Impact of positional difference on the measurement of breast density in MRI

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Background and Purpose: Quantitative 3D MR-based analysis of breast density can potentially provide an imaging biomarker for assessing cancer risk or predicting therapeutic efficacy of hormonal treatments. MRI provides detailed 3D distribution of fibroglandular tissue not subject to the tissue-overlapping problem as in mammography, and thus is suitable for volumetric measurements. To be qualified as a reliable imaging biomarker, factors affecting density measurement should be considered. Our previous study [1] has noted that the variation of fibroglandular tissue volume (FV) and percent density (PD) measured from four different MR scanners is around 5%, suggesting the parameters measured using different scanners can be used for a combined analysis in a multicenter study. For the correlation of PD between each pair of MR scanners, however, the variation was higher when the Siemens scanner was compared with any one of the three other scanners. The arms/hands position for scan using Siemens (hands-down, resting next to body) was different from the scan using GE and Philips scanners (hands-up, resting next to head), thus it was postulated that the difference of arm positions, hence the difference of breast positions, may partially account for the measurement variation. In this study we performed repetitive MR scan in healthy women using different arm and body positions to investigate their impacts on the measured breast density.

Materials and Methods: Thirty two healthy Asian women (age 22-53, mean 41) without history of breast diseases were recruited for this study. MRI was acquired using a 1.5T Siemens scanner. Each subject received a high resolution (512x512) T1W hands-up MRI followed by a low resolution (256x256) T1W hands-up MRI, then a high resolution T1W hands-down MRI. Lastly, the subject was off the examination bed and then on the bed again for another high resolution T1W hands-up MRI. Non contrast-enhanced T1-weighed MRI images were used for the analysis of breast density. The segmentation was performed using a fully automatic chest template-based method [2]. Unlike most model-based breast segmentation methods that use the breast region as the template, the chest body region on a middle slice was used as the template. Within the chest template, three body landmarks (thoracic spine and bilateral boundary of the pectoral muscle) were identified for performing the initial V-shape cut to determine the posterior lateral boundary of the breast. The chest template was mapped to each subject's image space to obtain a subject-specific chest model for exclusion. On the remaining image, the chest wall muscle was identified and excluded to obtain clean breast segmentation. The chest and muscle boundaries determined on the middle slice were used as the reference for the segmentation of adjacent slices, and the process continued superiorly and inferiorly until all 3D slices were segmented. The percent density (PD), calculated as ratio of fibroglandular tissue volume (FV) over breast volume, was compared among the four MR scan sessions. Coefficient of variation (CV), defined as the % ratio of standard deviation over the mean value of the four studies, was used to evaluate variations.

Results: Figure 1 shows correlations of four pairs of MR percent density results measured in the left breast. When using a general correlation analysis to compare the measured FV or PD, a high correlation between each pair was noted (all r>0.98, P→0.0). However, obviously some data points are away from the regression line. The mean CV of the measured FV among the four MR sessions in the 32 subjects was 9.3±6.2% (range 1.2~32.2%) in the left breast, and 7.4±5.2% (range 1.4~22.1%) in the right breast. The mean CV of the measured PD among the four MRs in the 32 subjects was 9.4±5.7% (range 1.8~31.2%) in the left breast, and 8.8±5.4% (range 5.4~21.6%) in the right breast. **Figures 2 and 3** illustrate two case examples showing the variation among the four MR measurements. **Figure 2** is a 44 y/o woman without history of breast diseases or surgery. Four MRI studies acquired in different positions/resolutions show very consistent results. The measured FV was 95.48 (hands-up), 98.78 (lower resolution hands-up), 98.76, (hands-down) and 96.74 ml (another hands-up); and PD was 19.03, 20.45, 19.07, and 20.45 % respectively in the right breast. The coefficient of variation (CV) among the four PD measurements was 4.1%. The results from the left breast (images not shown) were similar, with a CV of 3.5%. **Figure 3** is a 48 y/o woman without history of breast diseases or surgery. The measured FV was 130.88 (hands-up), 113.08 (lower resolution hands-up), 114.62, (hands-down) and 113.38 ml (another hands-up); and PD was 37.96, 37.29, 32.13, and 41.91 % respectively in the right breast. The PD measured in the hands-down position was much lower compared to the other three measurements done using the hands-up position. The coefficient of variation (CV) among the four PD results was 10.8%.

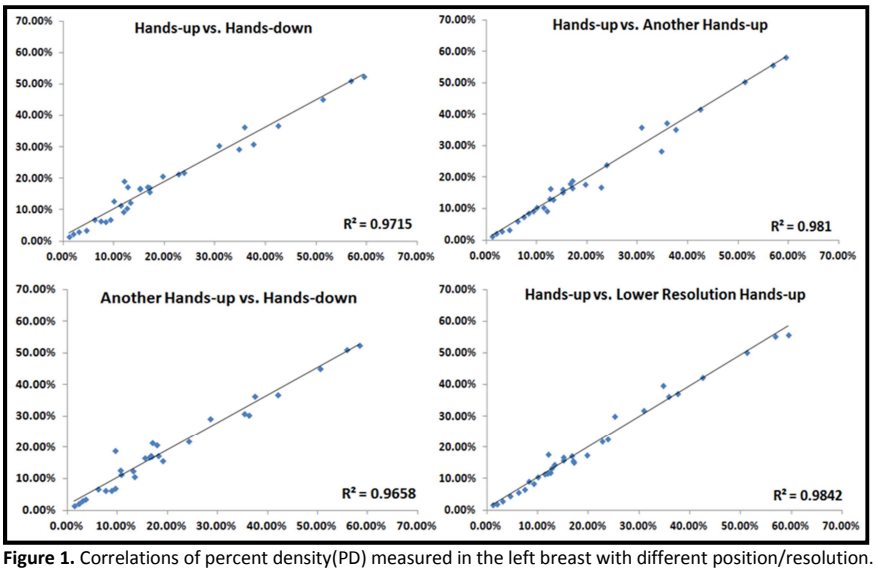
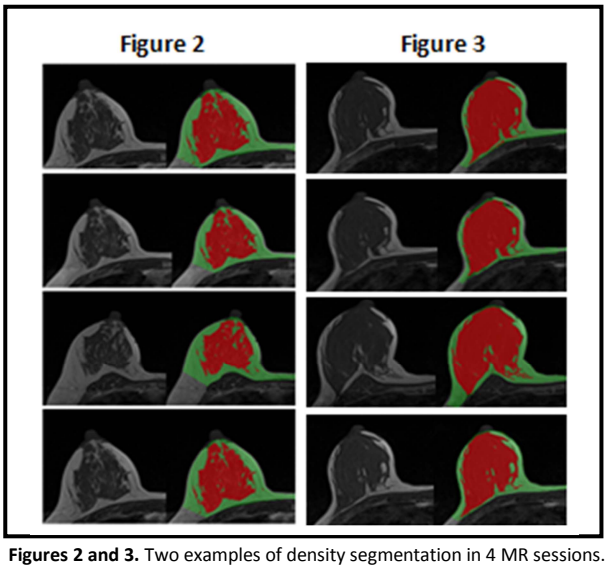


Figure 1. Correlations of percent density(PD) measured in the left breast with different position/resolution.



Figures 2 and 3. Two examples of density segmentation in 4 MR sessions.

Conclusions: Results of FV and PD measurements acquired from MRI of different position and resolution show small variations, with an averaged CV of <10%. A high variation was noted in some subjects, particularly in hands-down compared to hands-up positions. The results suggest that for a multi-center study of quantitative breast density measured using different MR scanners, the position of the arms/hands need to be standardized.

References: 1. Chen JH, et al. Medical Physics. 2012;39(8):4886-95.; **2.** Lin M, et al. Medical Physics 2013; E-pub ahead of print.

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