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Contralateral lesions detected by preoperative MRI in patients with recently diagnosed breast cancer: Application of MR CAD in differentiation of benign and malignant lesions☆

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ABSTRACT

Objectives: To retrospectively investigate the added value of kinetic features measured by computer-aided diagnosis (CAD) for differentiating benign and malignant contralateral breast lesions detected by preoperative MRI in breast cancer patients.
Methods: This study was approved by our institutional review board, and the requirement for informed consent was waived. Fifty-two breast MR images and their CAD kinetic features were obtained for 52 consecutive breast cancer patients with contralateral breast lesions detected by preoperative MRI and confirmed by excision (23 cancers and 29 benign lesions). Three experienced radiologists independently reviewed the MR images without CAD information and assessed probabilities of malignancy. Four weeks later, these probabilities were reanalyzed using stored CAD data. Diagnostic performances and detection rates of delayed washout components were compared between interpretations without and with CAD for each reader.
Results: Use of MR CAD increased detection of washout component by 2.4- to 3.7-fold than visual assessment for enhancing contralateral lesions, which increased sensitivity (91% vs. 87% in reader 1; 96% vs. 74% in reader 2; 91% vs. 70% in reader 3) and decreased specificity, but statistical significance was only found for decreased specificity in one reader (52% vs. 28%, $P = 0.039$), and overall performance (areas under ROC curves 0.672 vs. 0.616 in reader 1; 0.624 vs. 0.603 in reader 2; 0.706 vs. 0.590 in reader 3) remained unimproved.
Conclusion: Addition of MR CAD increased sensitivity and decreased specificity than radiologist's assessment alone for differentiating benign and malignant contralateral lesions in breast cancer patients and overall performance remained unimproved.

1. Introduction

Synchronous contralateral breast cancer found in 1–3% of women with newly diagnosed breast cancer has been associated with poorer disease free survival than unilateral cancer [1–3]. Furthermore, in 0.7% of patients per year, it has been reported that contralateral cancer may occur in women with a normal finding on mammography and physical examination for the contralateral breast at the time of cancer detection [4]. Breast MRI has been shown to have the ability to detect these contralateral cancers missed by mammography and physical examination with a 3.1% (30 of 969) cancer detection rate, 25% (30 of 121) positive predictive value (PPV), 91% (30 of 33) sensitivity, and 88% (822 of 936) specificity [5]. A recent meta-analysis study of the MRI screening of contralateral breasts also found that MRI detected abnormal findings not seen on conventional imaging in 9.3% of women, however, the reported PPV of 47.9% and true positive to false positive ratio of 0.92 indicate that MRI was not able to reliably differentiate benign and malignant lesions [6].

Computer-aided diagnosis (CAD) systems for breast MRI provide pixel by pixel kinetic information based on enhancement

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above a certain threshold level, and have been shown to improve specificity compared to radiologist's assessments alone by better demonstrating the presence of enhancement and delayed enhancement features [7–9]. As the kinetic curve type determined by the most suspicious kinetic feature, i.e., any presence of washout is considered to be more suspicious than plateau which in turn is considered to be more suspicious than persistence, is known to be significantly different between benign and malignant lesions, whole lesion assessment by CAD could be expected to improve diagnostic performance in differentiation of benign and malignant lesions [10–13].

However, no study has addressed whether kinetic types as determined by MR CAD can affect diagnostic performances in differentiation of benign and malignant contralateral lesions. Therefore, the purpose of this study was to retrospectively investigate the added value of kinetic features measured by CAD for differentiating benign and malignant contralateral breast lesions detected by preoperative MRI in breast cancer patients.

2. Materials and methods

2.1. Lesion and patient characteristics

Institutional review board approval was obtained and the requirement for informed consent was waived for this retrospective review of 1825 consecutive MR examinations of bilateral breasts performed between January 2007 and February 2009. The indication for a breast MR examination was a preoperative assessment of primary breast cancer extent in recently diagnosed cancer patients. During the study period, 110 contralateral breast lesions showed suspicious enhancement by MRI and were surgically excised after second-look ultrasound (US) and US-guided needle localization during surgery on the known index cancer. Of these 110 lesions, 56 lesions with abnormal findings on mammography (42 calcified lesions and 14 non-calcified asymmetries or masses) and 2 lesions in patients who underwent preoperative chemotherapy were excluded. Finally, a total of 52 suspicious lesions detected by MRI in 52 consecutive breast cancer patients (age range, 25–71 years; mean age, 46 years) who met the following inclusion criteria comprised this study group: unilateral breast cancer patients who underwent a bilateral breast MR examination prior to surgery; patients with an abnormal enhancing lesion on MRI in the contralateral breast; patients with a surgically confirmed histology; patients with negative clinical and mammographic findings; and patients who did not undergo preoperative chemotherapy.

Surgical histology of the contralateral breast lesions revealed that 23 (44%) were malignant and 29 (56%) were benign. Of the malignant lesions, 10 were infiltrating ductal carcinomas (IDC) not otherwise specified and 13 were ductal carcinoma in situ (DCIS). Of the benign lesions, 10 were fibrocystic changes without proliferation, 3 were fibrocystic changes with proliferation, 10 papillomas, 3 fibroadenomas, and 3 adenoses. Histologic diameters of lesions ranged from 5 to 20 mm (mean, 11.6 mm) for invasive cancers, 4 to 50 mm (mean, 20.8 mm) for DCIS, and 4 to 29 mm (mean, 9.5 mm) for benign lesions. The time interval between preoperative MRI and surgery varied from 1 to 68 days (mean, 11 days ± 15 days).

2.2. Breast MR imaging technique and interpretation in clinical practice

All MR examinations were performed using a 1.5-T system (Signa; General Electric Medical Systems, Milwaukee, WI) using a dedicated breast coil (8-channel HD breast array, General Electric Medical Systems, Milwaukee, WI). After obtaining a bilateral transverse localizer image, sagittal fat-suppressed T2-weighted fast spin-echo images were obtained (TR/TE, variable from 5500 to 7150/82; 256 × 160 matrix; field of view: 200 mm × 200 mm; 1.5-mm slice thickness; no gap). Dynamic contrast-enhanced examinations included one pre-contrast and five post-contrast, bilateral sagittal image acquisitions using a fat-suppressed T1-weighted 3D fast spoiled gradient echo sequence (TR/TE, 6.5/2.5; matrix 256 × 160; flip angle-10°; field of view: 200 mm × 200 mm; 1.5-mm slice thickness; no gap). Gadobenate dimeglumine (0.1 mmol/kg Multihance; Bracco Imaging, Milan, Italy) was injected using an automated injector (Spectris MR, Medrad Europe, Maastricht, Netherlands) through an indwelling IV catheter. Five post-contrast image series were obtained at 76, 165, 345, 434, and 583 s after contrast administration. For all studies, early subtraction (i.e., first post-contrast images minus pre-contrast images), axial reformatted images, and 3D maximum intensity projection images were generated.

One of two radiologists (W.K.M., N.C.) with 6–10 years of experience in breast imaging preoperatively interpreted and recorded preoperative MRI examinations using a picture archiving and communication system (PACS). Table 1 summarizes MR imaging features according to the American College of Radiology (ACR) Breast Imaging Reporting and Data System (BI-RADS) prior to sur-

Table 1
MR imaging features of lesions based on radiologist's unassisted prospective assessments.

Features	Benign (n = 29)	Malignant (n = 23)
Mean lesion size (range) (mm)	9 (4–29)	18 (4–50)
Mass	22	10
Shape		
Round	3	1
Oval	7	1
Lobular	2	1
Irregular	10	7
Margin		
Smooth	11	0
Irregular	11	9
Spiculated	0	1
Enhancement		
Homogeneous	12	4
Heterogeneous	9	6
Rim	1	0
Non-mass	7	13
Distribution		
Focal area	6	1
Linear	0	1
Ductal	0	1
Segmental	0	9
Regional	0	1
Multiple regions	1	0
Internal patterns		
Homogeneous	3	1
Heterogeneous	4	2
Stippled	0	1
Clumped	0	8
Reticular	0	1
Initial enhancement		
Slow	3	2
Medium	14	5
Rapid	12	16
Delayed enhancement		
Persistent	14	1
Plateau	8	16
Washout	7	6
Final assessment category		
4	29	22
5	0	1