Personalized pre-operative breast MRI: Selecting patients based on breast cancer prognostic factors.

Authors

Presenting: Ellie Kwak (Columbia University Medical Center)

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Purpose: To determine if disease prognostic factors can be used to select those breast cancer patients most likely to benefit from pre-operative breast MRI.

Methods: A HIPAA compliant retrospective study from 1/2010 to 2/2014 identified 328 breast cancer patients who had pre-operative breast MRI with prognostic information available; including age, menopausal status, amount of fibroglandular tissue, lymph node status, tumor size, Ki-67 index (High=>15%), ER/PR/HER2 status, nuclear grade and histologic subtype. Breast MRIs were reviewed and additional findings occult on mammogram, sonogram and physical exam were recorded; including multicentric/ multifocal disease, contralateral disease, chest wall involvement, skin/nipple involvement and internal mammary and axillary lymphadenopathy. For each prognostic factor, the number of patients with at least 1 additional finding on breast MRI and the number of findings per patient were calculated. Chi square test was used for analysis (significance, p-value < 0.05).

Results: Overall, pre-operative MRI identified at least 1 additional finding in 49.4% (162/328) of the patients with 1.39 (225/162) findings per patient. Among prognostic factors, significantly higher percentage of patients with additional findings on breast MRI were identified in patients with positive lymph nodes (76.2%), tumor size greater than 5 cm (75%), HER2+ tumors (69.6%), high nuclear grade tumors (61.8%), pre-menopausal status (60.2%) and high Ki-67 index tumors (56.9%) compared to negative lymph nodes (41.2%, p<0.0001), tumor size less than 2 cm (39%, p=0.0003), ER or PR +/HER2- tumors (44.2%, p=0.0009), low grade tumors (47.2%, p=0.0375), post-menopausal status (46.6%, p=0.0383) and low Ki-67 index tumors (39.4%, p=0.0166). Highest percentage of patients with additional findings on breast MRI were in patients with positive lymph node status with a tumor exhibiting a combination of HER2+, high Ki-67 index and size greater than 2 cm (100% with 2.42 findings per patient). Lowest percentage were identified in patients with negative lymph node status with a tumor exhibiting a combination of ER or PR+/HER2-, low Ki-67 index and size less than 2 cm (22.2% with 1.1 findings per patient).

Conclusion: Breast cancer prognostic factors help predict which patients are most likely to show additional, potentially clinically significant, findings on pre-operative breast MRI.

Clinical Relevance: Breast MRI is costly and clear clinical benefit has not been well established. However, by utilizing the breast cancer prognostic factors, patients can be selected who are most likely to have additional clinically relevant findings and thus most likely to benefit from pre-operative MRI.

MR Imaging in Pregnancy Associated Breast Cancer (PABC)

Authors

Presenting: Lauren Green (Memorial SLoan Kettering Cancer Center)

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Objective: To 1) describe the mammographic, ultrasound and MRI appearance of PABC, a diagnosis during pregnancy or one year following delivery and 2) assess impact of pre-treatment MRI on clinical management.

Materials and Methods: IRB approved HIPAA compliant retrospective study identified 123 PABC patients from 1995 to 2014. 87/123 (71%) had imaging available. 20/87 (23%) were pregnant, 67/87 (77%) had delivered at the time of diagnosis and 25/67 (37%) were lactating. 41/87 (47%) mammograms, 51/87 (59%) ultrasounds and 48/87 (55%) MRIs were available for analysis. 24/87 (28%) patients had available mammography, ultrasound and MRI allowing inter-modality comparison.

Results: Mean cancer size was 2.9 cm (range 0.8 – 6.2cm). Sensitivity is reported in the table below. Background parenchymal enhancement (BPE) was minimal in 8/48 (17%), mild in 13/48 (27%), moderate in 13/48 (27%) and marked in 14/48 (29%). In 18/48 (38%) patients, MRI demonstrated more extensive disease compared to mammography and/or ultrasound: larger size 7/48 (15%), multifocality 1/48 (2%) and multicentricity 10/48 (21%). MRI discovered unsuspected contralateral disease in 2/48 patients (4%). Extramammary MRI findings in 3/48 (6%) patients prompted PET/CT, demonstrating stage IV disease in 2/3 (67%). Overall clinical management for those undergoing MRI was altered in 22/48 (46%) patients.

Conclusion: MRI had high sensitivity for cancer detection in PABC despite the presence of BPE, demonstrating unsuspected multifocal or multicentric disease in 23%. Based on MRI findings, clinical management was altered in 46%. MRI plays an important role in the management of PABC patients.

Lessons Learned: The Benign Concordant MR Guided Breast Biopsy Result

Authors

Presenting: Jessica Hayward (University of California, San Francisco)

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Purpose: To research the appropriate time interval for imaging follow-up when benign concordant histology is obtained at MR guided breast biopsy. To educate the breast imaging community with cases of missed cancers after an initial benign concordant MR biopsy result.

Materials and Methods: We retrospectively reviewed all MR guided breast biopsies performed at our institution over 8 years from April 2005-December 2012. Benign concordant pathology was obtained in 368 cases. Of these, 218 lesions were excluded due to neoadjuvant chemotherapy, unexcised ipsilateral cancer, subsequent mastectomy, surgical excision in the same quadrant as the biopsy, recurrence as metastatic disease, or inadequate follow-up. The remaining 150 lesions were reviewed for development of cancer at the biopsy site or in the same quadrant of the breast.

Results: Of the 150 biopsied lesions included in the final analysis, 147 (98%) were considered truly benign concordant with average follow-up of 3.1 years and 3 (2%) ultimately proved to be malignant. In all malignant cases the lesion was stable at 6-month follow-up MR. One case of DCIS was biopsied due to increase in size on MR at 26 months. In one case of infiltrating ductal carcinoma (IDC), the lesion was stable on MR for 2.5 years, and the patient presented with a palpable mass at the biopsy site 5 years later that proved malignant. In the other IDC case, the lesion was stable at 6-month follow-up MR, but underwent repeat biopsy because of suspicious appearance at ultrasound performed 8 months later.

Conclusion: Long-term follow-up of benign concordant biopsy results at our institution is encouraging. The cancer detection rate of lesions with benign concordant histology at MR guided core biopsy was 2% (3/150). None of the cancers were detected due to enlargement at the initial 6-month follow-up MRI. Two of the cancers were detected after more than 2 years of follow-up.

Clinical Relevance: MR-guided breast biopsy had a low false negative rate of 2% in our series. Annual rather than 6 month follow-up breast MR may be performed without compromising cancer detection rate. Long-term imaging surveillance is prudent as cancer may be detected at the site of benign MR biopsy after more than two years of follow-up.

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Scientific Session - 205B

MRI-detected high-risk breast lesions: imaging features can predict which lesions upgrade at surgical excision

Authors

Presenting: Safia Cheeney (University of Washington, Seattle Cancer Care Alliance)

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Purpose: Suspicious enhancement on breast MRI yields high-risk pathology (e.g. atypical ductal hyperplasia [ADH], lobular neoplasia [LN]) in 3-21% of core needle biopsies (CNB). However, the majority of these lesions do not upgrade to malignancy on surgical excision, raising concerns for overtreatment. We aimed to determine whether dynamic contrast enhanced (DCE) and diffusion weighted (DW) MRI features could determine which MRI-detected high-risk lesions will upgrade to malignancy at surgical excision.

Materials and Methods: In this IRB-approved prospective study, participants had MRI-detected BI-RADS 4 or 5 lesions (10/2010-12/2013) yielding high-risk pathology on CNB that underwent surgical excision. All breast MRIs included DCE and DW (b=0, 800 s/mm2) sequences. Apparent diffusion coefficient (ADC), kinetic features (peak initial enhancement at 120 seconds and worst-curve type), morphology (mass, non-mass enhancement), maximum MRI size, and pathologic subtype were compared between high-risk lesions that upgraded to malignancy on excision and those that did not using Wilcoxon rank sum, Fisher's Exact, or $\chi 2$ test. Univariate and multivariate logistic regression modeling was used to identify MRI features that optimally identified lesions that upgraded, with performance described using areas under the receiver operating characteristic curve (AUCs).

Results: Twenty-four MRI-detected lesions yielded high-risk pathology on CNB in 19 women (average age=54±8 yrs), and 7/24 lesions (29%) upgraded to malignancy (3 invasive, 4 in situ) at surgery. High-risk lesions that upgraded demonstrated lower median ADC (1.13 x 10-3 mm2/s vs.1.39 x 10-3 mm2/s, p=0.02) and greater maximum lesion size (35mm vs. 8mm, p=0.03) than those that did not. There were no significant differences in morphology or kinetic features among the high-risk cohorts (p>0.05). Distribution of pathological subtypes that upgraded (43% [3/7] ADH, 57% [4/7] LN) was similar to those that did not (29% [5/17] ADH, 59% [10/17] LN, 12% [2/17] other, p=0.44). A model incorporating maximum lesion size and ADC provided the best performance for predicting malignant upgrades (AUC=0.87).

Conclusion: ADC and maximum lesion size on MRI show promise for predicting which MRI-detected high-risk lesions will upgrade to malignancy at surgical excision. Use of these MRI features could decrease overtreatment of these controversial lesions, and warrants further study.

Clinical Relevance Statement: The ability to predict which high-risk lesions will upgrade to malignancy on surgical excision with MRI biomarkers could help avoid unnecessary surgeries and reduce associated morbidity related to false-positive breast MRI interpretations.

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Scientific Session - 205B

Radial scar at MRI guided vacuum-assisted biopsy: rate of upgrade and correlation to MRI features.

Authors

Presenting: Sandra Brennan (Memorial SLoan Kettering Cancer Center)

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Objective: To evaluate the rate of upgrade to cancer of radial scar (RS) diagnosed at MRI guided vacuum-assisted biopsy (MRI-VAB) and to determine if any morphologic or kinetic features on MRI were predictive of upgrade.

Materials and Methods: HIPAA compliant retrospective review was performed on 1964 MRI-VABs between January 2003-December 2012. Lesions yielding RS were collected and classified as 1) RS without atypia or 2) RS with associated atypia and/or other high risk lesions. Patients with incomplete data or with synchronous ipsilateral cancer were excluded. Lesions yielding RS at VAB and cancer at surgery were defined an upgrade. Statistical analysis was performed ($p<0.05$) and 95% CI were calculated.

Results: 39/1964 (1.9%) MRI-VABs yielded RS; 2/39 were excluded for incomplete data and 10/39 for synchronous ipsilateral cancer yielding a total of 27 RS: 17/27 (63%) RS without atypia and 10/27 (37%) RS with atypia. Patients (mean age 51 yrs; range: 33-63) were predominantly post-menopausal (65.4%), with personal (23%) or family history (23%) of breast cancer and underwent MRI mainly for screening (65.4%). RS without atypia was mostly T2 hypointense 14/17 (82%), non mass-like enhancement 12/17 (71%) and had progressive or plateau kinetics 10/17 (59%). RS with atypia more frequently had washout 5/10 (50%) although this did not reach statistical significance ($p=0.96$), nor did any other morphologic features. Surgical histologic findings yielded malignancy in 1/17 (5.8%; CI 95%: 0.3-30%) RS without atypia (low grade DCIS) and in 2/10 (20%; CI 95%: 5.7-51%) RS with atypia (1 intermediate and 1 high grade DCIS): these rates did not differ significantly ($p=0.61$). Neither patient characteristics nor MRI features were predictive of upgrade, although 2/3 RS upgraded to cancer had washout ($p=0.83$).

Conclusion: Radial scars were identified in 1.9% of MRI-VABs performed over a 10 year period and their overall upgrade rate to cancer was 11% (CI 95%: 3.8-28%). Surgery should be performed for RS diagnosed at MRI-VAB, especially if associated with atypia and/or other high risk lesions.

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Scientific Session - 205B

Performance Benchmarks for Screening Breast MRI in Community Practice

Authors

Presenting: Elizabeth Valencia (University of Washington)

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Objective: To evaluate the performance of screening MRI in community practice compared with Breast Imaging Reporting and Data System (BI-RADS) benchmarks.

Materials and Methods: Our study protocol was IRB approved and HIPAA compliant. Five Breast Cancer Surveillance Consortium registries provided breast MRI data from 2005-2011, which were subsequently linked to regional Surveillance, Epidemiology, and End Results, state tumor registries, and institutional pathology databases. We included all MRI examinations with a provider-coded indication of screening in women aged 18 years and older. Examinations with missing BI-RADS assessment or assessment Category 6 (known malignancy), and those with less than one year of cancer status follow-up were excluded. Clinical, demographic, and imaging characteristics included: age, race, family history or personal history of breast cancer, BI-RADS mammographic density, and prior mammography utilization. The outcome was breast cancer diagnosis within one year of a screening MRI examination. The following performance measures were calculated according to the BI-RADS 5th edition: cancer detection rate (CDR) per 1000 examinations, positive predictive value (PPV), sensitivity, and specificity. Median tumor size and nodal status were also examined.

Results: A total of 4,416 examinations in 3,297 women were included for analysis. Median age was 51 years and 51% of examinations (2243/4416) were performed in women with a first-degree family history of breast cancer. Screening MRI detected 76 breast cancers with 20 interval cancers identified during the one-year follow-up period (96 total cancers, 28 in situ and 68 invasive). Cancer detection rate was 17.2 per 1000 screens (BI-RADS benchmark 20-30). PPV was 17% (BI-RADS benchmark 15%). Sensitivity and specificity were 79% and 82%, respectively (BI-RADS benchmark for sensitivity >80% and specificity 85-90%). Median tumor size of invasive breast cancers was 11 mm. Of 61 invasive cancers with known nodal status, 82% (50/61) were node negative.

Conclusion: Screening MRI performance in community practice approaches benchmarks based on clinical trials and observational studies.

Clinical Relevance: MRI performance values from community practice can supplement clinical trial data and inform ongoing performance benchmark development.

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Positive Predictive Value of Breast MRI BI-RADS Assessment Category Subdivisions 4A, 4B and 4C

Authors

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Purpose: The ACR Breast Imaging Reporting and Data System (BI-RADS) Atlas recommends that mammography and ultrasound category 4 assessment lesions be subdivided by likelihood of malignancy into 4A (> 2% to ≤ 10%), 4B (> 10% to ≤ 50%) and 4C (> 50% to ≤ 95%). However, category 4 is not currently subdivided for breast MRI due to a paucity of data. The purpose of this study was to calculate the positive predictive value of breast MRI BI-RADS assessment category 4 including subdivisions 4A, 4B and 4C.

Materials and Methods: We included all consecutive screening breast MRI examinations at our institution from 7/1/10–6/30/13 in this IRB-approved, HIPAA-compliant study. We use BI-RADS assessment category 4 subdivisions in routine clinical practice, and obtained prospectively assigned BI-RADS categories from the medical records. When more than one assessment was given per examination, it was categorized using highest order hierarchy of 5 > 4 (C > B > A) > 0 > 3 > (2, 1). Benign versus malignant outcomes were determined by pathology and/or ≥ 12 months clinical and/or imaging follow-up. Proportions of examinations for all BI-RADS categories and PPV2 (biopsy recommended) for categories 4 (including subdivisions) and 5 were calculated.

Results: Of 903 screening breast MRI examinations, there were 21 malignancies among the 93 BI-RADS category 4 and 5 assessments, for an overall PPV2 of 21/93 (22.6%). BI-RADS assessments were category 1 or 2 in 757/903 (83.8%), category 3 46/903 (5.1%), category 4 89/903 (9.9%), category 5 4/903 (0.4%) and category 0 7/903 (0.8%) of examinations. For BI-RADS 4 assessments stratified by subdivision, PPV2 values for 4A were 1/41 (2.4%), 4B 8/31 (25.8%), 4C 7/8 (87.5%), and category 4 not otherwise specified 2/9 (22.2%). PPV2 for category 5 was 3/4 (75%).

Conclusion: Subdivision of breast MRI BI-RADS assessment category 4 yields outcomes in ranges provided for mammography and ultrasound. It is helpful in predicting the likelihood of breast cancer, and provides a more meaningful practice audit. Additionally, the low likelihood of malignancy in BI-RADS category 4A lesions suggests the opportunity to avoid biopsy in some of these cases.

Clinical Relevance Statement: Subdivision of breast MRI BI-RADS assessment category 4 stratifies the likelihood of malignancy and facilitates a more meaningful practice audit, which may assist patients and clinicians with informed decision making. Given the low PPV2 of 4A lesions, a subset may be identified that can safely avoid biopsy.

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