# Symmetrical Analysis of Bilateral Breasts Based on 3D MRI

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***Background and purpose:***

Morphologically, bilateral breasts in a healthy woman are thought to be symmetrical. Asymmetrical change in mammography may indicate the potential abnormality in one breast. However, evaluation of breast asymmetry based on human visual perception is unreliable. In reading of mammography, the symmetry of breast tissues are often used as the comparative background for detection of lesions or micro-calcifications. Due to the nature of 2D projection, mammography cannot be used to analyze the true morphological distribution pattern of fibroglandular tissues. The acquired image can vary depending on how the breast is compressed, and as such, symmetry measures can be confounded by the nature of the imaging procedure itself. MRI acquires 3D images thus can be used to evaluate the symmetry in terms of the volume as well as the morphological distribution and the texture of fibroglandular tissues. Understanding the level of symmetry (or the degree of natural variation) between the bilateral breasts using quantitative analysis methods will help the development of computer-aided diagnostic system for detection of abnormalities. The analysis of symmetry is particularly important for detection of non-mass-like lesions on breast MRI. Despite of its well-known importance, none of the current commercially available software for breast MRI utilizes this feature, presumably due to the difficulty in obtaining quantitative parameters. The work present in this study may be incorporated into future CAD systems for diagnosis of breast lesion on MRI.

***Methods:***

57 healthy Asian women (range 20-64, mean age 35 y/o) were included in this study. The MRI was performed using a Siemens 1.5T scanner. In this study, only non-contrast-enhanced T1W1 was analyzed. The fibroglandular tissue was segmented slice-by-slice based on the method we have developed previously [1] and reconstructed as a 3D object. The breast volume (BV), fibroglandular tissue volume (FV) and percent density (PD) were measured. Three morphological parameters were developed in our previous work [2]. They were defined as followed: 1) Circularity, the ratio of the dense tissue inside a case-dependent sphere to the total dense tissue volume. The sphere position and size is determined and identical to the centroid and total volume of the dense tissue. 2) Convexity, the volume ratio of the total dense tissue to its minimum convex hull. 3) Irregularity, the index which compares surface area ratio the total dense tissue to the effective sphere where the sphere volume is identical to the dense tissue. Texture analysis consisted of the coefficient variance (CV) of image intensity, and the gray-level co-occurrence matrix (GLCM) texture evaluation based on the segmented fibroglandular tissue. Intensity CV and ten GLCM texture parameters were calculated on every slice, and then the pixel-weighted average from all slices was calculated.

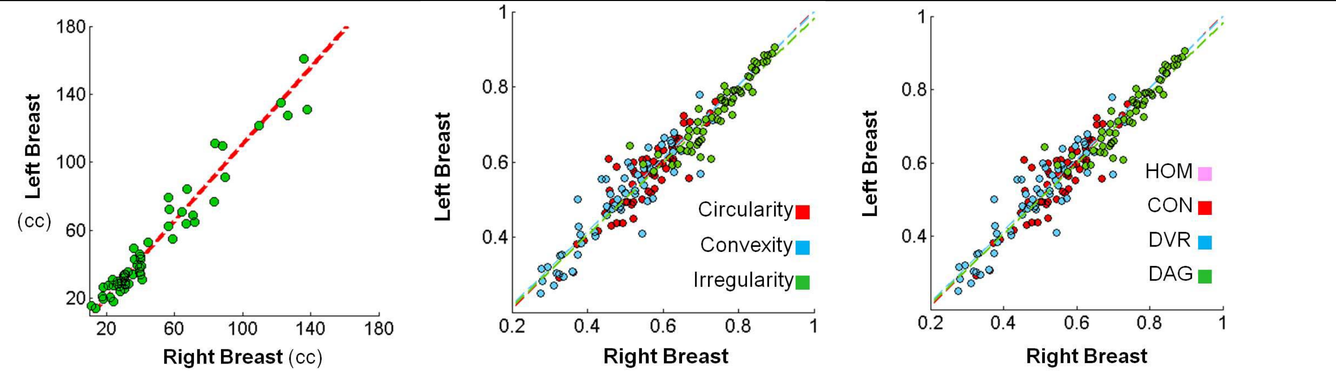


**Figure 1: Correlation of fibroglandular tissue volume (left), 3D morphology (center), texture (right) measured from the left vs. the right breasts.**

***Results:***

The correlation between the volume, 3 morphology, and 4 selected texture parameters are depicted in **Figure. 1**. The overall symmetry between the left and right breasts are analyzed by using linear regression, and the $R^2$ is 0.97 for fibroglandular tissue volume; 0.88, 0.91, and 0.94 for circularity, convexity and irregularity, respectively. In texture, they range from 0.72 for homogeneity (HOM) to 0.89 for difference average (DAG). For each subject the percent difference between the left and the right breasts is calculated, and the mean +/- stdev and the range from all subjects are summarized in Table 1 and Table 2. Although the mean values for each parameter measured from the left and the right breasts is very close, yet in individual analysis, very high % differences are seen in some subjects. Three cases had the difference larger than 30%. One is central type with FV 79.2 cc on left breast and 56.6 cc on right. The other two are heterogeneous fatty breasts. One case has left FV 49.7 cc, right FV 36.2 cc, and the other has left FV 26.5cc, right FV 18.2 cc.

**Table 1: The comparison of fibroglandular tissue volume and 3D morphological parameters of measured from the left and right breasts. The % difference in each subject is analyzed.**

| | Fibro-Tissue Volume | Circularity | Convexity | Irregularity |
|---|---|---|---|---|
| Left (N = 57) | 54 ± 39 (cc) | 0.56 ± 0.10 | 0.50 ± 0.12 | 0.74 ± 0.09 |
| Right (N = 57) | 50 ± 33 (cc) | 0.55 ± 0.09 | 0.49 ± 0.12 | 0.75 ± 0.09 |
| Percent Difference (Mean ± STD) | 13% ± 10% | 6.5% ± 5.5% | 8.1% ± 6.8% | 3.6% ± 4.2% |
| % Difference Range | 0.8% - 37% | 0.1% - 28.7% | 0.2% - 28.9% | 0.0% -22.4% |

**Table 2: The comparison of four GLCM texture parameters analyzed from the segmented fibroglandular tissue of the left and right breasts. The % difference in each subject is analyzed.**

| | CON | DVR | HOM | DAG |
|---|---|---|---|---|
| Left (N = 57) | 0.35 ± 0.11 | 0.49 ± 0.05 | 0.85 ± 0.04 | 0.32 ± 0.08 |
| Right (N = 57) | 0.35 ± 0.11 | 0.49 ± 0.05 | 0.84 ± 0.04 | 0.32 ± 0.08 |
| Percent Difference (Mean ± STD) | 12% ± 11% | 4.5% ± 4.4% | 1.7% ± 1.6% | 9.7% ± 9.5% |
| % Difference Range | 0.1% - 46.9% | 0.1% -17.8% | 0.0% - 7.6% | 0.1% - 33.7% |

***Discussion:***

We present a quantitative method to evaluate the symmetry of the bilateral breasts. Besides the volumetric analysis, we included the 3D morphology parameters (analyzing the shape and boundary) and texture parameters (reflecting internal distribution). The result may provide a reference dataset for detection of abnormal lesions based on symmetry on MRI. Some women may have asymmetric breasts, and future work is needed to address this problem (e.g. by adding contrast enhancements).

***References:*** **1.** Lin et al. Medical Physics. 2011;38:5-14. **2.** Nie et al. Medical Physics 2008;35:5253-62.