Age Correlation of Background Breast Tissue Enhancement Measured from the Entire Segmented Fibroglandular Tissue and the Hot-Spot in DCE-MRI

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Background and purpose:

Dynamic Contrast Enhanced MRI (DCE-MRI) is a well established clinical imaging modality for diagnosis, staging, and therapy monitoring of breast cancer. Since the detection of cancer is based on contrast enhancements, a strong background tissue enhancement may impact the diagnostic sensitivity; also it may affect the accuracy in pre-operative staging. Therefore, for screening MRI to be performed in asymptomatic high-risk women, the examination is recommended to be performed in days 8 to 15 after starting of menstrual cycle when the hormone level is the lowest to minimize the background tissue enhancement. It was also shown that for evaluating tumor extent, the accuracy of MRI with moderate/marked background enhancement was significantly lower than that with minimal/mild background enhancements [1,2]. Furthermore, the background tissue enhancement is associated with the risk of developing breast cancer. A recent study examining the relationships between breast cancer and both the amount and the enhancement level of fibroglandular tissue has found that the chance of diagnosing incidental breast cancer in asymptomatic women is increased with increasing amount of fibroglandular tissue, and that the background tissue enhancement remained significant after adjustment for the amount [3]. The mechanism is not well understood, but it is likely associated with a higher vascular supply in the fibroglandular tissue to facilitate development of cancer. The purpose of this study is to measure the background tissue enhancement based on the segmented fibroglandular tissue in the contralateral normal breast of patients who was diagnosed with breast cancer. An automatic method was used to search the enhancement hot spot. The mean enhancement measured from the entire fibroglandular tissue and the hot spot enhancement were correlated with age.

Methods:

The study subjects included 55 patients who received breast MRI for diagnostic or staging purposes before surgery or any neoadjuvant treatment. The age was ranging from 30 to 76 years, with a mean of 50.5. The MRI study was performed on a 1.5T MRI scanner using a 3D gradient echo sequence with 16 DCE frames (4 pre-contrast and 12 post-contrast). The temporal resolution is 42 seconds. The segmentation of fibroglandular tissue was performed using a computer program [4,5]. After the segmentation, the largest connecting piece is identified for the search of hot spot. Using this criterion can ensure that the hot spot is within the fibroglandular tissue, not from isolated vessels. A kernel of 3 x 3 pixel is applied to search through the largest connecting piece on the subtraction image taken at 5 min after contrast injection (frame #12), and the box that has the highest signal enhancement is identified as the hot spot. A mean signal enhancement time course was obtained by averaging over all pixels contained in the segmented fibroglandular tissue, also the hot spot enhancement time course was obtained by averaging over the 9 pixels contained in the hot spot box. The percent enhancement is calculated as the signal intensities measured between post-contrast frame (#12) and pre-contrast frame (#3) divided by pre-contrast intensity (x100%). The mean background enhancement and the hotspot enhancement were correlated with age. Also, subjects are divided into two groups as pre-/peri- menopausal (<55 years old, N=38) and post-menopausal (≥55 years old, N=17), and the mean percent enhancement is calculated and compared between them.

Results:

Two case examples are shown in **Fig.1**. The pre-contrast, post-contrast and enhancement images are illustrated. The green contour on the subtraction image outlined the segmented fibroglandular tissue, and the red color denotes the hot spot found by using the automatic searching program. The left panel shows the results from a 31-year-old woman with strong background parenchymal enhancement (202% from hot spot and 79% from whole fibroglandular tissue); and the right panel shows as 64-year-old woman with minimal background enhancement (4.4% from hot spot and 2.3% from fibroglandular tissue). **Fig.2** shows the correlation between the hot spot enhancement and the mean enhancement averaged from the entire fibroglandular tissue with age. A clear trend of decreased enhancement with increasing age is noted, and the correlation coefficient is r=0.35 for hot spot and r=0.33 for mean background enhancement, respectively. **Table 1** shows the comparison between pre/peri menopausal (< 55 y/o) and post-menopausal (≥55 y/o) groups: 75.6±60.9% vs. 29.8±19.6%, p=0.006 for the hot spot enhancement; and 32.6±27.1% vs. 14.3±9.5%, p=0.015 for the enhancement measured from the entire segmented fibroglandular tissue. The ratio between the hot spot and the mean background enhancement is about 2 fold.

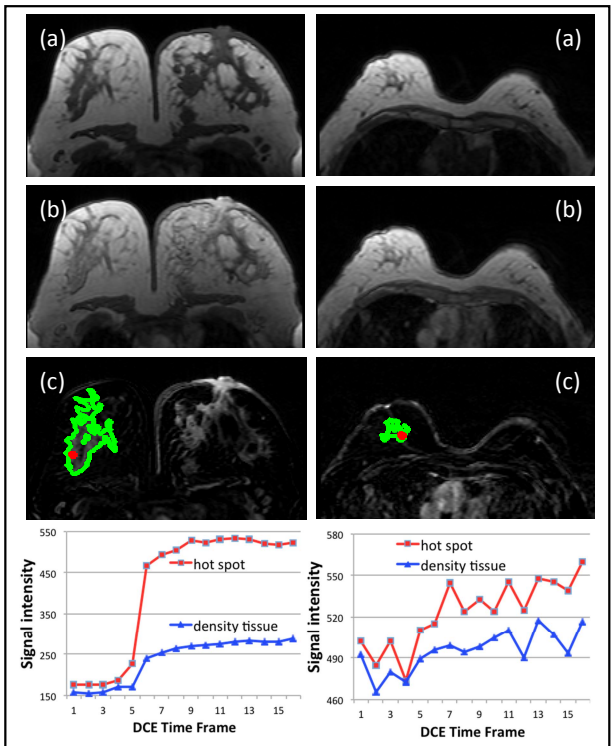

Fig. 1: Two case examples. (a) pre-contrast image, (b) post-contrast image, and (c) subtraction images @ 5-min post injection with outlining of the entire segmented fibroglandular tissue (green contour) and the hot spot (red) in the normal breast. The corresponding signal intensity time course measured from 16 time frames are also shown. The left case is 31-year-old showing strong background tissue enhancements; the right case is 64-year-old with fatty breast and minimal background enhancements.

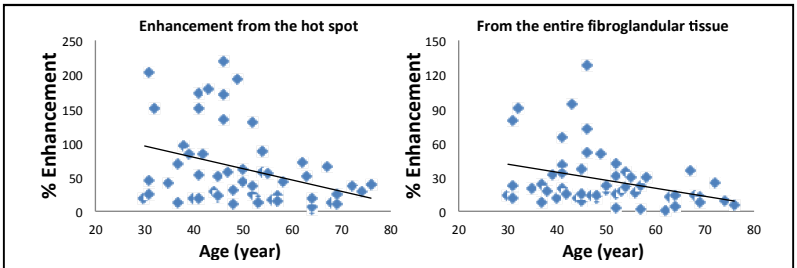

Fig. 2: Correlation of %enhancement measured from the hot spot and the entire fibroglandular tissue with age. A negative correlation is noted, with r = 0.35, and r = 0.33, respectively.

Table 1: Comparison of % enhancements [mean±stdev] measured from the two age groups

	% Enhancement in hot spot	% Enhancement from all dense tissues	Ratio of hot spot vs. mean tissue enhancement
Pre/Peri (< 55 y/o, N=38)	75.6% ± 60.9%	32.6% ± 27.1%	2.32
Post (≥ 55 y/o, N=17)	29.8% ± 19.6%	14.3% ± 9.5%	2.08

Discussion:

In this study we measured the background tissue enhancement in contralateral normal breast based of cancer patients based on the segmented fibroglandular tissue. A strong correlation between the degree of enhancement measured from hot spot and entire fibroglandular tissue with age was found, demonstrating that younger women not only have a higher breast density, also have higher background tissue enhancements. The analysis methods presented in this study can yield precise measurements of tissue enhancement that are not associated with the amount of dense tissue, and this can be used to investigate the role of background tissue enhancement in the risk of developing contralateral breast cancer in patients who had already been diagnosed with breast cancer.

Reference: [1] Uematsu et al, Eur Radiol. 2011; 21:2261-7. [2] Uematsu et al, Breast Cancer. 2012; 19:259-65. [3] King et al. Radiology. 2011; 260:50-60. [4] Nie et al. Medical Physics 2008; 35:5253-5262. [5] Lin et al. Medical Physics 2011; 38:5-14.