Detection of skeletal metastases in patients with solid tumors Whole Body-MRI as a new screening and staging technique in comparison to skeletal scintigraphy and Whole Body-FDG-PET

Abstract
Malignant primary tumors are often associated with metastatic disease to bone and bone marrow even at the first time of their presentation. Early detection of metastatic disease to bone enables faster therapy with a decrease of morbidity due to pain and complications. Metastatic disease of bone marrow is much more frequently found in approximately 50 up to 85 % in autopsy studies than in routine staging procedures, so the purpose of our study was to compare the diagnostic values of Whole Body-MRI, skeletal scintigraphy and Whole Body-FDG-PET in detection of skeletal metastases in patients with solid tumors. For Whole Body-MRI, a Turbo-STIR sequence was performed using a "rolling table platform" bodysurf-coil" for an unlimited field of view. Our preliminary results demonstrated that Whole Body-MRI as a fast imaging technique in cancer patients was superior to skeletal scintigraphy and Whole Body-FDG-PET. Whole Body-MRI is feasible and comparable to skeletal scintigraphy and Whole Body-FDG-PET.

Introduction
MRI, skeletal scintigraphy and PET are staging and screening procedures in clinical routine of oncologic patients used for the detection of metastatic disease to the bone. Due to a restricted field of view to a single body lesions, MRI consists of several separate investigations, whereas skeletal scintigraphy and Whole Body-FDG-PET can be performed as a whole body examination for staging and screening. Based on a rolling table platform with an integrated surface coil Whole Body-MRI seems to be feasible for tumor staging and screening cancer patients by using different imaging techniques.

Methods
73 cancer patients with different solid tumors were studied prospectively by Whole Body-MRI and skeletal scintigraphy for staging and screening of metastatic disease of bone. In 29 of these 33 patients Whole Body-FDG-PET was performed. Between the Whole Body-MRI, skeletal scintigraphy and Whole Body-FDG-PET examination no radiation therapy or chemotherapy was done. No previous chemotherapy within the last two months prior to PET was performed. The evaluation which was done by two experienced radiologists and nuclear physicians independently was only focussed on the metastatic disease to bone. The gold standard was the clinical follow up. The MRI examinations were done using a rolling table platform body surf coil for an unlimited field of view with a 1.5 Tesla system (Magnetom Sonnata, Siemens, Erlangen, Germany) For imaging of the different body regions including head, neck, thorax, abdomen, pelvis, and upper and lower extremities a coronal Turbo-STIR sequence with (TR5500–4230/TE102–94/TI160) was obtained. Skeletal scintigraphy was performed with 99 Tc-DPD four hours after injection of the radiopharmacon in anterior and posterior projections. For Whole Body FDG-PET, 300-500 MBq of FDG was injected intravenously and the uptake time was 90 min. The data were acquired with a two-dimensional ring scanner (ECAT EXACT, Siemens/CTI, Knoxville, Tennessee, USA) with a rod source.

Results
In comparison to the established imaging technique of skeletal scintigraphy, the results of skeletal scintigraphy and Whole Body-MRI were concordant in a 58/73 (79 %). In 27 of 33 (37 %) patients, no skeletal metastatic disease was found with both imaging techniques. In 16 of these 27 concordant-negative cases FTG-PET as available and negative, too, underlying the concordant imaging findings. In 31 of 73 (43 %) of the patients, both imaging techniques including Whole Body-MRI and skeletal scintigraphy detected metastatic disease to bone. However, in 16 of these 31 cases (52 %) Whole Body-MRI demonstrated more metastatic disease to bone in comparison to skeletal scintigraphy. Nevertheless, in four of 31 cases, nearly 13 %, skeletal scintigraphy was superior to Whole Body-MRI in detecting additional peripheral metastases. 15/73 patients (21 %) showed discordant imaging findings in skeletal scintigraphy and Whole Body-MRI. In 11 of these cases skeletal scintigraphy was negative, whereas Whole Body-MRI demonstrated diffuse and multifocal metastatic disease of bone in the appendicular and axial skeleton (Fig. 1). In four of these cases skeletal scintigraphy was false-positive and in one case, Whole Body-MRI was false-negative. Regarding the comparison between Whole Body-MRI versus Whole Body-FDG-PET which was available in 27 cases, there was a concordance of nearly 92 %. In only 2 cases Whole Body-FDG-PET was false negative, whereas Whole Body-MRI demonstrated metastatic disease of bone which was proven by the clinical follow-up.

Discussion
Our preliminary results suggest the Whole Body-MRI is an effective method for examining cancer patients by the use of a rolling table platform in agreement with the published data (1,3,5). Whole Body-MRI is a fast and accurate diagnostic imaging technique for evaluation of metastatic disease in cancer patients (1, 3). The recent development of a body serve or angioserve system for an unlimited field of view (MR Innovation, Essen, Germany) enables to perform Whole Body-MRI in a short time (1,3). This concept of the rolling table platform was successfully applied as well for the Whole Body MRI angiography (1). Although there is some limitation of Whole Body-MRI due to motion and pulsation artefacts of adjacent organs, false negative MRI findings are caused due to rib metastases which cannot be clearly depicted in coronal views. In agreement to the published data, we performed our Whole Body MRI investigation using a STIR-sequence which is more sensitive than spin-echo or gradient recalled-echo sequences. Some authors prefer spin-echo sequence for Whole Body-MRI and reported a sensitivity of 82 % in comparison to the established staging methods of skeletal scintigraphy of 71 %, and Whole Body FDG-PET of 90 % (5). In conclusion, Whole Body-MRI is an effective fast imaging method for examining cancer patients by the use of a rolling table platform, and it is undoubtedly more sensitive than skeletal scintigraphy and FTG-PET in for metastatic disease to bone in patients with solid tumors. Whole Body MRI might replace in future times Whole Body FDG-PET and skeletal scintigraphy in respect of the detection of metastatic disease to bone.

References:

Fig. 1 25 year old female with a PNET. Skeletal scintigraphy (a) and Whole Body-FDG-PET revealed no skeletal metastases, whereas Whole Body-MRI detected multifocal bone marrow signal intensities representing metastases (arrows).