Chapter 2
General Principles of Imaging

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Bone imaging has undergone significant changes during the last decades. Ultrasounds, CT, MR imaging, and PET have been added to arteriography, scintigraphy, and radiographs. At the same time, survival of primary malignant tumors has improved with chemotherapy, and local results have improved with conservative surgery. Imaging plays a major role in diagnosis, local and general staging, monitoring the treatment, and detecting recurrences.

2.1 Diagnosis

Patient age, location (bone or part of the bone involved), size (small is usually benign), calcifications and ossifications, limitation (the better seen, the slower the lesion growth), periosteal bone formations, and soft tissue involvement must be added to reach a reliable diagnostic probability. Combining clinical information, imaging, and histology leads to the most accurate results. Diagnosis of a bone tumor must be teamwork.

Radiographs remain the mandatory first step. They allow diagnosis of "leave-me-alone" lesions, and nothing more is usually added. If the lesion on radiographs is probably malignant, the next step should be immediate MR to stage the lesion.

Radiographs have limitations: superimpositions, partial cortex destruction could be overlooked, and flat and short bones and soft tissues are poorly analyzed.

CT is used in case of a diagnostic problem on radiographs. It allows a better study of the cortex, to detect and analyze small calcifications and thin periosteal bone formations. The nidus of an osteoid osteoma is well found (much better than on MR). Measuring tissue density can help characterize fat, fluid, blood, and

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calcification. After injection of contrast medium, soft tissue extension and vessels are well located.

The contrast remains however much lower than on MRI, which is the main modality for local staging. Its diagnostic role is limited, as calcifications and periosteal bone formations are more difficult to analyze (a black signal on MRI may be a calcification, but also fibrous tissue or chronic bleeding with hemosiderin). Fluid-fluid levels are better depicted than on CT, because of higher contrast and longer examination time. They are frequently seen in aneurysmal bone cysts but are nonspecific.

2.2 Local Staging

On MRI, the precise location of the tumor is well analyzed.

Intramedullary extension (and the level of surgical resection), skip metastases, soft tissue involvement, and extension to vessels and nerves are easily and reliably detected. The main limitation is articular extension, which could change the surgical technique: if the tumor abuts on the cartilage, we cannot reliably predict the joint involvement.

In case of contraindications (pacemakers and metallic ocular foreign bodies), CT is used but has a lower accuracy.

2.3 Distant Spread

Bone metastases and multiple lesions are detected on scintigraphy. Total body MRI is more sensitive without irradiation. Pulmonary metastases are sought by chest CT. We must keep in mind that although sensitivity is good, specificity is poor (or if we detect a lesion, we are not sure that it is actually a metastasis).

PET, now combined with CT, allows a global study of the patient, studying the tumor metabolic activity as well as the distal extent. Its spatial resolution is limited (lesions of less than 5 mm may be overlooked), and some malignant lesions are not very active metabolically (such as sclerotic metastases).

2.4 Evaluation of Treatment Effectiveness

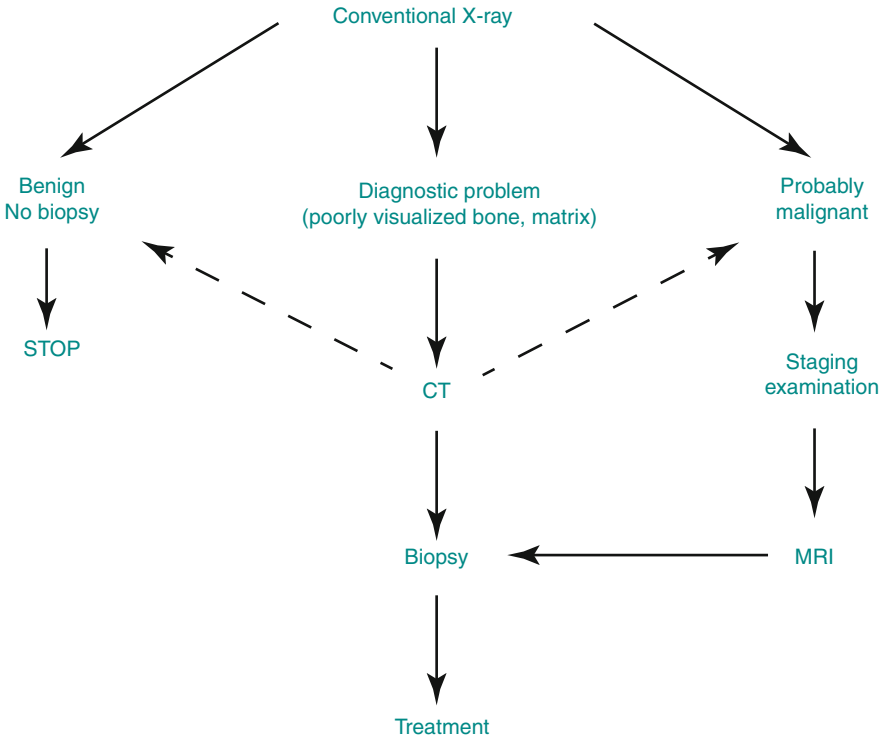
Most primary malignant tumors are treated with preoperative chemotherapy. Decrease of lesion size, ossification, and decrease of early contrast medium uptake on scintigraphy and most of all dynamic MRI are signs of an efficient treatment. They become reliable only late after the beginning of chemotherapy. The initial results of PET are not (yet?) much better.

2.5 Detection of Local Recurrences

In case of suspicion, a local MR can be performed if the prothesis is non-paramagnetic (that is in titanium).

2.6 Summary

Radiographs remain the first step to image a bone tumor. In case of diagnostic problems, the next step is CT. MR is the main imaging modality for local staging, treatment evaluation, and detection of recurrences. PET is still under evaluation.



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