Online survey of breast MRI ordering practices amongst referring providers in an academic network

PURPOSE: To evaluate referring providers’ ordering practices and perceptions of breast MRI in our academic network.

MATERIALS AND METHODS: An online survey was circulated to providers in our hospital and community practices. Questions included demographics, current ordering practices, challenges to ordering, and perceptions of breast MRI. Responses were analyzed using Fisher exact test.

RESULTS: A total of 135/525 (26%) responded, of which 56/135 (42%) order breast MRI. 44/56 provided demographic data. 64% were PCPs and 36% were specialists. PCPs ordering breast MRI practiced longer compared to specialists (p=0.04) but ordered fewer breast MRI (p = 0.01).

Prior to ordering breast MRI, specialists routinely calculate breast cancer risk (86%) compared to PCPs (55%, p=0.08), most commonly using Gail model (90%). In premenopausal women, only 28% are scheduled on days 5-15 of the menstrual cycle and PCPs more often let patients decide when to schedule (66% vs 7%, p<0.01). Insurance coverage (70%) and time spent on pre-approvals (55%) were the most limiting factors to ordering according to all providers.

Among all providers, breast MRI is often ordered to screen high-risk patients (84%) and rarely to never ordered to screen average-risk women with dense breasts (91%) or low-risk women (93%). Breast MRI is never to rarely ordered for implant integrity (91%), new cancer diagnosis (90%), or monitoring treatment response (83%). 52% order breast MRI to evaluate a breast concern after negative mammogram and ultrasound (46% PCPs vs. 87% specialists, p=0.06). 14% order breast MRI based on patient request.

A majority feels breast MRI leads to unnecessary biopsies (60%) but feels neutral that MRI results in increased mastectomy rates (75%) or decreased rates of re-excision (80%). 30% feel that dense breast legislation resulted in more breast MRI.

Of the 78 (58%) providers who do not order breast MRI, 44% do not find the exam useful in their practice and 42% are unfamiliar with it.
CONCLUSION: Our study suggests that regarding several potential indications, breast MRI may be under-utilized, particularly by PCPs. Opportunities exist to simultaneously advance breast imagers' roles as consultants and improve utilization by educating providers about the clinical utility of breast MRI.

CLINICAL RELEVANCE: Referring provider surveys are a useful tool for breast MRI practices to evaluate appropriate use and improve service and access. Targeted education interventions and advancing the role of breast imagers as consultants may help improve awareness, particularly among primary care providers, of the clinical utility of breast MRI.

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Abbreviated breast MRI protocol for high-risk screening: comparisons and benefits.

CLINICAL RELEVANCE: Screening breast Magnetic Resonance Imaging (MRI) is an increasingly utilized tool for detecting cancer in high-risk women. The monetary and resource costs to accommodate this increased utilization are significant, and optimizing scanning and reading times with diagnostic accuracy is paramount.

PURPOSE: To review the ability of an abbreviated high-risk screening breast Magnetic Resonance Imaging (MRI) protocol to detect cancer and conserve resources.

MATERIALS AND METHODS: High risk screening breast MRIs were reviewed as an abbreviated protocol and subsequently as the full diagnostic protocol. Cancer detection, positive predictive value (PPV) and changes in final Breast Imaging Reporting and Data System (BI-RADS) assessments, as well as scanner utilization and interpretation times were recorded and compared for each protocol.

RESULTS: 838 breast MRI cases were reviewed with both protocols between 2012 and 2015. The most prevalent risk factor for obtaining a screening breast MRI was a personal history of breast cancer, where 31% of screening MRIs were obtained in premenopausal women. The cancer detection rate was
There was no difference in the number of cancers detected. The PPV was 24% and 26% for the abbreviated and full protocols, respectively, which was not significantly different. A change in the final BI-RADS assessment occurred in 4.1% of all cases. Only 1 case was changed from a benign result on the abbreviated protocol to recommending biopsy on the full protocol, where this biopsy was subsequently found to be benign. Scan times were decreased by 21 minutes per case. Interpretation time was on average 2.2 minutes for the abbreviated protocol, compared to 7.2 minutes for the full protocol.

CONCLUSIONS: Abbreviated MRI is as effective as full protocol MRI for demonstration of cancers in the high risk screening setting. The accuracy of an abbreviated protocol is similar to the full protocol. The efficiency and resource savings are significant.

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Semi-automated quantification of background parenchymal enhancement compared with reader qualitative assessment: a pilot study
Purpose: Background parenchymal enhancement (BPE) has been associated with increased risk of breast cancer. Accurate assessment of BPE is therefore important. The aim of this study was to compare radiologists’ qualitative assessments of BPE with semi-automated BPE quantification.

Materials and Methods: This study was IRB-approved and HIPAA-compliant. Four breast imagers with 2-7 years experience independently graded the BPE (1-4) of 54 post-contrast subtraction MRI sequences obtained from 27 sequential patients (ages 26 – 76 years, mean 47 years) without a breast cancer between 7/24/15 and 9/18/15. A blinded image post-processing specialist segmented fibroglandular tissue (FGT) and fat from pre-contrast T1-weighted non-fat-suppressed sequences using an in-house semi-automated algorithm. A mask of the FGT was co-registered to the first two post-contrast subtraction sequences and the T1-weighted pre-contrast fat-saturated sequence from each MRI study to define the region of interest. Percent enhancement (PE) within the FGT mask was calculated as (mean signal intensity within each voxel on subtraction images / mean signal intensity within each voxel on pre-contrast fat-saturated images) x 100. ROC analysis was used to establish optimal thresholds for conversion of PE results to reader scoring of 1-4.
Results: Inter-reader agreement for BPE was moderate (kappa=0.53). Spearman correlation between reader BPE and semi-automated PE was r=0.34 (p<0.001). ROC analysis indicated that reader BPE was best predicted by: PE≤16.3 = 1; 16.3<PE≤29.6 = 2; 29.6<PE≤43.4 = 3; PE>43.4 = 4. Following ROC-based conversion of PE to 1-4 scoring, agreement between reader BPE assessment and semi-automated BPE assessment was fair (kappa=0.25). Agreement was significantly greater (p<0.001) when PE was below the median (19.2%) compared to when PE was above the median (66.7% vs. 32.4%). Below median PE, semi-automated BPE was higher than reader BPE 7.4% (7/108) of the time. Above median PE, semi-automated BPE was higher than reader BPE 57.4% (62/108) of the time.

Conclusion: Readers were less consistent with semi-automated assessments of BPE when quantified PE was above the median. Above median PE, readers more frequently underestimated BPE compared with quantitative BPE. This may be important as readers could thereby underestimate risk of breast cancer at higher levels of quantified PE.

Clinical Relevance: Readers underestimated BPE as compared with quantified assessment in 57.4% of cases with PE above the median. As patients with higher levels of BPE may be at increased risk of developing breast cancer, quantitative methods of BPE assessment warrant further investigation.

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Background Parenchymal Enhancement on Screening Breast MRI: Patterns and Influence on Diagnostic Performance

Purpose: Breast MRI background parenchymal enhancement (BPE) is now recognized as an important tissue property, including a potential indicator of cancer risk. Questions remain regarding BPE patterns and impact on MRI performance, including concerns that higher BPE may decrease diagnostic outcomes. We assessed BPE frequencies and impact on diagnostic performance in screening breast MRI examinations.

Materials and Methods: This IRB-approved, HIPAA-compliant study included consecutive screening breast MRI examinations from 1/1/2011–12/31/2013. For women with multiple examinations, only the most recent was included. We performed retrospective review and collected prospectively-reported BI-RADS BPE (minimal, mild, moderate, marked), assessment category and cancer status (by pathology
and/or ≥ 12 months clinical and/or imaging follow-up) for each MRI examination. Mammographic breast density was also obtained. BPE was categorized as minimal/mild versus moderate/marked. We calculated frequencies of BPE categories including by age (< 50, > 50 years) and mammographic breast density (fatty/scattered, heterogeneous/extremely dense), and compared BI-RADS-defined abnormal interpretation rate (AIR, BI-RADS assessments 0, 3, 4, 5), positive predictive value for biopsy recommended (PPV2) and performed (PPV3) using chi-square and Fisher’s exact tests.

Results: Of 623 screening breast MRI examinations, 579 had prospectively-assessed BPE and comprised the study cohort. Mean patient age was 46.9 (range 19-78) years. There were 15 breast cancers (nine invasive and six DCIS). Moderate/marked BPE comprised the minority of examinations (124/579, 21.4%), and was significantly more frequent in women < 50 compared to > 50 years (28.6% versus 9.0%, P < 0.001) and mammographically heterogeneous/extremely dense compared to fatty/scattered breasts (28.2% versus 7.6%, P < 0.001). AIR was not significantly different for higher compared to lower BPE (24.2% versus 16.9% P = 0.087). PPV2 and PPV3 were also not significantly different (7.1% versus 24.6%, P = 0.273; 8.3% versus 27.5%, P = 0.264).

Conclusion: Moderate/marked was less frequent overall (21.4%) than minimal/mild BPE, although more common in women aged < 50 years (28.6%) and in mammographically dense breasts (28.2%). However, higher levels of BPE were not significantly associated with lower diagnostic performance, although PPV results are limited by small cancer number in the higher BPE group.

Clinical Relevance statement: Although moderate/marked BPE was more frequent in women < 50 years and those with dense breasts, it was present in the minority of MRI examinations, and did not decrease diagnostic performance. Our results add to literature supporting the value and performance of breast MRI despite higher BPE.

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Does higher breast MRI background parenchymal enhancement increase risk for high burden axillary disease or distant metastasis? Quantitative and qualitative BPE analysis.

PURPOSE: MRI background parenchymal enhancement (BPE) is a proposed biomarker of breast cancer risk. We investigate if higher BPE is also associated with increased likelihood of high burden axillary disease or distant metastasis.
MATERIALS AND METHODS: A HIPAA compliant IRB approved case-control retrospective study identified 1416 consecutive breast cancer patients who had undergone pre-operative breast MRI from 1/2010 to 2/2015. From these, a subset of 26 patients with pathology proven distant metastasis diagnosed within 6 months of the pre-operative breast MRI were identified. A second subset composed of 21 patients with 3 or more enlarged axillary lymph nodes on pre-operative breast MRI exam and confirmed axillary metastases on surgical pathology was similarly identified. The control group was composed of 220 patients who had undergone pre-operative MRI from the same time period with a negative distant metastasis evaluation and low burden axillary disease (2 or less). Qualitative BPE assessments were performed on a 4-point scale by three breast fellowship trained radiologists by consensus, blinded to history in accordance with BI-RADS categories. Quantitative BPE analysis was performed using a validated in-house technique in a randomly selected 20 patients from each group. Logistic regression and chi square tests were performed.

RESULTS: The distribution of BPE categories for the metastasis group was 1(19.3%,5/26), 2(42.3%,11/26), 3(26.9%,7/26), 4(11.5%,3/26). The distribution for high burden group was 1(23.8%,5/21), 2(38.1%, 8/21), 3(28.6%,6/21), 4(9.5%,2/21). The distribution for control group was 1(21.8%,48/220), 2(40%, 87/220), 3(30.5%,67/220), 4(8.2%,18/220). The metastasis and high axillary burden groups were not significantly associated with higher degree of BPE compared to the control group (P>0.45). Quantitative analysis yielded average percent BPE of 31.3% for the metastasis group, 33.4% for the high burden group and 29.9% for the control group. No significant difference was present among the 3 groups (P>0.29). Subgroup analysis controlling for age and menopausal status also showed no significant difference among groups (P>0.39). Logistic regression analysis showed no predictive potential of BPE for high burden axillary disease or distant metastasis (p=0.645).

CONCLUSION: Higher breast MRI BPE is not associated with increased risk for high burden axillary disease or distant metastasis in patients with breast cancer.

CLINICAL SIGNIFICANCE: Although breast MRI BPE is associated with increased breast cancer risk, high BPE does not indicate greater likelihood for more advanced disease including high burden axillary disease or distant metastasis.

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Radiogenomics: Association between Mammographic and Breast MRI Features and Oncotype DX Recurrence Score

Purpose:
To evaluate the association between mammographic and breast MRI features and breast cancer recurrence risk, as determined by a validated gene expression assay.

Materials and Methods:
In this IRB-approved, HIPAA-compliant protocol, 408 patients diagnosed with invasive breast cancer between 2008 and 2013, who obtained an Oncotype DX assay (Genomic Health, Inc.) at the time of diagnosis were identified. Mammographic and MRI features were retrospectively recorded according to the ACR BI-RADS 5th edition lexicon. Linear regression models with imaging features predicting Oncotype DX recurrence score (ODxS) and post hoc pairwise comparisons of ODxS means by imaging features were assessed.

Results:
Mammographic breast density and presence of MRI non-mass enhancement (NME) associated with a primary mass or as the primary finding, were inversely associated with ODxS (p<0.01 and 0.04, respectively). The average ODxS significantly varied between mammographic density A (fatty) and D (extremely dense), independent of age (24.4 versus 16.5, p <0.02). Additionally, there was a statistically significant difference in the average ODxS for absence versus presence of MRI NME, adjusted for age (19.8 versus 16.6, p<0.04).

Mammographic masses with indistinct margins had significantly higher ODxS compared to other margin descriptors (p<0.003) with an average ODxS of 31.3. Fine linear branching microcalcifications had higher ODxS compared to other microcalcification morphologies (p<0.03).

Conclusion:
Both mammographic and MRI features are significantly associated with ODxS and may have predictive value in assessing recurrence risk. Specifically, women with fatty breasts or no MRI NME had intermediate risk of disease recurrence as compared to women with extremely dense breasts or presence of any MRI NME, who had low recurrence risk. Moreover, indistinct mammographic mass margins were associated with high recurrence risk.

Clinical Relevance:
Mammographic breast density, MRI NME and tumor imaging features have the potential to serve as imaging biomarkers of recurrence risk and may help to inform clinical treatment decisions. Larger studies will be needed to validate these findings.
Comparative Effectiveness of Breast MRI, Mammography and Breast Ultrasound in Screening Young Women with Elevated Risk of Developing Breast Cancer

PURPOSE

Screening guidelines recommend women with 20% or greater lifetime risk of breast cancer undergo annual breast MR screening to supplement mammography. While some literature reports MRI screening diagnoses early stage cancer, limited data exists for patients younger than age 40. The purpose of our study is to describe outcomes of MR screening in women 25-40 with and without mammography and/or ultrasound (US) at our institution and compare to benchmarks.

MATERIALS AND METHODS

After obtaining IRB approval, chart review identified patients age 25-40 undergoing breast MR screening. Demographics, risk factors, BI-RADS assessments, background parenchymal enhancement, mammographic breast tissue density and outcomes were recorded. Short term follow up (BIRADS 3), image guided biopsy (BIRADS 4,5) and PPV were calculated.

RESULTS

322 breast MRI exams were identified (average age was 33, 37% were nulliparous, 64% had prior benign biopsy). Risk factors included 64% with breast cancer in 1st degree relative(s), 90% had heterogeneous or extremely dense breast tissue on mammography, 16% were BRCA carriers. All patients underwent breast MRI and 66% had mammography, 38% had mammography and US, 37% had US. 72% had BIRADS 1 or 2 on MRI, 79% on mammography and MRI, 45% on US and MRI. Short term follow up was recommended in 15% by MRI, 8% by mammography and MRI, 12% by US and MRI. Biopsy was recommended in 6% by MRI only, 5% by mammography and MRI, 28% by US and MRI. Three invasive cancers were detected by MRI (9.3 cancers detected per 1000 examinations, 95% CI 6.1, 12.5), which were also detected on ultrasound but not mammography.

CONCLUSION

Compared with published mammography benchmarks, breast MRI screening in high-risk women under 40 yielded higher cancer detection rates (9.3 per 1000) with 15% recommended for short-term imaging follow up and 6% for image-guided biopsy. The cancer detection rate for supplemental mammography was 0% and the PPV for supplemental ultrasound was low suggesting that MRI alone may be useful in screening high-risk women under 40.
CLINICAL RELEVANCE

Breast MRI screening alone without supplemental mammography or ultrasound screening in high risk women under 40 maximizes early breast cancer detection while minimizing false positives.

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