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Radiodiagnosis

IS CHEMICAL SHIFT IMAGING USEFUL IN DIFFERENTIATING TUBERCULAR LESIONS FROM NEOPLASTIC LESIONS OF SPINE? : A CONTROVERSIAL STUDY.

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ABSTRACT

AIM: Tubercular and neoplastic lesions in the bone marrow usually have similar signal intensity on conventional MR imaging sequences. Purpose of this study is whether in phase opposed phase sequence in MRI can helps to differentiate tubercular from neoplastic lesions of spine.

SUBJECTS AND METHODS: 23 consecutive patients with suspected focal lesion or incidental bone marrow lesions underwent standard MR imaging (T1, T2, STIR) with additional in-phase and opposed-phase imaging done in sagittal planes. The images were assessed independently by two viewers who unaware of patient identities and clinical histories. An elliptical ROI measurement of signal intensity in the lesions site was made on the both in-phase and opposed phase images. From abnormal signal intensity of opposed phase to abnormal signal intensity of in-phase. Relative signal intensity ratio was calculated. Relative signal intensity ratio (SIR)= signal intensity of opposed phase image/ signal intensity of in-phase

Pathological confirmation obtained in 23 patients in whom 14 cases were positive for tuberculosis and 9 were neoplastic.

RESULTS: There was no significant difference in the mean signal intensity ratio(SIR) for the tubercular lesions (mean, 1.15; SD, 0.15) compared with the neoplastic lesions (mean, 1.16; SD, 0.12).

Presence of both fat and water in normal marrow results in suppression of signal intensity on the opposed phase. The existence of normal marrow fat should result in suppression of signal intensity on the opposed-phase images. In tuberculosis, though the pathology is thought not to be affecting the normal marrow, there is no suppression of marrow in opposed phase images.

In neoplastic lesions, normal fat-containing marrow is replaced with tumour, which resulted in lack of suppression on the opposed phase images.

CONCLUSION: In-phase and opposed phase imaging of bone marrow signal intensity abnormalities is unable differentiate Tubercular lesions from neoplastic lesions. However, further studies are warranted to establish this clause.

KEYWORDS : Tuberculosis, in/-out phase, chemical shift imaging, MRI.

INTRODUCTION:

Magnetic resonance imaging (MRI) is now the modality of choice in evaluation of bone marrow disorders. Bone marrow occupies 85% of the medullary bone cavities, the rest being occupied by a network of trabecular bone. Nearly, 50% of bone marrow is red marrow and the other half is yellow marrow. Yellow marrow consists of 80% fat, 15%water and 5% protein. Red marrow consists of 40% fat, 40% water and 20% protein [1]. The basic constituents of bones that contribute to the bone marrow signal characteristics in clinical MR images are fat, water, and, to a lesser extent, mineralized matrix. Each of the various MRI pulse sequences, ranging from spin-echo(SE), and short TI inversion recovery (STIR) to more advanced chemical shift techniques (in and out phase) is useful in detection and quantification of many disorders affecting bone marrow.

AIM:

Tubercular and neoplastic lesion in bone marrow can have similar signal intensity on conventional MRI sequences. Thus our aim is to see whether chemical shift imaging (in phase and out phase) is useful in differentiating tubercular lesion from neoplastic lesion of bone marrow.

MATERIALS AND METHODS:

We conducted a prospective study over duration of 9 months. The study population consist of 23 patients who were suspected of having spinal bone marrow disorders or the incidentally got diagnosed were included in the study. The study group consists of 17 male patients and 6 female patients of age range between 10 years to 65 years.
Histopathological confirmation was done in all patients.

INCLUSION CRITERIA:

- Patients who are not known case of tuberculosis.
- Patients who had not taken anti-tubercular treatment so far.
- Patients coming with complaints of backache and incidentally diagnosed with focal lesion in spine on x ray or ct scan.

EXCLUSION CRITERIA:

- Patient who are known case of tuberculosis.
- Patient who had taken anti-tubercular treatment in past.
- Patient who are known case of any malignancy of spine.
- Patient who did not give informed consent.

MRI protocol: all patients were studied using Siemens' Magnetom SKYRA 3T imaging machine.

Imaging sequences used were:

T1 (TE 400-600,TR 5-20)
T2 (TE 3500-5000, TR 70-110)
STIR (TE 4000-6000, TR 50-100)
In-phase (TR 140-180, TE 4.1-4.8 msec)
Out-phase (TR 140-180, TE 2.0-2.6 msec)

Calculation of signal intensity ratio:

Region of interest (ROI) were drawn on the lesions of bone marrow which was identical in location in both in and out phase sequence and signal intensity value was obtained.

Signal-intensity ratios were expressed for the in-phase images and the opposed-phase images as signal intensity ratio= normal or abnormal bone marrow Signal intensity /control signal intensity (normal marrow, muscle). Relative signal-intensity ratios were then expressed for comparison of the opposed-phase ratios with the in-phase ratios as to determine if a change occurred in the signal intensity of the lesion with opposed phase imaging.

$$\text{Relative signal-intensity ratio} = \frac{\text{Signal-intensity ratio of opposed phase image}}{\text{Signal-intensity ratio of in phase image}}$$

These images were then reviewed independently by two radiologists who were unaware of patient identity and clinical information, to visually determine if the signal intensity of the lesion relative to the control site decreased on the opposed phase images compared with the in phase images and each image was graded according to the following grading system:

Grade 1. Definitely no decrease in signal intensity in the lesion relative to the control site on opposed phase images:

Grade 2. Probably no decrease in signal intensity in the lesion relative to the control site on opposed phase images;

Grade 3. Indeterminate;

Grade 4. Probably a decrease in signal intensity in the lesion relative to

the control site on opposed phase images;

Grade 5. Definitely a decrease in signal intensity in the lesion relative to the control site on out-of-phase images.

The two radiologists then reviewed the images together and gave each patient a consensus grade.

OBSERVATION AND RESULTS:

Relative signal intensity ratio was calculated for all 23 patients

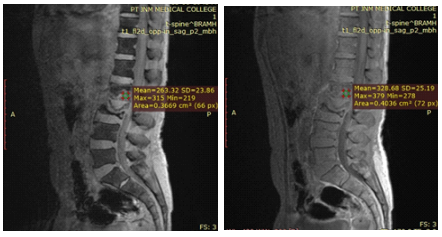


Figure 1: Method of signal intensity calculation in in-phase and out-phase imaging respectively.

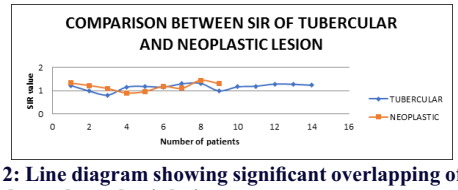
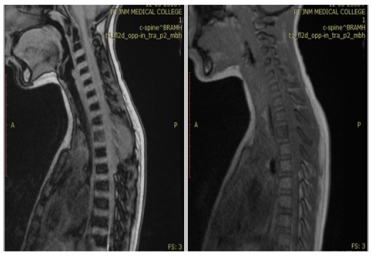


Figure 2: Line diagram showing significant overlapping of SIR of tubercular and neoplastic lesions

REPRESENTATIVE CASES WTH IMAGES:

1. EWINGS SARCOMA

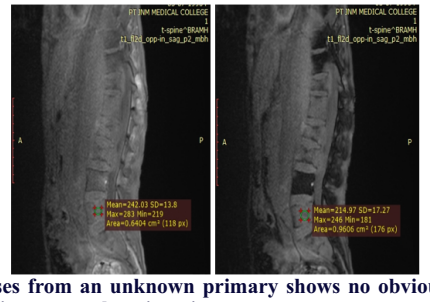


Neoplastic lesion (Ewing's sarcoma) of D2 bone marrow shows no signal suppression (hyperintense) in opposed phase image.

2. Tubercular Spondylodiskitis

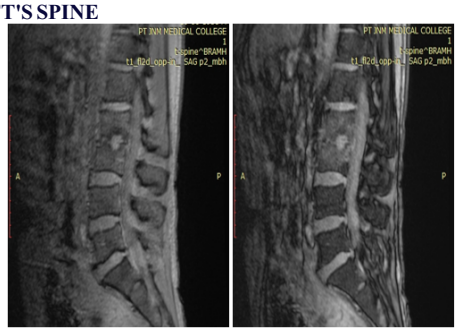
Tubercular Spondylodiskitis shows no obvious signal suppression on out phase imaging.

3. METASTASES FROM UNKNOWN PRIMARY



Metastases from an unknown primary shows no obvious signal suppression on out phase imaging.

4. POTT'S SPINE



Biopsy proven case of Pott's spine showing no suppression of fatty marrow of L2 and L3 vertebra in out-phase imaging.

DISCUSSION:

Our study shows that chemical shift imaging is not useful in differentiating tubercular from neoplastic lesions of spine. Visual assessment and expression of relative signal-intensity ratios were found to be of similar accuracy.

There is considerable overlap between signal intensity ratio of tubercular and neoplastic lesions, thus no single cut-off value could be calculated to differentiate between these two lesions.

The applications of chemical shift imaging has been well-established in case of adrenal masses [2] But there are only few studies which used this utility in spine[3]. The technique takes advantage of different precession frequencies

of water and fat protons due to the differences in their molecular environment. Clinically, the differentiation between tubercular lesion and neoplastic lesion is difficult as both conditions may present with similar complaints and their appearances mimic in routine MRI sequences. Therefore, it is necessary for a radiologist to differentiate between these two conditions as the plan of treatment differs largely. Chemical shift MR imaging can demonstrate the relationship between the amount of fat and water that coexist in the same voxel [4]. Osseous elements, however, will also affect this relationship; thus, the degree of signal intensity change may not be proportional to the quantity of hematopoietic marrow alone. As marrow contains both water and fat, there is suppression of signal intensity on out phase sequence [5]. In our study tubercular lesions would have suppressed in out-phase images. In contrast, there were no obvious suppression of signal intensity seen on out-phase imaging. Neoplastic lesions tend to infiltrate the marrow and replace fatty marrow components completely which result in lack of suppression of signal intensity on out phase sequences.

There are several advantages of chemical shift imaging:

1) This sequence can be performed rapidly and it usually adds 5 min. to a study.
2) Because both quantitative and visual interpretation appear equally accurate for assessment of focal marrow abnormalities, thus allowing for rapid interpretation from visual assessment. The high accuracy of both visual assessment and expressed relative signal-intensity ratios for bone marrow analysis is similar to results found for adrenal lesions [6].
3) In a study, it has been shown that chemical shift imaging has decreased the number of unnecessary biopsy in vertebral lesions [3].

Limitations of our study:

1) Our sample size was 23 which is small as there are large variety of disease which can affect bone marrow, thus larger sample is required to fully established the utility of chemical shift imaging .
2) We did not compare chemical shift MR imaging to traditional methods or define the incremental value as an adjunct for diagnosis, but rather, we evaluated the merit of using chemical shift MR imaging as a stand-alone technique.

CONCLUSION:

The results of our study has shown that tubercular lesions have similar behaviour at chemical shift MR imaging (i.e.: no obvious loss of signal intensity on out phase imaging), as compared to neoplastic lesions. Thus, chemical shift imaging was not useful in differentiating

tubercular lesion from neoplastic lesions of bone marrow of spine. This result should be considered preliminary and needs further evaluation and research. Future studies involving large patient groups might be helpful to determine and to prove the usefulness of CSI technique for spinal marrow disorders

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