LONGITUDINAL VARIATION OF FIBROGLANDULAR TISSUE AND BACKGROUND PARENCHYMAL ENHANCEMENT ON BREAST MRI IN HIGH-RISK WOMEN: A QUANTITATIVE ASSESSMENT

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TARGET AUDIENCE: Radiologists, oncologists, and quantitative scientists interested in imaging biomarkers for breast cancer risk assessment.

PURPOSE: Screening breast MRI is recommended for women at high risk (lifetime risk ≥20%-25%) of developing breast cancer. Recent studies have shown that the fibroglandular tissue volume (FGT) and background parenchymal enhancement (BPE) seen in breast MRI may be predictive of breast cancer risk [1] and are potential intervention-response biomarkers for risk-reducing salpingo-oophorectomy [2]. The purpose of this pilot study is to perform quantitative assessment on the longitudinal variation of FGT volume and BPE volume in sequential breast MRI scans for a cohort of high-risk women who did not undergo any specific risk-reduction intervention.

METHODS: We retrospectively identified 71 high-risk women in our high-risk screening program. For each participant we collected two longitudinal cancer-free MRI scans acquired at two time points (TPs) (TP1: early scan; TP2: later scan; the mean (±SD) of the temporal gap between TP1 and TP2 was 519±282 days, min=166 days and max=1613 days; the mean (±SD) of age is 45.0±8.5 years at TP1 and 46.6±8.8 years at TP2). A fully automated computerized methodology pipeline [2-4] was adapted to compute the FGT in the dynamic contrast enhanced (DCE) pre-contrast images and the BPE in the fourth DCE subtraction images (subtraction = post-contrast – pre-contrast) (Fig. 1). In total, 142 MRI scans were processed. For each scan, three quantitative measures are produced by the computerized methods: (1) volume of FGT (|FGT|); (2) volume of the enhancement detected over the whole breast ($|BPE_b|$); and, (3) volume of the enhancement detected over the FGT area only ($|BPE_f|$). For each measure, the mean (±SD) across scans at TP1 and TP2 was compared using a paired *t*-test for significance. The difference between paired values measured respectively at TP2 and TP1 (i.e., $X_{TP2} - X_{TP1}$) was compared to show the temporal variation for each of the 71 women.

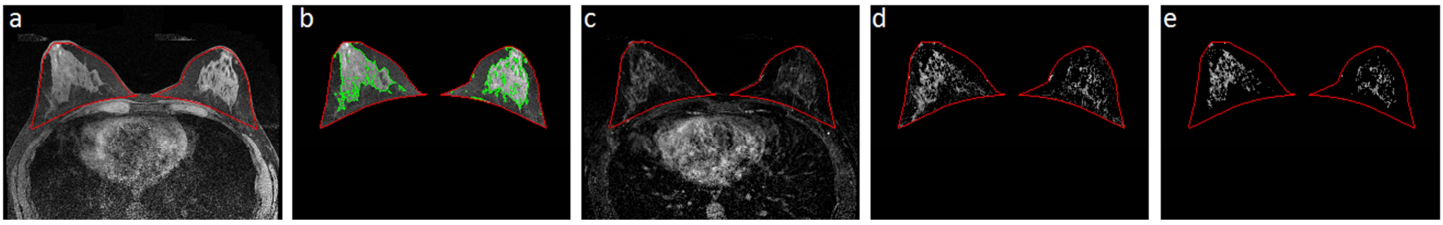

Fig. 1: FGT and BPE estimation. a. Whole-breast segmentation (red). b. FGT estimation (green). c. The fourth DCE subtraction image (SUB 4). d. BPE estimated on the whole-breast (BPE_b) area in SUB 4 image. e. BPE estimated on the FGT area only (BPE_f) in SUB 4 image.

RESULTS: Five women in the study cohort were diagnosed with breast cancer with an average of 432±188 days follow-up after TP2. The variation of each measure was analyzed for three subgroups: full cohort (N=71), cancer (N=5), and non-cancer (N=66). No significant change (all p>0.05) was observed in both |FGT| and $|BPE_f|$ for all three subgroups. However, there appears to be significant increase in the measure of $|BPE_b|$ in the full cohort (p=0.02) as well as the non-cancer group (p=0.03), albeit, not in the group of 5 cancer patients (p=0.3). Furthermore, based on the paired differences in the three measures (Fig. 2), it appears that from TP1 to TP2, $|BPE_b|$ increases for the three invasive cancer cases (i.e., ILC and IDC) while it decreases for the two cases of less-aggressive cancer (i.e., DCIS). At the same time, we also observe a large increase in $|BPE_b|$ at TP2 for several non-cancer participants (no breast cancer diagnosed at the time of the study).

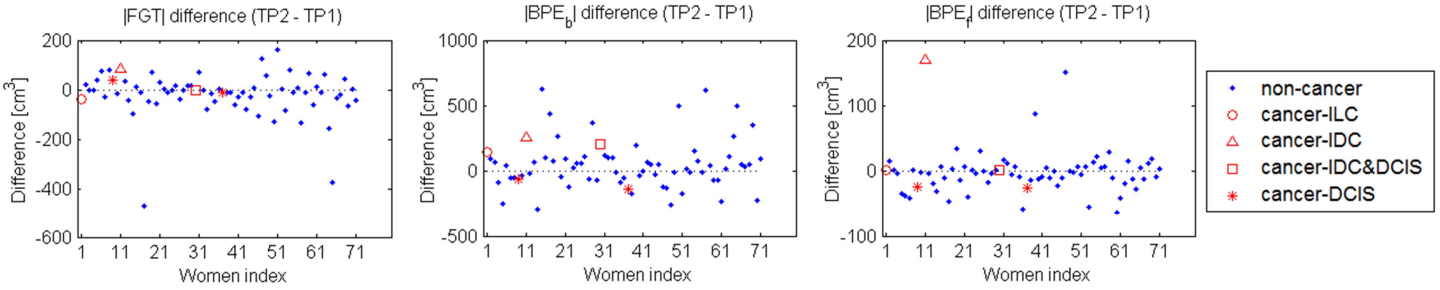

Fig. 2: Paired difference ($X_{TP2} - X_{TP1}$) in the three measures, i.e., |FGT| (left), $|BPE_b|$ (middle), and $|BPE_f|$ (right), for each woman of the study cohort.

DISCUSSION: The assessment of enhancement occurring only in the FGT area (i.e., $|FGT_f|$) is more relevant in clinic as in principle primarily FGT is expected to enhance. While there is no significant change in both |FGT| and $|FGT_f|$ within the time studied (i.e., TP2 - TP1), which is as expected, the observed significant variation in $|BPE_b|$ indicates that $|BPE_b|$ may capture certain properties that reflect biological differences (e.g., vasculature) in the non-FGT (fatty) area over time. In addition, although invasive cancer and DCIS may be separated by the paired differences in $|BPE_b|$, this finding should be interpreted quite cautiously because of the limited number of cancer cases and the observed increase in $|BPE_b|$ in several non-cancer women as well.

CONCLUSION: The preliminary results demonstrate the temporal variability of FGT and BPE, which may be useful as a reference measure when investigating these parameters as risk predictors and possibly as indicators of intervention-response in high-risk women.

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