Imaging of Spinal Manifestations of Hematological Disorders

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KEYWORDS

• Vertebral • Epidural • Cord • Meninges • Lymphoma • Leukemia • Myeloma • Hematological

KEY POINTS

- Imaging manifestations of hematological diseases and their potential complications are broad, and there may be significant overlap in features of various disease processes.
- Knowledge of appropriate choice of imaging test, pertinent imaging patterns, and pathophysiology of disease can help the reader increase specificity in the diagnosis and treatment of the patient.
- Most importantly, we encourage readers of this review to engage their radiologists during the diagnostic, treatment, and management phases of care delivery.

INTRODUCTION

The imaging of spinal manifestations of hematological disorders are best understood and appreciated by taking an anatomic compartment approach. In this review, we discuss such manifestations by focusing on the imaging appearance in the vertebral body/epidural, dural/leptomeningeal (meningeal), and spinal cord compartments. This review focuses on radiographic imaging, computed tomography (CT), and MRI, and will predominantly discuss vertebral and epidural disease. Where appropriate, details about meningeal and spinal cord involvement are included.

GENERAL IMAGING FEATURES

Vertebral/Epidural Disease

Compared with spinal metastatic disease, hematopoietic malignancies are more likely to be diffuse and less likely to have cortical destruction.[1] As such, MRI is often superior

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to radiography and CT, particularly in visualizing bony lesions that are largely in bone marrow. It is worthwhile discussing a few imaging basics, particularly regarding MRI sequences as they apply to vertebral marrow disease.

T1 spin-echo weighted imaging (T1WI) is essential in bone marrow evaluation. Due to the size and tumbling frequency of fat molecules, yellow marrow normally has a hyperintense (bright) appearance on T1WI due to a short T1 relaxation time. In contradistinction, tumor and most other pathologic processes will have prolonged T1 relaxation times producing hypointense (low) signal that typically stands out sharply against the hyperintense background of fatty marrow.

Younger patients have more red hematopoietic marrow than yellow marrow, making visualization of lesions on T1WI more challenging. Fat suppression should *not* be used for noncontrast T1WI of the marrow, as this will remove the intrinsic contrast. The opposite is true when performing postcontrast T1WI; if fat suppression is not used, enhancing hyperintense lesions will lose their conspicuity against T1 hyperintense marrow. Therefore, fat suppression is essential for postcontrast T1WI when evaluating vertebral disease.

By the same token, routine T2 spin-echo weighted imaging (T2WI) is not ideal for vertebral and epidural evaluation. Pathologic processes are generally hyperintense on T2WI, and can be masked against background T2 signal of normal marrow. For this reason, fat suppression is also essential for T2WI in vertebral and epidural evaluation of the spine. Short tau inversion recovery (STIR) sequences are often used for this purpose, and provide relatively homogeneous fat saturation. Abnormalities on STIR often appear brighter than on routine T2WI, in part due to the change in dynamic range of the image. For this review, however, we use STIR and fat-saturated T2WI interchangeably.

Noncontrast T1WI, fat-suppressed T2WI (or STIR), and postcontrast fat-suppressed T1WI sequences are the bread and butter of vertebral marrow imaging. There are several additional advanced sequences that are touched on later, which can be useful adjuncts, including diffusion-weighted imaging (DWI), chemical shift imaging (CSI), and dynamic contrast-enhanced (DCE)-MRI techniques.

Detection and characterization of an epidural mass is critical in the imaging evaluation of the spine. MRI is generally preferable to CT for this assessment. As an epidural lesion grows larger, it first narrows the thecal sac and effaces the cerebrospinal fluid (CSF) around the cord, then eventually progresses to compress the cord itself, potentially causing cord edema and eventually myelomalacia. At the lumbosacral levels, epidural masses can compress the cauda equina. Epidural extension of vertebral tumor commonly has a bilobed appearance in the anterior epidural space, which has been called the “curtain sign,” due to limitation by the posterior longitudinal ligament and attached midline septum.

Posterior epidural masses are seen more commonly in hematologic malignancy compared with metastatic disease.[1] Epidural masses can extend through intervertebral foramina and into the paraspinal regions. Contrast is useful not only in delineating extent of epidural tumor, but also in distinguishing tumor from disc herniation, which may mimic epidural tumor on noncontrast imaging but should not enhance with contrast.

Meningeal and Spinal Cord Disease

MRI is the standard for imaging meningeal and cord manifestations of hematological malignancy and any complications. Fat-saturated T2WI and postcontrast fat-saturated T1WI sequences are essential to evaluate the meninges, thecal sac CSF, spinal cord, and cauda equina. Precontrast T1WI is not vital by itself, but is useful