Section: Radiology

Original Research Article

ROLE OF MAGNETIC RESONANCE IMAGINGIN EVALUATION OF INFECTIOUS PATHOLOGIES OF SPINE

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ABSTRACT

Background: Spinal infections, although uncommon, carry significant morbidity due to delayed diagnosis and potential neurological compromise. Magnetic Resonance Imaging (MRI) is the modality of choice for early detection and comprehensive evaluation. This study aimed to assess the role of MRI in diagnosing and characterizing infectious pathologies of the spine.

Materials and Methods: The present study was conducted in department of radiology at Narendra Modi Medical College and L.G. hospital. Participants were asked to give written consent for the study after understanding the study protocol and procedure. A retrospective record based study was conducted on 200 patients with clinical suspicion of spinal infection.

Results: Out of 200 cases, 136 cases were of TB spondylitis, 35 cases were of pyogenic spondylitis, 15 cases were of brucellar spondylitis and 14 cases were of transverse myelitis. The most common site was the lumbar spine, followed by thoracic involvement. Typical findings included vertebral body destruction, intervertebral disc involvement, and pre-/paravertebral collections. MRI was also effective in differentiating tubercular from pyogenic spondylodiscitis, with tubercular cases showing contiguous multi-level involvement, large paravertebral abscesses, and relative disc preservation. Pyogenic infections more often demonstrated acute endplate destruction with early disc involvement. Post-contrast sequences improved detection of subtle collections and epidural disease.

Conclusion: MRI is highly sensitive and specific in evaluating infectious pathologies of the spine. It allows early diagnosis, delineation of extent, assessment of complications, and differentiation of etiologies, thereby guiding appropriate management and reducing morbidity.

Keywords: Spine, MRI, Infectious pathology, Spondylodiscitis, Epidural abscess, Tuberculosis.

INTRODUCTION

Spinal infections are serious clinical conditions that carry high morbidity and mortality rates, particularly when the diagnosis is not made in a prompt manner or they are misdiagnosed or treated improperly. Delayed diagnosis usually leads to neurological

deficit, permanent spinal deformities or even death.[1]

Spinal infections may involve bony structures (osteomyelitis), the disc (discitis), the epidural space (epidural abscess), subdural space (subdural empyema), the subarachnoid space (meningitis), or the cord itself (myelitis or cord abscess).[1] They can be classified bacteriologically into bacterial, viral, fungal and parasitic infections.[2]Early diagnosis of spinal infections will decrease morbidity in many cases.[3] Although a clinical diagnosis of infections of the spine can sometimes be made in patients presenting with fever, elevated sedimentation rate and back pain, confirmation of the diagnosis is nearlyalways made on imaging studies.[4]MR scanning is the imaging procedure of choice for the evaluation of patients suspected of having spinal infections and MRI has become the gold standard in the evaluation of disc space infection and osteomyelitis. Gadolinium enhanced MRI studies are superior to any other imaging modality for early recognition & anatomic localization of infectious processes of the spine.[5]Advantages of MRI include its multiplanarcapabilities and soft tissue contrast resolution,[7] MRI delineates the extent of the disease which may spread to the epidural or paravertebral spaces,[5] MR imaging is valuable for diagnosis in the early stages of the infection.[6]

Aims and Objectives

1. To determine the pattern of different infectious pathologies of spine on MR imaging.
2. To determine multilevel involvement of spine with comparison of different infectious pathologies of spine.
3. To determine the socio-demographic factors related to infectious pathologies of spine on MR imaging.

MATERIALS AND METHODS

Equipment used: Siemens magneto essenza 1.5 T MRI.

Source of Data: Hospital based study enrolled for study after obtaining an informed consent. Patients coming to radiology department with suspected infectious spinal pathologies.

Study type: Retrospective record-based study.

Sample: Patients attending L.G. HOSPITAL, MANINAGAR.

Plan for data analysis: Data will be depicted in the form of tables and charts and analysed.

Materials and methods: The main source of study are 200patients who were referred to the radiology department with clinically suspicion of spinal pathologies. The study was conductedfrom period of from July 2020 to July 2023 in department of radiology, Narendra Modi Medical College and L.G. Hospital, Maninagar, Ahmedabad.

Inclusion Criteria

1. All patients referred from clinicians in which spinal pathologies were noted on MRI studies.
2. All patients with spinal pathologies who give consent irrespective of age group and sex are taken up for the study.

Exclusion criteria:

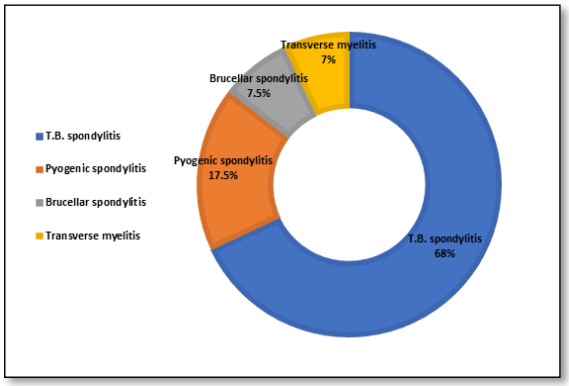
1. Patients not willing to take part in the study.
2. Previous spinal surgery or prosthesis of spine.
3. Patients with pace makers, metal implants in their bodies, foreign bodies in their eyes and those having claustrophobia.

All patients were studied in the sagittal plane with T1-weighted sequences (400-740 / 13-22) (Range of TRs/ range of TEs), and T2weighted sequences (2800-5000/104-120). Axial T1- and T2-WI were obtained in all cases.Coronal images were done in 2 cases only. Gadolinium Diethylene TriaminePenta-acetate (Gd-DTPA) was intravenously injected in 170 cases in a dose of 0.1 mmol/kg body weight.

Ethical aspects: Written and oral informed consent of the patients was taken whenever required and confidentiality of all data and photographs will be maintained.

RESULTS

Two hundred patients with suspected infectious spinal infections were included in this study. MRI of the spine was done for all the patients. The most common cause of infection in our study was tuberculous etiology with 136 patients in this category. Out of these 136 patients, 9 patients were operated with biopsy proven cases of tubercular infection, 25 patients were acid fast bacilli positive on sputum examination, 45 patients showed some of the x-ray features of pulmonary Koch's. 57 patients had previous history of Koch's infection with history of consumption of anti-tubercular therapy of drugs at some point previously. Out of these 41 patients had completed their anti-tubercular therapy satisfactorily. The remaining 16 patients were defaulters with history of irregular and intermittent consumption of anti-tubercular drugs. All the patients showed an elevated ESR. All patients had intermittent low-grade fever at some point before treatment with significant improvement post anti-tubercular drug therapy.



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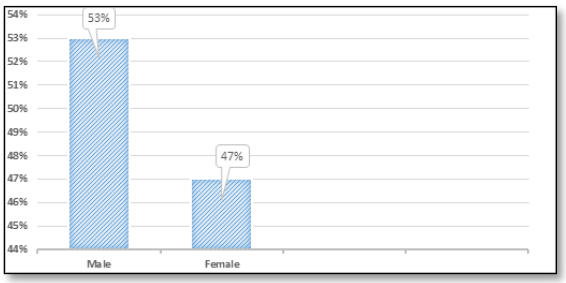

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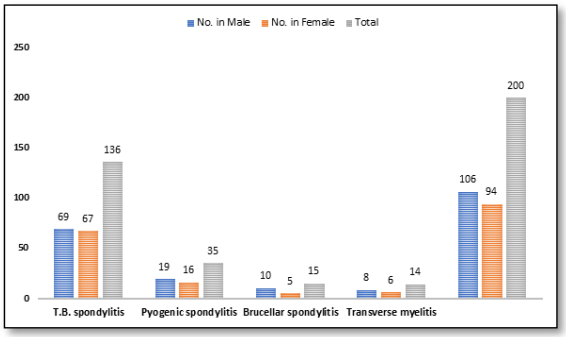

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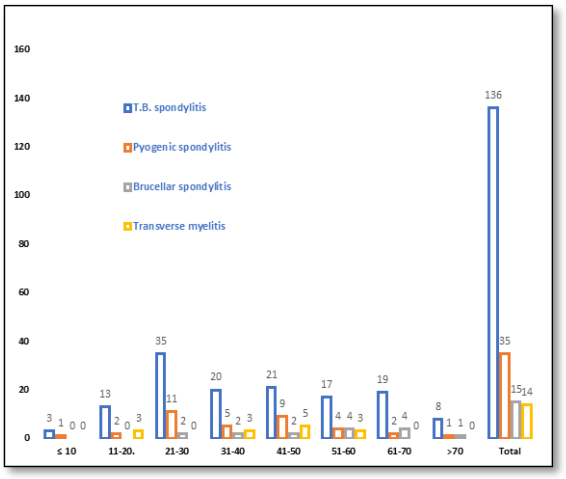

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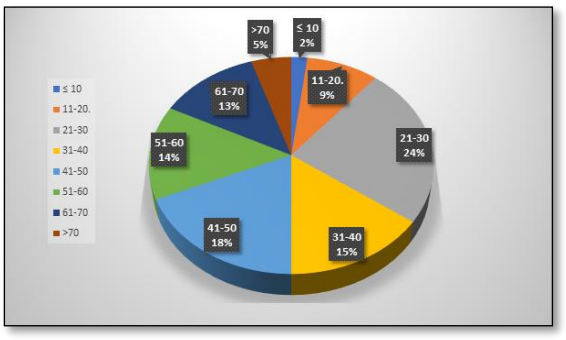

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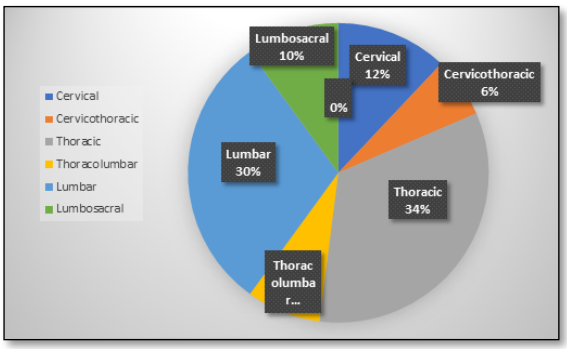

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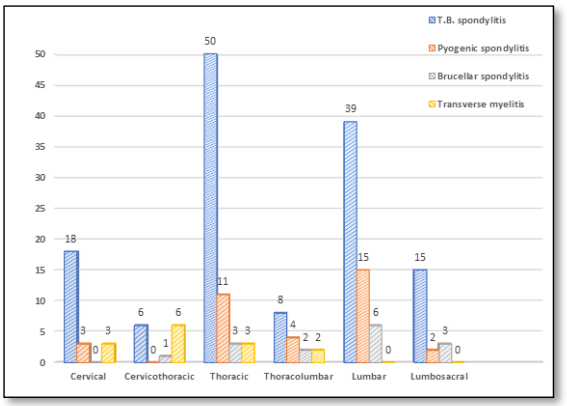

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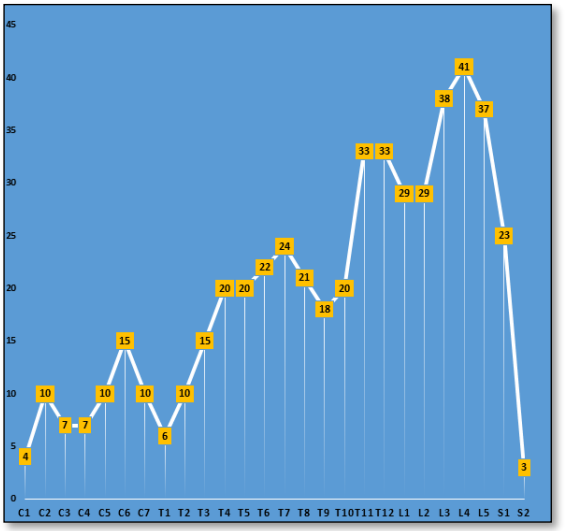

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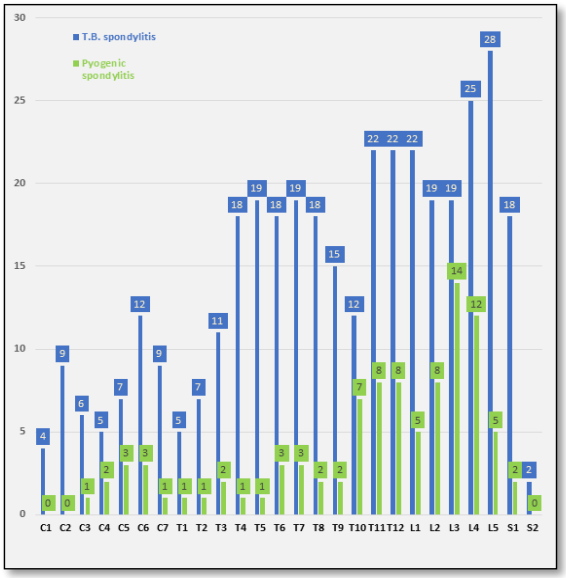

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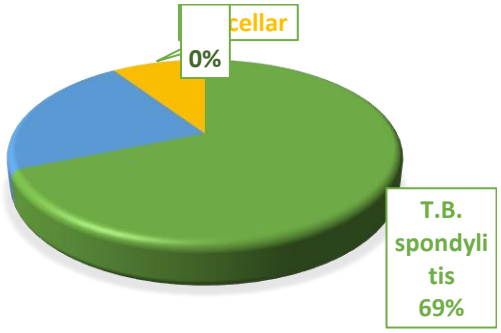

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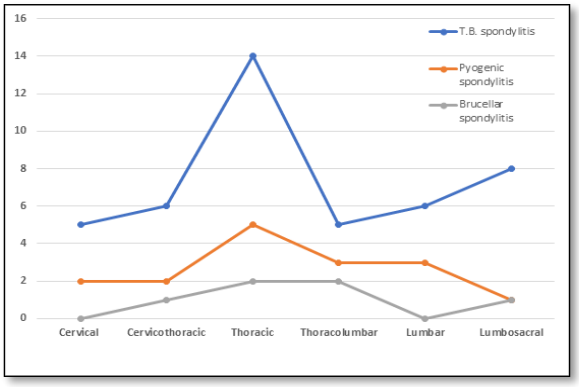

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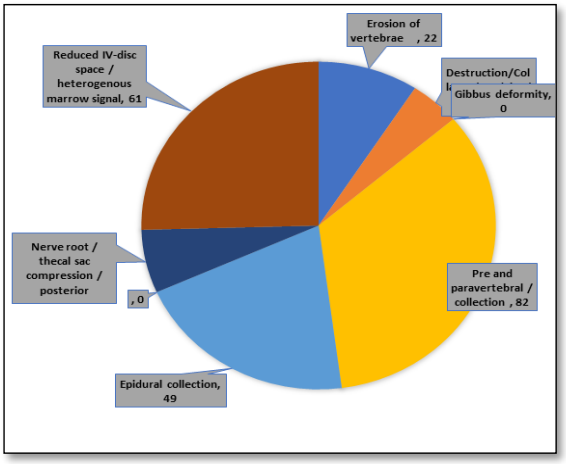

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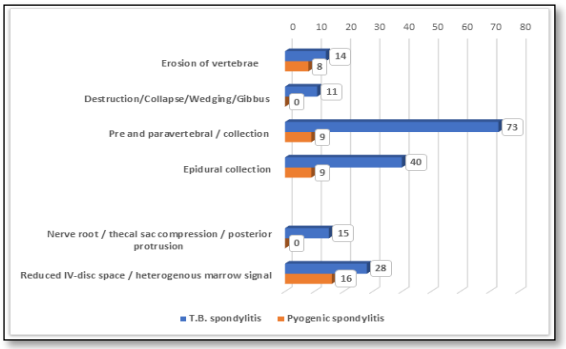


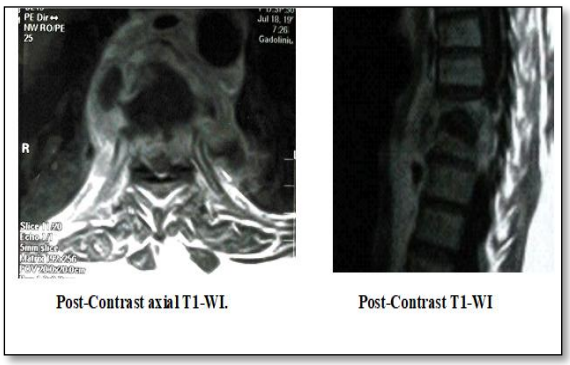
Table 12(chart)

MRI findings:

1. D9/10 vertebral bodies as well as the intervening disc spacesis seen replaced by abnormal signal intensity in the form of low signal intensity on T1-WI and high signal intensity on T2-WI with heterogenous contrast enhancement on post gadolinium T1-WI.
2. Associated prevertebral soft tissue component with thick marginal enhancement after IV. Contrast.
3. Associated large epidural abscess extending from the lower border of D8 down to the upper border of D11 showing low signal intensity on T1-WI and high signal intensity on T2-WI with contrast enhancement after IV Gadolinium administration.

As described in Figure 1

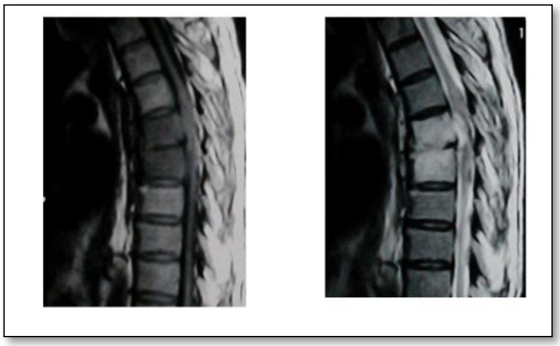
Sagittal T1-WISagittal T2-WI



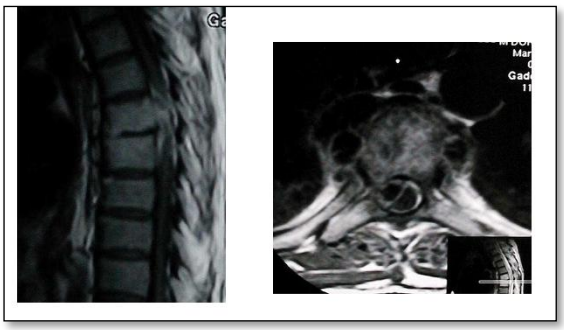
MRI Findings

1. The bone marrow of D6/7vertebral bodiesas well as the intervening disc space are replaced by abnormal signal intensity in the form of low signal intensity on T1-WI and high signal intensity on T2-WI.
2. Associated large paraspinal soft tissue component extending intraspinally through the related neural foramina compressing the dorsal spinal cord from the lower border of D5 down to the lower border of D7 vertebrae, more marked on the right side.
3. The soft tissue component shows low signal intensity on T1-WI and high signal intensity on T2-WI with thick marginal and septal contrast enhancement.

As described in figure 2.



Sagittal T1-WISagittal T2-WI

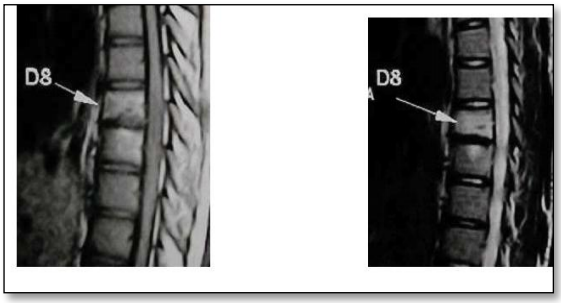


Post-Contrast Sagittal T1-WIPost-Contrast axial T1-WI.

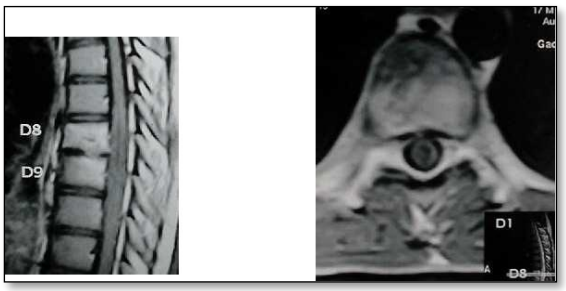
MRI - Findings

1. D9 vertebral body and upper posterior part of D8 together with the opposing end plates showing abnormal signal intensity being of low signal in T1-WI and of high signal intensity in T2-WI with homogenous contrast enhancement in post contrast T1-WI.
2. Intact vertebral bodies.
3. D8/9 intervertebral disc shows abnormal low signal intensity in both T1- and T2-Wis with contrast enhancement in postcontrast T1-WI.

As described in Figure 3.



Sagittal T1-WI. Sagittal T2-WI



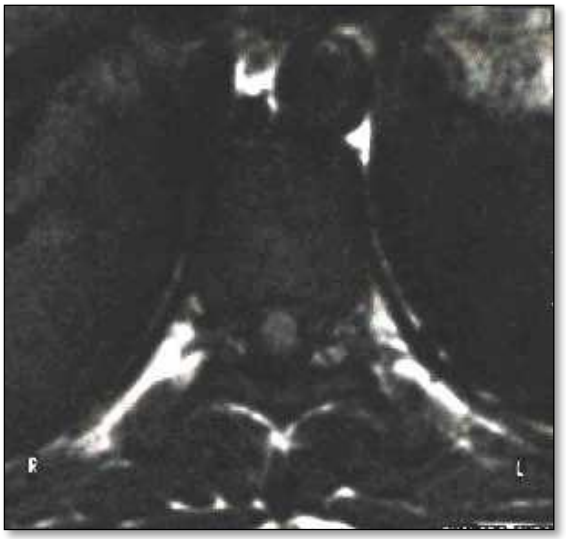
Post-Contrast Sagittal T1-WI. Post-contrast Axial T1-WI.

MRI - Findings

1. Long segment of the dorsal spinal cord and conusmedularis showing mild fusiform swelling,fainthyperintensesignal on T1-WI andintense high signal on T2-WI characteristically affecting the anterior portion of the spinal cord.

As described in figure 4

Sagittal T1-WISagittal T2-WI



Axial T1-WI

In Two Hundred Cases of Infectious Spinal Pathologies:

1. 67 cases in Thoracic region followed by 60 cases in lumbar region, 24 cases in the cervical region, 20 cases in lumbosacral region, 16 cases in thoracolumbar region and 13 cases in cervicothoracic region.
2. Maximum number of cases 48, were seen in third decade (21-30 years).
3. Most commonly affected vertebrae was L4 seen in 41 cases followed by L3 vertebrae seen in 38 cases.
4. Paravertebral & prevertebral extension was seen in 82 cases.
5. Epidural abscess was seen in 49 cases.
6. Destruction/Collapse/Wedging/Gibbus deformity seen in 11 cases.
7. Erosion of vertebrae seen in 22 cases.
8. Reduced IV-disc space / heterogenous marrow signal intensity seen in 61 cases.
9. Nerve root / thecal sac compression / posterior protrusion seen in 15 cases.
10. Multilevel vertebral involvement was seen in 64 cases, of which 21 in thoracic level, 10 in lumbosacral and thoracolumbar each level,9 cases in lumbar level and 7 cases of cervical and cervicothoracic each.

Patients with T.B. spondylitis (136 patients) show the following:

1. 50 cases in the thoracic region followed by 39 cases in lumbar region, 18 cases in the cervical region, 15 cases in lumbosacral region, 8 cases in thoracolumbar region and 6 cases in cervicothoracic region.
2. Maximum number of cases 35, were seen in third decade (21-30 years).
3. Most commonly affected vertebrae in T.B spondylitis was L5 seen in 28 cases followed by L4 vertebrae seen in 25 cases.
4. Paravertebral & prevertebral extension was seen in 73 cases.
5. Epidural abscess was seen in 40 cases.
6. Destruction/Collapse/Wedging/Gibbus deformity seen in 11 cases.
7. Erosion of vertebrae seen in 14 cases.
8. Reduced IV-disc space / heterogenous marrow signal intensity seen in 28 cases.
9. Nerve root / thecal sac compression / posterior protrusion seen in 15 cases.
10. Multilevel vertebral involvement was seen in 44 cases, of which 14 in thoracic level, 8 in lumbosacral level, 6 cases of cervicothoracic and lumbar level each and 5 cases of cervical and thoracolumbar.

Patients with pyogenic spondylitis (35 cases) showing the following:

1. 15 cases in lumbar region followed by 11 cases in the Thoracic region, 4 cases in thoracolumbar region, 3 cases in cervical region and 2 in lumbosacral region.
2. Maximum number of cases 11, were seen in third decade (21-30 years).
3. Most commonly affected vertebrae in pyogenic spondylitis was L3 seen in 14 cases followed by L4 vertebrae seen in 12 cases.
4. Paravertebral & prevertebral extension was seen in 9 cases.
5. Epidural abscess was seen in 9 cases.
6. Erosion of vertebrae seen in 8 cases.

7. Reduced IV-disc space / heterogenous marrow signal intensity seen in 16 cases.
8. Multilevel vertebral involvement was seen in 14 cases, of which 5 cases in thoracic level, 3 cases in thoracolumbar and lumbar level each, and 2 cases in cervicothoracic and of cervical each.

Patient with Brucellar spondylitis (15 cases) showing the following:

1. Out of 15 cases 6 cases show intraspinal abscess formation.
2. Disc affection: shows abnormal marrow signal intensity with granulation formation.

Patient with transverse myelitis (14 cases) showing the following:

1. Hyperintense signal on T1-WI and intense high signal on T2-WI characteristically affecting the spinal cord seen in all cases.
2. Expansion of affected cord was seen in 6 cases.

5 cases show abnormal leptomeningeal, nodular or ring like enhancement of cord.

Table 1: Distribution of spinal infections

	No. of cases	Percentage
T.B. spondylitis	136	68%
Pyogenic spondylitis	35	17.5%
Brucellar spondylitis	15	7.5%
Transverse myelitis	14	07%
Total	**200**	

Table 2: Distribution of spinal infections according to gender

	No. of cases	Percentage
Male	106	53%
Female	94	47%
Total	200	100%

Table 3: Gender wise distribution particular infection

	No. in Male	No. in Female	Total
T.B. spondylitis	69	67	136
Pyogenic spondylitis	19	16	35
Brucellar spondylitis	10	05	15
Transverse myelitis	08	06	14
			200

Table 4: Age wise distribution

Age Group (In Year)	T.B. spondylitis	Pyogenic spondylitis	Brucellar spondylitis	Transverse myelitis
≤ 10	03	01	00	00
11-20	13	02	00	03
21-30	35	11	02	00
31-40	20	05	02	03
41-50	21	09	02	05
51-60	17	04	04	03
61-70	19	02	04	00
>70	08	01	01	00

Table 5: Age wise distribution of cases

Age Group (In Year)	Total No. of Cases	Percentage
≤ 10	04	02%
11-20	18	09%
21-30	48	24%
31-40	30	15%
41-50	37	18%
51-60	28	14%
61-70	25	13%
>70	10	05%
Total	200	100%

Table 6: No. of cases according to vertebral location

	No. of cases	Percentage
Cervical	24	12%
Cervicothoracic	13	6.50%
Thoracic	67	33.50%
Thoracolumbar	16	8%
Lumbar	60	30%
Lumbosacral	20	10%
Total	200	100%

Table 7: Distribution of spinal infection according to vertebral level

	T.B. spondylitis	Pyogenic spondylitis	Brucellar spondylitis	Transverse myelitis
Cervical	18	03	00	03
Cervicothoracic	06	00	01	06
Thoracic	50	11	03	03
Thoracolumbar	08	04	02	02
Lumbar	39	15	06	00
Lumbosacral	15	02	03	00

Table 8: Distribution based on involvement of individual vertebrae.

Involved vertebral body	Total no. of cases
C1	04
C2	10
C3	07
C4	07
C5	10
C6	15
C7	10
T1	06
T2	10
T3	15
T4	20
T5	20
T6	22
T7	24
T8	21
T9	18
T10	20
T11	33
T12	33
L1	29
L2	29
L3	38
L4	41
L5	37
S1	23
S2	03

TABLE 9: Distributionaccordingtoinvolvement of individual vertebrae in T.B. spondylitis and pyogenic spondylitis.

Involved vertebral body	T.B. spondylitis	Pyogenic spondylitis
C1	04	00
C2	09	00
C3	06	01
C4	05	02
C5	07	03
C6	12	03
C7	09	01
T1	05	01
T2	07	01
T3	11	02
T4	18	01
T5	19	01
T6	18	03
T7	19	03
T8	18	02
T9	15	02
T10	12	07
T11	22	08
T12	22	08
L1	22	05
L2	19	08
L3	19	14
L4	25	12
L5	28	05
S1	18	02
S2	02	00

Table 10: Distribution based on multilevel affection of vertebrae

	No. of total cases
T.B. spondylitis	44
Pyogenic spondylitis	14
Brucellar spondylitis	06
Total	64

Table 11: Distribution of spinal infections based on multilevel affection of

	T.B. spondylitis	Pyogenic spondylitis	Brucellar spondylitis
Cervical	05	02	00
Cervicothoracic	06	02	01
Thoracic	14	05	02
Thoracolumbar	05	03	02
Lumbar	06	03	00
Lumbosacral	08	01	01

Table 12: Based on MRI findings

MRI findings	No. of cases
Erosion of vertebrae	22
Destruction/Collapse/WedgingGibbus deformity	11
Pre and paravertebral / collection	82
Epidural collection	49
Nerve root / thecal sac compression / posterior protrusion	15
Reduced IV-disc space / heterogenous marrow signal	61

Table 13: Comparison between T.B. spondylitis and pyogenic spondylitis based on MRI findings

	T.B. spondylitis	Pyogenic spondylitis
Erosion of vertebrae	14	08
Destruction/Collapse/Wedging/Gibbus deformity	11	-
Pre and paravertebral / collection	73	09
Epidural collection	40	09
Nerve root / thecal sac compression / posterior protrusion	15	-
Reduced IV-disc space / heterogenous marrow signal	28	16

DISCUSSION

Magnetic Resonance Imaging (MRI) has emerged as the imaging modality of choice in the evaluation of spinal infections due to its superior soft-tissue contrast, multiplanar capability, and lack of ionizing radiation. These attributes allow for early and accurate diagnosis, precise characterization of disease etiology, detailed assessment of complications, and effective monitoring of treatment response.[8-10] In our study of 200 patients, MRI provided critical insights into the spectrum of infectious spondylodiscitis, reinforcing its role as an indispensable tool in clinical practice.

Tuberculous Spondylitis: Tuberculous spondylitis was the most common etiology in our cohort, accounting for 68% of cases, reflecting the endemic nature of the disease in our geographical setting. MRI revealed several hallmark features of TB spondylitis, including paradiscal involvement, anterior vertebral body destruction, subligamentous spread, and large paraspinal abscesses often disproportionate to the degree of osseous destruction.[11-13] Skip lesions—non-contiguous vertebral involvement—were identified in 32% of cases, highlighting the disease's tendency for multifocal spread, a feature less reliably detected by conventional radiography or CT.[14]Signal characteristics were consistent across cases, with affected vertebral bodies and discs showing low signal intensity on T1-weighted images and high signal intensity on T2-weighted and STIR sequences. Disc height loss was observed in 21% of TB cases, though in many patients, relative disc preservation until later stages was evident—a hallmark feature that helps distinguish TB from pyogenic infections.[12,15] Post-contrast images typically demonstrated heterogeneous enhancement, with thick, irregular rim enhancement surrounding paraspinal or intraosseous abscesses, findings considered highly suggestive of TB.[11,13]These findings are in line with previous studies. Dagirmanjian et al. and Sharif et al. emphasized the value of MRI in defining the extent of disease, particularly subligamentous and paraspinal spread, and in differentiating tuberculous from pyogenic etiologies.[16,17] Our study corroborates these results and demonstrates that contrast-enhanced fat-suppressed sequences are particularly helpful in delineating abscess morphology and enhancing granulation tissue.

Pyogenic Spondylitis: Pyogenic spondylitis, found in 17.5% of patients, demonstrated a distinctly different pattern from tuberculous disease. MRI findings included low T1 and high T2/STIR signal changes within vertebral bodies and intervertebral discs, with early and often severe disc involvement.[18,19] Disc height loss was noted in 46% of cases, significantly higher than in TB, making this a hallmark of pyogenic infection.

Paraspinal abscesses were observed but were generally smaller and less complex compared to TB-

related abscesses.[20] Epidural collections were present in 26% of cases, contributing to cord compression and neurological symptoms.[19,21] Contrast enhancement patterns in pyogenic infections were usually homogeneous during early disease, but as necrosis developed, irregular rim enhancement of abscess cavities became more apparent.[22]

Brucellar Spondylitis: Brucellar spondylitis accounted for 7.5% of cases and exhibited a milder imaging pattern compared to TB and pyogenic spondylitis. The hallmark feature was focal involvement of the anterosuperior endplate, most commonly at the L4 vertebral body.[23,24] Unlike TB and pyogenic infections, disc height and vertebral architecture were usually preserved, and significant gibbus deformity was absent. Paraspinal soft tissue changes were minimal, and contrast enhancement was generally mild or patchy rather than robust.[25] Large paraspinal abscesses or extensive bony destruction, typical of TB, were not seen in brucellar cases. The combination of relatively subtle MRI findings, preserved structural integrity, and corroborative serological tests facilitated differentiation from other infectious etiologies.[24,26]

Transverse Myelitis: Though less frequent, transverse myelitis was also identified in our series. MRI findings included intramedullary T2 hyperintensity spanning multiple segments, with variable cord expansion and patchy enhancement. MRI not only confirmed the diagnosis but also excluded compressive etiologies, guiding appropriate medical management.[34]

CONCLUSION

A critical strength of MRI in spinal infections lies in its ability to identify complications that directly influence clinical outcomes and management strategies. In our study, MRI effectively detected epidural abscesses, cord compression, and myelomalacia.[27] The modality not only delineated the degree of compression but also characterized the nature of compressing material—differentiating between abscesses, granulation tissue, or phlegmon.[28] This distinction is vital for surgical planning, as abscesses often require drainage, while phlegmon and granulation tissue may be managed conservatively.[29]MRI was also superior in detecting extensive paravertebral and psoas abscesses, as well as subligamentous spread and skip lesions, which can be overlooked on CT or radiography.[14,29] Moreover, sagittal sequences provided an excellent overview of the craniocaudal extent of disease, guiding biopsy site selection and surgical approach.[30]

Monitoring Treatment Response: In addition to its diagnostic role, MRI proved valuable in monitoring therapeutic response. Resolution of marrow edema, reconstitution of fatty marrow (seen as increased T1 signal), reduction in abscess size, and decreased paraspinal soft tissue inflammation were reliable indicators of healing.[31] However, persistent contrast enhancement was observed in some patients despite clinical improvement. This phenomenon, well documented in the literature, underscores the importance of correlating imaging findings with clinical parameters andserological markers such as ESR and CRP.[32,33]

Limitations and Diagnostic Challenges: Despite its strengths, MRI has limitations in spinal infection imaging. Early degenerative endplate changes, particularly Modic type I changes, can mimic spondylodiscitis due to their low T1 and high T2 signal.[35] Postoperative spines pose another diagnostic challenge, as routine postoperative changes (granulation tissue, endplate enhancement) may closely resemble infection.[36] In such cases, image-guided biopsy and clinical correlation remain essential.[37]

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