Whole Body-MRI of bone marrow in patients with multiple myeloma and monoclonal gammopathy in comparison to plain films

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Abstract
The purpose of this prospective study was to evaluate Whole Body-MRI as a screening tool for bone marrow imaging in patients with multiple myeloma and monoclonal gammopathy. 22 cancer patients at initial diagnosis underwent Whole Body-MRI and conventional radiography in order to detect bone and bone marrow abnormalities. MRI was performed using a turbo-STIR-sequence combined with a rolling table platform. First results demonstrated that Whole Body-MRI as a fast screening examination is feasible in patients with bone marrow disorders. In comparison to conventional radiography, it is more sensitive and might be useful in the future as an independent parameter in staging patients with multiple myeloma and monoclonal gammopathy.

Introduction
Multiple myeloma and monoclonal gammopathy are a group of disorder characterized by a single proliferation of neoplastic plasma cells including a single clone of plasma cells which produces lesions similar to tumors which diffuse infiltrate bone marrow and extramedullary sites. The proliferation of these plasma cells leads to impaired hematopoetic ability which might result in osteolytic bone lesions detected by conventional radiograph. MR imaging has become the imaging technique of first choice for bone marrow disorders and is performed increasingly in patients with multiple myeloma and monoclonal gammopathy (1,2,3,4). Although MRI is an imaging technique for bone marrow imaging, Whole body-MRI is not used for staging of bone marrow infiltration according to Durrie and Salmon staging.

Methods
22 patients with plasmocytoma (n=18) and monoclonal gammopathy (n=4) were prospectively studied by Whole Body-MRI and conventional radiography for staging and tumor mass measuring at initial diagnosis. Conventional radiography consists of nine different projections including lateral view of the skull, a.p. view of the thoracic spine, lateral view of the lumbar spine, a.p. view of the pelvis and a.p. view of both lower and upper extremities. Whole Body-MRI was done using a 1.5 T unit (Magnetom Sonata, Siemens, Erlangen, Germany) equipped with high performance gradient, 40 mT maximum amplitude, slew rate 200 mT/m/msec. In order to evaluate the whole bone marrow space, a coronal STIR-sequences (TR5500-4203/TE 102–94/TI160) were used for imaging of different body regions including head, neck, thorax, abdomen, pelvis, upper and lower extremities. The evaluation was done by two experienced radiologists blinded to the clinical results of the second imaging technique. Disagreements were solved by consensus reading. MRI was performed using a rolling table platform for an unlimited field of view.

Results
In 4/22 patients both imaging technique revealed no osteolytic lesion or bone marrow infiltration. In 10/22 (45 %) patients Whole Body-MRI demonstrated a bone marrow infiltration whereas the conventional radiography was in all cases negative. In six of these ten cases, Whole Body-MRI demonstrated a varigated bone marrow pattern of infiltration. In four additional cases with negative findings in conventional radiography, Whole Body-MRI depicted a diffuse bone marrow infiltration (Fig.1). In one patient, MRI additionally demonstrated an extramedullary manifestation of multiple myeloma. (Fig. 2). In 8/22 patients (36 %) conventional radiography and Whole Body-MRI were positive in respect of bone marrow infiltration. However, Whole Body-MRI using a turbo-STIR-sequence was superior to conventional radiograph in respect to the extent of bone marrow infiltration and detected more bone marrow infiltrations in different localisations of the skeletal system.

Fig 1. Plain films were normal, whereas Whole Body-MRI demonstrated a diffuse bone marrow infiltration and a splenomegaly with an extramedullary multiple myeloma manifestation

Discussion
Multiple myeloma and monoclonal gammopathy as a bone marrow disorder might be staged by Whole Body-MRI. The extent and grade of bone marrow infiltration might be an integral part of the staging according to Durie and Salmon classification. (3). Bone marrow infiltration can be directly visualized and sensitively detected and measured. In comparison to the conventional radiograph, the bone marrow infiltration due to multiple myelomas and monoclonal gammopathy might correlate with focal or diffuse increase of cellularity due to bone marrow infiltration. Therefore, Whole Body-MRI as a fast and accurate screening method demonstrates bone marrow infiltration on the one hand of the axial skeleton including whole spine and pelvis and, on the other hand of the appendicular skeleton (lower and upper extremities and ribcage). Especially in patients with bone marrow disorders including metastastic disease, multiple myeloma and monoclonal gammopathy Whole Body-MRI should be performed. A turbo-STIR-sequence which is more sensitive than other spin-echo or gradient-recalled echo-sequences for detection of bone marrow infiltration should be used. As reported in literature, contrast media application can be added and might predict future and forthcoming complications (2).

In conclusion, the clinical potential of Whole Body-MRI must be proven in further clinical studies of larger series in comparison to the routine staging procedure like conventional radiograph, bone marrow biopsies and laboratory parameters in patients with multiple myeloma and monoclonal gammopathy. Whole Body-MRI might become a new criteria and play an important role in the disease management and monitoring. Demonstrating more extensive bone marrow infiltration the findings should be included in future times into the staging system of Salmon and Durie.

References