Consistency of Breast Density Measured in Four Different MR Scanners

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Background and Purposes:

The Breast Cancer Preventive Collaboration Group has recommended that mammographic density should be incorporated into the risk prediction model. Due to its two dimensional nature, mammographic density bears the intrinsic limitation of tissue overlapping, and cannot provide a true volumetric measure. Other methods that can measure quantitative breast density, e.g. based on 3D MRI, have been developed. Despite of its advantage of providing 3-D volumetric density data, screening MRI is only recommended for women with lifetime risk greater than 20%. 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 work is to compare the measurement consistency of breast volume, fibroglandular tissue volume and percent density using 4 different scanners, two at 1.5T and two at 3T. We also evaluate whether difference of breast morphology will impact on the consistency.

Materials and Methods:

Thirty-four healthy Asian female subjects (age 20-64, mean 35 y/o) were consented to receive non-contrast breast MRI studies at 4 different MR scanners, including GE 1.5T and 3T, Philips 3T, and Siemens 1.5T. The 4 MR scans were completed within 2 days. The sequences were optimized to make the image quality across the 4 scanners as consistent as possible. The imaging parameters were also kept as close as possible. Field of view varied case to case, ranging from 32cm to 38cm, but was kept the same for the same subject for all the four MR scanners. In this study only the non-fat-sat T1 weighted images were analyzed. The breast and fibroglandular tissue segmentation was performed based on a modified published method [1], using a novel method based on N3 and adaptive FCM algorithm for bias-field correction [2]. The breast volume (BV), fibroglandular tissue volume (FV) and percent density (PD) were measured, and the results were compared among the 4 scanners.

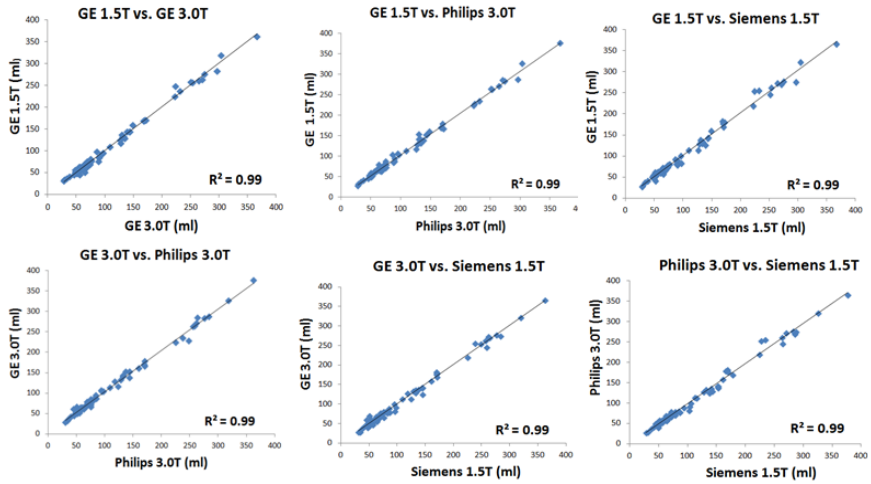

Figure 1. Correlation of fibroglandular tissue volume measured using different scanners.

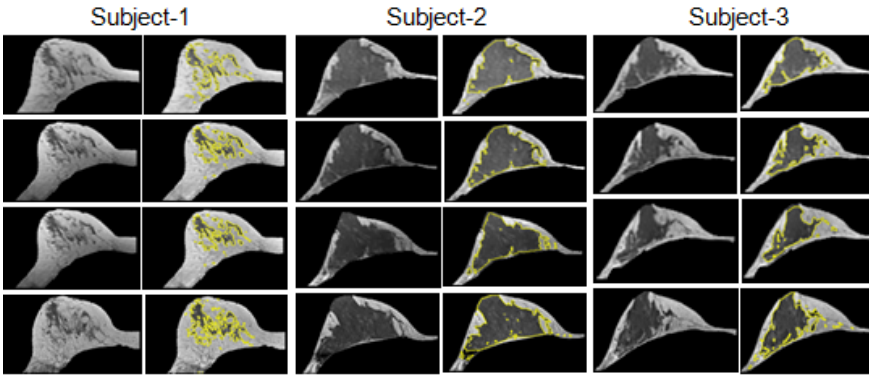

Figure 2. Subject-1 was a 55 y/o woman with intermingled breast morphology. Subject-2 was a 25 y/o woman with central type breast morphology. Subject-3 was a 28 y/o woman with central type breast morphology. The mean and range of percent difference for the measurement of FV in the three cases were 5.2% (1.0-10.1%), 4.0% (0.2-7.6%,) and 15.9% (1.5-31.2%) respectively. The high measurement variation in subject-3 was caused by the relatively smaller measurement of BV and FV acquired from the GE 3.0T scanner. **Row-1: GE 1.5T. Row-2: GE 3.0T. Row-3: Philips 3.0T. Row-4: Siemens 1.5T.**

Results:

In total, 68 breasts in 34 normal subjects were analyzed. Overall, these four scanners provided satisfactory image quality for density analysis. The contrast between fibroglandular tissue and the fatty tissue is clear for segmentation. Figure 1 shows the correlation of FV between each pair of two MR scanners, with all $R^2 \geq 0.99$. The differences between each pair were 5.9-7.8% for BV, 5.3-6.5% for FV, 4.3-7.3% for PD. Of the 34 subjects, 17 were central type, and 17 were intermingled breast morphology. The consistency for the measurement of BV, FV, and PD between these two morphology types was not significantly different (p=0.3). Figure 2 shows fibroglandular tissue segmentation in three subjects. For some cases, as subject-3, the measurement variation was high, which was due to a large difference of one scanner compared to the other three scanners. It is also clear that the positioning difference of subjects might also account for some measurement variations.

Discussion:

The results show that when MR pulse sequences are optimized, and a well-developed segmentation method is used, consistent density parameters from the same women can be obtained on images acquired using different MR scanners. Caution should be taken, however, that measurement may still show significant differences from scanner to scanner, and a test study should be performed. The positioning difference may account for some variation, and further optimization work may be developed to minimize its impact.

References: 1. Nie K. Medical Physics 2008;35:5253-62. **2.** Li MQ. Medical Physics. 2011;38:5-14.