Annals of Oncology Advance Access published October 19, 2011

Consistency of breast density measured from the same women using different MR scanners

The Breast Cancer Preventive Collaboration Group has recommended that mammographic density should be incorporated into the risk prediction model [1]. Due to its two-dimensional nature, mammographic density bears the intrinsic limitation of tissue overlapping and cannot provide a true volumetric measure. Quantitative breast density based on three-dimensional magnetic resonance imaging (MRI) has been developed [2–5].

For assessing the association between MRI-based density and cancer risk, a large dataset is required and combining MRI from multiple centers is the only feasible way to achieve this goal. However, combining data from different sites is challenging because of the different imaging protocols used in different scanners, as well as the intrinsic differences in the image quality. Thus, as a first step, whether or how the densities measured from different centers can be combined needs to be investigated. The purpose of this preliminary work is to compare the measurement consistency of breast volume (BV), fibroglandular tissue volume (FV) and percent density (PD) using three different scanners.

Five healthy Asian young female subjects (aged 27–35 years, mean 30 years) were recruited for this study. Each subject consented to receive noncontrast breast MRI using three different MR scanners, including GE 1.5T and 3T (GE Healthcare, Milwaukee, WI) and Siemens 1.5T (Siemens, Erlangen, Germany). The scans were completed within 2 days. The sequences were optimized to make the image quality across the three scanners as consistent as possible. The parameters for spatial resolution, slice thickness and field of view were kept as close as possible.

The breast and fibroglandular tissue segmentation was carried out based on a modified published method [5]. Online only supplementary Figure S1 (available at *Annals of Oncology* online) shows the key procedures. After the breast is segmented out, the total BV is calculated. The quantitative BV, FV and PD were obtained. The reproducibility of the measured parameters from the three scanners was compared based on the coefficient of variation (CV), which is the standard deviation from the three measurements divided by their mean.

All three scanners provided satisfactory image quality for density analysis, with a strong tissue contrast between the fibroglandular tissue and the fatty tissue for segmentation. Figure 1 demonstrates the MR images of three cases showing different breast morphological patterns. Online only supplementary Table 1 (available at *Annals of Oncology* online) shows the BV, FV and PD measured from the three subjects in Figure 1. The range (%), mean and standard deviation (%) of CV from the 10 analyzed breasts of the 5 studied subjects were 2.0–5.2 and 3.8 ± 1.0 for BV, 0.7–12.7 and 5.4 ± 3.3 for FV and 1.0–11.6 and 4.1 ± 3.4 for PD, respectively.

The mean CV fell in the range of intraoperator variation of 5% and positional difference of <5% in the same scanner for the segmentation method used [5], with only two individual breasts (12.7% in the left breast of a subject for the measurement of FV and 11.6% in the left breast of another subject for the measurement of PD) showing >10% of measurement variation. The segmented FV from Siemens 1.5T in these two breasts was smaller than from other two GE MR scanners. It was postulated that MR images of different quality from different vendors may account for the measurement variation in the fibroglandular tissue. In this study, imaging resolution of the Siemens 1.5T was slightly lower than that of the GE 1.5T and GE 3.0T MR (330 × 384 versus 512 × 384). This was also another potential source of measurement variation among different scanners. The average CV of 4.1% for percent density across different scanners was very similar to an averaged CV of 4.7% when reproducibility test of five different breast positions in the same magnet was carried out [5].

The preliminary results obtained so far in five subjects are very encouraging. The results indicated that since the breast density is analyzed based on three-dimensional images, as long as the entire breast is covered, and that the analysis is based on each individual woman's own body landmark, the measure density parameters from multiple centers using different imaging protocols are very likely suitable for combined analysis. Further prospective large cohort study is needed to investigate the variation in different types of breasts, in terms of breast size and the breast morphological pattern.

J.-H. Chen[1,2,3]*, S. Chan[4], D. H.-E. Chang[1] & M. Lin[1]
M.-Y. Su[1]

[1]Department of Radiological Science, Tu & Yuen Center for Functional Onco-Imaging, University of California Irvine, USA, [2]Department of Radiology, China Medical University Hospital, Taichung, [3]Department of Medicine, College of Medicine, China Medical University, Taichung, [4]Department of Radiology, Taichung Veterans General Hospital, Taichung, Taiwan
(*E-mail: jeonhc@uci.edu)

funding

This work was supported in part by NIH/NCI (Grant No. R03 CA136071) and California BCRP Grant (No. 14GB-0148 and 16GB-0056).

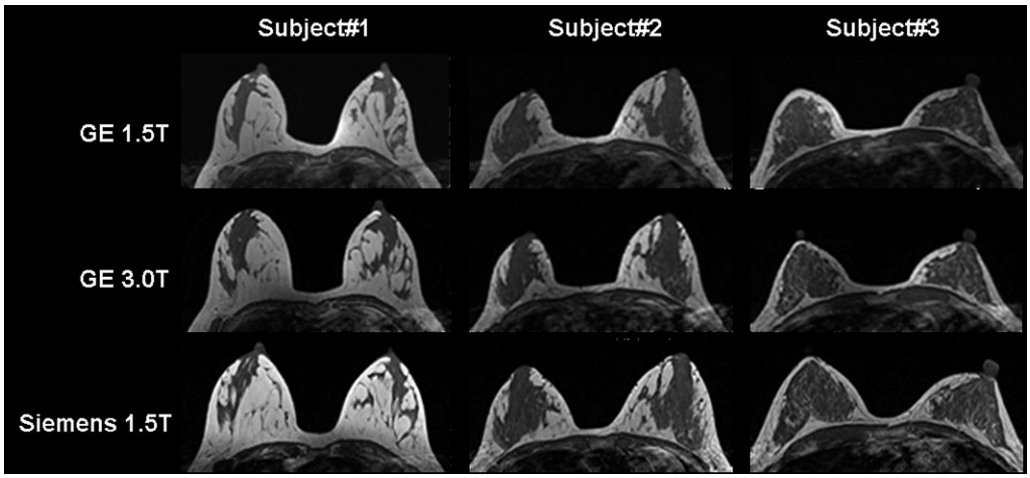

Figure 1. Representative T1W images of breast magnetic resonance imaging (MRI) from three subjects acquired using three MR scanners. They present different amount of dense tissues and different breast parenchymal morphological patterns. The coefficient of variation for the measurement of breast volume, fibroglandular tissue volume and percent density are 4.9%, 2.9% and 3.8%, respectively, for subject 1; 3.5%, 7.4% and 3.2%, respectively, for subject 2; and 3.9%, 7.1% and 9.4%, respectively, for subject 3.

disclosure

The authors declare no conflicts of interest.

references

1. Santen RJ, Boyd NF, Chlebowski RT et al. Breast Cancer Prevention Collaborative Group. Critical assessment of new risk factors for breast cancer: considerations for development of an improved risk prediction model. Endocr Relat Cancer 2007; 14(2): 169–187.
2. Eng-Wong J, Orzano-Birgani J, Chow CK et al. Effect of raloxifene on mammographic density and breast magnetic resonance imaging in premenopausal women at increased risk for breast cancer. Cancer Epidemiol Biomarkers Prev 2008; 17(7): 1696–1701.
3. Thompson DJ, Leach MO, Kwan-Lim G et al. Assessing the usefulness of a novel MRI-based breast density estimation algorithm in a cohort of women at high genetic risk of breast cancer: the UK MARIBS study. Breast Cancer Res 2009; 11(6): R80.
4. Wei J, Chan HP, Helvie MA et al. Correlation between mammographic density and volumetric fibroglandular tissue estimated on breast MR images. Med Phys 2004; 31(4): 923–942.
5. Nie K, Chen JH, Chan S et al. Development of a quantitative method for analysis of breast density based on 3-dimensional breast MRI. Med Phys 2008; 35(12): 5253–5262.

doi:10.1093/annonc/mdr456