Clinical Significance of MRI Findings During Medical Treatment for Tuberculous Spondylitis

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Purpose : To evaluate magnetic resonance (MR) imaging features of non-surgically treated tuberculous spondylitis and to evaluate the relationships between these features and clinical outcomes.

Materials and Methods : Data from ten patients (male:female = 6:4, mean age = 45 years) with clinically proven tuberculous spondylitis who were treated nonsurgically over three months were analyzed retrospectively from 2000 to 2007. MRI was performed at least three times for each patient, at baseline, every three or six months, and at the end of treatment. All images were analyzed by two radiologists.

Results : The mean follow-up period for the MR examination was 10.1 months (range, 4–17 months). Six patients had clinically complete resolution of tuberculous spondylitis with medication treatment only. Four patients were treated with surgical management alongside medication. All ten patients were divided into two groups by clinical outcome; six patients with complete treatment and four patients with incomplete treatment. In the complete treatment group, follow-up MR findings showed a loss of subligamentous spread of abscesses, decreased size of abscesses, no interval changes in vertebral body heights, and fatty changes in spinal lesions. MR findings in the incomplete treatment group showed bone marrow edema extension to adjacent vertebra, extension of the abscesses, and decreased height of the vertebral bodies.

Conclusion : During the nonsurgical management of tuberculous spondylitis, MR imaging may play a role in predicting patient response to antituberculous drug treatment.

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Introduction

Despite the reduced prevalence of tuberculosis since the advent of anti-tuberculous drugs, the incidence of extra-pulmonary tuberculosis continues to increase (1). The spine is the most common site of skeletal involvement (1, 2), and spinal tuberculosis is the most clinically significant extra-pulmonary form of tuberculosis. Early detection and treatment are necessary, as tuberculosis may lead to serious neurological sequelae due to compression of the spinal cord either by the disease itself or the resultant deformity. Although treatment of spinal tuberculosis has always been controversial, surgical treatment of tuberculous spondylitis is considered only in cases with severe spinal instability or with progressive neurological symptoms and evidence of cord compression or deformity. However, the use of medical management without surgical intervention has increased due to the effectiveness and specificity of modern drug treatments for tuberculosis (3, 4).

Magnetic resonance imaging (MRI) is sensitive enough to detect spinal tuberculosis, and is the imaging technique of choice in spinal infections (5). MRI is commonly used at the time of diagnosis; however, it is unclear whether spinal abnormalities seen on MRI change during medical treatment. The purpose of our study is to analyze MRI features of tuberculous spondylitis treated non-surgically and to correlate these features with clinical outcomes.

Materials and Methods

A retrospective study was designed and performed in our hospital from January 2000 to March 2007. We reviewed the medical records of 155 patients who had been treated for clinically proven tuberculous spondylitis. We excluded patients who were treated surgically within three months after their initial diagnosis. We also excluded patients in whom MRI was not performed more than twice, including at baseline, every 3 or 6 months, and the end of treatment.

MRI examinations were performed with a 1.5-T MR system (Vision; Siemens, Erlangen, Germany) using the following protocol: [1] sagittal T2-weighted (repetition time/echo time, 4000/120 ms; slice thickness, 3 mm; 256 × 138 matrix; 250 × 156-mm field of view), axial T2-weighted (repetition time/echo time, 4000/120 ms; slice thickness, 3 mm; 256 × 112 matrix; 200 × 125-mm field of view), sagittal T1-weighted (repetition time/echo time, 450/10 ms; slice thickness, 3 mm; 256 × 138 matrix; 250 × 156-mm field of view), sagittal T1-weighted images after gadolinium injection, and [2] axial T1 -weighted images (repetition time/echo time, 640/10 ms; slice thickness, 4 mm; 256 × 112 matrix; 200 × 125-mm field of view) [3] composed of two volumes, as well as sagittal T2-weighted images (repetition time/echo time, 4000/120 ms; slice thickness, 3 mm; 256 × 138 matrix; 500 × 156-mm field of view) to obtain sagittal views of the whole spine by using a standard spine circular polarization array coil.

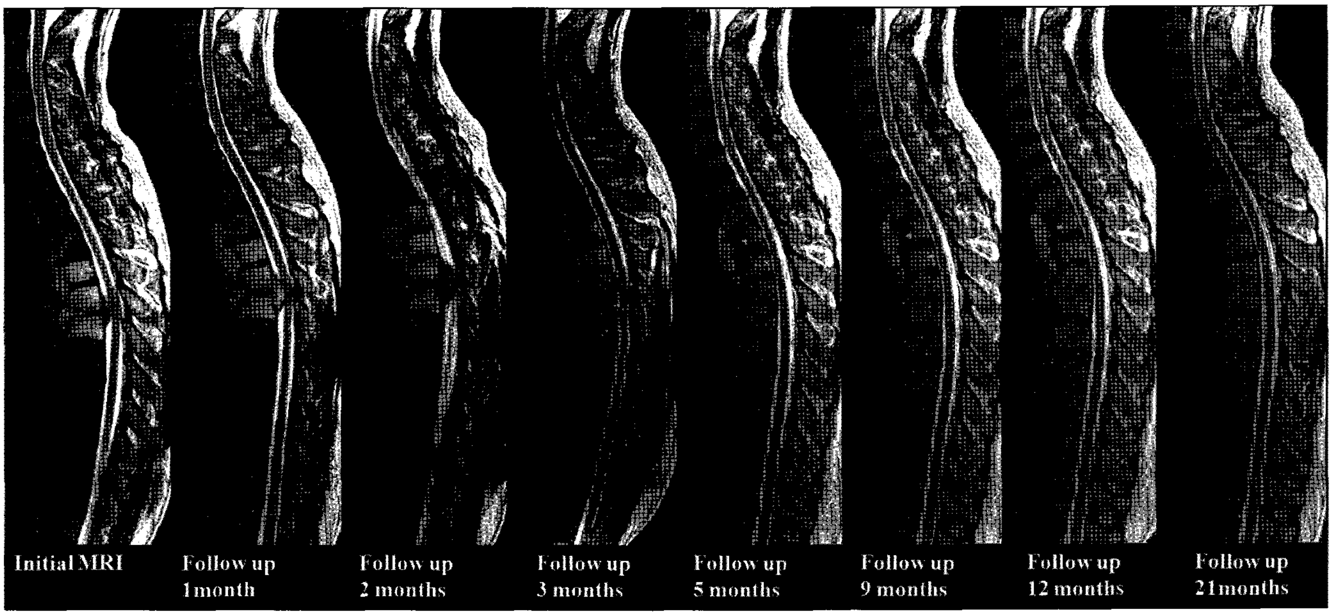
All images were analyzed via consensus by two radiologists who were blinded to clinical outcome. The following parameters were assessed on the initial and follow-up MR images (6): [1] distribution and number of involved vertebrae: bone marrow edema by T1 hypointensity and gadollium contrast agent enhancement; [2] presence of abscesses: sub-ligamentous, paravertebral, psoas; [3] vertebral deformity: loss of configuration of the vertebral body by spondylitis; [4] thecal sac compression: induced by backwards displacement of the posterior wall or epidural abscess; and [5] fatty change of the vertebra: bone marrow by T1 signal intensity.

Results

Our study involved six males and four females ranging from 19 to 61 years of age, with a mean age of 45 years. Back pain (90%) and fever (10%) were initially present in some patients; however, none of the patients had any major neurological deficits at baseline. No patients had a past history of tuberculosis. The mean follow-up period of the MR examination was 10.1 months (range, 4–17 months). Standard (first line) four-drug therapy (isoniazid, 400 mg; rifampicin, 600 mg; ethambutol, 800 mg; and pyrazinamide, 500 mg) was administered to all patients during a mean period of 11.3 months (range, 5–20 months).

On initial MR examination, all patients showed bone marrow edema in the involved vertebrae. Seven patients had two involved vertebrae, one patient had three involved vertebrae, and two patients had more than four vertebrae involved. The distribution of spinal lesions was thoracic (four lesions), lumbar (seven lesions), and sacral (one lesion). The affected locations were in the thoracic spine (three patients) and lumbar spine (six patients) or were multifocal/noncontiguous (one patient). Eight patients had abscesses (subligamentous, paravertebral, and psoas). Thecal sac compression was noted in six patients and had been induced by epidural abscess (four patients) or backward displacement of the posterior wall (two patients).

Clinically physicians concluded that complete resolution of tubercuous spondylitis-clinical assessment, such as sign, symptom, laboratory findings, and imaging findings - had occurred in six patients who were treated with medication only. Two patients underwent surgical drainage of psoas abscesses due to the increased size of these abscesses. Two patients were referred to another hospital for surgical treatment. We divided all patients into two groups according to the clinical outcomes - six



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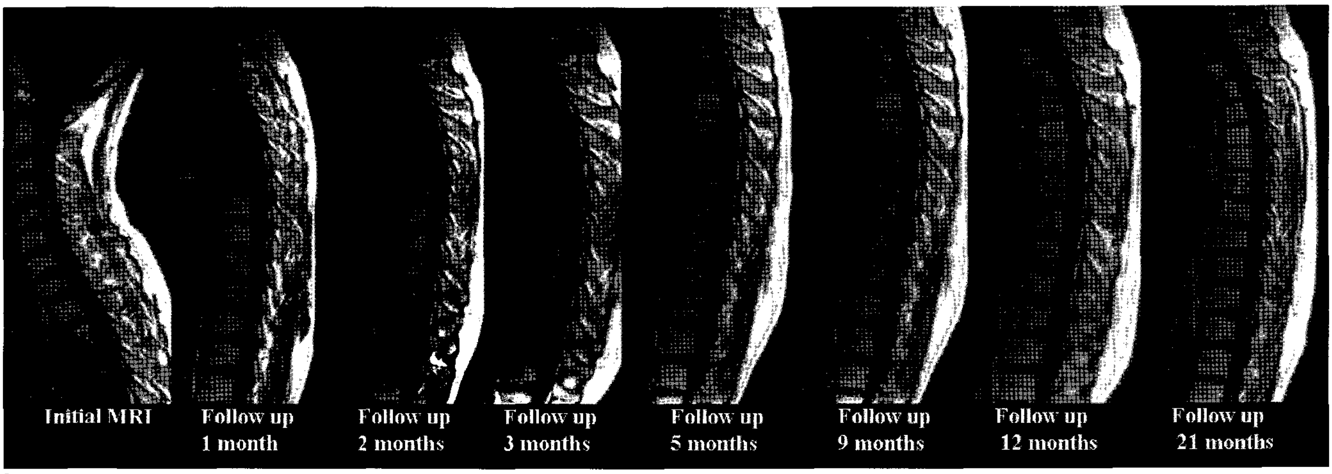

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Fig. 1. A 45-year-old man with tuberculous spondylitis, who experienced clinically complete resolution after drug-only therapy.
a. Serial T2-weighted sagittal images show a loss of the subligamentous spread of the abscess and decreased size of the epidural abscesses during the 21-month treatment. **b.** Serial T1-weighted sagittal images show disappearance of bone marrow edema and fatty change during the 21-month treatment.

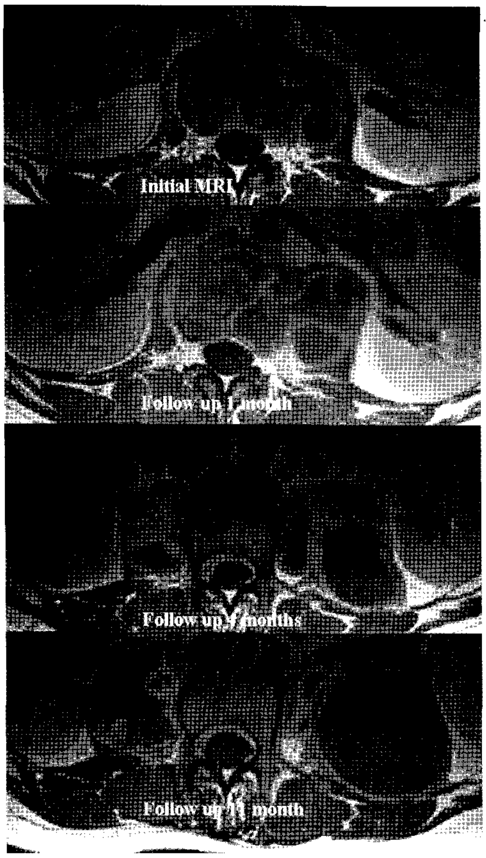
patients who received complete treatment and four patients who received incomplete treatment. Most of the follow-up MR findings for the complete treatment group (n = 6) showed loss of subligamentous spread of abscesses (6/6), decreased size of abscesses (6/6), no interval change of vertebral body height (4/6), and fatty changes of the spinal lesions (6/6). The follow-up MR findings of the incomplete treatment group (n = 4) showed bone marrow edema extension to adjacent vertebra (1/4), extension of the abscesses (4/4), and decreased height of vertebral bodies (3/4) (Figs.1 and 2; Tables 1 and 2).

Table 1. Clinical Characteristics and Initial MRI Findings of Complete Treatment and Incomplete Treatment Groups

	Complete Treatment group (n = 6)	Incomplete Treatment group (n = 4)
Mean age (range)	45 (19-61) years	58 (30-54) years
Male/Female	4/2	2/2
Site of lesion		
Thorasic	3	
Lumbar	2	4
Noncontiguous	1	
Number of involved vertebrae		
2	4	3
3		1
More than 4	2	
Abscesses	4	4
Spinal compression	2	4

Table 2. Characteristic Follow-up MRI Findings from Complete Treatment and Incomplete Treatment Groups

Complete Treatment (n = 6)	
Loss of subligamentous spread of abscess	6 (100%)
Decreased size of perivertebral/epidural abscess	6 (100%)
No interval change of vertebral body height	4 (66%)
Fatty change of the spinal lesion	6 (100%)
Incomplete treatment group (n = 4)	
Bone marrow edema extension to the adjacent vertebra	1 (25%)
Decreased height of vertebral body	3 (75%)
Extension of subligamentous spread of abscess	3 (75%)
Extension of psoas abscess	4 (100%)



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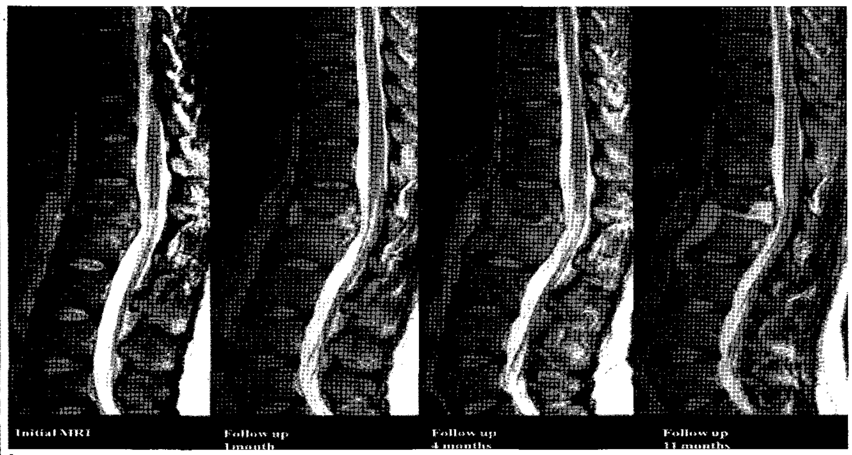

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Fig. 2. A 31-year-old woman with tuberculous spondylitis, who had a poor response to drug therapy.
a. Serial T1-weighted enhanced axial images show extension of the psoas abscess during the 11-month treatment. **b.** Serial T2-weighted sagittal images show subligamentous spread of the abscess during the 11-month treatment.

Discussion

Tuberculosis that has spread to the spine is caused by the hematogenous seeding of mycobacteria via the arterial or venous system, although the arterial route is more significant (7). The most frequently involved site is the thoracolumbar junction. Destruction of bone by tuberculosis can lead to kyphotic deformity (8-10).

Compared to computed tomography (CT), MRI is better at detecting asymptomatic lesions and allows for more precise assessment of neurological lesions, such as epidural abscess and spinal or radicular compression. MRI also generates better information for assessing paravertebral soft tissue involvement, spinal involvement, and edematous changes in medullar cancellous bone (11, 12).

Moorthy and Prabhu described four categories of lesions; [1] paradiskal lesions , adjacent to the intervertebral disc, [2] anterior subperiosteal lesion, over multiple levels [3] central lesions without disc involvement, [4] posterior element involvement. Most patients in this study showed a combined pattern of paradiskal lesions with anterior subperiosteal lesions (13). Two patients in the complete treatment group had a paradiskal lesion pattern that mimicked pyogenic spondylitis, and were confirmed as tuberculosis by polymerase chain reaction (PCR). One patient in the incomplete treatment group showed a central lesion pattern that mimicked a malignant lesion, with tuberculosis confirmed by biopsy. Thus, in this study, these patterns were not useful for diagnostically discriminating the complete treatment group from the incomplete treatment group. We did not observe posterior element involvement.

Page et al. (14) described imaging results with regard to the responsiveness of tuberculous spondylitis to medical treatment - paravertebral abscesses regressed in 85% of patients at 12 months, epidural abscesses regressed in 100% of patients at nine months, and the edematous signal of the vertebral body gradually converted to a fatty signal in 75% of patients at 12 months. In our study, fatty changes in the involved vertebrae were observed in all patients in the complete treatment group at a mean period of nine months (range, 6-13 months). Also, perivertebral and epidural abscesses had nearly disappeared at a mean period of 10 months (range, 6-13 months) in three patients in the response group. Although abscesses and bone marrow edema on adjacent vertebra remained, the initially involved vertebrae showed an increase in T1 weighted images (fatty change) on follow-up MRI. Therefore, we consider fatty changes on initially involved vertebrae to be a reliable indicator of response.

The MRI findings revealed extension of psoas abscesses in all of the incomplete treatment patients. Prevertebral, epidural-caused spinal compression or psoas abscesses were initially observed on MRI. With disease progression, psoas abscesses increased in size or were newly developed, while prevertebral, epidural abscesses decreased in size. Generally, in tuberculous spondylitis, a paraspinal abscess is formed secondary to destruction of the cortical bone and elevation of the periosteum. In one case of periosteal penetration by the inflammatory mass, the psoas abscess extended inferiorly as far as the groin and thigh under the psoas sheath along the muscle course (15). Our analysis of MRI showed an intra-osseous abscess in all cases, and this abscess caused deformity of the vertebrae and provided the route for psoas abscesses.

The limitations of this study include small sample size, retrospective data collection, unsatisfactory clinical information, and irregularity of the follow-up periods between MRIs. In particular, we could not correlate MRI findings and the clinical process and patient information, such as the patient's symptoms, as well as assessment of the success or failure of the patient's drug administration. Thus, this study had many biases. Because of these limitations, statistical analysis was impossible.

In conclusion, MRI may have a role in predicting the response to antituberculous drug treatment during non-surgical treatment of tuberculous spondylitis. Furthermore, follow-up MRI is helpful in monitoring the response to therapy.

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척추염 환자의 약물치료기간 중 추적 검사한 MRI소견 변화의 임상적 중요성

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목적: 비수술적 치료를 시행한 결핵성 척추염 환자의 MRI의 특징과 임상결과에 따른 MRI특징을 알아보고자 하였다.
대상과 방법: 2000년부터 2007년까지 임상적으로 결핵성 척추염을 진단 받은 환자 중 3개월 내에 수술적 치료를 받지 않은 환자를 대상하였으며 이중 최소한 3회 이상, 처음, 3개월 혹은 6개월 그리고 치료 종료시점상 MRI 검사를 시행한 환자를 연구군에 포함하여 후향적 분석을 시행하였다. 두 명의 영상의학과 의사가 모든 MR검사를 분석하였으며 임상결과와의 상관관계를 분석하였다.
결과: 열명(남:여=6:4, 평균나이=45세)의 환자가 연구대상 군에 포함되었으며 MR검사의 평균 추적검사기간은 10.1개월(4-17개월)이였다. 6명의 환자는 임상적으로 결핵성 척추염의 완치판정을 받았으며 4명의 환자는 3개월 이상 약물치료를 시행 받았으나 약물치료만으로는 완치되지 않아 추가적인 수술적 치료를 시행하였다. 모든 환자는 임상적 경과에 따라 두 군으로 분류하였으며 위의 6명은 완전 치료 군 4명은 불완전 치료 군으로 분류하였다. 완전 치료군의 MR특징은 결핵성 농의 인대 하 파급 및 농 자체의 크기감소, 척추체의 붕괴소견 없음 그리고 감염된 척추체의 지방변성이었음. 불 완전 치료군의 MR특징은 골수부종과 결핵성 농의 확장과 척추체의 붕괴였다.
결론: 결핵성 척추염의 비수술적 치료에 있어서 MRI는 치료반응을 예견하는데 한 역할을 담당할 것으로 생각된다.

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