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Positive Predictive Value of biopsy of palpable masses following mastectomy

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Abstract

Objective: Determine the positive predictive value (PPV) of biopsy of palpable masses following mastectomy (MX). Determine if there are patient characteristics, tumor or imaging features more predictive of cancer.

Materials and Methods: IRB-approved retrospective review of 16396 breast ultrasounds June 2008- December 2015 identified patients with MX presenting with palpable masses. Medical records and imaging studies were reviewed. Statistical analysis was performed with Fisher's exact test. 95% confidence intervals (CI) were calculated.

Results: 117 patients presented with palpable masses on the MX side. 101/117 patients who had a palpable mass on physical examination had a true sonographic mass to correlate with the clinical findings. 91/101 (90%) underwent biopsy: 19/91 (21%, 95% CI; 13–31) biopsies were malignant. 72/91 (79%) were benign. All 19 cancers were on the original cancer side. Recurrences ranged from 0.4 to 4.5 cm maximum diameter, mean 1.3 cm.

Prophylactic versus therapeutic mastectomy was very statistically significant (p=0.01). The use of tamoxifen or an AI was also statistically significant (p=0.04) Patient age (p=1.0), radiation therapy (p=1.05), chemotherapy (p=0.2) immediate breast reconstruction (p=0.2) or implant versus flap (p=0.2) had no statistically significant association with finding cancer on biopsy.

Lesion shape (irregular versus oval/round) was highly statistically significant (p=0.0003) as was non-parallel orientation on ultrasound (p=0.008). Circumscribed versus non-circumscribed margins was also statistically significant (p=0.008).

Conclusion: The PPV of biopsy of palpable masses on the side of MX was 21% (95% CI; 13–31). All recurrences were on the original cancer side and this was very statistically significant.

Keywords

Breast; Mastectomy; Biopsy; Fine-Needle; Cytology; Recurrence

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Introduction:

Over the past decade, several single-institution studies [1, 2] and population-based studies [3, 4] have documented an increase in mastectomy rates in the United States. In conjunction with this general rise, it has been noted that the rates of bilateral mastectomies—particularly contralateral prophylactic mastectomies—have also increased [5–7].

In women who undergo breast conserving surgery instead of mastectomy, mammography has a well-defined role in surveillance of women after breast conserving surgery [8–10]. Even though mammographic interpretation of the post-treated breast may be challenging, there are well-described patterns of recurrence such as increased density, architectural distortion or microcalcifications [11–14]. The accuracy of mammography in detecting recurrence is also improved by comparing the pre-treated breast to the post-treated breast and understanding the normal post-operative appearance. However, in women who undergo mastectomy, routine surveillance of the mastectomy side with mammography remains controversial. Some centers still routinely image these patients [15] while others feel the yield of finding recurrent cancer in asymptomatic patients is too low and clinical examination alone in the asymptomatic patient is more beneficial [16]. At our institution, we do not perform routine mammographic surveillance of the mastectomy side but rely on clinical breast examination and then image these patients accordingly based on physical findings such as palpable masses, skin thickening or retraction.

The incidence of malignancy in non mastectomy patients presenting with a palpable breast mass who undergo fine needle aspiration is about 50%[17, 18]. We conducted this study to determine the positive predictive value (PPV) of biopsy of palpable masses on the mastectomy side and to determine if there are patient, tumor or morphologic imaging features predictive of cancer. As this is the first study to date looking at the PPV of biopsy following mastectomy, it has the further potential to help guide radiologists in the management of palpable masses following mastectomy. We describe the classic imaging appearance of common benign palpable masses following mastectomy and reconstruction.

Material and Methods:

Following IRB approval, we performed a HIPAA-compliant retrospective review of 16396 consecutive diagnostic breast ultrasounds performed at our institution, a tertiary care cancer hospital, from June 2008 to December 2015. The need for informed consent was waived. Patients who presented for ultrasound because of a palpable mass on physical examination of the mastectomy side were identified and included in our study. The physical examination was performed by either the surgeon or breast oncologist who then referred the patient for ultrasound. Our cohort of patients included women who initially palpated a lump themselves which was then confirmed by their doctor or the lump was felt on clinical examination by the surgeon, medical oncologist or survivorship NP. The patients were then referred to radiology for imaging. We included patients with reconstructed and non-reconstructed breasts. Patients who had prophylactic mastectomy after breast cancer was diagnosed in the contralateral breast were also included.

The medical records and all imaging studies for the patients included in the study were reviewed by SB with 11 years experience. All patients had ultrasound performed (Acuson S2000, Siemens) with a linear probe and frequency range of 9–16MHz. Additional mammographic views were performed as needed at the discretion of the radiologist interpreting the study at the time of presentation. Some patients were also referred for MRI. The age of the patient, menopausal status and BRCA status if known were recorded. The side of the palpable lesion and whether the mastectomy was therapeutic or prophylactic were noted. A note was also made of whether the patient had nipple sparing or skin sparing mastectomy, immediate breast reconstruction or none and whether they had an implant or autologous flap reconstruction. The histology of the primary tumor including grade and hormone receptor status was recorded and adjuvant therapy with chemotherapy, radiation therapy or hormonal therapy was also noted.

On ultrasound examinations, all palpable lesions that had a sonographic correlate considered a true mass had size, shape (round, oval, irregular), margins (indistinct, angular, circumscribed, spiculated, micro-lobulated), presence of shadowing and orientation (parallel, anti-parallel) on sonography documented. Based on the BI-RADS lexicon 5th edition for ultrasound, indistinct, angular, micro-lobulated and spiculated were considered non-circumscribed. Palpable masses that were considered not to be true masses included surgical clips, implant fold, implant valve and dystrophic calcifications. These patients did not undergo biopsy and were not included in analysis.

If biopsy was performed of the palpable lesion then histology was recorded and if no biopsy was performed then follow-up if any was noted. Percutaneous biopsy, FNA or core, was done by a breast Radiologist under ultrasound guidance. No cytopathologist or cytotechnologist was available on site for immediate assessment of adequacy at the time of FNA. The FNA passes were immediately rinsed in CytoLyt® solution by the radiologist and transported to pathology for slide preparation where they were then evaluated for adequacy and diagnosis at a later time.

Statistical analysis was performed with Fisher's exact test. 95% confidence intervals (CI) were calculated. A p value <0.05 was considered statistically significant.

Results:

Patients

117 patients presented for targeted ultrasound of palpable masses on the side of a mastectomy (MX). These patients ranged in age from 25–82 years with a mean of 52 years.

101/117 patients who had a palpable mass on physical examination had a true sonographic mass to correlate with the clinical findings. 16/117 had no sonographic mass and the palpable lesion was found to be related to the implant itself in 7 with the patient feeling the implant valve (Fig. 1), folds (Fig. 2) or implant edge. Four patients were feeling a surgical clip, calcification (Fig. 3) or suture material, and one patient was feeling her rib. These patients did not undergo biopsy. Four patients had a palpable mass on clinical examination and no sonographic correlate to account for the physical findings. 91/101 (90%) patients

with a palpable sonographic mass ultimately underwent biopsy of the mass. 78/91 patients had fine needle aspirations (FNA), 8/91 had core biopsies and 5/91 had surgical biopsies. 66/78 (85%) patients had FNAs which were deemed diagnostic or satisfactory for evaluation and 12/77 (15%) patients had FNAs which were deemed nondiagnostic or acellular. 5 out of these 12 cases had either a follow up core biopsy, FNA or excision with benign results. 5/12 of these lesions resolved with the FNA and could no longer be seen on subsequent imaging. Only 2 out of the 12 lesions deemed nondiagnostic/acellular were unchanged after FNA and had no follow up surgical procedure. Specifically, these 2 lesions had an initial low suspicion on imaging and no imaging change or recurrence after a follow up of 52 and 31 months.

10/101 (10%) patients did not undergo biopsy and had follow-up imaging (range of follow-up was 6–83, with a mean of 34 months) with no cancer found on follow-up.

19/91 (PPV: 21%, 95% CI; 13–31) of those who underwent biopsy had cancer (age 35–68, mean 48 years) and 72/91 (79%) were benign. 15/19 cancers were diagnosed by FNA and 4/19 by core biopsy. All 19 cancers were on the original cancer side not the prophylactic contralateral MX side (p=0.01). The range of follow-up for patients with a benign biopsy result was 19–77 months, mean 45 months, with no cancer found on follow-up. 20/91 (22%) patients underwent biopsy of a lesion on the prophylactic mastectomy side and these were all benign. So 19/71 (PPV: 27%, 95% CI;17–39) who underwent biopsy of a palpable mass on the side of a therapeutic mastectomy had cancer.

Cancer recurrences ranged from 0.4 to 4.5 cm in maximum diameter, mean 1.3cm.

No cancer was found on the prophylactic mastectomy side and this was very statistically significant (p=0.01). Recurrences was more likely in patients who did not receive anti-estrogen therapy and this was statistically significant (p=0.04). Neither patient age < 50 years versus ≥ 50 years (p=1.0), chemotherapy (p=0.2), or radiation therapy (p=1.0) had a statistically significant association with finding cancer on biopsy. 106/117 (91%) patients had reconstruction. 103/117 (88%) patients had immediate breast reconstruction (IBR), three had delayed reconstruction and eleven patients declined reconstruction. 90/106 (85%) had implant reconstructions and 16/106 (15%) had autologous flap reconstruction. Only 9 patients had nipple sparing mastectomies and 107/117 (91%) had skin sparing mastectomies. The surgical technique and timing of reconstructive surgery had no statistical significance on cancer recurrence [Immediate breast reconstruction (p=0.2), nipple sparing mastectomy (p=0.7. Of the patients with cancer recurrences, 6/19 (32%) had received prior radiation, 12/19 (63%) hormonal therapy with anti-estrogens and 15/19 (79%) chemotherapy. 18/19 recurrences were in patients with implant reconstructions (p=0.2 for implant versus flap only and p=0.3 reconstructed versus not reconstructed breasts). Patient characteristics in cancer and benign patients who underwent biopsy are shown in Table 1.

101/117 patients who had a palpable mass on physical examination had a true sonographic mass to correlate with the clinical findings. 16/117 had no sonographic mass and the palpable lesion was found to be related to the implant itself in 7 with the patient feeling the implant valve (Fig. 1), folds (Fig. 2) or implant edge. Four patients were feeling a surgical clip, calcification (Fig. 3) or suture material, and one patient was feeling her rib. These

patients did not undergo biopsy. Four patients had a palpable mass on clinical examination and no sonographic correlate to account for the physical findings. Only 8/117 patients had mammography in the evaluation of the palpable mass. This included routine MLO, CC views and a cone compression view in some cases. In one patient the mammogram showed that the palpable mass was a dystrophic calcification, 2 patients demonstrated an oil cyst/fat necrosis, one patient a mass or density which was ultimately benign. The remainder had no findings on mammography. Only 16 patients had MRI performed and 7 patients had mammographic views performed.

On ultrasound, lesion shape (irregular versus oval/round) was highly statistically significant (p=0.0003) as was non-parallel orientation on ultrasound (p=0.008). Circumscribed versus not-circumscribed margins was also statistically significant (p=0.008). Lesion size and presence of shadowing were not statistically significant (p=1.0). Imaging features on ultrasound in cancer and benign patients who underwent biopsy are shown in Table 2.

Genetic status was unknown for many patients (48/117, 41%). 10 patients were BRCA 1 positive, 7 were BRCA 2 positive and one patient had a CHEK 2 mutation. 51 patients tested negative for a genetic mutation. Two patients who were BRCA 2 positive had a recurrence, 9 recurrences were in the tested negative patients and 8 were in the unknown group. The majority of the original primary cancers were invasive ductal carcinomas (88/117, 75%). Twelve patients had prior invasive lobular carcinoma, 11 DCIS, 4 DCIS with microinvasion, 2 had no primary and had undergone bilateral prophylactic mastectomies. 86/117 (74%) of the original primary tumors were ER positive, 21/117 (18%) were ER negative. 72/117 (62%) were PR positive and 35/117(30%) were PR negative. 21/117(18%) were HER-2 positive and 86/117 (74%) were HER-2 negative. In total, 16 patients had Triple Negative primary cancers and 2 of these patients developed a recurrence (p=1.0). Having an ER negative primary cancer had no statistical significance (p=0.7) because most of the recurrences were in ER positive patients and the majority of patients were ER positive. The remainders are unknown or not available. The histology, grade and hormone receptor profiles of the original primaries in the patients who developed recurrences are listed in Table 3. 16/19 (84%) of the patients who developed a recurrence originally had an invasive ductal carcinoma, 2 patients had microinvasive DCIS and one DCIS.

Discussion:

Despite advances in surgical technique, radiotherapy and chemotherapy, locoregional recurrences after mastectomy are still a concern. The rate of local recurrence following mastectomy is reported to be between 5% and 27% [16, 19, 20]. Despite this, routine surveillance of the mastectomy side with mammographic screening is not advocated as most recurrences are clinically evident. Fajardo et al. found that mammographic imaging of the mastectomy site did not increase the detection of locally recurrent breast cancer and found mammography to be useful in only 2/20 patients [16]. At our institution, routine surveillance mammography for patients with breast cancer treated with mastectomy is only done on the contralateral intact breast. We rely on physical examination for asymptomatic mastectomy patients and refer those with suspicious clinical findings for imaging. As mastectomy rates are rising, it is likely to expect more of these patients presenting for imaging.

Local recurrence after mastectomy has a negative impact on survival so the threshold to biopsy mastectomy patients is low. In the work-up of mastectomy patients with palpable masses ultrasound is the imaging test of choice. In some cases however mammography may be helpful to confirm the palpable is an oil cyst, dystrophic calcification or part of the implant itself for example the implant valve.

In an effort to better select patients for biopsy and know what our positive predictive value of biopsy is in this patient cohort, we reviewed the data at out institution. Studies to date looking at the supplemental benefit of screening breast ultrasound show higher PPV of biopsy if lesions are characterized and classified correctly [21–24]. And while certain lesion characteristics such as irregular lesion shape, non-parallel orientation and non-circumscribed margins were more likely to be malignant (Fig. 4) we found some overlap in sonographic features between benign and malignant lesions in our patient population. Some biopsy-proven recurrences had benign imaging features. In keeping with the literature and the variable appearance of fat necrosis, some had classic imaging appearance (Fig. 5) while others were more indeterminate (Fig. 6). Also, one of the biopsy-proven cases of recurrence appeared echogenic on ultrasound a feature we associate often with fat necrosis. Yoo et al evaluated local recurrence of breast cancer in reconstructed breasts using TRAM flaps and similarly found that imaging findings may mimic benign lesions and advised caution and pathological confirmation even in benign-appearing lesions[25].

Our data shows significant P values for lesion characteristics in keeping with the BI RADS lexicon in so far as lesions with irregular shape, not-circumscribed margins and anti-parallel orientation on ultrasound were more likely to be malignant. Biopsy of lesions with any or all of these morphologic descriptors is advised. We also found a very significant P value for prophylactic mastectomy versus not. No cancers were found on the prophylactic mastectomy side. In the setting of a mass with benign morphologic features on the prophylactic mastectomy side we suggest short term follow up rather than biopsy in conjunction with clinical follow up. In all women, palpable findings with or without imaging correlates should be managed clinically with perhaps a higher level of suspicion in patients who have undergone mastectomy for cancer rather than a prophylactic mastectomy. While the BI-RADS lexicon provides guidance for characterizing the morphologic features of a mass and the associated risk of malignancy, our results show that caution should be taken in evaluating palpable lesions in patients who have undergone mastectomy for breast cancer. In these patients, the palpable finding may be so small that accurate assessment of morphologic imaging features may be precluded. With regards to palpable findings, lesions that may typically be considered to have predominately benign imaging characteristics according to BI-RADS must be considered in the context of the patient’s history including symptoms, risk for primary or recurrent breast cancer, prior cancer histology and prior adjuvant therapy.

We felt it was important to include prophylactic mastectomy patients because they may also present with a palpable mass and there is little if no data in the literature on the work-up and management of these lesions. Our data showed a very significant P value when the palpable lesion was on the prophylactic mastectomy side and all of the masses biopsied on the prophylactic mastectomy side were benign. So assuming the morphologic features of the

palpable lesion imply benignity and the clinical suspicion is low we suggest short term imaging and clinical follow up of these patients.

The majority of the reconstructions were with implants so with little numbers of autologous implants we cannot comment on significance. However the work-up of patients with a palpable mass in an autologous reconstruction is the same as for a palpable mass in any patient. With the exception that Mammography may be more helpful to assess for calcifications and MRI to better characterize fat necrosis. Some institutions perform screening mammography on autologous reconstructions. In the absence of data to support routine screening mammography in these patients at our institution we rely on clinical examination in the routine follow up of these patients.

This study shows the specific issue of FNA yielding a nondiagnostic or acellular specimen after MX. The majority of the lesions biopsied were sampled with FNA technique. Fine-needle aspiration of palpable breast masses has been showed to be sensitive (97–99%) and specific (78–99%) with positive and negative predictive values of 92 to 99% respectively. The overall rate of false positive and false negative cases reported in the literature is less than 10% [17, 18]. These lesions are often small and after mastectomy there may be only skin and underlying chest wall or implant making core biopsy difficult. For the same reasons, the yield from FNA is sometimes low with sparse cells present and samples sometimes deemed acellular or nondiagnostic by the cytopathologist. 12/77 (15%) of our FNAs were deemed nondiagnostic. For these cases we perform careful radiologic correlation and based on our level of suspicion determine if there is a need for surgical biopsy or if these lesions are safe to follow. 4/12 resolved with the FNA, one lesion was half the original size post aspiration and 3/12 were unchanged after FNA. One patient subsequently had a core biopsy which was benign and one had a surgical excision also benign. None of the lesions which were called nondiagnostic on FNA proved to be malignant on follow-up (range of follow-up was 6–58 months, mean 29 months). An adequate specimen obtained by FNA is one that leads to resolution of a problem presented by a lesion in a particular patient’s breast. There is no specific requirement or national standard for minimum number of ductal cells to be present for specimen adequacy. Therefore, adequacy is determined by the opinion of the aspirator that the cytologic findings based on the report are consistent with the clinical-radiological impression and that the lesion was adequately sampled, and the opinion of the pathologist examining the smears that the described cytologic findings are concordant and slides do not have significant distortion or artifacts, and can be interpreted [26, 27].

While we did not review our overall total rate of reconstructive surgery after mastectomy at our institution, our numbers are in keeping with current trends. Most (88%) of the patients in the group had immediate breast reconstruction (IBR) and most (85%) were with implants [28, 29]. IBR has been shown to be safe and not associated with an increased risk of local recurrence[30] and while all recurrences in our group had IBR this was not statistically significant (p=0.2) as most of the patients in the group had IBR. Similarly, reconstruction versus no reconstruction (p=0.3) or the type of reconstruction (implant versus flap) were not significantly associated with recurrence (p=0.2).

While our study did have some limitations, in that it was retrospective and not all patients underwent biopsy, it is the first study to date looking at the positive predictive value of biopsy following mastectomy. It is also the only study to address the specific issue of FNA yielding a nondiagnostic or acellular specimen after MX. In conclusion, the positive predictive value of biopsy in mastectomy patients for palpable masses is high, reaching 21% in this study. This is higher than accepted <2% risk of malignancy for BI RADS 3 probably benign lesions. An irregular shape, non-parallel orientation on sonography and not-circumscribed margins had a statistically significant association with finding cancer. All cancers in our study were on the original cancer side and this was statistically significant (p=0.01). Since we did have some overlap with benign sonographic features in lesions that were malignant, we cannot suggest using only BI-RADS descriptors to avoid biopsy. Since recurrence after mastectomy may mimic benign lesions pathologic confirmation is advised. However if we had spared the 20 patients who underwent biopsy on the prophylactic mastectomy side our PPV would have increased slightly to 27% (19/71). Therefore we suggest that lesions with benign sonographic features and low clinical suspicion on the prophylactic mastectomy side could undergo short-interval follow-up rather than biopsy. However, these numbers were small and future studies are needed.

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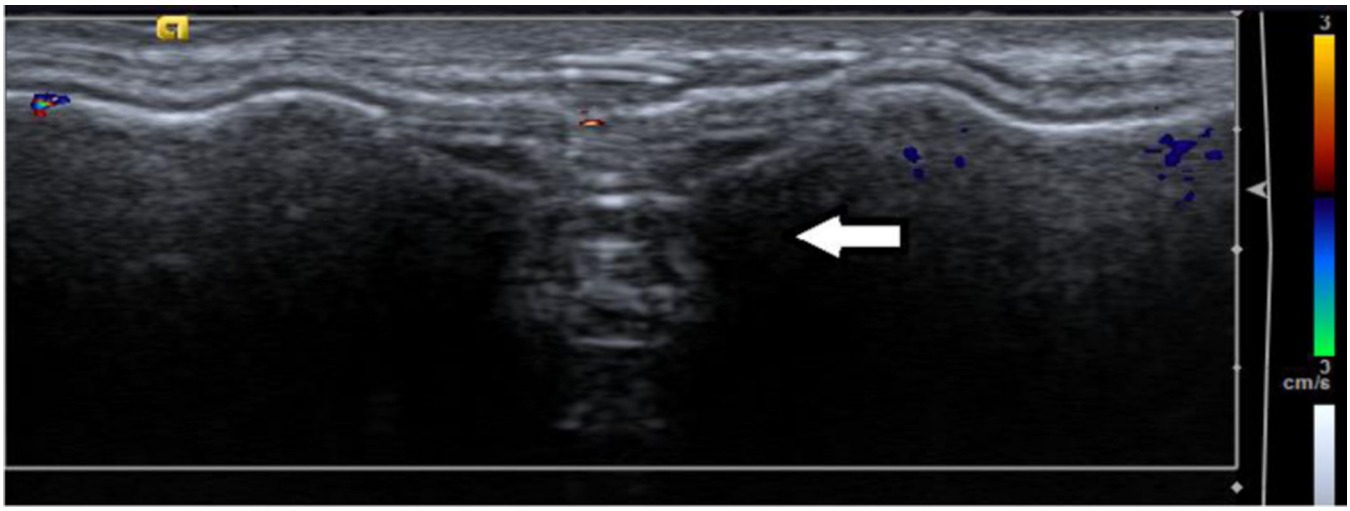

Fig. 1—.
Typical sonographic appearance of the implant valve as reverberating echogenic lines.

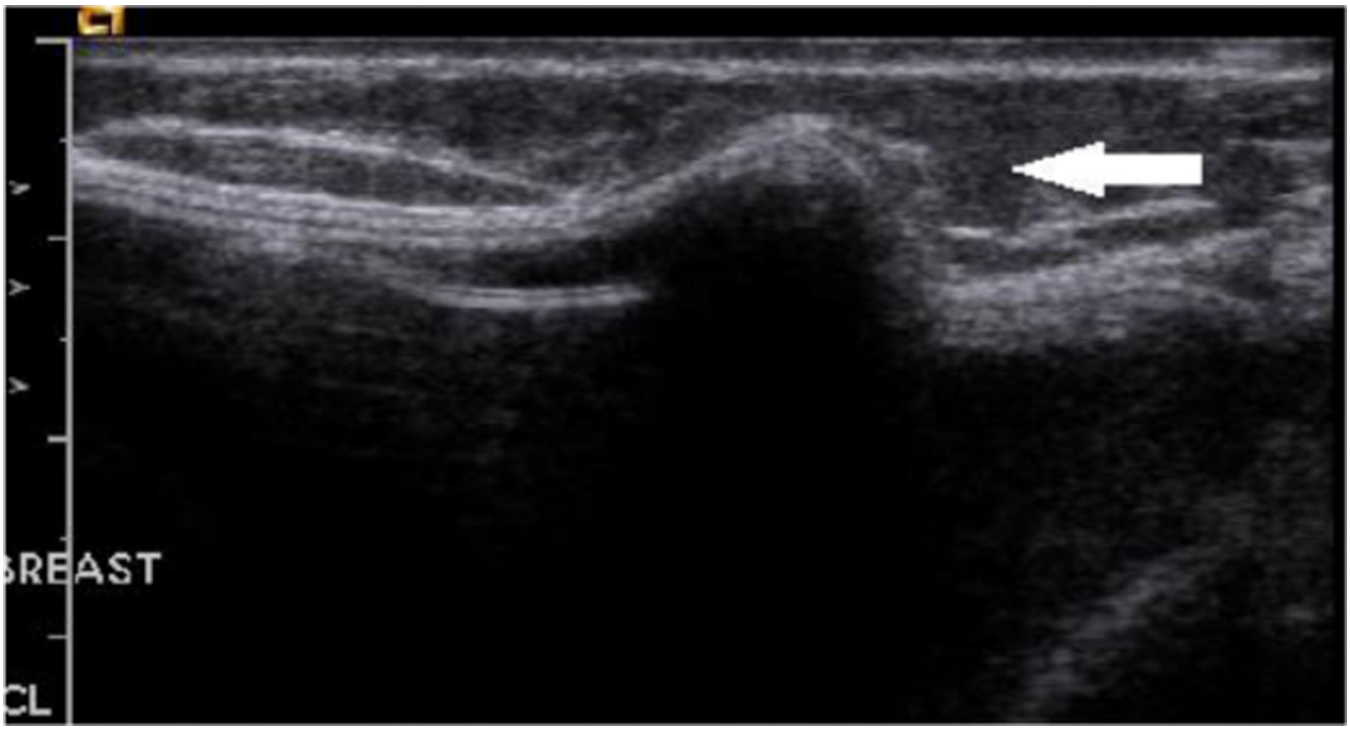

Fig. 2—.
Sonogram of an intact implant with fold or bulge (arrow) which was felt by the patient as a mass.

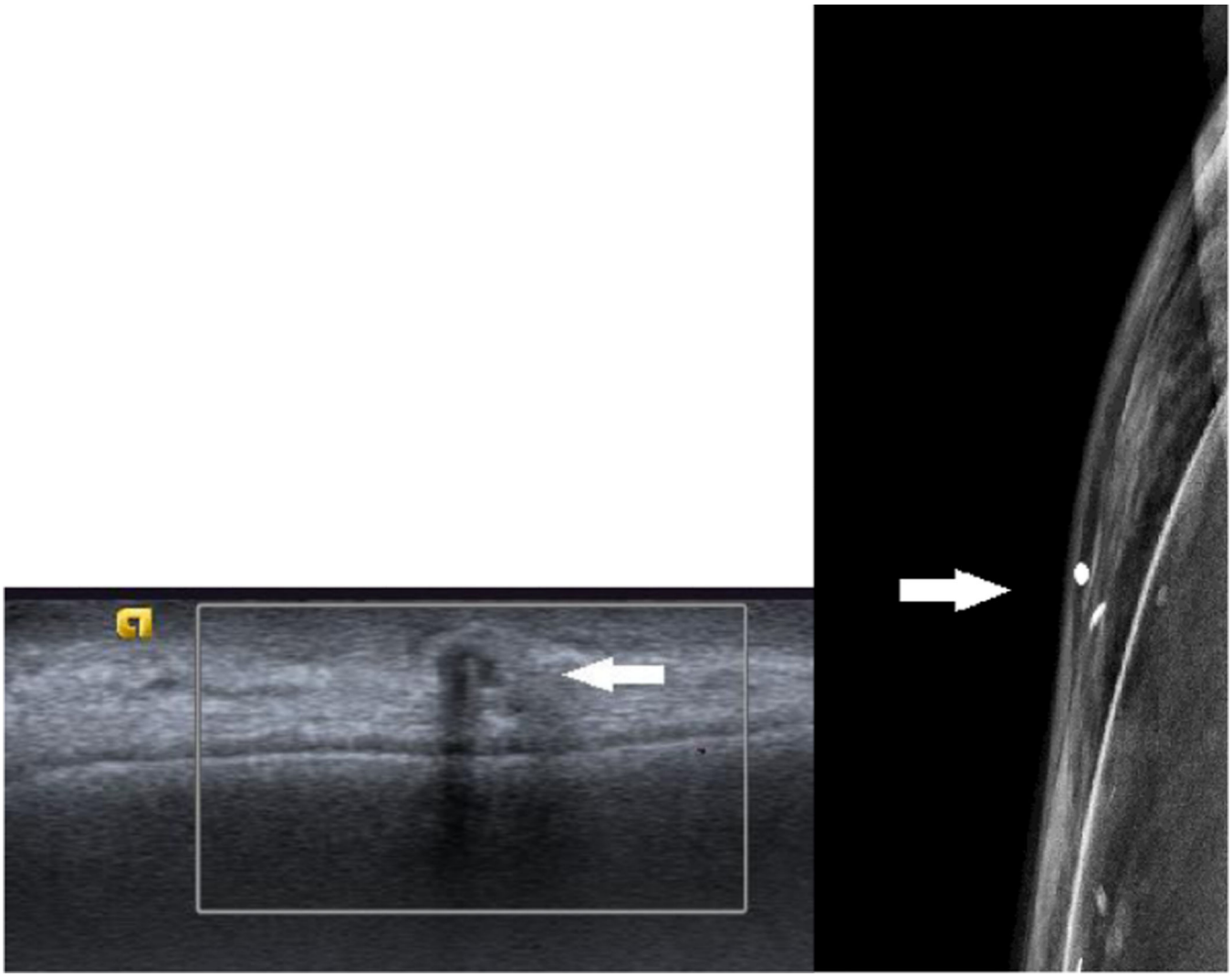

Fig. 3—.

Patient status post-mastectomy with implant reconstruction. Palpable mass which on ultrasound (3a) was anechoic with no vascularity and dense posterior shadowing (arrow). Cone mammographic view (3b) confirmed this was a calcification.

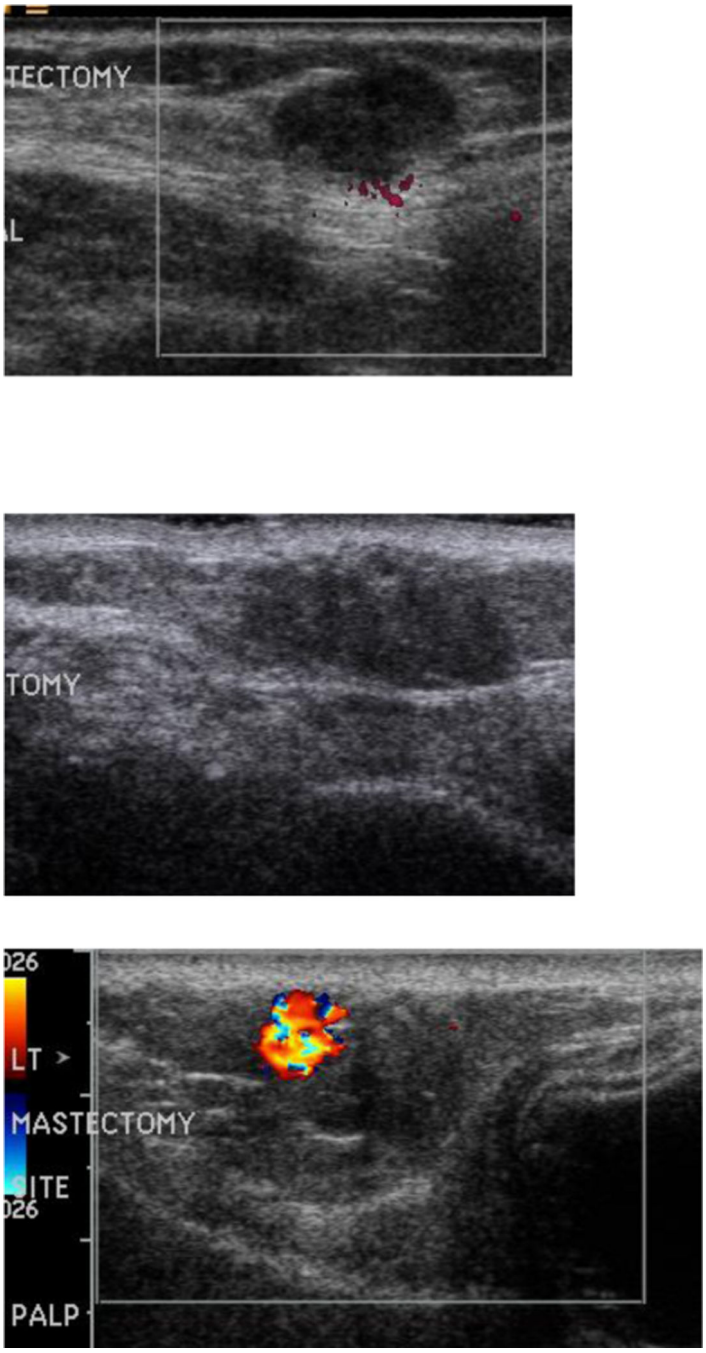

Fig. 4—.

Palpable masses (4a-c) in patient's status post-mastectomy, all with irregular shape and vertical orientation and yielding recurrent invasive ductal carcinoma on biopsy.

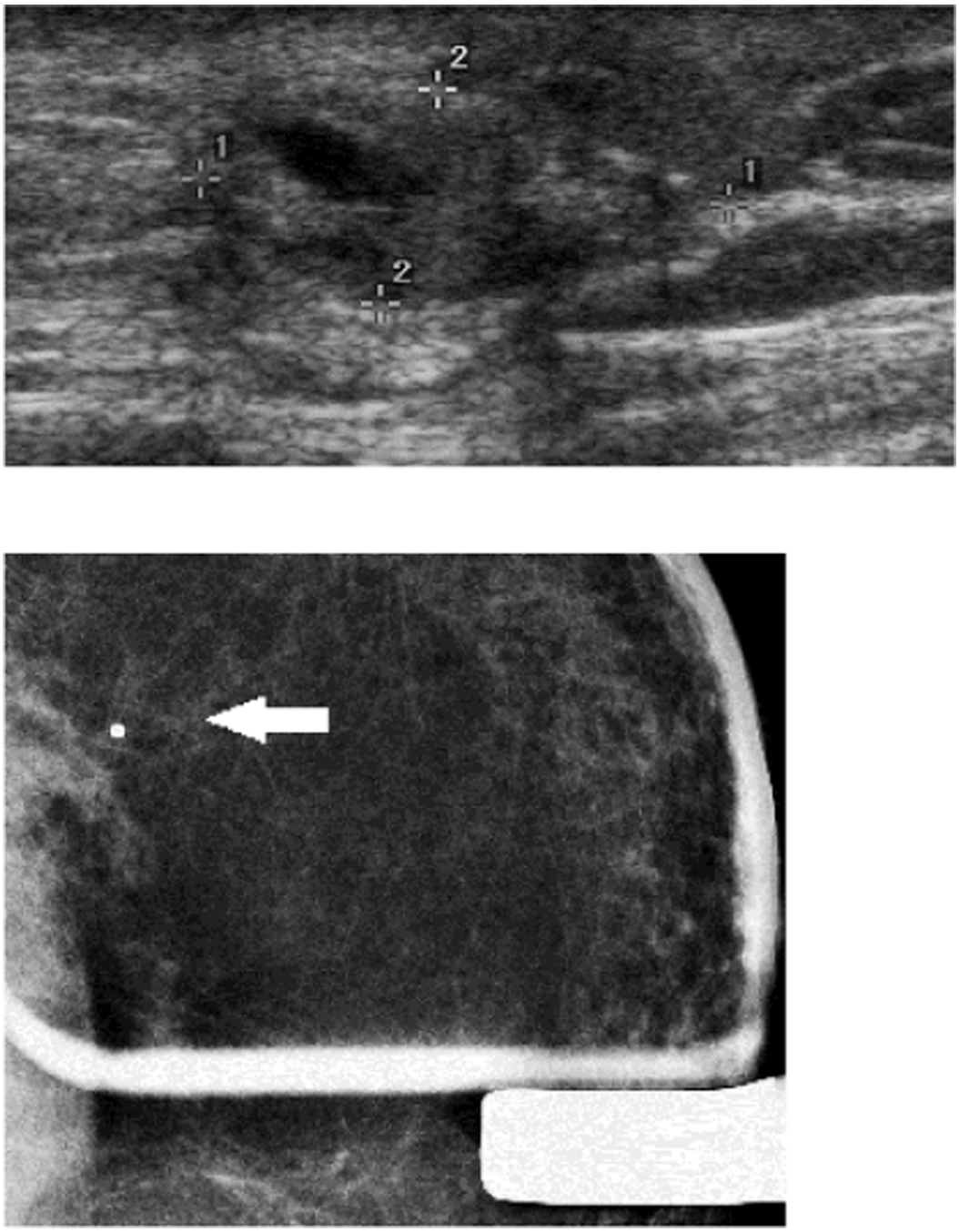

Fig. 5—.

Patient status post-mastectomy with TRAM flap reconstruction and a palpable mass in the reconstructed left breast. On ultrasound (fig. 5a) it appeared as an oval parallel isoechoic mass with central anechoic component (arrow). Cone mammographic (fig. 5b) view over the palpable mass shows an area of increased density and central fat (arrow) consistent with fat necrosis.

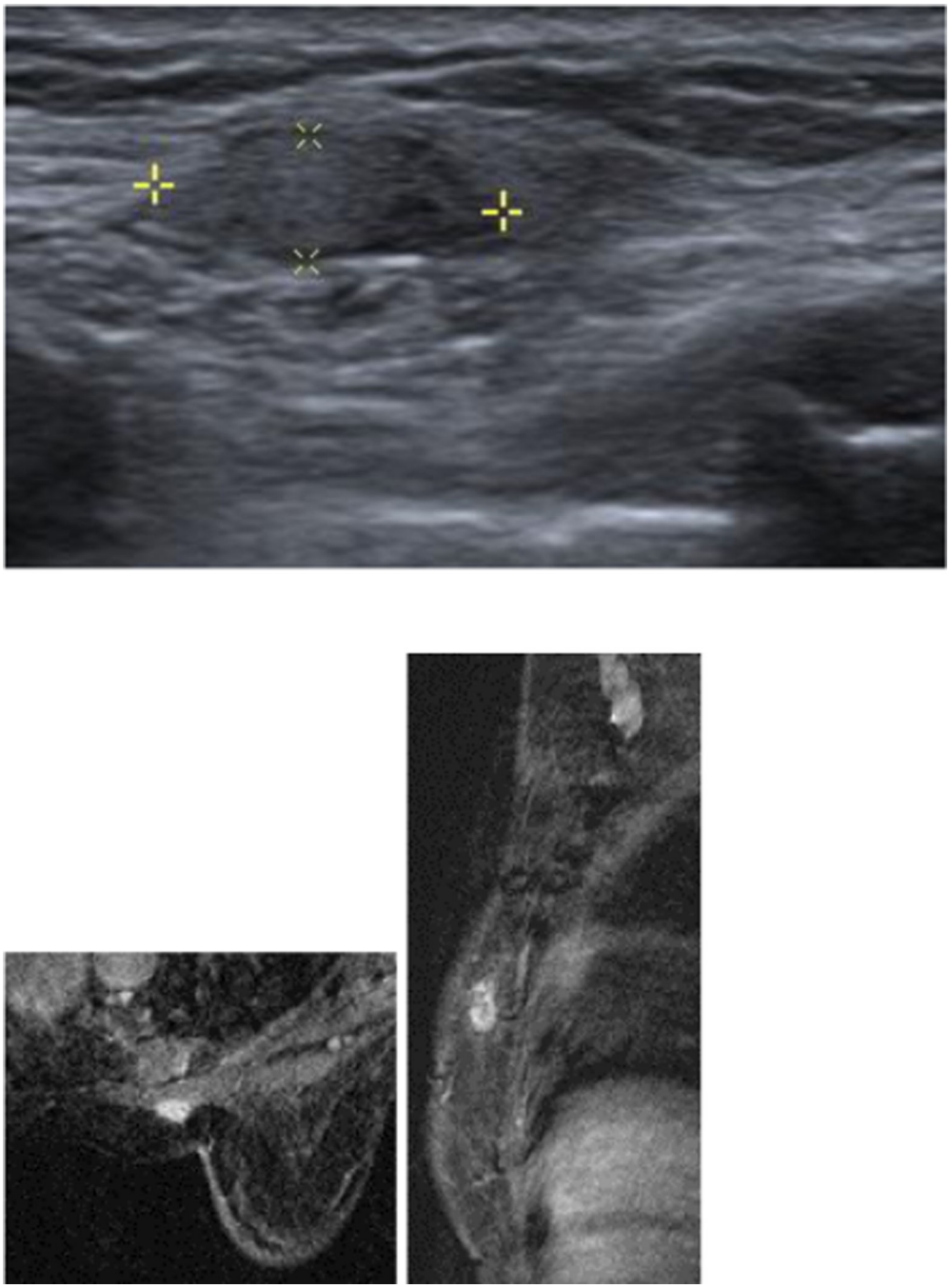

Fig. 6—.

Patient status post right mastectomy with TRAM flap reconstruction and palpable mass in the medial right breast. On ultrasound (Fig. 6a) it was oval, parallel and iso to hyperechoic with no vascularity (arrow). MRI (Fig. 6b and c) show a heterogeneously enhancing mass in the medial reconstructed breast.

Table 1.

Patient characteristics in cancer and benign patients who underwent biopsy of palpable masses on the side of a mastectomy.

Patient Characteristics	Cancer/Benign (%)	*p*-value
AGE (YEARS)		1.0
≤50	13/60 (22)	
>50	6/31 (19)	
ANTI-ESTROGENS		0.04
YES	12/74 (16)	
NO	7/17 (41)	
RADIATION		1.0
YES	6/27 (22)	
NO	13/64 (20)	
CHEMOTHERAPY		0.2
YES	15/59 (25)	
NO	4/32 (13)	
IBR		0. 2
YES	19/83 (23)	
NO	0/8 (0)	
NSM		0.7
YES	1/9 (11)	
NO	18/82 (22)	
RECONSTRUCTION		0.2
IMPLANT	18/70 (26)	
FLAP	1/15 (7)	
PROPHYLACTIC		0.01
YES	0/19 (0)	
NO	19/72 (20)	

Total N=91 number who underwent biopsy.

Note—Numbers in parentheses are percentages. IBR=immediate breast construction; SPM=skin sparing mastectomy; NSM=nipple sparing mastectomy

Table 2.

Imaging features on ultrasound in cancer and benign patients who underwent targeted ultrasound of palpable masses on the side of a mastectomy.

Imaging Features	Cancer/Benign (%)	*p*-value
SHAPE		**0.0003**
ROUND/OVAL	9/73 (12)	
IRREGULAR	10/18 (56)	
MARGINS		**0.008**
CIRCUMSCRIBED	6/54 (11)	
NOT-CIRCUMSCRIBED	13/37 (35)	
ORIENTATION ON SONOGRAPHY		**0.008**
PARALLEL	12/77 (16)	
ANTI-PARALLEL	7/14 (50)	
SHADOWING		1
YES	2/12 (17)	
NO	17/79 (22)	

Table 3.

Histology, grade and hormone receptor profiles of the original primaries in 19 patients who developed recurrences.

Age	NSM	SSM	IBR	Hist	Grade	ER	PR	HER2	RT	TAM/AI	Chemo	BRCA
35	no	yes	yes	IDC	3	+	+	−	yes	yes	yes	−
41	no	yes	yes	DCIS*	3	N/A	N/A	N/A	no	no	yes	N/A
42	no	yes	yes	IDC	2	+	+	+	yes	yes	yes	N/A
42	no	yes	yes	DCIS*	3	+	+	−	no	no	yes	−
43	no	yes	yes	IDC	3	−	−	−	no	no	yes	BRCA 2
45	no	yes	yes	IDC	2	+	+	−	yes	yes	yes	N/A
47	no	yes	yes	IDC	1	+	+	−	yes	yes	no	−
49	no	yes	yes	IDC	3	+	+	+	no	no	no	N/A
54	no	yes	yes	IDC	3	+	+	−	yes	no	yes	−
59	no	yes	yes	IDC	3	−	−	−	no	no	yes	N/A
63	no	yes	yes	IDC	2	+	+	−	no	yes	yes	N/A
68	no	yes	yes	IDC	2	+	−	−	no	yes	yes	N/A
44	no	yes	yes	IDC	3	+	+	−	no	yes	no	−
46	no	yes	yes	IDC	2	+	−	−	no	yes	yes	BRCA 2
44	no	yes	yes	IDC	3	+	+	+	no	yes	yes	−
49	no	yes	yes	IDC	2	+	+	−	no	yes	yes	−
58	yes	yes	yes	DCIS	2	+	+	−	no	no	no	−
37	no	yes	yes	IDC	2	+	+	+	yes	yes	yes	−
51	no	yes	yes	IDC	3	+	+	−	no	yes	yes	N/A

Note—NSM =nipple sparing mastectomy; SSM=skin sparing mastectomy; IBR=immediate breast reconstruction; Hist=histology of the primary; Grade=histological grade of the primary; ER=estrogen receptor; PR=progesterone receptor; HER2=human epidermal growth factor receptor 2; RT=radiation; TAM=tamoxifen; AI=aromatase inhibitor; CHEMO=chemotherapy; DCIS*=DCIS with microinvasion