Agreement between Quantitative and Radiologist-Assessed Qualitative Background Parenchymal Breast Enhancement at MRI

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Purpose: Breast MRI background parenchymal enhancement (BPE), defined as enhancement of normal fibroglandular breast tissue after administration of contrast, varies throughout the population and with hormonal influences. Higher levels of BPE can interfere with MRI interpretation by masking or mimicking cancer. In addition, BPE has been associated with breast cancer risk and the upcoming version of the American College of Radiology's Breast Imaging-Reporting and Data System (BI-RADS) manual will require reporting of BPE (1). Given growing interest in BPE on breast cancer risk and diagnostic performance of breast MRI, an accurate quantitative measure of BPE is needed to further research in these areas. Despite the current interest in studying background parenchymal enhancement, investigation of whole breast quantitative BPE in a non-cancer population has not been performed. Therefore, the purpose of this study is to define whole breast BPE using an accurate quantitative method in a normal population and compare this quantitative measure to radiologist assessed qualitative BPE.

Methods: After institutional board review approval, a retrospective analysis of dynamic contrast enhanced breast MRIs with a BI-RADS 1 (normal) or 2 (benign) interpretation from April 2007 to November 2010 was performed. Each patient had a corresponding benign or normal mammogram within four years of the MRI. Patients with a current or prior history of breast cancer, atypia, or surgery including breast implants were excluded due to potential impact on intrinsic MR background parenchymal enhancement. In addition, patients with significant motion artifact limiting quantitative analysis were excluded. Of approximately 1380 MRIs conducted during this period, 179 patients ranging from ages 23 to 79 met the above criteria. At the time of the study, qualitative MR background parenchymal enhancement was assigned by the radiologist into quartiles as follows: minimal (correlates to approximately < 25% fibroglandular tissue enhancement), mild (25-49% fibroglandular tissue enhancement), moderate (50-74% fibroglandular tissue enhancement) and marked (> or equal to 75% fibroglandular tissue enhancement). Quantitative MRI BPE was obtained using a Fuzzy C Means (FCM) algorithm as previously described by Klifa et al (2). Fibroglandular tissue was differentiated from fat throughout the entire breast on a voxel by voxel basis (Figure 1). One degree of erosion at the periphery of each breast tissue mask was used to compensate for slight peripheral motion between the precontrast and postcontrast scans. Whole breast percent BPE was acquired by subtracting the fibroglandular tissue from the noncontrast and first postcontrast images. Pearson correlation coefficient was used to assess correlation between quantitative analysis and qualitative classification.

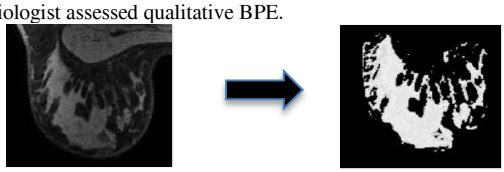

Figure 1: Segmentation of breast into fat and fibroglandular tissue

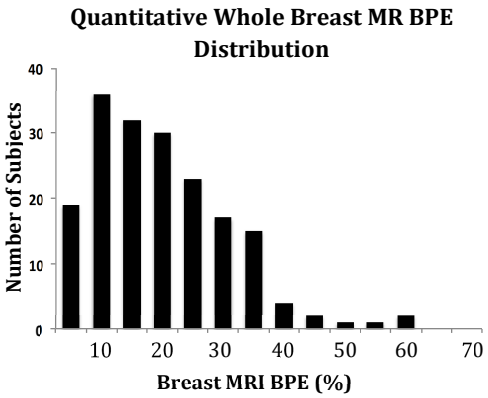

Figure 2: Distribution of whole breast quantitative MRI background parenchymal enhancement (BPE) in a normal population. Maximum enhancement was 57%.

Results: The distribution of quantitative whole breast background parenchymal enhancement in the normal population is displayed in Figure 2. Regardless of menopausal status, menstrual cycle timing, or age the maximum quantitative whole breast BPE in non cancer patients is 57%. The median and mean quantitative BPE is 15 and 17% respectively with a standard deviation of 11%. Quantitative and qualitative enhancement are significantly correlated (p = 2.157 e-05) however, qualitative enhancement trends towards overestimating background enhancement. Mean and median qualitative BPE is mild (25-49%). Comparison of quantitative to qualitative percent enhancement after binning into quartiles is demonstrated in Figure 3. Premenopausal patients had a statistically significantly higher average quantitative and qualitative BPE than postmenopausal patients. Similarly, younger patients (age < 50 years) also had higher quantitative and qualitative BPE values than older patients (age > 50 years).

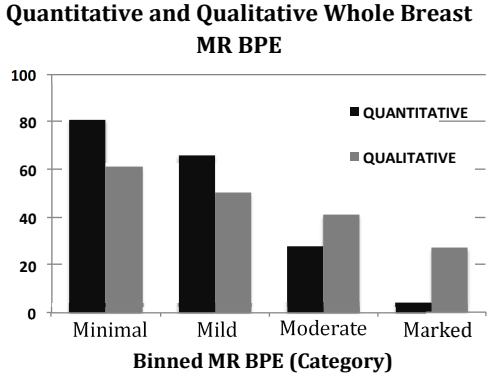

Figure 3: Quantitative vs radiologist assessed MR background parenchymal enhancement (BPE). Qualitative enhancement trends towards overestimating background enhancement.

Conclusion: Average whole breast quantitative MR BPE does not exceed 60% in the normal population and the majority of normal patients do not exhibit more than 15% of average whole breast background parenchymal enhancement. Quantitative and qualitative BPE do significantly correlate, however, radiologist assessed BPE demonstrates consistently higher values than quantitative BPE. These findings serve as benchmark data for accurate quantitative values of whole breast MR BPE in normal patients. Though further study is needed, understanding of normal quantitative BPE may provide additional guidance in breast cancer risk assessment, aid breast MRI interpretation, and lead to improvement in breast cancer diagnosis.

References: 1. King, V., et al., *Background parenchymal enhancement at breast MR imaging and breast cancer risk.* Radiology, 2011. **260**(1): p. 50-60.
2. Klifa, C., et al., *Quantification of background enhancement in breast magnetic resonance imaging.* Journal of magnetic resonance imaging : JMRI, 2011. **33**(5): p. 1229-34.

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