The role of imaging studies in the diagnosis of intraosseous lipomas.

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Learning objectives

To describe the typical radiological findings of intraosseous lipomas.
Background

Intraosseous lipomas are rare benign primary bone tumors, representing between 0.1-2.5% of primary bone tumors. However, with the increasing use of CT and MR imaging, osseous lipomas are often seen more than expected (1). It is the most common of the lipogenic bone tumors. Malignant transformations have been sporadically described.

In the literature there are few reports. DeLee published the first case in 1901 (3). The highest number of cases was presented by Milgram (61 cases) and Campbell et al., which describes 35 cases collected by members of the British Society of Skeletal Radiology and conducted a meta-analysis of the cases presented in English literature since 1966 (5).

These tumors have no sex predilection and occur in patients aged between 5 and 70 years, with a peak incidence between the fourth and sixth decades of life (3).

Most lesions are asymptomatic, but up to 66% have reported pain. The exact cause of the pain is unclear, but it may be due to expansile bone remodelling, or it may be incidental (eg, referred pain due to joint disease). For this reason, the lesions are usually incidentally discovered (2).

The most common sites of intraosseous lipoma are in the metadiaphyses of the long bones, predominantly the intertrochanteric and subtrochanteric regions of the femur. The next most common sites, in order of decreasing frequency, are: the calcaneus, ilium (particularly the part adjacent to the sacroiliac joint), proximal tibia, fibula, humerus, ribs, craniofacial bones, pelvis, and spine. Within the long bones, diaphyseal involvement is not uncommon; however, epiphyseal involvement is unusual. In rare cases, multiple intraosseous lipomas are found, and this condition is known as lipomatosis (1).

The exact nature of intraosseous lipoma is controversial. While some authors believe it is a true tumor, for others it is a degenerative phenomenon related to trauma or infection (3).

Milgram outlined a three-stage classification system for intraosseous lipomas, depending on the degree of involution and radiological and pathological correlation (1):

- **Stage I lesions** consist of viable enlarged fat cells organized into lobules resembling mature adipose tissue. The adipocytes replace the normal bone marrow and encase the preexisting trabeculae. Indeed, in one study by Milgram, surgeons described the lesions as normal fat. Cellular expansion of the adipocytes incites bone resorption, the pace of which typically increases...
with increasing stages of disease. Expansile remodeling is seen in all stages.

- **Stage II lesions** also consist of viable lipocytes but are distinguished from stage I lesions in that they contain areas of partial fat necrosis. The fat necrosis is associated with calcification and formation of reactive bone that stains darkly when hematoxylin is applied. The regions of fat necrosis also contain foamy macrophages with accompanying fibrosis. These lesions are frequently expansive and radiolucent, but the slow growth leads to bone neoformation around the lesion. Besides, central dystrophic calcification can be seen inside the fat necrosis areas (3).

- **Stage III lesions** are further differentiated by the near-complete or complete involution of the lipoma and a thicker, more radiodense border. Cyst formation is more characteristic of stage III lesions and is due to the myxomatous degeneration of fat cells. The cystic areas can be small or constitute a large part of the lesion (2).

According to the treatment, intraosseous lipomas that do not affect bone stability may be treated conservatively. Cases with imminent fractures are treated by curettage and bone grafting. The prognosis is generally excellent, and recurrences have not been documented.

The differential diagnosis of these lesions may mimic other entities such as fibrous dysplasia, aneurysmal bone cysts, simple cysts, bone infarcts and chondroid tumors. Although the stage of the lesion affects the list of differential diagnosis. Any expansile bone lesion such as simple bone cyst, fibrous dysplasia and chondromyxoid fibroma may be confused with stage I lesions. CT and MRI are helpful diagnostic tools, as they can easily demonstrate the fat contents of the lesion. Radiographically, enchondromas may mimic stage III lipomas. Fortunately, tissue examination can lead to diagnosis, taking into consideration that lipomas contain no cartilage tissue. Osteoblastoma should also be considered in the differential diagnosis of uncommon ossifying lipomas (2).

However, in very involuted bone lipomas (stage III), MR findings can be ambiguous, which may make the diagnosis more difficult (3).
Findings and procedure details

We review radiological findings of these lesions according to staging Milgram:

- The imaging characteristics of stage I lesions are dictated by their fat content. On radiographs, the lesion appears lucent because it consists predominantly of mature adipose tissue. On CT images, the lesion has CT attenuation coefficients consistent with the range for fat (#60 to 100 HU) (1). Magnetic resonance imaging (MRI) is useful in the study of musculoskeletal injuries. Intraosseous lipoma is a tumor with very characteristic signs on the MRI, as it is able to demonstrate exactly the fat component and therefore it is useful in the diagnosis and evolutionary staging of intraosseous lipoma (7). On all MR images, including those obtained with fat suppression, the lesion has signal intensity isointense to that of subcutaneous fat. The signal intensity of intralesional fat is often mildly higher than that of bone marrow because of the additional cellularity of marrow. Expansile remodeling may be seen. On CT and MR images, trabecular resorption is evident. The thin rim of sclerosis that is sometimes seen with radiography and CT has low signal intensity on T1- and T2-weighted MR images (1).

- The imaging characteristics of stage II lesions are due to fat necrosis and dystrophic calcification, which appear as regions of increased density on radiographs and increased attenuation on CT images. On MR images, areas of fat necrosis have variable signal intensity on T1-weighted images and high signal intensity on T2-weighted images. Areas of calcification show low signal intensity on both T1- and T2-weighted images. If the lesion has a predominant fatty component, it should not cause confusion with other diseases (3). We must also have the clinical history, which if we add to the combination of different MRI sequences, can easily help us to diagnose intraosseous lipoma in I and II stages, making a biopsy unnecessary.

We review the plain radiographs, CT and MRI images of four patients (Fig 1-7). In all these four cases, the diagnosis was as an incidental finding in the plain film. All were female, and aged between 35 and 60 years old.

The mass in our patient imaging showed characteristics of a stage II lesion, observing osteolytic lesions with well-defined and sclerotic edges, located in the metadiaphysis of the humerus in three cases, and of the tibia in the other case. CT demonstrated predominant fat content, a finding supported by the MR imaging appearance of the lesion. Three of them had central calcification, which was confirmed with the CT images. One
of the lesions showed a central necrotic area. The CT and MR imaging diagnostic were characteristic. None of them required surgical treatment.

- The imaging characteristics of stage III lesions shows a greater degree of involution, in addition to the signal characteristics of stage 2 lesions, may contain fluid-equivalent cavities and signal-void bony septae and calcifications, and are surrounded by thickened, signal-void rims of sclerotic bone. Although there are typically no signs of aggressive behaviour, expansile intraosseous lipomas may outgrow the cortical border (7).
**Fig. 1:** CASE 1. Intraosseous lipoma.

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**Fig. 2:** CASE 1. Intraosseous lipoma.

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Fig. 3: CASE 2. Intraosseous lipoma.

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Fig. 4: CASE 2. Intraosseous lipoma.

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Fig. 5: CASE 3. Intraosseous lipoma.

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Fig. 6: CASE 4. Intraosseous lipoma.

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Fig. 7: CASE 4. Intraosseous lipoma.

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Conclusion

The radiological study of intraosseous lipomas should include plain film, CT and MRI, which confirm the fat component and the benign pattern of the lesion. They can be reliably diagnosed by imaging techniques, and not additional procedures are necessary.
References