Whole-Body MRI and 11C-Choline PET/CT in Patients with Prostate Cancer

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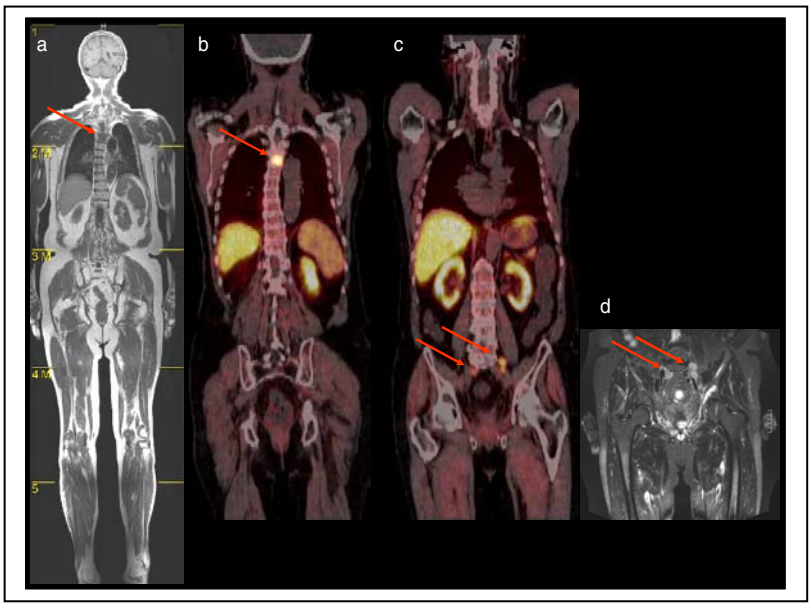
Introduction: Prostate cancer is the most common malignant disease and second in causes of cancer death among men in Western Europe and North America. The most favourable outcome that can be achieved is associated with a complete tumor resection. For optimizing therapeutic outcome and avoiding unnecessary complications it is a great need to obtain precise information about local tumor extension as well as distant tumor spread particularly to the most common sites, e.g. bone marrow and lymph nodes. It has been shown that endorectal MRI (endMRI) and MRS provide the most accurate prediction of pathologic outcome of extracapsular extension and seminal vesicle invasion [1, 2]. However, unexpected high failure rates are observed even after intended curative treatment and must be attributed to unknown systemic progression. High-resolution whole-body MRI (wb-MRI) shows great potentials for fast assessment of tumor spread in cancer patients [3]. Recently, it has been shown that PET/CT with ^{11}C-choline (Cho-PET/CT) is feasible to identify foci of cancer within the prostate [4, 5]. Goal of this study is to compare the diagnostic potential of wb-MRI and Cho-PET/CT to detect distant tumor spread in patients with prostate cancer.

Materials and Methods: Up to now 22 patients (69.0+/-7.6 y/o) with bioptic proven prostate cancer have been included in this ongoing study. All patients underwent staging examinations by Cho-PET/CT and WB-MRI due to initial diagnosis of prostate cancer (8 patients), increase of serum PSA either after curative intended therapy (11 patients) or during antihormonal treatment (3 patients). Wb-MRI was performed on a 1.5 T whole-body MR system equipped with 32 receiver-channels (MAGNETOM Avanto, Siemens Medical Solutions, Germany). Patients were placed in supine position with their arms beside the body and five to six surface coils were attached: head coil (12 coil elements), neck coil (4 coil elements), depending on the size of the patient two or three body phased-array coils for abdomen/pelvis (12 or 18 coil elements), and peripheral angio coil for lower extremities (8 coil elements). The spine coil with 24 elements is embedded in the patient table. Using automatic table move in 5 subsequent table positions the whole body was examined in coronal and the spine additionally in sagittal direction using STIR- and T1-weighted turbo spin-echo MR sequences with parallel imaging (acceleration factor of 2, GRAPPA reconstruction). Breath-hold axial STIR- and VIBE-sequences were additionally acquired for the examination of the ribs. The total examination time lasted about 45 min. Cho-PET/CT examinations were performed 0-3 days before WB-MRI using a LSO Hi-REZ Biograph 16 system (Siemens Medical Solutions, Germany). Following contrast-enhanced whole-body CT, PET images were acquired 5 minutes after i.v. administration of 800 MBq ^{11}C-Cholin produced at the own cyclotron facility (7-8 table positions with acquisition time of 3 min each). The interpretation of MRI, CT and PET, and colour-coded PET/CT images was first performed separately by experienced specialist for oncologic radiology and nuclear medicine. Consensus reading was finally performed including and comparing all imaging modalities.

Results: In total 58 malignant lesions were detected in 21/22 patients: local primary or recurrent tumor (11) as well as metastases to bone (33), lymph nodes (8), lung (3) and brain (3). Bone metastases were clearly displayed with high contrast on T1w MR images due to the characteristic osteoblastic behaviour. Small vertebral metastases in 3 cases were detected initially only by MRI, but retrospectively also by Cho-PET/CT. Rib metastases were detected by both modalities. Lymph node metastases were better visualized on STIR MR imaged with high signal compared to surrounding fat tissue. Cho-PET/CT showed in 9 patients small (<1cm), on MRI normal appearing inguinal and mediastinal lymph nodes with ambiguous choline uptake. In one patient a suspicious colonic polyp was detected only on Cho-PET/CT, but retrospectively also visualized on MRI. Consensus reading showed that lesions were visualized by both modalities, but generally with higher contrast on PET/CT.



Discussion:

Our initial data suggest that wb-MRI is a very promising diagnostic tool for evaluating distant tumor spread in patients with prostate cancer. Particularly bone marrow involvement could better be visualized by wb-MRI than by Cho-PET/CT. The potential of wb-MRI for detecting bone metastases in general has been shown by clinical studies proving that MRI is even more sensitive than conventional skeletal scintigraphy [6]. The distinct advantage of MRI is furthermore its high sensitivity for detecting metastases in parenchymal organs, e.g. the brain. Regarding lymph node involvement, however, wb-MRI and Cho-PET/CT are both limited and visualize only relatively large metastases (>1cm). The synopsis of Cho-PET/CT and wb-MRI (PET/MR) turned out to be most favorable regarding both the detection and interpretation of tumor suspicious findings. High-resolution MRI after intravenous application of magnetic nanoparticles enables to detect even small lymph node metastases with high sensitivity and specificity [7]. For initial and repeated staging the combination of wbMRI and endMRI/MRS may consequently be most advantageous to differentiate patients with localized disease and systemic progression. Prospective clinical studies should now be initiated to justify this diagnostic approach.

Figure 1: Whole-body MRI of a prostate cancer patient with bone and lymph node metastases. Osteosclerotic vertebral metastases are clearly visualized on T1-weighted (a) and lymph node metastases on T2-weightes STIR MRI (d). Cho-PET/CT demonstrates increased uptake of ^{11}C-Cholin in corresponding areas (b,c).

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