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Pediatric tuberculous spondylitis – A study of the relationship of neurological status to different variables at tertiary centers in a developing country

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ABSTRACT

Objectives: Tuberculous spondylitis constitutes 50% of all tuberculosis (TB) cases involving the bones and remains a significant problem in developing countries. If not adequately managed, spinal TB can lead to complications and comorbidities for patients with high burdens, especially in young patients. This study aimed to determine patients' profiles and the relationship between complications, morbidity, and nutritional status in pediatric TB spondylitis patients.

Methods: This analytical descriptive study was conducted at three hospitals in Indonesia. The study involved 142 pediatric TB spondylitis patients aged 0–18 from January 2018 to June 2023.

Results: The majority of patients were female and between 9 and 18 years old. Most patients had good nutritional status and presented with neurologic deficits. Septic shock and respiratory failure were significantly associated with neurological deficits, as were pressure ulcers.

Conclusion: The investigation yielded a single correlation between the deficit neurological condition and certain comorbidities, including gibbus and ulcerated decubitus. However, no statistically significant correlation between deficit neurological conditions and nutritional status was identified.

Keywords: Malnutrition, Neurologic deficit, Patient profiles, Pediatrics, Spinal tuberculosis

INTRODUCTION

Tuberculosis (TB) is a major problem in various countries, especially in developing nations like Indonesia. TB causes 1.8 million deaths worldwide.[1] Out of the many new TB cases globally, 1 million occur in children under 15 years of age. Among all pediatric TB cases, 75% are found in 22 high-burden countries. The incidence of extrapulmonary TB is 3% globally, with 10% of those being TB of the bones. Spinal TB accounts for 50% of all bone TB cases. If not adequately managed, spinal TB can lead to the destruction of the vertebral bodies, posterior elements of the spine, and pars interarticularis, ultimately resulting in deformity, spondylolisthesis, and paraplegia.[2] In children and adolescents, from 2013 to 2017, there were 149 recorded TB patients, with 26%

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of them being diagnosed with extrapulmonary TB based on symptoms supported by radiography findings. For cases of TB spondylitis, data show that there were 521 patient visits for treatment at Dr. Soetomo General Academic Hospital, Dr. Ramelan Naval Central Hospital, and Dr. Saiful Anwar General Hospital from 2017 to 2021.[3] Despite this high number of visits, in-depth and detailed research regarding its epidemiology is lacking.

TB spondylitis cases are mostly found at the complication stage due to the lack of an early detection system and awareness of the dangers of these cases, which are preventable. Early and accurate diagnosis is vital to circumvent superfluous diagnostic procedures, complications, and therapeutic interventions. The hypothesis was that neurological deficits are associated with several other factors, including comorbidities, complications, nutritional status, and mortality. A decline in the immune system results from TB infection in children. Nutritional status is a contributing factor, as it influences the body's antibody and lymphocyte formation in response to invading germs. This, in turn, affects the body's ability to combat infection, leading to complications and the emergence of other comorbidities. In severe cases, it can even result in death. As a developing country, Indonesia faces unique challenges in healthcare. In light of the various health complexities, facilities, social status, and nutritional status of patients, this study hopes to contribute to the ongoing efforts to improve the quality of care for patients with TB spondylitis. This data can serve as a reference for developing better programs for managing and treating pediatric TB spondylitis.[4] The visible cases represent only a small portion of the true extent of the problem, with many more cases likely going undetected or untreated. This study aimed to gain a deeper understanding of the profile of patients with TB spondylitis and to explore the potential correlation between complications and nutritional status in a tertiary care hospital in Indonesia. This highlights the urgent need for increased awareness, early detection, and proactive management strategies to address TB spondylitis effectively and prevent its devastating consequences.

MATERIALS AND METHODS

Study design

This study is a descriptive-analytic study involving pediatric TB spondylitis patients. It was conducted at three tertiary hospitals, Dr. Soetomo General Academic Hospital, Dr. Ramelan Naval Central Hospital, and Dr. Saiful Anwar General Hospital, Indonesia. Sampling was done using a universal sampling technique involving all pediatric TB spondylitis patients from January 2018 to June 2023. The inclusion criteria were patients diagnosed with TB spondylitis aged 0–18 years based on history taking, physical examination, and supporting investigations documented in the medical records of Dr. Soetomo General Academic Hospital, Dr. Ramelan Naval Central Hospital, and Dr. Saiful Anwar General Hospital The exclusion criteria were patients with symptoms resembling spinal TB who have other congenital spinal abnormalities and incomplete medical records.

Patient profiles were collected based on age, sex, nutritional status, diagnostic basis, and anti-TB drug use. Neurological deficits were evaluated according to the Frankel scoring system from A to E. Nutritional status was assessed based on the standard deviation calculated from the CDC 2000 growth curve.[5,6] Morbidity in this study was defined as a description of clinical symptoms experienced by individuals before the TB diagnosis, while complications were clinical manifestations experienced by individuals after the TB spine diagnosis. Morbidity and complications were measured as the percentage of the number of events per total TB spondylitis cases.

Statistics

Descriptive studies were conducted to analyze the profile of pediatric TB spondylitis patients. Statistical analysis was performed using the Statistical Package for the Social Sciences version 25.0. Normality tests were conducted using the Kolmogorov–Smirnov test. The analysis of each variable utilized the Kruskal–Wallis test to determine the relationship between neurological deficits (Frankel) and nutritional status, complications, comorbidities, and mortality. The significance level was defined as $P < 0.05$.

RESULTS

Demographically, the sex distribution shows that most patients were females (77 patients, 54.2%). Regarding age categories, most patients were within the range of 9–18 years old [Table 1].

Undernutrition was present in 6.3% of patients, while patients with good nutritional status have the highest prevalence at 60.1%. Pulmonary TB was the most common comorbidity (46.1%), followed by anemia at 11.7%. The most common complications are gibbus formation in 46.9% of patients, decubitus ulcers in 42.2%, and paraparesis in 66.2%.

There are five categories of neurological deficits, ranging from Frankel A to Frankel E. Frankel A accounts for approximately 4.9% of the total sample, indicating the most severe neurological deficit, while Frankel E represents 33.8% of the sample. The other categories are Frankel B (12%), Frankel C (26.10%), and Frankel D (23.2%). These results provide a detailed overview of the distribution of neurological deficits within the study sample, serving as a basis for further analysis and research regarding neurological conditions in the studied population. The location of TB spondylitis infection is nearly equal between the lumbar (48.3%) and thoracic (44.1%)

Table 1: Patients' demographics and profile.

Patient characteristic	*n*	Percentage
Sex		
Males	65	45.80
Females	77	54.20
Age		
1–8 years old	40	28.20
9–18 years old	102	71.80
Nutritional status (based on CDC 2000[6])		
Undernutrition	9	6.3
Good nutrition	86	60.1
Overweight	41	28.7
Obesity	7	4.9
Comorbidity		
Anemia	17	11.72
Malnutrition	4	2.72
Organic mental disorder	1	0.68
Pulmonary tuberculosis	78	53.7
Under immunization	1	0.68
Neurofibroma	1	0.68
Acute lymphoblastic leukemia	1	0.68
Septic shock	1	0.68
Pleural effusion	2	1.37
Hydrocephalus	1	0.68
Epilepsy	1	0.68
Respiratory failure	1	0.68
None	36	24.8
Complication		
Gibbus	30	46.87
Decubital ulcers	27	42.18
Pathological fracture	1	1.56
Neurological deficits		
Frankel A	7	4.90
Frankel B	17	12
Frankel C	37	26.10
Frankel D	33	23.20
Frankel E	48	33.80
Vertebral site		
Lumbosacral	11	7.7
Thoracic	63	44.1
Lumbar	69	48.3
Tuberculosis score		
<6	104	73.20
≥6	38	26.80
C-reactive protein		
Yes	111	78.20
No	31	21.80
Magnetic resonance imaging examination		
Done	51	42.50
Not yet (on waiting List)	69	57.50
Mantoux test		
Done	39	27.50
No	103	72.50
Anti-tuberculosis therapy		
Completed	124	87.30
Discontinue	18	12.70
Action		
Operative	49	34.50
Non-operative	93	65.50
Mortality	6	4.20

(*Contd*...)

regions, while the remaining percentage is in the lumbosacral region.

A total of 73.2% of patients have a TB score ≥6, while 26.8% have a TB score ≥6. Diagnostic examinations were analyzed, including C-reactive protein (CRP) testing, which was conducted in most patients (78.20%). About 30.6% of patients had CRP levels exceeding 10. Magnetic resonance imaging (MRI) examinations are crucial for diagnosing spinal changes, identifying lesions, assessing disease severity, and guiding treatment planning. These examinations were performed on 42.5% of patients. In comparison, the remaining 57.5% did not undergo this examination.

Mantoux tests were conducted on 27.5% of patients. Regarding treatment, most patients (87.30%) completed anti-TB drug therapy. Surgical intervention was performed in 34.50% of patients.

Meanwhile, comorbidities such as septic shock and respiratory failure were significantly associated with neurological deficits ($P = 0.002$). On the other hand, several comorbidities, such as anemia, malnutrition, and mental retardation with organic mental disorders, did not show a significant relationship with neurological deficits. These findings provide valuable insights into understanding the correlation between comorbid conditions and the level of neurological deficits in pediatric patients [Table 2].

Concerning neurological deficits, the most influential complication is gibbus (9.9% in Frankel C and 5.6% in

Frankel D; $P = 0.008$). Decubitus ulcers were also significantly associated with neurological deficits ($P < 0.0001$), particularly in Frankel B and Frankel C [Tables 3-6].

Table 3 demonstrates a significant correlation between neurological deficits and nutritional status; patients with undernourished status have more severe neurological deficits with a $P < 0.001$, suggesting that nutritional status influences the severity of neurological deficits. No significant difference in mortality rate was found between patients with different nutritional status ($P = 0.382$). These results provide insights into the complexity of the relationship between nutritional status, comorbidities, neurological deficits, and mortality in the pediatric population.

DISCUSSION

This study identified the age group of 9–18 years as particularly vulnerable to TB spondylitis due to factors such as social activity, limited health knowledge, and engagement in riskier lifestyles.[7] Of 236 patients included in the study, there were 142 pediatric patients diagnosed with TB spondylitis and who met the inclusion criteria, with ages ranging from 0 to 18 years old. Of these, 65 (45.80%) were boys and 77 (54.20%) were girls. The findings of this study differ slightly from previous studies, which noted a higher prevalence of males among TB spondylitis cases.[8-10]

The study revealed that only 6.3% of patients were undernourished, while 28.7% were found to be overnourished, and a further 4.9% were identified as obese. These findings differ from those of previous studies, which have shown malnutrition as the leading risk factor for TB, surpassing that of human immunodeficiency virus. Malnutrition was attributable to 2.3 million cases in 2019.[8-10]

The CRP examination was also conducted in most patients, specifically in 111 patients (78.20%), with increased CRP levels detected in 76 patients (68.4%). While CRP examination is more specific for acute infections, assessing the response to anti-TB treatment in TB spondylitis patients is still necessary.[11] The sensitivity CRP for diagnosing

Table 2: Analysis of the relationship between comorbidities and neurological deficits.

Variable	Neurological deficits					*P*-value
	Frankel A (%)	Frankel B (%)	Frankel C (%)	Frankel D (%)	Frankel E (%)	
Comorbid						
Anemia	1 (0.7)	3 (2.1)	6 (4.2)	3 (2.1)	4 (2.8)	0.812
Malnutrition	0 (0)	0 (0)	1 (0.7)	0 (0)	0 (0)	0.722
Organic mental disorder	3 (2.1)	8 (5.6)	20 (14.1)	22 (15.5)	25 (17.7)	0.182
Pulmonary Tuberculosis	0 (0)	0 (0)	1 (0.7)	0 (0)	0 (0)	0.722
Under immunization	0 (0)	0 (0)	0 (0)	1 (0.7)	1 (0.7)	0.527
Neurofibroma	0 (0)	0 (0)	0 (0)	0 (0)	1 (0.7)	0.584
Acute lymphoblastic leukemia	0 (0)	0 (0)	0 (0)	0 (0)	2 (1.4)	0.497
Septic shock	0 (0)	0 (0)	1 (0.7)	0 (0)	0 (0)	0.722
Pleural effusion	0 (0)	0 (0)	1 (0.7)	0 (0)	0 (0)	0.002
Hydrocephalus	0 (0)	0 (0)	1 (0.7)	0 (0)	0 (0)	0.622
Epilepsy	1 (0.7)	0 (0)	0 (0)	0 (0)	0 (0)	0.002
Respiratory failure	1 (0.7)	0 (0)	0 (0)	0 (0)	0 (0)	0.002
None	1 (0.7)	2 (1.4)	4 (2.8)	9 (6.3)	20 (14.1)	0.520

Table 3: Analysis of the relationship between nutritional status and neurological deficits.

Characteristic	Nutritional status				*P*-value
	Undernutrition	Good nutrition	Overweight	Obesity	
Frankel					
A	3	0	4	0	0.001
B	1	6	9	0	
C	5	12	21	0	
D	0	23	6	0	
E	0	45	1	1	

Table 4: Analysis of the relationship between complications and neurological deficits.

Variable	Neurological Deficits					*P*-value
	Frankel A (%)	Frankel B (%)	Frankel C (%)	Frankel D (%)	Frankel E (%)	
Complications						
Gibbus	3 (2.1)	2 (1.4)	14 (9.9)	8 (5.6)	3 (2.1)	0.008
Decubital ulcers	6 (4.2)	13 (9.2)	8 (5.6)	0 (0)	0 (0)	0.001
Pathological fractures	0 (0)	0 (0)	1 (0.7)	0 (0)	0 (0)	0.622

Table 5: The Frankel scale for spinal cord injury classifies the extent of the neurological/functional deficit into five grades.

Frankel scale		
A	Complete	No motor or sensory function below the level of lesion
B	Sensory only	No motor function, but some sensation preserved below level of lesion
C	Motor useless	Some motor functions without practical application
D	Motor useful	Useful motor function below the level of lesion
E	Recovery	Normal motor and sensory function may have reflex abnormalities

Table 6: Parameters used for the TB score.

Parameters	Points assigned
Self-reported	1
Cough	1
Hemoptysis	1
Dyspnea	1
Chest pain	1
Night sweating	1
Anemic conjunctivae	1
Tachycardia	1
Positive finding at lung auscultation	1
Axillary temperature >37.0°C	1
BMI* <18	1
BMI <16	1
MUAC* <220	1
MUAC <200	1

*BMI: Body mass index, MUAC: Middle upper arm circumference, TB: Tuberculosis

spinal TB is only 71%. However, a study by Yoon *et al.*, using a CRP cut-off of 10 mg/L, reported a sensitivity of 93% and specificity of 62%.[12] The high proportion of patients undergoing the CRP examination indicates an awareness of the importance of monitoring inflammation in medical management. Elevated CRP levels have also been found in several studies involving patients with TB spondylitis.[13,14]

Thirty-nine patients (27.50%) underwent Mantoux testing, while 103 (72.50%) did not. The Mantoux test has a relatively low sensitivity (40–50%) and a specificity of 75%. Hence, this examination is not often performed in tertiary hospitals. The World Health Organization recommends using the Mantoux test in low-income countries; however, it lacks diagnostic value in endemic areas and can yield false-negative results in individuals with weakened immune systems. Therefore, it is only applicable to latent TB.[15]

The MRI examination was conducted in 51 patients (42.50%) as a more in-depth diagnostic step. In TB spondylitis, MRI's superior contrast resolution effectively demonstrates continuous vertebral involvement, skip lesions, and collections around the spine. MRI imaging provides critical information about the spinal cord and can detect epidural abscesses in patients with neurological deficits. MRI imaging has a sensitivity of 100% and a specificity of 80% for diagnosing spinal TB. The high sensitivity, specificity, and relatively easy utilization make MRI the gold standard for spinal TB examination.[15] In our study, some patients exhibited improvement after anti-TB drug treatment, leading them to express reluctance toward undergoing scheduled MRI scans due to a perceived lack of necessity.

Unlike MRI, radiography examination is not recommended for diagnosing spinal TB because radiography has a sensitivity of only 15%. Radiography imaging is only helpful if the patient has complaints of spinal deformities, such as scoliosis or kyphosis, which are found in the advanced stages of spinal TB.[15] However, MRI, the gold standard for diagnosis, is not routinely performed and can be easily overlooked, especially in developing countries, due to limited facilities and high examination costs. We recommend screening pediatric patients with low back pain and changes in daily behavior with spine radiography before complications arise.

Spinal deformities in spinal TB can lead to neurological deficits. The study found that 66.20% of cases had paraparesis (Frankel score A to D), while patients with Frankel E score (without neurological deficits) were observed in 33.80%. A study by Garg and Somvanshi adds that 40% of TB cases with paraplegia show recovery with anti-TB treatment, bed rest,

and/or traction. Another study in South Africa, which treated patients conservatively, showed that 27% of cases experienced paraplegia and 12% experienced paraparesis. Within three years, approximately two-thirds of these patients had recovered the functional use of their lower limbs.[16] The outcome for neurological deficits after surgery is better in children than adults, with good correction of kyphotic deformity.

Clinically, children may initially present with vague symptoms such as back pain and stiffness or constitutional symptoms such as fever and weight loss. However, these manifestations may not adequately reflect the severity of vertebral destruction and spinal deformity caused by the disease. Consequently, without appropriate diagnostic interventions, the full extent of spinal involvement, including abscess formation, vertebral collapse, and neurological compromise, may remain unrecognized.

Gibbus is the most common deformity that causes kyphosis in patients with spinal TB.[17] Gibbus is the most influential complication, with proportions of 14 (9.9%) in Frankel C and 8 (5.6%) in Frankel D, showing a significant relationship (P = 0.008), followed by decubitus ulcers, which show a significant correlation (P < 0.0001). Patients with limited mobility and movement are at an increased risk of decubitus ulcers. Immobilization harms the overall body, increasing the risk of developing decubitus ulcers.[18]

Correlations were obtained regarding the relationship between neurological deficits and nutritional status. This indicates that malnutrition can exacerbate neurological deficits. The cause is estimated to be a deficiency in micronutrients and minerals. Micronutrients are crucial for proper nutrition, often serving as cofactors in enzymatic reactions involving the catabolism of carbohydrates, proteins, or fats.[19] Deficiencies in fat-soluble vitamins (A, D, E, and K) and water-soluble vitamins have neurological consequences similar to low intake or absorption of minerals.[20] Evidence for the potential impact of nutritional care and improved nutritional status on patient prognosis was more challenging to evaluate due to the heterogeneity of patient populations, treatment protocols, and treatment durations and goals.

The high incidence of complicated TB spondylitis highlights the importance of maintaining a high index of suspicion for pediatric spinal TB, especially in endemic areas, and the critical role of advanced imaging modalities, such as MRI, in uncovering the hidden burden of disease. In this context, screening pediatric patients with respiratory symptoms for extrapulmonary TB, including TB spondylitis, is also important. Therefore, a comprehensive and accurate assessment is needed to ensure that these conditions can be detected and effectively managed in pediatric patients.

Despite its scope, our multicenter study still encountered several limitations. One notable constraint is the variation in the International Statistical Classification of Diseases and Related Health Problems (ICD) codes across different hospitals, which increases the likelihood of patients not being properly recorded within our sample. Further research should include a broader range of hospitals, with standardized coding and developing an ICD-10 coding framework to improve data collection and minimize sample loss.

Therefore, given the significant association with poor nutrition, there is a need to improve the identification and nutritional interventions for patients with malnutrition. In addition, further research is recommended to understand the factors that may influence the non-significant relationship observed in some findings. These steps are expected to enhance the holistic understanding and management of pediatric TB spondylitis patients.

CONCLUSION

Data analysis indicates a significant association between neurological deficits and the emergence of patient comorbidities and complications. Furthermore, there is an association between neurological deficits and nutritional status, particularly in patients with malnutrition.

Recommendations: We recommend screening spine radiography for pediatric patients with low back pain and changes in daily behavior before complications arise. In this context, screening pediatric patients with respiratory symptoms for extrapulmonary TB, such as TB spondylitis, is also important.

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Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patients have given their consent for their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published, and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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