

# Evaluation of Spinal Tuberculosis by Plain X-Rays and Magnetic Resonance Imaging in a Tertiary Care Hospital in Northern India -A Prospective Study

Rumeet Kukreja<sup>1</sup>, Mukta Mital<sup>2</sup>, Prashant K. Gupta<sup>3</sup>

## ABSTRACT

**Introduction:** Plain X-ray remains the primary imaging modality to evaluate spinal tuberculosis. MRI additionally detects spinal canal narrowing, cord compression / cord oedema and can also pick up clinically/X-ray occult cases as well as multilevel involvement, without the risk of ionizing radiation. The purpose of the study was to describe the radiological features of spinal tuberculosis on MRI (Magnetic Resonance Imaging) and plain X-rays, to co-relate the findings and to evaluate the role of each in spinal tuberculosis.

**Method and Materials:** The study was conducted on sixty five patients suspected of spinal tuberculosis. After taking an informed consent, all patients were subjected to evaluation by plain radiographs and MRI, while post contrast MRI study was done, wherever required.

**Results:** Dorsal vertebrae were most commonly involved with the paradiscal type being the most common radiological type of involvement. Disc involvement, endplate irregularity, abscess, calcification, reduction in vertebral height and spinal cord compromise were important radiological features. MRI was noted to be a better modality for the evaluation of the spinal cord/ canal status. Plain radiography showed a crucial role in picking up calcification within the abscess.

**Conclusion:** MRI is the modality of choice in evaluation of spinal tuberculosis, however, both X-rays and MRI are complimentary to each other.

**Keywords:** Tuberculosis, Spinal, Plain X-rays, MRI.

## INTRODUCTION

Tuberculosis (TB) is an infectious disease caused by various strains of mycobacteria usually *Mycobacterium tuberculosis*.<sup>1,2</sup> It is more common in the Eastern hemisphere of the world. In fact it is estimated that India alone has got one-fifth of the total world population of tuberculous patients.<sup>2</sup> Tuberculosis typically affects the lungs, but can also affect other parts of the body.<sup>3</sup> Of all the patients suffering from tuberculosis, nearly 1–2% have involvement of the skeletal system<sup>4</sup> with spinal tuberculosis being the most common form of skeletal tuberculosis, constituting about 50% of all cases.<sup>2</sup>

Spinal tuberculosis is possibly one of the oldest demonstrated diseases of mankind, having been documented in ancient Egyptian mummies.<sup>5,6</sup> The first modern case of spinal tuberculosis was described by Sir Percival Pott<sup>7,8</sup> was first to describe the spinal tuberculosis in 1779, after whom the disease is commonly referred to as “Pott’s Spine”.

Spinal TB occurs most commonly by haematogenous

spread from pulmonary tuberculosis but could be from extra pulmonary site as well.<sup>9,10</sup> It usually involves the thoracic and lumbar spine with thoracolumbar junction being the most frequent site of involvement.<sup>11</sup> Other sites like cervical region and sacrum being less common.<sup>2</sup> Four radiological types of vertebral involvement have been described: paradiscal, anterior, central, neural arch or appendiceal.<sup>1,12,13</sup> Out of these paradiscal type is the most common.

The diagnosis of spinal TB can be challenging due to the non-specific constitutional symptoms. Imaging plays an important role in the early diagnosis and treatment decisions.<sup>14</sup> Plain film radiography (PFR) is one of the first and the most common imaging technique used to confirm the diagnosis of spine tuberculosis by the radiologists in most clinical settings and has been reported to have a diagnostic efficacy of 91-99%.<sup>15</sup> The best diagnostic modality in the present scenario for the diagnosis of spinal tuberculosis is MRI. It is more sensitive than radiography and more specific than CT in the diagnosis and can also provide the diagnosis of Pott’s spine 4-6 months earlier than conventional methods, offering the benefits of earlier detection and treatment.<sup>11,16,17,18,19</sup>

The present study was conducted with the aim to describe the radiological features of spinal TB on plain X-Rays and Magnetic Resonance Imaging (MRI), to co-relate the findings and evaluate the role of each modality in spinal TB.

## MATERIAL AND METHODS

This observational study was conducted on sixty five (65) patients suspected of spinal tuberculosis on clinical examination and referred to the Radiology department of a tertiary care hospital for evaluation by Plain X-Rays and MR Imaging, after taking approval from the ethical committee. A detailed clinical history and examination was done for each patient and general observations were made in respect to demographic distribution and detailed signs and symptoms. Each patient selected for the study was explained the entire procedure and an informed consent was taken from

<sup>1</sup>Resident, <sup>2</sup>Professor, <sup>3</sup>Director and Professor, Department of Radiology, Subharti Institute of Medical Sciences, Meerut, U. P., India

**Corresponding author:** Dr. Mukta Mital, B-13, Damodar Colony, Garh Road, Meerut, U. P. 250004, India

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each before enrolment. Old treated cases/ cases already undergoing treatment for Spinal Tuberculosis and patients who did not give consent for the participation in the study were excluded.

**X-ray** was done on 500 milli-amperes (mA) SIEMENS X-ray Kienscope Unit, 800 milli-amperes (mA) ALLENGER HF Unit and Care Stream Health Care Computerized Radiography system 850(CRS) with Dry View Camera 6800(DV) for Computerized Radiography(CR) with small focal spot. X-ray of region of interest of spine was done in two perpendicular planes i.e. Antero-Posterior [AP] and Lateral using collimation and relevant Kvp and mA techniques and the X-Ray findings were recorded in detail.

Chest X-Ray was done as a part of routine investigation in all patients, mostly in postero-anterior view, however in some cases antero-posterior view was also done.

**MRI** - After taking an informed consent from the patient, the patient was made to lie down supine on the gantry table with arms resting by the side in a 1.5T imaging system (G.E.Healthcare).8 channel MR coils were placed over the patient. After taking the planar images, the following sequences were taken at baseline – Sagittal Fast Spin Echo T2 weighted image, Sagittal Fast Spin Echo T1 weighted image, Coronal STIR image, Axial T2 frFS image, Axial T1 FSE image and Sagittal STIR image. Diffusion weighted images were done, wherever required and contrast studies were done in cases where above sequences lead to inconclusive diagnosis. The MRI findings were recorded in detail.

The radiological observations in all cases were made with respect to level of vertebral involvement, intervertebral disc space narrowing or involvement, end plate irregularity, paravertebral / prevertebral / epidural abscess formation, calcification, wedging and compression fracture, vertebral body height reduction, scalloping of anterior vertebral surface, bone density, kyphosis and scoliosis, spinal canal narrowing and cord compression and oedema.

The X-Ray and MRI Imaging findings were correlated with clinical history and clinical examination.

Clinical response to treatment and/or clinico-pathological

findings were considered confirmatory for the diagnosis of spinal TB in all patients.

## STATISTICAL ANALYSIS

All data were compiled in tabulated manner and results were expressed as mean +standard deviation for the statistical analysis using stat Graphics Centurion (Version 6.2).

## RESULTS

Out of the total 65 patients enrolled for the study majority of the patients, that is, 27 patients (41.5%) were between 21 – 40 years. The mean age was calculated to be 39.68±18.7 years. 32 patients were male (49.2 percent) and 33 were female (50.8 percent) with M:F ratio of 1:1.03. No specific sex predilection was seen in the study.

The mean duration of symptoms was calculated to be 14.25±11.8 months. The most common complaint was backache noted in 53(81.5%) patients, followed by fever noted in 45(69.2%) patients. Other common complaints were weight loss noted in 36 cases (55.4%), malaise in 35 cases (53.8%), local tenderness in 32 cases (49.2%). 31 patients (47.7%) had bladder and bowel involvement and 29 cases (44.6%) had neurological involvement (excluding bladder and bowel involvement).

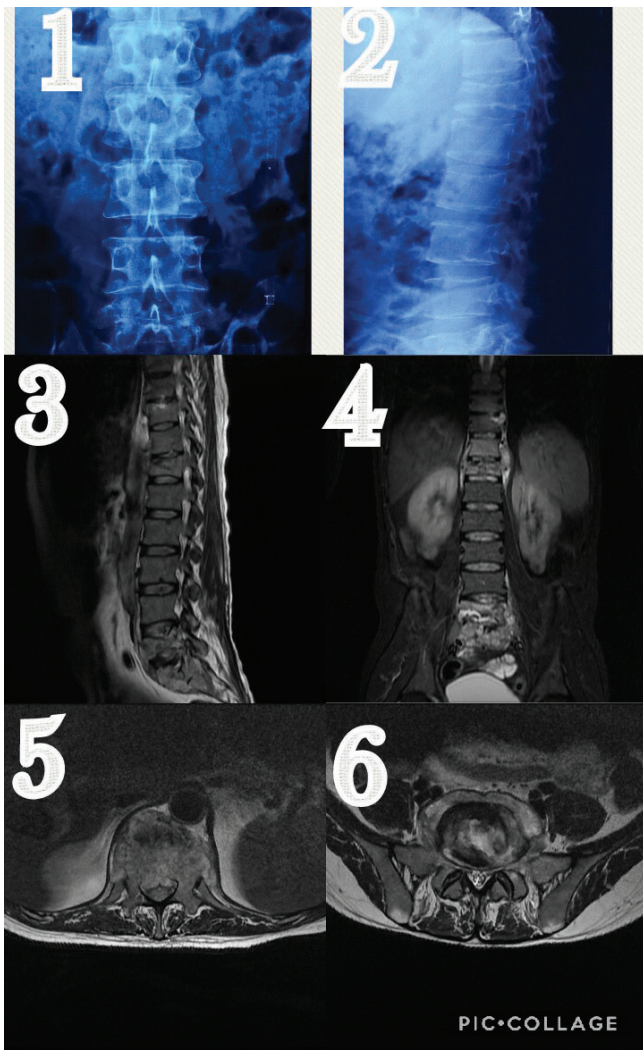
The most common site of involvement was dorsal spine noted in 35(53.8%) cases, followed by the lumbar spine in 31(47.7%) patients. Sacral involvement was noted in 8(12.3%) cases and cervical spine was involved in 4(6.2%) of patients. Non -contiguous multiple level vertebral involvement was noted in 3 cases out of 65, that is 4.6 percent of the total cases studied [Collage 1-Figure 1-6].

The most common type of involvement was Paradiscal type in 51 cases (78.5%) [Collage 2-Figure 7-11], followed by Anterior subligamentous type which was noted in 14 cases (21.5%) [ Collage 3-Figure 12-13]. The Central type of lesion was noted in 9 patients (13.8%) and Posterior element involvement was noted in the least number of cases accounting for 3 patients (7.7%) of the total 65 studied patients.

Chest X-ray revealed evidence of healed or active pulmonary lesion in 35.4% (23 cases) in association with the imaging

Radiological Findings	Plain Radiography Findings(Frequency)	MRI Findings (Frequency)	Difference in percentage (MRI-X-Ray)
I.V. Disc space/Disc Involvement	36(55.4%)	51(78.5%)	23.1
Abscess	21(32.3%)	38(58.5%)	26.2
End Plate Irregularity	24(36.9%)	51(78.5%)	41.6
Thecal Sac Indentation	-	37(56.9%)	56.9
SpinalCord Compromise/Canal Stenosis	-	12(18.5%)	18.5
Cord Oedema	-	5(7.7%)	7.7
Calcification	7(10.8%)	-	-10.8
Reduced Bone Density	26(40%)	-	-40
Wedge Collapse	16(24.6%)	16(24.6%)	0
Compression Fracture	9(13.8%)	9(13.8%)	0
Vertebral Body Height Reduction	28(43.1%)	28(43.1%)	0
Kyphosis	26(40%)	26(40%)	0
Scoliosis	12(18.5%)	12(18.5%)	0

**Table-1:** Shows the correlation between the frequency of plain radiography and MRI findings

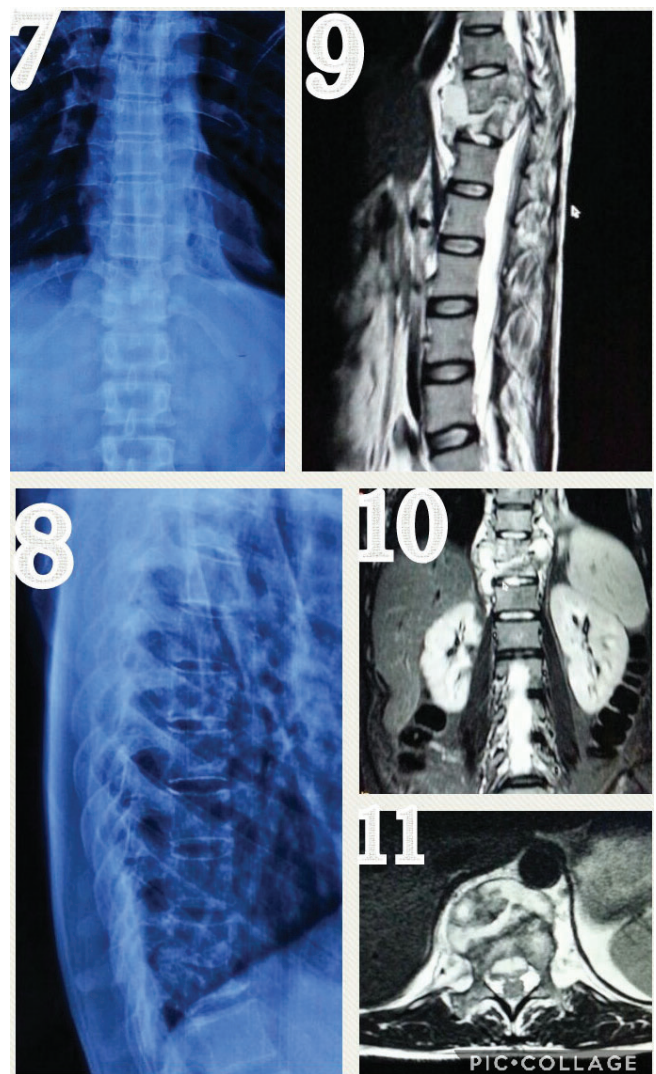


**Figures 1-6:** X-Ray lumbar spine AP/LAT reveals reduced height and endplate irregularity of D12 vertebrae and partial destruction of L5 AND S1 vertebrae. MR Sag T2 and Cor STIR Images showing altered signals and reduced height of D12 body and reduced disc height at D11-12 Level with bilateral paravertebral collection. Associated destruction of L5,S1 and S2 vertebral bodies, with i/v disc involvement and subligamentous collection. Additionally irregularity of endplates of D9 and D10 vertebra seen (not picked on X- Ray).MR Axial T2 images reveal epidural collection at D12 and subligamentous collection at L5-S1 Level.

#### findings in the spine

Plain X- Ray findings of patients revealed I.V. Disc space/disc involvement in 36 patients (55.4%), abscess in 21 patients (32.3%), calcification in 7 patients (10.8%), end plate irregularity in 24 patients (36.9%), reduced bone density in 26 patients (40.0%), wedging in 16 patients (24.6%), compression fracture in 9 patients (13.8%), vertebral body height reduction in 28 patients (43.1%), kyphosis in 26 patients (40.0%) and scoliosis in 12 patients (18.5%) out of total 65 studied patients.

MRI findings of patients revealed I.V. Disc space/ disc involvement in 51 patients (78.5%), abscess in 38 patients (58.5%), end plate irregularity in 41 patients (63.1%), thecal sac indentation in 37 patients (56.9%), spinal cord compromise/canal stenosis in 12 patients (18.5 percent), cord oedema in 5



**Figures 7-11:** X-Ray DORSOLUMBAR Spine AP/LAT Views reveal reduced heights of D11 and D12 vertebral bodies with end plate irregularity and reduced intervening i/v disc height. MR Sag T2, Coronal STIR and AXIAL T2 images reveal reduced heights and altered signal in D11-12 vertebrae with end plate irregularity and reduced intervening i/v disc height. Associated pre and bilateral paravertebral collections with epidural collection causing spinal canal stenosis.

patients (7.7 percent), wedge collapse in 16 patients (24.6%), compression fracture in 9 patients (13.8%), vertebral body height reduction in patients 28(43.1%), kyphosis in 26 patients (40.0%) and scoliosis in 12 patients (18.5%).

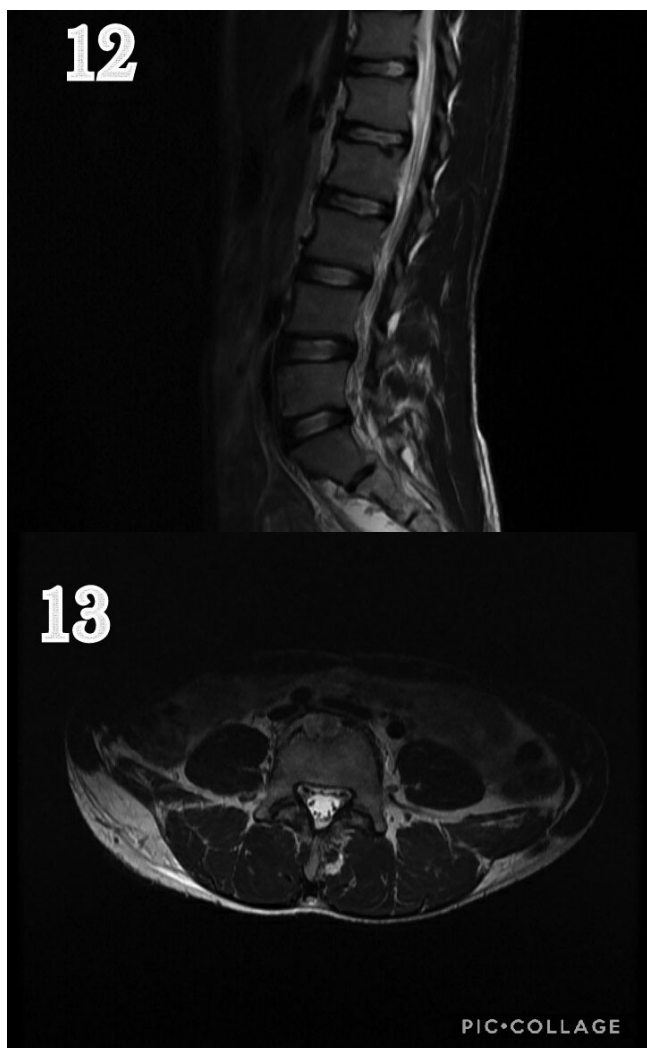
Diffusion weighted imaging was done in 45 patients, in which 34 patients showed evidence of restriction in the abscess.

Post contrast studies were done in 19 patients out of the total 65 patients. 11patients showed post contrast enhancement. The X-Ray and MRI findings were co-related [Table 1].

The plain radiograph described changes consistent with TB spine were seen in 98.4% (64 out of 65) of cases. In the remaining 1 case, MRI picked up the findings suggesting spinal tuberculosis.

#### DISCUSSION

Out of the total 65 patients enrolled for the study, the most



**Figures 12-13:** MR Sag T2 and Axial T2 images reveal anterior subligamentous type of involvement at sacral level

common age group affected was between 21-40 years with 27 patients (41.5%), followed by 41-60 years age group with 18 patients (27.7%). The mean age group affected was calculated to be 39.68±18.7 years. This is in corroboration to the findings of Mirsaiedi et al.,<sup>20</sup> who found a mean age of 39 + 16 years. Similar finding was also stated by Sinan et al.,<sup>21</sup> who found 43% cases in their study belonged to the age group of 30-49 years. Osborn<sup>22</sup> also stated that in the developing countries like India, spinal tuberculosis was prevalent in the younger age group, while in the western world, it was found in the middle age (mean 40-45 years).

No specific sex predilection was noted in our study, which is in corroboration with Osborn<sup>22</sup>, however, tuberculosis of the spine was found to be more common in males than in females in few of the previously published series<sup>20,21</sup>

Chest X-ray revealed evidence of healed or active pulmonary lesion in 35.4% (23 cases) in association with the imaging findings in the spinal tuberculosis. Several authors<sup>23,24</sup> in the past have also stated that 33-50% of patients with spinal TB have an associated primary lung focus or have a reported history of pulmonary TB.

The lower thoracic and upper lumbar levels have been

reported to be the most common site of involvement in several previous studies<sup>21,25,26</sup> which is in corroboration with our study, in which also the most common site of involvement was dorsal spine noted in 53.8% cases (35 patients), followed by lumbar spine in 47% cases (31 patients).

In this study, the most common type of involvement was Paradiscal type in 51 cases (78.5%), followed by Anterior subligamentous type which was noted in 14 cases (21.5%). The Central type of lesion was noted in 9 patients (13.8%) and Posterior element involvement was noted in the least number of cases accounting for 3 patients (7.7%) of the total 65 studied patients. Ansari S et al<sup>1</sup> also quoted that paradiscal type was the most common in their study, noted in 83.3% of the total cases, followed by central, anterior subligamentous and neural arch type in descending order. Tuli et al<sup>4</sup> also stated that paradiscal lesions are the most common type in vertebral tuberculosis.

Diagnosis of spinal tuberculosis depends on the presence of characteristic clinical and neuroimaging findings. Plain radiographs give a good overview and often provide enough information for the diagnosis and treatment of spinal TB especially in a resource –poor country like India. MRI is useful in determining the spread of the disease to the soft tissues and to determine the extent of spinal cord involvement.

The radiological findings included were intervertebral disc involvement, abscess formation, endplate irregularity, the cal sac indentation, spinal cord compression /canal stenosis, cord oedema, calcification, reduced bone density, wedging, compression fracture, vertebral body height reduction, kyphosis and scoliosis. In fact the presence calcification within the abscess is considered virtually diagnostic of spinal tuberculosis.<sup>27</sup>

In our study intervertebral disc space involvement was noted in 36 cases (55.4%) on plain X- rays and in 51 cases (78.5%) on MRI. This is in corroboration with the studies of Rivas-Garcia A et al<sup>28</sup>, Sinan et al.,<sup>21</sup> who found the involvement of the intervertebral disc in majority of their cases. Bajwa GR<sup>29</sup> found intervertebral disc space involvement in 95 percent of cases. Ansari S et al<sup>1</sup> in addition also noted that MRI was better than X-Rays to visualize intervertebral disc involvement.

Osborn<sup>22</sup> stated that a paraspinal abscess was present in 55-95% of the cases, which is in corroboration to our study in which X-Ray showed presence of abscess in 21 cases (32.3% of cases) while on MRI it was noted in 38 cases (58.5%). Other authors<sup>1,28</sup> have also reported better detection rates of abscesses on MRI. In our study post contrast study showed rim enhancement of abscess in 13 of 19 patients. Sharif HS<sup>30</sup> reported that thick rim enhancement in these abscesses is strongly suggestive of spinal TB and is not seen in non-granulomatous spondylitis.

The presence of calcification within the abscess is virtually diagnostic of spinal tuberculosis. Such calcifications are formed because of the lack of proteolytic enzymes in *M. tuberculosis*.<sup>27</sup> In our study Plain X-Ray was superior to MRI for evaluation of calcification. On X-Ray, it was noted in

7 cases (10.8%). Calcification was noted in 46 percent of cases in a study by Rivas-Garcia A et al<sup>28</sup> while Bajwa GR et al<sup>29</sup> found calcification in 40 percent of the cases which is in contrast to our study.

End plate irregularity was also better picked on MRI as compared to plain X-Rays. Wedging, compression fractures and vertebral body height reduction were equally detected on both modalities. This is in corroboration with other studies.<sup>1,29</sup>

Reduction in bone density could only be picked up on X-Ray, that too in 40% cases. Approximately one third of the calcium must be lost from a particular area for osteolysis to be appreciated radiographically. Similar incidence has been reported by Ansari S et al.<sup>1</sup> Thecal sac indentation, spinal cord compromise/ canal stenosis and cord oedema which are important findings for deciding patient management and future prognosis were picked up only on MRI.

In our study the plain radiographic described changes consistent with spinal TB were picked up in 98.4%(64 out of 65) of cases.

Imaging evaluation of patients with spinal TB showed that disc involvement, abscess and end plate irregularity were statistically better visualized on MRI as compared to X ray. Bone density and calcification were only noted on X-Ray, while spinal canal narrowing, cord compression and compressive myelopathy could only be commented upon on MRI.

## CONCLUSION

Both Plain X-Rays and MRI are important imaging modalities for diagnosis of spinal tuberculosis and are also useful to monitor the response of the patients to the treatment.

Plain X-ray remains the primary and the first imaging modality to evaluate the disease. It is a considerably less expensive investigation and is easily and widely available within the reach of most patients. One of the key roles of X-rays is ability to detect calcification and reduced bone density, which are important diagnostic features of the disease. However, plain radiography has few shortcomings in that radiographs generally remain normal in the early stages of the disease, hence by the time the disease is evident on plain X-Ray, the patient has already reached an advanced stage. Spinal canal narrowing, cord compression and cord oedema which are particularly important for further patient management cannot be commented upon on plain X-Rays. X-rays are also less perceptive than MRI to evaluate intervertebral disc involvement, soft tissue involvement, abscesses and end plate irregularity. MRI has the advantages of improved contrast resolution for bone and soft tissues along with possibility of multiplanar imaging. It carries no risk of radiation which is particularly important in children and pregnant women. It can even pick up clinically/X-ray occult multilevel involvement. However, MRI has the disadvantage of being a relatively expensive imaging modality which is particularly important in our country where quite a few patients belong to the low socio economic status. It is also not readily available in all the hospitals and

is also contraindicated in patients with pacemakers, cardiac defibrillators, etc. It is also unable to identify the soft tissue calcification, which is an important imaging feature of the tubercular infection of the spine and has little role in guided percutaneous diagnostic abscess aspiration or soft tissue biopsy.

Therefore, we would like to conclude that MRI is a better and more informative imaging modality in evaluation of patients of Pott's spine, however, both X-rays and MRI have their own diagnostic importance, advantages and disadvantages and both are complementary to each other for evaluation of tuberculosis of spine.

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