Original Articles/นิพนธ์ต้นฉบับ

Diagnostic Accuracy of Subligamentous Spread in Magnetic Resonance Imaging for Diagnosis of Spinal Tuberculosis

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Abstract

Objective: To evaluate the diagnostic value of subligamentous spread in the spinal tuberculosis (TB).

Methods: Retrospective review of spinal magnetic resonance images was performed to evaluate the subligamentous spreading in 84 patients. The differentiation of subligamentous spreading in group of spinal tuberculosis and spinal metastasis were analyzed.

Result: There was statistically significant difference (p-value < 0.05) by univariate and multivariate analyses in parameters of location of the spinal involvement and maximum thickness of subligamentous spread between the groups of spinal TB and spinal metastasis. The presence of subligamentous spread and number of level involved had statistically significant difference by univariate analysis. Each millimeter of increased maximum thickness of subligamentous spread increased the probability of spinal TB about 1.36 times. The sensitivity, specificity, accuracy, positive predictive value and negative predictive value are 78.38%, 59.57%, 67.86%, 60.42%, and 77.78%, respectively.

Conclusions: There was statistically significant difference in the presence of subligamentous spread, number of level involved, maximum thickness, and location of spinal involvement between the groups of spinal tuberculosis and spinal metastasis. Increased maximum thickness of subligamentous spread increases the probability of spinal tuberculosis.

Keywords: Spinal tuberculosis, Pott's disease, subligamentous spread

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Introduction

According to World Health Organization tuberculosis report in 2014, the global estimated 9.0 million TB patients are developed and 1.5 million patients died from the tuberculous infection. More than half of developed tuberculosis was in South-East Asia and Western Pacific regions. The prevalence of mycobacterium tuberculous infection in Thailand in 2013 is 149 per 100,000 and the incidence is 119 per 100,000.(1) Mycobacterial infection is one of the oldest infectious diseases that still cause morbidity and mortality, even though the medical treatment has greatly improved.

Tuberculosis (TB) is one of the most mimicker diseases. It can manifest like other infections or neoplastic processes; such as pyogenic infection, bone metastasis or primary bone tumor. It can involve any organ in the body. The early and accurate diagnosis of tuberculous infection is still challenged. Spinal TB is the most common spinal infection and the common site of extra-pulmonary TB that needs early diagnosis and appropriate treatment to prevent complications, especially neurological involvement and spinal deformity. Turgut M suggested that early surgery at the onset of disease for decompression in spinal TB can decrease neurological involvement.(2) The patients presented with neurological deficit but the spinal cord is preserved, still have good respond to conservative treatment.(3)

Magnetic resonance (MR) imaging provides more sensitivity than plain radiograph and more specificity than computer tomography to evaluate spinal TB.(4) MR imaging findings of spinal TB are bone marrow and disk signal changes in T1 and T2-weighted images, bone and endplate destruction, and paravertebral or epidural soft tissue involvement/abscesses.(5) Subligamentous spread is one of the common features of soft tissue involvement in TB and causes noncontiguous multilevel vertebral involvement. This finding can be found but is not typically seen in other spinal diseases, e.g. spinal metastasis, lymphoma, or multiple myeloma.(6-8) We conducted this research study to evaluate the diagnostic value of subliga-mentous spreading in the case of spinal TB.

Material and methods

We retrospectively reviewed medical recodes of 118 patients with chronic low back pain and recorded the demographic data such as age, sex and laboratory results. Patients were divided into two groups. One group was diagnosed as spinal TB which was proved from at least one of these methods; histology, acid fast bacilli stain, or mycobacterial culture. Another group was spinal metastasis proved by histology. All patients had MR imaging of the spine which included sagittal T1-weighted, sagittal T2-weighted, sagittal proton density-weighted, and sagittal gadolinium-enhanced T1-weighted images.

Thirty-four patients were excluded from this study due to history of spinal traumatic fracture, prior spinal surgery, or prior treatment with antituberculous drug.

Totally 84 patients were included. There were 37 patients with spinal TB (15 men, 22 women; mean age 45.05 years; age range 15-79 years), and 47 patients with spinal metastasis (29 men, 18 women; mean age 54.44 years; age range 18-83 years).

MR images were performed by using 1.5T-MR system (Picker Vista HPQ) and oval surface coil. The protocol composed of T1-weighted sequence (repetition time [TR] 360-400 msec, echo time [TE] 16-18 msec), T2-weighted sequence (TR 1,800-400 msec;

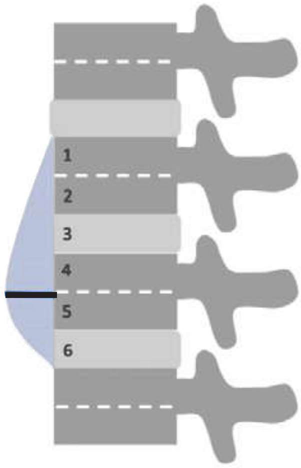

Figure 1. *Diagram shows each vertebral body height (dark gray) was divided into two parts equally (no. 1,2 and 4,5) and the intervertebral disk (light gray) was counted as one level (no. 3 and 6). The subligamentous spread (blue) in this diagram involved 6 levels, and the maximum thickness (black line) was measured in millimeters.*

TE 80 msec), and proton density-weighted sequence (TR 1800 msec; TE 20 msec). The images were obtained in sagittal plane with section thickness of 3-5 mm and intersection gap 1 mm.

Two observers retrospectively reviewed MR images (one is a musculoskeletal radiologist and one is a final-year [fourth year] orthopedic resident) with consensus agreement. They were blinded to MR reports and final clinical diagnosis of the patients. MR images were reviewed whether there was a presence of subligamentous spread; and further evaluated its location, number of levels involved, and its maximum thickness. Subligamentous spread was defined as elevation of the anterior longitudinal ligament from anterior border of the vertebral bodies. In this study, we designed to divide each vertebral body height into two levels equally; upper and lower parts. The intervertebral disk was counted as one level (Figure 1). The levels of the subligamentous spread were counted from its uppermost to lowermost border.

The sensitivity, specificity and accuracy of the subligamentous spread was calculated.

Result

In the 37 patients with spinal TB; three patients had disease involving the thoracic spine, 16 at the thoracolumbar spine, and 18 at the lumbar spine. No lesion was detected at the cervical spine. The subligamentous spread was found in 29 of 37 patients (78.37%). The mean of involved levels was 7.37 levels (range 0-19).The mean of maximum thickness of subligamentous spread was 3.56 mm (range 0-10 mm) (Table 1).

For 47 patients with spinal metastasis; thirteen patients had lesions at the cervical spine, 16 at the thoracic spine, 4 at the thoracolumbar spine, and 14 at the lumbar spine. The subligamentous spread was found in 19 of 47 patients (40.43%). The mean of involved levels of subligamentous spread was 3.38 levels (0-15). The mean of maximum thickness of subligamentous spread was 1.21 mm (range 0-9 mm) (Table 1).

With univariate analysis (Table 2), there was statistically significant difference (p-value < 0.05) in parameters of age, spinal location of disease involvement, presence subligamentous spread, and the num-

Table 1. Characteristic of the studied subgroups

Variable	Spinal tuberculosis (n=37)	Spinal metastasis (n=47)
Mean age (year)	45.05 (SD = 15.52)	54.44 (SD = 15.44)
Sex Male Female	15 (40.54%)22 (59.46%)	29 (61.70%)18 (38.30%)
Spinal location of disease involvement		
Cervical spine	0	13 (27.66%)
Thoracic spine	3 (8.11%)	16 (34.04%)
Thoracolumbar spine	16 (43.24%)	4 (8.51%)
Lumbar spine	18 (48.65%)	14 (29.79%)
Subligamentous spread		
Presence	29 (78.37%)	19 (40.43%)
Absence	8 (21.63%)	28 (59.57%)
Mean number of involved levels	7.37 (SD = 5.44)	3.38 (SD = 4.62)
Mean maximum thickness (mm)	3.56 (SD = 3.05)	1.21 (SD= 2.21)

Table 2. Univariate analysis from multiple logistic regressions

Variable	OR (95%CI)	p-value
Age (year)	0.96 (0.93-0.99)	0.010
Sex		
Male	1.00 (-)	-
Female	2.36 (0.97-5.7)	0.056
Spinal location of disease involvement		
Cervical spine	-	-
Thoracic spine	1.00 (-)	-
Thoracolumbar spine	21.33 (4.09-111.03)	< 0.0001
Lumbar spine	6.85 (1.66-28.28)	0.008
Subligamentous spread		
Presence	5.34 (2.01-14.17)	0.001
Absence	1.00 (-)	-
Number of involved levels	1.16 (1.06-1.28)	0.001
Maximum thickness (mm)	1.41 (1.15-1.73)	0.001

ber of involved levels and maximum thickness of subligamentous spread between the groups of spinal TB and spinal metastasis.

The most different location of disease involvement between spinal TB and metastasis was the thoracolumbar spine. The possibility of spinal TB increased about 1.16 times for every increased level of involvement of subligamentous spread. The probability of spinal TB increased about 1.4 times for each millimeter increase in maximum thickness of subligamentous spread.

With multivariate analysis (Table 3); there was statistically significant difference in the parameter of spinal location of disease involvement at the thora-

Table 3. Multivariate analysis from multiple logistic regressions

Variable	OR (95%CI)	p-value
Age (year)	0.98 (0.94-1.02)	0.355
Spinal location of disease involvement		
Cervical spine	-	-
Thoracic spine	1.00 (-)	-
Thoracolumbar spine	22.53 (3.55-142.88)	0.001
Lumbar spine	6.31 (1.24-32.09)	0.026
Maximum thickness of subligamentous spread (mm)	1.36 (1.06-1.75)	0.015

Table 4. Diagnostic test of subligamentous spread for spinal tuberculosis

	Sensitivity	Specificity	Positive predictive value	Negative predictive value	Accuracy	Likelihood ratio (positive test)	Likelihood ratio (negative test)
Presence	78.38	59.57	60.42	77.78	67.86	1.93	0.36
Maximum thickness > 2 mm	70.27	74.47	68.42	76.09	72.62	2.75	0.40
Involved levels ≥ 5	72.97	61.70	60.00	74.36	66.67	1.90	0.44

columbar spine (p=0.001) and lumbar spine (p=0.026), and maximum thickness of subligamentous spreads (p=0.015). Each millimeter of increased maximum thickness of subligamentous spread increased the probability of spinal TB about 1.36 times.

The sensitivity, specificity, positive and negative predictive value, accuracy and likelihood ratio of the presence of the subligamentous spread, including the levels involved and maximum thickness was shown in Table 4.

Discussion

MR imaging is the modality of choice to evaluate spinal infection;[9,10] included the diagnosis, severity, soft issue extension, and complications particularly neurological involvement. The destruction of bony structures such as vertebral body, endplate, and posterior elements can be evaluated in early stage. Because MR image provides excellent soft tissue contrast, it is suitable to evaluate soft tissue involvement, such as subligamentous spread, paraspinal and epidural extension and abscess.[4]

The differentiation between spinal tuberculosis and spinal metastasis is important because of different treatment and prognosis. Many MR imaging findings were described in spinal tuberculosis and subligamentous spread is one of them. Lack of proteolytic enzyme in mycobacterium was suggested to be the cause of subligamentous spreading, whereas other bacterial infection has this enzyme.[4] Although subligamentous spread is typically occurred in spinal tuberculosis, it can be observed in other spinal diseases, such as pyogenic spondylitis or certain tumors of the spine.

Our study found that the common locations of spinal TB was the thoracolumbar and lumbar spine but it was less common in thoracic spine. Jeong et al[11] also reported that the common location of spinal TB was at the lumbar region. However, there were some studies[2,12] reported that the common location of spinal TB was at the thoracic region. This may be due to difference in location categorization. In our study, we separated the location of the spinal involvement into thoracic, thoracolumbar, and lumbar regions.

We found that the presence of subligamentous spread was suggestive of spinal TB. Go et al and Chang et al[11,12] also addressed that subligamentous spread was typically seen in spinal TB and possibly associated with adjacent vertebral body involvement.

Tuberculosis is a slow progressive disease. The insidious onset of the TB may delay the diagnosis and treatment, ranges from weeks to several years,[5] so the imaging presentation in spinal TB are more pronounced when the diagnosis was done. This may be explaining why the more levels involved and the more thickness of the subligamentous spread was associated with the more likely diagnosis of spinal TB in our study.

The sensitivity, specificity and accuracy of subligamentous spread are not excellent enough to be the only imaging finding to diagnose spinal TB. These is corresponding with the prior study that showed no pathognomonic MR findings to differentiate TB form neoplasm.[4] However, the combination of subligamentous spread with other MR findings is useful. Jain et al[7] reported that 82% of spinal TB had combination of subligamentous spread, paravertebral collection, marrow edema, diskitis, and endplate erosion. Danchaivijitr et al[14] also reported 100% sensitivity and 88.2% specificity of the overall MR imaging findings for spinal TB.

The limitation of our study was a small number of subjects, so our results may not represent the whole population of our country. In addition, tuberculous infection itself has many predisposing factors that can make the disease more or less extensive and may affect the MR manifestation of spinal TB, such as malnutrition, alcoholism, drug abuse, diabetes mellitus, immunosuppressive treatment, and HIV infection.[4] But such factors are not included in our study.

Conclusion

There was statistically significant difference in the presence of subligamentous spread, the number of level involved, the maximum thickness, and the location of spinal involvement between the groups of spinal TB and spinal metastasis. The presence of subligamentous spread with the maximum thickness more than 3.56 mm is suggestive of spinal tuberculosis. Each millimeter of increased maximum thickness of subligamentous spread increased the probability of spinal TB about 1.36 times.

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Original Articles/นิพนธ์ต้นฉบับ

ความแม่นยำในการวินิจฉัยวัณโรคของกระดูกสันหลังด้วยลักษณะของ subligamentous spread ในภาพเอ็มอาร์ไอ

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บทคัดย่อ

วัตถุประสงค์: ศึกษาถึงการความน่าเชื่อถือของลักษณะ subligamentous spread ที่พบในภาพเอ็มอาร์ เพื่อใช้การวินิจฉัยวัณโรคของกระดูกสันหลัง

วัสดุและวิธีการ: ทำการศึกษาย้อนหลังจากภาพเอ็มอาร์ของผู้ป่วยที่เป็นวัณโรคที่กระดูกสันหลัง และผู้ป่วยที่มีการกระจายของมะเร็งมาที่กระดูกสันหลังรวมทั้งหมด 84 ราย เพื่อหาความแตกต่างของลักษณะ subligamentous spread ในผู้ป่วยทั้งสองกลุ่ม

ผลการศึกษา: พบว่าตำแหน่งของรอยโรคที่กระดูกสันหลังและความหนาที่มากที่สุดของ subligamentous spread มีความแตกต่างกันอย่างมีนัยสำคัญทางสถิติทั้งในการวิเคราะห์แบบหลายตัวแปรและตัวแปรเดี่ยว ในการวิเคราะห์ตัวแปรเดี่ยวยังแสดงถึงการพบ subligamentous spread และจำนวนของระดับที่พบ subligamentous spread ก็แตกต่างกันอย่างมีนัยสำคัญทางสถิติ ความหนาของ subligamentous spread ที่เพิ่มขึ้นทุก 1 มิลลิเมตรจะเพิ่มความน่าจะเป็นของวัณโรคที่กระดูกสันหลังขึ้น 1.36 เท่า ลักษณะ subligamentous spread มีค่าความไวร้อยละ 78.38 ความจำเพาะร้อยละ 59.57 คุณค่าทำนายผลบวกร้อยละ 67.86 คุณค่าทำนายผลลบร้อยละ 60.42 และความแม่นยำร้อยละ 77.78

สรุป: ตำแหน่งของรอยโรคที่กระดูกสันหลัง การพบ subligamentous spread จำนวนของระดับที่พบและความหนาของ subligamentous spread มีความแตกต่างกันอย่างมีนัยสำคัญทางสถิติในกลุ่มผู้ป่วยที่เป็นวัณโรคของกระดูกสันหลัง และผู้ป่วยที่มีการกระจายของมะเร็งมาที่กระดูกสันหลัง ความหนาของ subligamentous spread ที่เพิ่มขึ้นจะเพิ่มความน่าจะเป็นของวัณโรคที่กระดูกสันหลังขึ้น

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