

RADIOLOGY CORNER

Osteoid Osteoma

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Note: This is the full text version of the radiology corner question published in the April 2007 issue, with the abbreviated answer in the May 2007 issue.

Osteoid osteoma is a common, osteoid-producing, benign bone neoplasm affecting pediatric and young adult patients. This tumor most often occurs in the cortical bone as a small, fibrovascular nidus with surrounding sclerosis and soft tissue edema. The diagnosis of osteoid osteoma can usually be made on the basis of radiographic findings, however other entities including stress fracture, osteomyelitis and osteoblastoma occasionally present a diagnostic challenge and can influence which imaging modalities are appropriate for the work-up of a particular lesion. With a high clinical suspicion and imaging support, CT-guided percutaneous radiofrequency ablation has become the treatment of choice for most cases of osteoid osteoma.

Introduction

Composing nearly 10% of benign bone neoplasms, osteoid osteoma is a common pediatric and young adult bone tumor found most frequently in the lower extremities.¹ Over 50% of these tumors occur in the femur and tibia. The male-to-female ratio has been reported as approximately 3:1.² Patients classically complain of mild to moderate pain that is worse at night and relieved with aspirin. This history, in the epidemiological setting of young adults may suggest osteomyelitis, a musculoskeletal overuse syndrome such as a stress fracture, or another primary bone neoplasm. Intra-articular lesions, although rare, may mimic an arthritic condition with joint effusion and lymphoproliferative synovitis.³

The lesion of osteoid osteoma is most frequently located in the metaphyseal or diaphyseal cortex, appearing on initial radiographic studies as a cortically based radiolucency less than 1.5 cm in diameter with surrounding sclerosis and cortical thickening.⁴ Follow-up CT is effective in identifying the nidus with associated central calcification, while bone scanning may detect smaller lesions not seen on plain film.⁵

History

This patient was a 29-year-old male with right medial thigh pain that had gradually increased over the prior 3 years, eventually progressing to a level of severity requiring the use of crutches for ambulation. His pain was worse at night although it never woke him from sleep. Non-steroidal anti-inflammatory medications provided temporary relief of his symptoms. Physical exam revealed moderate tenderness to palpation over the right medial mid-thigh, and a 2-3 cm deep, firm, non-mobile mass was palpable in the same region. He demonstrated full range of motion of his right lower extremity, although the pain was exacerbated by forced extension of the right knee.

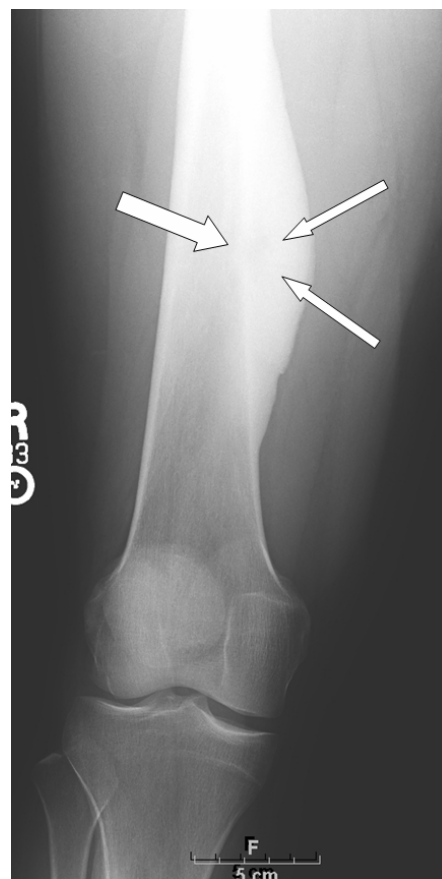


Fig. 1. AP projection of the lower femur showed wide cortical thickening medially with a subtle central lucency (thin arrows). Note subtle component of associated cortical penetration (wide arrow).

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Summary of Imaging Findings

Anteroposterior (AP) and lateral (lateral not shown) radiographs of the right femur demonstrated a zone of thick cortical thickening with a smooth contour along the medial aspect of the distal right femoral metadiaphysis (Fig 1). A central lucency measuring 2.5 cm craniocaudal was noted (narrow arrows) with a small component of associated cortical penetration (wide arrow). No surrounding soft tissue abnormalities were evident.

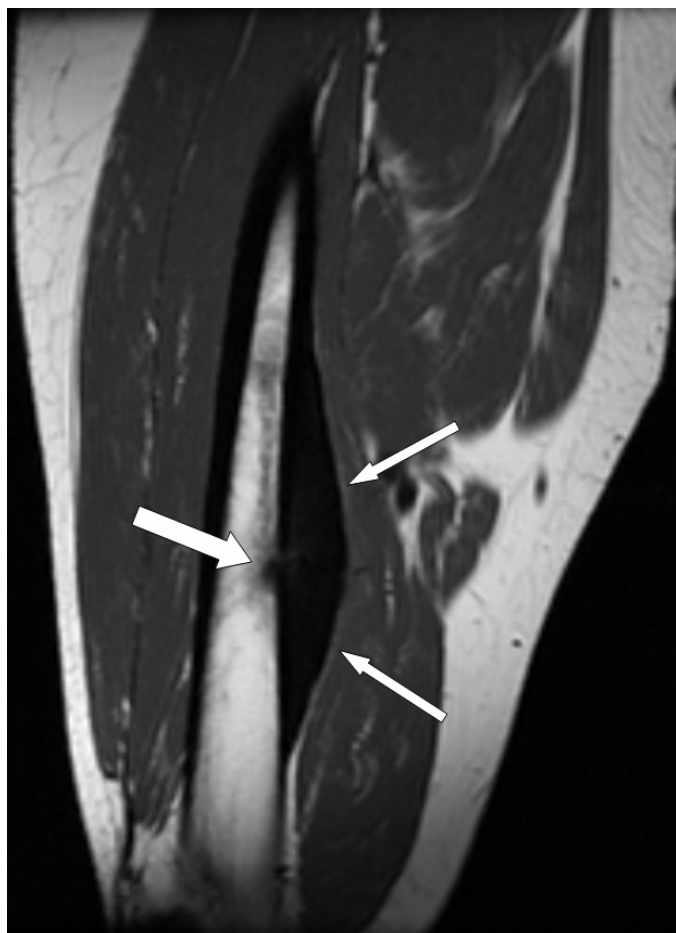


Fig. 2A. MR T1 coronal image demonstrates the wide cortical thickening (thin arrows) with associated cortical penetration (wide arrow).

Follow-up MR imaging validated the cortical thickening as low signal intensity (Fig 2A thin arrows). On T2-weighted images a nidus in the mid femoral shaft was noted with high signal intensity and enhancement following administration of intravenous gadolinium (Fig 2B, C). There was marked bone production medially, with adjacent bone marrow edema involving the mid femoral shaft. Finally, nuclear medicine bone scan using technetium-99m (Tc 99m) HDP revealed intense focal uptake eccentrically in the right distal third of the femur; all consistent with osteoid osteoma (Fig 3).

Discussion

The majority of patients with osteoid osteoma present with the classic history of pain that is worse at night and that is relieved by non-steroidal anti-inflammatory medications. This history however, in a young athletically active patient, is suggestive (but not diagnostic) of osteoid osteoma. Other entities including stress injuries, primary bone neoplasia and an infectious process are occasionally included in the differential diagnosis. Radiographs are the initial study of choice for most complaints of bone pain, the results of which may narrow the differential.⁶ CT and MRI may be used to better characterize bony involvement as well as to localize the central nidus in preparation for interventions such as radiofrequency ablation or surgical resection. Finally, radionuclide bone scanning with technetium-99m phosphonates has a high sensitivity for detecting osteoid osteoma, although disproportionately low specificity may limit its utility in the work-up of this disease.

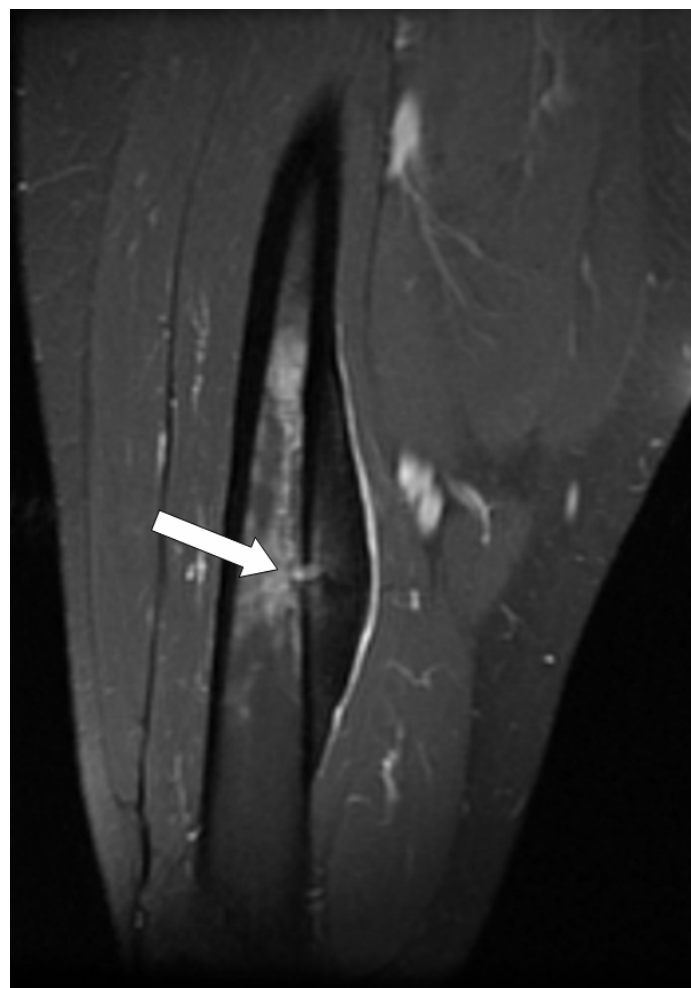


Fig. 2B. MR T2 coronal image after administration of IV gadolinium demonstrates the nidus enhancing (wide arrow).

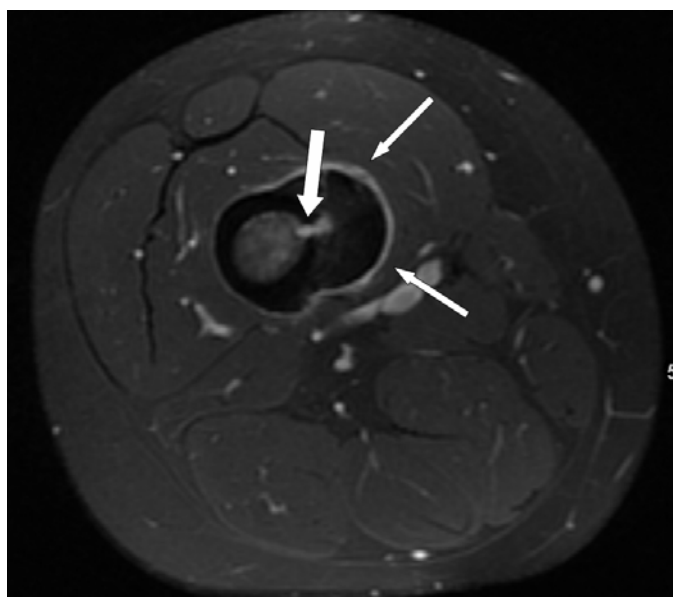


Fig. 2C. MR T2 axial image post-gadolinium shows the extreme cortical thickening (narrow arrows) as low signal intensity (dark). Also note the enhancing nidus with associated cortical penetration (wide arrow).

The features of osteoid osteoma on initial radiographic study are influenced by the site of involvement, by the disease progression, and by the age of the patient. An ovoid lucent defect usually smaller than 1.5 cm in diameter is seen in nearly 75% of patients. The degree of bony sclerosis is largely determined by the site of the tumor, with cortical and subperiosteal tumors being associated with more sclerosis than the rare medullary tumors. Intra-articular lesions may be associated with a small joint effusion, and more than half of patients with a lesion in this location are affected by osteoarthritis as a result. Although the majority of cases have features suggestive of osteoid osteoma on plain film, certain locations such as the spine, the femoral neck, and the small bones of the hands and feet make the diagnosis more difficult due to an atypical radiographic appearance.

The primary differential diagnosis of osteoid osteoma based on history and radiographic features includes stress fracture, chronic osteomyelitis, and osteosarcoma in cortical bone and Brodie's abscess, bone island, and osteoblastoma in medullary bone.⁷ Stress fracture is a prevalent disorder, with as many as 10% of sports medicine patients affected.⁸ Although a history of reproducible bone pain with specific exercise and radiographic findings of linearly oriented sclerosis are the typical presentation, stress fractures may appear as periosteitis with no linear component and with a variable history.⁹ Subacute osteomyelitis is an insidious manifestation of hematogenous osteomyelitis, primarily affecting older children and most frequently involving the metaphysis of the tibia. Radiographic findings in subacute osteomyelitis include a florid periosteal reaction with focal cortical thickening, areas of bone destruction, cortical defects and a sequestrum. This sequestrum on plain film is difficult to distinguish from a calcifying nidus of osteoid osteoma, although on CT the nidus is central, round, and well defined while a sequestrum is

usually irregular and eccentric within the radiolucent cavity. Osteosarcoma most commonly occurs in the long bones near metaphyseal growth plates, with the majority of cases demonstrating signs suggestive of a more aggressive lesion such as a sunburst pattern of periosteal reaction or a Codman's triangle of elevated periosteum.

Brodie's abscess is a subtype of subacute osteomyelitis seen on plain film as a central, well-defined lucency with surrounding reactive sclerosis. While the radiolucent center of a Brodie's abscess is characteristically in the medullary canal or cancellous bone and the nidus of osteoid osteoma is typically in the cortex; further imaging with CT or biopsy may be necessary to distinguish these two processes. Bone islands are usually associated with "brush" trabecular borders and are differentiated from osteoid osteoma by a normal bone scan in the former. Finally, osteoblastoma is an uncommon primary bone neoplasm producing osteoid that has a varied radiographic picture depending on the degree of mineralization. Very similar to osteoid osteoma pathophysiologically, these tumors tend to be larger than 1 cm and located more frequently in the spine and the diaphysis of long bones.

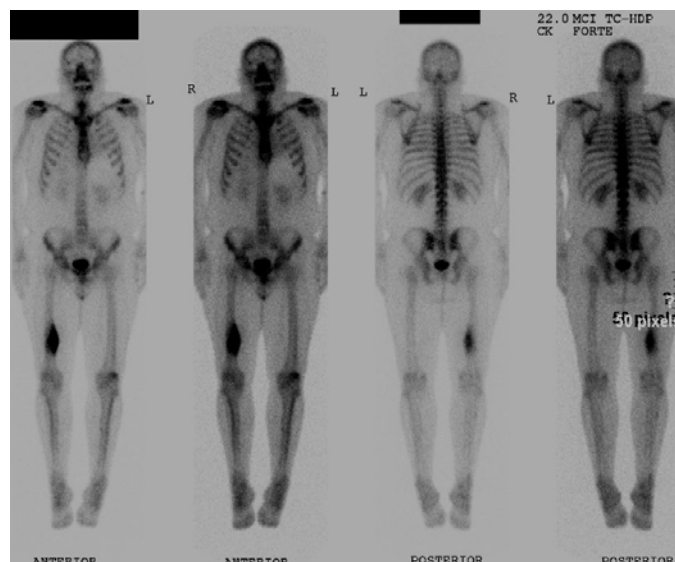


Fig. 3. Nuclear Medicine Bone Scan with Tc 99m HDP shows intense uptake of radiopharmaceutical in the lower right femur.

If the diagnosis of osteoid osteoma is suspected, CT is the imaging procedure of choice to both exclude alternative diagnoses and localize the nidus for therapeutic intervention. In the absence of plain film findings, CT is more accurate than MRI in 63% of cases.¹⁰ This imaging modality is particularly effective when assessing complex elements of the spine and femoral neck. The nidus enhances rapidly with administration of intravenous contrast medium, showing amorphous mineralization and a variable degree of surrounding reactive sclerosis. This rapid uptake of contrast medium may help to distinguish this lesion from osteomyelitis, which has a much slower enhancement. Abscesses may be distinguished from osteoid osteoma on CT by drainage tracts leading away from

the lesion through an opening or cloaca. When located in cancellous bone, CT may not detect the nidus of osteoid osteoma due to lack of attenuation changes around the nidus. Finally, CT may be the preoperative evaluation of choice for surgical planning.⁴

Although less useful than CT for detecting the nidus of osteoid osteoma, MRI may be most useful in showing the degree of associated bone marrow and soft tissue edema. The nidus is typically isointense to muscle on T1 weighted images, and associated bone marrow edema is present in up to 60% of cases. MRI may also better characterize the joint effusion and synovial involvement in intra-articular lesions, and this modality is also preferred in evaluating cancellous osteoid osteoma.

Radionuclide bone scanning with technetium-99m phosphonates shows increased activity of the lesion in osteoid osteoma. Additionally, the increased uptake in the surrounding cortical sclerosis and a superimposed, smaller area of very intense uptake in the nidus may result in a double-density sign on pin hole imaging. Although the sensitivity of this modality approaches 100%, it lacks specificity, as many other processes including infection, fibrous dysplasia, and traumatic causes may demonstrate a similar pattern.

Treatment of osteoid osteoma typically follows one of three different approaches: surgical, medical, and percutaneous. Traditional surgical treatment has been complicated by lesions that are difficult to identify intraoperatively and by incomplete removal leading to recurrence.¹¹ Medical management while awaiting spontaneous regression under observation has been

advocated, but this treatment relies on nonsteroidal anti-inflammatory medications and the time to regression is unpredictable.¹² CT-guided percutaneous radiofrequency ablation has become the treatment of choice for most osteoid osteomas located in the appendicular skeleton and pelvis, and a success rate of 91% has been demonstrated as compared to surgical success rates of 60%.¹³ After needle biopsy, the radiofrequency electrode is introduced under CT guidance and the tip temperature increased to 90°C and maintained for 3-6 minutes. This technique is limited in that the electrode must be positioned at least 1 cm away from major nerves, making lesions in the hand or in the posterior arch of the vertebrae poor candidates. Cases unsuccessfully treated the first time are successfully treated with a second procedure; reported at high as 100%.¹⁴

The work-up of bone pain depends heavily on radiographic findings and subsequent imaging studies. In the appropriate clinical setting, the diagnosis of osteoid osteoma can be reliably made on the basis of radiographic findings alone or distinguished from the broader differential by characteristics seen on CT or MRI. Furthermore, CT-guided percutaneous radiofrequency ablation has been shown to be a safe and highly effective therapy for this lesion, lending further support to the central role of radiographic studies and interventions in both the diagnosis and treatment of osteoid osteoma.

Note: Follow this link for Category 1 CME or CNE in the case of the week in the MedPix™ digital teaching file.

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