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● *Original Contribution*

EFFECT OF BACKGROUND PARENCHYMAL ENHANCEMENT ON PRE-OPERATIVE BREAST MAGNETIC RESONANCE IMAGING: HOW IT AFFECTS INTERPRETATION AND THE ROLE OF SECOND-LOOK ULTRASOUND IN PATIENT MANAGEMENT

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Abstract—Background parenchymal enhancement (BPE) on breast magnetic resonance imaging (MRI) may either obscure or mimic malignancy. We evaluated the impact of BPE on the diagnostic performance of pre-operative MRI in breast cancer patients, and how second-look ultrasound (US) can help in guiding patient management. Two hundred fifty-three breast cancer patients with pre-operative MRI were included. In moderate or marked BPE, abnormal interpretation rate (38.9% vs. 12.2%) and biopsy rate (27.8% vs. 8.3%) were higher, and specificity (64.7% vs. 89.8%) was lower, compared with minimal or mild BPE (all $p < 0.001$). Visibility of MRI-detected additional suspicious lesions on second-look US did not differ between the two groups (86.7% in minimal or mild BPE vs. 77.1% in moderate or marked BPE, $p = 0.296$). Increased BPE was related to increased abnormal interpretation rate, additional biopsy rate and decreased specificity. Second-look US was useful in visualization of MRI-detected additional suspicious lesions, regardless of BPE. (E-mail: lvjenny@yuhs.ac)

Key Words: **Background parenchymal enhancement, Breast, Magnetic resonance imaging, Second-look ultrasound.**

INTRODUCTION

Background parenchymal enhancement (BPE) on breast magnetic resonance imaging (MRI) refers to the normal enhancement of the patient's fibroglandular tissue seen on the first post-contrast image (American College of Radiology [ACR] 2013). This BPE is influenced by hormonal changes and fluctuates with the menstrual cycle, being greatest during the first and the last weeks of the menstrual cycle, when estrogen, which causes hyperemia, vasodilation and capillary leakiness, is at its peak (Delille et al. 2005; Kuhl et al. 1997). A description of BPE has been incorporated into the recent version of the Breast Imaging Reporting and Data System (BI-RADS) lexicon (ACR 2013), because the presence, pattern and degree of BPE may affect the accuracy of MRI interpretation (DeMartini et al. 2012; Giess et al. 2014; Hambly et al. 2011).

It has been hypothesized that BPE may either obscure or mimic malignancy, leading to false-negative or false-positive results (DeMartini et al. 2012; Giess et al. 2014; Hambly et al. 2011). Two recent studies have evaluated the effect of BPE on the detection and recall/biopsy rates of patients undergoing MRI for screening purposes (DeMartini et al. 2012; Hambly et al. 2011), in which increased BPE was associated with higher abnormal interpretation rates with (DeMartini et al. 2012) or without increases in biopsy rates (Hambly et al. 2011). Patients included in the prior studies were women at high risk for breast cancer, and the effect of BPE may differ in pre-operative staging MRI in breast cancer patients. Breast MRI has been increasingly used for the purpose of pre-operative staging for patients with newly diagnosed breast cancers to evaluate the extent of ipsilateral disease and to screen the contralateral

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breast (Kuhl et al. 2005; Lehman et al. 2009). As in screening MRI, increased BPE would have significant effects on the diagnostic performance of pre-operative MRI in breast cancer patients (DeMartini et al. 2012; Giess et al. 2014; Hambly et al. 2011). However, to date, there are no studies focusing on the impact of BPE on the accuracy of pre-operative breast MRI for staging purposes. Also, second-look US is helpful in differentiating unexpected lesions that are detected on breast MRI (Nam et al. 2015; Park et al. 2013), but little is known about whether second-look US is actually useful in detecting the additional MRI-detected lesions according to BPE and deciding on further management according to BPE.

Therefore, the purpose of this study was to investigate the impact of BPE on the diagnostic performance of pre-operative breast MRI in breast cancer patients and how second-look US can help in guiding patient management for the additional MRI-detected lesions according to BPE.

METHODS

This study has a retrospective design and has been approved by the institutional review board of Severance Hospital, Seoul, Korea. Neither patient approval nor informed consent was required for the review of medical records or images. Informed consent was signed and obtained from all patients for image-guided percutaneous biopsy before procedures.

Study population

Between January and June of 2011, 357 consecutive patients underwent pre-operative breast MRI after an initial diagnosis of breast cancer. At our institution, all patients with the diagnosis of breast cancer routinely undergo pre-operative breast MRI for staging purposes. If an additional suspicious finding other than the proven malignancy is noted on MRI, second-look US is performed. However, in patients for whom total mastectomy is planned and who have additional suspicious findings located in the ipsilateral breast, second-look US is not performed. On second-look US, if a lesion correlated to that on breast MRI is identified and considered to have suspicious US features, either US-guided core needle biopsy or US-guided localization excision is performed based on the operating schedule. Patients were excluded from surgery because (i) surgery was not performed at our institution and the patient had been lost to follow-up (n = 5), (ii) neo-adjuvant chemotherapy was performed before surgery because of an initial diagnosis of distant metastasis (n = 14), (iii) post-operative follow-up US had not been performed for at least 2 y (n = 62) or (iv) pathology of the additional suspicious findings noted on breast MRI had not been confirmed with US-guided core needle biopsy or US-guided localization excision because total mastectomy was performed (n = 23). Finally, a total of 253 patients were included in this study. The mean age of the 253 women was 51.2 ± 10.2 y (range: 27–80 y).

Breast MRI

Breast MRI was performed with patients in the prone position using a 3.0-T scanner (TrioTim, Siemens, Erlangen, Germany) with a dedicated breast coil. Baseline breast MRI consisted of T2-weighted fast spin echo axial images (TR/TE, 4360/100 ms, flip angle: 150°, field of view [FOV]: 360 mm, matrix: 512 × 512 pixels, slice thickness: 3 mm), T2-Weighted short tau inversion recovery (STIR) axial images (TR/TE: 4400/76 ms, inversion time: 220 ms, flip angle: 80°, FOV: 360 mm, matrix: 320 × 320 pixels, slice thickness: 3 mm), axial diffusion-weighted imaging using single-shot echo planar imaging (application of diffusion-sensitizing gradients along the x-, y- and z-directions, with b values of 0 and 600 s/mm^2; TR/TE: 8900/78 ms; FOV: 360 mm; matrix: 192 × 95 pixels; slice thickness: 3 mm) and T1-weighted fat-suppressed pre-contrast and dynamic post-contrast enhanced images (TR/TE: 280 ms/2.6 ms, flip angle: 65°, FOV: 360 mm, matrix: 512 × 343 pixels, slice thickness: 3 mm) obtained before and after a bolus injection of 0.1 mmol/kg the rate of 2 mL/s, followed by a 20-mL saline flush. Five sequential contrast-enhanced images were used. The first contrast-enhanced images were obtained 66 s after the start of contrast agent injection, and subsequent images were obtained every 51 s thereafter. Menstrual cycle of the premenopausal women was not considered in obtaining breast MR images, because all patients had surgery planned in the near future. MR images were interpreted by the three staff radiologists (H.J.M., M.J.K., and E.K.K.) with 8 to 13 y of experience in breast imaging. If additional lesions other than the proven malignant mass with suspicious MRI features were detected, they were categorized as BI-RADS category 4 or 5, and second-look US was recommended.

Second-look US

Second-look US was performed by 11 radiologists (3 faculty and 8 fellows with 1 to 15 y of experience in breast imaging, all of whom were board-certified radiologists specialized in breast imaging who were well-informed of the BI-RADS findings) with a 5- to 12-MHz linear transducer (HDI 5000 or iU22, Philips Advanced Technology Laboratories, Bothell, WA, USA). Harmonic or Doppler imaging was performed at the discretion of the radiologist who performed the examination. MR images were thoroughly reviewed before