Correlation of morphological and kinetic features at magnetic resonance imaging and pathohistological prognostic factors in invasive ductal breast cancer

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Aims and objectives

Breast cancer is the most frequent cancer in women. Lowering mortality rates is possible through early detection using mammography screening, appropriate diagnostic work-up and treatment management (1). Breast magnetic resonance imaging (MRI) is well established radiological modality for the detection, diagnosis, and staging of breast carcinoma. It provides important information, not only on the morphology of lesions, but also on the functional aspects reflected by the differences in spatial and temporal uptake of contrast material. Integration of both morphological and kinetic features is important for accurate diagnosis (2).

The purpose of this study was to correlate morphological and kinetic MRI features of invasive ductal carcinoma not otherwise specified (IDC NOS) according to Göttingen score (GS) with pathohistological factors including tumor size, axillary lymph node status, histological grade, lymphovascular invasion, estrogen receptor (ER), progesterone receptor (PR), HER2, and Ki-67.
114 consecutive patients with pathohistologically confirmed IDC NOS who underwent MRI within one month prior to surgery between July 2012 and March 2014 were included in this retrospective study. Patients with special types of breast carcinoma were not included in this study, as well as patients with unusable preoperative MRI (motion artifacts) or patients after neoadjuvant chemotherapy.

All studies were performed with a 1.5 T MR unit (Avanto, Siemens, Erlangen, Germany) using a dedicated breast coil, with the patient in a prone position. Abnormal enhancement was classified as mass or non-mass enhancement. The shape of the mass was described as round/oval or irregular. The margin was described as smooth or irregular/spiculated. The internal enhancement pattern was described as homogeneous, inhomogeneous or rim enhancement.

Signal intensities were measured on precontrast and each postcontrast series using operator defined region of interest (ROI) which was the smallest possible (5 pixels). Measurement was performed in at least three positions within the lesion and the maximally enhancing ROI was selected for analysis.

The following kinetic parameters were analyzed for each tumor: initial enhancement, peak time, initial slope, type of kinetic curve. According to GS (3), each of the five parameters was scored with 0, 1 or 2 points and total score was calculated.

The following pathohistological prognostic factors were assessed for each patient: tumor type, tumor size, axillary lymph node status, histological grade, LVI, ER, PR, HER2, and Ki-67.

Depending on tumor size and axillary nodal status, tumors were divided into groups according to TNM classification system. Tumor grade was estimated by the Elston Ellis modification of the Scarff-Bloom-Richardson method, and tumors were classified into low grade (grade 1), intermediate grade (grade 2) and high grade (grade 3) (4).
Results

All 114 (100%) IDC NOS presented as mass lesions (Fig. 1 on page 5) and there were no non-mass enhancement lesions. MRI characteristics are summarized in Table 1 on page 5.

Based on Göttingen MRI scoring system, most tumors were scored with value 5 or more (Fig. 2 on page 6).

Tumor size ranged from 0.5 cm to 4.5 cm (median 1.5 cm). 82 (71.9%) tumors were smaller than 2 cm, while 32 (28.1%) were larger than 2 cm. There were 84 (73.7%) patients with negative axillary lymph nodes, 20 (17.5%) patients with 1-3 positive lymph nodes, 5 (4.4%) patients with 4-9 positive lymph nodes, and 5 (4.4%) with more than 9 positive lymph nodes. 24 (21.1%) tumors were grade 1, 65 (57%) tumors were grade 2, and 25 (21.9%) were grade 3. The presence of LVI was identified in 15 (13.2%) tumors, while 99 (86.8%) tumors showed no signs of LVI. 16 (14.0%) tumors were ER negative, and 98 (86.0%) were ER positive. 29 (25.4%) tumors were PR negative, while 85 (74.6%) were PR positive. 14 (12.3%) tumors were HER2 positive, and 100 (87.7%) were HER2 negative. 61 (53.5%) tumors were Ki-67 positive, and 53 (46.5%) were Ki-67 negative. There were 36.8% tumors of Luminal A and B1 subtype, while only 3.5% of tumors were HER 2.

By univariate analysis, irregular shape of the tumor was significantly associated with negative expression of PR (p=0.024). Smooth margins were significantly associated with LN (p=0.001), tumors larger than 2 cm in size (p<0.001), and negative expression of ER (p=0.009). Tumors sized 2-5 cm were significantly associated with rim enhancement (p=0.046). Initial enhancement of more than 100% was significantly associated with positive LN status (p=0.043) and LVI (p=0.009). Initial slope was significantly associated with positive LN (p=0.024). GS was significantly associated with tumor size (p=0.048) and 3 (p=0.047). Mean values of GS was 7 (range 3-8) was noted in tumors larger then 2 cm, while it was 6 (range 3-8) in tumors less then 1 cm in diameter. There was no correlation between MRI features with the expression of HER2 and Ki-67. No correlations were found between PT and pathohistological prognostic factors.

Parameters found to be significant by univariate analysis were selected for logistic regression analysis. By multivariate analysis, smooth margin was a significant, independent predictor of a larger tumor size (p < 0.041), axillary LN invasion (p=0.013), and negative expression of ER (p = 0.022). High GS was significant, independent predictor of a histological grade 3 (p < 0.022). Round or oval shape of the mass was significant, independent predictor of positive PR (p=0.027) (Table 2 on page 6).
Images for this section:

**Fig. 1:** Different MRI characteristics of breast tumors: round lesion with rim enhancement and spiculated margins (a), oval lesion with homogeneous enhancement and smooth margins (b) and irregular mass with inhomogeneous enhancement and irregular margin (c)

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Table 1: Morphological and kinetic characteristics of IDC on MRI

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Fig. 2: Number of tumors according to Göttingen score value

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Table 2: MR characteristics of IDC-a in prediction of pathohistological prognostic factors

<table>
<thead>
<tr>
<th></th>
<th>S.E.</th>
<th>OR</th>
<th>Lower bound</th>
<th>Upper bound</th>
<th>P</th>
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S.E.- standard error, OR- odds ration, CI- confidence interval.
Conclusion

This study showed that some morphological and kinetic characteristics on MRI are able to predict biologically aggressive types of breast carcinoma.

The most important parameter of unfavorable pathohistological prognostic factor is smooth margin of lesion detected on MRI. A smooth margin of breast cancer on MRI was able to predict positive axillary lymph nodes, larger tumor size and lower expression of ER. Signal intensity increase and initial enhancement correlated with LN invasion and LVI. Except for a higher histological grade, GS was not able to predict other unfavorable prognostic factors, mainly due to the fact that no points were assigned to smooth margins. In future research, modified GS should be considered where smooth margins should be given more points than spiculated or irregular margins.
Personal information

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References