Diagnosing Insufficiency Fractures in the Pelvis and Proximal Femur

- Insufficiency fractures of the pelvis are a major cause of low back and hip pain in elderly patients with osteoporosis
- Osteoporosis in the elderly decreases the sensitivity of plain film radiography to detect fractures
- MRI is more sensitive than radiography or CT imaging for the diagnosis of insufficiency fractures
- MRI may be helpful in distinguishing insufficiency fractures from pathological fractures due to tumor infiltration

Over 1.5 million cases of fractures related to osteoporosis and osteopenia occur in the USA annually. Pelvic and sacral insufficiency fractures are an important subset of this entity. First described by Lourie in 1982, insufficiency fractures arise when a normal or physiologic stress is applied to weakened bone with reduced mineralization and elasticity. Insufficiency fractures may be associated with several conditions including osteoporosis, previous radiation therapy, rheumatoid arthritis, prolonged corticosteroid therapy, renal failure, and mechanical changes after hip replacement surgery. Most patients with insufficiency fractures are older than 55 years of age, with the mean age of 70-75. The true incidence of the disease is unknown but is estimated to be 1-5% of the at-risk population.

Figure 1. 72 year old woman with left hip and leg pain, unable to walk after a minor fall. (A) Radiographic imaging of the pelvis demonstrated diffuse osteopenia with bowel gas obscuring the sacrum. No definite displaced fracture was identified. (B) Axial T1 MR image demonstrates vertically oriented fracture line in the right sacral ala (arrow) consistent with a sacral insufficiency fracture. (C) Axial T1 MR image of the lower pelvis demonstrates an accompanying second fracture of the left pubic symphysis (arrow). (D) Follow-up radiograph several months after the injury demonstrates sclerosis and healing of pelvic fractures (arrows).
Patients with insufficiency fractures may present after minor trauma or may have symptoms of low back, pelvic, or groin pain that are often vague and non-specific and do not seem to be related to any remembered trauma. Therefore, in order to avoid a delay in diagnosis, an insufficiency fracture should be considered in all patients who have pain with ambulation or are non-ambulatory, including those patients with a history of cancer. Prior radiation therapy is a well-known risk factor for pelvic insufficiency fractures, especially in post-menopausal women. It is essential to avoid inappropriate diagnosis of tumor recurrence in these patients.

If an insufficiency pelvic fracture is present, the likelihood of a fracture at another site is high; multiple fracture sites have been observed in over two-thirds of cases of insufficiency fractures. Multiple fractures are particularly common when a fracture is found in the acetabulum or pubic bone. In patients with total hip arthroplasty, insufficiency fractures frequently occur in the superior and inferior pubic rami, the pubo-ischeal junction, or the ischium around the obturator foramen.

**Radiography**

When patients present in the emergency department with symptoms suggestive of an insufficiency fracture, the first imaging examination is radiography. Although radiography may not be sensitive for non-displaced or minimally displaced fractures, cases of displaced fractures can be easily identified, thereby potentially completing the diagnostic work-up. Radiographic findings of insufficiency fractures are frequently only visible in the later phases of healing rather than the acute setting. Late fracture findings of sclerosis or bone resorption along the fracture line may be seen. Overall, the sensitivity of radiography for acute pelvic insufficiency fractures was estimated to be 14.8% in one recent study.

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Figure 2. 83 year old woman with left hip pain without significant trauma. A) Pelvic and dedicated hip radiographic imaging demonstrated osteopenia without displaced fracture. B) Coronal-orientated fluid sensitive MR image demonstrates isolated increased signal in the proximal left femoral head (arrow). C) Cone down (magnified) view demonstrates a fracture line with surrounding bone marrow edema at the femoral head-neck junction (arrow), a classic location for a femoral neck insufficiency fracture. D) Follow up image demonstrates percutaneous nail fixation of the non-displaced fracture, normally a well-tolerated procedure which can be performed with spinal rather than general anesthesia.
Figure 3. 78 year old with history of prostate cancer with bilateral hip pain. A) Bone scintigraphy demonstrated increased uptake in both femoral heads (arrows). B) Coronal image from a subsequent CT scan failed to demonstrate a cause for the patient’s pain and abnormal tracer uptake on bone scan. C) Coronal fluid-sensitive MRI image demonstrates bone marrow edema within the femoral heads with fracture lines at the classic location for insufficiency fracture, the head-neck junction (arrows). The MRI ruled out the possibility of metastatic disease as the cause for the pain and abnormal bone scan.

**MRI**

In the event of negative radiographic studies in the non-ambulatory patients, MRI is recommended for further evaluation (Figure 1). MRI is valued despite its cost because delayed diagnosis of a pelvic insufficiency fracture can lead to immobility and complications such as deep vein thrombosis, loss of strength, decreased cardiac output, and depression. Late diagnosis can also result in more invasive therapy. For example, if a femoral neck insufficiency fracture is diagnosed before there is progressive bone displacement, it can be stabilized with surgical pins rather than requiring total hip arthroplasty (Figure 2). MRI can also be helpful in distinguishing between insufficiency fractures and pathological fractures due to tumor infiltration (Figure 3).

Both insufficiency fractures and stress fractures demonstrate characteristic bone marrow edema on MRI, and fracture lines are frequently seen. MRI is also helpful because soft tissue lesions are visualized. There is little data on the comparative sensitivity of MRI versus CT, but in one side-by-side comparison of patients who received both MRI and CT, MRI was shown to be significantly more sensitive (98%; CI, 94-100%) than CT (53%; CI, 39-64%) for the detection of insufficiency fractures of the pelvis and proximal femur (p=0.0001).

**Other Imaging Techniques**

Bone scintigraphy is a sensitive method for the detection of osseous abnormalities such as metastatic bone lesions and fractures. When the typical H-shaped ‘Honda’ sign or butterfly pattern is seen in the sacrum, this is considered diagnostic of sacral insufficiency fracture. However, it is not possible to see a fracture line with this imaging modality. Moreover, if this typical pattern is not seen, the findings may be mistaken for malignancy or other etiologies. Therefore, this time consuming scan is not generally recommended.

**CT**

CT imaging is recommended for patients who cannot tolerate MRI or whose medical condition prohibits them from entering the high magnetic field environment of an MRI scanner. Although shown to be less sensitive than MRI, CT is significantly more sensitive than radiography for the diagnosis of pelvic insufficiency fractures. Its ease of acquisition and abundant access often validates its use in diagnosis.

**Image-Guided Interventional Therapy**

Conservative medical therapy with rest, limited ambulation, and pain medication has been the mainstay of treatment. Open surgical fixation is reserved for severe fractures that do not heal with rest. Sacroplasty is an alternative treatment for sacral ala fractures that do not respond to conservative treatment. Much like vertebroplasty, synthetic bone cement (polymethylmethacrylate) is injected into the site of the fracture under fluoroscopic or CT image guidance typically while the patient is under conscious sedation (Figure 4).
**Scheduling**

MR imaging examinations are performed on the main Mass General campus including the Emergency Department, MassGeneral West Imaging, Waltham, and MassGeneral Imaging, Chelsea. They may be scheduled online through Radiology Order Entry (http://mghroe) or by calling 617-724-9729 (4-XRAY).

**Further Information**

For further questions on the diagnosis of pelvic insufficiency fractures, please contact Laura Avery, MD, Emergency Radiology, Mass General Imaging, at 617-726-8396. For further questions regarding sacroplasty, please contact Joshua A. Hirsch, MD, Neuroradiology, at 617-726-1767.

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**References**


