The Kinetics and Morphology of Ductal Carcinoma in Situ (DCIS) on Dynamic Contrast Enhanced MRI (DCEMRI)

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Introduction: Qualitative and semi-quantitative assessment of contrast media uptake and delayed phase washout is often applied to benign breast lesions and invasive cancers with the goal of better distinguishing the two[1,2]. Few studies of this kind have included an analysis of DCIS[3,4]. The purpose of this study is to assess the kinetic and morphologic characteristics of pure DCIS lesions on DCEMRI.

Methods: Eighty four histologically proven pure DCIS lesions in 71 women were found in a retrospective review of 1200 MRI examinations performed between 05/02 and 09/04. All patients were imaged with bilateral breast MR prior to percutaneous or excisional biopsy. MR protocol: Axial T_2 weighted fast spin echo (FSE), one pre and five post contrast bilateral T_1-weighted spoiled grass (SPGR) (68 second (s) acquisition) and bilateral sagittal T_1-weighted spin echo (SE) with fat saturation. Histologic classification was: 12 low, 16 intermediate and 40 high grade pure DCIS lesions with 16 unclassified. Two experienced radiologists performed a qualitative analysis of kinetic and morphologic criteria according to the ACR lexicon. Signal intensity vs. time curves were generated by placing a region of interest on the most rapidly enhancing part of the lesion. Several semi-quantitative parameters were calculated: the initial enhancement percentage $E_1=100x(S_1-S_0)/S_0$, a measure of maximum washout $W_{peak}=(S_{peak}-S_0)/(S_{last}-S_0)$ (S_{peak} is the maximum signal following CA injection, S_0 is the baseline signal, and S_{last} is the signal intensity in the final T_1-weighted post-contrast image) and the time to peak enhancement in seconds, T_{peak}. Morphologic assessment of the shape, margin, enhancement pattern and lesion size was recorded.

Results: The distributions of the delayed phase and initial rise are shown in Fig. 1 (a) and (b) respectively. The average E_1 was 189+-120%, the average T_{peak} was 258+-135 s and the average W_{peak} was 1.08+-0.2 which represents a slight washout over time. There was no statistically significant trend in contrast media kinetics across DCIS lesion grade, as demonstrated in Fig. 2 and Fig. 3 ($p > 0.05$ according to the two tailed variance t-test).

The morphologic type of enhancement was 80% non-mass and 20% mass. The enhancement pattern was: heterogeneous (35%), clumped (30%) and other (35%). The distribution was focal (26%), linear (22%), segmental (25%) and other (27%). The range of lesion size was 6-58mm with a mean size of 22mm.

Discussion: These results suggest that there are significant differences in the morphology and kinetics of pure DCIS lesions compared to previously reported characteristics of invasive and benign lesions in the literature [1,2]. DCIS lesions have longer T_{peak} and less washout than invasive cancer lesions and conversely have a shorter T_{peak} and more washout than benign lesions. Also, DCIS lesions have significantly lower E_1 than *both* invasive and benign lesions[5]. These differences may point to the unique physiology of DCIS lesions and associated vasculature. Recognition of these distinctive characteristics of DCIS, together with the promise of higher temporal and spatial resolution imaging in the future, should allow for more precise diagnosis of DCIS on MR imaging and thus hopefully reduce the incidence of invasive breast cancer.

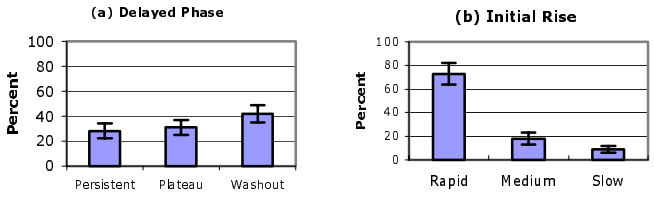

Figure 1: Qualitative assessment of (a) delayed phase and (b) initial rise in all DCIS lesions.

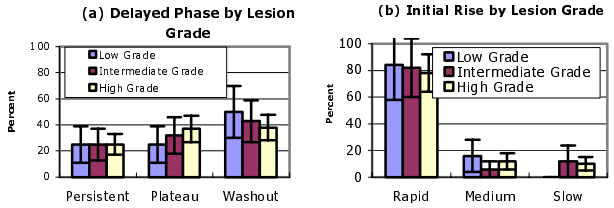

Figure 2: Qualitative assessment of (a) delayed phase and (b) initial rise by lesion grade.

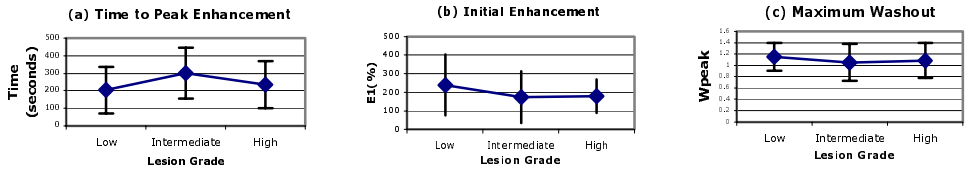

Figure 3: (a) Time to peak enhancement, (b) initial enhancement percentage and (c) maximum washout by lesion grade.

References:[1] Kuhl et al. Radiology 211:101-10, 1999. [2] Szabo et al. Acta Radiol.44:379-86, 2003.[3] Gilles et al. Radiology, 196: 415-19, 1995. [4] Neubauer et al. British Journal of Radiology, 76: 3-12, 2003. [5] Newstead et al, manuscript in preparation.