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Spinal Tuberculosis: Spectrum of MR Findings with Laboratory Evaluation

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ABSTRACT

Background: Tuberculosis infections are endemic diseases in Asian countries. Although the incidence is rare, tuberculous spondylitis manifests as a severe and life-threatening disease. This study aims to correlate the abnormal result of erythrocyte sedimentation rate (ESR) and magnetic resonance (MR) imaging findings.
Subjects and Method: MR imaging of 60 patients with characteristics of spinal tuberculosis in 4-year 5 month period (January 2019 – May 2023) from Siloam Lippo Village is retrospectively analyzed and reviewed. Data were collected from Infinitt PACS and analyzed by SPSS. Dependent variables in this study are clinical suspicion for tuberculosis infection, erythrocyte sedimentation rate (ESR), and tuberculosis infection in different organs. Meanwhile, the independent variables in this study are multilevel vertebral involvement, multilevel disc involvement, abscess formation, and myelopathy.
Results: Association with elevated ESR (erytrocyte sedymentation rate) are seen in 11 out of 31 patients aged >40 (OR=0.45; CI 95%= 0.16 to 1.26; p=0.120), 19 out of 37 patients with clinically suspected for tuberculosis infection (OR=1.98; CI 95% 0.68 to 5.78; p=0.210); 27 out of 55 patients with multilevel vertebral body involvement (OR=0.8; CI 95%= 0.12 to 5.17); p=1); 13 out of 30 patients with intervertebral disc involvement (OR=0.87; CI 95% 0.32 –to2.42); p=0.8); 20 out of 50 patients with abscess formation(OR=0.29; CI 95%=0.66 to 1.24; p=0.08); 5 out of 12 patients with tuberculosis infection on other organs(OR=0.84; CI 95%=0.24 – 3.04; p=0.8); and 5 out of 6 patients with myelopathy(OR=7.3; CI95%=0.79 TO 66.6; p=0.04).
Conclusion: MR has an important role in detecting extrapulmonary tuberculosis lesions, especially in the spine. Elevated ESR results play important roles for physicians in identifying patients with the possibility of spondylitis TB.

Keywords: Tuberculosis, tuberculous spondylitis, ESR, MR.

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BACKGROUND

Tuberculosis (TB) involves both pulmonary and extrapulmonary sites, Tuberculous spondylitis (TS) is one of the common causes of spinal infection (Lee, 2014). The first case of spinal TB was described in 1779

by an English surgeon Percival Pott (1714-1788) (Momjian and George, 2014). It is important to differentiate tuberculous spondylitis from other spondylitis, because proper treatment for the disease may reduce the rate of disability and functional impairment clinically and radiologically (Lee, 2014).

Approximately 8 million TB cases have been identified worldwide, which have resulted in 2 million deaths (Moon, 2014). TS is the most common as well as the most dangerous form of musculoskeletal TB and accounts for 50% of all cases of skeletal TB, any part of the spine can be affected but the thoraco-lumbar junction is the most common site of involvement (Momjian and George, 2014).

The onset of spinal TB is insidious, typically progressing over four to 11 months. Back pain is the most common symptom.5 Constitutional symptoms such as fever, weight loss, and night sweats were present in approximately 40% of the cases.6 Spine deformities and neurological deficits are the worst complications of tuberculous spondylitis (Lacerda et al., 2017).

The definitive diagnosis of spinal spondylitis can only be made from microscopic or bacteriological examination and culture of the infected tissue, in TS, culture-positive rates of tissues are between 50 and 70 % but the results are only reported more than 3 weeks (Kim et al., 2016).

Magnetic Resonance Imaging (MRI) is considered to be the imaging modality of choice as it not only demonstrates the bony involvement but also the associated complications such as pre-, paravertebral, and epidural abscesses and cord edema (Maurya et al., 2018). MRI provides high-resolution images of the bone and soft tissues that can be clearly distinguished. Next, MRI can visualize the entire spine and differentiate between individual structures, such as the vertebral body, intervertebral discs, spinal canals, posterior elements, ligaments, paravertebral muscles, nerve roots, and spinal cord. The routine protocol for MRI of the spine includes axial and sagittal T1- and T2-weighted images. Additional sequences, such as sagittal T2 sequences with fat suppression (e.g., short tau inversion recovery [STIR]) and contrast-enhanced T1 sequences, can be added as required (Kim et al., 2020)

In TS, the commonly affected vertebrae were Lumbar vertebrae, Contiguous two vertebral involvement and intervertebral disc involvement was the most common pattern. Involvement of epidural soft tissue components may lead to cord edema or compression (Maurya et al., 2018). Pre and paravertebral soft tissue components in TS can be solid in cases of granulomatous inflammation or can be cystic collection due to abscess formation, T2W/ STIR images to demonstrate the collection easily but a caseating paravertebral soft tissue component is best demonstrated on post-contrast T1W fat sat images. Psoas abscess is a complication of tubercular spondylitis which occurs due to tracking of pre or paravertebral abscess along the Psoas muscle. It is seen as a hypointense lesion on T1W images and as a hyperintense collection on T2W/ STIR images. But the best way to demonstrate a Psoas abscess is post contrast T1W fatsat sequence which shows the abscess as a central non-enhancing area with peripheral wall enhancement (Maurya et al., 2018). Radiculomyelitis is a common manifestation of TS in high TB/HIV prevalence settings, frequent findings by MRI in these patients include subdural abscess and intramedullary tuberculoma.

Single vertebral and skip lesions are atypical presentations of the TS. Skip lesions or noncontiguous vertebral tuberculosis occur due to hematogenous spread through

the vertebral venous system that spreads the infection to multiple vertebrae. Another rare case is Craniovertebral junction tuberculosis which accounts for 0.3 to 1% of all TS cases. MRI is used to differentiate Craniovertebral junction tuberculosis from other lesions affecting the craniovertebral junction (Megaloikonomus et al., 2016).

TB causes profound bone marrow and peripheral blood abnormalities by interfering with normal hematopoiesis and is associated with peripheral blood abnormalities such as anemia, increased Erythrocyte sedimentation rate (ESR), and leucocytosis (Firdaus et al., 2020). The ESR is deemed a useful indicators by many clinicians in understanding infectious conditions including spondylitis (Lee et al., 2018). The usefulness of routine monitoring of ESR during treatment in TS has been reported. In TS, ESR elevation at the time of diagnosis is common. Previous studies reported that ESR tended to decrease after the initiation of treatment for TS. ESR and treatment tended to remain higher in patients with unfavorable outcomes than those in patients with favorable outcomes, and the trend for ESR was statistically significant (Kim et al., 2019).

Another challenging issue is differentiating TS from pyogenic spondylitis (PS) which is usually difficult, although there are many previous claims that some features may be helpful. ESR and CRP levels were significantly higher in the patients with PS than TS.1 TS has reported that abscess involves uniquely multiple vertebral bodies, especially in gadolinium-enhanced MRIs. Destruction of vertebral bodies in TS entails more of such contrast enhancement. It is assumed that abscess is formed more and also available to be used for beneficial indices when performing a differential diagnosis. Epidural extension and epidural abscess formation have been reported to be observed more in TS.1 Paraspinal abscess is frequently found in PS; but well-defined paraspinal abnormal signal, thin and smooth abscess wall, and presence of paraspinal or intraspinal abscess are more suggestive of TS than of PS, if the wall of the abscess is relatively thick entailing irregular contrast enhancement, it has been reported to be implying PS.1 Vertebral body was damaged more severely in TS than in PS because of the lack of proteolytic enzymes in Mycobacterium as compared with agents of pyogenic infection has been proposed as the cause of the relatively preserved intervertebral disc, found totally sequestered within the involved vertebrae (Lee, 2014).

The aim of treatment in TS is to eradicate the infection, restore and preserve the structure and function of the spine, and alleviate pain. Another issue is TS in children results in bone loss as well as disturbed growth potential, hence spinal deformities may progress as the child grows. There is a lot of effort should be made to avoid vertebral damage by diagnosing TB early before severe damage occurs and these patients should be followed until skeletal maturity to carefully monitor the effect of growth on spinal deformity (Jain et al., 2014).

The Objective of this study is to find a correlation between elevated erythrocyte sedimentation rate in patients with tuberculous spondylitis, the correlation between elevated erythrocyte sedimentation rate with multilevel vertebral body and intervertebral disc lesion in patients with tuberculous spondylitis, correlation between elevated erythrocytes sedimentation rate with paravertebral abscess in patient with tuberculous spondylitis and correlation between elevated erythrocytes sedimentation rate with myelopathy in patient with tuberculous spondylitis.

SUBJECTS AND METHOD

1. Study design

Study design: descriptive: Cross-Sectional
Study site: Siloam Hospital Lippo Village, Indonesia

2. Population and Sample

The subjects of the study are spinal tuberculous patients who are retrieved from Infinitt Software(PACS r

3. Study Variables

Dependent variables in this study are clinical suspicion of tuberculosis infection, erythrocyte sedimentation rate (ESR), and tuberculosis infection in different organs. Meanwhile, the independent variables in this study are multilevel vertebral involvement, multilevel disc involvement, abscess formation, and myelopathy. Inclusion criteria are any patient with or without clinical suspicion of tuberculous spondylitis and had MR finding characteristics of tuberculous spondylitis that also undergone ESR laboratory examination. Exclusion criteria are patients who have not undergone MR and ESR examination at the same time interval.

4. Operational Definition of Variables

Clinical suspicion for tuberculosis infection: as described by clinician doctors

Erythrocyte sedimentation rate (ESR): a blood test that shows ongoing inflammation. Normal values for the ESR, as derived using the Westergen method, are as follows:

Male <= 15 mm/hr.
Female <=20 mm/hr.
Child <=10 mm/hr.

Tuberculosis infection on different organs: co-existing tuberculosis infection on extra-spinal location.

Multilevel vertebral involvement: tuberculosis infection on more than 1 vertebra body.

Multilevel disc involvement: tuberculosis infection on more than 1 intervertebral disc.

Abscess formation: soft tissue necrotic fluid collection adjacent to infection.

Myelopathy: Spinal cord inflammation related to infection condition.

5. Study Instruments

Spinal tuberculosis reported by Siloam Hospital Lippo Village radiologist Infinitt application PACS(Picture Archiving And Communication System).

Laboratory findings and clinical descriptions obtained from medical records.

6. Data analysis

Association with ESR result elevation between variables were analyzed categorically with 2x2 tables with the chi-square method which calculates Odds Ratio, P-Value, and Confidence Interval (Age < 40 and >40; clinical suspicion of spinal tuberculosis; multilevel vertebral body involvement; multilevel intervertebral disc involvement; abscesses formation; other organ involvement; and myelopathy).

7. Research Ethics

Research ethical issues including informed consent, anonymity, and confidentiality, were addressed carefully during the study process. The research ethical clearance approval letter was obtained from The Ethics Committee of the Faculty of Medicine, Pelita Harapan University, NO:087/K-LKJ/ETIK/II/2024.t

RESULTS

1. Sample Characteristics

Mean of age of sample was 40.61 years old (SD= 17.45), with the youngest age was 9 years old and the oldest was 68 years old.

Table 1. Descriptive analysis of sample characteristics

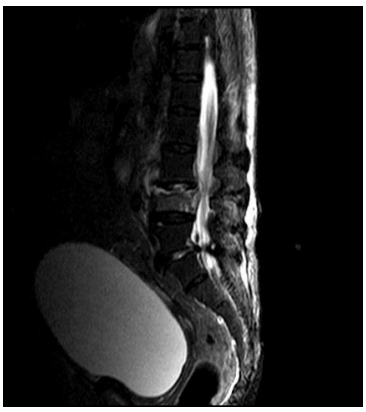
Patients Clinical Descriptions	n	%
Clinical Features		
Neck and or back pain	20	33.40%
Previously diagnosed tuberculous spondylitis	12	20%
suspected tuberculous spondylitis	10	16.70%
Suspected herniated nucleus pulposus	8	13.40%
Paraplegia/paraparesis	3	5%
Fracture	2	3.40%
Kyphosis	2	3.40%
Scoliosis	2	3.40%
Suspected spinal tumor	1	1.67%
MR Findings Of Vertebral Lesion Location		
Vertebral involvement		
Cervical	1	1.67%
Thoracal	20	33.30%
Lumbar	22	36.70%
Cervical and thoracal	1	1.67%
Thoracal and lumbar	8	13.30%
Lumbar and sacral	5	8.40%
Cervical, lumbar, and sacral	1	1.67%
Cervical, thoracal, lumbar, and sacral	1	1.67%
Extra Spinal TB Location		
Vertebral abnormality		
Destruction	37	61.6%
Erosion	6	10%
Erosion and compression fracture	2	3.40%
Destruction and compression fracture	3	5%
Destruction and edema	10	16.7%
Collapsed vertebral body	1	1.67%
Pathologic intensity lesion	1	1.67%
Intervertebral disc abnormality		
Intervertebral disc abnormality (destruction)	30	50%
Extra spinal tuberculosis		
Lung	7	11.67%
Meninges	2	3.40%
Lung + meninges	1	1.67%
Neck lymph nodes	2	3.40%
Follow-up MR		
Improvement	8	53%
Inclement	5	33%
Status quo	2	13%

2. Bivariate Analysis

Table 2. Bivariate analysis of factors related with elevated erythrocyte sedimentation rate

Variable	Elevated Erythrocyte Sedimentation Rate				OR	p
	No		Yes			
	N	%	N	%		
Age						
<40 years old	13	67.4	20	32.6	0.45	0.120
≥40 years old	16	81.5	11	18.5		
Clinically Suspected For TB Infection						
No	15	86.5	18	13.5	1.98	0.210
Yes	8	65.8	19	34.2		
Multilevel Vertebral Involvement						
No	5	85.1	28	14.9	0.8	0.100
Yes	0	67.3	27	32.7		
Multilevel Disc Involvement						
No	16	79.2	17	20.8	0.87	0.800
Yes	14	70.7	13	29.3		
Abscess Formation						
No	3	79.2	30	20.8	0.29	0.080
Yes	7	70.7	20	29.3		
Myelopathy						
No	32	79.2	1	20.8	7.3	0.040
Yes	22	70.7	5	29.3		
Tuberculosis Infection On Different Organ						
No	26	79.2	7	20.8	0.84	0.800
Yes	22	70.7	5	29.3		

a



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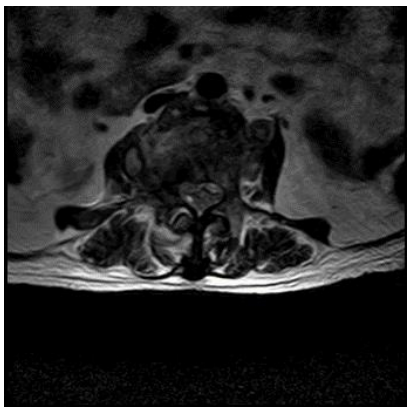

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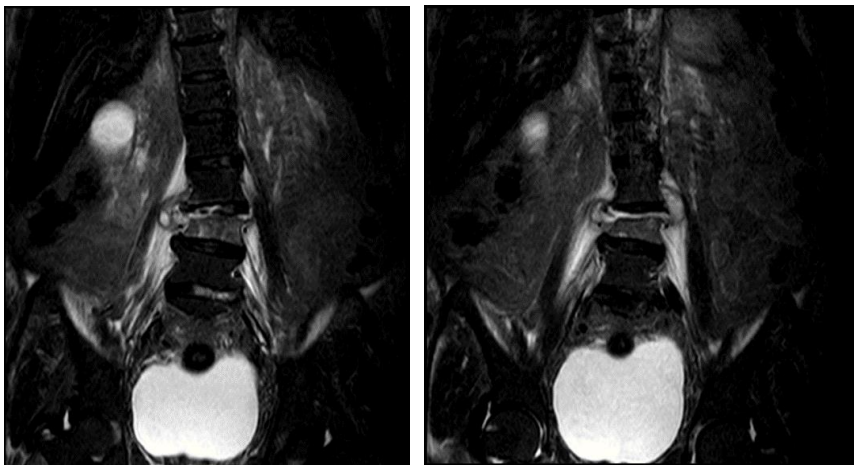
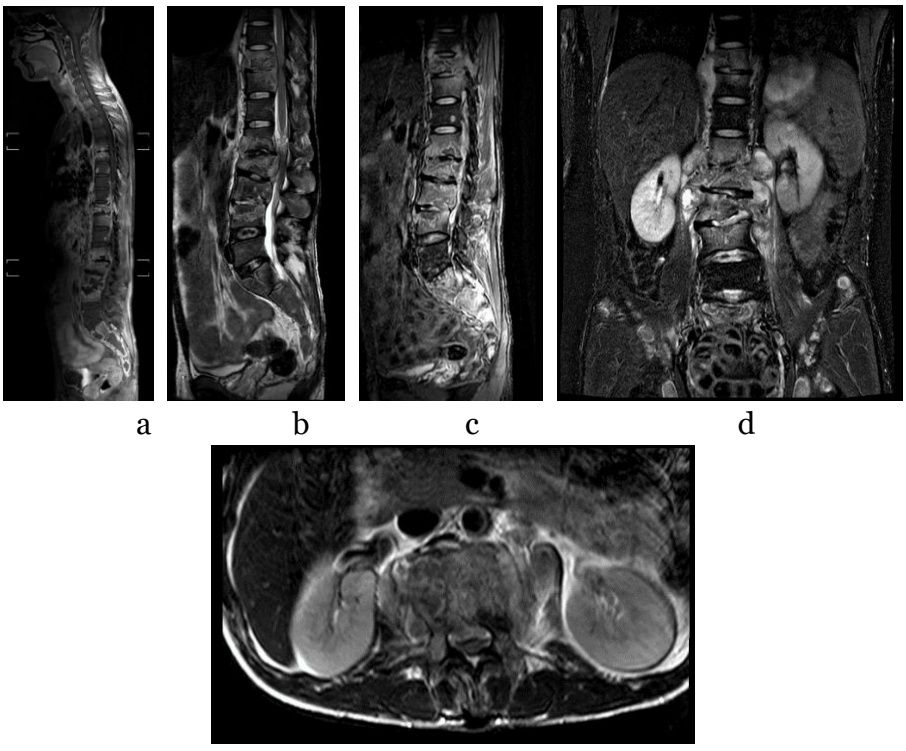


d e

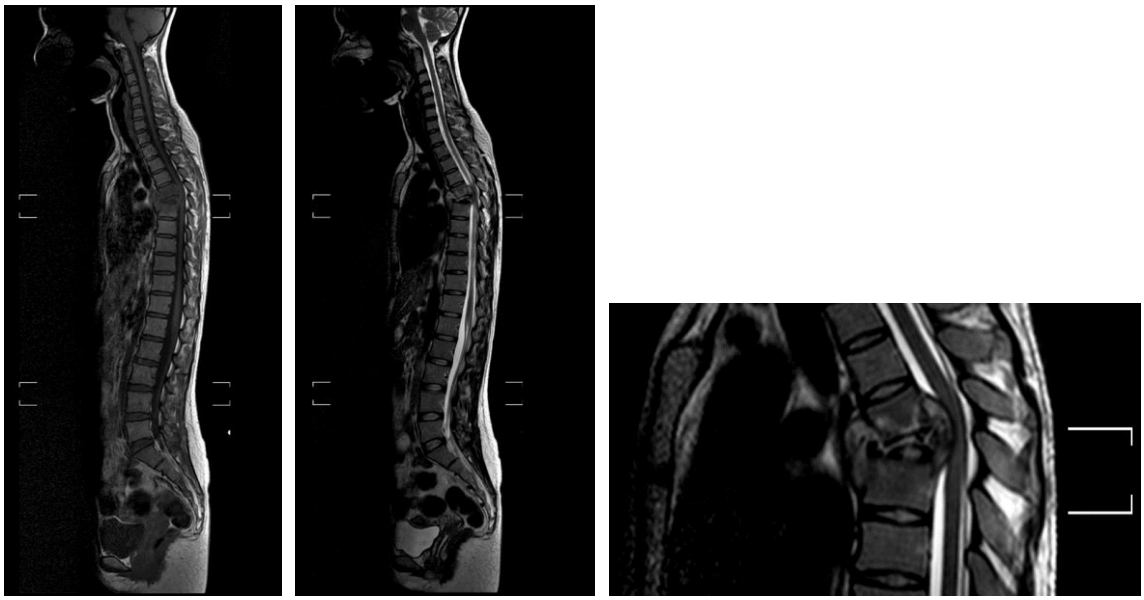
Fig 1. Classic findings of tuberculous spondylitis. (a,b,c,d). T2-weighted, STIR weighted showed L4 vertebral destruction and lesion at the intervertebral L3-L4 disc. (e). STIR weighted shows paravertebral and bilateral musculus psoas abscess.



a b c d

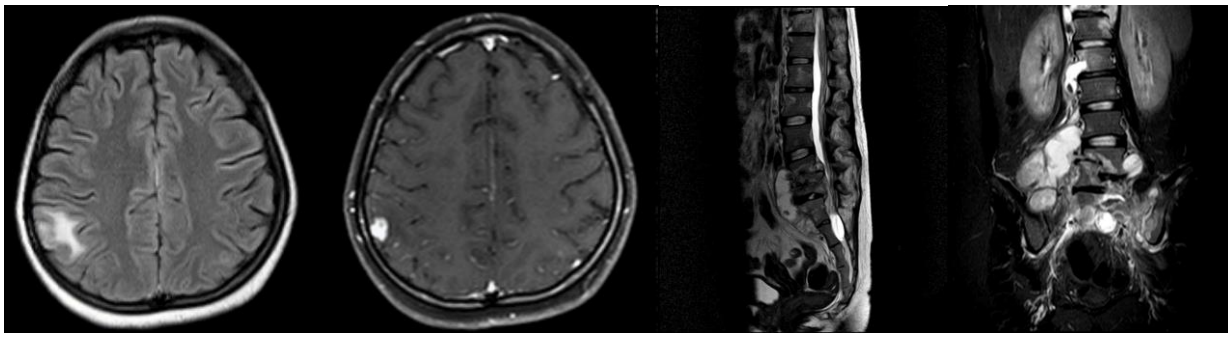
e

Figure 2. Tuberculous spondylitis lesions spread in multiple vertebrae levels. (a,b,c,d,e) T1w fat sat weighted, e STIR weighted, e T2 weighted, e STIR tse Weighted, T2 weighted showed destruction of vertebral pedicle bodies, articular processes, and transverse processes T5-T6, T10-T11, and L1-L4, involving T10-T11, L1-L2, and L3-L4 intervertebral discs, with bilateral psoas abscess formation.



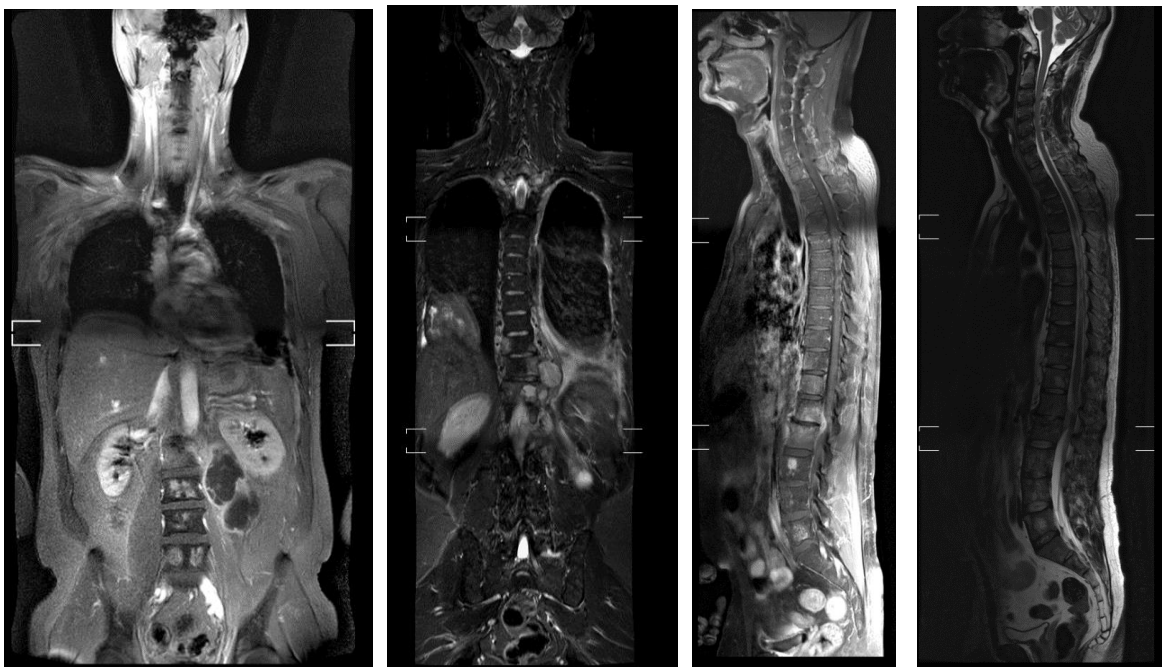
a b c

Figure 3. A 23-year-old female patient presented with paraplegia. (a) T1 weighted and (b,c) T2 weighted showed destruction of the T5-T7 corpus and endplates of the T5-T7 bodies (especially collapse of the T6 bodies) that forms the gibbous and involves the T5-T6 and T6-T7 discs with paravertebral abscesses. Spinal cord myelopathy as high as T5-T6.



a b c d

Figure 4. Tuberculous spondylitis patient with coexisting extra spinal tuberculosis. (a,b). MR Head with IV Contrast showed multiple contrast-enhancing lesions in the cortical-subcortical right parietal lobe, with perifocal edema suggesting tuberculoma. (c,d). Non-contrast lumbal MR suggesting L5 vertebral body destruction with L4-S1 edema with L4-L5 spondylolisthesis and posterior paravertebral infiltrate involving right L4 root, left L5 root, and left S1 root.



a b c d

Figure 5. Tuberculous spondylitis coexisting tuberculous empyema. (a,b) MT sequence, STIR weighted showed split pleura sign on right hemithorax. (c,d) T1 weighted, T2 weighted showed multifocal tuberculous spondylodiscitis

DISCUSSION

We found that tuberculous spondylitis is most prevalent in adults (aged >40), and other studies found a similar mean age of patients was 43.9 ± 16.9 years (Gupta et al., 2022). Although tuberculosis is endemic in Indonesia, we found tuberculous spondylitis is a rare manifestation of extraspinal infection site, compared to other studies that mentioned that TS accounts for less than 1% of total tuberculosis cases.

Low back pain are nonspecific clinical manifestation of tuberculous spondylitis that can often be misdiagnosed, some patients may lack clinical symptoms even in the presence of active spinal disease, and Constitutional symptoms present in only 20%-30% of cases (Dean et al., 2019), as in our study up to 53 % patient are had no suspicion of tuberculous spondylitis.

Diagnosing tuberculosis remains a challenge in clinical practice. The majority of patients in our study have only tuberculosis in the spinal system (no pulmonary tuberculosis). A study by Bordman et al. (2021) reported that among patients identified with TB disease, 79.2% were asymptomatic at the time of diagnosis.

ESR (erythrocyte sedimentation rate) is a valuable diagnostic marker for evaluating inflammation in the body, often associated with conditions such as infections (Pelagalli et al., 2023). As in a comparison study, up to 67 of 126 patients with tuberculosis with favorable outcomes had elevated ESR. The ESR is the basic laboratory test and is widely available (Kim et al., 2019). The ESR is commonly done as a nonspecific test during the initial diagnostic workup for TB, which is a chronic bacterial infection, Making ESR a simple yet useful laboratory marker in suspecting tuberculous spondylitis before imaging (Mandal, 2016).

Most of the patient in this study has multilevel vertebral body and intervertebral

disc involvement (93 % and 8, respectively). Another study also reported contiguous two vertebral involvement and intervertebral disc involvement was the most common pattern in tuberculous spondylitis (Maurya et al., 2018). This may help to differentiate from pyogenic spondylitis which usually has less than 3 vertebral disc involvement (Lee, 2014). The broad impact of tuberculosis on the spinal system, puts patients at risk of developing complications such as abscesses (69%), neurologic deficits (40%), spinal instability (21%), and spinal deformity (16%) (Batirel et al., 2015)

There are limitations to this study, The subjects of our study have no information on previous tuberculosis laboratory examinations like sputum analysis, IGRA, or serology. Most of the patients of tuberculous spondylitis were found "incidentally" (Jung et al., 2022). And based on other studies up to 48.6% of patients with confirmed TB disease had negative sputum cultures (Bordman et al., 2021)

In conclusion, Laboratory tests and imaging have an inseparable role in diagnosing tuberculous spondylitis. As in this study, spinal MRI has the superiority of depicting tuberculous lesions on the spinal system, and ESR had a great sensitivity to inflammatory conditions. Outside that, we also are more vigilant with patient history taking and recognizing clinical features. This the importance of addressing tuberculous spondylitis in early stages may prevent patients from developing further disabilities and even life-saving.

AUTHOTS CONTRIBUTIONS

All authors contributed to the writing of this article.

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CONFLICT OF INTEREST

There are no conflicts of interest

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