Comparison of breast density in the contralateral normal breast of patients with invasive and in situ breast cancer measured on MRI

Mammographic density has been proven as an independent risk factor for breast cancer [1, 2]. Recently, a large, population-based longitudinal study has confirmed that breast density was also associated with risk of developing ductal carcinoma in situ (DCIS) [3]. The literature report, or the biological basis for cancer development, did not indicate that there is a difference in the association between breast density and the risk of developing invasive ductal cancer (IDC) versus DCIS. However, there are no data to confirm this either. In this study, we measured and compared breast density in patients who had confirmed IDC versus DCIS, using a quantitative three-dimensional (3D) magnetic resonance (MR)-based density analysis method [4]. Magnetic resonance imaging (MRI) provides strong soft tissue contrast distinguishing between fibroglandular and fatty tissues in the entire breast without compression and has been shown capable of measuring density with a small variability.

In a retrospective review of patients who participated in a breast MRI study at our institution from 2004 to 2006, a total of 141 patients with unilateral pathologically proven breast cancer were identified, including 100 patients with IDC and 41 patients with DCIS. The density was measured from the contralateral normal breast of each subject. It was commonly agreed that density of the two breasts of the same women are highly correlated [5], so the density in the normal breast of patients who had IDC versus DCIS were compared to investigate whether the density was associated with development of invasive versus in situ cancer. This study was approved by the institutional review board and was Health Insurance Portability and Accountability compliant. All patients gave written informed consent for receiving the MRI study.

The MRI study was carried out using a 1.5-T MR scanner with a 4-channel phased-array bilateral breast coil (Philips Medical Systems, Cleveland, OH). The bilateral dynamic contrast-enhanced imaging was carried out using a 3D spoiled gradient recalled (radiofrequency-spoiled-fast acquisition at steady rate) pulse sequence. Thirty-two axial images with 4-mm thickness were prescribed to cover both breasts. The density was analyzed on pre-contrast T1-weighted images without fat suppression (repetition time = 8.1 ms, echo time = 4.0 ms, flip angle = 20°, matrix size = 256 × 128, field of view = 38 cm).

Breast density measurement was carried out based on our published method [4]. The breast and the fibroglandular tissues were segmented using computer-assisted algorithms. The key procedures of the breast segmentation consisted of the following: (i) an initial V-shape cutting using three body landmarks to determine the posterior boundary of the breast, (ii) a fuzzy c-means (FCM)-based segmentation algorithm with the b-spline curve fitting to obtain the whole breast area, and (iii) dynamic searching to exclude the skin. For fibroglandular tissue segmentation, the adaptive FCM was applied for bias field correction to remove image intensity nonuniformities and for segmentation of the fibroglandular tissue from the surrounding fatty tissue. The volumes of the total fibroglandular tissues and the entire breast were calculated, and the ratio × 100% was defined as the percent density.

The mean age was 53 years in the IDC group and 58 years in the DCIS group. Overall, the measured breast density did not
show significant difference between the two groups of patients (10.9% ± 8.4% for the IDC group versus 10.4% ± 6.2% for the DCIS group, \( P = 0.73 \)). Figure 1 shows the scattered plot between the percent density and the age of all patients. It was noted that there was no difference among patients with these two cancer types. However, an age dependence was observed. A decreased density was clearly noted in patients >55 years old. A logistic model was applied to analyze the difference in density, controlling for age, and the results show no significant difference between IDC versus DCIS. Figure 2 shows two case examples with IDC and DCIS.

In summary, this study showed that the breast density between patients who had IDC and DCIS did not have significant differences. Although breast density is a well-established risk factor for breast cancer, it does not predict whether a woman is more likely to develop invasive cancer or in situ cancer. Other genetic or molecular markers need to be investigated.

funding

National Institutes of Health/National Cancer Institute (R01 CA90437, R21 CA121568, R03 CA136071); California Breast Cancer Research Program (9WB-002, 14GB-0148); National Science Council (Taiwan) (97-2314-B-039-031).

J.-H. Chen1,2*, D. Chang1, K. Nie1, F.-T. Hsu2, H.-N. Shih2, C.-C. Hsu2, O. Nalcioğlu1 & M.-Y. Su1

1Center for Functional Onco-Imaging, School of Medicine, University of California Irvine, Irvine, CA, USA, 2Department of Radiology, China Medical University Hospital, Taichung, Taiwan

(*E-mail: jeonhc@uci.edu)

acknowledgement

This work was conducted at Tu and Yuen Center for Functional Onco-Imaging at University of California, Irvine.

references


doi:10.1093/annonc/mdp361