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"Role of Magnetic Resonance Imaging in the Evaluation of Non-Discogenic Causes of Backache"

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ABSTRACT
Backache is emerged as one of the leading causes of disability and loss of work days in our society. Abnormalities of almost all spinal and paraspinal structures are capable of manifestation as backache. This study was done to identify and summarize various non-discogenic causes of backache and describe the MRI findings and to find any significant correlation between different variables with the causes of non-discogenic backache. The study results highlight the role of MRI as the definitive modality in assessing the soft tissues of spine and spinal abnormalities.

I. INTRODUCTION

Backache is a broadly defined term which represents a variety of conditions presenting as mild discomfort with no consequences for the individual to far more painful and severely disabling conditions. Backache is not a simple entity and should be looked upon from several angles. According to the scientific literature there are many potential risk factors and in experimental studies it has been shown that abnormalities of almost all spinal and paraspinal structures are capable of manifestation as backache.

Among the patients suffering from backache most of the cases are due to degenerative changes of the spine of which most are due to disc related problems including disc bulge, annular tears, and extrusions. Studies have shown that the modic vertebral end plate changes and schmorl's nodes are also results of disc degeneration. However a lot of non-discogenic causes are also associated with backache. Knowledge of the non-discogenic causes is important for their correct diagnosis. At times identifying a prolapsed disc might overshadow the presence of a non-discogenic cause which also has potential to cause patients symptoms. One good example might be a case of Baastrup's disease with concurrent disc protrusion which might remain undiagnosed if attention is not given to the posterior elements of the spine. Therefore it is necessary to keep the list of non-discogenic causes in the differential while evaluating a patient presenting with backache.

Although conventional radiography is used as the initial modality to evaluate a patient with backache it is not possible to visualize all the spinal structures in plain radiography. The muscles, ligaments, nerve roots, spinal cord and meningeal coverings are not identifiable in plain radiography for which MRI serves as a very useful modality. Plain radiographs have a low sensitivity for identifying traumatic spinal lesions. Therefore trauma victims with plain films negative for spine injury but with a high

clinical suspicion of injury should undergo MR for a more definitive evaluation of the spine. MRI is the definitive modality of choice in assessing spinal soft tissue injuries, especially in evaluation of spinal cord, intervertebral discs and spinal ligaments. It is mainly used to exclude occult injuries and to identify spinal cord lesions. In case of spinal trauma, MRI demonstrates the relationship of fractured /subluxated vertebral bodies to the cord and highlights a significant stenosis. The signal abnormalities within this cord can be identified, helping to localize and define the degree of trauma.

In case of neoplasm, MRI serves as an excellent method for imaging tumor involving spinal column, canal and cord. Of all the areas of spinal pathology, it may be in the field of spinal tumors that MRI has had the most impact. Almost immediately after its inception, even with poor quality of early scans, the potential of MR in the evaluation of suspected neoplasms of the spine was recognized. Today, MRI is considered the procedure of choice for the work-up of all spinal tumors.

Till date no studies have been done to collectively analyze the various nondiscogenic causes of backache. Although separate studies are available in the literature on every single potential cause there is lack of compilation. This study is therefore an attempt to compile all the non-discogenic causes of backache using MRI into scientific analysis and to bring into the attention any correlation between various causes.

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II. MATERIALS AND METHODS

This study was a cross sectional study carried out on 60 patients referred for undergoing MRI scan to the Department of Radiodiagnosis, Gauhati Medical College and Hospital (GMCH) for a period of 12 month duration. The study population is a mixture of male and female population. On MRI findings, cases who were diagnosed with purely discogenic backache were excluded from the study. The study group included a total sample size of 60 patients selected by purposive sampling after studying the MRI imaging findings. A complete clinical history of the patients were taken. Relevant laboratory tests and HPE reports were collected wherever possible. Informed consent was taken from all the patients after explaining the procedure. Any history for contraindication of MRI was specifically taken.

The study was done With the predesigned proforma and with MRI machine, **MAGNETOM AVANTO FIT 1.5 TESLA WHOLE BODY SCANNER (MAKE – SIEMENS)**. Standard surface coils and body coils were used for cervical, thoracic and lumbar spine for acquisition of images.

SEQUENCES:

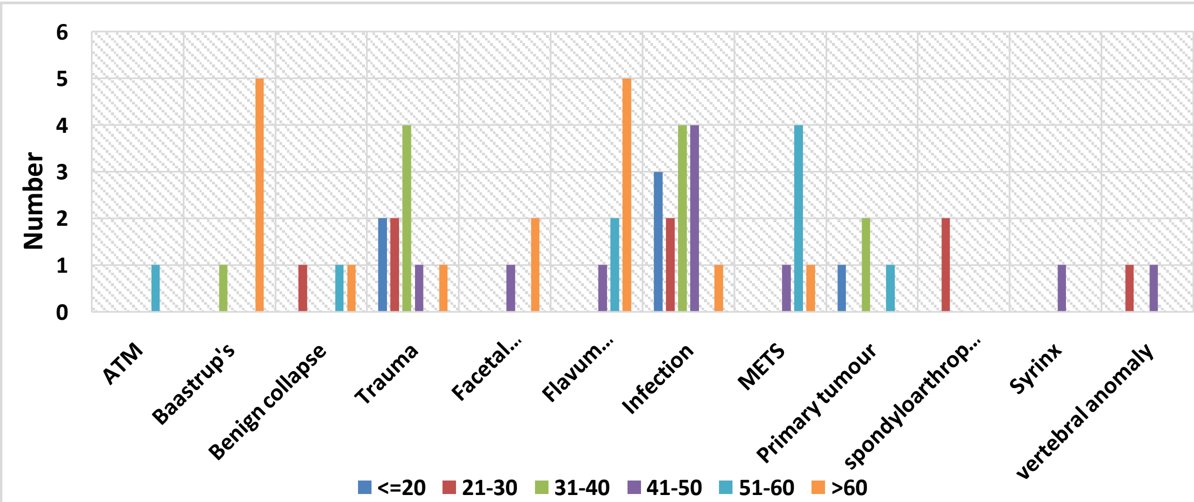
Conventional spin echo sequences T1WI, T2WI, STIR sag, T1WI, T2WI axial, GRE sagittal, post contrast T1WI axial, Sag and coronal, DWI , In-Phase/ opposed phase sequence were used.

III. STATISTICAL METHODS:

Data collected was subjected to descriptive statistical analysis in the present study. Results on categorical measurements are presented in Number (%). Significance is assessed at 5% level of significance. Data collected using history sheets were compiled using Microsoft Excel sheets and statistically analyzed using SPSS 17. Chi square test and unpaired T test were used to find any association between different variables. A 'P value' of < 0.05 was considered as statistically significant association.

IV. RESULTS

Figure 1: Bar diagram showing evaluation of various causes of Non-discogenic backache with Age.



Majority of patients of Baastrup's disease (83.3%), Facetal arthropathy (66.7%) and Flavum hypertrophy (62.5%) are older than 60 years. Most of the metastases were seen in 51-60 years age group with no case under 40 years of age. Both the cases of spondyloarthropathy were found in 21-30 yrs age group. Cases with infection were more common in patients younger than 40 yrs.

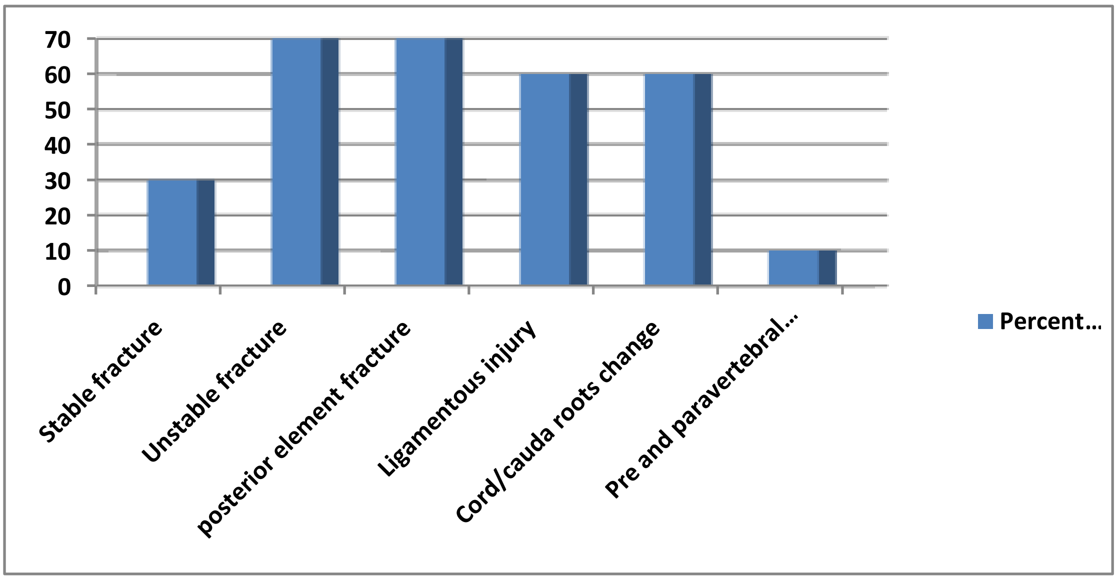
Table 1: Table showing evaluation of level of lesion with different causes

Level of lesion	ATM	Baastrup's	Benign collapse	Trauma	Facetal Arthropathy	Flavum Hypertrophy	Infection	METS	Primary tumour	spondyloarthropathy	Syrinx	vertebral anomaly	P Value
C	0	0	0	0	0	0	1(7.1)	4(66.7)	0	0	1(100)	0	0.001
D	1(100)	0	1(33.3)	6(60)	0	0	11(78.6)	6(100)	2(50)	0	1(100)	1(50)	0.001
L	O	6(100)	2(66.7)	7(70)	3(100)	8(100)	6(42.9)	2(33.3)	2(50)	0	0	1(50)	0.026
S	0	0	0	0	0	0	0	1(16.7)	0	0	0	0	0.608
SIJ	0	0	0	0	0	0	0	0	0	2(100)	0	0	0.001

On applying Chi Square test, it is seen that there is a significant relation between the various causes of Non-discogenic backache with the level of lesion (P value <0.05) except at sacral level.
Most of the degenerative changes including Baastrup's disease, Facetal Arthropathy and Flavum Hypertrophy were seen at lumbar level.

In Neoplasm (Primary and Secondary), the common site involved is the thoracic region.
In Infections dorsal level was most commonly affected.
In trauma lumbar was most commonly affected

Figure 2: Bar diagram showing characterization of spinal injuries by MRI:



MRI depicts not only the spinal cord changes but also the relationship of subluxated/ dislocated vertebral bodies to the cord, posterior elements fracture, ligamentous disruption, soft tissue injuries which all have prognostic implication and can be used to classify injury into stable/unstable.

Figure 3: Bar diagram showing characterization of spinal infection by MRI:

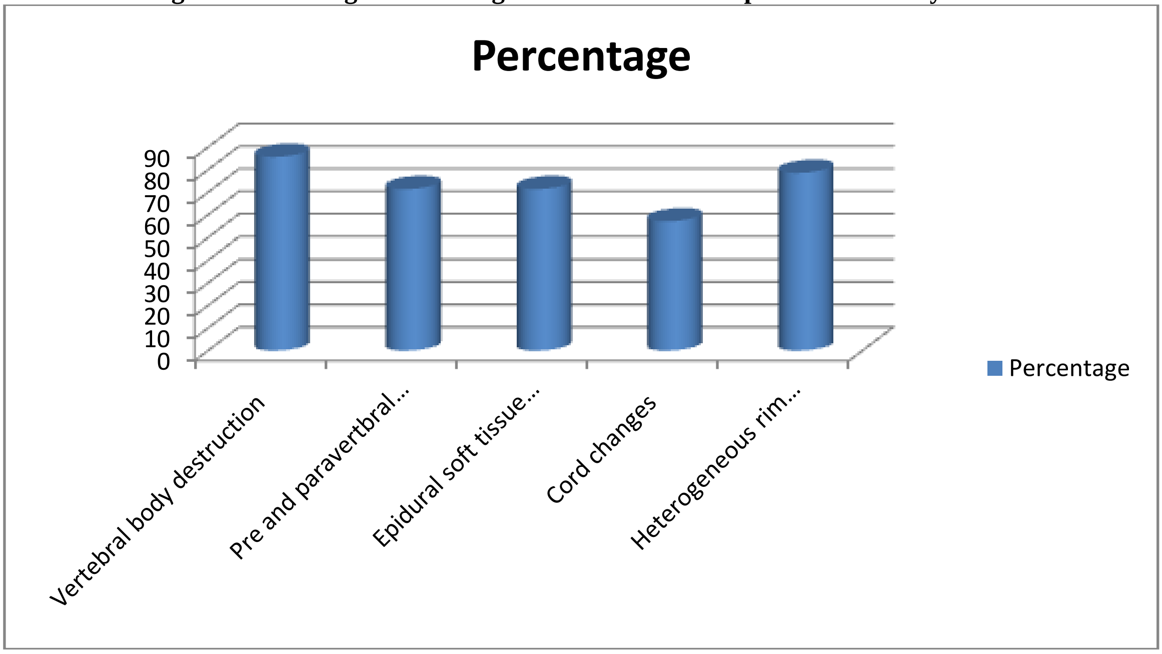


Table 2: Table showingMean ADC values:

Category	Mean ADC value	Std. Deviation
Benign collapse	1.607	0.164
Infection	1.031	0.182
METS	0.922	0.127

Mean ADC value for infection and metastasis differed slightly whereas significant difference was there compared to mean ADC value of the benign collapse cases.

TABLE 3: Table showing mean SIR values

Category	Mean	Standard deviation
METS	1.11	0.23
Benign collapse	0.67	0.05

TABLE 4: Table showing Association of Facetal arthropathy with other conditions

Category	Absent	Present	Total	P value
Baastrup's	1(2.7%)	5(21.7%)	6(10%)	0.017
Flavum hypertrophy	2(5.4%)	6(26.1%)	8(13.3%)	0.022
Vertebral compression fracture	4(10.8%)	5(21.7%)	9(15%)	0.249

*Figures given in percentage indicate percentage among total cases with or without Facetal arthropathy.

There is significant association between presence of Facetal arthropathy with either of Baastrup's disease and flavum hypertrophy. However no significant association was found between vertebral compression fractures and Facetal arthropathy.

V. DISCUSSION

The ability of MRI to show the spine, the spinal cord, the posterior ligaments and paraspinal structures with greater sensitivity and specificity than plain radiography, myelography and CT is well established for trauma, infective, neoplastic, congenital, & 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 non – invasiveness.

In our study of patients presenting with backache after excluding the cases with purely discogenic backache, we found 60 cases attributable to at least one non-discogenic cause of backache. Among these are infectious causes (14), trauma (10), metastasis (6), primary neoplasms (4), Benign collapse (3), Baastrup's disease (6), Flavum hypertrophy (8), Facetal arthropathy (3), Spondyloarthropathy (2), vertebral anomaly (2), syringomyelia in Chiari 1 malformation (1) and Acute transverse myelitis (1).

All of the spinal cord injury patients showed hypointensity on T1WI and hyperintensity on T2WI and STIR images suggestive of cord edema / contusion. These signal changes were consistent with studies done previously by Hackney DB et al[1] who found that the increased signal on T2WI probably represents edema. In our study, ligamentous injury was found in 6 out of 10 cases (60%) which was comparable with the study done by Haba H et al[2] where PLC injuries were found to be 65.7 %. In our study 5 patients had multiplicity (50%) i.e. a secondary injury level was present. This is an intermediate value between that of 77% and 41.8% found by Green RA et al[3] and Qaiyum M et al[4] respectively. Among these 3(30%) were in non contiguous location which is similar to 34% as reported by Green RA et al.

MRI showed vertebral body destruction in 12(85%) cases with pre and para vertebral collection in 10(71%) cases of infectious spondylitis. Epidural component compressing the cord was seen in 10 (71%) cases which was hypo intense on T1WI, heterogeneously hyper intense on T2WI and STIR images. These findings were concurrent with the study done by Rivas-Garcia A et al [5] where they found large abscesses affected paraspinal tissues in 65 % of patients, vertebral body destruction in 85 % cases and epidural component in 80 %.

Study by Roos DEA et al [6] and Moorthy, S et al[7] showed thoraco–lumbar junction as the most common affected site as in our study. They showed rim enhancement around the intra–osseous and paraspinal soft tissues abscess which was similar to the pattern of enhancement in our study.

The involved vertebral bodies showed heterogeneous enhancement which was comparable with the study done by Chang MC et al[8] where he reported that focal and heterogeneous enhancement of the vertebral body is seen TB spondylitis whereas diffuse and homogeneous enhancement of the vertebral body is seen in pyogenic spondylitis. Similar finding was also reported by Rivas-Garcia A et al. 12 (85.7%) cases had posterior 12 (85.7%) cases had posterior element involvement that is in concordance with Smith AS et al [9] who reported that in TB posterior element involvement is more common.

There was a case of syringomyelia due to tuberculosis in our study. It was a known case of tubercular meningitis on follow up post ATT.

There was syrinx in the cervicodorsal cord extending from the level of C4-C5 disc space to the level of D11-D12 disc space. It appeared iso to hypointense on T1 and heterogeneously hyperintense on T2 and STIR. There was symmetric expansion of the spinal cord with narrowing of the CSF column circumferentially. The involved areas showed diffusion restriction. On post contrast study there was predominantly peripheral enhancement. There were many nodular enhancing lesions suggestive of tubercular granulomas. There was diffuse thickening of the pachymeninges showing post contrast enhancement. Our findings are concurrent with that reported in the literature by Gupta A et al[10], Bernaerts A et al[11], Phadke RV et al[12] etc.

We used T1WI, T2WI, STIR, DWI, In-Phase(IP) and Opposed Phase(OP) sequence and post contrast to image spinal metastases. T1WI was useful in the detection of bone marrow metastases and STIR helped in picking up more marrow lesions. All the metastasis involved vertebrae appeared hypointense on T1. 5 cases appeared hyperintense on T2 and STIR and only 1 case appeared hypointense on T2 WI that was a case of sclerotic metastasis from carcinoma breast. The benign collapse group showed variable signal intensity. Posterior convexity(100% cases), epidural mass(50% cases), pre & paravertebral soft tissue component (50% cases), involvement of posterior elements(100% cases) and heterogeneous post contrast enhancement (100% cases) helped us in differentiating the metastatic cases from benign collapse which showed retropulsion of osseous fragments in all cases, variable marrow signal intensity, absence of posterior convexity, absence of epidural and pre & paravertebral soft tissue component and homogeneous contrast enhancement(contrast study was done in 1 among the 3 cases of benign collapse) .

All the cases of metastasis showed increased signal on opposed phase imaging due to vertebral marrow replacement by tumour cells. The mean signal intensity ratio was found to be1.11±0.23 in the metastatic group and 0.67±0.05 in the benign collapse group. The results are similar to that found by Eito K et al [13]who found mean SIRs and standard deviations (SDs) in their study as: neoplastic group: 1.02 ± 0.11; non-neoplastic group: 0.63 ± 0.21. Ragab Y et al [14]also reported similar findings. Our results also match with the use of SIR of 0.80 as a cutoff, with more than 0.8 defined as malignant and less than 0.8 defined as a benign result as reported by Erly, W.K et al[15].

With a review of the literature we found various studies supporting the role of quantitative ADC mapping in the evaluation of benign and malignant vertebral compression fractures and infection. Balliu E et al [17]found high mean ADC values ($1.9 \pm 0.39 \times 10^{-3}$ mm2/s) for benign collapsed vertebral bodies, and lower mean ADC values for the infectious lesions ($0.963 \pm 0.491 \times 10^{-3}$ mm2/s). The mean ADC values obtained in metastatic lesions was $0.917 \pm 0.13 \times 10^{-3}$ mm2/s. In our study the mean ADC values were: $0.922 \pm 0.127\times 10^{-3}$ mm2/s for metastasis, $1.607\pm 0.164\times 10^{-3}$ mm2/sfor benign collapse and $1.031\pm 0.182\times 10^{-3}$ mm2/s for infection which is in concurrence with their results.

We had 4 cases of primary tumour presenting with backache which includes 2 cases of PNST(neurofibroma), 1 case of menigioma and 1 case of epidural lymphoma.

Neurofibromas were iso- to- hypointense on T1WI and hyperintense on T2WI and showed intense heterogeneous enhancement on post contrast. Both cases showed extension into the neural foramina. Study done by Friedman DP et al [17] showed that on T1WI, the signal varied from hypo to iso intense to the cord and on T2WI, they are hyperintense in signal and also may show decreased signal in the central portion due to a dense central area of collagenous stroma. Neurofibromas showed marked enhancement which was heterogeneous. Similar imaging features and pattern of enhancement was found in our study.

The meningioma case showed iso to hypointensity on T1 & T2WI and showed intense homogeneous enhancement on post contrast study. Gezen F et al[18] showed signal characteristic of meningioma as iso intense to the cord on T1 and T2WI with intense homogenous enhancement on post contrast study which is in concurrence with our study. There was presence of dural tail sign which was comparable with the findings of De Verdelhan O et al[19] where they reported that “dural tail sign”, a dural enhancement or thickening near the tumour was found in only meningiomas.

The primary epidural lymphoma appeared isointense on T1 and hyperintense on T2 and and showed intense homogeneous post contrast enhancement. The case also showed foraminal extension. These findings are concurrent with that of Li MH et al [20]. Within the spinal canal, the location of the tumor is usually dorsal, rather than ventral as reported by Boukobza M et al which is similar to our case.

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There were 6 cases of Baastrup's disease in our study. All changes were located at lumbar level among which 5 were in L4-L5 and one was in L3-L4 level. This is in concurrence with studies by Maes R et al [23] and Kwong Y et al [22] where they reported that Baastrup's disease usually affects the lumbar spine with L4-L5 being the most commonly affected level.

Most(83.3%) of the patients in our study were elderly patients above 60 years of age of which 4 were 70 years and above. This was concurrent with Maes R et al. Kwong Y et al stated that in most of the cases, only one level is affected and further degenerative changes (such as facet joints hypertrophy, intervertebral disc herniation or spondylolisthesis) can be seen in this pathological level. In our study all cases were at a single level which is similar to their study. Also facetal arthropathy was seen in 5(83.3%) of the cases. There was a statistically significant association found between Baastrup's disease and presence of facetal arthropathy in our results.

All the cases showed reduced Interspinous distance with spinous process contact found in 5 of the cases. Interspinous bursitis in the form of T2 and STIR hyperintensity was present in all the cases.

Facetal arthropathy was found in 25 among the 60 cases in our study. A total of 44 facet joints were found abnormal. The most common level affected was found to be L4-L5 where 15 joints had arthropathic changes. The second most common level affected was L3-L4(10 joints) followed by L5-S1(9 joints). In our study there was no statistically significant association found between facetal arthropathy and acute/subacute lumbar vertebral body compression fractures.

This is contradictory to the study of Lehman VT et al [24] who reported an association between facet joint signal changes on MR imaging and acute/subacute lumbar vertebral body compression fractures.

Ligamentum flavum thickness was measured in all the patients on both the sides. There was no statistically significant difference found between thickness measured on both sides in different age groups. Overall, the mean thickness on right side were (L3-L4:3.04 mm, L4-L5:3.66 mm and L5-S1:3.16 mm) and on the left side were (L3-L4: 3.06 mm, L4-L5:3.67 mm and L5-S1:3.17 mm)

The maximum mean thickness of the ligamentum flavum in our study was measured at L4-L5 level in all the age groups and also age increases flavum thickness increases. Similar findings were reported by Munns JJ et al [25] and Karavelioglu E et al[26] .

In our study we found a statistically significant association between ligamentum flavum hypertrophy and presence of facetal arthropathy in different age groups. This is in concurrence with that found by Karavelioglu E et al.

In 8 patients the flavum thickness was greater than 5 mm at least one level resulting in lumbar spinal canal stenosis. These cases had only flavum hypertrophy as cause of backache. The other cases had some other cause of non-discogenic backache.

There were 2 cases of sacroiliitis in our study. STIR images revealed hyperintensity in both the cases along with post contrast enhancement suggestive of active inflammation(BMO/osteitis). The rest of the spine did not reveal changes attributable to ankylosing spondylitis in both the cases. We also observed erosions as STIR hyperintense areas in both the cases. These findings are consistent with the ASAS (Assessment of SpondyloArthritis international Society) criteria for definition of sacroiliitis by MRI. Both the cases had combination of sacroiliitis and HLA–B27 positivity. There was no bony ankylosis observed in either of the cases which indicates the superiority of MRI in detection of early sacroiliitis that might be missed on plain radiography.

There were 2 cases of vertebral anomalies in our study including a case of hemivertebra and a case of butterfly vertebra. The hemivertebra was located at L3 level. There was fusion of L3 and L4 vertebra with lateral wedging of L3 and L4 vertebrae along with decreased vertical height on the left side. There was resultant dextroscoliotic deformity centered at L3-L4 level which is the possible cause of backache in this case according to DeRuiter C [27], who stated that neurological problems may result if the hemivertebrae cause severe angulations of the spine, narrowing of the spinal canal, instability of the spine, or fractured vertebrae. The butterfly vertebra was noted at D4 level. The patient complained of pain in the upper back without any radiation. Although most of the cases of butterfly vertebra remain asymptomatic, there has been reports in the literature of butterfly vertebra associated backache. One such case was reported by S. Kapetanakis et al[28]. However reports in the dorsal level are very few. Adam D et al [123] reported a D6 butterfly vertebra with backache. They concluded it to be due to kyphotic deformity of the spine at that level. In our case also the possible cause of backache is alteration in alignment of the spine due to presence of a butterfly vertebra.

VI. CONCLUSION

MRI is the definitive modality in assessing soft tissues of the spine and spinal abnormalities.

MRI is very sensitive and considered the imaging modality of choice to detect, characterize and determine the extent of various spinal tumours and potential spinal infections. MRI is the most sensitive modality to detect, characterize and grade spinal infection. MRI is very sensitive as well as specific in detecting lesions such as metastases, infective spondylitis with pre and paravertebral and epidural soft tissue component. Advanced imaging techniques such as Chemical shift MRI and Apparent Diffusion Coefficient (ADC) plays a pivotal role in differentiating vertebral collapse due to underlying osteoporosis or neoplastic process. Also MRI is sensitive in detecting primary spinal neoplasms.

Facet joints, pedicles, ligaments, spinous processes and SI joints have all been implicated as sources of nonradicular axial back pain. Imagers should be aware of these causes and tailor imaging examinations to identify these sources of back pain. Posterior element related causes of back pain may remain unrecognized secondary to use imaging techniques which fail to demonstrate the bone marrow edema, soft-tissue inflammation and hypervascularity often associated with posterior element pain generators. Fat-suppressed FSE T2-weighted and/or fat-suppressed CE T1-weighted sequence should be performed in at least one imaging plane in all MR examinations of the lumbar spine.

In our study with the help of MRI, we could successfully evaluate and characterize the spinal tumours and assess the integrity of spinal cord and ligament after acute spinal trauma. Hence it can be rightly concluded that MRI is very definitive, sensitive, accurate, non invasive, radiation free modality for evaluation of non-discogenic backache, though it is a bit costly.

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