MR images of bone lesions in children treated due to leukemia

Monika Bekiesinska-Figatowska, Sylwia Szkudlinska-Pawlak, Anna Romanik-Doroszewska, Hanna Bragoszewska, Agnieszka Duczkowska

Department of Diagnostic Imaging, Institute of Mother and Child, Warsaw, Poland

Author’s address: Monika Bekiesinska-Figatowska, Department of Diagnostic Imaging, Institute of Mother and Child, Warsaw, Poland, e-mail: m.figatowska@mp.pl

Summary

Leukemia is the most frequent malignancy in children (30–40%); acute lymphoblastic leukemia (ALL) accounts for 85% of cases of this leukemia. Apart from bone marrow infiltration, MR imaging reveals other lesions in the bones of these children, that may be a complication of the disease or of its therapy and do not require referral to the oncologist unless they are misinterpreted. These lesions include osteonecrosis, stress fractures due to osteopenia, osteomyelitis – often resulting from administration of corticosteroids. The authors present MR images of these lesions, often misinterpreted as leukemic infiltration.

Key words: acute lymphoblastic leukemia (ALL) • magnetic resonance imaging (MRI) • osteonecrosis • stress fracture • osteomyelitis

These features of the MRI image of the spine are quite commonly known, while the image of other bones and the whole range of their lesions in the course of leukemia treatment – much less. The imaging examinations of children referred to Clinical Department of Oncological Surgery for Children and Youth of our Institute are sent to the Department of Diagnostic Imaging for consultation. That is why we thought about describing the lesions of the bones that may appear in the process of leukemia treatment, as complications of the disease or its treatment and that do not require oncological consultation if interpreted correctly.

Bone marrow is the most common location of leukemia recurrence [4]. Thus, MRI examinations in children with symptoms from bones and joints are common and justified. On the other hand, bone necrosis is here more frequently asymptomatic than symptomatic [4]. It should be a common knowledge to differentiate between the disease recurrence and other, unrelated lesions, such as osteonecrosis, stress fractures due to osteopenia, or osteomyelitis [2,6]. Treatment with corticosteroids has a significant influence on the development of these lesions. Some of the children with leukemia receive bone marrow transplant. They also develop bone necrosis due to large doses of steroids.
Figure 1. A 17-year-old boy after ALL treatment, examined after 2 years following bone marrow transplantation. Osteonecrosis in both condyles of the femur and tibia. Lateral condyle of the tibia is fractured, its articular surface is markedly lowered, and the articular space is widened. MRI, coronal projection. (A) SE/T1-. (B) STIR. In the medial condyle of the tibia there is a well visible ‘double line’.

Figure 2. The same patient as in Figure 1. Foci of osteonecrosis in the distal shaft of the femur, below the loaded surface and in the upper part of the patella. MRI, sagittal projection. (A) SE/T1-. (B) FSE/PD with fat saturation.
Figure 3. A 16-year-old girl after ALL treatment. Foci of necrosis in the heads of both femurs and in the acetabula of both hip joints. MRI, coronal projection. (A) SE/T1-. (B) STIR.

Figure 4A, B. A 15-year-old boy, with inflammation of the right humeral bone, during ALL treatment. (A) STIR, sagittal projection. (B) SE/T1 – with fat saturation, coronal projection.
Some of the medicines used in chemotherapy, such as methotrexate, may cause osteopenia and fractures, especially of the lower limbs [1,8] (Figure 1). In the English literature, avascular necrosis and bone infarcts are jointly termed osteonecrosis. The shape of such lesions is geographical in long bone shafts and more regular in adjacency to articular surfaces, with a good delineation in the form of a rim showing a low signal intensity in T1-weighted images and different intensities in T2-weighted images (including STIR): low or high, and being most typical when appearing as a double line, i.e. parallel lines of high and low signal intensity [5,9]. In patients with leukemia examined and consulted on in our center, this is the most common osseous pathology (Figures 1, 2). The most typical location of the necrosis is the head of the femur [7] (Figure 3) but the lesions may also be found in humeral bones, distal parts of the lower limbs, and in vertebrae.

Infections are common in patients with reduced immunity, and thus also in children with hematological neoplasms. Infections include bone inflammation that may appear in leukemia and may be especially hard to diagnose. Stacy and Dixon included bone inflammation in the group of diseases with ambiguous features, which do not allow for a strong suspicion of malignancy or benign lesion on the basis of an MRI and require further diagnostics (Figures 4, 5) [9].

Leukemia recurrence in the bone marrow, as opposed to diffuse lesions found in the first diagnosis, includes nodular lesions of low signal intensity in T1-weighted images, and of high signal intensity in T2-weighted images, well delineated from the surrounding structures, both in children and in adult patients. Good delineation constitutes the major feature differentiating the recurrence from non-neoplastic lesions, manifesting themselves with bone marrow edema [10].

In our own material, as in examinations performed outside our Center, there was no image of leukemia recurrence in the bones, while the descriptions of the examinations were clear about the presence of recurrence or its suspicion in the course of the basic disease (out of the whole range of possible diagnoses). This induced us to collect the above presented material.
References:

1. Bernard EJ, Nicholls WD, Howman-Giles RB et al: Patterns of abnormality on bone scans in acute childhood leukemia. J Nucl Med, 1998; 39: 1983–86

2. Moulopoulos LA, Domopoulos MA: Magnetic resonance imaging of the bone marrow in hematopoietic malignancies. Blood, 1997; 90(6): 2127–47

3. Sze G, Bravo S, Baierl F et al: Developing spinal column: gadolinium-enhanced MR imaging. Radiology, 1991; 180: 497–502

4. Gaynon PS, Ou RE, Chappell RJ et al: Survival after relapse in childhood acute lymphoblastic leukemia: impact of time and site of first relapse – the Children’s Cancer Group experience. Cancer, 1998; 82: 1387–95

5. Karimova EJ, Rai SN, Ingle D et al: MRI of knee osteonecrosis in children with leukemia and lymphoma: part 2, clinical and imaging patterns. Am J Roentgenol, 2006; 186: 477–82

6. Strauss AJ, Su JT, Dalton VM et al: Bony morbidity in children treated for acute lymphoblastic leukemia. J Clin Oncol, 2001; 19: 3066–72

7. Tauchmanova L, De Rosa G, Serio B et al: Avascular necrosis in long-term survivors after allogeneic or autologous stem cell transplantation. A single center experience and a review. Cancer, 2003; 97: 2453–61

8. Marchese VG, Connolly BH, Able C et al: Relationships among severity of osteonecrosis, pain, range of motion, and functional mobility in children, adolescents, and young adults with acute lymphoblastic leukemia. Phys Ther, 2008; 88: 341–50

9. Stacy GS, Dixon LB: Pitfalls in MR image interpretation prompting referrals to an orthopedic oncology clinic. Radiographics, 2007; 27: 805–26

10. Herman Kan J, Hernanz-Schulman M, Frangoul HA et al: MRI diagnosis of bone marrow relapse in children with ALL. Pediatr Radiol, 2008; 38: 76–81