Contrast-enhanced MR Features of Triple-negative breast carcinomas (TNBC) associated with High Histological Grade

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Introduction: Triple-negative breast carcinomas (TNBC) which account for between 10% and 20% of all breast cancer patients are a class of tumors which are estrogen receptor (ER)-negative, progesterone receptor (PR)-negative and have negative over-expression or amplification of human epidermal growth factor receptor (HER2) (1)-consequently they exhibit aggressive biological and clinical features (2). The purpose of this study was to retrospectively identify MR features of TNBC and to correlate them to tumor histologic grade.

Methods: The institutional review board issued a waiver of informed consent for this HIPAA-compliant study. Thirty-six (n=36) breast cancer patients who underwent MRI fulfilled all inclusion criteria, which were that results of pathologic analysis from surgical lumpectomy were available and contrast enhanced (CE)-MRI was performed. Histologic findings were considered the reference standard.

MR Image Acquisition – MRI examinations were performed with a 1.5- or 3.0-T whole-body MRI unit (GE Medical Systems, Waukesha, WI) equipped with a dedicated 8 or 16-channel breast coil. *CE-MRI* – A simultaneous bilateral T1-weighted sagittal fat-suppressed sequence (flip angle, 35°; bandwidth, 32 kHz; field of view, 18–22 cm; matrix, 192 × 256; slice thickness, 3 mm; gap, 0 mm) was acquired before and three times after intravenous administration of 0.1 mmol/L gadopentetate dimeglumine (Magnevist; Bayer Health Care Pharmaceuticals, Montville, NJ) per kilogram of body weight; a 20-mL saline flush followed. *Image Analysis* - Breast MR images were evaluated by an experienced radiologist and a region-of-interest (ROI) was placed on enhancing regions. The ROI was segmented by a semi-automatic region-growing method proposed by Petrick et al. (3).Morphological features including form-factor, roundness, aspect ratio, convexity, and solidity were measured (4). The Linear-slope parametric model of enhancement was fitted to the normalized data to quantify enhancement slope (ES), wash-out slope (WS) and time-to-peak (TTP) (5). In addition, the initial area under the contrast curve at 120s (IAUC-120s) was estimated using semi-quantitative analysis. Texture descriptors were calculated using the 3D gray-level co-occurrence matrix (GLCM) method. The GLCM-based features quantified different texture characteristics of the lesion including contrast, correlation, energy, homogeneity, and entropy (6, 7). *Tumor characteristics* –Histology: Invasive ductal carcinoma NOS (n=34), mixed invasive ductal and lobular carcinoma (n=1), and metaplastic carcinoma NOS (n=1). *Histologic Grade*: Grade II (n=16), and Grade III (n=20).

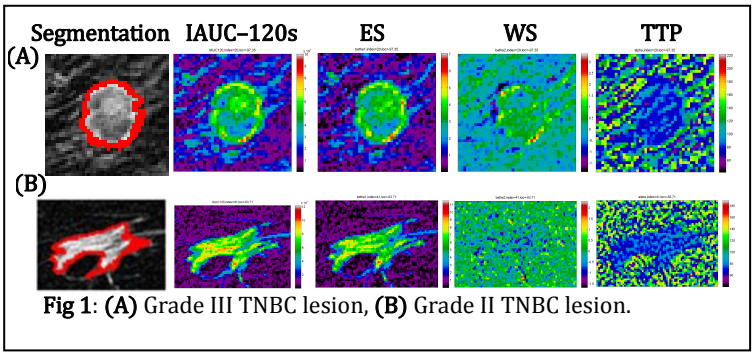

Fig 1: **(A)** Grade III TNBC lesion, **(B)** Grade II TNBC lesion.

Results & Discussion: Figure 1 shows representative examples of TNBC lesion with histologic Grade III (Fig. 1A) and Grade II (Fig 1B), respectively. The lesion was segmented using the region-growing algorithms and morphological, kinetic, and texture analysis parameters were estimated. The higher grade tumor shows regular margins of the cancer and rapid enhancement. The enhancement for high grade lesions is mainly concentrated at the periphery of the mass (Fig 1A). Table 1 summarizes parameter statistics calculated from the kinetic curves, morphology, and texture analysis measured from our patient cohort. Differences between histologic Grade II and Grade III were tested using a paired Student's t-test. Among the kinetic features, ES (P = 0.028) and IAUC – 120s (P = 0.045) were significantly associated with Grade III tumors. The quantity IAUC-120s, which integrates the area under the contrast curve during the first 120s, reflects how fast as well as how much contrast material is delivered to the lesion. Among morphological feature, roundness (a measure of the degree to which the periphery of the tumor lacks sharp corners) was significantly associated with Grade III tumors (P = 0.019). From texture analysis, entropy (a statistical measure of randomness that can be used to characterize image texture) was significantly associated with Grade III tumors.

Parameters	Grade II	Grade III	P-value
ES	5.21	8.70	0.028*
WS	0.61	1.17	0.50
TTP	83.13	85.20	0.67
IAUC – 120s	65.05	104.75	0.045*
Form-Factor	0.38	0.51	0.18
Roundness	0.60	0.69	0.019*
Aspect Ratio	1.58	1.36	0.13
Convexity	0.73	0.80	0.24
Solidity	0.79	0.77	0.68
Contrast	1.28	1.34	0.71
Correlation	0.65	0.67	0.6
Energy	0.1	0.16	0.07
Homogeneity	0.69	0.7	0.68
Entropy	6.23	6.81	0.03*

Conclusions: The ability to characterize TNBC using morphological, kinetic, and texture features has several implications. First, the MR imaging findings would help to better understand the biological behavior of this class of tumors. Second, it could assist in treatment planning and prognosis. Our preliminary results suggest that high grade (grade III) TNBC characteristic feature on imaging (as compared to Grade II) are rapid enhancement, higher IAUC, roundness, and entropy.

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