SCIENTIFIC RESEARCH

MAGNETIC RESONANCE IMAGING FINDINGS FEATURES FOR DIFFERENTIATING TUBERCULOUS AND PYOGENIC SPONDYLODISCITIS

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SUMMARY

Objectives: Differentiating tuberculous spondylodiscitis (TBSD) from pyogenic spondylodiscitis (PSD) remains a diagnostic challenge due to the low positivity rates in microbiological and histopathological tests. This study aimed to determine MRI imaging features that can help distinguish between TBSD and PSD.

Methods: A retrospective study was conducted on patients diagnosed with SD (either by microbiological, histopathological findings, or treatment response), who had undergone contrast-enhanced MRI scans of the spine before treatment. Imaging features on MRI were described and compared between TBSD and PSD group.

Results: A total of 65 patients were studied, including 23 (35.4%) with TBSD and 42 (64.6%) with PSD. Of the 13 MRI features analyzed, 8 showed significant differences between the two groups ($p<0.05$). Features indicative of TBSD: Thoracic spine involvement (OR=8.073), vertebral body destruction >50% height loss (OR=21.867), presence of intraosseous abscess (OR=4.604), disc preservation (OR=8.217), thin and smooth-walled paravertebral abscess (OR=11.511). Features indicative of PSD: Lumbar-sacral spine involvement (OR=5.681), epidural abscess formation (OR=7.752), thick and irregular-walled paravertebral abscess (OR=21.739).

Conclusion: Several MRI features can help differentiate between TBSD and PSD, guiding appropriate treatment selection, particularly when microbiological confirmation is unavailable.

Keywords: *Magnetic resonance imaging, spine, spondylodiscitis, tuberculosis, pyogenic.*

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I. INTRODUCTION

Infectious spondylodiscitis (SD) is an infection that affects the intervertebral discs and adjacent vertebral bodies. The two primary causes are pyogenic bacteria and *Mycobacterium tuberculosis*. The annual incidence of SD among adults in developed countries ranges from 2.4 to 7.2 per 100,000 individuals, with a slow but steady increase worldwide [1].

The treatment for tuberculous spondylodiscitis (TBSD) and pyogenic spondylodiscitis (PSD) differs significantly. PSD requires a minimum of six weeks of antibiotic therapy, whereas TBSD necessitates at least six months of anti-tuberculosis treatment. Diagnosis relies on clinical presentation, blood tests (e.g., CRP, ESR, WBC count), and microbiological analysis of sputum (AFB smear, MGIT/BACTEC culture, GeneXpert). Tissue samples obtained through biopsy, histopathology, or abscess drainage also play a crucial role in confirming the diagnosis [2,3].

However, establishing a definitive diagnosis is often challenging. Although biopsies are valuable, they are invasive and may yield false-negative results due to inadequate sample collection or prior antibiotic use. Studies have reported a positive biopsy rate of only 33%, while blood cultures yield positive results in 50%–72% of cases [4-7].

MRI plays a crucial role in diagnosing SD, particularly when microbiological evidence is inconclusive, as it helps identify the causative agent and guide appropriate treatment. While previous studies have described distinct MRI features differentiating TBSD from PSD [3,8-10], no such studies have been conducted in Vietnam. Therefore, our study aimed to describe the MRI characteristics of infectious spondylodiscitis and identify imaging findings that differentiate TBSD from PSD.

II. MATERIALS AND METHODS

Study Subjects

The inclusion criteria included patients diagnosed with TBSD or PSD who underwent contrast-enhanced spinal MRI before treatment. The exclusion criteria included patients with undetermined etiology or alternative causes (e.g., fungal or parasitic infections).

Data Collection

We evaluated the following features on MRI: isolated vertebral involvement (low signal on T1-weighted images, high signal on STIR, post-contrast enhancement, disc sparing), isolated disc involvement, paravertebral soft tissue involvement (inflammation, abscess), epidural involvement (inflammation, abscess), posterior complex involvement (facet joints, ligamentum flavum, interspinous/supraspinous ligaments).

We evaluated MRI features for differentiation between group TBSD and PSD, including: location (cervical, thoracic, or lumbosacral spine), extent of vertebral involvement (single vs. multiple levels), degree of vertebral destruction (>50% vs. <50% height loss), disc involvement, presence of intraosseous abscess, epidural involvement (phlegmon vs. abscess formation), paravertebral abscess wall thickness (thin/smooth vs. thick/irregular), posterior complex involvement.

Statistical Analysis

Data were analyzed using SPSS 20.0. Chi-square tests were performed to compare categorical variables, with $p < 0.05$ considered statistically significant. Logistic regression analysis was used to determine odds ratios (ORs) for significant MRI features.

Ethical Considerations

Patient confidentiality was strictly maintained, and the study was conducted solely for research purposes in accordance with ethical guidelines.

III. RESULTS

Among the 65 patients, 23 (35.4%) had TBSD, while 42 (64.6%) had PSD. The final diagnosis was based on microbiological and histopathological findings or treatment response.

Based on Table 1, the characteristics observed in more than 50% of patients with spinal infections included vertebral and disc lesions (86.2%), paraspinal soft tissue inflammation (100%), epidural space involvement (98.6%), paraspinal abscess (89.6%), and epidural abscess (67.7%).

Among the 13 studied characteristics, 8 showed

significant differences between the two etiological groups, as determined by the chi-square test, and were presented in Tables 2.1, 2.2, and 3.

Based on Table 2.1, the location of spinal lesions in the thoracic and lumbosacral regions differed between the two groups. Specifically, TBSD was more commonly found in the thoracic spine (52.2% vs. 11.9%; p = 0.000), whereas PSD was more frequently observed in the lumbosacral spine (92.9% vs. 96.6%; p = 0.026). No significant difference was observed in cervical spine involvement (p = 0.547).

According to Table 2.2, the following characteristics were more common in the tuberculosis group: vertebral body height destruction >50% (34.8% vs. 2.4%, p = 0.001), intraosseous abscess (73.0% vs. 38.1%, p = 0.006), inflammation sparing the intervertebral disc (39.1% vs. 4.8%, p = 0.001), and thin, smooth-walled paraspinal abscess (60.9% vs. 11.9%, p = 0.000). In contrast, the pyogenic infection group more frequently presented with an epidural abscess (83.3% vs. 39.1%, p = 0.000) and a thick, irregular-walled paraspinal abscess (85.7% vs. 21.7%, p = 0.000). Other characteristics showed no significant differences between the two etiological groups.

According to Table 3, imaging characteristics indicative of TBSD included thoracic spine involvement (OR = 8.073), vertebral body height destruction >50% (OR = 21.867), intraosseous abscess (OR = 4.604), preservation of the intervertebral disc (OR = 8.217), and thin, smooth-walled paraspinal abscess (OR = 11.511). Meanwhile, characteristics associated with PSD included lumbosacral spine involvement (OR = 5.681), epidural abscess (OR = 7.752), and thick, irregular-walled paraspinal abscess (OR = 21.739). Among these, the most significant imaging findings for diagnosis were vertebral body height destruction >50% (OR = 21.867), thin, smooth-walled paraspinal abscess (OR = 11.511), and thick, irregular-walled abscess (OR = 21.739).

IV. DISCUSSION

Our retrospective study of 65 patients with spondylodiscitis, including 23 cases caused by tuberculosis and 42 cases caused by pyogenic bacteria, found that the condition was more common in males than females across both etiological groups. The study confirmed the usefulness of MRI in differentiating between these two causes (Figures 1 and 2).

Among the eight MRI features of infectious spondylodiscitis, the most frequently observed diagnostic characteristics included: infection affecting both vertebrae and the intervertebral disc, extensive spread to the paraspinal soft tissues, epidural space involvement and formation of paraspinal and epidural abscesses.

Less common findings included posterior complex involvement and atypical presentations, such as isolated discitis without vertebral involvement or isolated spondylitis without disc involvement.

Our study aimed to identify MRI differences between TBSD and PSD. Among the 13 imaging characteristics analyzed, 7 showed statistically significant differences.

Consistent with previous studies [3,8-10], we found that the following features were strongly suggestive of TBSD: thoracic spine involvement, vertebral body height destruction >50%, intraosseous abscess formation, “cold” paraspinal abscesses with thin, smooth walls. Additionally, disc destruction was less frequent in TBSD.

In contrast, the following features were more indicative of PSD: lumbar spine involvement, paraspinal abscesses with thick, irregular walls.

The avascular nature of the adult intervertebral disc and the lack of proteolytic enzymes, along with the chronic progression of TB infection, may explain the relative preservation of the disc and the formation of cold abscesses with thin, smooth walls. Conversely, pyogenic infections typically follow an acute course, leading to the formation of “hot” abscesses with thick, irregular walls.

Unlike previous studies, we found that epidural abscesses were more frequently associated with PSD. Other features-including the number of affected vertebral levels, posterior complex involvement, epidural phlegmon, and intradiscal abscess formation-did not show significant differences between the two groups.

Among the distinguishing features, the most useful MRI findings for differentiating TBSD and PSD were:

1. Vertebral body height destruction >50%
2. Paraspinal abscesses with thin, smooth walls (suggesting TBSD)
3. Paraspinal abscesses with thick, irregular walls (suggesting PSD)

Our study has several limitations. It was retrospective with a relatively small sample size, and only one-third of cases were TB-related. Larger studies with a more balanced distribution between the two groups could provide a more accurate assessment of the diagnostic value of MRI in differentiating TBSD and PSD.

V. CONCLUSION

MRI imaging features that aid in diagnosing infectious spondylodiscitis include vertebral and disc involvement, paraspinal soft tissue or epidural space involvement, and the presence of paraspinal and epidural abscesses. MRI is a valuable tool for diagnosing infectious SD and differentiating TBSD from PSD.

Table 1. MRI Imaging Characteristics of Infectious Spondylodiscitis

Imaging Features	n (%)
Isolated vertebral involvement	11 (16.9)
Isolated disc involvement	0 (0)
Combined vertebral and disc involvement	56 (86.2)
Paraspinal soft tissue inflammation	65 (100)
Epidural inflammation	64 (98.6)
Paraspinal soft tissue abscess	58 (89.2)
Epidural abscess	44 (67.7)
Posterior complex involvement	21 (32.3)

Table 2. MRI Imaging Characteristics in Tuberculous and Pyogenic Spondylodiscitis

Location		Tuberculosis SD (n=23)	Pyogenic SD (n=42)	p-value
Cervical spine	Present	0 (0)	3 (7.1)	0.547
	Absent	23 (100)	39 (92.9)	
Thoracic spine	Present	12 (52.2)	5 (11.9)	0.000
	Absent	11 (47.8)	37 (88.1)	
Lumbar-sacral spine	Present	16 (69.6)	39 (92.9)	0.026
	Absent	7 (30.4)	3 (7.1)	

Table 3. MRI Imaging Characteristics in Tuberculous and Pyogenic Spondylodiscitis

MRI findings		Tuberculosis SD (n=23)	Pyogenic SD (n=42)	p-value
Number of affected vertebral levels	1	15 (65.2)	32 (76.2)	0.344
	≥ 2	8 (34.8)	10 (23.8)	
Degree of vertebral destruction	≤ 50%	15 (65.2)	41 (97.6)	0.001
	> 50%	8 (34.8)	1 (2.4)	
Intraspinal abscess	Present	17 (73.9)	16 (38.1)	0.006
	Absent	6 (26.1)	26 (61.9)	
Disc involvement	Present	14 (60.9)	40 (95.2)	0.001
	Absent	9 (39.1)	2 (4.8)	
Intravertebral disc abscess	Present	9 (39.1)	16 (38.1)	0.935
	Absent	14 (60.9)	26 (62.9)	
Paravertebral abscess	Present	19 (82.6)	39 (92.9)	0.233
	Absent	4 (17.4)	3 (7.1)	
Thin-walled, smooth abscess	Present	14 (60.9)	5 (11.9)	0.000
	Absent	9 (39.1)	37 (88.1)	
Thick-walled, irregular abscess	Present	5 (21.7)	36 (85.7)	0.000
	Absent	18 (78.3)	6 (14.3)	
Epidural phlegmon	Present	22 (95.7)	42 (100)	0.354
	Absent	1 (4.3)	0 (0)	
Epidural abscess	Present	9 (39.1)	35 (83.3)	0.000
	Absent	14 (60.9)	7 (26.7)	
Posterior complex involvement	Present	10 (43.5)	11 (26.2)	0.154
	Absent	13 (56.5)	31 (73.8)	

Table 3. Logistic regression analysis

Independent Variable	p-value	Significant Odds Ratio (OR)
Thoracic spine involvement	0.000	8.073
Lumbar-sacral spine involvement	0.026	5.681
Vertebral destruction > 50%	0.001	21.867
Disc preservation	0.001	8.217
Intraspinal abscess	0.006	4.604
Epidural abscess	0.000	7.752
Thin-walled, smooth abscess	0.000	11.511
Thick-walled, irregular abscess	0.000	21.739

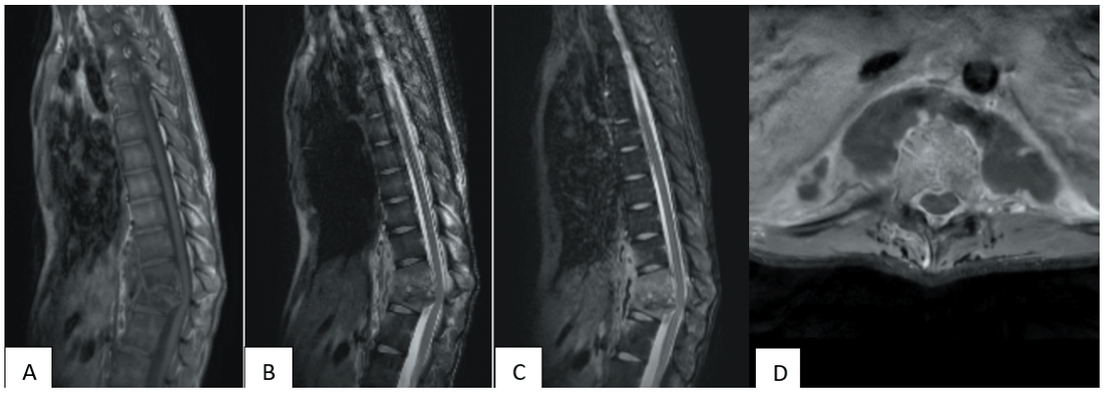

Figure 1. A 20-year-old male patient with tuberculous spondylodiscitis. *A. T1-weighted sagittal image shows heterogeneous hypointensity in vertebrae D10-L1, with more than 50% destruction of the D12 vertebral body, posterior wall protrusion, and spinal canal compression at the D12 level. B. T2-weighted sagittal image reveals heterogeneous hyperintensity in vertebrae D10-L1. C, D. Post-contrast T1-weighted images show epidural and paraspinal abscesses with thin, smooth walls.*

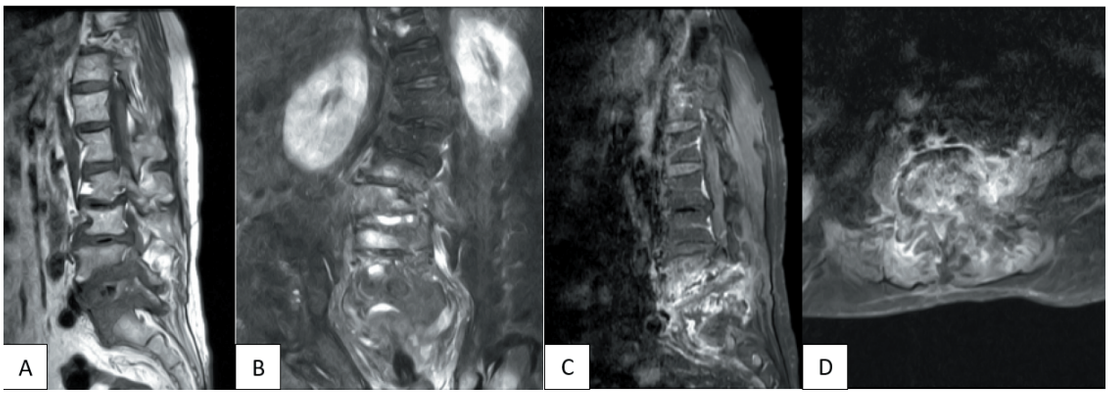

Figure 2. A 65-year-old female patient with pyogenic spondylodiscitis. *A.T1-weighted sagittal image shows hypointensity in vertebrae L4-S1 and the L5-S1 intervertebral disc. B. STIR coronal image reveals hyperintensity in the affected vertebrae and intervertebral discs. C, D. Post-contrast T1-weighted images show diffuse enhancement of the L4-S1 vertebral bodies and the L5-S1 intervertebral disc, with extensive spread to the surrounding soft tissues, forming epidural and soft tissue abscesses with thick, irregular walls.*

REFERENCES

1. Zimmerli, W. Clinical Practice. Vertebral Osteomyelitis. *N. Engl. J. Med.* 2010, *362* (11), 1022–1029. https://doi.org/10.1056/NEJMcp0910753.
2. Kumar, Y.; Gupta, N.; Chhabra, A.; Fukuda, T.; Soni, N.; Hayashi, D. Magnetic Resonance Imaging of Bacterial and Tuberculous Spondylodiscitis with Associated Complications and Non-Infectious Spinal Pathology Mimicking Infections: A Pictorial Review. *BMC Musculoskelet. Disord.* 2017, *18* (1), 244. https://doi.org/10.1186/s12891-017-1608-z.
3. Jung, N.-Y.; Jee, W.-H.; Ha, K.-Y.; Park, C.-K.; Byun, J.-Y. Discrimination of Tuberculous Spondylitis from Pyogenic Spondylitis on MRI. *AJR Am. J. Roentgenol.* 2004, *182* (6), 1405–1410. https://doi.org/10.2214/ajr.182.6.1821405.
4. *CT-Guided Biopsy in Suspected Spondylodiscitis – The Association of Paravertebral Inflammation with Microbial Pathogen Detection - PMC*. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4699662/ (accessed 2023-07-31).
5. *The Efficacy of Computed Tomography-Guided Percutaneous Spine Biopsies in Determining a Causative Organism in Cases of Suspected Infection: A Systematic Review - Madeleine Sertic, Leighanne Parkes, Sabrina Mattiassi, Kenneth Pritzker, Michael Gardam, Kieran Murphy, 2019*. https://journals.sagepub.com/doi/full/10.1016/j.carj.2018.09.003 (accessed 2023-07-31).
6. Ahuja, N.; Sharma, H. The Effectiveness of Computed Tomography-Guided Biopsy for the Diagnosis of Spondylodiscitis: An Analysis of Variables Affecting the Outcome. *Eur. Rev. Med. Pharmacol. Sci.* 2017, *21* (9), 2021–2026.
7. Kim, C.-J.; Kim, E. J.; Song, K.-H.; Choe, P. G.; Park, W. B.; Bang, J. H.; Kim, E. S.; Park, S. W.; Kim, H.-B.; Oh, M.; Kim, N. J. Comparison of Characteristics of Culture-Negative Pyogenic Spondylitis and Tuberculous Spondylitis: A Retrospective Study. *BMC Infect. Dis.* 2016, *16* (1), 560. https://doi.org/10.1186/s12879-016-1897-0.
8. Chang, M.-C.; Wu, H. T. H.; Lee, C.-H.; Liu, C.-L.; Chen, T.-H. Tuberculous Spondylitis and Pyogenic Spondylitis: Comparative Magnetic Resonance Imaging Features. *Spine* 2006, *31* (7), 782–788. https://doi.org/10.1097/01.brs.0000206385.11684.d5.
9. Harada, Y.; Tokuda, O.; Matsunaga, N. Magnetic Resonance Imaging Characteristics of Tuberculous Spondylitis vs. Pyogenic Spondylitis. *Clin. Imaging* 2008, *32* (4), 303–309. https://doi.org/10.1016/j.clinimag.2007.03.015.
10. Frel, M.; Białecki, J.; Wieczorek, J.; Paluch, Ł.; Dąbrowska-Thing, A.; Walecki, J. Magnetic Resonance Imaging in Differentatial Diagnosis of Pyogenic Spondylodiscitis and Tuberculous Spondylodiscitis. *Pol. J. Radiol.* 2017, *82*, 71–87. https://doi.org/10.12659/PJR.899606.

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