

Fluctuation of Contralateral Normal Breast Enhancement in DCE-MRI of Breast Cancer Patients Undergoing Chemotherapy

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Purpose:

Contrast enhancements in normal fibroglandular breast tissue of women are commonly observed in dynamic contrast enhanced (DCE)-MRI. The degree of enhancements may vary, possibly due to the menstrual cycle the woman is undergoing at the time of MRI [1]. This may cause a problem for MRI screening of breast cancer, or monitoring of therapeutic response. The high background enhancements could obscure the lesion detection, or make evaluation of disease extent difficult. However, it is not always practical to perform MRI with respect to the patient's menstrual cycle. Neoadjuvant chemotherapy has been increasingly used for treatment of breast cancer. At our institute we have been performing longitudinal MRI studies for monitoring response. In this study we analyzed contrast enhancements from fibroglandular tissues in the normal contralateral breast, and evaluated the variations in longitudinal studies during the course of treatment. The patients were separated into pre/peri menopausal (<55 years old) versus post-menopausal groups (≥ 55 years old), and compared the enhancement magnitude and variations between them. To avoid the bias coming from the arbitrary ROI selection, we applied a computer-based segmentation algorithm to segment the entire fibroglandular tissues contained in the normal breast, and measured the mean enhancement time course. The enhancements at 3 time periods (1-3, 3-5, 5-7 min) after contrast injection were analyzed.

Methods:

Thirty-four subjects were analyzed in this study (N=27 for <55 yo, and N=7 for ≥ 55 yo). The patient cohort was recruited from May 2002 to July 2006, who elected to receive neoadjuvant chemotherapy either due to inoperable tumor or with clinically documented lymph node involvement. Each patient had at least 3 MRI scans, one baseline and 2 follow-up. All MRI was performed on a 1.5T Philips Eclipse MR scanner. Bilateral DCE-MRI was acquired using a 3D gradient echo pulse sequence, 32 axial partitions with 4-mm thickness. Sixteen frames (4 pre and 12 post) were prescribed, each of which took 42 sec to acquire. The contrast agent (Omniscan®, 1 cc/10 lbs) was injected in about 15 sec followed by a saline flush at start of the 5th frame acquisition. For analysis, first the normal contralateral breast was segmented, and then the entire fibroglandular tissues contained in all 32 imaging slices were obtained using the fuzzy C-means algorithm. Lastly a volume-averaged enhancement time course was generated for each study. The mean enhancement intensity in each of three time segments was calculated: 'early' (the first 4 post-contrast frames, approximately 1-3 min), 'middle' (the next 4 frames, 3-5 min), and 'late' (the last 4 frames, 5-7 min). For each of these 3 parameters, the variation between the baseline and 2 follow-up of the same patient was calculated as the standard deviation. Finally the enhancement and variation between two age groups (< vs. ≥ 55 yo) were compared.

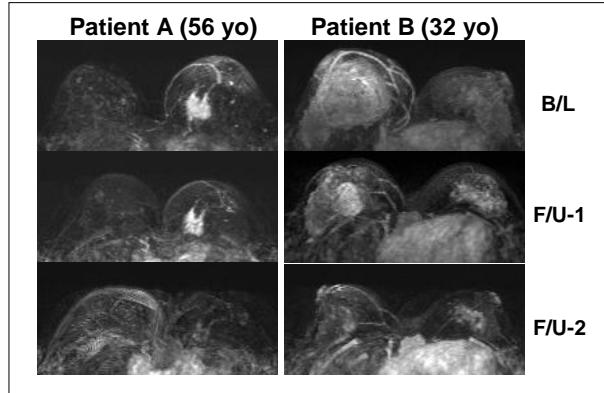


Fig. 1: MIP of subtraction images. Patient-A had a 2.5 cm lesion in the left breast, and Patient-B had a large 8 cm lesion in the right breast. Fibroglandular tissue enhancements in the normal breast were seen.

Results:

Fig. 1 shows examples from two patients, A-56 yo and B-32 yo. Both patients demonstrated appreciable enhancements from the fibroglandular tissue in their contralateral breast; but the enhancements were higher in Patient-B. Fig. 2 shows the plots of the percent enhancement time course measured from the lesion and the contralateral fibroglandular tissues, in the baseline and 2 follow-up studies. It can be seen that the normal tissue enhancements were much lower compared to lesion enhancements in the 56 yo, but those in the 32 yo were stronger, and showing a higher degree of variation between B/L and F/U studies. The mean enhancements during the three post-injection time segments, and the variation among all 3 studies, are summarized in Table 1. Also the mean value of the enhancement intensity and variation in the <55 and ≥ 55 yo groups are listed in Table 1. The early enhancement was 8%, and variation was 2.5% in ≥ 55 yo group, and that for < 55 yo group was 13.6% and 5.3%, respectively. Two-tailed t-test revealed that the 'early' and 'late' mean variations (STD) were significantly lower in the post-menopausal group. Although the enhancement intensity was lower in post-menopausal women in all 3 time segments, only the difference in the 'late' enhancement was significant.

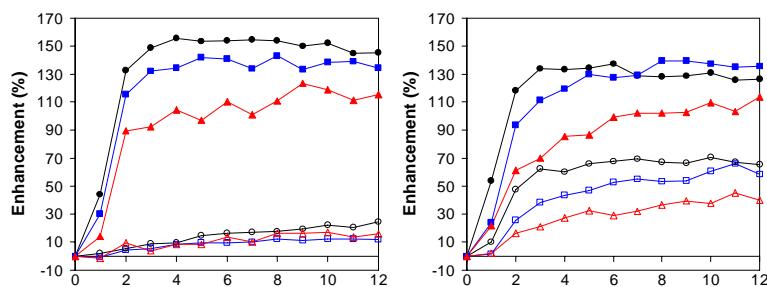


Fig. 2: The enhancement time course for patient-A (56 yo, left) and patient-B (32 yo, right). Solid symbols show enhancements from the lesion at B/L (black), F/U-1 (blue), and F/U-2 (red). Open symbols are for fibroglandular tissue in contralateral normal breast, with stronger enhancement and higher variation in B.

Mean Enh. (%)	Patient-A (56 yo)				Patient-B (32 yo)			
	B/L	F/U-1	F/U-2	STD	B/L	F/U-1	F/U-2	STD
Early	6.4	4.2	5.1	1.1	45.1	27.4	16.7	14.3
Middle	16.5	10.5	12.1	3.1	67.5	51.7	32.5	17.5
Late	21.6	12.2	15.6	4.8	67.5	59.8	40.6	13.8
Group mean	Post-menopausal (≥ 55 yo)				Pre/Peri-menopausal (< 55 yo)			
Early	8.0	7.7	8.1	2.5*	13.6	12.2	7.3	5.3*
Middle	16.5	12.2	16.4	5.1	24.3	21.7	14.8	7.7
Late	19.2*	14.9	16.2	5.0*	28.7*	26.2	18.5	8.6*

Table 1: The percent fibroglandular enhancement in 3 post-injection time segments in the B/L and two F/U studies, and the variation in individual woman. The results in two patients A and B, and the group mean are shown. * notes significant between groups.

Discussion:

The results indicated that younger women (pre/peri menopausal < 55 yo) had a higher fibroglandular enhancement in the contralateral normal breast, also a higher variation measured in serial studies performed over time. The fibroglandular enhancement was still lower than that of ipsilateral lesion for the two patients shown as examples, who had mass type lesions. But in a few patients presenting the non-mass type enhancement lesions, the fibroglandular enhancements could affect the evaluation of residual disease. The cut-off age (55 yo) was chosen to ensure that women ≥ 55 yo were indeed post-menopausal. This resulted in a small number of patients in the post-menopausal (N=7) compared to pre/peri-menopausal group (N=27). Nevertheless, the results were as expected, showing that post-menopausal women had lower fibroglandular enhancements and lower variations over time, possibly indicating less fluctuation coming from the influence of menstrual cycle. Since these patients were receiving chemotherapy, the normal breast might also show some treatment effects, which needs to be further investigated.

References: [1] Delille et al. Breast J. 2005; 11(4):236-41.

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