

Abbreviations

- Monoclonal gammopathy of undetermined significance (MGUS)
- Multiple myeloma (MM)
- Myeloma-defining event (MDE)
- Smoldering MM (SMM)
- Solitary plasmacytoma of bone (SPB)
- International Myeloma Working Group (IMWG)

Multiple Myeloma

- Also known as plasma cell myeloma, is a multifocal proliferation of plasma cells based in the bone marrow.
- Most common primary malignant bone neoplasm in adults.
- It arises from red marrow due to the monoclonal proliferation of plasma cells and manifests in a wide range of radiographic abnormalities.
- Multiple myeloma remains incurable
- Any patient with MGUS, SMM, or SPB: must exclude MM; whole-body MR or FDG PET/CT best options
- Assess for impending pathologic fracture

Demographics

- Age
 - Primarily 40-80 years old
- Sex
 - $M > F$
- Ethnicity
 - Black > White patients

Smoldering multiple myeloma

- Premalignant stage between monoclonal gammopathy of undetermined significance (MGUS) and multiple myeloma.
- MRI is of prognostic importance in smoldering multiple myeloma.
- 50% of patients with smoldering multiple myeloma have abnormal bone marrow on MRI ranging from focal to diffuse changes
- Patients with marrow changes on MRI have a much shorter time to progression than those without.
- On average 10% of smoldering multiple myeloma patients per year will develop active multiple myeloma

Monoclonal gammopathy of undetermined significance

- Most common plasma cell disorder
- Refers to the presence of an abnormal monoclonal antibody in the blood but the absence of the overt bone marrow and clinical signs of multiple myeloma
- Ninety-percent of multiple myeloma patients are seen to have been in an MGUS phase before transitioning into multiple myeloma
- Plain radiograph and CT
 - Osteoporosis and vertebral fractures are more common in MGUS patients than in healthy controls

Complications

- Presentation may also be with a complication, including:
- Pathological fracture
 - Vertebral compression fracture
 - Long bone fracture (e.g. proximal femur)
- Amyloidosis
- Recurrent infection: e.g. pneumonia due to leukopenia
- Plasmacytomas typically progress to multiple myeloma
- The initial presentation occasionally is a polyneuropathy when it is part of POEMS syndrome (mostly the sclerotic form).
- Laboratory findings include:
 - reverse albumin/globulin ratio (i.e. low albumin, high globulin)
 - monoclonal gammopathy (IgA and/or IgG peak)
 - Bence Jones protein (Ig light chain) proteinuria
 - hypercalcemia
 - decreased or normal alkaline phosphatase (ALP) unless there is a pathological fracture due to impaired osteoblastic function

Imaging

- Location: axial > appendicular skeleton (proximal > > distal)
- Radiography
 - Intramedullary lytic punched-out lesions or
 - Diffuse osteoporosis advanced for age and sex
 - Multifocal or diffuse infiltration of bone marrow
- CT
 - Diffuse osteopenia ± compression fractures
 - Intramedullary soft tissue mass producing lytic lesions
 - ± endosteal scalloping
 - ± cortex breakthrough and soft tissue mass
 - Underestimates number of lesions and tumor burden
- MR patterns (may coexist)
 - Micronodular (variegated or "salt and pepper")
 - Multifocal (≥ 5 mm by definition)
 - Diffuse marrow infiltration
 - MR appearance of lesions
 - Fluid-sensitive sequences: untreated and treated disease can have increased signal intensity
 - ADC maps: range of active disease: $0.7\text{-}1.4 \times 10^{-3} \text{ mm}^2/\text{s}$
 - T1 C+: untreated and treated disease both can enhance
- FDG PET/CT: active lesions = activity above background

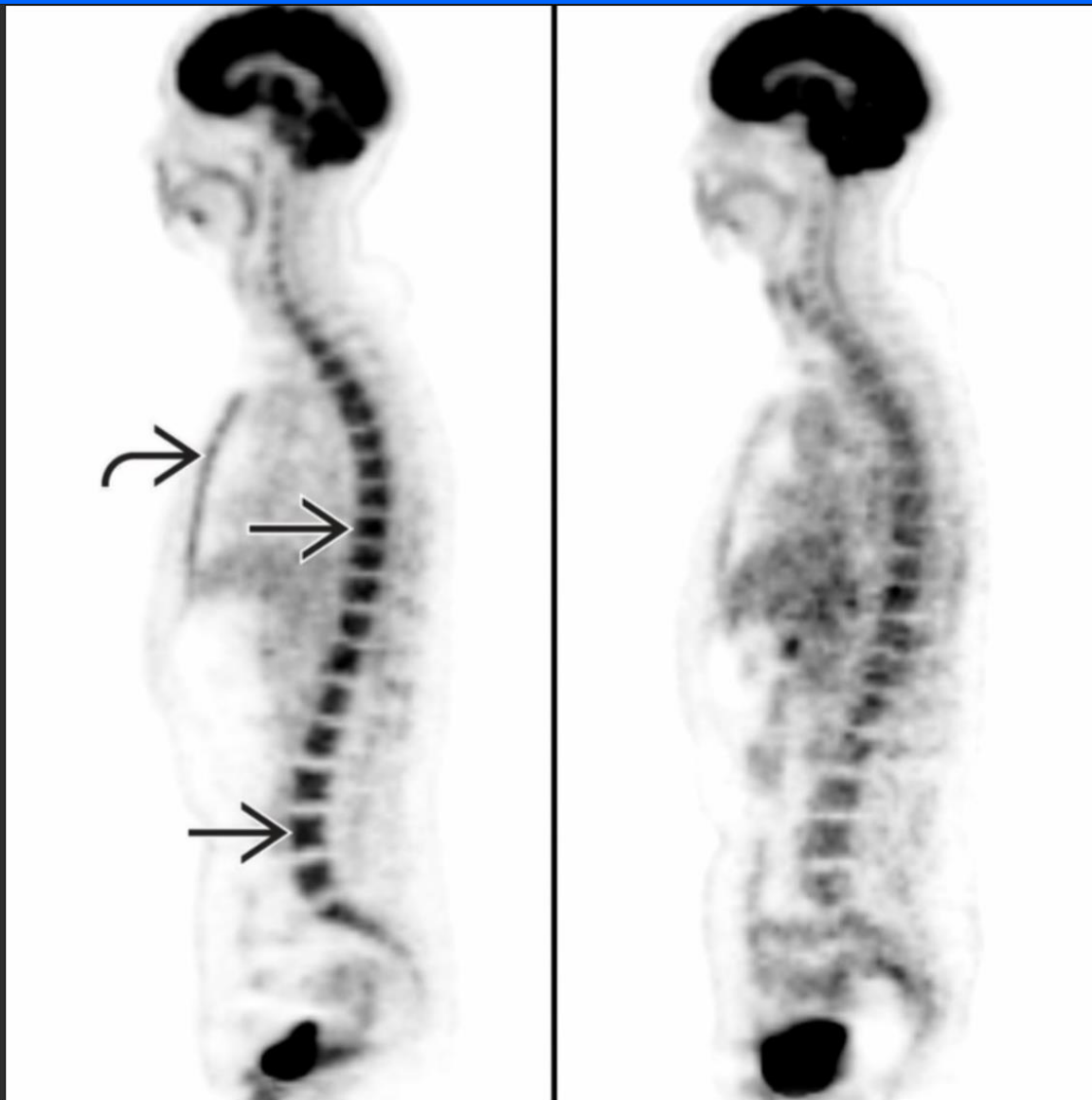
Nuclear Medicine

■ FDG PET/CT



- Active lesions: activity above background
- Lesions can be subtle in some cases and after minimal therapy (e.g., corticosteroids)
- Marrow FDG activity without CT lytic bone lesion does not meet diagnostic criteria for MM
- Treatment response: decreased FDG avidity

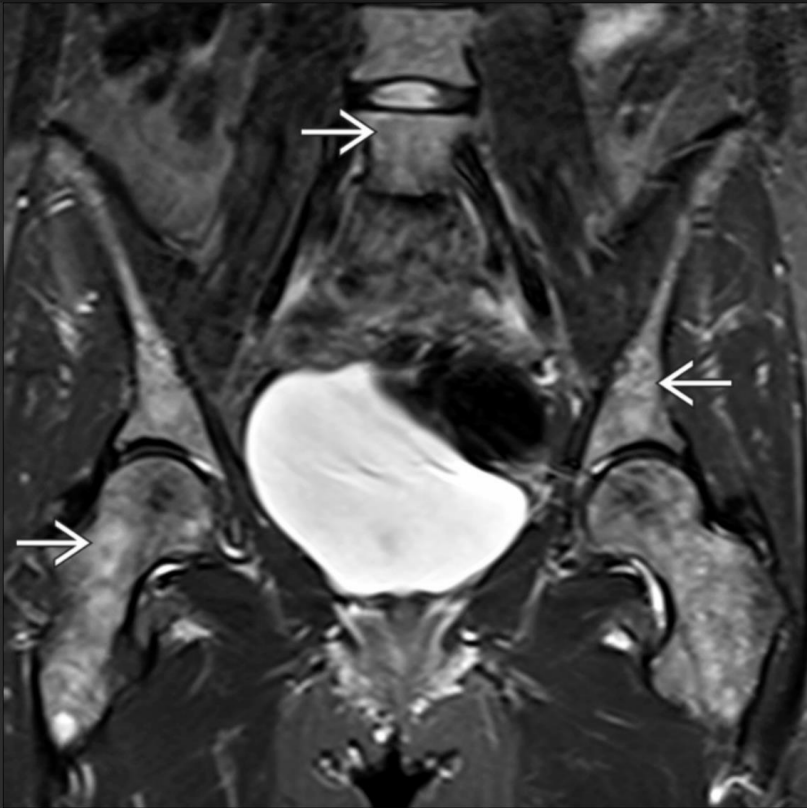
■ Bone scan not useful in evaluating MM

- High false-negative rate for individual lesion



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Sagittal PET images in a 44-year-old woman with MM are shown. Diffuse myeloma within spinal  and sternal  bone marrow is present prior to treatment (L). After therapy, the patient was in complete remission (R). Significant decrease in bone marrow activity is easily visualized.



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Coronal STIR MR through the pelvis prior to treatment demonstrates diffuse relatively homogeneous increased STIR signal within the vertebral bodies, iliac bones, and proximal femurs → in this patient with diffuse MM infiltration.



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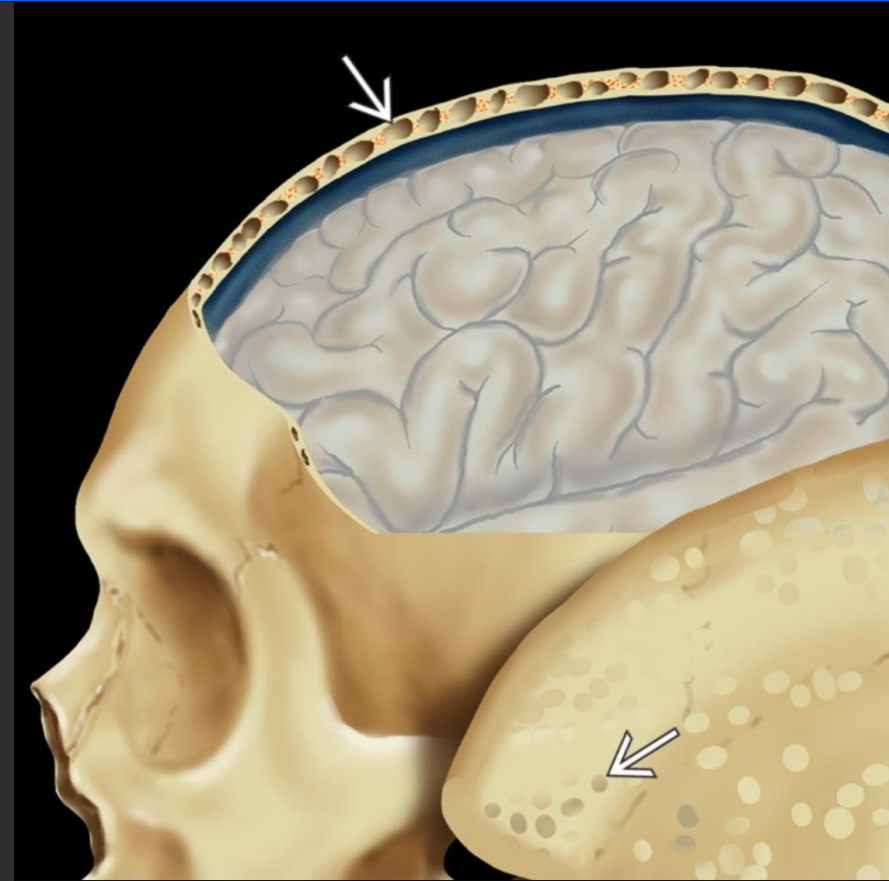
Coronal PET in the same patient before treatment demonstrates marked increased FDG activity in the bone marrow ⇒





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Lateral radiograph of the skull in a 55-year-old woman shows innumerable punched-out lytic lesions of the skull.



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Sagittal graphic through the skull depicts focal well-circumscribed MM lesions within the diploic space →. These appear as lytic lesions by radiography and are high SI on STIR MR.



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AP radiographs in the same patient show a similar pattern in the long bones, including distal to the elbows and the knees. **Multiple myeloma** (MM) lesions typically develop in areas of red marrow, so disease beyond proximal humeri and femurs is unusual; distal to the elbows and knees only occurs when MM is severe and extensive.



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Coronal T1 MR in the same patient shows diffuse heterogeneous appearance of the marrow. The SI remains higher than that of skeletal muscle and disc. The pattern may be seen with marrow hyperplasia.

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