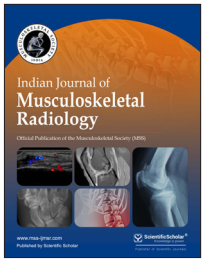
www.mss-ijmsr.com

ScientificScholar®
Knowledge is power
Publisher of Scientific Journals

Indian Journal of Musculoskeletal Radiology



Original Article

A Novel Magnetic Resonance Imaging Scoring System in Making Specific Diagnosis of Tubercular Spondylitis in Advanced Infection

Raghu Teja Sadineni[1], N. V. Anupama[2], B. T. Pushpa[2], Kavya Mikkineni[2], Muhil Kannan[2], S. Rajasekharan[3]

[1]Department of Radiology, Pramodini Imaging and Diagnostics, Vijayawada, Andhra Pradesh, Departments of [2]Radiology, [3]Orthopedics, Ganga Medical Centre and Hospital, Coimbatore, Tamil Nadu, India.

***Corresponding author:**
Dr. Raghu Teja Sadineni, MD, EDiR, Fellow in MSK Radiology, Consultant MSK and MRI Radiologist, Pramodini Imaging and Diagnostics, Vijayawada, Andhra Pradesh, India.

sadineniraghu@gmail.com

Received : 28 July 19
Accepted : 05 August 19
Published : 18 August 19

DOI
10.25259/IJMSR_14_2019

Quick Response Code:

ABSTRACT

Objective: The diagnosis of tuberculous spondylitis by microbiological and histopathological analysis is time consuming. Non-invasive methods such as magnetic resonance imaging (MRI) are useful for early diagnosis of infective spondylitis; however, the usefulness of MRI in accurate prediction of tuberculosis rather than non-specific infections is still not elucidated. There is a lacuna in the literature with regard to this. Non-invasive identification of tubercular etiology help in initiation of appropriate treatment and thus a better therapeutic response. We intend to devise a novel MRI score in making a confident diagnosis of tubercular spondylitis rather than non-specific infective spondylitis.

Materials and Methods: A retrospective observational analysis was performed on 125 biopsy-proven infective spondylitis patients which included 70 tubercular (Group A) and 55 pyogenic (Group B) patients. Tubercular spondylitis was confirmed by either positive result of tissue gene expert test, histopathology or culture results. Eight MRI findings described in literature to be favorable for tubercular spondylitis were selected and analyzed for their predictive value, and a scoring system is derived based on the observations.

Results: Statistically significant differentiation was noted in six out of selected eight MRI parameters, namely, (1) involvement of more than two contiguous vertebrae, (2) presence of para or intraosseous abscess, (3) subligamentous spread, (4) vertebral collapse, (5) large collection with thin abscess wall, and (6) presence of hypointense debris/wall on T2WI. Positive predictive value for tubercular spondylitis was obtained for the following MRI parameters by multivariate regression analysis: (1) Sub-ligamentous spread, (2) vertebral collapse, (3) large collection with thin abscess wall, and (4) presence of T2 hypointense debris. These MRI parameters having an independent prediction of tuberculosis were given two points score for each. Less significant MRI findings of more than two contiguous vertebral involvement and presence of intraosseous abscess were given a score of one for each. A total score of 10 was formulated and scoring for both groups was tabulated and analyzed. Contrary to that available in literature, no significant statistical correlation for differentiation was observed in our group for the presence of skip lesions and absence of intervertebral disc involvement. Hence, these were not included in our scoring system. Distribution of scores among the subjects aged 53.4 ± 17 years showed $P < 0.001$ (*t*-test and Mann–Whitney U-test) with mean of 7.4 for tubercular and 2.9 for pyogenic group (SD of 1.9). A score of 6 or above suggested tuberculosis and score below 6 suggested pyogenic infection (Chi-square value of 87.67 and $P < 0.00001$).

Conclusion: MRI can thus be used for accurate diagnosis of spinal tuberculosis, and our novel MRI scoring system can be applied to exclude non-specific spondylodiscitis, help in reducing the burden of additional invasive investigations, expenditure and the time delay for initiating antitubercular treatment.

Keywords: Abscess wall, Antitubercular therapy, Bone collapse, Spine infection, T2 hypointense debris

INTRODUCTION

Magnetic resonance imaging (MRI) can make a diagnosis of infective spondylodiscitis if there is an alteration of signal in the disc and adjacent vertebrae with or without the presence of collections. However, by imaging alone, it is often difficult to ascribe to a particular causative pathogen for spondylodiscitis. Many radiological features common to tuberculosis and pyogenic spondylodiscitis with varying percentages have been described in the literature with some overlapping features and characteristic findings.[1]

We performed a review of the MRI features of pathologically proven cases of tubercular and pyogenic spondylodiscitis. We have attempted to postulate a scoring system to help in the confident prediction of tuberculous (TB) etiology.

MATERIALS AND METHODS

The study was carried out at our hospital from January 2014 to December 2017. All patients who had a clinical suspicion of spinal infection, MRI findings depicting features of spinal infection and operated/biopsied for tissue culture confirmation were included in the study. A retrospective observational analysis was performed on 125 such biopsy-proven infective spondylitis patients which included 70 tubercular (Group A) and 55 pyogenic (Group B) patients, the infection was confirmed by tissue gene expert test for tuberculosis, histopathology or culture results.

The imaging was performed on 1.5 T Siemens Symphony MRI machine with eight channels and equipped with dedicated spine coil. Pulse sequences used included T1W and T2W sagittal sections, T2 STIR sagittal and Coronal, T2W SE axial, and T2W SE whole spine screening. Section thickness was 4 mm and the intersection gap was 1 mm. The MRI parameters for diagnosing spondylitis based on literature were identified and compared.[2,3]

The variables were identified if they had the patterns of involvement as described in literature.[2,3] The various variables studied include (1) contiguous involvement (> two adjacent vertebrae),[4] (2) presence of para or intraosseous abscess, (3) subligamentous spread of infection, (4) presence of vertebral collapse, (5) large collection (>1.5 cm) with thin abscess wall (<2 mm), (6) presence of T2 hypointense debris, (7) presence of non-contiguous skip lesions,[5-7] and (8) intervertebral disc involvement.

Less often recognized pattern is the presence of T2 hypointense debris which has been described in literature, however, is not discussed extensively.[8] It can be seen within vertebral bodies or in the collections on T2W images; they correlate to the fragmentation of bone caused by the slowly progressing infection, appearing as hypointense areas and correspond to bony fragmentation sign on computed tomography (CT) scans.

Imaging findings on MRI of both groups were then compared, analyzed and features helping in differentiation were tabulated. An attempt to devise a novel MRI score to differentiate the two groups was done and results statistically analyzed.

Statistical methods

Descriptive and inferential statistical analysis was carried out. Chi-square/Fisher exact test was used to find the significance of study parameters on a categorical scale between both the groups. Significant level of correlation was set at 0.05. Distribution of scores between the groups was assessed using an independent *t*-test and Mann–Whitney U-test. Univariate and multivariate regression analysis was performed for associating factors with the outcome.

RESULTS

The mean age of the study population was 52 years for tubercular and 54 years for pyogenic group with a minimum age of 12 and maximum of 87 years. No statistically significant age differentiation for the groups was observed.

The positive predictive value with the prevalence of each MRI parameter within both the groups and relationship of each parameter with tubercular group compared against pyogenic group was assessed. The Pearson's Chi-square test and univariate logistic regression analysis have shown significant differentiation between the two pathologies with the first six MRI features [Table 1]. No significant statistical correlation for differentiation was observed for the presence of skip lesions and degree of intervertebral disc involvement.

Among the six statistically significant MRI parameters, the independent predictors for tubercular involvement turned out to be (1) sub-ligamentous infectious spread (adjusted odds ratios [AOR] = 21.6, 95% confidence interval [CI] = 2.19–59.9, $P < 0.05$), (2) presence of vertebral collapse (AOR = 8.68, 95% CI = 1.25–40.6, $P < 0.05$), (3) large collection with thin abscess wall (AOR = 43.07, 95% CI = 5.7–74.6, $P < 0.001$), and (4) presence of T2 hypointense debris (AOR = 14.56, 95% CI = 2.94–55.6, $P < 0.05$) which was obtained by multivariate regression analysis.

A score of 2 for each of the four significant independent predictors of tubercular spondylitis was given, and a score of 1 was given for the two parameters including the presence of contiguous involvement and para or intraosseous abscess which were statistically significant but not significant independent predictors. Thus, a total score of 10 was devised [Table 2].

Scoring for both group A and group B was tabulated and analyzed [Table 3].

Distribution of scores among the subjects aged 53.4 ± 17 years showed $P < 0.001$ (*t*-test and Mann–Whitney U-test) with mean of 7.4 for tubercular and 2.9 for pyogenic group

Table 1: Relationship of MRI parameters with the diagnosis.

MRI parameter	Diagnosis		Sensitivity (%)	Specificity (%)	PPV (%)	χ^2	*P* value
	Tuberculosis (%)	Pyogenic (%)					
Contiguous involvement >2 levels	47.1	16.4	47.1	83.6	78.5	13.07	<0.001
Para or intraosseous abscess	88.6	56.4	88.5	43.6	66.6	16.77	<0.001
Subligamentous spread	87.1	36.4	87.1	63.6	75.3	34.81	<0.001
Vertebral collapse	88.6	56.4	88.5	43.6	66.6	16.52	<0.001
Large collection with thin abscess wall	90	35	90	65.3	85.7	28.4	<0.001
T2 hypointense debris	80	36	80	63.6	73.6	24.6	<0.001
Skip lesions	10	7	10	92.7	63.6	0.28	0.5
Disc involvement	97	96	97.1	3.6	56.1	0.06	0.8

Pearson Chi-square used; $P<0.05$ is significant. Unadjusted odd's ratio is for the univariate regression of factors associated with outcome where outcome variable is tubercular pathology compared against pyogenic. MRI: Magnetic resonance imaging, PPV: Positive predictive value

Table 2: Score assigned to statistically significant MRI parameters.

MRI parameter	Score
Contiguous involvement >2 levels	1
Para or intraosseous abscess	1
Sub-ligamentous spread	2
Vertebral collapse	2
Large collection with thin abscess wall	2
T2 hypointense debris	2
Total score	10

MRI: Magnetic resonance imaging

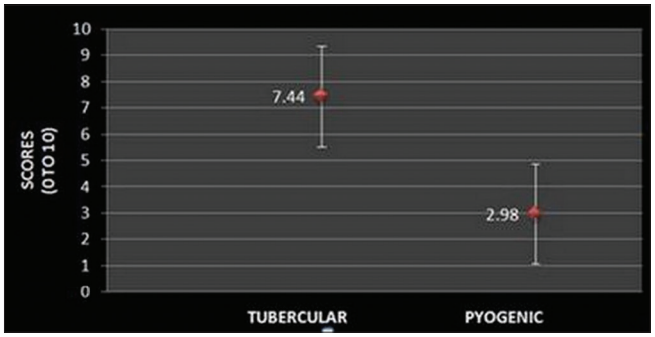


Figure 1: Comparison of scores between the groups.

(SD of 1.9). A score of 6 or above suggested tuberculosis and score below 6 suggested pyogenic infection (sensitivity – 94.2%, specificity – 89%, positive predictive value – 94.2%, and Chi-square value of 87.67, $P < 0.00001$) [Table 4 and Figure 1].

DISCUSSION

Osteoarticular tuberculosis involves 2–5% of all tubercular lesions in the body, of which 50% affect the spine.[3] In 2015, 1.4 million people died from TB, including 0.4 million among people with HIV. Tuberculosis of the spine, if not diagnosed and treated in time can lead to serious complications such as deformity, instability, and neurological deterioration.

Imaging plays a key role in the detection of spinal infections as it provides valuable information regarding the detection and location of infection, the severity of disease, associated morphological changes and also might provide clue in detecting causative organism.

The diagnosis of etiology is important for many reasons. The treatment is entirely different for tubercular and pyogenic spinal infections. The prognosis of the disease differs for both. For tuberculosis with no neurological complications, the prognosis is good with early detection and starting antitubercular medical therapy. Cases with neurological deficit require additional surgical management for stabilization.

The rates for isolating the causative organism are <50% in TB spondylitis[9,10] and 60–80% for pyogenic spondylitis.[5-7] Moreover, even histopathologic evaluation of biopsy material does not always provide a specific diagnosis. In general, it is reported that the sensitivity and specificity of MRI for diagnosis of spinal TB are 100% and 88.2%, respectively.[11]

Usually, two contiguous vertebrae are involved in both pyogenic and tubercular infections. It is reported in literature that typical TB spondylitis is seen affecting the single region in approximately 65%, multiple contiguous level infections are seen in 20% [Figure 2], and multiple non-contiguous skip levels of involvement are seen in about 10% of cases.[12] Hence, in our protocol, we screen the whole spine with sagittal T2WI MRI sequence when investigating a spinal TB patient to identify non-contiguous (skip) lesions before surgical planning [Figure 3].[13,14] Contiguous vertebral involvement of more than two levels is traditionally described for tuberculosis, in our study, although we found it to be specific for tubercular, it is less sensitive and we did not find it statistically significant as an independent predictor of tuberculosis; hence, a score of only one was given. The reason could be due to a few

Figure 2: Multiplanar T2, T1, and T2Fat sat magnetic resonance images depict contiguous vertebral involvement, anterior subligamentous spread with intraosseous and paravertebral collections, epidural abscess with cord compression, collapse of vertebral bodies, T2 hypointense areas and thin abscess wall. Features suggest tubercular etiology with a score of 10.

Table 3: Distribution of scores between the groups.

Variable	Group A (*n*=70)		Group B (*n*=55)		*t*-value	*P* value
Total score (Independent t-test)	Mean 7.44	SD 1.9	Mean 2.98	SD 1.9	12.9	<0.001
Total score (Mann–Whitney U-test)	Median 7	IQ range 6-9	Median 2	IQ range 2-5	12.9	<0.001

P<0.05 is significant

Table 4: Relationship of scores and diagnosis.

Score	Diagnosis				χ^2	*P* value
	Tuberculosis (*n*=70)		Pyogenic (*n*=55)			
	n	%	*n*	%		
6 or more	66	94.2	6	10.9	87.67	<0.00001
<6	4	5.8	49	89.1		

Pearson Chi-square used; *P*<0.05 is significant

atypical cases included in our group including brucellosis, polymicrobial including fungal spondylitis infections, which also can involve more than two vertebrae.

Atypical lesions are also described in tuberculosis which is rare and includes vertebra plana (common in children), ivory vertebra, isolated involvement of neural arch, solid soft tissue component, and non-contiguous bony lesions.[15]

Soft tissue component can be either phlegmon or abscess in epidural, paravertebral or paraspinal regions. They appear as loculated and well-encapsulated collections with smooth walls. Our study showed that though the presence of abscess was more common in tubercular cases, it is not an independent predictor for tuberculosis as it is seen in both the pathologies; hence, no scoring was given. The size of the collection and thickness of the abscess wall showed a significant difference among both groups. Larger sized abscesses (size >1.5 cm) with thinner walls (<2 mm) were seen in the tubercular group while smaller abscesses with thick irregular wall were frequently seen in pyogenic infections [Figure 4]; hence, a score of 2 was given for larger abscesses.

The avascular nature of the intervertebral disc favors it to be the primary site of pyogenic infection [Figure 5]. On the contrary, due to hematogenous spread of tubercular bacilli, vertebra is primarily involved, and disc shows late involvement. In our study, involvement or sparing of disc was the least specific

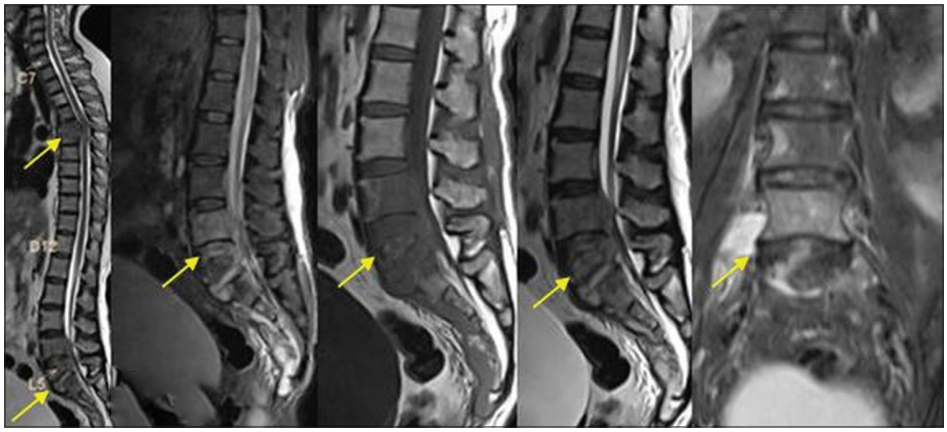


Figure 3: Multiplanar T2,T1 and T2Fat sat MR images depict skip lesions, contiguous involvement, subligamentous spread with intraosseous collections and thin abscess wall. Features sugggesting Tubercular etiology with score of 7.

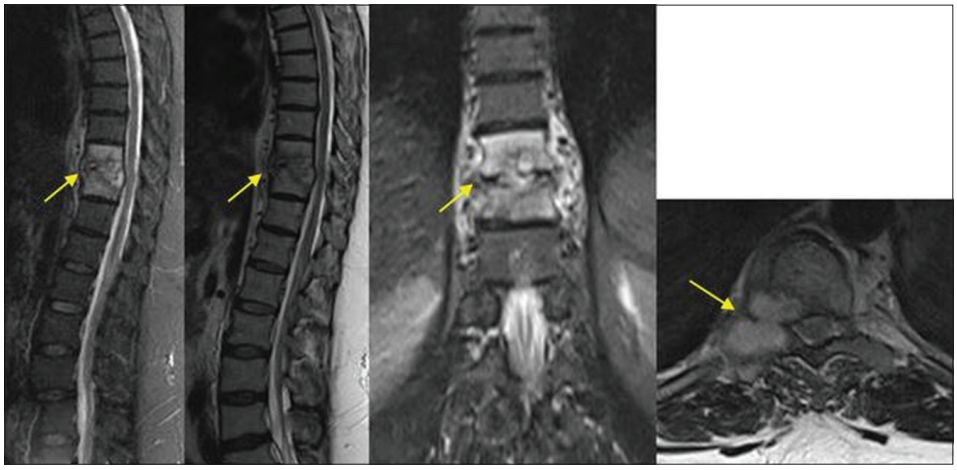


Figure 4: Multiplanar T2 and T2Fat sat MR images depict absence of contiguous involvement, collapse and subligamentous spread, presence of intraosseous and paravertebral collections with thick abscess wall. Features sugggesting Pyogenic etiology with score of 1.

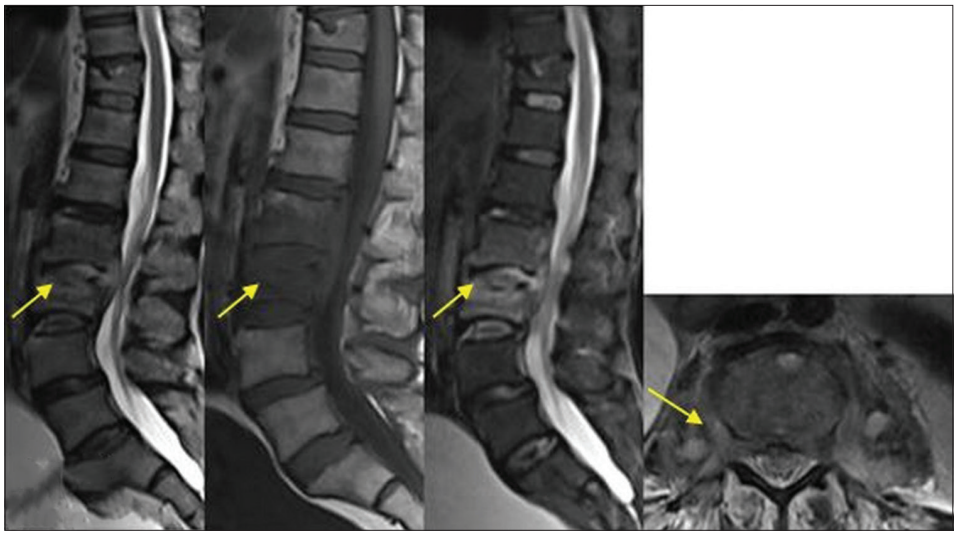


Figure 5: Multiplanar T2,T1 and T2Fat sat MR images depict presence of disc involvement, intraosseous and paravertebral small collections with thick abscess wall. Features sugggesting Pyogenic etiology with score of 1.

(3.6%) and not statistically significant between the two groups; hence, no score was given. We presume that being a tertiary referral center; our group had more advanced and delayed presentation cases wherein tubercular cases also had secondary involvement of disc. Presence of vertebral body destruction more than half suggesting collapse was highly sensitive (88.5%) and seen in cases of tuberculosis; hence, score of 2 was given.

A relatively less discussed but yet important imaging finding is the presence of T2 hypointense debris corresponding to the fragmented appearance due to bone destruction seen on CT images. It is said to be specific for tuberculosis due to the slow and continuous destruction caused by the tubercle bacilli. Even the presence of T2 hypointense rim around the collections/abscesses which correspond to marrow sclerosis has been described to be specific for tuberculosis. We have found this imaging feature to be quite sensitive (80%) and very useful for delineating the etiological diagnosis; hence, a score of 2 was assigned.

The use of contrast enhanced MRI studies for spinal infections has also been described for demonstrating heterogeneous vertebral body enhancement, enhancement of the inflamed meninges or rim enhancement around abscesses.[7,11,16,17] In our study, we have not done contrast since all the findings included are detectable sufficiently by routine plain MRI scan.

The use of above-mentioned MRI parameters and scoring can lead to a confident differentiation of TB from pyogenic lesions, in case of doubt (or) for further confirmation of diagnosis, image-guided needle biopsy/aspiration or surgical biopsy may be done and samples of bone tissue or abscess are obtained to stain for AFB and isolate organisms for culture, antibiotic sensitivity, and histopathology.[16] Biopsy is also recommended to evaluate for rifampicin sensitivity before the start of antitubercular therapy.

Limitations

The study did not consider the time interval between the onset of symptoms/disease and the presentation for MR imaging. This could be one of the reasons for obtaining more number of tubercular cases with disc involvement. This is a retrospective study as only operated cases were included. Inter-observer variability was not assessed. Being a tertiary referral center, many of the patients assessed were in severe/advanced stage of disease rather than early presentation; hence, early features could be a little variable.

CONCLUSION

In our study, we have found that sub-ligamentous infectious spread, presence of vertebral collapse, large collection with thin abscess wall, and presence of T2 hypointense debris are independent predictors of tubercular involvement. MRI can thus be used for noninvasive and confident diagnosis of spinal tuberculosis. This scoring system can be used in all cases of spinal infections to identify the etiology wherein a score of 6 or above indicates advanced tuberculosis and <6 indicates pyogenic spondylitis. This will reduce the burden of additional invasive investigations, additional costs, and time delay for initiating early treatment.

Declaration of patient consent

Patient's consent not required as patients identity is not disclosed or compromised.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Lee KY. Comparison of pyogenic spondylitis and tuberculous spondylitis. Asian Spine J 2014;8:216-23.
2. Sharif HS, Morgan JL, al Shahed MS, al Thagafi MY. Role of CT and MR imaging in the management of tuberculous spondylitis. Radiol Clin North Am 1995;33:787-804.
3. Jung NY, Jee WH, Ha KY, Park CK, Byun JY. Discrimination of tuberculous spondylitis from pyogenic spondylitis on MRI. AJR Am J Roentgenol 2004;182:1405-10.
4. Emel E, Güzey FK, Güzey D, Bas NS, Sel B, Alatas I, *et al.* Non-contiguous multifocal spinal tuberculosis involving cervical, thoracic, lumbar and sacral segments: A case report. Eur Spine J 2006;15:1019-24.
5. Ansari S, Amanullah MF, Ahmad K, Rauniyar RK. Pott's spine: Diagnostic imaging modalities and technology advancements. N Am J Med Sci 2013;5:404-11.
6. Khattry N, Thulkar S, Das A, Khan SA, Bakhshi S. Spinal tuberculosis mimicking malignancy: Atypical imaging features. Indian J Pediatr 2007;74:297-8.
7. Moorthy S, Prabhu NK. Spectrum of MR imaging findings in spinal tuberculosis. AJR Am J Roentgenol 2002;179:979-83.
8. Veena C, Kumar GA, Niranjan K. Diagnostic Radiology: Musculoskeletal and Breast Imaging. New Delhi: Jaypee Brothers Medical Publishers Pvt. Ltd.; 2012.
9. Sharif HS. Role of MR imaging in the management of spinal infections. AJR Am J Roentgenol 1992;158:1333-45.
10. Resnick D, Niwayama G, editor. Osteomyelitis, septic arthritis and soft tissue infection: The axial skeleton. In: Diagnosis of Bone and Joint Disorders. Philadelphia, PA: Saunders; 1988. p. 2619-754.
11. Jain AK. Tuberculosis of the spine: A fresh look at an old disease. J Bone Joint Surg Br 2010;92:905-13.
12. DeSanto J, Ross JS. Spine infection/inflammation. Radiol Clin North Am 2011;49:105-27.
13. Shanley DJ. Tuberculosis of the spine: Imaging features. AJR Am J Roentgenol 1995;164:659-64.
14. Polley P, Dunn R. Noncontiguous spinal tuberculosis:

Incidence and management. Eur Spine J 2009;18:1096-101.
15. Momjian R, George M. Atypical imaging features of tuberculous spondylitis: Case report with literature review. J Radiol Case Rep 2014;8:1-4.
16. Rasouli MR, Mirkoohi M, Vaccaro AR, Yarandi KK, Rahimi-Movaghar V. Spinal tuberculosis: Diagnosis and management. Asian Spine J 2012;6:294-308.
17. de Souza CG, Gasparetto EL, Marchiori E, Bahia PR. Pyogenic and tuberculous discitis: MRI findings for differential diagnosis. Radiol Bras 2013;46:173-7.

How to cite this article: Sadineni RT, Anupama NV, Pushpa BT, Mikkineni K, Kannan M, Rajasekharan S. A Novel Magnetic Resonance Imaging Scoring System in Making Specific Diagnosis of Tubercular Spondylitis in Advanced Infection. Indian J Musculoskelet Radiol 2019;1(1):7-13.