IMAGING OF SPINAL INFECTION

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Learning Objectives:

1. To review the pathophysiology of pyogenic and atypical spinal infections, routes of contamination and common organisms in specific age groups.
2. To review current concepts, advantages and disadvantages of all imaging techniques that currently are utilized in diagnosis and follow-up of spinal infection including radiography, magnetic resonance imaging (MRI), computed tomography (CT), and nuclear imaging.
3. To review multimodality imaging findings of spinal infections.

Purpose:

To be comfortable in the imaging work-up and follow-up of pyogenic and atypical spinal infections in everyday radiology practice.

General Content:

Spinal infection with or without disk space involvement is a common entity, frequently with inflammatory changes in the adjacent paraspinal tissues and with extension into the epidural space causing possible spinal cord compression. Early diagnosis allows prompt treatment which can prevent unwanted complications.

Routes of contamination in spinal infections are: hematogeneous (Batson’s paravertebral venous system), contiguous spread, direct implantation and postoperative.

The most common organism of pyogenic infection in all age groups is *Staphylococcus aureus* and the other causative organisms have predilections for certain age groups. Mycobacteria, fungi and other atypical organisms may also cause spinal infection and typically have more indolent course.

The imaging should start with radiographs which lack the sensitivity but may provide valuable information. In early infection (subendplate vertebral body), radiographs are frequently normal. One to three weeks later, cortical irregularity of the endplate(s), disk space narrowing/involvement (irregularity of the neighboring vertebral endplates), and paravertebral extension may be seen. Approximately 10-12 week later, regenerative changes with sclerosis and eburnation are observed. Children who have vascularized disks may develop diskitis with less destructive changes, and the radiographic findings are commonly delayed for several weeks. Occasionally, diskitis may occur in adults.
MRI is quite sensitive for early vertebral osteomyelitis as it can demonstrate a bone marrow edema pattern in the vertebral endplates/bodies. This imaging modality has a superb contrast resolution with an accuracy of approximately 90% and is the imaging procedure of choice for diagnosing spinal osteomyelitis. On T2 weighted images, the normal intervertebral disk has an area of decreased signal intensity called the intranuclear cleft which indents the nucleus pulposus. The infected intervertebral disk may show increased T2 signal intensity resulting in loss of the intranuclear cleft. On T1 weighted images, there is decreased signal intensity within the vertebral body adjacent to the endplates and disk with indistinctness of the disk/vertebral interface. Enhancement of the disk and endplates usually occurs after intravenous contrast administration. In addition, MRI allows delineation of any associated epidural or paravertebral abscesses. A common challenge to diagnosing spinal osteomyelitis with MRI is that severe degenerative disk disease with Modic endplate changes can mimic the findings seen with infection.
Multi-slice high resolution CT imaging with coronal, sagittal and 3D reformatting allows excellent visualization of anatomical structures and the regions of abnormalities. CT parallels the radiographic findings of the spinal infections allowing a superb spatial resolution. This imaging modality is of great value in the patients who have contraindications for MRI. CT enables good evaluation of the destructive changes of the vertebral end plates. This imaging modality is employed frequently in the evaluation of infected hardware and is the best for visualization of soft tissue gas. Like MRI, contrast enhanced CT shows enhancement of the affected soft tissues and depicts rim enhancing soft tissue and epidural abscesses. CT is most frequently utilized for guiding percutaneous biopsy.

In difficult cases, radionuclide imaging with gallium has been an alternative choice but is time consuming and requires the patient to return over several days for multiple imaging sessions. Several studies have shown Ga-67 SPECT imaging to be equivalent to MRI for vertebral
infection with one study also confirming detection of complicated epidural abscess in a number of patients. Only a small number of studies have been published evaluating the efficacy of FDG-PET in the evaluation of osseous spinal infections. The results appear to suggest that FDG-PET may be superior (higher sensitivity and specificity) to Ga-67 imaging for differentiating spinal osteomyelitis from degenerative changes. This is thought to be due to the paucity of granulocytes and macrophages present in the degenerative process. FDG-PET may therefore be useful to exclude infection in equivocal MRI cases and to evaluate response to treatment.

The classic pattern of tuberculosis in the spine is to have more than one vertebral level involved along with the intervening disks. However, destruction of the intervertebral disks is usually delayed. Spread of infection also occurs along the paraspinal tissue with subsequent abscess formation (Pott’s abscess). Calcification of the abscess is virtually diagnostic of tuberculosis. Longstanding, untreated infection results in anterior vertebral body wedging, kyphosis and gibbus formation. The posterior elements are more commonly involved with tuberculous spinal infection when compared to pyogenic. Alternatively, tuberculous infection can be confined to the anterior subligamentous structures of the spine, spreading superiorly and inferiorly, sparing the intervertebral disks. Despite the different modes of spread, tuberculous infection of the spine usually lacks reactive sclerosis or local periosteal reaction seen in pyogenic infections of the spine.

Ultrasound is generally not useful in the evaluation of spinal infection but may potentially guide aspiration of the paraspinal abscesses.

Positive Ga-67 and PET/CT studies in two different patients with fungal spinal infections