

Primary Bone Lymphoma of the Tibia Mimicking Stress Injury: The Classic Imaging Paradox Between Conventional Imaging and MRI

Kevin Pierre, Rishabh Agrawal, Kalyani N Ballur, Diego A L Garcia*

Abstract

Primary bone lymphoma (PBL) is an uncommon malignant neoplasm that frequently presents nonspecific symptoms and subtle findings on conventional imaging, which may delay diagnosis. A characteristic image feature of PBL is the discrepancy between minimal abnormalities on radiographs or computed tomography (CT) and extensive marrow involvement on magnetic resonance imaging (MRI).

We report the case of a 25-year-old male presenting with progressive anterior tibial pain after recreational soccer activity. Initial clinical suspicion was a tibial stress injury. Radiographs and CT demonstrated only subtle intramedullary sclerosis without cortical destruction or periosteal reaction. In contrast, MRI revealed extensive marrow infiltration involving the proximal tibial epiphysis, metaphysis, and diaphysis. Image-guided biopsy confirmed diffuse large B-cell lymphoma. This case highlights the classic imaging paradox of primary bone lymphoma and emphasizes the crucial role of MRI when clinical symptoms appear disproportionate to findings on radiography or CT. Early recognition of this imaging pattern can expedite biopsy and diagnosis, preventing delays in treatment.

Keywords: Primary bone lymphoma; Tibia; Stress injury; MRI; Imaging paradox; Diffuse large B-cell lymphoma.

Introduction

Primary bone lymphoma (PBL) is a rare malignant tumor defined as lymphoma arising within bone without evidence of systemic disease at the time of diagnosis or within the initial staging period. It accounts for approximately 3–5% of primary bone tumors and less than 1% of all non-Hodgkin lymphomas [1-4]. Diffuse large B-cell lymphoma (DLBCL) represents the most common histologic subtype, comprising nearly 70–80% of cases [5-7]. PBL typically affects adults in the fourth to sixth decades of life, although younger individuals may also be affected [8-10]. Patients most often present with localized bone pain, which may precede diagnosis by several months. Systemic “B-symptoms,” including fever, night sweats, and weight loss, are uncommon in isolated skeletal disease [11-13]. One of the most distinctive imaging features of PBL is the discordance between subtle findings on radiographs or CT and extensive marrow involvement on MRI. This phenomenon reflects the infiltrative biological behavior of lymphoma cells within the medullary cavity and has been described as the imaging paradox of primary bone lymphoma [14-18]. Because of this discrepancy, early imaging studies may appear deceptively benign, leading to misinterpretation as stress injury, osteomyelitis, or other benign musculoskeletal conditions,

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particularly in physically active patients [19-21]. We present a case of primary bone lymphoma of the tibia in a young athlete initially suspected to have a tibial stress injury. The case illustrates the classic imaging paradox between conventional imaging modalities and MRI and underscores the importance of advanced imaging when clinical symptoms are disproportionate to initial imaging findings.

Case Presentation

A 25-year-old previously healthy man presented with progressive pain localized to the anterior aspect of the right tibia. The pain began shortly after a recreational soccer match. The patient did not recall a specific traumatic event but described persistent focal discomfort that gradually worsened over several weeks. Initially, the pain was activity-related but subsequently became constant, limiting the patient's ability to run and participate in sports. There was no history of systemic symptoms such as fever, night sweats, or weight loss. Physical examination revealed localized tenderness over the proximal tibial shaft without swelling, erythema, or palpable mass. Given the clinical presentation and the location of symptoms, the initial diagnostic consideration was a tibial stress reaction or early stress fracture, a common injury in physically active individuals and athletes [22-24].

Because of persistent symptoms despite conservative management, imaging evaluation was pursued.

Imaging Findings

Radiography

Plain radiographs of the tibia and fibula were obtained as the initial imaging study (Figure 1). The radiographs demonstrated subtle and nonspecific findings consisting of faint, ill-defined intramedullary sclerosis within the proximal tibia. No fracture line, cortical disruption, periosteal reaction, or soft-tissue abnormality was identified.

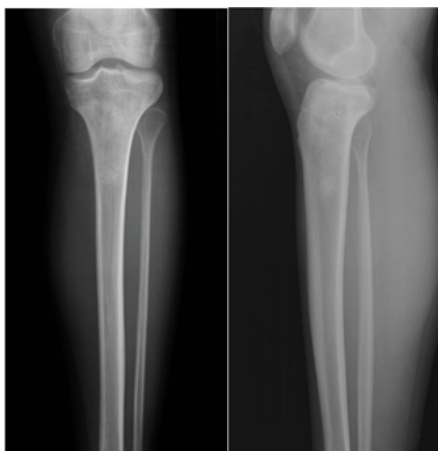


Figure 1: Anteroposterior and lateral radiographs of the tibia demonstrate faint ill-defined intramedullary sclerosis within the proximal tibial metaphysis and diaphysis without cortical disruption, periosteal reaction, or visible fracture line.

Given that early stress injuries may demonstrate minimal or absent radiographic abnormalities, these findings remained compatible with a possible stress-related injury.

Computed Tomography

Computed tomography (CT) of the tibia was subsequently performed to better evaluate cortical integrity (Figure 2).

CT demonstrated mild ill-defined medullary sclerosis involving the proximal tibial metaphysis and diaphysis. Cortical bone remained largely preserved, and no aggressive bone destruction, periosteal reaction, or fracture line was identified.

Although the findings remained nonspecific, the absence of a fracture line and the presence of ill-defined marrow alteration raised concern for a marrow-replacing process, prompting further evaluation with MRI.

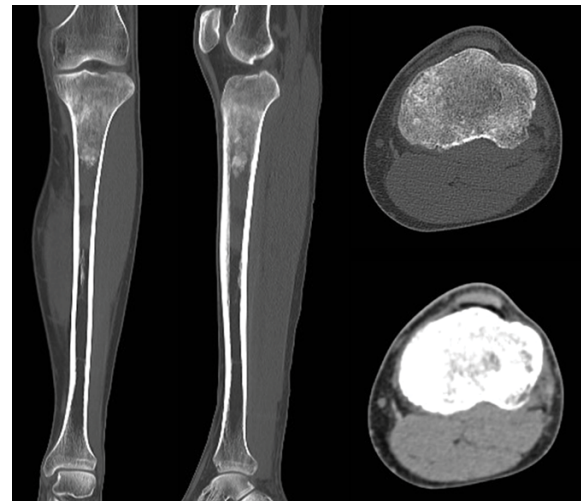


Figure 2: Coronal, sagittal, and axial reformatted CT images of the tibia show subtle, ill-defined medullary sclerosis involving the proximal tibial metaphysis with preservation of cortical bone and absence of periosteal reaction or extraosseous soft-tissue component.

Magnetic Resonance Imaging

MRI of the tibia demonstrated findings that were markedly disproportionate to those observed on radiography and CT (Figures 3 and 4).

A large region of the tibia showed diffuse replacement of normal fatty marrow signal extending from the proximal tibial epiphysis through metaphysis and along the diaphysis. The involved marrow appeared hypointense on T1-weighted images and mildly hyperintense on fluid-sensitive sequences. Despite extensive intramedullary involvement, cortical integrity remained relatively preserved and no significant extraosseous soft-tissue component was identified. These findings revealed a substantially greater extent of disease than suggested by radiography or CT, illustrating the classic imaging paradox associated with primary bone lymphoma.



Figure 3: MRI of the tibia demonstrates diffuse marrow infiltration involving the proximal tibial epiphysis, metaphysis, and diaphysis. The lesion appears hypointense relative to normal marrow on T1-weighted sequences and hyperintense on fluid-sensitive sequences, consistent with extensive marrow replacement.

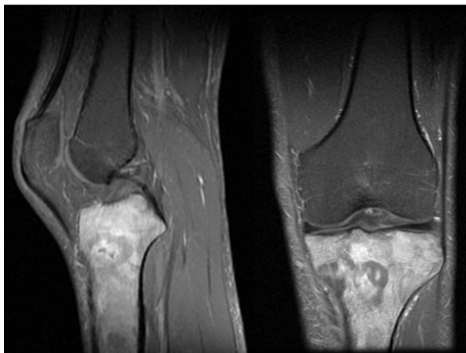


Figure 4: Post-contrast fat-suppressed T1-weighted MRI images demonstrate diffuse, mildly heterogeneous enhancement within the infiltrated marrow of the proximal tibia, without evidence of cortical destruction or extraosseous soft-tissue extension.

Histopathology

Image-guided percutaneous core needle biopsy of the tibial lesion was performed. Histopathologic examination demonstrated diffuse infiltration of the bone marrow by large atypical lymphoid cells with irregular nuclear contours and prominent nucleoli. Immunohistochemical analysis showed tumor cells positive for CD20 and CD79a, with a Ki-67 proliferation index of approximately 80%, consistent with diffuse large B-cell lymphoma (DLBCL). Subsequent staging evaluation, including PET-CT, demonstrated no additional sites of disease, confirming the diagnosis of primary bone lymphoma.

Discussion

Primary bone lymphoma demonstrates distinctive biological and imaging characteristics that differentiate it from most primary bone malignancies. Unlike aggressive bone sarcomas, which often produce early cortical destruction and soft-tissue mass formation, lymphoma tends to infiltrate the medullary cavity while preserving cortical architecture [25-28]. Tumor cells spread along the marrow space and through the Haversian and Volkmann vascular channels, allowing longitudinal propagation along bone without extensive cortical destruction [29-31]. This infiltrative growth pattern explains the classic imaging paradox observed in primary bone lymphoma: extensive marrow disease with minimal abnormalities on radiographs or CT [14-18].

Radiographic findings may range from normal appearance to subtle medullary sclerosis, permeative bone destruction, or mixed lytic-sclerotic lesions [32-34]. However, early disease often demonstrates only minimal abnormalities, which may delay diagnosis.

MRI is the most sensitive imaging modality for detecting bone marrow infiltration [35-38]. Typical MRI features include diffuse low signal intensity on T1-weighted images, hyperintense signal on fluid-sensitive sequences, and longitudinal marrow involvement.

Another characteristic feature is the relative preservation of cortical bone despite extensive marrow replacement [39-41].

In the present case, radiographs and CT demonstrated only subtle medullary sclerosis, whereas MRI revealed extensive marrow infiltration extending from the proximal tibial epiphysis through the diaphysis. The dramatic discrepancy between imaging modalities exemplifies the classic imaging presentation of primary bone lymphoma.

Differential Diagnosis

In a young adult presenting with tibial pain, the differential diagnosis may include:

- Tibial stress reaction or stress fracture
- Osteomyelitis
- Ewing sarcoma
- Leukemic infiltration
- Metastatic disease
- Osteosarcoma
- Langerhans cell histiocytosis

Stress injuries are particularly common in athletes and frequently present with normal radiographs early in the disease course. However, stress fractures typically demonstrate a focal cortical or periosteal abnormality on MRI rather than diffuse longitudinal marrow infiltration.

The combination of extensive marrow replacement on MRI with minimal abnormalities on radiography or CT should raise a strong suspicion for primary bone lymphoma.

Clinical Implications

Early recognition of this imaging pattern is clinically important because primary bone lymphoma is a potentially curable malignancy with favorable outcomes when treated promptly with systemic therapy. Diagnostic delay may occur when clinicians rely primarily on radiography or CT findings. MRI plays a critical role in identifying marrow infiltration and defining the true extent of disease.

Teaching Point

Extensive marrow infiltration on MRI with only subtle abnormalities on radiography or CT represents a classic imaging presentation of primary bone lymphoma and should prompt early biopsy.

Conclusion

Primary bone lymphoma may mimic benign stress-related injuries in young physically active individuals presenting with tibial pain. The key diagnostic clue is the discrepancy between minimal abnormalities on radiography or CT and extensive marrow involvement on MRI. Recognition of this imaging paradox is essential for timely biopsy and accurate diagnosis.

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