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Determining the Accuracy of MRI in Evaluation of Infective Vertebral Lesions

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ABSTRACT

Introduction:

MRI is highly accurate in identifying vertebral anomalies by detecting even the smallest changes in water and fat components, making it the preferred method for assessing infectious lesions in the vertebral column. Clinical observations and different imaging properties can help with early diagnosis and treatment. Vertebral endplate destruction, changes in the signal intensity of intervertebral disc and bone marrow, and involvement of the soft tissues surrounding the vertebrae are typical MRI findings of infectious vertebral lesions.

Methods:

To determine the diagnostic accuracy of MRI in patients suspected of having infective vertebral lesions, a cross-sectional study was conducted involving 52 individuals. The study compared the validity of MRI diagnosis with the diagnosis obtained through CT-guided fine needle aspiration cytology for infective vertebral lesions.

Results:

By comparing the MRI diagnoses with those of fine needle aspiration cytological diagnosis of vertebral lesions, the sensitivity, specificity, positive and negative predictive values (PPVs and NPVs), and ultimately diagnostic accuracy of MRI, were computed. The sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of MRI diagnosis for infective vertebral lesions were 95.6%, 71.4%, 95.6%, and 71.4%, respectively and 92.3% of diagnoses were made correctly overall.

Conclusions:

The finding of this study suggested that MRI should be considered to be the imaging modality of choice for patients with suspected infective vertebral lesions.

Keywords: *Cytology; Intervertebral Disc; Spinal Diseases; Water*

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INTRODUCTION

Tuberculous spondylitis, which has traditionally been prevalent in developing countries, has seen a recent increase in cases in developed countries as well.[1]

Tuberculosis, caused by Mycobacterium tuberculosis, remains a major public health hazard, especially in developing countries in which poverty, malnutrition, and the presence of drug-resistant strains have combined to aid the spread of the disease. Spine tuberculosis is the commonest form of skeletal tuberculosis and constitutes about 50% of all cases of tuberculosis of bones and joints. Tuberculosis spondylitis now accounts for 6% of new extrapulmonary tuberculous cases.[2,3]

The typical patient presentation includes low-grade fever, backache, gibbus formation, and occasionally neurological abnormalities like paraplegia. If early diagnosis and timely treatment may prevent irreversible neurologic damage, tuberculous spondylitis is a treatable condition.[2]

Tuberculous spondylitis is most commonly caused by Mycobacterium tuberculosis, but any species of Mycobacterium may be responsible.[4]

MRI is the preferred imaging modality for spinal infection due to its ability to provide multiplanar capabilities, excellent soft tissue contrast, and simultaneous visualization of neural elements. Radiographs may struggle to visualize faint lytic/ sclerotic bone lesions, whereas MRI excels in detecting bone marrow lesions, making it superior to other imaging techniques.[5,6]

Imaging findings play a crucial role in confirming and localizing spinal infections. Magnetic resonance imaging (MRI) is the preferred choice due to its high sensitivity and specificity. The involvementof two consecutive vertebrae and the intervening disk is a strong indicator of infectious spondylitis. Typical signal intensity on T1- and T2-weighted images and enhancement in the affected bone marrow after contrast material administration are commonly observed in spinal infections. However, these findings may be nonspecific, particularly in the early stages of infection.[7,8]

In the chronic progress with delayed diagnosis,high signal intensity is sometimes shown in the T1-weighted images. In addition, low signal intensity is shown in both T1 and T2-weighted images, if the vertebral body has progressed to a collapse and has irregular endplate sclerosis. Many of the studies dealing with tuberculous spondylitis have reported that abscess involves uniquely multiple vertebral bodies, especially in gadolinium-enhanced MRI Hence contrast enhancement images of the gadolinium are specifically required.[9,10]

Image-guided fine needle aspiration cytology (FNAC) has emerged as the first line of investigation in the assessment of radiologically detected vertebral and paravertebral lesions.[11]

METHODS

This cross-sectional study was conducted from July 2016 to July 2018 at the Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Department of Radiology and Imaging. Power analysis was used to calculate the sample size for a single proportion after performing purposeful sampling. Fifty six was the intended sample size as a result. Due of incomplete cytopathological data, four cases were discarded.

Patient with clinically suspected infective vertebral lesions attending the Department of Radiology & Imaging, BSMMU, Dhaka, for MRI scan were included in this study. Patient who refused to do CT guided fine needle aspiration cytology for major concomitant disease, recent myocardial infarction, recent cerebrovascular disease; uncontrolled diabetes mellitus were excluded from this study. Data were collected by a pre-designed proforma. Patient information was obtained using an information sheet which included a questionnaire, clinical findings, and radiological and cytopathological findings.

Patients with clinically suspected infective vertebral lesions underwent an MRI examination. MRI scan was performed on a 1.5 Tesla SIEMENS MRI machine.

MRI protocol included;

1. Sagittal T1 and T2 weighted images by using spin-echo and fast spin-echo.

2. Axial images with T1 weighted spin echo sequence and proton density.
3. Post-contrast T1 sagittal, T1 TRA and T1 FS AXIAL were also obtained.

CT guided fine needle aspiration of sample was done under standard guideline. Cytopathological examination was performed and reports were collected and compare with MRI findings.

RESULTS

In this study, the majority of patients (28 patients) fell within the age range of 41-60 years. The average age was found to be 46 years, ranging from 16 to 71 years. Approximately two-thirds (65.0%) of the patients were male, resulting in a male-to-female ratio of approximately 2:1. All patients in the study presented with back pain, functional disability, and tenderness. Fever was observed in 75% of the patients. Neurological deficits were found in 27 individuals (51.9%), and bladder involvement was observed in 25 patients (48.1%) (as depicted in Table 1).

Table 1: Distribution of the study patients by demographic variables (n=52)

Age Group	Frequency	Percent
<21 year	4	7.7
21-40 years	12	23.1
41-60 years	28	53.8
61-80 years	8	15.4
Sex		
Male	34	65.4
Female	18	34.6
Occupation		
Farmer	9	17.3
Day labour	16	30.8
Service holder	14	26.9
Housewife	10	19.2
None	3	5.8

The study revealed that the duration of symptoms varied among the cases. In 18 cases (32.1%), the symptoms lasted for 12 to 15 months, followed by 16 cases (28.6%) with symptoms lasting 9 to 12 months, 12 cases (21.4%) with symptoms lasting 6 to 9 months, 5 cases (8.9%) with symptoms lasting more than 15 months, and 1 case (1.8%) with symptoms lasting 3 to 6 months. The study also found that 18 cases (32.1%) had a history of tuberculosis.

Loss of curvature was observed in all 52 (100%) patients. The majority of the lesions affected the thoracic spine in 20 patients (38.5%), followed by the lumbar spine in 16 patients (30%). Five patients (9.6%) had lesions in the thoracolumbar region, and another 5 patients had involvement of multiple vertebrae in the dorso-lumbar-sacral region (9.6%). Three patients each had involvement in the lumbar and sacrum regions. Among the cases, 8 patients (15.14%) had involvement of a single vertebra, 27 patients (51.9%) had involvement of two vertebrae, and 5 patients (9.6%) had involvement of multiple contiguous vertebrae. Skip lesions were observed in 12 patients (23.1%).

Contrast enhancement was seen in all 52 (100%) cases. A posterior bulge with pathological fracture causing thecal sac indentation was observed in 23 cases (44.2%), while a posterior bulge without pathological fracture was seen in 14 cases (26.9%) and no posterior bulge was observed in 15 cases (28.8%). Among the patients, 32 (61.5%) showed involvement of intervertebral discs, while 20 (38.5%) did not show any involvement. Signal change in the disc was observed in 13 cases (25.0%), and a reduction in disc height was seen in 19 cases (36.5%). End plate irregularity in the contiguous vertebral body was observed in 27 cases (51.9%), while end plate irregularity with the involvement of a single vertebral body was seen in 4 cases (7.7%). No irregularities were found in 21 cases (40.0%).

Epidural and paravertebral abscesses were found in 27 cases (51.9%). The current study observed septate loculated collections extending beyond the number of vertebral bodies involved in all 49 (100%) cases. Soft tissue extension was present in 31 cases (59.6%). Neurological deficits were observed in only 14 cases (28.75%). All cases (100%) exhibited a combination of marrow edema and paravertebral collections. (Table 2)

Table 2: Pattern of vertebral and intervertebral disc involvement

Vertebral and intervertebral disc involvement	Frequency	Percentage
Number of vertebra involvement		
Single	8	15.4
Contiguous	27	51.9
Multiple skip lesions	12	23.1
Multiple contiguous lesions	5	9.6
End plate irregularity		
One vertebral body	4	7.7
Contiguous vertebral body	27	51.9
No irregularity	21	40.4
Involvement pattern		
Involvement of posterior elements/pedicles	15	28.8
Epidural/ Paravertebral abscess	27	51.9
Soft tissue extension	31	59.6
Skip lesions	14	26.9
Central involvement	23	44.2

When evaluating the MRI diagnosis of infective vertebral lesions using cytopathology, the study found 41 true positive cases, 2 false positive cases, 2 false negative cases, and 7 true negative cases.

In this present study, it was observed that the validity of MRI diagnosis for infective vertebral lesion was correlated by calculating sensitivity (95.6%), specificity (77.8%), accuracy (92%), positive predictive value (95.6%) and negative predictive value (71.4%). The accuracy of MRI in this study was 92.3%. (Table 3)

Table 3: Diagnostic accuracy of MRI and FNAC evaluation of infective vertebral lesion

MRI DIAGNOSIS	FNAC DIAGNOSIS		
	POSITIVE (35)	NEGATIVE (17)	
POSITIVE (19)	43 (True positive)	2 (False positive)	POSITIVE PREDICTIVE VALUE: 95.6%
NEGATIVE (23)	2 (False negative)	5 (True negative)	NEGATIVE PREDICTIVE VALUE:71.4%
	SENSITIVITY: 95.6%	SPECIFICITY: 71.4%	ACCURACY: 92.3%

DISCUSSION

The patients in this study were found to be on average 46 years old. The study also revealed that there were more male patients. In another investigation done by Khalequzzaman SI et al. reported similar findings. Additionally, in our study, more than one-third of the patients were either working or jobless, showing that spondylitis disproportionately affects those from financially poor backgrounds.[13]

According to our study, the length of the symptoms was comparable to what Lee et al. described in their study. Our study showed involvement of the thoracic vertebra was most followed by the lumbar, compared to the study done by Liebegrall M et al. who found that the lumbar area of the spine has vertebral osteomyelitis more frequently than the thoracic or cervical spine. The most frequent sites of tuberculous infection have been identified in

multiple investigations to be the thoracic spinal vertebrae, followed by the lumbar and thoracolumbar spine in descending order.[12]

The number of vertebrae involved in our studywas similar to that of a previous study conducted by Khalequzzaman SI et al. Additionally, the preservation of discs affected by tubercular spondylitis showed a similar pattern to the findings reported in a study by Chang et al.[10,13]

Intervertebral disc involvement, as observed by Ledermann HP et al. characterized by a loss of disc height that results in high signal intensity on T2 (present in between 50 and 90% of cases, with 95% sensitivity and low signal intensity on T1).[14]

More than half of the cases in the current investigation had epidural and paravertebral abscesses, which is consistent with Panta et al. findings. The dorsal spine experiences epidural collection the most commonly, followed by the lumbar spine and the cervical spine infrequently.[15]

Chang et al. reported that nearly all cases of tuberculous spondylitis were accompanied by both spinal and paraspinal abscesses, whereas our study found this association to be present half of cases.[10]

According to a study conducted by Andronikou S et al., a significant majority of their patients displayed neurological impairments, whereas our study revealed a lower percentage of patients with neurological deficits.[17]

Khalequzzaman SI and colleagues discovered that the MRI demonstrated a sensitivity of 95.2% and a specificity of 75%, which aligns closely with the results of our own investigation.[13]

CONCLUSION

A typical infective vertebral lesion often exhibits erosion of the end plate and changes in the bone marrow surrounding the disk. The use of MRI is highly effective in detecting these conditions, offering excellent visibility. Several non-infectious diseases can resemble a spinal infection, making MRI an invaluable tool for accurate diagnosis. With its high sensitivity, specificity, and diagnostic accuracy, MRI is considered the preferred imaging technique for patients suspected of having infective spinal lesions.

CONFLICT OF INTEREST

None

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None

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