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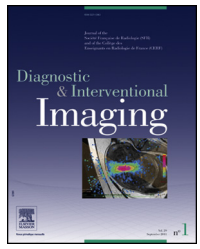

ORIGINAL ARTICLE / *Breast imaging*

Effect of background parenchymal enhancement on breast cancer detection with magnetic resonance imaging

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KEYWORDS
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Abstract
Objective: To investigate whether background parenchymal enhancement (BPE) may influence the sensitivity of dynamic contrast-enhanced magnetic resonance (DCE-MR) imaging in breast cancer detection.
Materials and methods: A total of 180 consecutive women with 194 breast cancers underwent MR imaging examination. Women were assigned to two different groups depending on the degree of BPE. Group 1 consisted of women with minimal or mild BPE and group 2 of women with moderate or marked BPE. The distributions of histotypes of tumors within the two groups were compared using the χ^2 test. Difference in sensitivities of DCE-MR imaging for tumor detection between the two groups was searched for using the Student *t*-test.
Results: No differences in terms of distributions of histotypes of tumors between the two groups of women were found ($P = 0.5$). The 11% difference in sensitivity of DCE-MR imaging for tumor detection between group 1 (91/92; 99%; 95% CI: 94—100%) and group 2 (90/102; 88%; 95% CI: 80—94%) was statistically significant ($P = 0.0058$).
Conclusion: The sensitivity of DCE-MR imaging is significantly lower in women with moderate and marked BPE as compared with women with minimal and mild BPE regardless of cancer histotype. BPE could represent a limitation for breast MR imaging interpretation and should be indicated in MR imaging reports.

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The introduction of dynamic contrast-enhanced magnetic resonance (DCE-MR) imaging in the field of breast imaging has improved the diagnosis of breast cancer with reported sensitivities and specificity of 95—99% and 80%, respectively and has provided crucial information regarding normal breast tissue [1—6]. In fact, enhancement on MR imaging after intravenous administration of a gadolinium chelate is not limited to breast lesions but also involves normal breast parenchyma. For this reason, the concept of breast background parenchymal enhancement (BPE) referring to the enhancing glandular tissue of the healthy surrounding breast as assessed on dynamic MR sequences has been introduced [7,8]. Even if BPE can occur only in the glandular component of the breast, Hansen et al. reported that the degree of BPE on DCE-MR imaging does not exactly correspond to the mammographic density [9]. This could be due to the variable perfusion of the fibroglandular tissue rather than to the breast gland amount [9].

BPE represents a dynamic process, which greatly varies among women and is typically bilateral, diffuse and symmetric [10—12]. BPE can be classified as minimal, mild, moderate and marked on the basis of the percentage of enhancing glandular tissue (< 25%, 25—50%, 50—75% and > 75%, respectively) [7,8]. BPE depends on several factors, including tissue vascularity and permeability, vascular supply to the breast, endogenous and exogenous hormones and endocrine therapy effects [8,13—17].

The two main clinical issues with BPE are its association with breast cancer risk and its effect on breast tumor detection with DCE-MR imaging. With regard to the former issue, King et al. investigated the relationship between breast cancer and both the amount of glandular tissue and the level of BPE at MR imaging [10]. They found that marked BPE strongly correlates with breast cancer [10]. With regard to the latter issue, some researchers have hypothesized that BPE may lower the sensitivity of DCE-MR imaging by obscuring enhancing malignant lesions and the specificity by creating enhancing areas mimicking cancer. However, to our knowledge, no general consensus exists in the medical literature in this field and different studies consider MR imaging as an accurate imaging tool also in breasts that show moderate and marked BPE on DCE-MR imaging [18—23].

The goal of this was to investigate whether background parenchymal enhancement (BPE) may influence the sensitivity of DCE-MR imaging in breast cancer detection.

Materials and methods

Patients

Between May 2012 and February 2015, 180 consecutive women with a mean age of 54.7 years ± 9.7 (standard deviation [SD]) (range, 32—80 years) underwent breast MR imaging examination for preoperative staging and were enrolled in this monocentric retrospective study. They were 105 premenopausal and 75 post-menopausal women, with a total of 194 newly diagnosed breast cancers. No women were excluded.

All women underwent clinical examination, bilateral mammography and ultrasound of the breasts. Sixty-five out of 194 breast tumors were palpable. One hundred twenty-one out of 194 breast cancers (62.5%) were visible at both mammography and ultrasound, 69/194 (35.5%) only on ultrasound and the remaining 4 (2%) only on mammography. Definitive lesion characterization was obtained by histopathological examination of surgical specimens in all women.

Ethics committee approval was obtained for the study and written informed consent was obtained from all women.

MR protocol

MR imaging examinations were performed on a 1.5 T MR device (Achieva®, Philips Medical Systems, Best, The Netherlands) by using a four-channel breast coil. MR examination was performed in the second week of menstrual cycle in case of pre-menopausal women. The protocol included a short TI inversion recovery (STIR) turbo-spin-echo (TSE) sequence, a T2-weighted TSE sequence and a three-dimensional (3D) DCE T1-weighted sequence. The transverse STIR TSE sequence was obtained with the following parameters: (TR/TE/TI = 3800/60/165 m; field of view (FOV) = 250 × 450 mm (AP × RL); matrix size, 168 × 300; 50 partitions with 3-mm slice thickness, intersection gap = 0; 3 signal averages; turbo factor 23; voxel size, 1.5 × 1.5 × 3.0 mm^3). The T2-weighted TSE sequence was obtained in the transverse plane with the following parameters: TR/TE = 6.300/130 ms; FOV = 250 × 450 mm (AP × RL); matrix size, 336 × 600; 50 slices with 3-mm slice thickness; intersection gap = 0; 3 signal averages; turbo factor 59; SENSE factor 1.7; voxel size, 0.75 × 0.75 × 3.0 mm^3. The 3D DCE T1-weighted high resolution isotropic volume (THRIVE) sequence was obtained with the following parameters: TR/TE = 4.4/2.0 ms; FOV = 250 × 450 × 150 mm (AP × RL × FH); matrix size, 168 × 300; 100 partitions with 1.5-mm slice thickness; turbo factor 50; SENSE factor, 1.6; 6 dynamic acquisitions, resulting in 1.5-mm^3 isotropic voxels; a dynamic data acquisition time of 1 min 30 s; total sequence duration, 9 min. Gadobenate dimeglumine (Multihance®, Bracco, Milan, Italy) was intravenously injected at a dose of 0.1 mmol/kg of body weight and flow rate of 1.5 mL/s followed by 20 mL of saline solution. After the dynamic series, image subtraction sequences were created in order to suppress the signal from fat tissue and enhancing lesions were identified on the subtracted images.

Image analysis

All MR imaging data were transferred to and analysed on a diagnostic workstation equipped with dedicated software for MR imaging examination (View-Forum R5.1 V1L1 2006). BPE was evaluated on subtracted MR images and classified as minimal (< 25% of glandular tissue enhancement), mild (25—50% enhancement), moderate (50—75% enhancement) and marked (> 75%) by two radiologists working in consensus (Fig. 1) [7,8]. Women were then assigned to two different groups depending on the degree of BPE. Group 1 consisted of women with minimal or mild BPE and group 2 of women with moderate or marked BPE.

Two radiologists with more than 5 years of experience in the field of breast MR imaging blinded to the patient history and to the clinical, mammographic and ultrasound findings retrospectively and in consensus evaluated MR images