


MRI Characteristics Distinguishing Tuberculous Arthritis from Rheumatoid Arthritis: A Comparative Study

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Abstract

Objective: Skeletal tuberculosis (TB) arthritis is an uncommon but significant cause of osteoarticular morbidity, representing less than 1% of all TB cases. Delayed diagnosis often leads to persistent joint stiffness and pain. This study aims to identify early magnetic resonance imaging (MRI) features that distinguish TB arthritis from rheumatoid arthritis (RA).

Methods: The MRI scans were retrospectively analyzed from 2010 to 2017 of 21 patients diagnosed with TB arthritis and 82 patients with RA. Imaging characteristics including synovial effusion, synovial membrane thickness, abscess wall thickness, bony erosions, rice body formation, tenosynovitis, adjacent soft tissue inflammation, and joint space narrowing were compared between the 2 groups.

Results: Compared to RA, TB arthritis patients demonstrated significantly greater abscess wall thickening ($P=.001$) and rice body formation ($P=.008$), alongside less pronounced joint space narrowing.

Conclusion: In patients presenting with chronic arthritis, the presence of thickened abscess walls, rice bodies, and relatively preserved joint space on MRI serve as early diagnostic markers favoring TB arthritis over RA.

Keywords: Abscess wall, joint space narrowing, magnetic resonance imaging, rheumatoid arthritis, rice bodies, skeletal tuberculosis, tuberculous arthritis

Introduction

Musculoskeletal tuberculosis (TB) is a relatively uncommon form of extrapulmonary TB caused by *Mycobacterium tuberculosis*, accounting for approximately 1% to 3% of all TB cases worldwide.^{1,2} Among these musculoskeletal cases, about half involve the spine, commonly known as Pott's disease, while the remaining cases affect extraspinal osteoarticular joints such as the hips, knees, ankles, and small joints of the hands and feet.³⁻⁸ Tuberculous arthritis typically presents as a monoarticular infection, characterized by the direct invasion of *M. tuberculosis* into the synovium, where the organism can often be isolated.⁹ Uslu et al¹⁰ reported a rare case of wrist monoarthritis due to tuberculosis, initially misdiagnosed as carpal tunnel syndrome, highlighting the diagnostic challenge and rarity (~1%) of wrist involvement in skeletal TB.

Despite its relatively low prevalence, musculoskeletal TB remains a major cause of morbidity, particularly in endemic regions or immunocompromised populations.^{11,12} One of the main challenges in managing TB arthritis is the frequently long delay in diagnosis. This delay often stems from its nonspecific clinical manifestations and radiologic features, which may closely mimic other more common conditions such as rheumatoid arthritis (RA), septic arthritis, or osteoarthritis.^{13,14} Patients often present with chronic joint pain, swelling, and limited motion without systemic symptoms, complicating early clinical suspicion.¹⁵

Early diagnosis of TB arthritis is critical to prevent irreversible joint damage. Preservation of articular cartilage and maintenance of joint space require prompt initiation of appropriate anti-tuberculous therapy alongside supportive treatment.¹⁶ Failure to recognize the disease in its early stages can lead to joint destruction, deformities, and long-term functional impairment.¹⁷ Unfortunately, diagnosis is often delayed due to multiple factors, including the insidious onset of symptoms, lack of characteristic early radiographic findings, absence of constitutional symptoms or active pulmonary TB, and limited awareness among clinicians, particularly in non-endemic areas.¹²

Radiographic imaging plays a vital role in evaluation, but plain X-rays are often normal or nonspecific in the early stages.¹⁸ Ultrasound may reveal synovial thickening and effusion, but these findings are also common in inflammatory arthritis of other etiologies.¹⁹ Magnetic resonance imaging (MRI), with its superior soft tissue contrast and ability to detect early synovial and bone marrow changes, has increasingly become

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the modality of choice for early detection of TB arthritis.²⁰ However, specific MRI features that can reliably differentiate TB arthritis from other forms of chronic arthritis remain under investigation.

Therefore, the objective of this study was to systematically identify and compare the clinical, radiographic, ultrasound, and MRI characteristics of TB arthritis with those of rheumatoid arthritis. Recognizing these distinctive imaging markers can facilitate earlier diagnosis and improve patient outcomes by guiding timely and appropriate treatment.

Material and Methods

Research Design

This study was designed as a retrospective case-control analysis aimed at comparing imaging features between patients diagnosed with TB arthritis and those with RA. Cases included patients confirmed to have TB arthritis, while controls consisted of patients diagnosed with RA. The study period spanned from January 2010 through December 2017. This design enabled a direct comparison of MRI characteristics between these 2 distinct but clinically overlapping arthritic conditions, following similar approaches reported in previous musculoskeletal imaging studies.^{20,21}

Patient Selection Criteria

Diagnostic Criteria for Tuberculous Arthritis

The diagnosis of TB arthritis was established through definitive microbiological and histopathological evidence. Specifically, patients were included if *Mycobacterium tuberculosis* was isolated by culture or polymerase chain reaction from synovial tissue or fluid specimens.

In cases where culture results were negative or unavailable, the diagnosis was supported by characteristic granulomatous inflammation with caseating necrosis on biopsy, consistent with prior protocols for diagnosing osteoarticular tuberculosis.²² Clinical presentation and response to anti-tuberculosis therapy also aided confirmation.

Diagnostic Criteria for Rheumatoid Arthritis

Patients classified as having RA fulfilled the 2010 American College of Rheumatology (ACR)/European League Against Rheumatism (EULAR) classification criteria for RA.²³ This included patients exhibiting joint involvement, serologic markers such as rheumatoid factor and anti-cyclic citrullinated peptide antibodies, acute phase reactants, and symptom duration. These criteria have been validated internationally and are widely accepted for clinical and research purposes.

Inclusion Criteria

Eligible patients were those aged 20 years or older who had undergone MRI examinations of the affected joint(s) during the study period. Both TB arthritis and RA groups required MRI studies of sufficient quality to allow detailed assessment of synovial and periarticular structures.

Exclusion Criteria

Patients were excluded if they met any of the following criteria to reduce confounding factors that might affect joint imaging or systemic health status:

1. Presence of joint infection caused by pathogens other than *Mycobacterium tuberculosis*, including bacterial or fungal arthritis.²⁴
2. Recent history (within 3 months) of significant cardiovascular or cerebrovascular events, such as primary intracerebral hemorrhage, myocardial infarction, or unstable peripheral vascular disease, major surgery, or systemic hemorrhage, which could influence inflammatory markers or imaging findings.²⁵
3. Known hematological malignancies or disorders affecting coagulation, platelet function, or counts, as these conditions may alter synovial vascularity and imaging characteristics.²⁶
4. Major systemic illnesses including end-stage renal disease, liver cirrhosis, or congestive heart failure, given their potential to influence systemic inflammation and fluid balance, thereby confounding MRI assessments.²⁷

Imaging Protocol and Evaluation

All MRI examinations were performed using standardized imaging protocols on 1.5 or 3 Tesla scanners. Imaging sequences included T1-weighted, T2-weighted with fat saturation, and post-contrast enhanced images to evaluate joint structures comprehensively. Experienced musculoskeletal radiologists blinded to clinical diagnoses independently reviewed the images for features such as synovial effusion, synovial membrane thickness, abscess formation and wall thickness, bony erosions, rice body presence, tenosynovitis, adjacent soft tissue inflammation, and joint space narrowing.

Ethical committee approval was received from the Ethics Committee of University of Chang Gang (Approval no: 201700938B0, Date: June 1, 2017).

Statistical Analysis

Data analysis was conducted using SPSS software, version 22 (IBM Corp., Armonk, NY, USA). Continuous variables are expressed as means \pm standard deviations. Independent *t*-tests were applied to compare mean values of MRI features between TB arthritis and RA groups. Multivariate logistic regression analyses were employed to identify imaging characteristics independently associated with TB arthritis while controlling for potential confounders. Statistical significance was defined as a 2-tailed *P*-value less than .05, consistent with conventional biomedical research standards.²⁸

Results

Between December 2011 and December 2017, a total of 103 patients were enrolled in this study, comprising 21 patients diagnosed with TB arthritis and 82 patients with RA. The mean age of the TB arthritis cohort was 64.1 ± 14.48 years, notably older than the RA group, whose mean age was 56.85 ± 12.19 years. This age difference may reflect the typical demographic distribution of these conditions, as TB arthritis often affects older individuals, whereas RA can present across a broader adult age range.

The anatomical distribution of affected joints in the TB arthritis group was relatively varied. Specifically, 5 cases involved the knee joint, another 5 involved the shoulder, 2 cases affected the hip, 5 the wrist, and the remaining 5 involved the ankle joint. This distribution underscores the predilection of TB arthritis for large weight-bearing joints and those with extensive synovial tissue, consistent with previous epidemiological reports.

Main Points

- Early magnetic resonance imaging (MRI) features can help differentiate skeletal tuberculosis (TB) arthritis from rheumatoid arthritis.
- The TB arthritis shows significantly thicker abscess walls compared to RA ($P = .001$).
- Rice body formation is more frequent in TB arthritis ($P = .008$).
- Joint space is relatively preserved in TB arthritis despite chronic symptoms.
- Magnetic resonance imaging–based recognition of these features may facilitate earlier diagnosis and targeted treatment.

When comparing MRI features between the TB arthritis and RA groups, several significant differences emerged. The TB arthritis patients demonstrated a markedly greater degree of abscess wall thickening ($P=.001$), suggesting a higher tendency toward localized infectious collections with granulomatous inflammation. This finding was exemplified in Figure 1, where thickened abscess walls surrounding joint effusions were clearly visualized.

Additionally, rice body formation—small, fibrinous bodies within the joint space—was significantly more prevalent in the TB arthritis group ($P=.008$). The presence of rice bodies is considered characteristic of chronic synovial inflammation and has been particularly associated with tuberculous and other granulomatous arthritis.

Conversely, joint space narrowing, a hallmark of chronic inflammatory joint destruction, was significantly less pronounced in the TB arthritis group compared to RA patients ($P=.001$). This likely reflects the more aggressive synovial pannus and cartilage degradation typically seen in RA, whereas TB arthritis may preserve joint space in early or mid-stages despite significant synovial pathology.

For other MRI parameters, such as joint effusion volume, synovial membrane thickness, presence of bone erosion, bone marrow edema, tenosynovitis, and adjacent soft tissue inflammation, no statistically significant differences were observed between the 2 groups. These overlapping imaging features highlight the challenges in distinguishing TB arthritis from

RA based solely on routine MRI parameters, underscoring the diagnostic value of identifying specific findings such as abscess wall thickening and rice bodies.

All relevant MRI findings are summarized in Table 1, providing a comprehensive comparison of imaging characteristics between TB arthritis and RA groups.

Discussion

Monoarticular arthritis encompasses a broad spectrum of etiologies, including infectious causes such as pyogenic and tuberculous arthritis, as well as noninfectious disorders like synovial osteochondromatosis, pigmented villonodular synovitis, RA, gout, and hemophilic arthropathy.²⁹ Differentiating among these causes based on clinical and imaging features can be challenging, particularly in the early stages of disease. Osteoarticular tuberculosis accounts for approximately 1.5% to 3% of musculoskeletal tuberculosis cases.³⁰ The global incidence of extrapulmonary tuberculosis has been rising steadily over recent decades, largely due to demographic shifts such as an aging population, the increasing prevalence of chronic illnesses, and greater numbers of immunocompromised individuals, including those with HIV/AIDS or receiving immunosuppressive therapies.²⁴

Early diagnosis and initiation of appropriate therapy are critical for a favorable prognosis and the preservation of joint function in TB arthritis. Unfortunately, diagnosis is often delayed due to the low sensitivity of tissue culture and the indolent, nonspecific clinical

Table 1. Differences of MRI Characteristics between TB Arthritis and RA

	TB (n = 21) (%)	RA (n = 82) (%)	P
Wall thickness	11 (52.4)	3 (3.7)	.001
Effusion	21 (100)	69 (84.1)	.473
Thick synovium	17 (81.0)	57 (69.5)	.797
Rice bodies	3 (14.3)	0 (0)	.008
Bone erosion	14 (66.7)	66 (80.5)	.239
Bone marrow edema	14 (66.7)	63 (76.8)	.400
Tenosynovitis	12 (57.1)	62 (75.6)	.108
Adjacent soft tissue inflammation	13 (61.9)	34 (41.5)	.140
Joint space narrowing	11 (52.4)	82 (100)	.001

MRI, magnetic resonance imaging; RA, rheumatoid arthritis; TB, tuberculosis.

presentation of the disease. This often necessitates invasive procedures, such as surgical biopsy, to obtain histological confirmation.³¹ Given these challenges, the study aimed to explore the potential utility of noninvasive imaging techniques, particularly magnetic resonance imaging (MRI), to identify characteristic features that may facilitate early recognition of TB arthritis.

Because RA is also a chronic inflammatory arthritis that leads to progressive cartilage degradation, bone erosion, and eventual joint deformity and loss of function,³² RA patients were selected as a comparison group to help elucidate imaging findings that are more specific to TB arthritis. Both conditions can manifest overlapping radiographic features, such as periarticular osteopenia, marginal erosions, and joint effusions, which complicates differential diagnosis.²⁰ For example, Chen et al described a case of ankle TB arthritis exhibiting multiple loculated cystic lesions with wall enhancement on MRI.³³ Building upon such findings, the study confirmed that abscess wall thickening is a prominent and distinguishing MRI feature in TB arthritis; more than half of the TB arthritis patients exhibited this characteristic, whereas it was uncommon in RA patients. This supports the notion that abscess wall thickening is an important early marker for TB arthritis.

Extraarticular “cold” abscesses are well-documented in tuberculous arthritis.²² On MRI, these abscesses typically appear as cystic

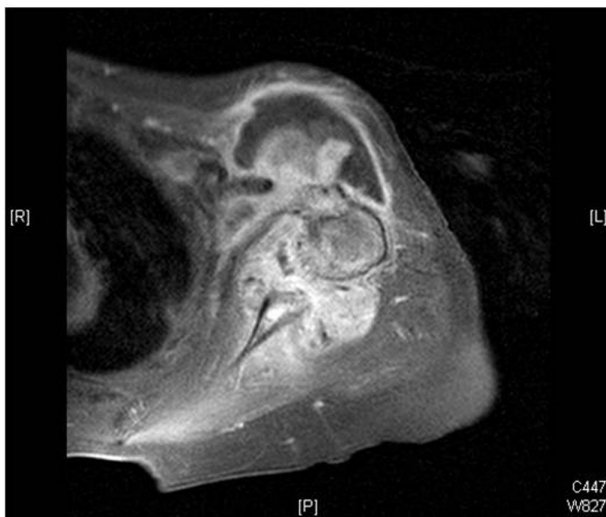


Figure 1. Magnetic resonance image (T1-weighted) of a 70-year-old male presenting with chronic pain and swelling in the left shoulder. The image demonstrates synovial thickening within the glenohumeral joint accompanied by joint effusion. Notably, there is marked thickening of the abscess wall and a fluid collection with a thickened capsule located over the subdeltoid bursa.

masses with rim enhancement but without significant surrounding edema or inflammatory changes, distinguishing them from pyogenic abscesses.³³ The thickened wall observed in these abscesses likely reflects the chronic granulomatous inflammatory response characteristic of TB infection. This finding is consistent with previous reports emphasizing the role of cold abscesses in the pathology of musculoskeletal TB.³⁴

Another significant observation in the study was the presence of rice bodies within the joint space. Rice bodies are small fibrinous aggregates that arise in chronic synovitis and have been associated with several inflammatory and infectious arthritides, including RA and infections such as candidiasis.³⁵ In the TB arthritis cohort, rice bodies were identified in 3 out of 21 patients (14.3%). While the presence of rice bodies may suggest chronic synovial inflammation, their occurrence alone is not pathognomonic for TB arthritis and should be interpreted alongside other clinical and imaging findings.³⁵

Bone marrow edema, a marker of active inflammation and bone involvement, was observed in both TB arthritis and RA patients without significant difference between the groups. This is in line with previous studies indicating that bone marrow edema is a nonspecific finding present in various inflammatory arthritides.³⁶ Similarly, both TB arthritis and RA patients exhibited hypertrophic synovium and bony erosions, limiting the utility of these findings in distinguishing between the 2 diseases. However, joint space narrowing was significantly more prominent in RA, which may be explained by the more aggressive and chronic synovial pannus formation in RA that leads to progressive cartilage destruction.²⁰

Several limitations should be considered when interpreting the results. First, the heterogeneity in affected joints between the TB arthritis and RA groups introduced potential selection bias, as different joints may exhibit varying imaging characteristics. Matching patients by joint site would strengthen future analyses. Second, the retrospective nature of this study limited the ability to calculate sensitivity, specificity, or predictive values for individual MRI features, which would be valuable for clinical application. Third, variability in MRI protocols and parameters could have influenced imaging assessments. Prospective studies using standardized imaging protocols are warranted to validate these findings.

In conclusion, the study demonstrates that MRI findings of abscess wall thickening, rice body formation, and relatively preserved joint space are more characteristic of TB arthritis than RA. While overlapping features exist, MRI evaluation can provide important clues to differentiate these 2 clinically similar yet distinct entities, potentially enabling earlier diagnosis and timely treatment of TB arthritis.

Data Availability Statement: The data that support the findings of this study are available on request from the corresponding author.

Ethics Committee Approval: Ethical committee approval was received from the Ethics Committee of University of Chang Gung (Approval no: 20170093880, Date: July 5, 2017).

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