HHS Public Access

Author manuscript

Acad Radiol. Author manuscript; available in PMC 2018 February 01.

Published in final edited form as:

Acad Radiol. 2017 February ; 24(2): 191–199. doi:10.1016/j.acra.2016.11.015.

Incremental cancer detection of locoregional restaging with diagnostic mammography combined with whole breast and regional nodal ultrasound in women with newly-diagnosed breast cancer

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Author disclosures:

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Beatriz E. Adrada, MD Nothing relevant to disclose.
Roland Bassett Nothing relevant to disclose.
Kelly K. Hunt, MD Nothing relevant to disclose.
Henry M. Kuerer, MD, PhD Nothing relevant to disclose.
Benjamin D. Smith, MD Nothing relevant to disclose.
Mariana Chavez-MacGregor, MD Nothing relevant to disclose.
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IRB statement: This study was approved by the Institutional Review Board of The University of Texas MD Anderson Cancer Center.

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Abstract

RATIONALE AND OBJECTIVES—To determine if locoregional restaging with diagnostic mammography and ultrasound of the whole breast and regional nodes performed for quality assurance in women with newly-diagnosed breast cancer referred to a tertiary care center yields incremental cancer detection.

MATERIALS AND METHODS—An institutional review board-approved retrospective, single institution database review was performed on the first 1000 women referred to our center in 2010 with a provisional breast cancer diagnosis. Locoregional restaging consisted of diagnostic full-field digital mammography combined with ultrasound of the whole breast and regional nodal basins. Bilateral whole breast ultrasound was performed in women with contralateral mammographic abnormality or had heterogeneously or extremely dense parenchyma. Demographic, clinical and pathologic factors were analyzed.

RESULTS—Final analyses included 401 women. 34% (138/401) of women did not have their outside images available for review upon referral. Median age was 54 years, range 21–92; median tumor size was 2.9 cm, range 0.6–18, for women whose disease was upstaged and 2.2 cm, range 0.4–15, for women whose disease was not upstaged. Incremental cancer detection rates were 15.5% (62/401) in the ipsilateral breast and 3.9% (6/154) in the contralateral breast ($p<0.0001$). Total upstage rate was 25% (100/401). Surgical management changed from segmentectomy to mastectomy in 12% (50/401). Re-excision rate after segmentectomy was 19% (35/189).

CONCLUSION—Locoregional restaging with diagnostic mammography combined with whole breast and regional nodal ultrasound that is performed for standardization of the imaging workup for newly-diagnosed breast cancer patients can reduce underestimation of disease burden and impact therapeutic planning.

Keywords

breast cancer; staging; nodes; mammography; ultrasound

INTRODUCTION

Locoregional staging of breast cancer is performed not only to determine the primary tumor size (T stage) and the regional nodal status (N stage), but also to identify additional foci of malignancy and to delineate the extent of disease to facilitate optimal treatment. The primary tumor size and the regional nodal status are important prognostic indicators. Neoadjuvant chemotherapy (NAC) is offered to women with node- positive or aggressive disease (i.e., triple-negative or HER2+ subtypes [human epidermal growth factor receptor 2-positive]) or

large tumors. Defining the extent of disease aids surgical planning and helps determine the appropriateness of breast-conserving surgery (BCS) versus mastectomy. The clinical N stage, which is based in part on imaging data, guides adjuvant radiation planning.

The standard of care for initial staging of breast cancer is imaging with mammography. The most common adjunct modalities to mammography are ultrasound (US) and magnetic resonance imaging (MRI). The use of breast US varies from whole breast to mammographic- or MRI-directed, targeted breast US. Additionally, the use of US to examine nodal basins has not been universally adopted. When regional nodes are examined using US, some centers evaluate only the axilla and other centers evaluate all regional nodal basins of the breast, including the axillary, infraclavicular, internal mammary, and supraclavicular regions. Despite reports in literature showing that MRI can identify additional disease in both the ipsilateral and contralateral breasts, the use of breast MRI for staging remains practice dependent [1,2]. Controversy remains regarding benefits of preoperative breast MRI as measured by rates of re-excision, recurrence, and survival [3–6].

For women with newly-diagnosed breast cancer who are referred to tertiary care centers, the pre-referral diagnostic breast imaging workup varies widely in the approach and the extent of the staging evaluation. Because of this variability, breast imaging for these women may have to be repeated for quality assurance. The primary aim of this study was to determine if locoregional restaging using diagnostic mammography and whole breast and regional nodal US in women with newly-diagnosed breast cancer impacts the incremental cancer detection rate (ICDR) relative to initial interpretations based on outside imaging (OSF). The secondary aim was to determine how locoregional restaging impacts the clinical stage.

MATERIALS AND METHODS

Patient Selection

This single-institution, HIPAA-compliant, retrospective study was approved by the institutional review board with a waiver of informed consent. We reviewed the records of the first 1000 women who were referred to our imaging center with a provisional diagnosis of breast cancer in 2010. Women with the following characteristics were excluded: 1) prior excisional biopsy which provided the diagnosis of breast cancer (n = 131), 2) missing OSF reports (n = 119), 3) prior OSF staging breast MRI (n = 117), 4) consultation at our institution prior to 2010 (n = 83), 5) stage IV disease (n = 39), 6) received NAC (n = 35), 7) suspected rather than biopsy-proven breast cancer (n = 19), 8) prior OSF positron emission tomography/computed tomography (PET/CT) or breast-specific gamma imaging for staging (n = 16), 9) recurrent breast cancer (n = 16), 10) ductal carcinoma in situ (DCIS) with no residual calcifications after biopsy (n = 12), 11) restricted charts which required patient permission for review (n = 7), or 12) lymphoma or metastatic disease to the breast (n = 5). Thus, a total of 401 of the first 1000 women referred to our imaging center in 2010 were included in our data analysis.

Clinicopathologic Assessment

The following data were extracted directly from the outside imaging reports and on-site imaging reports and compared: largest index tumor dimension, chest wall/skin/nipple involvement, nodal disease, focality/centricity (unifocal, multifocal, or multicentric disease), laterality (ipsilateral ± contralateral disease), clinical stage, and the type of definitive surgery performed (segmentectomy or mastectomy). Multifocal disease was defined as disease with two or more foci separated by ≥0.5 cm and <4cm within the same quadrant of the breast [7]. Multicentric disease was defined as disease extending over two or more quadrants of the breast or disease with foci separated by ≥4 cm [7].

All outside breast and nodal histopathology data were routinely reviewed by dedicated breast pathologists. Diagnosis of invasive lobular carcinoma (ILC) was confirmed with E-cadherin staining. Diagnosis of HER2+ tumors was determined by immunohistochemistry and/or by fluorescence in situ hybridization (FISH).

On-Site Mammography Performed during Locoregional Restaging

Bilateral full-field digital mammography (FFDM) was performed by obtaining three standard views (craniocaudal, mediolateral oblique, lateromedial) with a mammography unit (Hologic Selenia, Bedford, MA). Additional views were performed as necessary. Each mammogram was originally interpreted by 1 of 14 dedicated breast radiologists with ≥5 years of experience; these radiologists had access to the diagnostic findings from the outside imaging if the patients had the images and reports with them at the time of referral to our center.

On-Site Ultrasound Performed during Locoregional Restaging

Grayscale and color Doppler US was performed using a Sonoline Antares system with a 5-to13-MHz broadband linear transducer (Siemens Ultrasound, Mountain View, CA) by 1 of 9 dedicated breast sonographers. Unilateral whole breast ultrasound (UWBUS) of the affected breast including the regional nodal basins (axillary, infraclavicular, and internal mammary) was performed for all women even when no mass had been identified in the breast on mammography or by physical examination. Supraclavicular US was performed when the initial axillary survey revealed suspicious nodes. Whole breast US of the contralateral breast was also performed in women with mammographic findings requiring additional imaging or who had heterogeneously or extremely dense parenchyma. The average scan time was 15 minutes for UWBUS with nodal basins and 30 minutes for bilateral whole breast ultrasound (BWBUS) with nodal basins. Images were originally evaluated by 1 of 14 breast radiologists with ≥5 years of experience; these radiologists did not interpret the associated repeat mammogram but had access to the images and reports from both the outside and on-site mammograms.

On-Site Imaging-Guided Biopsies Performed during Locoregional Restaging

US-guided fine needle aspiration biopsy (FNAB) was performed using 20- or 21-gauge hypodermic needles. US-guided core needle biopsy (CNB) was performed using 14-, 16-, or 18-gauge spring-loaded devices (C.R. Bard, Inc., Covington, GA) or a 12-gauge vacuum-assisted device (Suros Celero, Hologic, Bedford, MA). Biopsies were performed on the two

lesions that were farthest apart to confirm multifocal or multicentric disease. FNAB of suspected satellite breast masses was initially performed; however, CNB or vacuum-assisted biopsy was performed when FNAB yielded inconclusive results. FNAB of the highest-order suspicious lymph node was performed to establish the N stage. Stereotactic biopsies using 9-gauge vacuum-assisted needle devices (Suros Eviva or Atec, Hologic, Bedford, MA) were performed on suspicious calcifications visualized only with mammography.

Retrospective Reinterpretation of Outside Images

The availability of outside images in PACS (picture archiving and communication system) was determined retrospectively. When outside images were available for retrospective review on PACS, image quality was graded as missing (no images or incomplete set of images), interpretable or non-interpretable. Images that were deemed non-interpretable were those that had loss of imaging resolution when compared to the source format; these included printed film-screen mammograms that were digitized and images that were incompatible with our PACS. A fellowship-trained breast radiologist with 4 years' experience (RPC) provided a second opinion on the "interpretable" cases, blinded to the interpretation based on imaging performed for locoregional restaging. On-site mammogram and on-site US images were not reinterpreted during the retrospective review.

Surgical Management

At our institution, all women with newly-diagnosed breast cancer undergo locoregional restaging with bilateral FFDM and UWBUS prior to the first clinical visit. The recommended surgical plan after locoregional restaging with FFDM and US was determined from the electronic charts. The guiding principles for surgical planning based on outside reports and reinterpretation of outside images were: BCS for disease limited to one quadrant of the breast and mastectomy for disease involving more than one quadrant, skin and/or nipple (HMK).

Data Analysis

The Fisher's exact test was used to assess associations between categorical variables and upstaging. The Wilcoxon rank-sum test was used to assess associations between continuous variables and upstaging and to compare the determinations of disease extent and stage between outside institutions and our institution. *P* values less than 0.05 were considered significant. No adjustment was made for multiple statistical testing. Descriptive statistics were used to summarize demographic and clinicopathologic information for all women. The software package R version 3.1.0 (http://www.r-project.org) was used for statistical analyses.

Institutional Review Board Statement

A waiver of informed consent was approved by the institutional review board because of the retrospective nature of this study.

RESULTS

Patients and Imaging Procedures

The median patient age was 54 years (range, 21–92 years). Of the 401 women included in this study, 64 (16%) had interpretable outside images in PACS, 138 (34%) had missing images, and 199 (50%) had non-interpretable images. Of the 64 women who had retrospective reinterpretation of outside images, 3 (5%) had additional disease foci identified compared to initial outside imaging interpretation: [one converted from unifocal to multifocal, one unifocal to multicentric, and one unifocal to unifocal, contralateral]. This reclassification represents an ICDR of 3% in the ipsilateral breast (2 of 64 women) and 3% in the contralateral breast (1 of 31 women who had BWBUS), for a total ICDR of 5% (3 of 64 women with interpretable outside images).

Eighty-two (20%) of the 401 women had film-screen outside mammograms, and 319 women (80%) had digital outside mammograms. Appendix Table A.1 summarizes the various breast and nodal US protocols that the patients underwent at the outside institutions. These 401 women were referred from 116 outside institutions: 9 (8%) academic medical institutions and 107 (92%) community practices. 141 of 401 (35%) women lived outside the metropolitan area in which our institution is located (requiring at least 1.5-hour drive). The three most common ultrasound protocols performed at outside institutions were 1) BWBUS with axillary US (n = 88, 22%), 2) unilateral targeted breast US without nodal US (n = 85, 21%), and 3) unilateral whole breast and axillary US (n = 78, 19%).

UWBUS and BWBUS were performed in 247 (62%) and 154 (38%) of the 401 women at our institution, respectively. Of 154 women who underwent BWBUS, 53 (34%) were performed for dense breast parenchyma, 89 (58%) for mammographic findings that required further evaluation, and 12 (8%) in cases for which BWBUS was specifically requested by the ordering clinician. Regional nodal US was performed in all 401 women.

Characteristics Associated with Disease Upstaging

Women whose disease was upstaged on the basis of locoregional restaging had significantly larger tumors than women whose disease was not upstaged ($p<0.0001$). The median index tumor size was 2.9 cm (range, 0.6–18 cm) for women whose disease was upstaged and 2.2 cm (range, 0.4–15 cm) for women whose disease was not upstaged.

Women aged ≤40 years were more likely to have disease upstaged than older women ($p=0.004$); African-American and Hispanic women more likely than white and Asian women ($p=0.0006$); women with estrogen receptor (ER)- disease more likely than those with ER+ disease ($p=0.02$); women with HER2+ disease more likely than women with HER2- disease ($p=0.004$); women with ILC more likely than those with other histopathology types ($p=0.006$) [Table 1]. In the subset of 22 women with ILC,10 (45%) had disease that was upstaged with an ICDR of 27% (6 of 22 cases) in the ipsilateral breast (no contralateral disease). Additionally, the disease was upstaged in 8 (28%) of 29 women with an extensive intraductal component (EIC), with an ICDR of 24% (7 of 29 cases).

Positive Predictive Value of Biopsies

As part of locoregional restaging, 119 US-guided breast biopsies were performed in 108 women, and 210 US-guided nodal biopsies were performed in 172 women. The PPV3 (positive predictive value of biopsies) for US-guided breast biopsies was 52% (48 true positives [TPs] in 93 total biopsies) in the ipsilateral breast and 27% (7 TPs in 26 biopsies) in the contralateral breast. The PPV3 for US-guided nodal biopsies was 46% (96 TPs in 210 biopsies). The PPV3 for stereotactic-guided biopsies was 50% (7 TPs in 14 biopsies) in the ipsilateral breast and 5% (1 TP in 20 biopsies) in the contralateral breast.

Reassessment of Disease Extent on the Basis of Locoregional Restaging

Table 2 shows a comparison of the extent of disease described in outside imaging reports with the extent of disease described in reports from locoregional restaging ($p<0.0001$). The extent of disease changed in 68 (17%) of the 401 women. This represents an ICDR of 15.5% (62 of 401) in the ipsilateral breast and 3.9% (6 of 154) in the contralateral breast (Table 3). Of 68 women with additional disease foci, 11 (16%) were identified only by mammography. All 11 cases represented ductal carcinoma in situ: 8 of the 11 cases were multifocal, 2 were multicentric, and 1 was contralateral. Additional disease foci were identified only by US in 40 (59%) of 68 women: 18 of the 40 cases were multifocal, 19 were multicentric, and 3 were contralateral. Additional disease foci were identified by both mammography and US in 17 (25%) of 68 women: 6 of the 17 cases were multifocal, 9 were multicentric, and 2 were contralateral. For additional foci identified in the ipsilateral breast by US, the median size was 1 cm; the mean size was 1.6 cm. For additional foci identified in the contralateral breast by US, the median size was 0.6 cm; the mean size was 1 cm.

Reassessment of Surgical Plans on the Basis of Locoregional Restaging

The surgical management changed from BCS to mastectomy in 50 of 401 women (12%), who were found to have extensive multifocal or multicentric disease based on locoregional restaging. For the 68 women in whom additional disease foci were identified, 4 (6%) opted for prophylactic mastectomy and 5 (7%) opted for mastectomy instead of the originally recommended BCS. The re-excision rate for women who underwent segmentectomy was 19% (35 of 189 women).

Reassessment of Disease Stage on the Basis of Locoregional Restaging

For the 52 women with disease initially identified as carcinoma in situ (Tis), T and N stages were upgraded in 5 (10%) and 3 (6%) women, respectively. For the 350 women with disease initially identified as unifocal, T and N stages were upgraded in 76 (22%) women each. For the 26 women with disease initially identified as multifocal, T and N stages were upgraded in 7 (27%) women each. For the 22 women with disease initially identified as multicentric, T and N stages were upgraded in 3 (14%) and 11 (50%) women, respectively.

Locoregional restaging resulted in a higher N stage in 94 (23%) of the 401 women (Table 4) and a higher T stage in 86 (21%) of the 401 women relative to the staging evaluation performed at outside institutions ($p<0.0001$ for both). All 83 of 357 (23%) women whose disease was reclassified from N0 to ≥N1 received NAC and underwent axillary lymph node

dissection (ALND). Locoregional restaging resulted in upstaging of disease in 100 (25%) of the 401 women (Table 4).

DISCUSSION

Locoregional restaging is sometimes performed in women with newly-diagnosed breast cancer who are referred to tertiary care centers when prior imaging is not available and for quality assurance. This practice allows for standardization of the staging workup of patients with a diagnosis of breast cancer; however, the value of this practice has not been formally validated. Bassett et al reported that only 50% of prior mammograms from outside institutions could be obtained in women presenting for annual screening mammography [8]. In this study, 34% of women presenting to our tertiary referral center with a new diagnosis of breast cancer had missing OSF images. When OSF images are unavailable for review or are suboptimal in quality, locoregional restaging can play a critical role in the timely management of newly-diagnosed breast cancer patients. More specifically during the timeframe from which this cohort was derived, there was a two-month waiting list to be seen at our institution. Further delay in management related to attempts in obtaining outside images is not well tolerated by patients who are anxious to start treatment many of whom travel long distances to receive tertiary care; in our cohort, 35% did not reside in our greater metropolitan area.

Our results indicate that locoregional restaging with FFDM and WBUS in women with newly-diagnosed breast cancer leads to incremental cancer detection, which impacts surgical management, radiation strategies, and consideration for NAC. Bilateral FFDM interpreted by subspecialty breast radiologists is routine in many comprehensive breast care centers. Meticulous WBUS and US of the regional nodes performed by dedicated breast sonographers and breast radiologists is practiced in some centers. Yet, this study shows that targeted breast US with and without axillary US is the routine protocol at many imaging centers. These findings confirm the variability of diagnostic breast workup that exists in the community.

Although many breast imaging centers successfully utilize staging breast MRI, this practice remains controversial. Staging breast MRI at our institution is performed selectively in women with ILC, suspected chest wall involvement, or diffuse benign breast lesions which limit the usefulness of US [9–11], and staging PET/CT is performed at our institution only in women with locally advanced breast cancer. A recent study showed that the ICDR obtained with MRI is reduced when BWBUS and mammography are performed in women with newly-diagnosed breast cancer [12]. Our findings confirm prior work that showed bilateral FFDM combined with whole breast and regional nodal US can facilitate incremental cancer detection even in the absence of MRI use [13–16]. In 2000, Berg et al observed that 14% of malignant foci in the ipsilateral breast was mammographically-occult and identified only by WBUS [13]. In a later work in 2004, Berg et al found that additional tumors in 18% of affected breasts were identified by WBUS after mammography [14]. Similarly in 2002, Moon et al showed that WBUS identified mammographically-occult tumors in 14% of patients [15]. Nonetheless, although our results are similar, our study had a

different design in which our patient cohort was being restaged at our institution and underwent repeat imaging.

Our data suggests that the restaging work-up diagnostic mammogram and ultrasound that are performed for a woman with a known diagnosis of breast cancer (BI-RADS 6) may confer different thresholds for biopsy of additional lesions identified, when compared to the initial interpretation of both breasts in a woman without a known diagnosis or personal history of breast cancer. Interestingly, our ipsilateral ICDR of 15.5% and contralateral ICDR of 3.9% in the breasts are comparable with the ipsilateral ICDR of 16% and contralateral ICDR of 4% for breast MRI as reported in a meta-analysis by Houssami et al [2]. The majority of patients who had additional disease foci were identified (59%, 40 of 68) through repeat WBUS; this finding is likely attributable to the variability in the OSF ultrasound evaluation and underlines the importance of meticulous and comprehensive real-time scanning. Additional disease identified only by FFDM in our study may be attributable to double reading (i.e., interpretation of a mammogram with a known, biopsy-proven cancer) resulting in lower threshold for stereotactic biopsy in women with known cancer. Previous clinical trials have shown that double reading of mammograms results in increased cancer detection [17,18]. Our high PPV3 rates can be partially attributed to an enriched population where 64% (256 of 401) of the patients had at least Stage II disease.

Performing regional nodal US as part of locoregional restaging led to an N stage upgrade in 94 of 401 women (23%). An earlier, non-overlapping series from our institution demonstrated an N stage upgrade in 37% in women with clinical stage III breast cancer who had regional nodal US performed [19]. Women with metastatic nodal disease confirmed by US-guided needle biopsy routinely receive NAC and comprehensive regional nodal irradiation followed by boost(s) to these areas [20–23]. Since the publication of the American College of Surgeons Oncology Group (ACOSOG) Z0011 findings, management of metastasis to the axilla has evolved [24]. Regional nodal US helps to predict extent of nodal disease and to guide clinicians in appropriate treatment of the axilla [23]. Current studies are exploring appropriate application of targeted axillary dissection of clipped biopsy-proven metastatic nodes and sentinel lymph nodes, per National Comprehensive Cancer Network (NCCN) guidelines [25].

A significant number of women in our cohort (21%) were upstaged in T-size, possibly related to more accurate measurement of tumor size using US compared with mammography [26,27]. It has been shown that accurate preoperative assessment of tumor size decreases re-excision rates for women attempting BCS [28,29]. Positive and close surgical margins in BCS increase local recurrence risk. Our cohort's re-excision rate of 19% is at the lower spectrum of reported re-excision rates (range, 23–50%) in women undergoing BCS [30,31]. Our 12% change in surgical management from BCS to mastectomy is similar to other reported changes in surgical management when WBUS was combined with mammography for staging breast cancer, ranging from 8 to 18% across series [12–16]. Our total upstage rate of 25% (100 of 401 women) included 99 women upgraded to ≥stage II disease and subsequently qualified for NAC and 42 women upgraded to stage III. Upstaging to stage III has considerable impact on prognosis, given the 5-year relative survival rate of 72% compared to >90% for women with stages 0-II disease [32].

Women with ILC had a disease upstaging rate of 45% and an ICDR of 27% in the ipsilateral breast, concordant with prior studies that showed the value of US as an adjunct to mammography in evaluating ILC [13,33–35]. Women with EIC were upstaged by 28% and had an ICDR of 24% in the ipsilateral breast. These findings are concordant with previous reports suggesting that cancers with EIC are underestimated by mammography alone [13,36].

Our study has limitations including the retrospective nature and single-institutional experience of the review. Additionally, a large proportion of excluded patients had breast MRI performed at an OSF and may have been accurately staged prior to referral; however, locoregional restaging in these patients would have had the advantage of MRI guidance during the diagnostic work-up, which could have resulted in identification of a falsely elevated number of additional disease foci. Their exclusion allowed us to compare directly results of mammography and US performed externally versus restaging with mammography and US in a tertiary referral center. We acknowledge that breast imaging centers have variable and heterogeneous practices as regards to the staging work-up of newly diagnosed breast cancer patients, and recognize that our findings may be most applicable to referral centers that routinely do not perform staging breast MRI.

We further acknowledge that our attempt at retrospective reinterpretation of OSF mammograms and US is also limited in that review of static US images is not equivalent to real-time scanning. Another limitation is the large proportion of cases with missing or non-interpretable images. Moving forward, most images from outside institutions are now digital and are transferred via compact discs or uploaded to cloud-based systems, which eliminates the issue with films. A prospective study may help resolve this issue by comparing the ICDR of reinterpretation of outside images versus the ICDR of repeat imaging and in determining what can be attributed to training, expertise, and/or technology. Such a prospective study would allow determination of which components of the imaging staging evaluation need to be repeated and permit further refinement of our center practice.

CONCLUSIONS

In conclusion, locoregional restaging with diagnostic FFDM combined with meticulous whole breast and regional nodal US that is performed for standardization of the imaging workup for newly-diagnosed breast cancer patients can reduce underestimation of disease burden and impact therapeutic planning.

Acknowledgments

Funding: This study was supported in part by the NIH/NCI under award number P30CA016672.

The authors would like to thank Arthur Gelmis for manuscript editing.

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APPENDIX

TABLE A.1

Combinations of outside breast and nodal ultrasound protocols for 401 women with a diagnosis of primary breast cancer.

Breast ultrasound n(%)	Nodal ultrasound n(%)				
	Axillary region	AX+IC+IM	AX+IC+IM +SC	Not performed	Total
Bilateral targeted	5 (1.2)	0 0)	1 (0.2)	6 (1.5)	12 (3.0)
Bilateral whole breast	88 (21.9)	5 (1.2)	8 (2.0)	36 (9.0)	137 (34.2)
Unilateral targeted	26 (6.5)	1 (0.2)	0 (0)	85 (21.2)	112 (27.9)
Unilateral whole breast	78 (19.5)	2 (0.5)	3 (0.7)	35 (8.7)	118 (29.4)
Not performed	NA	NA	NA	22 (5.5)	22 (5.5)
Total	197 (49.1)	8 (2.0)	12 (3.0)	184 (45.9)	401 (100)

AX, axillary; IC, infraclavicular; IM, internal mammary; NA, not applicable; SC, supraclavicular.

TABLE 1

Locoregional restaging by age group, race/ethnicity, hormone receptor status and histopathology in 401 women with primary breast cancer.

Variable	No change in stage n(%)	Upstaged n(%)	P value
AGE GROUP			
20–30 years	7(70)	3(30)	0.004
>30–40 years	22(47)	25(53)	
>40–50 years	71(69)	32(31)	
>50–60 years	77(66)	40(34)	
>60–70 years	53(71)	22(29)	
>70 years	41(84)	8(16)	
RACE/ETHNICITY			
White	180(74)	64(26)	0.0006
African-American	32(54)	27(46)	
Asian	26(79)	7(21)	
Hispanic	28(50)	28(50)	
Other	5(56)	4(44)	
HORMONE RECEPTOR STATUS			
ER status			
ER−	40(54)	34(46)	0.02
ER+	189(68)	91(32)	
ER status not evaluated *	42(89)	5(11)	
HER2 status			
HER2−	205(68)	96(32)	0.004
HER2+	24(45)	29(55)	
HER2 status not evaluated *	42(89)	5(11)	
HISTOPATHOLOGY			
Ductal carcinoma in situ (DCIS)	40(89)	5(11)	0.006
Invasive ductal carcinoma (IDC)	124(65)	68(35)	
IDC/DCIS	82(67)	41(33)	
IDC/invasive lobular carcinoma (ILC)	7(54)	6(46)	
ILC/ALH,LCIS **	12(55)	10(46)	
Other ***	6(100)	0(0)	

ER, estrogen receptor; HER2, human epidermal growth factor receptor 2.

Note.

* ER and HER2 status was not evaluated for women who had DCIS

** Includes ILC alone, ILC + atypical lobular hyperplasia (ALH), ILC + lobular carcinoma in situ (LCIS), and ILC + ALH + LCIS

*** Includes tubular carcinoma, mucinous carcinoma, spindle cell carcinoma, medullary

carcinoma

TABLE 2

Comparison of disease extent based on outside imaging reports and locoregional restaging at our institution for 401 women with primary breast cancer ($p < 0.0001$).

	EXTENT OF DISEASE AFTER LOCOREGIONAL RESTAGING					
INITIAL OSF EXTENT OF DISEASE	**U n(%)**	**MF n(%)**	**MC n(%)**	**U,CL n(%)**	**MF,CL n(%)**	**MC,CL n(%)**
U – 350 women	290(83)	30(9)	24(7)	0(0)	2(0.6)	4(1)
MF – 26 women	0(0)	19(73)	7(27)	0(0)	0(0)	0(0)
MC – 22 women	0(0)	0(0)	22(100)	0(0)	0(0)	0(0)
U,CL – 2 women	NA	NA	NA	1(50)	1(50)	0(0)
MC, CL – 1 woman	NA	NA	NA	0(0)	0(0)	1(100)

CL, contralateral disease; OSF, outside imaging; MC, multicentric disease; MF, multifocal disease; U, unifocal disease.

TABLE 3

Incremental cancer detection rates after locoregional restaging at our institution for 401 women with primary breast cancer.

	INCREMENTAL CANCER DETECTION	
MODALITY	**IPSILATERAL BREAST n=401**	**CONTRALATERAL BREAST n=154**
FFDM	2.5% (10/401)	0.6% (1/154)
WBUS	9.2% (37/401)	1.9% (3/154)
FFDM+WBUS	3.7% (15/401)	1.3% (2/154)
TOTAL	**15.5% (62/401)**	**3.9% (6/154)**

FFDM, full-field digital mammography; WBUS, whole breast ultrasound.

NOTE.

* Bilateral whole breast ultrasound was performed in 154 patients.

TABLE 4

Comparison of N stage ($p < 0.0001$) and disease stage ($p < 0.0001$) identified by outside imaging and locoregional restaging at our institution for 401 women with primary breast cancer.

	N STAGE AFTER LOCOREGIONAL RESTAGING			
INITIAL OSF CLASSIFICATION	**N0 n(%)**	**N n(%)1**	**N2 n(%)**	**N3 n(%)**
N0 - 357 women	274(76.8)	66(18.5)	1(0.3)	16(4.5)
N1 - 42 women	0(0)	31(73.8)	1(2.4)	10(23.8)
N2 - 1 woman	0(0)	0(0)	1(100)	0(0)
N3 - 1 woman	0(0)	0(0)	0(0)	1(100)
	DISEASE STAGE AFTER LOCOREGIONAL RESTAGING			
INITIAL OSF CLASSIFICATION	**Stage 0 n(%)**	**Stage I n(%)**	**Stage II n(%)**	**Stage III n(%)**
Stage 0 - 52 women	47(90.4)	1(1.9)	3(5.8)	1(1.9)
Stage I - 157 women	0(0)	95(60.5)	53(33.8)	9(5.7)
Stage II - 172 women	0(0)	2(1.2)	137(79.7)	33(19.2)
Stage III - 20 women	0(0)	0(0)	0(0)	20(100)

OSF, outside imaging.