewed with whole spine imaging to look for changes in cervical and dorsal spine, and sacroiliac joints.independently with final agreement on consensus.

RESULTS: Of the 220 patients with marrow reconversion changes who fulfilled the inclusion criteria,66 (29.5%)patients had subclinical vitamin D deficiency,26(12%) patients had imaging features suggestive of tuberculosis in spine, 23(10%) patients had findings of sacroiliitis, 89(40.04%) were found to be normal & 17(8%) cases had metastasis /multiple myeloma.

CONCLUSION: The knowledge of the normal and abnormal signal intensities of bone marrow on MRI lumbar spine imaging is mandatory to decide what is potentially pathologic and what is not. We conclude that any signal alteration on MRI spine in bone marrow should not be ignored. Altered marrow signal particularly homogenous hypointensity on T1-W imaging of lumbar spine is one of the indicator of subclinical vitamin D deficiency. Routine measurement of blood vitamin D levels and screening of whole spine is suggested to evaluate for the underlying cause for the incidental finding of marrow reconversion.

KEYWORDS :

INTRODUCTION:

Bone marrow reconversion is a process of reverse replacement of red marrow by yellow marrow by redmarrow. The process of red to yellow bone marrow reconversion occurs inevitably with ageing, withby the fatty replacement of haematopoietically active cells begins in the peripheral appendicular skeleton and progresses to the central axial skeleton . The physiological reconversion progresses from the peripheral appendicular skeleton to the axial skeletonYellow-to-red marrow reconversion generates normal red marrow in the places where yellow marrow occur and this is a physiologic response to increased hematopoietic demands of the body. This can be seen in various physiologic (stress, smoking) and pathological conditions (anemia, chronic infectious or inflammatory and neoplastic conditions) (6).The causes may be physiological or pathological depending on the age of the patient,exposure factors and the site of reconversion

Magnetic resonance imaging (MRI) is the primary imaging modality for evaluation of bone marrow and routine sequences [T1-weighted, T2-weighted, Proton density (PD) fat saturation sequences, short-tau-inversion recovery (STIR)] are usually sufficient to evaluate the presence of bone marrow reconversion changes. The presence of altered bone marrow signal due to marrow reconversion is one of the common incidental radiological findings in routine spine MRI reporting. The manifestation of reconversion can be challenging in interpretation of musculoskeletal system imaging and can be mistaken as a pathologic finding. The knowledge about the significance of these marrow reconversion signal changes due to marrow reconversion is essential for image interpretation because the exact etiology of the marrow changes can be identified based on the imaging appearances alone.

Current increase in use of Magnetic Resonance Imaging (MRI) spine has resulted in dramatic increase in the reporting of incidental findings like altered bone marrow signal .[1]. Currently, the significance and etiology of these abnormal marrow signals on imaging have been studied and described in few prior studies. To the best of our knowledge, there is no published large prospective study of adult patients evaluating the etiology of marrow reconversion on imaging. The current study aims to evaluate the incidence and various etiologies of these incidentally detected abnormal marrow signal changes of reconversion on routine MRI spine subsequently leading to oncologic and non-oncologic diagnosis.

PURPOSE:

Aim of our study is evaluation of altered bone marrow signal(incidental) on spine MRI with regards to their prevalence in cases with coexistence of inflammatory/infectious disease process such as spondyloarthritis,seronegative arthritis and tuberculous arthritis, subclinical Vitamin D deficiency and other pathologies affecting the spine.

MATERIALS AND METHODS:

This is a prospective observational study conducted at Ggovernment Royapettah hospital / Kkilpauk medical college for a period of 18 months from July 2015 to December 2016.The study was approved by the institutional research ethics board and consent from all the included participants has been obtained.

Patient Selection:

All the patients underwent routine MRI lumbosacral spine for the evaluation of non-specific low backache referred from various medical services including internal medicine, neurology, neurosurgery, orthopedics and rheumatology were included.

The inclusion criteria included: 1) Age group 20-40 years

undergoing MRI of lumbar spine;2)

EExclusion criteria included: 1) age less than 20 and more than 40 years as physiological presence of red bone marrow is seen in less than 20 years and physiological reconversion of yellow to red marrow is prevalent in more than 40 years old subjects; 2) known primary or secondary malignancies or hematological disorders; 3) subjects with history of chronic smoking; 4) subjects with hemoglobin less than 12g/dl within the last three months.

The patients included are those who come for MRI lumbar spine, mostly with complaints of nonspecific low back ache. Few cases with complaints of infection and arthritis. The age group included in this study was: 20 to 40 years.

Clinical and Laboratory Analysis:

The patient's clinical history, presenting complaints, history of smoking, history of associated inflammatory pathologies and neoplastic conditions are were obtained before performing MRI by co-investigator who was not an MRI readerbefore performing MRI.

Cases in which patient had associated malignancies / blood disorders were excluded.Since physiological presence of red bone marrow is noted in cases with age less than 20 years and physiological reconversion of yellow to red marrow is prevelant in cases more than 40 years, patients <20 and >40 years were excluded from the study.

Chronic smokers within the above specified age group and cases with Hb <12g/dl within three months of MRI date were excluded.Patients undergoing MRImultiple times were included only once.

MRI Techniques and Image Acquisition:

All MRI examinations were performed without IV contrast administration with a 1.5-T MRI system (Magnatom Avanto , Siemens 8 channel).The MRI protocol included T1 sagittaland axial(TR<800700-1000mms;TE 10-20mms<30; 4mm slice thickness with slicslice gap 10% e gap---; FOVFOV 350mms),T1 axial TR600 - 800mms TE12 FOV 200mm ,3mm slice thickness , ,T1 fat suppressed axial (write all parameters?), T2 sagittal and axial(TR2500-3000>2000; TE90-110<80;ms; 4mm slice thickness with slice gap 10%---; FOV), T2 axial (TR 3000-5000,TE 90-110ms,3mms slice thickness, 3mms) Short Tau Inversion Recovery(STIR) coronal (TR: >3000ms2000 ,TE: >40ms60, inversion time (TI): 160ms20-170). STIR sequence was obtained in all casesto exclude cases with bone marrow edema. T2 and T1 sagittal screening of the cervical and thoracic spine was done in cases where there was altered signal intensity (Low T1W signal intensity in vertebral marrow comparing to the adjacent muscles) within the lumbar spine.

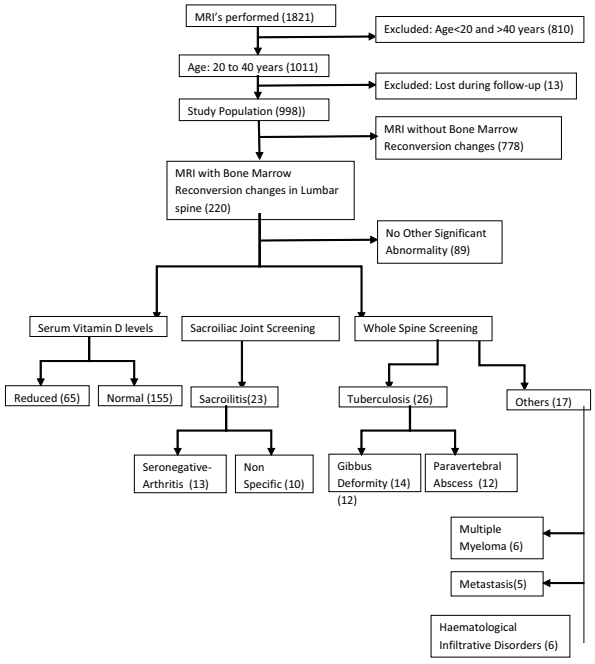
Analysis:

Two Reporting was done by 2 radiologists with 10 years and 2 years of experience in musculoskeletal imaging read all the MRI examinations to look for bone marrow reconversion.

All these cases with marrow reconversion changes in lumbar spine MRI are also subjected to measurement of blood vitamin D levels. Vvitamin D deficiency should be defined as circulating levels of 25-hydroxyvitamin D that are less than 32 ng per milliliter (80 nmol per liter). [5]

RESULTS:

Of the 220 patients with marrow reconversion changes who fulfilled the inclusion criteria, were89(40.04%) were found to have subclinical vVitamin D deficiency (decreasesddecreased blood vitamin D levels with no clinical features to suggest the same), 65(30%) patients had have no other significant abnormality, 26(12%) patients has imaging findings suggestive of infective spondylodiscitis when otherdorsal spine was included in the study. Among the 26 patients with, 14 had imaging features of tuberculosis and 12 had pyogenic spondylodiscitis in the thoracolumbardorso- lumbar spine spine. 23(10%) patients had findings of sacroiliitis eitiswith articular surface irregularity and erosions along the iliac side of the SI joint. Among those 23 patients, 18 were found to have seronegative arthritis and 5 of them had non-specific unilateral sacroiliitisitis. Among the remaining 17(8%) cases, 6 patients had multiple myeloma with multifocal lytic lesions in whole spine from clivus to sacrum and soft tissue lesion in few, 5 were biopsy proven case of vertebral metastasis in dorsothoraco-lumbar spine and 6 of them had haematological infiltrative disorders when the imaging was done from clivus to sacrum.



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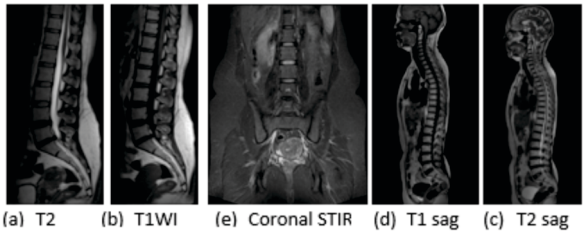
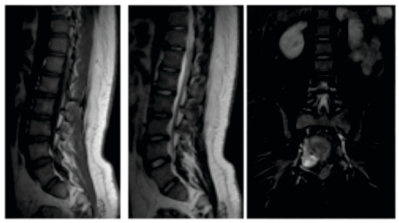
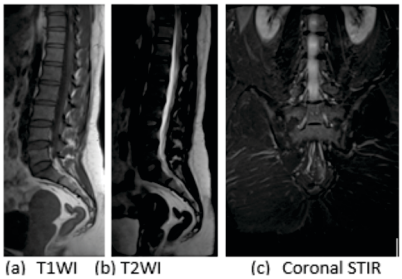


Fig 1: Normal marrow signal intensity on T2WI (a) and T1WI (b). (c) Normal sacroiliac joint on Coronal STIR sequence. d) T1 sag e) T2 sag



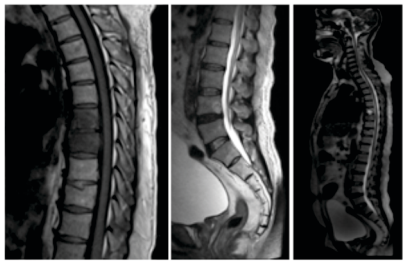
(a) T1WI (b) T2WI (c) Coronal STIR

Fig 2: Mild hypointense marrow signal on T1WI (a) and T2WI (b). (c) Normal sacroiliac joint on Coronal STIR sequence.



(a) T1WI (b) T2WI (c) Coronal STIR

Fig 3: Mild hypointense marrow signal on T1WI (a) and T2WI (b). (c) Sacroilitis on Coronal STIR sequence.



(a) T1WI of Dorsal spine (b) T2WI of lumbosacral spine (c) T2WI of whole spine

Fig 4: Bone marrow reconversion changes in lumbar spine(b) with D7-D8 spondylodiscitis(a).

DISCUSSION:

At birth, majority of marrow is hematopoietically active red marrow. Physiological conversion of red marrow to yellow marrow always begins from periphery to center of the bones. This reconversion starts from childhood and completes by 25 yrs of age. This conversion mostly follows a constant manner starting in the peripheral bones and progressing to the axial skeleton. During reconversion the process takes place in the reverse direction with marrow changes beginning in the pelvis and then progressing to the appendicular skeleton. [2]

Common causes for marrow reconversion include physiological stress, nonmedical condition like heavy smoking causing recoversion due to reduction in oxygen carrying capacity and hypoxic state[3](>2yrs), medical causes like obesity, diabetes and chronic anemia (hemoglobinopathy, chronic infectious disease), marrow infiltrative disorders (myeloma ,leukemia).

The normal imaging appearances of bone marrow depends on their chemical composition. Red marrow is normally constituted by 40% fat, 40% & water 20% protein. Yellow marrow is normally constituted by 80% fat, 15% & water 5% protein [6].

The most reliable and sensitive sequence for imaging the bone marrow changes is T1weighted MRI sequences. Red bone marrow appears hypointense and yellow marrow appears hyperintense on T1weighted imaging compared to adjacent musculature & intervertebral discs. T1 weighted nonfat suppression sequence is more reliable for the imaging of bone marrow signal.

There is no additional use of contrast administration to the T1 weighted images.

The most reliable feature on MRI spine imaging to diagnose the presence of marrow reconversion is the presence of homogenous low T1W signal intensity in vertebral marrow comparing to the adjacent muscles[7]

Routine sequences such as T1,T2,STIR are sufficient to detect the presence of marrow reconversion changes. .

In cases with marrow reconversion changes detected on lumbar spine MRI, reviewing the whole spine MRI the incidence of reconversion changes was detected to be21% in our study.

The study has shown that in patients with incidental finding of bone marrow reconversion in lumbar spine MRI, screening of the whole spine from clivus to sacrum is warranted to detect pathologies like tuberculosis in dorsal spine and multiple myeloma, metastasis and haematological infiltrative disorders at multiple spinal levels. Sacroiliac joint should be screened to detect sacroilitis due to various causes. Further the novelty of our study is that most common associated finding in our study was low serum levels of vitamin D. Most of these patients were asymptomatic with subclinical deficiency. Hence, routine evaluation of vitamin D levels in blood should be done in patients with marrow reconversion changes in MRI.

Advantages of this study is that our study is the first study to evaluate for the subclinical vitamin D deficiency in cases with altered marrow signal.

LIMITATIONS:

- Selection bias, since we included only cases who came for MRI lumbosacral spine.
- Single institutional study.
- Some patients had no complete work up and lost follow up in the course of evaluation.
- Two radiologists with varying experience(2 and 10 years) raises interobserver bias.

CONCLUSION:

Knowledge about the normal and abnormal signal intensities of bone marrow in MRI spine imaging is mandatory to decide what is potentially pathologic and what is not. We conclude that any signal alteration on MRI spine in bone marrow should not be ignored. Altered marrow signal is one of the indicator of subclinical vitamin D deficiency. Routine measurement of blood vitamin D levels and screening of whole spine is suggested to evaluate for the underlying cause for the incidental finding of marrow reconversion.

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