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Diffusion-weighted magnetic resonance imaging: the influence of different b-gradient factors on the apparent diffusion coefficient for normal fibroglandular tissue of the breast

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Background: Previous diffusion-weighted imaging (DWI) studies of human breast tissues reported discrepant apparent diffusion coefficients (ADC). The ADC-values generally derived from two sets of images acquired with b-gradient factors varying considerably. The purpose of this study is to evaluate the influence of a range of b-values on the measurement of ADC-values for normal fibroglandular tissue of the breast.

Materials and Methods: Fifteen patients (mean age: 40.6 years) underwent breast MRI using a 1.5 Tesla scanner (Avanto; Siemens) equipped with a dedicated bilateral breast coil. DWI was performed with single shot echo planar imaging with b-values of 50, 200, 500 and 800 s/mm2. The scan parameters were TR/TE 8000/91 ms, band width 1630Hz, FOV 340 mm, slice thickness 4 mm. ADC-maps were reconstructed from b-value pairs of 50–200, 50–500, 50–800s/mm2 and all b-values together. The ADC-values of 25 breasts were determined for regions of interest (ROI) in fibroglandular tissue appearing homogeneous on both ADC map and T2-weighted images. ROI's were first drawn on the ADC map with a b value of 800s/mm2 and subsequently reproduced on the others. Variation in the amount of fibroglandular tissue per breast resulted in varying ROI dimensions (32.4−45.4 mm2). A paired t-test was used for analyzing the statistical significance of differences between the ADC-values in the three b-value pair reconstructions compared to ADC derived from all b values together, serving as gold standard.

Results: The mean ADC-value of normal fibroglandular tissue was 2.13 $\pm$ 0.46$\times 10^{-3}$ mm2/s for b-values 50–200 and 2.19$\pm$ 0.33$\times 10^{-3}$ mm2/s for b-values 50–500. For b-values 50–800 and all b values together the mean ADC-values were almost similar, namely 1.96$\pm$ 0.27$\times 10^{-3}$ mm2/s and 1.97$\pm$ 0.29$\times 10^{-3}$ mm2/s, respectively. The standard deviation decreased for higher b-values. A statistical difference was found for b-value pair 50–200 compared to all b-values together ($p = 0.029$) and for b-value pair 50–500 compared to all b-values together ($p = 0.000$). There was no significant difference between b-value pair 50–800 and all b values together ($p = 0.231$).

Conclusion: In clinical DWI of the breast, using just two scans for time saving, one should be acquired with a b-value of at least 800s/mm2. This will improve the accuracy of the reconstructed ADC-maps and thus reduce ADC-measurement discrepancies as reported in several studies.

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Three dimensional fused image of positron emission tomography and CT with contrast medium is useful for breast conserving surgery

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Background: When breast conserving surgery (BCS) is performed, it is important to accurately assess intraductal spread and axillary node involvement before the surgery. For this purpose, breast MRI and enhanced breast CT have achieved the status of gold standard. On the other hand, there has been no report on the usefulness of positron emission tomography (PET) in this field because the spatial resolution is low. However, a PET image fused in three dimensions with enhanced CT can provide a more accurate assessment compared with enhanced CT alone.

Patients and Methods: From June 2006 to December 2007, 113 patients were recruited in the study. 4.5MBq/Kg of 18F Fluoro-2-deoxy-D-glucose (FDG) was injected. At 120 minutes after FDG injection, imaging data were obtained with a Biograph Sensation 16 (Siemens/CTI) scanner. After routine PET study, a CT study with iodine contrast medium was performed immediately with the patient in the same position. A 3-dimensional image combined with PET and contrast enhanced CT used evaluation of intraductal spreading and axillary assessment. Degree of FDG accumulation and enhanced effect of contrast medium were judged by one radiologist specialized in PET image. On the basis of this diagnosis, we decided to select surgical options, which were BCS with sentinel node biopsy (BpSNB), BCS with axillary dissection (BpAx), mastectomy with SNB (BtSNB), and mastectomy with axillary dissection (BtAx).

Results: 78 of 113 (69.0%) patients were performed BCS on the basis of fused 3D image diagnosis. Only 6 of 78 (7.7%) patients were evident cancer in surgical margin. However, no local recurrence was observed. And there were no significant difference of standardized uptake value (SUV) between patients with positive surgical margin and negative. Sensitivity, specificity and accuracy of axillary node assessment were 46.8% (15/32), 93.7% (75/80) and 79.6% (90/113), respectively. Average SUV of each surgical options were as follows; BtAx 6.80, BpAx 6.68, BtSNB 6.02, BpSNB 4.49 ($p = 0.0065$).

Conclusion: This novel three dimensional fused image of PET and CT with contrast medium was useful for selection of BCS indication. However, because of low tracer uptake of micrometastasis, axillary node assessment was difficult and further instrumental improvement would be needed.

At the conference, we will present some example images which were useful for selection of BCS.

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Outcomes of stereotactic breast core biopsy (SBCB) of BIRADS category 4 microcalcifications

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Background: To evaluate the pathological findings and subsequent surgical management of patients who underwent SBCB of BIRADS category 4 microcalcifications.

Materials and Methods: Patients diagnosed with BIRADS category 4 microcalcifications on screening mammogram were included for analysis in this retrospective review. A 14-gauge device was used to perform SBCB under local anaesthesia utilising an upright stereotactic mammographic localization system. All cases were performed on an ambulatory basis. Routine specimen radiography was done to document the presence of calcium in the cores obtained. Histopathological analysis was reviewed by the same team of pathologists. Assessment for concordance is achieved by reviewing imaging findings alongside the pathology report during a weekly scheduled meeting. Concordant malignant cases are referred to a surgeon for definitive treatment. Discordant cases and high-risk pathology findings (atypical ductal hyperplasia, lobular neoplasia, papillary lesions and columnar cell lesions) are referred to a surgeon for open excision biopsy. Concordant benign cases are placed on a follow-up imaging protocol.

Results: A total of 170 SBCB were performed in 149 consecutive patients over a period of 26 months. The median age of patients was 51 (range 34−75 years old). The median number of cores obtained was 6 (range 2−41). The incidence of high-risk pathology findings, DCIS and invasive cancer was 11.8%, 12.9% and 3.5% respectively. The rate of non-compliance with recommended excision was 22%. The overall discordant rate was 6.5%. The overall false negative rate for malignancy was 15.4%. There were no false positives. 47.6% of DCIS diagnosed on SBCB was found to reveal invasive cancer on subsequent surgery. These findings are found to be independent of the side of biopsy, the quadrant of breast biopsied, number of cores obtained or the radiologist performing the procedure.

Conclusions: The launch of screening mammography in Singapore has resulted in an increase in the incidence of non-palpable breast cancers. Stereotactic large core needle biopsy has been proven to be a reliable alternative to open surgical biopsy; with advantages of minimal scarring, minimal distortion on subsequent mammograms, lower overall costs and faster patient recovery. However, the false negative rate in our study is significantly higher than reported rates of 2−6.7%. This may be contributed by a high percentage of unknown final histology (22%) due to non-compliance with recommended surgery; as well as technical difficulties of difficult visualization of dense Asian breasts (65%) on localization. Vacuum-assisted biopsies with more representative sampling may be able to overcome the high false negative rate as well as the high percentage of underestimation of DCIS.

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Contralateral breast screening using mammography – is it worthwhile in developing countries?

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Background: As per standard guidelines, contralateral mammography is advised in the west for detecting 1.8% incidence of synchronous breast cancers. In view of low breast cancer incidence in India and more than 85% population being below age 50 years, wherein the diagnostic sensitivity of mammography is low, there is no evidence to support these recommendations. A retrospective analysis was therefore carried out to

evaluate the diagnostic efficacy of contralateral mammography in patients presenting with unilateral operable breast cancer.

Methods: The case records and bilateral mammograms of 1755 patients who were operated between May 2005 and December 2006 were reviewed. Of these 1755 women, 40 (2.3%) patients had a clinically palpable abnormality in the contralateral breast; all were subjected to mammography and biopsy. The remaining 1715 patients had a clinically normal contralateral breast, of which, 5 patients had an abnormal contralateral mammogram. All 5 underwent mammographic localization and biopsy of the suspicious lesions.

Results: In 40 women with clinically abnormal contralateral breast, 19 also had a suspicious or indeterminate lesion on mammogram. On biopsy, 23 of 40 (or, 1.3% out of 1755) turned out to be malignant. Of the remaining 1715 patients with clinically normal contralateral breast, 5 had abnormal mammograms and only one of these 5 (0.06% of 1755) had a positive finding in the form of ductal carcinoma in situ (DCIS) at biopsy. Thus, 1715 mammograms were done to detect one DCIS (0.06%). It was interesting to note that no mammographic abnormality was detected in the clinically normal contralateral breast in women below the age of 50 years.

Conclusion: Thus, in a country like India, where the incidence of breast cancer is low, in women with unilateral breast cancer, mammography is neither useful nor cost-effective in the diagnosis of contralateral breast cancer at time of diagnosis.

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Comparative analysis of synchrotron radiation images of breast cancer tissue with their histopathologic findings

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Background: Synchrotron radiation is expected to improve the quality of clinical breast imaging. It provides detailed images of internal structures of the breast tissue samples with a great magnification and an excellent resolution. Using phase contrast technique, we got monochromated synchrotron images of breast cancer tissue. To figure out relation with their histopathologic findings, we compared the synchrotron images of the breast cancer tissues with their optical microscopic findings of stained adjacent breast tissue section.

Material and Methods: A 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 10μm-thick breast cancer tissues were attached onto the Kapton film. The sample was positioned 25 m away from the beam source. The x-ray image of sample was converted into a visual image on the CsI(Tl) scintillation crystal, and magnified 20 times by microscopic objective lens. After additional 10 fold digital magnification, this visual image was captured by a full frame CCD camera. For a comparative analysis with its synchrotron image, adjacent tissue section was stained and the histopathologic features of the sample were captured by image analyzer.

Results: The monochromated x-ray microscopic images of breast tissue from breast cancer were obtained with a good resolution. The total magnifying power of this microscope was up to 200×. These images revealed various structures of breast cancer tissues with a good contrast and high visibility by phase contrast technique including proliferation and irregular infiltration of stroma, loss of ductal structures and infiltrating tumor cells into adjacent fat tissues. But lymphocytes nests infiltrating into connective tissues and other fine histopathologic features of breast cancer tissue were not identified well with this phase contrast technique only.

Conclusions: Using monochromated synchrotron radiation, the x-ray microscopic images of the breast cancer tissue were obtained. These images showed a good correspondence with the histopathologic findings of adjacent stained tissue sections. From these images obtained, x-ray microscopic imaging of breast cancer tissue with synchrotron radiation appears to have a great possibilities of use for clinical and research purposes in the near future.

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Examination of US and MR images for pathological complete response in early breast cancer cases

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Background: In cases in whom primary systemic chemotherapy (PSC) has been effective, it is often very difficult to distinguish on preoperative images whether or not a residual tumor still exists. We examined US and MR images in cases showing a pathological complete response (pCR) to identify specific features which would be useful for assessing residual disease.

Materials and Methods: All 149 cases undergoing surgery after PSC, from January 2006 through December 2007 in our institution, had received anthracycline-based chemotherapy followed by taxanes or anthracycline alone. There were 14 pCR cases and 13 in whom only ductal carcinoma in situ (DCIS) remained. We examined mainly US and MR images from these cases, after chemotherapy, in detail.

Results: Proportions of cases positive for NG3, ER(−), PR(−) and HER2(3+) were high among those with pCR and only DCIS. Among these cases, only hormone receptor levels differed significantly in comparison with other PSC cases.

All five cases in whom evidence of tumors disappeared on US showed pCR. Other US findings included 6 with mastopathy-like findings, 3 with intra-ductal lesions and 12 with nodules. DCIS was observed in all cases in whom an intra-ductal lesion persisted. Even if nodules remained, the proportion showing pCR was relatively high (75%) if an acoustic shadow suggesting fibrous change was present.

On MR imaging, disappearance of lesions was seen in eight cases, while eight showed a segmental enhancement pattern and five had nodules. DCIS was observed in 63% of cases that showed a segmental enhancement pattern. Likewise, two-thirds of cases with mastopathy-like findings on US had residual tumors. The presence of mastopathy in the background, may obscure remnant tumors. Both examinations must therefore be conducted with great care to avoid missing these residual tumors.

All three cases in whom lesions were undetectable on both US and MR images showed pCR. Two-thirds of cases in whom the lesions were undetectable on either US or MR images had pCR.

Conclusions: The diagnostic usefulness of US and MR images is limited due to the degree of ductal spread, which often persists after PSC and varies markedly among cases. With US, it is difficult to distinguish between benign and malignant lesions. MR imaging often overestimates residual disease. However, we can enhance the prediction of pCR to some extent by using these two imaging modalities together and carefully interpreting the results.

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Stereotactic vacuum-assisted microbiopsy and precancerous/in situ breast lesions – a monoinstitutional experience

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Background: The issue of diagnostic assessment after mammographic detection of suspicious early disease has been recently improved by new technologies. Our aim was to retrospectively assess the accuracy and clinical usefulness of stereotactic vacuum-assisted microbiopsy (VAB) in the diagnosis of precancerous and in situ lesions of the breast.

Patients and Methods: From January 2003 to July 2007 a consecutive monoinstitutional series of 222 patients underwent a stereotactic VAB. The biopsies were performed using a vacuum suction device (11 gouge probe) with digital stereotactic equipement-guided Mammotome (Fisher prone table). A mean number of 10.8 samples (3−19) were obtained, measuring 3−50 mm (mean size: 13 mm) in diameter. The biopsy site was marked with a nonmagnetic metallic clip when the entire lesion was removed. Among this population we selected patients with VAB diagnosis of both atypical hyperplasia (AH) and intraepithelial neoplasia (IN) and data were compared with definitive diagnosis on surgical specimen.

Results: In 96.3% of patients VAB resulted incisional (lesion only partially removed) while in the remaining 3.7% of cases excisional (lesion totally removed). Among all 222 patients who underwent the procedure the VAB diagnosis was: n = 91 benign lesions (40.9%), n = 38 AH (17.1%; ADH 81.5%, ALH 18.4%), n = 54 IN (24.5%; ductal IN 94.4%, lobular IN 5.5%) and n = 39 invasive carcinoma (IC: 17.5%). Surgery was performed in all