

imaging findings of osteoporosis

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- ▶ The radiologist's role is to detect osteoporosis and to monitor progression of disease after the initiation of treatment.
 - ▶ Current clinical practice measures BMD.
 - ▶ Both DEXA and quantitative computed tomographic (CT) densitometry provide quantitative, reasonably accurate, and reproducible measurements of bone density.
 - ▶ DEXA is the more widely used because it is less expensive and uses less radiation.
 - ▶ Specialized ultrasonographic (US) equipment can measure the density of the calcaneus, but this technique is less widely used.

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- ▶ The World Health Organization has established guidelines for diagnosis With DEXA
 - ▶ BMD is reported at several sites in absolute value (g/mL), relative to normal young adults (the standard deviation is the T-score) and relative to age- and sex-matched reference populations (the standard deviation is the Z-score).
 - ▶ T-scores between -1 and -2.5 (i.e., bone density between 1 and 2.5 standard deviations below the average of normal young adults of the same sex) are defined as osteopenic.
 - ▶ T-scores below -2.5 are defined as osteoporotic. Be aware that these definitions of osteopenia and osteoporosis are specific to reporting on DEXA scans. is of osteoporosis, with emphasis on fracture risk, using DEXA.

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- ▶ In evaluating DEXA scans, the radiologist's role is to ensure proper placement of regions of interest for BMD measurement and to ensure absence of radiographic abnormalities that might interfere with measurement.
 - ▶ Such confounders include osteophytes in the spine, compression fractures, and soft-tissue calcification (e.g., diffuse idiopathic skeletal hyperostosis or aortic calcification), any of which can erroneously increase a BMD value on DEXA.
 - ▶ Usually measurements at four lumbar levels are averaged and a measure of the proximal femur (and occasionally the wrist) is obtained.
 - ▶ Measurements at each site of risk are more predictive of fracture risk at that site than is a measurement from a remote site. Thus the risk for hip fracture is best determined from a BMD measurement of the hip.
 - ▶ Measurements at two or three sites are routine in patients undergoing DEXA.

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- ▶ As noted earlier, current clinical practice measures BMD. However, BMD alone does not completely describe bone strength.
 - ▶ Trabecular architecture also is an important factor in overall bone strength (or perhaps more precisely, bone fragility, in osteoporosis).
 - ▶ Quantitative CT densitometry is more sensitive than DEXA because the cross-sectional nature of data acquisition allows evaluation limited to trabecular bone where generalized osteoporosis is most greatly manifested.
 - ▶ CT densitometry may be more accurate for assessing bone density than DEXA in patients with diffuse idiopathic skeletal hyperostosis, aortic calcification, spine fracture, and excessive degenerative osteophyte formation
 - ▶ High-resolution magnetic resonance imaging (MRI) also can display trabecular architecture and is gaining popularity as a research tool.

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- ▶ Radiography provides a less quantitative evaluation of bone density. Approximately 30% to 50% of bone mineral must be lost for grossly diminished bone density to be subjectively apparent on radiographs.
 - ▶ The least subjective radiographic finding of osteoporosis in long bones is cortical bone loss. A specific location to look for cortical thinning is in the second and third metacarpal shafts, where middiaphyseal cortical width should account for at least 50% of bone width in individuals with normal bone density

the transverse width of the medullary spaces exceeds one half the transverse width of the shafts (*long lines*) because of cortical bone loss.



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- ▶ The relatively rapid bone loss associated with hyperparathyroidism, hyperthyroidism, disuse regional hyperemia, and reflex sympathetic dystrophy can cause small, discrete areas of endosteal or subperiosteal cortical bone loss, as well as fine linear radiolucencies within the diaphyseal cortex termed “cortical tunnels” or “intracortical lucencies,” which are difficult to see without magnification radiographs
 - ▶ These subtle defects are several millimeters in length and less than 0.5 mm in diameter and are parallel to the long axis of the bone

Intracortical lucencies in osteoporosis



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- ▶ Additional findings of osteoporosis in long bones include accentuation of stress- or load-bearing trabeculae (because these are the last to be resorbed), insufficiency fractures, and transverse trabeculae in the diaphysis or metaphysis, termed *bone bars* or *reinforcement lines*.
 - ▶ Progressive loss of trabeculae in the proximal femur reflects the least important trabecular lines of force, starting with the secondary tensile trabeculae, followed by the primary tensile trabeculae, and then the secondary compressive, followed by the primary compressive trabeculae

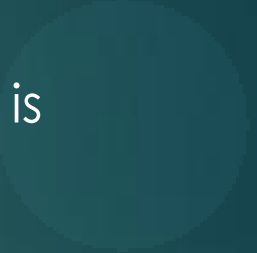
AP view of hip shows an exaggerated trabecular pattern in the primary compressive lines of force. The tensile lines of force are largely absent, indicating advanced osteoporosis



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- ▶ There are numerous radiographic findings in osteoporosis in the spine. Vertebral end plates may appear thinned, with exaggerated contrast between the vertebral body end plate and the central density
 - ▶ Compression fractures may be seen and can take the shape of anterior wedging, biconcavity of end plates, or generalized loss of height.
 - ▶ In addition, osteoporosis can be manifested with increased conspicuity of vertically oriented, trabecular bone in the spine due to generalized dropout of horizontally oriented trabeculae.

Lateral radiograph of spine shows exaggerated contrast between the end plates and the medullary bone.



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- ▶ Bone scans in patients with primary osteoporosis are normal unless arthritis or a stress fracture with healing response is present.
 - ▶ MRI is highly sensitive for detection of insufficiency fractures and is more sensitive than bone scanning, especially within the first few days after the fracture.
 - ▶ Vertebral body marrow often has a mottled appearance on T1-weighted MR images in patients with osteoporosis, but this appearance is neither sensitive nor specific.

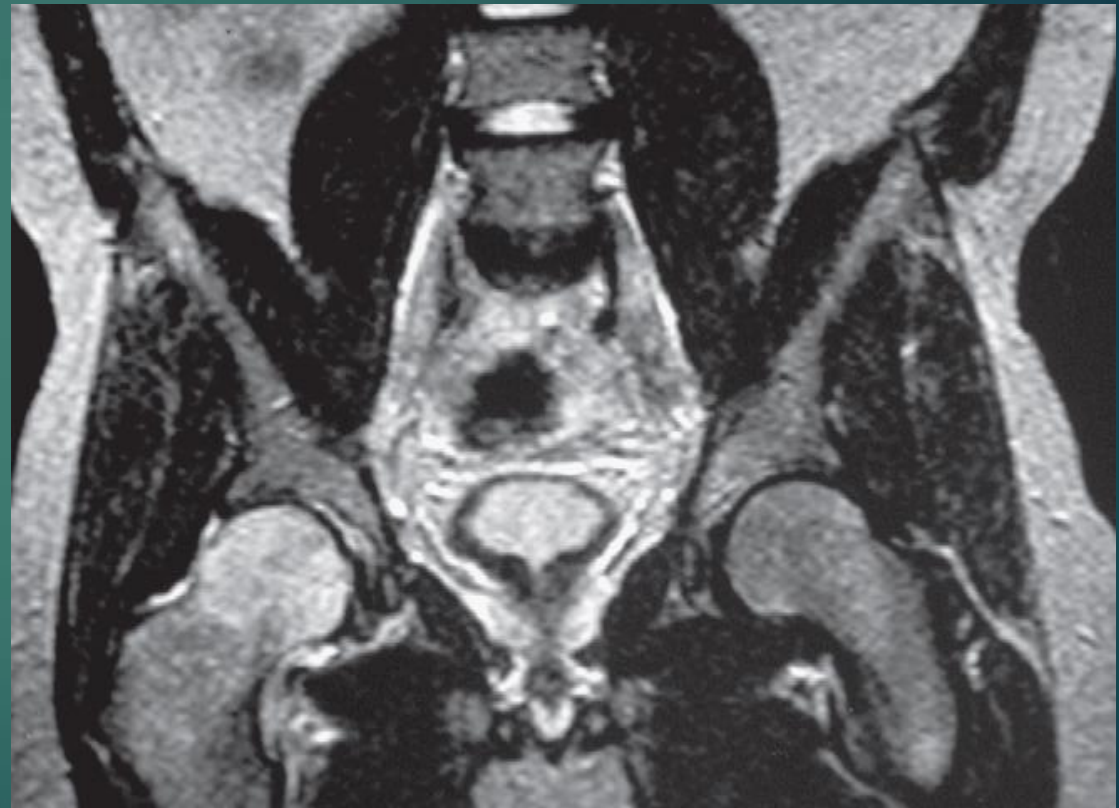
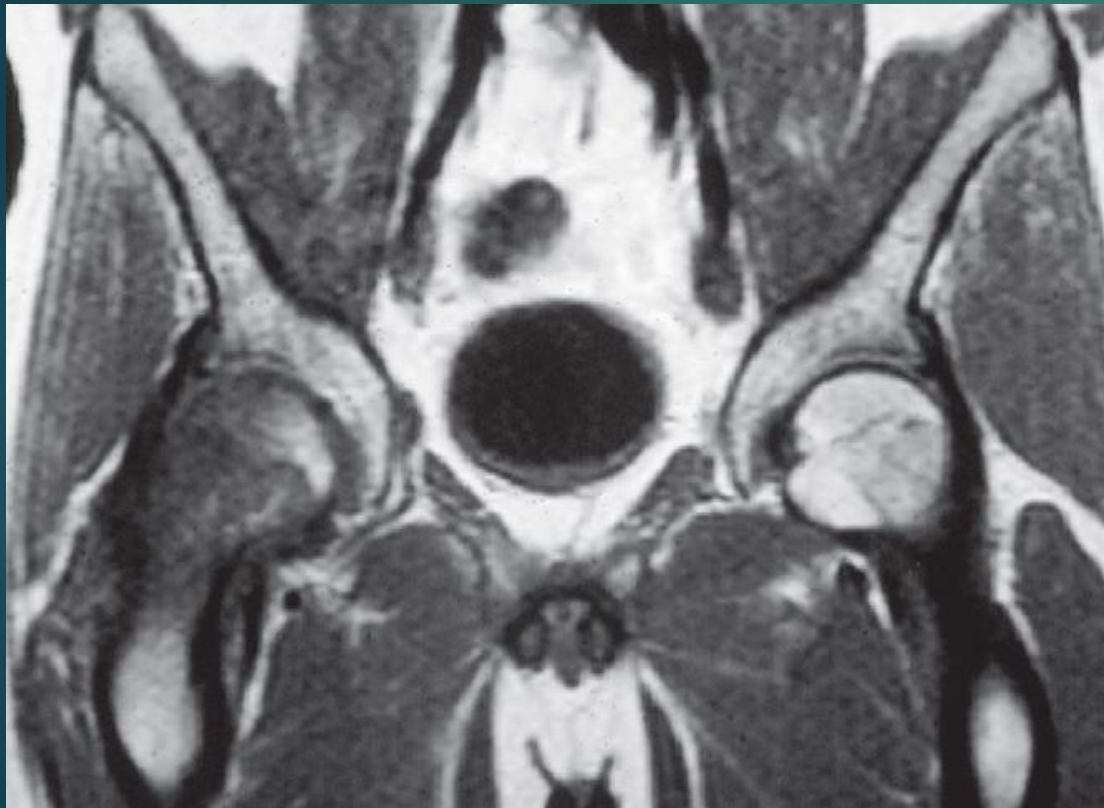
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REGIONAL OSTEOPOROSIS

Transient osteoporosis of the hip:

- ▶ is seen most commonly among middle-aged men (either hip) and pregnant women (usually the left hip) and often occurs in patients with no history of significant trauma or known risk factors for AVN. Patients present with sudden onset of severe hip pain.
- ▶ Asymmetric diminished bonedensity is seen radiographically in the affected hip.
- ▶ MRI shows marrow edema with diminished signal on T1-weighted images, increased signal on fat-suppressed T2-weighted inversion recovery MR images , and contrast enhancement throughout the femoral head and neck, often associated with a joint effusion. This marrow edema is in marked contrast with generalized osteoporosis, which does not show marrow edema unless a fracture or other focal pathologic process is present

Transient regional osteoporosis

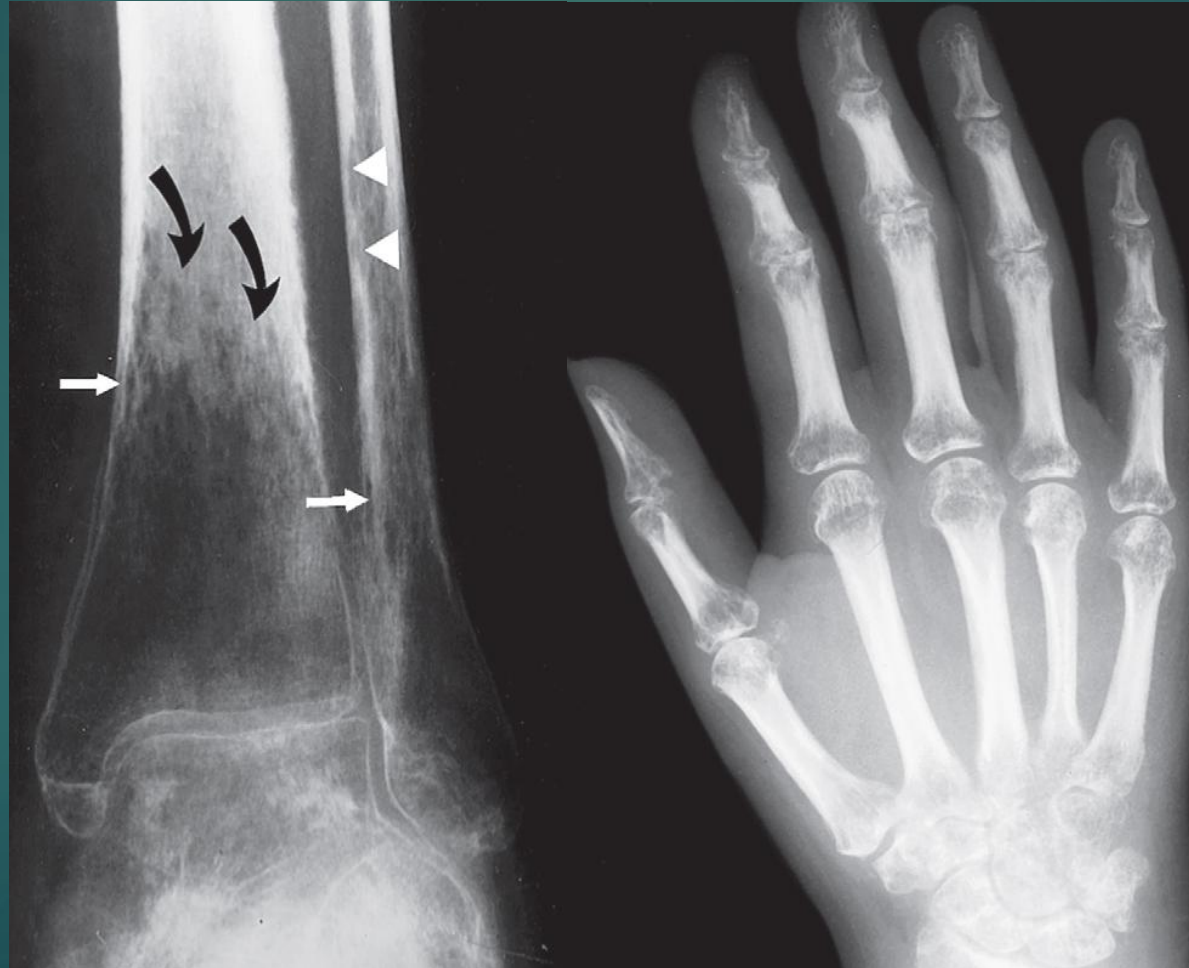




Complex regional pain syndrome (CRPS): also known as *reflex sympathetic dystrophy* (RSD) and Sudeck atrophy

- ▶ is thought to be mediated by dysfunction of the sympathetic nervous system. Its cause is unknown, but the condition is associated with traumatic, neurologic, or vascular events.
- ▶ It is associated not only with severely diminished bone density but with soft-tissue trophic changes that include swelling and hyperesthesia followed by atrophy and contracture of an entire extremity at and distal to the affected site.

Complex regional pain syndrome



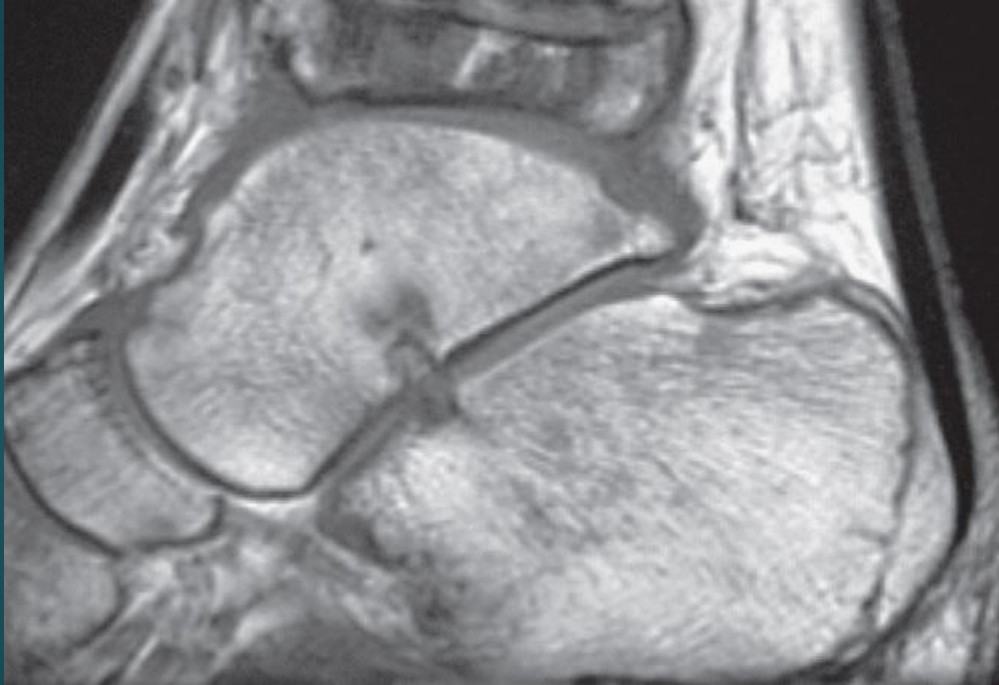
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- ▶ Disuse of a limb is also associated with localized diminished bone density because bone mass is directly proportional to the forces acting across the bone. Casting of a fracture combines disuse and hyperemia related to the injury.
 - ▶ Localized forms of osteoporosis can appear aggressive because of active remodeling of bone, with evidence of intracortical lucencies, metaphyseal bandlike lucencies, and subcortical/ subchondral resorption of bone

Osteoporosis related to disuse and local hyperemia. Disproportionate focal demineralization of the metaphysis after casting.

This radiograph was obtained during a cast change for a fifth metatarsal fracture. Note the transverse band of demineralization (*arrows*) in the distal tibia and fibula, proximal to the former position of the physes.



Marrow changes on MR imaging in a 14-year-old boy after casting and internal fixation of a distal tibia fracture. Sagittal T1-weighted and inversion recovery MR images of the hindfoot show a “mottled” pattern of decreased T1-weighted and increased T2-weighted marrow



Axial CT image in an adult with a recently operated, healing tibial plateau fracture shows multiple tiny lytic areas(*arrowheads*) that can falsely suggest a highly aggressive infiltrating tumor or infection.

