CORRELATION OF MRI FINDINGS WITH NEUROLOGICAL DEFICIT IN SPINAL TUBERCULOSIS

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INTRODUCTION

Pott’s spine or spinal tuberculosis (TB) represents less than 1% of all tubercular cases and 50% cases of skeletal tuberculosis.1-3 Spinal TB is a dangerous type of skeletal TB as it can lead to neurological complications in 10% to 43% cases.1 MRI plays an important role in the diagnosis of spinal TB as it is equally good in defining bone, soft tissue and neural structures.3-5 MRI helps in the confident diagnosis of spinal TB by revealing the characteristic findings like marrow edema, pre and paravertebral loculated collections, subligamentous collections and end plate erosions.7 In addition, degree of spinal canal encroachment and cord changes are well delineated. MRI not only helps in early diagnosis of spinal TB but also in selecting cases which will benefit from surgery for preventing neurological complication and deformity. However, in spite of considerable literature on application of MRI in diagnosis of Spinal TB, there are only few studies to assess the correlation between MR findings and neurological deficit assessed by clinical examination.8 In contrast, correlation of MRI findings with neurological status has been done extensively in traumatic spine injuries. The present study was conducted to correlate the various MR findings in spinal TB with neurological status.

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ABSTRACT

Very few studies have been performed in spinal tuberculosis to correlate the MRI findings with neurological status. This prospective observation study was conducted to correlate the MR findings in spinal tuberculosis with neurological deficit. Forty consecutive patients diagnosed with spinal tuberculosis were included from February 2015 to October 2016. Diagnosis of spinal tuberculosis was made on clinico-radiological criteria and/or histopathology/microbiological results. MRI findings were correlated with neurological impairment using ASIA scale. For statistical analysis Fisher exact test, spearman rank correlation coefficient and binary logistic regression were used. Thecal sac narrowing was noted in 23 patients due to epidural abscess, granulation tissue, vertebral bulge or a combination of above. In 4 patients anterior CSF space was obliterated, whereas both anterior and posterior CSF spaces were obliterated in 14 patients. Cord compression was present in 13 patients. Cord edema was seen in 15 patients, which was associated with compression in 10 patients. In 4 patients cord edema was without any compression, and three of these patients were having neurological deficit. In one patient cord edema was due to associated tubercular arachnoiditis. Statistically significant correlation was noted between ASIA scale and thecal sac narrowing, obliteration of CSF space around cord, cord compression and cord edema. MRI parameters like thecal sac narrowing, obliteration of CSF space around spinal cord, cord compression and cord edema correlate with severity of neurological impairment in spinal tuberculosis. Cord edema even in absence of compression could lead to neurological deficit.
MATERIAL AND METHODS

Total 40 consecutive patients recently diagnosed with spinal tuberculosis from Neurology and Neurosurgery Department were included in the study from February 2015 to October 2016. Approval of the study was taken from institute ethics committee. After taking the informed consent, the MRI features and clinical neurological findings were recorded in each case. The diagnosis of spinal TB was based on a combination of clinico-radiological findings, biochemical factors and/or histopathology/ fine needle aspiration cytology/microbiology results. Out of total 40 cases, 25 had undergone USG or CT guided aspiration or biopsy and 15 had confirmatory histopathological, microscopic or culture evidence of tuberculosis whereas results were negative for granuloma or acid fast bacilli in 10 cases. No aspiration or tissue biopsy was done in 15 cases. Diagnosis in non-definite cases was based on typical imaging findings, exclusion of alternative diagnosis and response to anti-tubercular treatment as retrospective supportive evidence.

MRI was performed in all patients on a 3 tesla Signa HDxt scanner (GE Healthcare, Milwaukee, WI, USA). MRI protocol consisted of T2w sagittal, T2w fat suppressed sagittal, T1w sagittal and T2w axial sequences followed by post contrast T1w fat suppressed sequence in sagittal and axial plane. Instead of post contrast T1w fat suppressed sequence, a T1 IDEAL sequence was performed in dorsal and cervico-dorsal region to obtain homogenous fat suppression. Level of predominant involvement was categorized into cervical, cervico-dorsal, dorsal, dorso-lumbar, lumbar and lumbo-sacral region. In cases of multi-level involvement (skip lesion), the level having more severe disease in terms of thecal sac narrowing was documented as predominant level. Number of contiguous vertebra affected at predominant level was recorded as single, two or more than two. Presence of kyphosis was noted.

Type of vertebra involvement was described as paradiscal, central, anterior subligamentous, posterior element and mixed type. Involvement of intervening disc and presence of paravertebral granulation tissue or abscess was noted. Percentage narrowing of thecal sac was calculated in relation to diameter of thecal sac one vertebra level above/below the lesion. In most of cases it was calculated on mid-sagittal images; however, if epidural pathalogy was laterally situated, an axial image was used for measurement. Thecal sac narrowing was categorized as; absent, grade 0; up to 20%, grade I; 21-40%, grade II, 41-60%, grade III; 61-80%, grade IV, more than 80%, grade V. Cause of thecal sac narrowing was recorded. Obliteration of anterior and posterior CSF space around cord, presence of cord compression, grade of cord compression and cord edema were also recorded whenever present. Cord compression was graded by measuring cord diameter, similar to the thecal sac narrowing.

Findings of the neurological examination were recorded and grading of neurological status was estimated according to the ASIA scale. Grade A is no sensory or motor function is preserved in the sacral segments S4-S5. Grade B is sensory but not motor function is preserved below the neurological level and includes S4-S5. Grade C is motor function is preserved below the neurologic level, and more than half of key muscles below the neurologic level have a muscle grade of less than 3. Grade D motor function is preserved below the neurologic level, and at least half of key muscles below the neurologic level have a muscle grade of 3 or more. Grade E is motor and sensory function are normal.

Statistical analysis: To test the association between neurological status and MRI findings, fisher exact test was used as in any cell, expected frequency was <5. Spearman rank correlation coefficient (ρ) was used to test the linear relationship between ordinal variables. Univariate binary logistic regression analysis was used to calculate odds ratio and corresponding significant level. The variables found significant in univariate analysis have been included in multivariate binary logistic regression analysis to calculate adjusted odds ratio and significance level. A p value <0.05 have been considered as significant. Statistical package for social sciences, version 23 (SPSS-23, IBM, Chicago, USA) was used for data analysis.

RESULTS

Patient’s demographics have been described in Table 1.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>Male</td>
</tr>
<tr>
<td></td>
<td>19</td>
</tr>
<tr>
<td>Multi-level involvement</td>
<td>7</td>
</tr>
<tr>
<td>Number of vertebra affected</td>
<td>2</td>
</tr>
<tr>
<td>at predominant level</td>
<td>23</td>
</tr>
<tr>
<td>Kyphosis</td>
<td>15</td>
</tr>
</tbody>
</table>

The mean age of patients was 41.8 years. Predominant level of vertebral involvement is shows in graph (Fig1). Paradiscal pattern was the most common type of vertebral involvement seen in 27 patients. Central type of vertebral involvement was noted in 5 patients. Mixed pattern of involvement was seen in 8 patients. Intervertebral disc was involved in 29 patients. Intervertebral disc was mostly affected in paradiscal type of disease; however, there were 5 cases in which intervening discs were not involved despite the paradiscal disease. In 25 patients, paravertebral abscess with or without solid enhancing soft tissue was noted, whereas solid enhancing paravertebral soft tissue was noted in 8 patients.

![Predominant level of involvement](image)

Thecal sac narrowing was noted in 23 patients; grade I narrowing in 2, grade II in 6, grade III in 11 and grade IV in 4 patients. Cause of thecal sac narrowing included epidural
abscess, epidural granulation tissue, vertebra bulging into spinal canal or a combination of above. Epidural abscess was noted in 11 patients. In one patient epidural abscess was noted along with part of vertebra bulging into spinal canal. Enhancing epidural soft tissue was noted in 5 patients. In one patient enhancing epidural soft tissue was noted along with vertebral bulge. In 5 patients the thecal sac narrowing was due to vertebral bulge into the spinal canal without any epidural abscess or soft tissue.

In 10 patients the disease was located below the level of conus. In 12 patients both anterior and posterior CSF space around cord was maintained. In 4 patients anterior CSF space was obliterated, whereas in 14 patients both anterior and posterior CSF spaces were obliterated. Thecal sac narrowing was the cause of CSF obliteration in all cases except one, where anterior CSF space was obliterated due to cord swelling. In 13 patients, cord compression was present; grade I compression in 3, grade II in 8, and grade III in 2 patients. Cord edema was present in 15 patients. Cord edema was seen in association with cord compression in 10 patients (Fig 2).

In one patient cord edema was related to enhancing cord surface exudates rather than vertebral disease which was located below the conus (Fig 3). In 4 patients, cord edema was noted without any evidence of cord compression and in 1 of these patients there was evidence of long segment cord edema (Fig 4). Three out of these 4 patients were having neurological deficit.

Correlation of Neurological status was done with MRI variables in 37 cases, after excluding 3 cases with concomitant tubercular meningitis. ASIA scale was grade A in 3, grade B in 2, grade C in 5, grade D in 12 and grade E in 15 patients. No statistically significant association was noted between ASIA scale and predominant level of involvement, number of vertebra affected, kyphosis and paravertebral abscess or soft tissue. Statistically significant association was noted with presence of thecal sac narrowing (p=0.027) and grade of thecal sac narrowing (p=0.5177, p=0.001). Correlation of ASIA scale with MRI variables like obliteration of CSF space around cord, presence of cord compression, grade of cord compression and cord edema could be done in 29 cases after further excluding 8 cases with “below conus disease”. No statistically significant association was noted between ASIA scale and predominant level of involvement, number of vertebra affected, presence of kyphosis, presence of thecal sac narrowing and paravertebral abscess or soft tissue. On the other hand, statistically significant correlation was noted between ASIA scale and grade of thecal sac narrowing (p=0.516, p=0.004), obliteration of CSF space around cord (p=0.601, p=0.001), presence of cord compression (p=0.001), grade of cord compression (p=0.604, p <0.001) and presence of cord edema (p=0.001).
presence of thecal sac narrowing (p=0.011), grade of thecal sac narrowing (p=0.008), obliteration of CSF space around cord (p=0.003), presence of cord compression (p=0.005), grade of cord compression (p=0.013) and cord edema (p=0.003) were individually found significantly associated with outcome variable (ASIA scale).

Table 2 Logistic regression analysis in 29 patients after excluding cases with below conus disease and tubercular meningitis.

<table>
<thead>
<tr>
<th>MRI Variables</th>
<th>Univariate Logistic Regression Analysis</th>
<th>Multivariate Logistic Regression Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>p value</td>
<td>Odds ratio</td>
</tr>
<tr>
<td>Predominant level of vertebral involvement</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Number of vertebra affected at predominant level</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Presence of Kyphosis</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Presence of paravertebral abscess or soft tissue</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Presence of thecal sac narrowing</td>
<td>9.33</td>
<td>1.65-52.69</td>
</tr>
<tr>
<td>Grade of thecal sac narrowing</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Obliteration of CSF space around cord</td>
<td>26.40</td>
<td>2.65-262.70</td>
</tr>
<tr>
<td>Presence of cord compression</td>
<td>5.18</td>
<td>1.41-19.03</td>
</tr>
<tr>
<td>Cord edema</td>
<td>35.75</td>
<td>3.47-368.83</td>
</tr>
</tbody>
</table>

Out of the significant variables, presence of thecal sac narrowing, grade of thecal sac narrowing, obliteration of CSF space around cord and grade of cord compression were excluded from multivariate analysis, as they were highly correlated with other predictors. In the final model two variables namely cord compression (adjusted odds ratio = 14.67, 95% CI =1.09-197.96, p=0.043) and cord edema (adjusted odds ratio = 21.42, 95% CI = 1.68-272.72, p=0.018) were found significant. The final model was best fitting as Hosmer and Lemeshow goodness of fit test showed that observed and predicted value was statistically equal ( p= 0.863).

Three cases had mild neurological deficit (Grade D) without significant epidural or spinal cord disease. Two of these cases were having disease in lumbar spine with significant amount of paravertebral abscess with granulation tissue extending into neural foraminas. However, in one case involving cervico-dorsal spine there was only small amount of paravertebral granulation tissue.

**DISCUSSION**

Neurological involvement is the most debilitating complication of spinal tuberculosis. Initially the neurologic symptoms of Spinal TB may be subtle but eventually progress to paraplegia or quadriplegia depending on level of involvement. Neurological complication in active disease usually develops due to compression of spinal cord or nerve roots by epidural abscess, granulation tissue, debris, sequestrated disc, vertebral subluxation and dislocations, concertina collapse and internal gibbus.1,3 Presence of tuberculous granuloma, tuberculous meningomyelitis; infective thrombosis or endarteritis of spinal vessels, and tuberculous arachnoiditis may also produce neurological deficit. The reported incidence of neurological deficit in spinal tuberculosis varies from 23 to 76%.2 In our study 57.5 % of patients had neurological deficit which is likely due to the referral of complicated cases to our institute. Thecal sac narrowing was noted in 57.5% of our patients caused by epidural abscesses, epidural granulation tissue and internal vertebral bulge or a combination of above. Thecal sac narrowing has been reported in 75.5-89.3% cases in spinal tuberculosis.4 12Grade of thecal sac narrowing was more consistently associated with neurological deficit rather than mere presence of thecal sac narrowing. In one study Jain et al have calculated that up to 76% encroachment of the spinal canal by tubercular pathological tissue is compatible with undisturbed neural status.7 They mentioned that spinal cord appears to have the physiological reserve to withstand considerable pressure if it is slow in onset. However, in another report Jain et al mentioned that due to concomitant vascular cause or mechanical instability, the neural deficit may develop at lesser canal compromise. Ansari S et al reported that neurological symptoms were found in patients with degree of spinal canal compression exceeding 20%.13 Mushkin et al also reported that deterioration of the neurological status is related to the degree of spinal stenosis.8

In our study statistically significant association was noted between neurological deficit and obliteration of CSF space around cord. In the study conducted by Dunn R et al, statistically significant correlation was found between CSF space obliteration anterior to cord to non-ambulatory status of the patient.9 In another study, conducted by Gupta AK et al, loss of CSF anterior to cord was seen in 76.67% cases with a significant difference between ambulatory and non-ambulatory patients.14 Thecal sac narrowing was the cause of CSF obliteration in all our cases except one, where anterior CSF space was obliterated due to cord swelling.

Presence as well as severity of cord compression was significantly associated with neurological deficit. Similar to our study, a statistically significant correlation was found between the cord diameters and ambulatory status of the patient by Dunn R et al.9 Similarly, Gupta AK et al also found statistically significant difference in the spinal cord diameter between the ambulatory and non-ambulatory patients.14

Presence of cord edema was also strongly association with neurological deficit in our study. Similarly Dunn R et al also found a statistically significant correlation between cord signal changes and the ambulatory status of the patient.7 In the study conducted by Gupta et al,they didn’t find any significant correlation between the cord signal changes and the ambulatory status of the patient.13 However, majority of patients in there series with cord edema were having neurological deficit in form of ASIA D scale despite of being ambulatory. In most of our cases cord edema was associated with cord compression. Interestingly in 4 patients, cord edema was present without cord compression and one of these patients had a long segment cord edema. This may be attributed to direct involvement of spinal cord, surrounding meninges and roots by tuberculous infection or by involvement of blood vessels supplying the spinal cord.2

Three patients in our study had associated tubercular meningitis and tubercular arachnoiditis. These patients were excluded from analysis due to complex pattern of neurological involvement.15 16 Although the results from our study are encouraging, there are many limitations. A small number of
patients were included in the study and cases were from all regions of spinal column. As the spinal cord end at L1 level, the same amount of mechanical compression will have more neurological deficit if it is cervical or dorsal spine compared with below conus disease in lumbar spine.3 In few cases presence of large paravertebral component was surrounding the exiting nerve roots and leading to neurological deficit without presence of significant epidural disease. Lastly, ASIA scale is not the ideal method, as it does not classify all types of neurological deficit associated with Pott’s spine.17

CONCLUSION
There are several parameters on MRI which correlate with the severity of neurological impairment like thecal sac compression, obliteration of CSF space around cord, cord compression and cord edema. Cord edema may be present without any compression and may leads to neurological deficit.

References

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