technique which is widely available and less time consuming. Patients who are positive on AUS guided FNAC can proceed for ALND directly thereby obviating the need for SNB.

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Detection of extra-axillary lymph nodes with FDG PET/CT in patients with locally advanced breast cancer

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Background: Depicting lymph node involvement in levels or basins other than those addressed by routine axillary lymph node dissection (ALND) may have impact on treatment strategies. Although FDG PET/CT is less sensitive than sentinel node biopsy, its specificity for the detection of axillary lymph node metastases has been shown to be almost 100%. The aim of this prospective study was to assess the incidence of extra-axillary lymph node involvement on baseline FDG PET/CT in patients with stage II-III breast cancer, scheduled for neo-adjuvant chemotherapy.

Material and Methods: Patients with invasive breast cancer of >3 cm and/or lymph node metastasis underwent FDG PET/CT before neo-adjuvant chemotherapy. Baseline ultrasound of the infra- and supraclavicular regions was performed, with fine needle biopsy as needed. FDG PET/CT was performed using a hybrid system (Gemini II, 16-slice CT), 60 minutes after administration of 180–240 MBq 18F-FDG intravenously. Patients were scanned in prone position on a special hanging breast device. Two millimetre slices were obtained of PET and CT. All visually FDG-positive nodes were regarded as metastatic, based on the previous reported high specificity of the technique.

Results: Sixty patients were included. In 17 patients (28%) extra-axillary lymph nodes were detected by FDG PET/CT. Ultrasound guided cytology detected extra-axillary lymph node involvement in 7 of these patients. In 10 patients with positive extra-axillary lymph nodes on FDG PET/CT, ultrasound could not confirm. Lymph nodes outside the axilla on FDG PET/CT were localized in the intra mammary chain (1 lymph node), mediastinal (2 lymph nodes), internal mammary chain (9 lymph nodes), intra- and interpectoral (6 lymph nodes), infraclavicular (5 lymph nodes) and in the contra-lateral axilla (3 lymph nodes).

Conclusion: FDG PET/CT detected extra-axillary lymph node involvement in almost one-third of the patients with locally advanced breast cancer, including in several regions not evaluable with ultrasound. FDG PET/CT may be useful as an additional imaging tool to assess extra-axillary lymph node metastasis, with impact on adjuvant radiotherapy management. Particularly patients with high risk tumours, who are candidates for neo-adjuvant chemotherapy, are candidates for FDG PET/CT.

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MRI characterization of dissected sentinel lymph nodes of breast cancer patients at 7 T

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Background: Axillary lymph node status is the most important factor determining breast cancer prognosis. Assessment of nodal status requires surgical resection. This is associated with morbidity. We started a trial comparing non-invasive 3T MRI-based staging to surgical staging. The performance of the 3T in vivo MRI is controlled by 7T ex vivo MRI of all surgical specimens. This is followed by a node-to-node matching to pathology. Here we describe the results of the 7T MRI characterization of dissected sentinel nodes of breast cancer patients, with pathology as the gold standard.

Materials and Methods: We included 20 consecutive breast cancer (stage $\geqslant$T2) patients about to undergo a sentinel node biopsy. 7T scan protocol included a morphological 3D-T1 weighted (3D-T1W) scan (180μm isotropic resolution). Also the mean absolute T1, T2, T2* relaxation times and apparent diffusion coefficients were determined, as were the 3D nodal dimensions and the presence of a fatty hilus. To maintain accurate correlation of MRI to pathology, the nodes were mapped, numbered and dyed to detail their anatomical orientation. Next they were sliced in 4 mm sections, paraffin embedded, cut into 3μm thick slices and stained with Haematoxylin & Eosin. Statistical analyses; logistic regression analyses according to the generalized estimating equations method.

Table 1. T1, T2*, T2, apparent diffusion coefficient (ADC), and width × height × depth (w×h×d) for all nodes[a]

	Healthy	Metastatic	Significance
T1, ms	1454 (557)	1569 (661)	0.17
T2*, ms	15 (2)	19 (5)	0.01
T2, ms	30 (3)	34 (8)	0.02
ADC, mm^2/s	0.11×10^{-3} (0.1)	0.11×10^{-3} (0.1)	0.91
w×h×d, mm^3	873 (1203)	1725 (1211)	0.23

[a]Values are mean (±standard deviation [SD]).

Results: All 83 nodes could be matched to pathology, allowing correlation of intra-nodal imaging features to pathology. Table 1 shows the quantitative analyses. 77% of benign and 64% of malignant nodes had a fatty center. On the 3D-T1W scans, lymph- and blood vessels, cortical fat, activated b-cell follicles and a metastasis in a lymph vessel were identified. Intranodal metastases could not be localized morphologically.

Conclusion: While the intranodal location of metastases could not be delineated, there was a significant difference in T2 and T2* relaxation times between metastatic and non-metastatic nodes. Also, the very high resolution scans allowed identification of structural nodal details and detection of a small in-transit metastasis in a lymph vessel.

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Contrast-enhanced magnetic resonance imaging as problem solving modality in mammographic BIRADS 3 lesions

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Background: The purpose of this study is to determine whether contrast-enhanced Magnetic Resonance Imaging (MRI) can be used as problem solving modality in breast lesions which were classified as BIRADS 3 with mammography.

Materials and Methods: In this study 191 patients had a mammographic BIRADS 3 lesion. 77 out of the 191 patients underwent a breast MRI as work-up. MRI scans were obtained on a 1.5T MR scanner (Avanto; Siemens) using a dedicated bilateral breast coil. The standard MRI protocol included a T2 Turbo Spin Echo, a T1 3D FLASH sequence before and after intravenous contrast medium and a T1−3D FLASH water excitation. MRI scans were coded using the ordered categories of the ACR BIRADS lexicon. The sensitivity, specificity, positive predict value (PPV), and negative predictive value (NPV) were calculated on the basis of final pathology reports or long-term clinical and radiological follow-up findings over at least 2 years. Lesions which were classified as BIRADS 3, 4 or 5 at breast MRI were considered positive for malignancy.

Results: Fifty-four out of the 77 mammographic BIRADS 3 lesions were correctly classified as BIRADS 1 or 2 with MRI. Eleven lesions were classified as BIRADS 3. Two out of these 11 lesions showed malignancy with pathology. Seven lesions were classified as BIRADS 4. Six out of these 7 lesions were malignant. Five lesions were classified as BIRADS 5 and pathology confirmed malignancy in all cases. The breast MRI had a sensitivity of 100%, specificity of 84.4%, PPV of 56.5% and NPV of 100%. Thirteen (16.9%) out of the 77 mammographic BIRADS 3 lesions were malignant.

Conclusion: Our results indicate that breast MRI can be used as problem solving modality in mammographic BIRADS 3 lesions to rule out malignancy.

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Positron emission tomography combined with computed tomography (PET-CT) in asymptomatic breast cancer patients showing elevation of circulating tumour markers

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Background: Routine tumour marker testing after surgery in the follow-up of asymptomatic patients suffering from breast cancer still remains a controversial issue and international guidelines not recommend the use of carcinoembryonic antigen (CEA) and/or carbohydrate antigen (CA 15−3) to detect recurrence after a primary breast cancer therapy. However, due to multiple factors, several patients and physicians do not accept only monitor

clinical signs of recurrence or metastasis, knowing that more sensitive means of early diagnosis are available.

Methods: We retrospectively selected women on the database of the PET center of the Bordet Institute. Only were selectionated patients with proven breast cancer who had undergone prior curative intent treatment; an asymptomatic elevation of the circulating tumor marker (CA15−3 and/or CEA); no known recurrent disease; and a follow-up for at least 12 months. PET(CT) images were assessed by 2 experienced nuclear medicine specialists. Both were blinded to the results of the other observer and to the medical recors of the patients. A pre-established patient-based classification was used. Finally, both investigators in consensus assessed the results.

Results: Twenty-four asymptomatic women were included. Previously performed diagnostic imaging revealed no evidence of tumour at all. Mean age was 61.1 years. Median CEA level was 10.0 ng/ml (reference >2.5 ng/mL) and median CA 15−3 level was 100.4 U/ml (reference >30.0 U/mL). Four patients presented elevated levels in both tumour markers. Ten patients presented only CEA elevated levels. The follow-up of 12 months after the date of the PET demonstrated a tumoral recurrence in thirteen patients (54.2%). PET(CT) was true positive in ten cases, false positive in one patient and false negative in three cases. The patient-based sensitivity and specificity of PET(CT) was 77% and 91% respectively. The negative predictive value was 77%; the positive predictive value was 91% and accuracy of 83%.

Conclusion: Our data demonstrates the usefulness of PET/CT in the follow-up of asymptomatic women suffering from breast cancer who have elevated levels of tumour markers, by providing an accurate method for detecting metastases and/or an alternative diagnostic for example a second primary. Nowadays, combined PET/CT seems to be the best imaging modality (all in one) detecting in a reliable way disease recurrence in the follow-up of women breast cancer.

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Accuracy of breast cancer detection with full-field digital mammography (FFDM) and integral computer-aided detection (CAD) correlated with breast density as assessed by a new automated volumetric breast density measurement system

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Background: To retrospectively assess the diagnostic performance of computer-aided detection (CAD) for full-field digital mammography (FFDM) in terms of sensitivity and specificity correlated with breast density as assessed by an automated breast density measurement system in histopathologically proven breast cancers and age-matched healthy controls.

Materials and Methods: 200 consecutive histopathologically proven breast cancers imaged with FFDM (Senographe DS or GE Essential, GE Healthcare) and 200 age-matched healthy controls identified from June 2005 through February 2009 were evaluated retrospectively using CAD (Hologic R2, version 8.3.17). Each case included a craniocaudal and mediolateral oblique view. Each cancer case was matched to one control case by date of birth, age at examination and laterality of mammogram used for density determination. In all cancer cases the malignant lesion was identifiable in at least one projection on radiologist review. A CAD mark was scored true-positive, if it correctly indicated a malignant lesion. All other CAD marks were considered false. CAD sensitivity and specificity were calculated and correlated with mammographic breast density (percentage of fibroglandular tissue) as assessed by an integral automated volumetric breast density measurement system (Hologic, Quantra).

Results: CAD correctly identified 157 of the 200 cancers, a sensitivity of 79%. Sensitivity was suggestively but non-significantly lower with increased density ($p = 0.09$). In those cancer cases with density at or below the median of 20%, sensitivity was 82%, compared to 75% in those with density above the median. The presence of one or more false CAD prompts was suggestively but not significantly more likely in controls than cases (87% vs 80%, $p = 0.06$). The number of false prompts was significantly higher in controls (average 3.6 vs 2.6, $p < 0.001$). False prompts were significantly less likely with higher density ($p = 0.008$). False prompts were present in 86% of cases and controls with density at or below the median, and in 81% of those with density above the median.

Conclusion: Increased breast density is significantly associated with higher specificity of CAD, and there is suggestive evidence that it is also associated with lower sensitivity. Radiologists should be aware that CAD is likely to be less sensitive in mammography screening of younger women with denser breast tissue.

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Quantitative multivoxel magnetic resonance spectroscopy in 13 breast lesions, a pilot study

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Background: The purpose of this study is to determine whether a new quantitative multivoxel Magnetic Resonance Spectroscopy (MRS) can differentiate benign from malignant breast lesions by measuring the highest choline concentration.

Materials and Methods: Twelve patients with 13 breast lesions (7 mammographic BIRADS-3 lesions and 6 mammographic BIRADS-4 lesions) underwent an MRI and MRS at 1.5 Tesla using a Magnetom Avanto system (Siemens, Erlangen). The multivoxel MRS technique used was 2D-chemical shift imaging (CSI) with point resolved spectroscopy (PRESS), first without suppression of the water and fat signals (repetition time (TR) 1500ms, echo time (TE) 30ms) to serve as a reference measurement, and subsequently with suppression of the water and fat signals (TR 1500ms, TE 135ms) to be able to detect choline. The choline concentrations were measured in 36 voxels of $0.5 \times 0.5 \times 1\,cm^3$.

Results: The highest choline concentrations for the seven mammographic BIRADS-3 lesions were found in 2 to 4 voxels: 0.05mM, 0.13mM, 0.13mM, 0.10mM, 0.15mM, 0.15mM and 0.23mM, respectively. The work-up of the last one (0.23mM) showed invasive ductal carcinoma, the other mammographic BIRADS-3 lesions showed no malignancy. The highest choline concentrations for six mammographic BIRADS-4 lesions were found in 4 to 6 voxels: 0.22mM, 0.41mM, 0.46mM, 0.25mM, 0.68mM and 0.10mM, respectively. The last lesion with 0.10mM highest choline concentration was not malignant. Pathology confirmed malignancy in all other mammographic BIRADS-4 lesions: 4 lesions were invasive ductal carcinomas and 1 lesion was a medullair carcinoma.

Conclusion: The new quantitative multivoxel MRS method can differentiate benign from malignant lesions by indicating that a breast lesion with a highest choline concentration exceeding 0.20mM is malignant.

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Comparison of synchrotron images of Paget's disease of the breast with their pathologic findings

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Background: Synchrotron radiation x-ray imaging has revealed its possibilities to evaluate various breast diseases non-invasively. Using a phase contrast technique, we received monochromated synchrotron images of Paget's disease of the breast tissue section. To figure out the relation with their optical microscopic features, we compared the synchrotron images of the Paget's disease with their histopathologic findings of the same stained section.

Material and Methods: An x-ray microscope was installed on 1B2 beamline of Pohang Light Source, a third generation synchrotron radiation facility with operating energy of 2.5 GeV in Pohang, Korea. The x-ray energy was set at 11.1 keV, and the x-ray beam was monochromatized by a W/B4C monochromator. Zernike phase-shifter was adapted for phase contrast x-ray microscopy. Formalin-fixed 5μm-thick breast tissue sample was attached onto the Kapton film, and positioned 25 m away from the beam source. The synchrotron image of the sample was converted into a visual image on the CsI(Tl) scintillation crystal, and this visual image was captured by a full frame CCD camera. After scanning, we put together these images one another to show the large area of the tissue section. For the comparative analysis with their synchrotron image, synchrotron-scanned breast tissue sections were stained, and the histopathologic findings of the samples were captured by the image analyzer. To identify the association of synchrotron image with its histopathologic findings, we compared them with each other. The magnifying power of this microscope was 100x.

Results: The monochromated x-ray microscopic images of Paget's disease of the breast tissue sections were obtained with a good contrast and high visibility by phase contrast technique. These images showed the large lacuna-shaped Paget cells within the epidermis of nipple. The Paget cells revealed large electron-dense nuclei and electron-lucent abundant