Correlation of Magnetic Resonance Enhancement Morphology and Breast Density Patterns for Ductal Carcinoma In Situ.

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Introduction: Ductal carcinoma in situ (DCIS) is a highly heterogeneous group of cancerous lesions of the ducts that represents 15 to 25% of all newly diagnosed breast cancers. These pre-invasive lesions have a strong potential for progression to invasive breast cancer [1]. Recent applications have shown that Magnetic Resonance Imaging (MRI) of DCIS provides more valuable information than mammography on extent of disease [2], and a classification of DCIS enhancement patterns on contrast-enhanced MR is defined in [3]. The purpose of our retrospective study was to study the prevalence of these DCIS enhancement patterns in different breast density types on MR data in order to better understand breast pathologies in different populations, in particular for high-risk women with dense breasts for whom mammography is of limited effectiveness. Our study involves two qualitative assessments, (1) MR breast tissue patterns ("MR breast density") from pre-contrast MR and (2) DCIS lesions enhancement patterns using pre and post-contrast MR data. Since MRI provides a very high-resolution anatomical display of the breast, breast tissue can be seen as "infiltrated" by fat on pre-contrast data. The assessment of various breast tissue patterns can be qualitatively assessed from pre-contrast MR data. The long term goal of this study is to ultimately better understand which DCIS lesions may progress to invasive cancer.

Materials and Methods: Our retrospective study involved MR data of 47 patients with biopsy proven DCIS who had a breast MR exam at our center after 1995. The 47 patients were women between 35 and 78years, (average 51). All exams were performed on a 1.5T Signa system (General Electric Medical Systems, Milwaukee, WI) using a bilateral phased array breast coil, and gadopentetate dimeglumine (Magnevist, Schering, Berlin Germany) was injected at a dose of 0.1mmol/kg of body weight. A high resolution fat suppressed T1-weighted 3D fast gradient echo sequence was used, and data was acquired before contrast injection and at two time points after injection.The MR exam parameters were 20 cm field of view, 2 mm slice thickness and 256x192 acquisition matrix. The resulting in-plane resolution was approximately 0.78x0.78mm and 60 slices were acquired in the sagittal orientation.We first qualitatively assessed the MR breast density type of each patient following the scoring system shown in figure 1. Our MR breast density scoring system recognizes 4 groups of MR breast tissue/fat patterns, determining the amount of fat involvement in the breast tissue, and providing a general classification of MR breast density. The scores range from 1 (for dense breast tissue with no or very little fat involvement) to 4 (for fatty breasts with very little amount of breast tissue). Score 2 corresponds to large smooth regions of interest in the breast tissue with some fat involvement, whereas score 3 corresponds to a more mixed and equal amount of fat and breast tissue. We then used pre and post contrast-enhanced MR data to score the DCIS lesion enhancement patterns following the classification described in [3] as linear (M1), granular (M2), segmental (M3) or focal (M4). Two independent users assessed each exam. Patient age and menopausal status, as well as DCIS grade (high,medium,low and comedo vs non-comedo) were also recorded .

Results: The review of 47 cases showed a higher percentage of high-grade comedo in dense breasts (categories 1 and 2) than in fatty breasts (categories 3 and 4), see figure 2. As anticipated, our results showed a clear difference between the mean age of patients given a breast density score of 1 (mean age 45 years) and those given a score of 4 (mean age 58 years). We found no clear association between breast density scores (1 to 4) and DCIS grade, age or menopausal status. The enhancement patterns showed that 50% of our study population had granular (M2) and 25% focal (M4) DCIS enhancement patterns, confirming results in [3]. Most importantly we noticed that the percentage of M4 and M3 enhancements were higher (55 and 57%) in dense breasts (breast density scores 1&2) than in fatty breasts (scores 3&4) (45% and 42%). Finally 81% of M4 enhancement corresponds to high grade DCIS with 66% of them in dense categories (1,2) compared to 34% in fatty categories 3&4. We noted that if the majority of M2 enhancement happens in fatty types 3&4 (61%), only 43% of M2 enhancement corresponds to high grade DCIS.

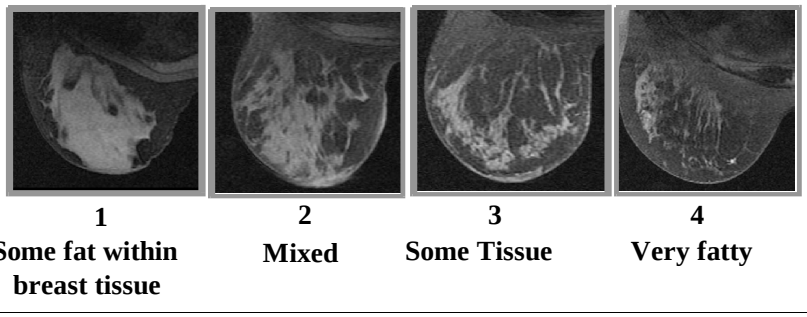

Figure 1: Visual scoring of breast density type from pre-contrast MR data (dense categories:1,2 / fatty categories: 3, 4)

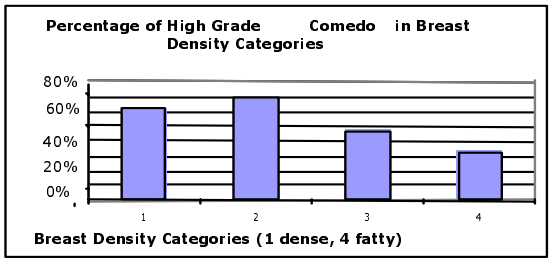

Figure 2: Percentage of high grade comedo DCIS in the 4 MR breast density types

Discussion: The average age found in each breast density score reflects the population under study. Older populations have generally more fatty breasts, which explains why the average age found in score 4 (fatty breast) is much older than the average age from score 1 (dense breast).
Since our results showed that a larger percentage of high-grade comedo DCIS (with higher risk of becoming invasive) was present in the dense breast categories than in the fatty breast categories, there is a need for future studies on DCIS evolution in young populations with dense breasts. We showed that typical DCIS patterns (granular M2) were found more in fatty breasts where ducts are more scarce than in denser categories. On the other hand, for larger DCIS lesions in this study, we found more DCIS focal enhancement patterns (M4) in dense breasts than in fatty breasts. These preliminary results suggest that introducing breast density evaluation in the clinical assessment of MR enhancing lesions could potentially help improve MR characterization of breast cancers. Future studies involving a larger DCIS population will test this hypothesis. A non invasive, quantitative MRI technique, which would link breast density assessment to enhancement patterns in DCIS lesions could result in the development of very informative complementary MR techniques for evaluating DCIS risk (or potential) of invasion, in particular for patients with high breast densities.

References: [1] Hetelekidis S:"Management of DCIS", Cancer J. Clin 1995:45,244-253, [2] Hwang SE:"MRI in patients diagnosed with DCIS", Annals Surg. Oncology, 10(4):381-388, [3] Neubauer H:"High grade and non high grade DCIS on dynamic MRM", Brit. J. Radiol.76 (2003),3-12