

## Correlation of three dimensional mammographic density (Quantra) and breast density acquired using 3D MRI

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**Background and Purpose:** Limitations of 2D area-based measures of breast density have led to the development of volumetric measures of breast density. Recently two automated breast assessment tools have been approved by FDA and are increasingly being used. One is Quantra, and the other is Volpara. Both quantitative tools give an objective estimate of the total volume of fibroglandular tissue as well as the total volume of the breast in cubic centimeters, without uncertainty coming from the judgment of human operators. A complex model of the x-ray imaging chain to calculate the amount of dense tissue contained within each pixel in the image, which is independent of how the image was acquired is used. Despite of the development of these new analysis tools, still it is not known how accurate the acquired density results are. A first evaluation of breast density by Quantra software showed that Quantra provided systematically lower density percentage values as compared to visual classification [1]. MRI provides strong soft tissue contrast distinguishing between fibroglandular and fatty tissues. More importantly, it provides a 3-dimensional view of breast tissues without compression. Therefore, MRI does not suffer from the tissue overlapping, or x-ray exposure calibration problem as mammography. This study aimed to compare the results of density measurements using Quantra and 3D MRI in the same women.

**Materials and Methods:** 56 women suspicious of breast lesions and with both breast MRI and Quantra breast density analysis were included. Breast MRI was acquired using a 1.5T scanner. Only the normal breast was analyzed. Non-contrast enhanced fat-saturation T1WI was used for the density analysis based on a novel semi-automatic method [2]. In the method, Fuzzy-C-means (FCM) clustering and B-spline curve fitting were applied to obtain the breast-chest boundary. A method based on non-parametric non-uniformity normalization (N3) and an adaptive FCM algorithm was used to remove the strong intensity non-uniformity and correct the bias field for segmentation of fibroglandular tissue and fatty tissue. Dynamic searching was applied to exclude the skin along the breast boundary. The standard FCM algorithm was applied to classify all pixels on the image. After completing the process, the dense tissue ROI was mapped onto the original MRI and the operator went through the images slice by slice to inspect the segmentation quality by comparing the segmented images with the original non-segmented images. In case of segmentation error(s), several strategies were used for the correction. These strategies included (a) further improvements in field inhomogeneity correction; (b) breast region re-segmented using a different landmark; (c) nipple exclusion redone using computer algorithms; (d) local contrast changed; and (e) FCM cluster setting changed for segmentation. Quantitative breast volume (BV), fibroglandular tissue volume (FV), and percent density (PD, calculated as the ratio of FV over BV  $\times$  100%), were obtained. The acquired PD was correlated with the density results from Quantra.

**Results:** In total 46 right breasts and 50 left breasts with both modalities were analyzed. The correlation of MR breast density with results from Quantra was only moderate with  $r=0.55$  for the right breast and  $r=0.65$  for the left breast respectively. Figure 1 shows the Bland-Altman plot (or difference plot) of two modalities. As noted, the 95% limits of agreement was from -22.3% to 22.9%. The mean difference was -0.31%. A trend was noted that when the averaged density between the two modalities was higher, the difference of breast density tended to be higher. Remarkably discrepant results were noted in some subjects. 72 breasts (72/96, 75%) showed an absolute density difference  $> 5\%$  between the two modalities, with Quantra underestimating density in 30 breasts (30/96, 31.3%), and overestimating density in 42 breasts (42/96, 43.8%). Figure 2 are two case examples showing consistent measurements between MRI and Quantra (upper panel, 20.2% vs. 20% and middle panel, 28.0% vs. 28%), and one woman with homogeneous breast morphology showing a high variation between the two modalities (lower panel, 42.9% vs. 26%). In our study, women with heterogeneous breast morphology were also likely to show a high measurement discrepancy between the two modalities (not shown here).

**Conclusions:** The results demonstrate that using MR-measured density as the ground truth, breast density acquired by Quantra only showed a moderate correlation. Some subjects have a high variation of breast density measured between these 2 modalities, but these cases cannot be predicted based on the density or morphology. Since Quantra is a new volumetric method for quantification of breast density, there is an urgent need to investigate the factors which affect its accuracy and consistency.

**References:** 1. Ciatto S, et al. Breast. 2012 Aug;21(4):503-6; 2. Lin M, et al. Medical Physics. 2011;38(1):5-14.

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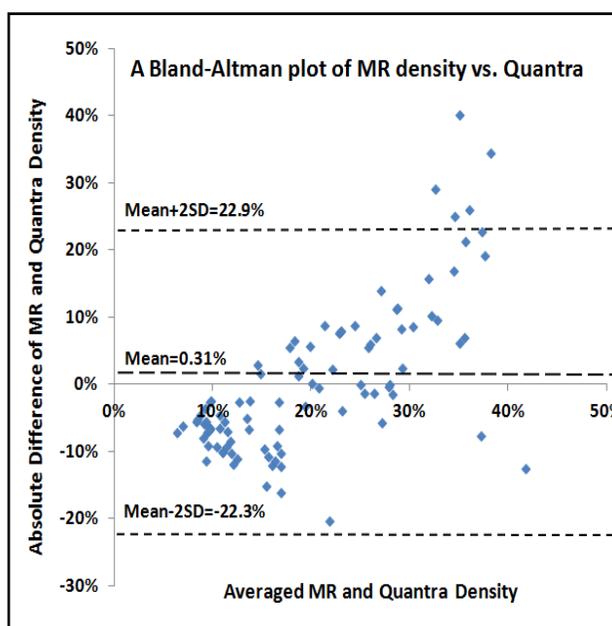


Figure 1. Difference plot of breast density measured by MRI and Quantra.

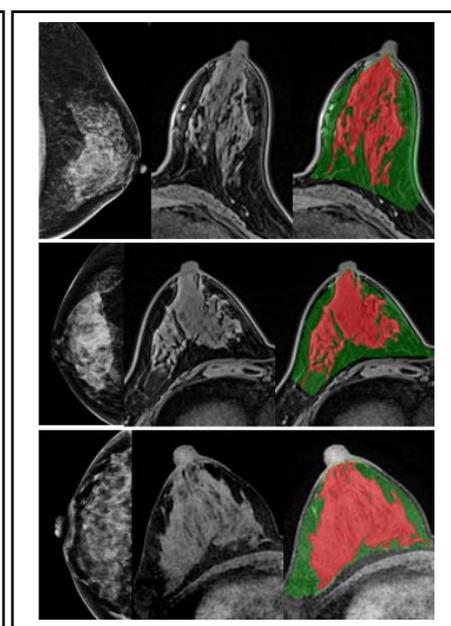


Figure 2. Examples of breast density in 3 women