Imaging of Pediatric Musculoskeletal Neoplasms

Philippe Petit¹, Michel Panue²

¹ Service de Radiopédiatrie, Hôpital Timone-Enfants, Marseille, France
² Service d'Imagerie, Hôpital Nord, Marseille, France

Introduction

Information regarding the frequency, location, imaging criteria, and diagnostic clues of pediatric bone and soft-tissue lesions, either benign or malignant, are described in several excellent radiology text books [1, 2]. Ideally, this information is sufficiently known to radiologist such that these pathologies can be diagnosed quickly and confidently. In current practice, the radiologist’s job can be described as comprising three essential responsibilities.

The Choice of the Proper Imaging Modality

The choice of the proper imaging modality depends on the initial clinical signs.

Cases Involving Trauma and/or Pain

In patients who have suffered trauma or experience pain, plain-film X-rays constitute the first diagnostic step, as they guide the radiologist’s decision to subsequently perform an imaging exploration or other procedures.

First, it will identify the presence of a bony or soft-tissue lesion. Here, the radiologist’s role is to describe the aggressiveness, location (longitudinal and transverse for long bones), degree of mineralization of a bony lesion, and the density and its relationships with the underlying bone of a soft-tissue mass. The next step is to decide whether the lesion is actually a normal variant (Fig. 1) [3, 4] or an incidental finding, definitely benign and not requiring treatment (Figs. 2, 3).

Second, if the lesion needs further imaging exploration, i.e., it is of unknown origin or exhibits marked aggressiveness, the most appropriate modality must be chosen. The endpoint of imaging is not employ the entire armamentarium of imaging modalities but the one that will yield the greatest degree of diagnostic accuracy, with minimal radiation exposure of the patient and the lowest cost, while affording surgeons and clinicians information essential to the child’s management. Depending on the initial imaging suspicion, the strategy generally proceeds as follows:

Fig. 1 a, b. Anteroposterior (a) and lateral (b) views of the left knee in a 6-year-old boy: normal irregular ossification of the lateral aspect of the distal femoral epiphysis
Imaging of Pediatric Musculoskeletal Neoplasms

Fig. 2 a-c. Posterior cortical defect of the medial condyle created by chronic avulsions of the medial gastrocnemius; (a) lateral view, (b) sagittal T1-weighted image, (c) axial T2-weighted image

Fig. 3. Congenital tibia vara

- Stress fracture: In the acute phase magnetic resonance imaging (MRI) is preferred over computed tomography (CT); in the delayed phase (>10 days after the first X-ray): the plain-film X-ray should be repeated (Fig. 4).
- Osteoid osteoma, osteoblastoma, myositis ossificans/para- and peri-osteal sarcomas: CT is recommended to analyze mineralization, position of the calcification (central or peripheral), and the relationship with the underlying bone (Fig. 5). In osteoid osteoma, this step precedes percutaneous treatment [5].
- Other lesions: MRI is the method of choice to evaluate the signal of the lesion and its extension either in the medulla and/or the soft tissues [6].
- Metastatic disease (rare) or a potentially diffuse process (fibrous dysplasia): While bone scintigraphy Tc-99 was previously recommended in these cases, it has largely been replaced by 3D whole-body MR (STIR or diffusion) [7].

Third, if the lesion needs to be biopsied, it must be preceded by a thorough imaging work-up, ideally discussed during a multidisciplinary meeting (pathologist, oncologist, orthopedic surgeon, radiologist) [8]. The margins of the lesion, as seen on MRI, will be greatly increased due to the trauma of biopsy, leading to unnecessary bone and soft-tissue resection if a surgical procedure is planned. MRI and positron emission tomography (PET)-CT are the two most important examinations for, respectively, local and general assessment of the nature of a lesion. Both techniques are used not only in the initial work-up but also in the follow-up of patients with malignant tumors, to assess the response to chemotherapy [9-11].

However, it may be that a lesion is not visible on plain X-ray. Assuming that the patient's symptoms have been correctly assessed, the appropriate clinician prescriptions chosen, and the X-ray images (or those obtained with other imaging technique) are of adequate quality, then several different sceneries are possible: (1) if there is no lesion and the patient has become asymptomatic; a clinical follow-up, but not further imaging, is required. (2) If a lesion should be visible (Fig. 6), the discrepancy with the clinical status indicates the need for a repeat X-ray or a more sensitive imaging mode (bone scintigraphy or MRI). (3) It may be the case that the clinical signs persist but that the lesion is not yet visible on X-ray; in this case, the recommendations of step (2) should be followed.

Cases Involving a Soft-Tissue Mass

The first imaging exam carried out in our department is ultrasound-Doppler examination [12-14]. Nonetheless,