Learning objectives

To describe radiologic findings of osteoid osteoma, in particular atypical findings, and its variants and mimics.
Background

Osteoid osteoma is a small spherical tumor with a diameter of 2 cm or less, composed of a central zone named nidus which is an atypical bone completely enclosed within a well-vascularized stroma (1). The peripheral sclerotic reaction zone is composed of osteoblasts, osteoclasts and dilated capillaries surrounding the nidus. Peripheral nerve fibers are abundant in and around an osteoid osteoma. Pain is typically at night and it is promptly relieved by the administration of salicylates. Tumors are classified as cortical, medullary or subperiosteal on the basis of radiographic findings.

Cortical osteoid osteoma is the classic type of the disease consisting of a small central nidus, usually radiolucent, associated with perifocal dense bone. The medullary type involves the neck of the femur, vertebra and small bones. This type is unable to cause peripheral reactive bone formation and consequentially the detection of the nidus may be difficult. The subperiosteal type most frequently occurs in the intra-articular portion of the bones and may be difficult to detect. Typical radiographic findings of osteoid osteoma include an intracortical nidus, which may display a variable amount of mineralization, accompanied by cortical thickening and reactive sclerosis in a long bone shaft (2).
Findings and procedure details

Typical radiographic findings:
In plain radiographs the lesion is characterized by a small nidus surrounded by dense bone; the nidus is mostly seen as a radiolucent area significantly or mildly calcified depending on the disease duration (1).
At CT, the nidus is well defined and round or oval with low attenuation. An area of hypoattenuation may be seen centrally with a peripheral reactive sclerosis (3).
At MRI, the nidus has low to intermediate signal intensity on T1-weighted images and variable signal intensity on T2-weighted images (2).
Radionuclide scans are helpful in identifying the lesion.
Osteoid osteoma can involve any bone of the skeletal system, but is mostly reported in long bones of the lower extremity.

Atypical radiographic findings:
Osteoid osteoma is most common in the femur and tibia. Uncommon locations are the spine, hands, or feet. Very rare sites are the skull, scapula, ribs, pelvis, mandible and patella.
It's difficult to diagnose spinal osteoid osteoma (Fig 1) on the basis of radiographic findings because of the complexity of spinal anatomy and overlapping areas of soft tissue. Spinal osteoid osteoma is usually localized in the neural arch and it's usually associated with bone marrow edema in the involved pedicle and lamina that extends to the posterolateral vertebral body (2).
In the hands and feet, cancellous osteoid osteoma occurs in the carpal and tarsal bones, (Fig 3). Carpal and tarsal osteoid osteoma may display less reactive sclerosis. Because of the proximity of the bones in the hands and feet, an inflammatory reaction that originates from one carpal or tarsal lesion often spreads to adjacent bones and joints (4).

Intra-articular Osteoid Osteoma, which occurs within or near a joint, is uncommon, accounting for approximately 12% of all osteoid osteomas and is considered a separate clinical entity. Reactive cortical thickening is minimal or absent, a finding believed to be due to a lack of cambium, the inner layer of the periosteum. The most commonly involved joint is the hip (5, 6)

The diagnosis of osteoid osteoma can be very challenging when clinical and radiological presentations are atypical. This occurs especially when it's accompanied by severe inflammatory changes such as a prominent peri-osteal reaction, exaggerated synovial hypertrophy and joint effusion, extensive bone marrow and soft-tissue edema. Otherwise the dense sclerotic reaction is also can be absent or minimal. When these confusing imaging findings are present the nidus is hard to identify and diagnosis is hard to be reach.
Conditions That Mimic Osteoid Osteoma:

- A stress fracture appears as an infraction in the center of an area of cortical thickening, whereas osteoid osteoma appears as a round nidus (7). Cross-sectional imaging, especially in the coronal and sagittal planes, is useful for differentiating between the two conditions (8).
- At radiography, an intracortical abscess and an osteoid osteoma often are indistinguishable. At CT, in osteoid osteoma, the inner side of the nidus is smooth, and a round calcification is seen in the center of the nidus. In an intracortical abscess, the inner margin is irregular, and an irregularly shaped sequestrum is seen eccentrically (9).
- Intracortical hemangioma is an extremely uncommon primary bone tumor. Histologically it consisted of a capillary, arteriovenous, or (more frequently) cavernous hemangioma located within the cortical bone without an adjacent soft-tissue mass (10). Radiographically, intracortical hemangiomas demonstrate localized lytic lesion with or without cortical thickening and sclerosis with vertically aligned intralumar calcifications of the trabeculae. At CT, a hypoattenuating intracortical lesion with vascular channels and spotty internal calcification, or a so-called wire-netting appearance, is seen.
- Chondroblastoma is a rare, benign, locally aggressive bone tumor that typically affects the epiphyses or apophyses of long bones. Plain radiograph shows a characteristically lucent lesion and well-defined margins. At CT, Solid peristomal reaction, internal calcification and cortical breach are appreciated. When mineralized, chondroblastoma demonstrates punctate calcification, whereas osteoid ostoma displays a concentric pattern of mineralization (11, 12).
- Osteoblastoma is a rare primary neoplasm of bone, categorized as a benign bone tumor that is closely related to osteoid osteoma. It commonly affects the vertebral column, with approximately 30% of these lesions arising within the posterior elements of the spine. Pain does not respond to salicylates (13). Moreover, unlike osteoid osteoma, osteoblastoma displays progressive growth and has malignant potential (14). At imaging, lesions are typically larger than 2 cm in size and have less reactive sclerosis surrounding the mass than osteoid osteoma (15).
- Compensatory hypertrophy of the pedicle may be mistaken for osteoid osteoma because spinal osteoid osteoma frequently occurs in the posterior neural arch and induces thickening and sclerosis of the pedicle. Contralateral spondylolysis and lack of a typical nidus are indicative of compensatory hypertrophy of the pedicle (16).
Fig. 1: Osteoid osteoma of the cervical spine in a 26 years old female (a) sagittal, (b) axial and (c) coronal CT scan: uncommon site (C2 vertebra), nidus is inhomogeneously hypoattenuating; (d) Sagittal T2-weighted MRI image: the nidus has intermediate to high signal intensity in (e,f) Sagittal T1-weighted pre- and post- contrast images: dynamic MRI increase nidus conspicuity compared to nonenhanced MRI

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Fig. 2: Intra-articular Osteoid osteoma of right femoral neck in a 25 years old man. CT scan (a) and MRI (b,c) were performed and shows an absent periosteal reaction with an irregularity of cortical profile (a), in axial and coronal T2-weighted MRI image diffuse hyperintensity of the femoral neck due to the presence of bone marrow edema and intra-articular effusion masks the nidus (b,c). Later a CT scan (d,e) was performed and shows clearly the nidus as an hyperdense area surrounded by an area of hypoattenuation, periosteal reaction is absent.

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**Fig. 3:** A) Plain radiography of the right ankle: a sclerotic lesion of subtalar cortical bone is showed (arrowhead). B) CT section (bone window) through the subtalar bone reveals a small low-attenuation lesion (nidus) (arrow) surrounded by a high-attenuation zone of osteosclerosis (*). C) MR SE T1-weighted axial image: the nidus is well depicted (arrow) and it is surrounded by a low-intensity zone (S). D) MR STIR sagittal image showing intra-articular effusion (V) and intense edema of cancellous bone (*) masking the nidus (arrowhead) (5).

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Fig. 4: A) Plain radiography of the left hip reveals a small radiolucent nidus in the proximal femur with a tiny central calcification (arrowheads). B) Technetium-99m-labeled MDP scintigraphy shows early increased activity in the area of the femoral neck related to the nidus (arrowheads) followed, lately (C), by the accumulation of the radio-tracer in the proximal femur. D) T1-weighted axial MRI image: the nidus is demonstrated as intermediate-intensity lesion (N) in the posterior aspect of the femoral neck, surrounded by a low-intensity rim (perilesional sclerosis). E) MR STIR axial image: the nidus shows high intensity signal (arrow); intra-articular effusion (v) and diffuse hyperintensity of the femoral neck due to the presence of edema are also well depicted (5).

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Conclusion

To make the correct diagnosis, it is important to be familiar with the radiologic findings of osteoid osteoma, its mimics and confusing imaging findings.
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References


