Typical and atypical MRI findings of bone lymphomas

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Purpose

1. The aim of our study is to present and illustrate the most common features of bone lymphoma lesions.
2. To determine the role of MRI in evaluation of local extension of the disease.
3. To emphasise the role of MRI in monitoring the response to therapy, and detect residual disease after first-line chemotherapy.
Methods and Materials

PATIENTS

Retrospective study, between 01.01.2005-01.05.2011, that included 86 patients (the male-to-female ratio being 1.8:1, with ages between 9-87 years ), with bone lymphoma lesions.

63 patients of our study were in a clinical context of non-Hodgkin’s lymphoma (NLH) and 23 patients were with Hodgkin’s lymphoma (HL) amongst 730 patients sent to the Department of Radiology and Imaging Fundeni with the diagnosis of Hodgkin and non Hodgkin's lymphoma.

TECHNIQUE

Patients with bone lymphoma followed an imaging protocol that included at least a standard radiograph of the bone segment in question and a MRI exam targeted at the site of the lesion.

MRI examination was performed with a 1.5-T high-field magnet (Signa Horizon General Electric), using multiplanar T2 weighted and T1 weighted sequences before and after intravenous Gd-DTPA injection, with a slice thickness of 3-5 mm and spacing of 0.5-1. Optional we use STIR or PD fat sat sequences.
Results

According to the literature, bone involvements by lymphoma may occur as a part of disseminated disease or an isolated manifestation (ie. primary lymphoma of bone)\textsuperscript{4}.

MRI ASPECTS

Primary bone lymphoma is a rare disease and during the period of our study, we didn’t found any primary bone lymphoma.

All patients included in our study had secondary lymphomatous bones lesions. Involved bones, were those that normally contain red marrow. Preferentially localized in the metaphysis of long bones, lymphomatous tumors were clinical accompanied by bone pain or local swelling.

Common sites, in order of decreasing frequency, included the following: femur, humerus, tibia, spine, pelvic bones.

Number of lesions: 68% of our cases presented solitary lesions and 7% multiple lesions, mostly polyostic (90%).

Types of lesions. 75 % of cases showed osteolytic lesions (Fig. 1 on page ) Typically this appear to MR examination with lower signal intensity than muscle on T1-weighted sequences and higher or brighter than muscle on T2-weighted sequences. These tumors typically demonstrate diffuse heterogeneous to homogeneous enhancement when IV contrast is used. Mixted type osteolytic and sclerotic lesions were observed in 15% of patients. An osteosclerotic component are hypointense on T2, hyperintense on T2 with fat supresion sequences and enhance after gadolinium injection.

Tumor size: Tumor dimensions, highly variable, generally extensive, were established by measuring length, width and depth, assessed from the combination of axial and longitudinal images. Tumor size is a useful marker in posttreatment monitoring.

Paravertebral and intracanalar tumor extension in vertebral involvements. (Fig. 1 on page , Fig. 2 on page 7 ). In our study it was found in 29% of patients of our group.
Bone marrow involvement: SIs of the bone marrow component and homogeneity were assessed on T1- and T2-weighted sequences, compared with muscle SI (higher, equal/intermediate, lower, mixed) and opposed to the high SI of normal bone marrow. Tumor margins were defined as sharp or unsharp. (Fig. 3 on page 8).

Cortical bone destruction/ anomalies: Appearance of the cortical bone was determined as normal or abnormal on both T1- and T2-weighted images. Abnormal cortical bone appearance was subdivided into focal destruction (normal low signal intensity, partially replaced by high SI of tumor with focal disturbance of cortical integrity) (Fig. 4 on page 9) and more frequent, permeative lesions (Fig. 5 on page 10). That means tumoral extraosseous extension without interruption of cortical and it was found in 70% of our cases.

Extension into the soft tissues: A soft tissue tumoral component, defined as a mass beyond the margins of cortical bone and periosteum, was present in 85% of cases.

Signal intensities of soft-tissue mass associated: SIs were predominantly high relative to muscle SI, assessed on both T1- and T2-weighted sequences. Furthermore, homogeneity or heterogeneity of the SI on T2-weighted images was assessed. (Fig. 4 on page 9).

Soft-tissue edema: Soft-tissue edema was considered to be present when areas of perilesional high signal intensity (SI) were noticed on T2-weighted sequences and/or contrast enhanced T1-weighted sequences in an ill-defined feathery pattern, without disruption of the fascial planes. (Fig. 6 on page 11). In our study it was found in 30% of patients of our group.

Enhancement of bone marrow component. The presence or absence of intraosseous tumoral enhancement and the pattern (homogeneous, heterogeneous, focal, diffuse) of enhancement on static T1-weighted Gd-DTPA-enhanced sequences were determined.

Contrast enhancement of malignant infiltration in lymphoma was a constant finding (Fig. 4 on page 9 Fig. 5 on page 10), even between the patients in whom we could assess the enhancement of bone marrow tumor component, 61% showed heterogeneous enhancement.

Post treatment evaluation.
The differentiation of residual tumor and treatment-associated changes, including tumor necrosis and granulation tissue, may be challenging on MR images of bone tumors after treatment. In our patients, tumor volume decreased in a pronounced fashion (71-96%) after 6 months of therapy (Fig. 6 on page 11). In 8 cases, the MRI after corticotherapy has revealed bone infarction (Fig. 7 on page 12).

An atypical localization (on the skull) of a permeative lymphomatous lesion was found in a patient of nine years old, the age being also a particular aspect. (Fig. 8 on page 13).

DIFFERENTIAL DIAGNOSIS

The MR pattern is, however, not specific to lymphoma and there is necessary to differentiate from other entities, depending on a lesion's exact radiographic appearance and on the age of the patient, includes the following: metastatic carcinoma, osteosarcoma, Ewing sarcoma, malignant fibrous histiocytoma or fibrosarcoma of bone, neuroblastoma and other small round cell tumors, osteomyelitis, Langerhans cell histiocytosis, multiple myeloma, leukemic infiltrate, Paget disease, giant cell tumor.
Fig. 1: Multiple osteolytic lesions. M, 58 years old, NHML Multiple vertebral osteolytic lesions, with lymphomatous mass extending into spinal canal.

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Fig. 2: Lymphomatous diffuse, infiltrating lesion B.H., M, 48 years old. Diffuse, heterogeneous replacement of the bone marrow, more visible at first lumbar vertebral body.

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Fig. 3: Infiltrative lesion M, 44 y, NHML. Extensive replacement of calcanean, navicular and cuboid bone marrow for a low signal tissue (arrows).

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Fig. 4: Unique infiltrativ lymphomatous lesion M,87 years old, NHML Unique infiltrativ lymphomatous lesion. Non homogeneous lesion at the level of right tibial epiphyseal, metaphyseal and proximal diaphyseal region, associating with focal destruction of lateral cortical bone and bulky soft-tissue tumoral mass. Multiple popliteal adenopathy (*).

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Fig. 5: Unique permeative lymphomatous lesion F, 67 years old, NHML Enhancement within the intramedullary right femoral lesion and soft-tissue involvement. Extrasosseous tumor without obvious destruction of the cortical bone, reflect the permeative nature of the tumor.

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Fig. 6: Monitoring the response to therapy M, 56 years old, NHML At diagnosis hyperintense homogeneous olecranon tumor mass (asterics) with large soft-tissue edema (white arrowheads). Six months after start of therapy - MRI show decrease of tumor volume with complete disappearance of the soft-tissue edema.

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**Fig. 7:** Treatment-associated changes M, 21 years old, NHML Patient with non-Hodgkin lymphoma presenting with bone pain at right knee level, at 10 months after start of therapy.

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**Fig. 8:** Atypical location of permeative lymphomatous lesion. M, 9 years old, NHML. Hyperintense right parietal bone marrow lesion, with cortical integrity, but spindly tissue mass developed on both sides of bone involved. Enhancement within the intramedullary parietal lesion and soft-tissue involvement. Patient age is a particular aspect.

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Conclusion

In Malignant Non Hodgkin Lymphoma and even in Hodgkin disease, lytic lesions predominate. Presences of associated soft-tissue mass, often preserving the integrity of cortical bone are the most common radiologic findings.

MRI plays an essential role in lymphomatous lesions detection and assessment of local extension. Moreover is the optimal modality to demonstrate the extent of bone marrow replacement, particularly using T1-weighted sequences.

MRI has also a crucial role in the evaluation and monitoring of bone lymphomas, highlighting the best both dimensional reduction of bone tumor and disappearance of soft tissue lymphomatous component.
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