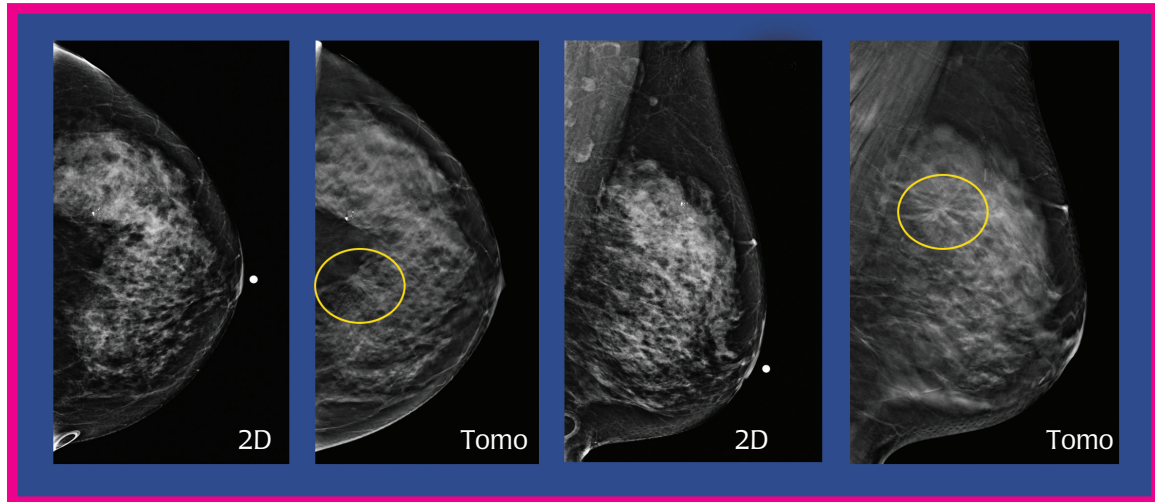


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The Use of Breast Tomosynthesis in Clinical Practice

- 2 Tomosynthesis enables definitive identification of unsuspected lesions in multifocal or multicentric cancers, decreasing the need for second-look US and post-MRI biopsy
- 4 Tomosynthesis finds a spiculated mass not seen in traditional 2D mammogram
- 6 Tomosynthesis significantly reduces screening callback rates and increases our ability to detect early cancers
- 8 Diagnosis of US/MRI-occult asymptomatic multifocal invasive lobular carcinoma using breast tomosynthesis
- 10 Tomosynthesis improves cancer detection and simplifies workup of suspected abnormalities
- 12 Tomosynthesis used for a diagnostic mammogram identifies a true positive cancer that spot compression missed
- 14 Stage 1 breast cancer diagnosed by tomosynthesis in dense breasts

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Tomosynthesis enables definitive identification of unsuspected lesions in multifocal or multicentric cancers, decreasing the need for second-look US and post-MRI biopsy

By Linda R. N. Greer, MD

Background

Breast tomosynthesis is a new method for breast cancer screening and diagnosis. Unlike prior-generation mammography systems, which generate 2-dimensional images, breast tomosynthesis produces 3-dimensional images that are intended to reveal the inner architecture of the breast, free from the distortion typically caused by tissue shadowing or density.

In clinical studies Hologic submitted to the FDA, radiologists reading 2-dimensional + 3-dimensional mammography (breast tomosynthesis) compared to 2-dimensional mammography alone demonstrated superior clinical performance in specificity, the confidence to rule out breast cancer without recalling the patient for further study, and also demonstrated improved sensitivity, the proportion of mammograms which include breast cancers that were correctly diagnosed. Based on pooled multi-reader receiver operating characteristic (ROC) analysis, Hologic's clinical trials reviewed by the FDA showed the potential to increase cancer detection by up to 16% and the potential to reduce recall rate by up to 40% when using combo-mode (2-dimensional + 3-dimensional breast tomosynthesis) compared with 2-dimensional mammography alone.

Patient Information

A 35-year-old female presented with a new lump at the left nipple, noted for about one week. She had no other palpable masses. The patient's paternal aunt and paternal great aunt had breast cancer. A 2-dimensional + 3-dimensional (breast tomosynthesis) exam was performed on a Hologic Selenia Dimensions system with nipple markers in place and a triangular marker over the palpable lump.

Imaging Findings

The patient's 2-dimensional mammogram reveals dense breasts with multiple areas of increased density and mild distortions throughout both breasts, with no

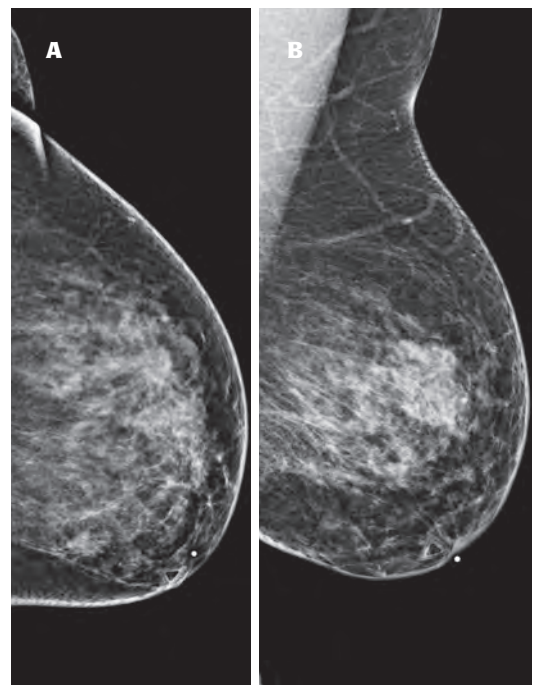


Figure 1. The patient's 2-dimensional mammogram revealed dense breast tissue and multiple areas of asymmetry and mild distortion.

clear correlates (Figure 1). The 2-dimensional mammogram showed a triangle marking a palpable retroareolar mass. The retroareolar mass was not well seen with the 2-dimensional mammogram.

The 3-dimensional breast tomosynthesis images as seen in Figure 2 clearly showed a spiculated mass in the left upper outer quadrant (UOQ): CC slice 36, mediolateral oblique (MLO) slice 40, measuring about 1.6 cm.

Corresponding to the palpable area at the nipple, ultrasound revealed a 1.1-cm thickening. Ultrasound also showed a 1.7-cm hypoechoic mass at 2 o'clock left breast, with irregular margins and slightly increased vascularity.

Dr. Greer is a Medical Director and Radiologist, Breast Health & Research Center, John C. Lincoln Health Network, Phoenix, AZ

A breast magnetic resonance imaging (MRI) exam showed a 1.9-cm heterogeneous spiculated mass in the left UOQ with washout kinetics and a 1.6-cm mass with washout kinetics in immediate retroareolar area, involving skin of the nipple.

Diagnosis

T1c, N1, M0 stage 2 left breast cancer with 2 separate primaries:

1.3-cm infiltrating ductal carcinoma left UOQ, grade 3, estrogen and progesterone receptors > 90% positive. HER-2/neu negative. One out of 7 lymph nodes positive at 1.2 mm (micromets).

The second tumor 7 cm from the palpable retroareolar tumor: infiltrating ductal carcinoma 1.3 cm, grade 1 ER 50% and PR > 90%. HER-2/neu negative.

Treatment

The patient had a bilateral mastectomy. The right breast was negative for malignancy. The patient is undergoing chemotherapy at this time.

Discussion

In the setting of dense breasts with many potential areas of concern on the 2-dimensional mammogram, the breast tomosynthesis study was the definitive tool in this patient's diagnosis. The sonography finding at the area of palpable concern was mild, and in the absence of the strong tomosynthesis result, it is possible that the palpable nipple lesion could have been "downplayed" and she might not have received the immediate care she needed (biopsies of both lesions were done the following day).

The 3-dimensional (breast tomosynthesis) images obtained at the same time as the 2-dimensional images and under the same compression clearly demonstrated a mass with spiculated margins allowing very accurate localization in the UOQ and size determination. Based on the breast tomosynthesis information, we were able to very confidently predict that this would be a malignancy. Additionally, the 3-dimensional (breast tomosynthesis) imaging easily proved that other similar areas of asymmetry in the patient's dense busy breast were due to superimposed tissues rather than additional masses, particularly medially on the left CC view.

Conclusion

Three-dimensional breast tomosynthesis clearly allows better visualization of tissues in dense breasts and accurate localization for ultrasound and biopsy

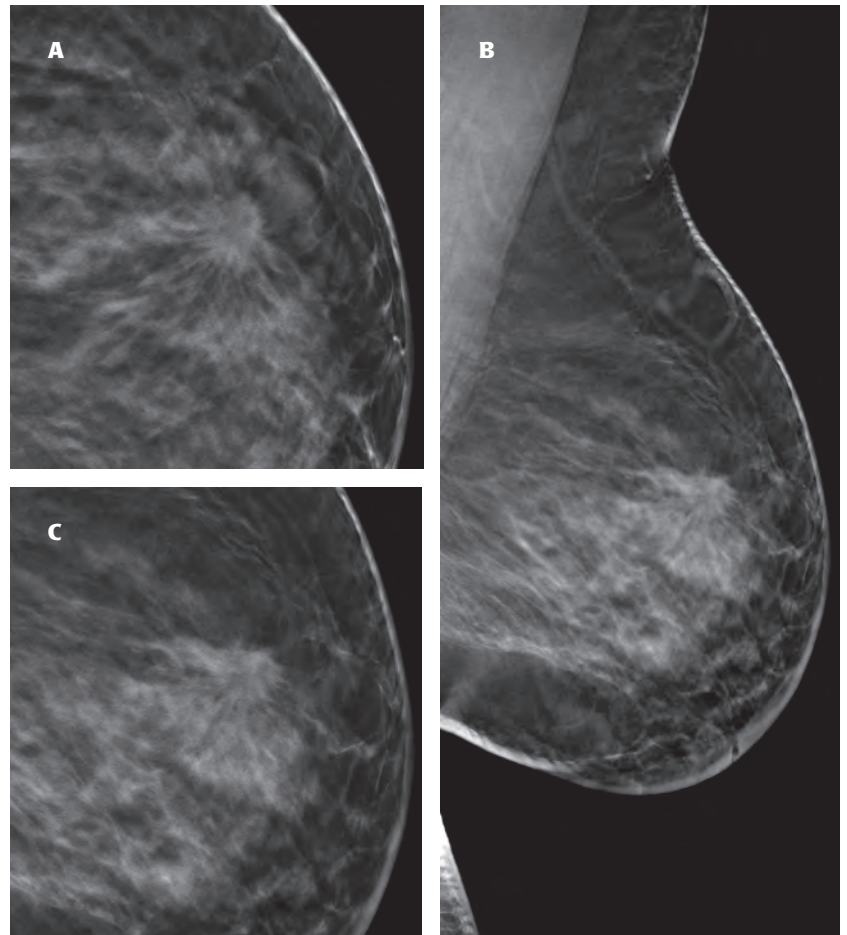


Figure 2. The 3-dimensional images as seen in Figure 2 clearly showed a spiculated mass in the left UOQ: (A) CC slice 36, (B and C) MLO slice 40, measuring about 1.6 cm.

studies or for localization for additional mammographic imaging. (For example, knowing that calcifications are located medially so as not to waste time imaging the lateral aspect of the breast). Breast tomosynthesis also allowed us to better see or identify internal calcifications within masses.

In this case and other tomosynthesis cases, we have been able to definitively identify additional unsuspected lesions when cancers are multifocal or multicentric, which could help decrease the need for second-look ultrasound and biopsy after MRI.

Reference

1. The Hologic Selenia Dimensions clinical studies presented to the FDA as part of Hologic's PMA (P080003) submission that compared Hologic's Selenia Dimensions 2-dimensional + 3-dimensional tomosynthesis to Hologic's 2D FFDM.

Tomosynthesis finds a spiculated mass not seen in traditional 2D mammogram

By Stephen L. Rose, MD

Background

Breast tomosynthesis is a new method for breast cancer screening and diagnosis. Unlike prior-generation mammography systems, which generate 2-dimensional images, breast tomosynthesis produces 3-dimensional images, which are intended to reveal the inner architecture of the breast free from the superimposition of overlying structures. While tomosynthesis can be acquired independently, a screening examination, as required by the U.S. Food and Drug Administration (FDA), includes a tomosynthesis data set in combination with a 2-dimensional image. The perfectly registered images take only seconds longer to acquire than a conventional 2-dimensional digital mammogram at a total exam dose within current FDA guidelines for screening mammography.

A tomosynthesis scan virtually eliminates detection challenges associated with overlapping structures in the breast, which is the primary drawback of conventional 2-dimensional analog and digital mammography. In addition, breast tomosynthesis offers other potential benefits, including increased lesion and margin visibility, help in localizing structures in the breast, a reduction in recall rates, and increased cancer detection.

Patient Information

A 42-year-old female presents for a routine screening mammogram.

Imaging Findings

A 2-dimensional mammogram shows no suspicious findings. Upon review of the tomosynthesis dataset, a 7-mm spiculated mass was detected in the upper outer quadrant of the left breast at 2 o'clock. Ultrasound confirmed the presence of a suspicious mass at 2 o'clock measuring 7 mm.

Diagnosis

T1b, N0, M0 stage 1A invasive ductal carcinoma

Treatment

Lumpectomy with radiation. No chemotherapy.

Discussion

The use of tomosynthesis in the screening setting was essential for the early diagnosis in this patient. The tumor is imperceptible on standard 2-dimensional imaging, however, the tomosynthesis slices demonstrate a spiculated mass because of the ability to peel away the superimposing tissue that obscures the distortion on the 2-dimensional images. This can be seen clearly on both MLO and CC projections.

We have seen a reduction in call back rates for additional testing by approximately 50%, while increasing our detection of very early cancers.

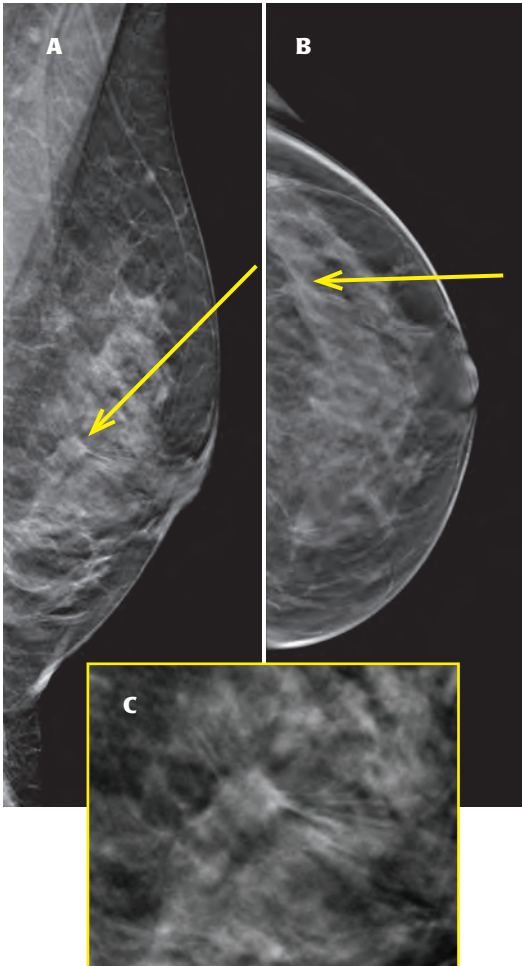
The ultrasound exam confirms the presence of a small lesion at 2 o'clock in the left breast. An ultrasound-guided biopsy was performed documenting a 7-mm infiltrating ductal carcinoma.

Early detection of breast cancer is associated with decreased mortality and reduced morbidity.¹ It is unclear when or if this cancer would be revealed on future 2-dimensional mammography in this heterogeneously dense breast or if it would have only been discovered as a palpable finding at a much later stage in the disease process. In addition to the drawbacks of 2-dimensional imaging, many women, especially in their 40's, do not get yearly mammograms, therefore, we would miss any opportunity to detect this cancer before it.

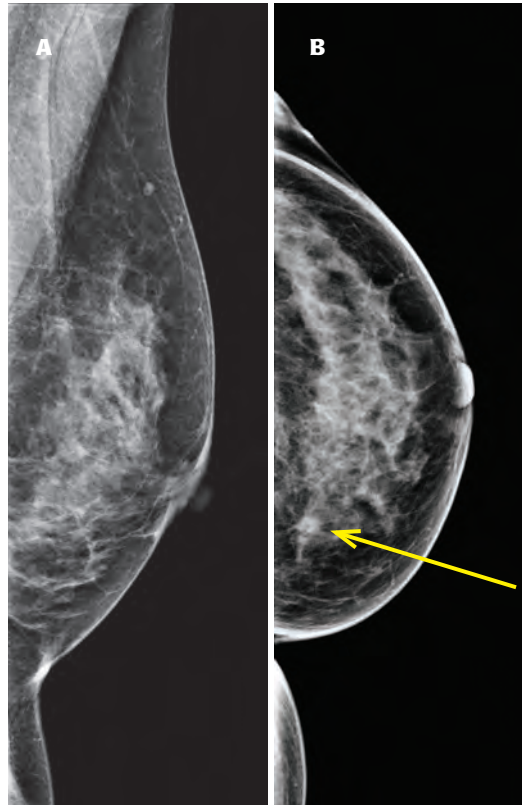
Conclusion

Tomosynthesis is a revolutionary new approach to screening for breast cancer. In our practice, we have seen a reduction in call back rates for additional testing by approximately 50%, while increasing our detection of very early cancers. Our practice has performed over 10,000 screening tomosynthesis exams

Dr. Rose is Medical Director of the Tops Comprehensive Breast Center, Houston, TX, and President and Founder of Houston Breast Imaging, Houston, TX.



Tomosynthesis Exam. The (A) LMLO and (B) LCC slices of the tomosynthesis dataset demonstrate a spiculated mass in the upper outer quadrant (arrows). The region of interest is shown enlarged in (C). The mass is not visible in the corresponding 2-dimensional images because of superimposed structures.



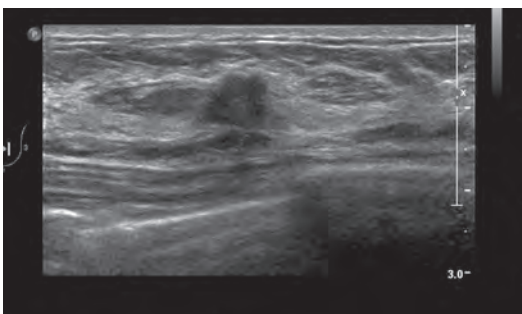
Conventional 2-dimensional Exam. The upper outer quadrant lesion is not visible in the standard (A) LMLO and (B) LCC views. (Note: the medial mass in the 2-dimensional CC view (arrow) was shown to be superimposed structures using tomosynthesis.)

and is currently doing an evaluation of 2-dimensional exams read alone versus the combination of 2-dimensional/tomosynthesis exams. Initial results are extremely encouraging. Our data on call back rates match those reported by others using tomosynthesis in the screening environment.²

“I think tomosynthesis is a practical solution because unlike some modalities,” said Dr. Rose, “tomosynthesis is easy to use and efficient, enabling us to screen almost everyone.”

References

1. Gullien R, Eben E, Ekseth U, et al. Reading time of FFDM and tomosynthesis in a population-based screening program. RSNA 2011. Breast series: Emerging technologies in breast imaging. MSVB31-07. http://rsna2011.rsna.org/search/event_display.cfm?printmode=n&em_id=11011027. Updated November 29, 2011. Accessed March 13, 2012.
2. Tabár L, Vitak B, Chen TH, et al. Swedish two-county trial: Impact of mammographic screening on breast cancer mortality during 3 decades. *Radiology*. 2011;260:658-663. Epub 2011 Jun 28.



Ultrasound Exam. An ultrasound exam confirmed the presence of a small lesion at 2 o'clock in the left breast. An ultrasound-guided biopsy was performed documenting a 7-mm infiltrating ductal carcinoma.

Tomosynthesis significantly reduces screening callback rates and increases our ability to detect early cancers

By Edward R. Lipsit, MD

Background

The interpretation of conventional 2-dimensional mammography is a challenging task due to low sensitivity and low positive predictive value, especially in the dense breast.¹ Superimposition of normal breast structures can simulate an abnormality and obscure true lesions. Approved by the FDA in February 2011, breast tomosynthesis is a 3-dimensional imaging method that can reduce or eliminate tissue overlap. In combination with the standard 2-dimensional mammogram, multiple low dose images of a stationary compressed breast are acquired at multiple angles during a short scan sequence. The images are then reconstructed into a series of 1-mm high-resolution slices that can be displayed individually or in a cine format.

The expected benefits from this technique include reduced screening recalls due to tissue superimposition, improved cancer detection and lesion characterization, and more precise localization of diagnosed lesions.

Dr. Lipsit is a Radiologist and the President of Washington Radiology Associates, PC, Fairfax, VA.

Patient Information

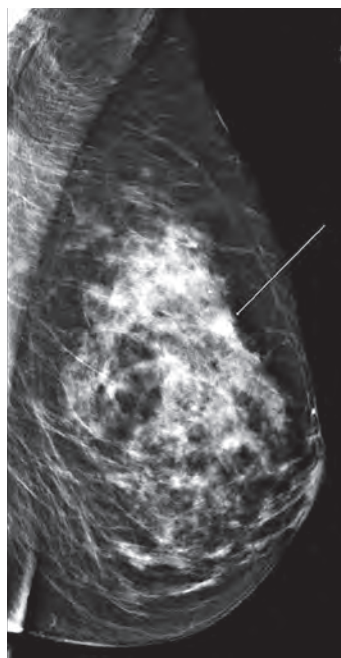
A 60-year-old female presents for a routine screening mammogram. There is significant family history of breast cancer (mother and sister).

Imaging Findings

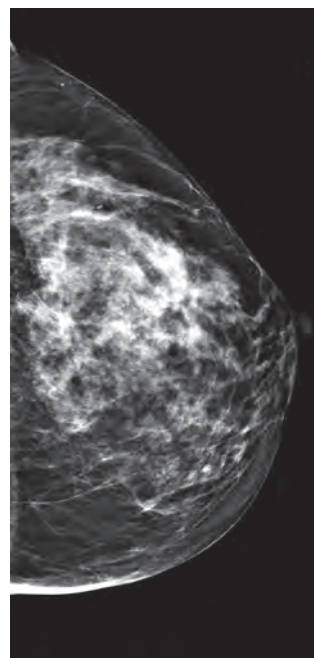
A 2-dimensional mammogram showed an asymmetry in the anterior third of the superior left breast. At callback, breast tomosynthesis demonstrates the asymmetry to represent normal superimposed tissue, however, the dataset reveals distortion in the inferior lateral breast that was not apparent on the initial screening study. Ultrasound confirms there is an irregular 1.1-cm shadowing mass. An ultrasound-guided core biopsy confirms the diagnosis of carcinoma. Postbiopsy magnetic resonance imaging (MRI) indicates a solitary breast cancer.

Diagnosis

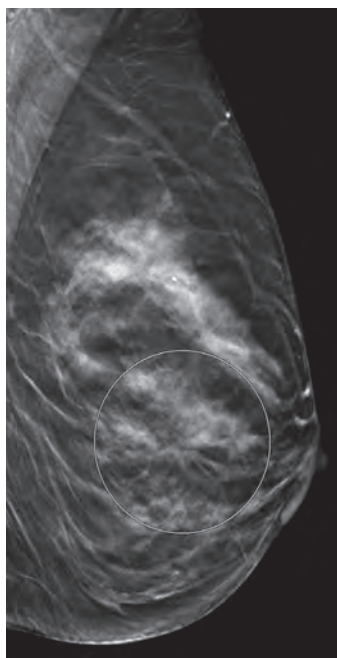
Clinical Stage1 T1c N0 hormone receptor positive (ER 90%, PR less than 1%, Her2 negative) invasive ductal carcinoma



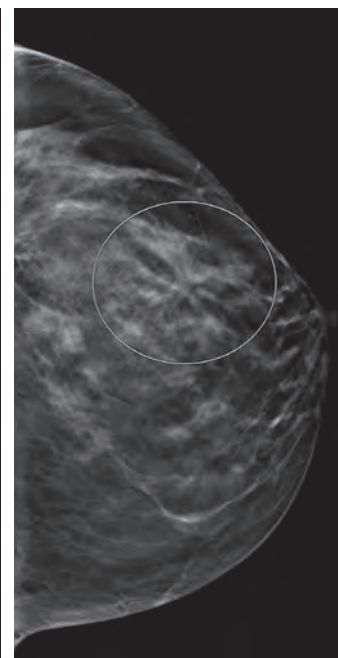
2-dimensional mammogram. An asymmetry is identified in the superior breast on the standard LMLO view.

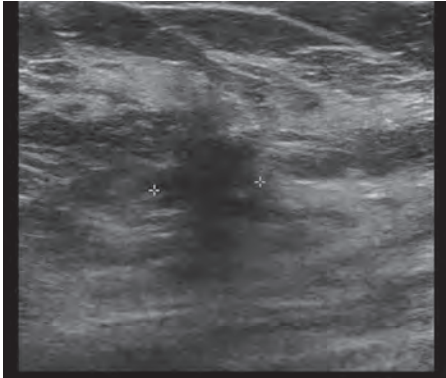


2-dimensional mammogram. The standard LCC view shows a dense heterogeneous breast pattern.

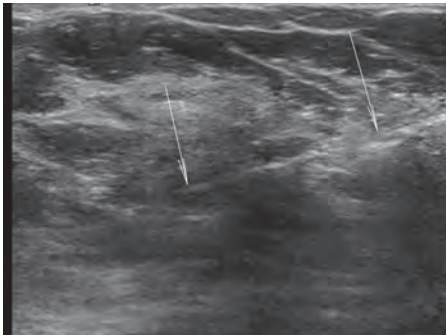


Breast tomosynthesis. LMLO and LCC slices from the tomosynthesis dataset clearly depict the spiculated lesion (circle).



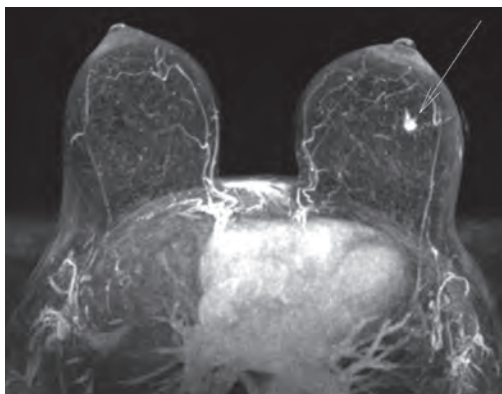


Ultrasound exam. The ultrasound image confirms a highly suspicious irregular mass with shadowing (between calipers).

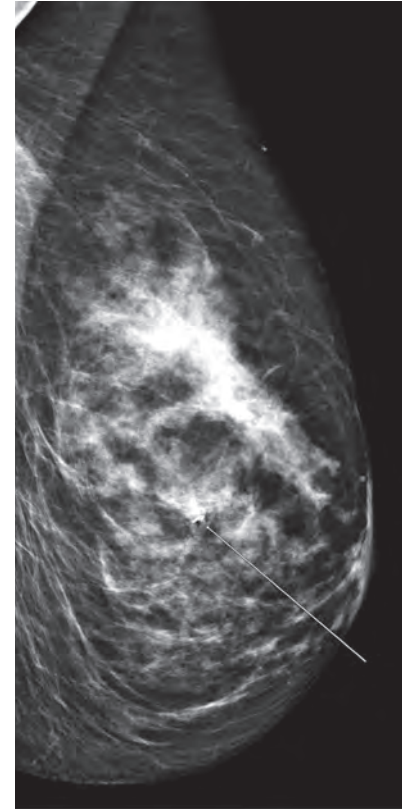


Ultrasound-guided core biopsy. The echogenic core needle (arrows) traverses the lesion.

A 3-dimensional tomosynthesis reveals distortion in the inferior lateral breast that was not apparent on the initial screening study.



MRI exam. This axial view demonstrates an enhancing spiculated mass (arrow) corresponding to the patient's known carcinoma. No additional lesions were seen.



Postbiopsy 2-dimensional mammogram. This LMLO view shows the biopsy clip placement (arrow). Note that the site of the lesion is inferior to the asymmetry, which prompted the call back.

Treatment

The original area of concern was cleared as superimposition on the tomosynthesis exam. The patient is in consultation with her breast surgeon and medical oncologist and is scheduled for a lumpectomy.

Discussion

The 2-dimensional screening study in this high-risk patient failed to image the invasive cancer as it was obscured by the patient's dense breast pattern. In fact, the need for additional imaging was prompted by normal superimposed breast tissue, which was perceived as an abnormality.

This case illustrates the shortcomings of standard mammography and the potential of 3-dimensional tomosynthesis to significantly reduce screening callback rates and increase our ability to detect early cancers.² The tomosynthesis dataset revealed a lesion, which was not apparent on the 2-dimensional examination. For this patient, the addition of breast tomosynthesis to our imaging protocol led to an ultrasound-guided biopsy and an early diagnosis of a solitary invasive cancer.

Conclusion

Tomosynthesis is a newly approved technique, which should prove useful in screening and diagnostic mammography. It should especially benefit the estimated 40% of the population with dense breast tissue, who often require additional imaging beyond the current standard of 4 2-dimensional views.³ In our practice, it is offered to all patients, and we anticipate lower callback rates and improved detection of small, early cancers. As more clinical studies on the use of tomosynthesis are published and reimbursement is worked out with insurance providers, we anticipate breast tomosynthesis will gain widespread usage in screening mammography.

References

1. Kolb T, Lichy J, Newhouse J. Comparison of the performance of screening mammography, physical examination and breast ultrasound and evaluation of factors that influence them: An analysis of 27,825 patient evaluations. *Radiology*. 2002;225:165-175.
2. Park J, Franken Jr E, Garg M, et al. Breast tomosynthesis: Present consideration and future applications. *Radiographics*. 2007;27:S231-S240.
3. Cole E, Pisano E, Kistner E, et al. Diagnostic accuracy of digital mammography in patients with dense breasts who underwent problem-solving mammography: Effects of image processing and lesion type. *Radiology*. 2003;226:153-160.

Diagnosis of US/MRI-occult asymptomatic multifocal invasive lobular carcinoma using breast tomosynthesis

By Marte Wasserman, MD,
Cindy L. Davis, MD, MEd,
Diana L. Edgar, MD, Carmela
I. Monteiro, MD

Dr. Wasserman is Assistant Professor of Radiology and Chief, Division of Women's Imaging, University of Florida College of Medicine—Jacksonville, Shands Jacksonville Breast Health Center, Jacksonville, FL; Dr. Davis is a Fellow, Department of Pathology, University of Florida College of Medicine—Jacksonville; Dr. Edgar is Assistant Professor, Department of Radiology, Division of Women's Imaging, University of Florida College of Medicine—Jacksonville; Dr. Monteiro is Associate Professor, Medical Director, Surgical Pathology, Department of Pathology and Laboratory Medicine, University of Florida College of Medicine—Jacksonville, Jacksonville, FL.

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Jules H. Sumkin, DO, FACR
Professor and Chief of Radiology
Magee-Womens Hospital, University
of Pittsburgh Medical Center,
Pittsburgh, PA

Barry M. McCook, MD, Chairman,
Department of Radiology, Chief,
Division of Functional and Molecular
Imaging, University of Florida
College of Medicine—Jacksonville,
Jacksonville, FL

Background

In February 2011, the U.S. Food and Drug Administration (FDA) approved the use of breast tomosynthesis for use in breast cancer screening and diagnosis. A tomosynthesis data set is produced by obtaining 15 low-dose tomographic images of the breast at multiple angles across a 15° arc. These images are then reconstructed into 1 mm slices for viewing on a diagnostic workstation.

The distinct advantage of tomosynthesis is a significant reduction in the number of “pseudo lesions” or false-positives recalled from screening mammography that are simply superimposed breast tissue appearing as an abnormality on a traditional 2D mammogram.

A tomo data set allows the radiologist to detect and define lesion borders and areas of architectural distortion much more readily than on 2D images because overlap by surrounding breast tissue is virtually eliminated. Clinical experience with this modality at our institution supports the early clinical reports provided by the manufacturer (Hologic, Inc, Bedford, MA) suggesting a significant increase in mammographic specificity without a loss in sensitivity.¹

Although invasive lobular carcinoma (ILC) comprises only about 5% to 15% of breast carcinomas, the incidence has been steadily increasing in the last two decades, especially in the 50 and older age group.² Classic invasive lobular carcinoma has a highly infiltrative growth pattern, spreading throughout the surrounding stroma in single file, often allowing it to become extensive before becoming palpable or detectable by imaging studies. Therefore, it is often a challenging clinical and imaging diagnosis.

Patient Information

Our patient is an asymptomatic 56 year old female with no personal history of breast cancer. Her family history is notable for breast cancer diagnosis in her sister at 55 years of age and a maternal great aunt who was post menopause when diagnosed with breast cancer. She is G2 P2 with the first pregnancy at age 28 and menarche at age 12. Due to her perimenopausal symptoms, she has used estrogen HRT for the last 8-10 years. She was recalled from routine annual screening 2D mammography for an ill-defined asymmetry in the left upper breast, seen only on the MLO view, within a background of heterogeneously dense breast tissue (Figure 1).

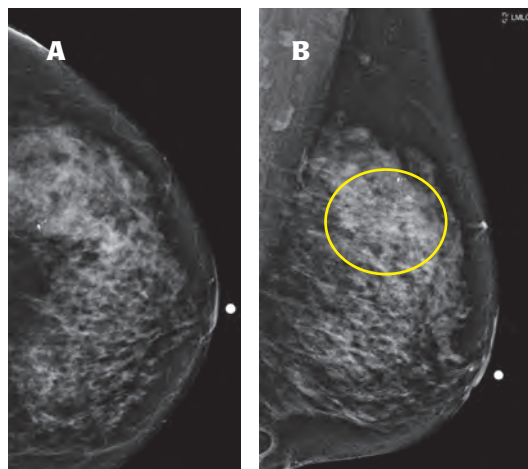


Figure 1. (A) 2-dimensional digital screening mammogram. No correlate lesion was seen on the CC view. (B) shows a dense asymmetry in the upper left breast (circle).

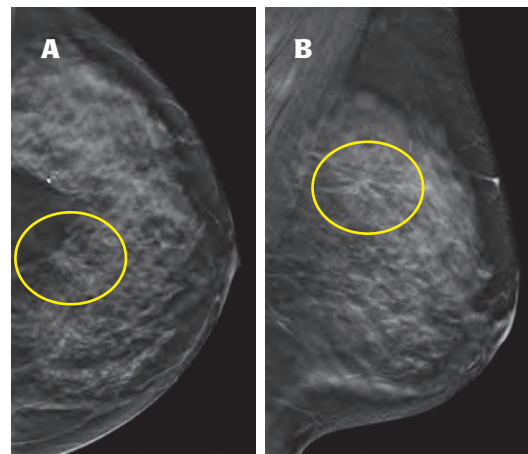


Figure 2. Breast tomosynthesis. (A) Tomo LCC slice shows a spiculated lesion in the mid-retroareolar posterior third left breast (circle). (B) Tomo LMLO shows a spiculated lesion in the upper left breast (circle).

Imaging Findings

Breast tomosynthesis was performed as part of our current diagnostic protocol using the Hologic Selenia Dimensions unit. The tomosynthesis CC and MLO images clearly delineate a spiculated mass in the upper mid left breast (Figure 2). Subsequent targeted ultrasound was performed which revealed normal breast echotexture with no focal abnormality in this region.

Because of the very suspicious nature of this lesion on tomosynthesis, contrast-enhanced breast MRI was performed on a 3T Siemens Trio™, ACR-accredited for breast imaging. No abnormal enhancement was

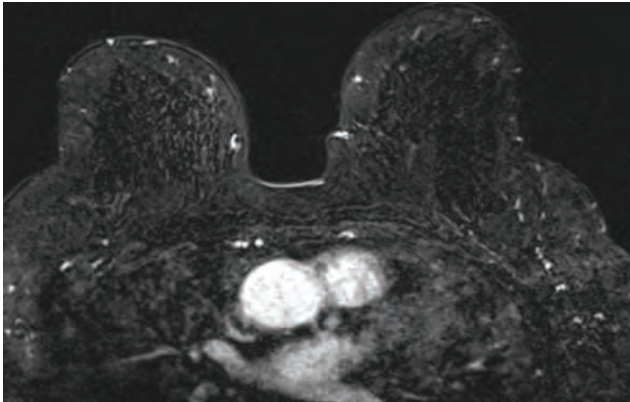


Figure 3. MRI exam. Contrast-enhanced subtraction MR image upper left breast in the area of concern based on tomo views shows no abnormal enhancement.

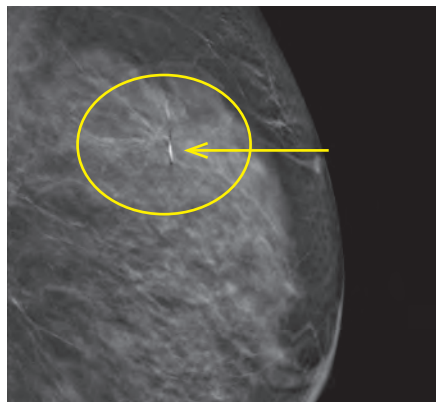


Figure 4. Tomosynthesis image slice showing placement of I-125 radioactive seed next to spiculated lesion in LLM view. (circle)

present in either breast, and there was very minimal background glandular enhancement (Figure 3).

Because no definitive target for biopsy could be identified for stereotactic, MR, or ultrasound guidance, I-125 seed-localized surgical lumpectomy was recommended. The lesion was only clearly seen on tomosynthesis, therefore, the stereo-localization with 2D images was challenging. However, by performing a true lateral tomosynthesis view along with the orthogonal tomosynthesis CC view, placement of the seed adjacent to the spiculated mass was performed using a typical localization compression paddle with grid line markers.

The CC and LM tomosynthesis key images were placed next to the 2D mammographic localization images for estimation of the location of the lesion. The breast was placed in the CC position, and an 18 gauge needle was placed in the approximate area of the spiculated lesion seen on tomosynthesis. The breast was then placed in LM position and the needle tip was withdrawn to the level of the area of the spiculated lesion seen on tomosynthesis. The I-125 seed was deposited in this location successfully. Post-seed placement tomosynthesis in both planes confirmed accurate targeting of the lesion within 1 cm (Figure 4).

Diagnosis

Grossly, the lumpectomy had firm, white, somewhat translucent fibrotic parenchyma comprising approximately 85% of the specimen. Microscopically, multiple foci of invasive lobular carcinoma, ranging in size from less than 1 mm to 8 mm in greatest dimension, were scattered throughout most of the specimen. Tumor foci were within 1 mm of several margins. Multiple foci of lobular carcinoma in situ were also present. Pathologic staging was pT1b(m) N0, ER/PR positive, HER-2/neu negative.

Treatment

The patient subsequently underwent re-excision of the tumor bed and was found to have a few microscopic foci of invasive lobular carcinoma with

microcalcifications, but margins were adequate and free of tumor. She had 0/1 sentinel lymph nodes on biopsy.

Post-operatively the patient has done well. Radiation oncology has recommended adjuvant radiation to the left breast and axilla to optimize local control and disease specific survival. Hematology/Oncology has been consulted for further treatment recommendations.

Discussion

This case demonstrates the profound impact tomosynthesis breast imaging provides for early breast cancer detection. In this case, an abnormality was detected on 2D mammography, but the highly suspicious characteristics and definitive location of the lesion were clearly defined only on the tomo views. Specifically, contrast-enhanced MR has been established as a very sensitive and useful tool for ILC detection and determining extent of disease prior to treatment.³ This case report exhibits the clinical utility of tomosynthesis, especially in the absence of abnormal MR enhancement. Ultimately, the use of conventional 2D imaging alone, in this particular patient, may have led to a delayed diagnosis of primary breast malignancy.

Conclusion

Tomosynthesis is quickly becoming an extremely valuable imaging modality for early breast cancer detection. The use in the general screening population increases the radiologist's overall accuracy. Our own experience illustrates an increased specificity and shows a trend for increased sensitivity. In addition, tomosynthesis imaging is proving to be a powerful tool for breast cancer detection in those at high risk for developing breast cancer, such as in this patient with a significant family history for breast cancer and dense breast tissue on mammography.

The Hologic Selenia Dimensions clinical studies were presented to the FDA as part of Hologic's PMA (P080003) submission that compared Hologic's Selenia Dimensions 2D + tomosynthesis to Hologic's 2D FFDM.

References

1. Rakha EA, Ellis IO. Lobular breast carcinoma and its variants. *Semin Diagn Pathol.* 2010 Feb;27(1):49-61.
2. Li CI, Anderson BO, Daling JR, Moe RE. Trends in incidence rates of invasive lobular and ductal breast carcinoma. *JAMA.* 2003;289(11):1421-1424.
3. J. Lopez, MD and L.W. Bassett, MD. Invasive lobular carcinoma of the breast: Spectrum of mammographic, US, and MR imaging findings. *RadioGraphics.* 2009;29:165-176.

Tomosynthesis improves cancer detection and simplifies workup of suspected abnormalities

By Melissa A. Durand, MD,
and Liane E. Philpotts, MD

Dr. Durand is Assistant Professor of Diagnostic Radiology, Yale University School of Medicine, New Haven, CT, and **Dr. Philpotts** is Professor of Diagnostic Radiology and Chief of Breast Imaging, Yale University School of Medicine, New Haven, CT.

Background

Breast tomosynthesis (BT) is a novel technology that has the potential to advance the field of mammography in both the screening and diagnostic environment. Initial studies estimated reduced recall rates from screening mammography of 30% to 40%.^{1,2} Higher cancer detection rates, better lesion margin analysis and more precise lesion location have also been reported.^{1,2} Tomosynthesis also has the potential to improve workflow efficiency as the 2-dimensional (2D) + tomosynthesis images have been shown to be equal to if not better than additional diagnostic 2D views.³

Presently approved for use as an adjunct to conventional 2D mammography, tomosynthesis images are acquired as 15 low-dose projection images, in a 4 sec sweep. These projection images are then reconstructed into 1-mm slices of the breast. Since the 3-dimensional (3D) images are acquired under the same compression as the 2D image, patient positioning is the same for both exams. The ability to review images slice by slice allows breast tissue to be displayed with less tissue superimposition compared to 2D mammography. This allows true lesions to be more clearly demonstrated.

Patient Information

A 47-year-old female with heterogeneously dense breasts presented for a 6-month follow-up after a benign left breast biopsy and an annual mammography of the right breast. The patient had no family history of breast cancer. A combined 2D and 3D breast tomosynthesis examination was performed on a Hologic Selenia Dimensions system.

Imaging Findings

The 2D (RCC and RMLO) views demonstrate an ill-defined equal density mass in the 12 o'clock position (Figure 1). On the 2D views alone, the margins are not clearly seen. Right CC and MLO views from the previous year are also shown. These images illustrate the challenge of cancer detection in heterogeneously dense breasts (Figure 2).

The 3D (RCC and RMLO) views clearly demonstrate a spiculated mass in the 12 o'clock position, which is highly suspicious for malignancy (Figure 3). Because the tomosynthesis images provided exquisite lesion shape and margin detail along with precise location, additional spot compression views were not necessary and the patient went directly to ultrasound.

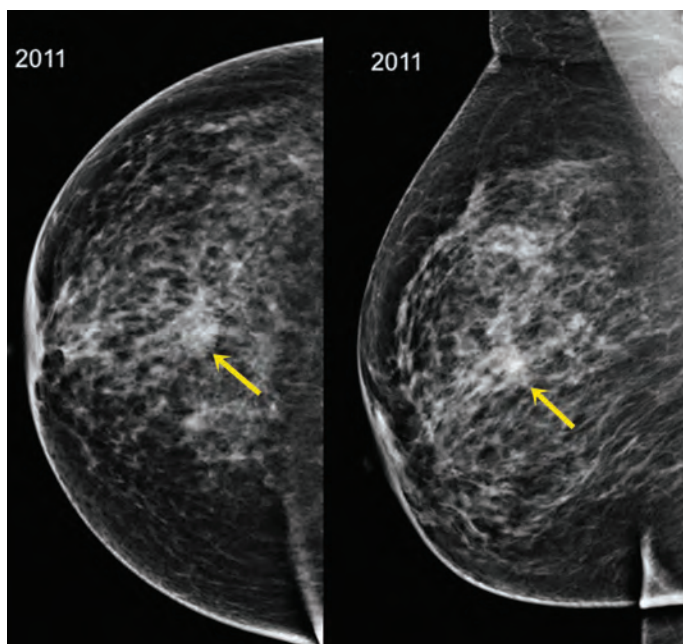


Figure 1. Right CC and MLO 2D views from 2011 demonstrate an ill-defined equal density mass in the 12 o'clock position.

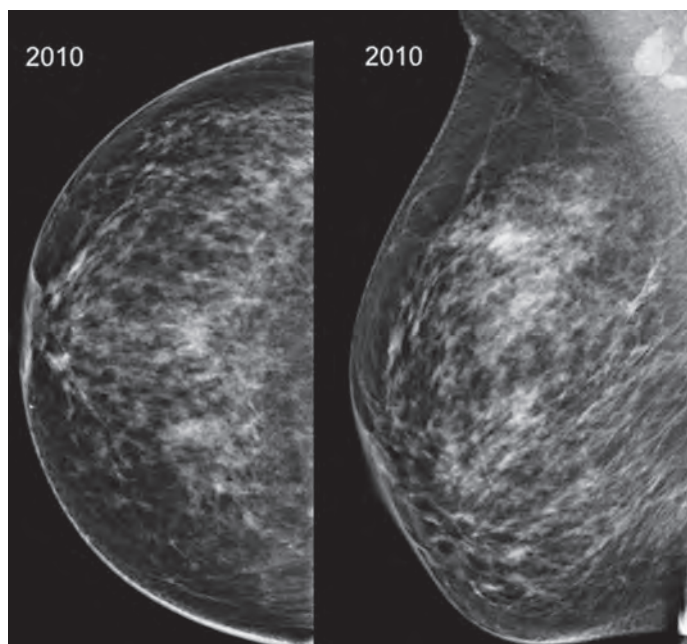


Figure 2. Images from 2010 show that there was little interval change in the 2D appearance of the breast, highlighting the challenge in cancer detection in heterogeneously dense breasts.

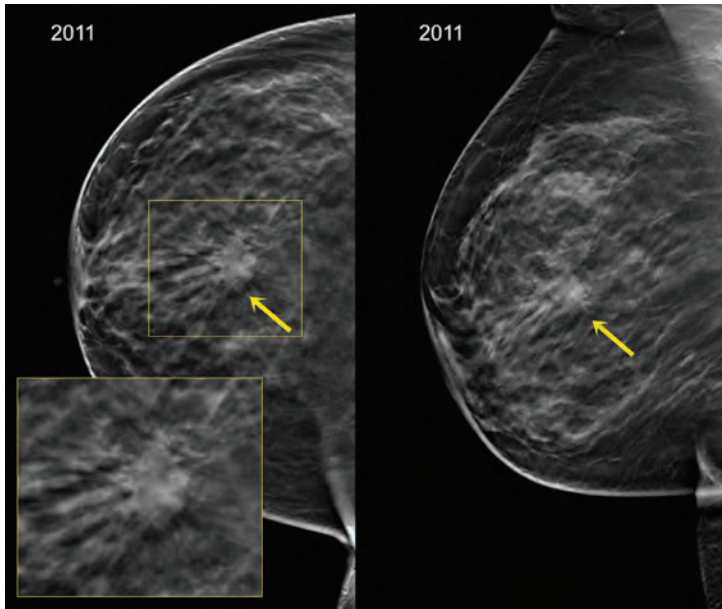


Figure 3. Right CC and MLO tomosynthesis views clearly demonstrate a spiculated mass in the 12 o'clock position.

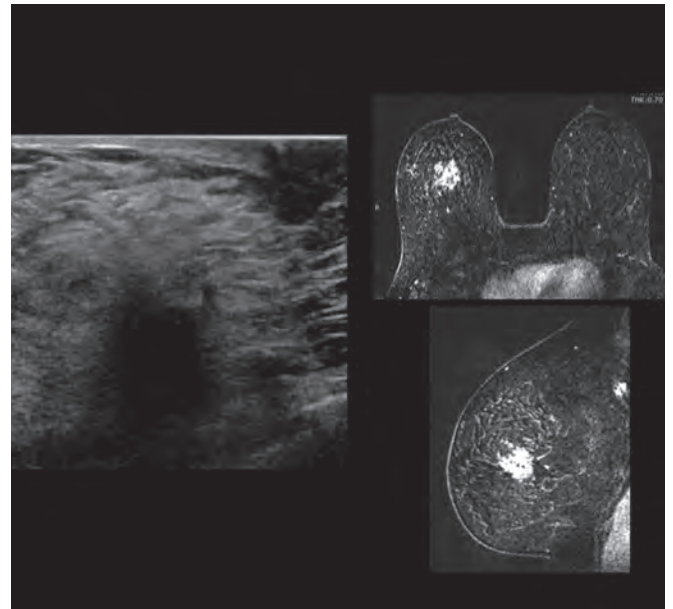


Figure 4. Right breast ultrasound confirmed a hypoechoic, shadowing mass with irregular margins and a bilateral breast MRI showed a spiculated mass with mixed kinetics including washout.

Right breast ultrasound confirmed a 1.9-cm hypoechoic, shadowing mass with irregular margins (Figure 4).

A bilateral breast MRI for extent of disease showed a 2.8 x 3.1-cm spiculated mass with mixed kinetics including washout (Figure 4).

Additional imaging for extent of disease demonstrated osseous metastases to a T12 vertebral body and the left frontal calvarium (not pictured).

Diagnosis

Clinically, Stage IV due to presence of osseous metastases.

The index lesion was a right breast infiltrating ductal carcinoma, nuclear grade 2 with a mucinous carcinoma component. The tumor was 90% estrogen receptor positive, 10% progesterone receptor positive, HER2-positive, and FISH negative.

Treatment

The patient was treated with palliative radiation therapy for the T12 vertebral metastasis and is currently being treated with tamoxifen for systemic treatment of ER+ metastatic disease and denosumab for bone disease.

Discussion

The sensitivity of conventional 2D digital mammography has been shown to be lower in women with dense breasts compared to women with scattered fibroglandular or fatty breasts.⁴ In our case, the abnormality, though visible on 2D, was a vague area of increased density on a background of heterogeneously dense tissue, not significantly changed from the patient's previous mammogram. Without

tomosynthesis, the lesion may not have been appreciated. Additionally, at least 2 supplementary views would have been required for better characterization. However, with the tomosynthesis images, the lesion is clearly visible as a distinct mass with an irregular margin and long spicules. We could confidently assess this as a BIRADS 5, highly suspicious finding, enabling the patient to proceed directly to ultrasound. No additional spot compression views were necessary. In the appropriate clinical setting, this decreased need for additional views could potentially be cost saving, time saving, and radiation dose saving.

Conclusion

Breast tomosynthesis allows for better visualization of lesions, especially in dense breasts. This can result in improved cancer detection and better characterization of lesion margins. We have been able to definitively identify highly suspicious lesions with the use of breast tomosynthesis that would otherwise have required additional views on conventional 2D mammography.

References

1. Poplack SP, Tosteson TD, Kogel CA, Nagy HM. Digital breast tomosynthesis: initial experience in 98 women with abnormal digital screening mammography. *AJR Am J Roentgenol.* 2007;189:616-623.
2. Gur DM, Abrams GS, Chough DM, Gonatt MA, Hakim CA, et al. Digital breast tomosynthesis: observer performance study. *AJR Am J Roentgenol.* 2009;193:586-591.
3. Hakim CM, Chough DM, Ganott MA, Sumkin JH, Zuley ML, Gur D. Digital breast tomosynthesis in the diagnostic setting: a subjective side by side review. *AJR Am J Roentgenol.* 2012;195:172-176.
4. Pisano ED, Hendrick RE, Yaffe MJ, Baum JK et al. Diagnostic Accuracy of Digital versus Film Mammography: Exploratory Analysis of Selected Population Subgroups in DMIST. *Radiology.* 2008;246:376-383.

Tomosynthesis used for a diagnostic mammogram identifies a true positive cancer that spot compression missed

By Laurie Margolies, MD, FACR **Background**

Breast tomosynthesis, approved by the FDA in February 2011, is increasingly used for screening and diagnostic mammography in the United States. The 1-mm thin sections essentially remove overlapping breast tissue, revealing true abnormalities, while allowing one to correctly dismiss summation shadows. Studies have shown that it has superior sensitivity with enhanced specificity in the screening setting.

Diagnostic mammograms performed after an abnormal screening mammogram usually include spot compression views with or without magnification. The improved image detail, improved spatial resolution, improved contrast, noise reduction, and reduction of superimposition of tissue all combine to allow one to better assess if an asymmetry is a true mass, if suspected architectural distortion is a true finding, and better characterize margins of a mass. Spot compression has been used for over 20 years to evaluate abnormal screening mammograms with equivocal findings. Berkowitz, et al, looked at 75 spot compression views obtained to evaluate such findings and demonstrated the utility of spot compression — 65/75 appeared less suspicious, 2/75 did not change and 8 cancers looked more suspicious with spot compression.¹

Patient Information

Patient B presented to our screening facility for her first mammogram. She is a 59-year-old woman without relevant prior history. An aunt does, however,

have a history of breast cancer. She has no other risk factors. A 2-dimensional (2D) full-field digital mammogram was performed and the patient was recalled for additional images to evaluate a focal asymmetry in the left breast. Upon additional questioning, she stated that she might have felt a change in her breast.

At recall, a spot compression view and a lateral view were obtained. Three-dimensional (3D) tomosynthesis was then acquired using a Selenia Dimensions breast tomosynthesis system.

Imaging Findings

The patient's 2D full-field digital screening mammogram reveals heterogeneously dense breasts. On the cranio-caudal (CC) view (Figure 1A), no abnormality was seen, but on the medial lateral oblique (MLO) view (Figure 1B), a spiculated focal asymmetry was seen and the patient was recalled.

A spot view (Figure 2B) appeared to show no abnormality, with effacement of the area of concern, but an abnormality persisted on the lateral image (Figure 2B).

The 3D breast tomosynthesis images, as seen in Figures 3A and B, clearly show a spiculated mass in the upper outer quadrant of the left breast measuring about 2 cm.

Ultrasound confirmed the presence of the mass and was used for biopsy guidance.

Diagnosis

Infiltrating mixed ductal and lobular cancer. A lumpectomy with sentinel node dissection followed by radiation therapy is planned.

Discussion

This case illustrates the role of tomosynthesis in the workup of the recalled patient and also illustrates the benefit of screening with tomosynthesis. If one had relied on just the spot compression view, the patient might have suffered a delay in diagnosis. If tomosynthesis had been the screening exam, the next step would have been ultrasound-guided biopsy and no additional mammographic images would have been needed.

Several studies have evaluated the role of tomosynthesis in diagnostic mammography. Skaane et al, for example, evaluated 84 women who presented for diagnostic evaluation who were dismissed with normal or benign results after 2D imaging. These women also had 3D mammograms, which were interpreted separately. Some women were recalled based purely

Dr. Margolies is an Associate Professor of Radiology and Director of Breast Imaging, Dubin Breast Center, Mount Sinai School of Medicine, New York, NY.

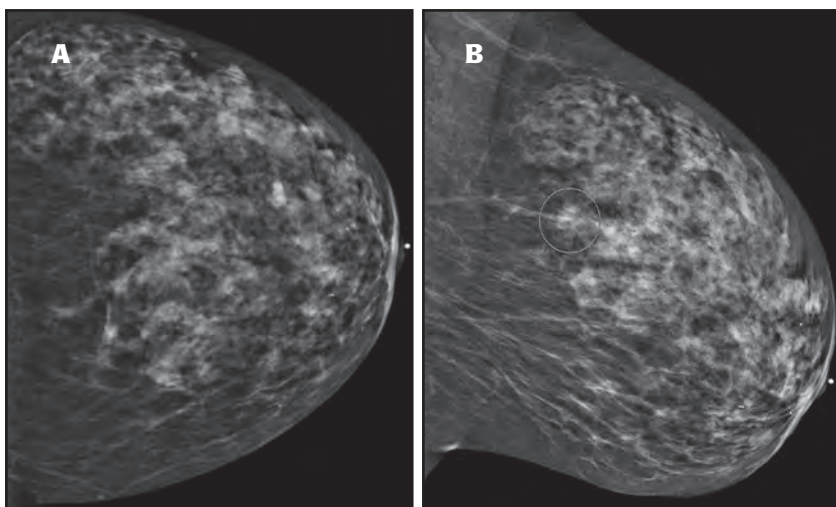


Figure 1. On the cranio-caudal (CC) view (A), no abnormality was seen. The patient's 2D mammogram shows an asymmetry posteriorly on the MLO view (B).

on the tomosynthesis imaging. That is, the 2D exams were read as BIRADS 1 or 2, while the tomosynthesis was read as BIRADS 4 or 5. Four of 84 patients were recalled for biopsy based on the tomosynthesis; 2 of these women had cancer correctly diagnosed on tomosynthesis, but missed on the 2D diagnostic exam. The increased sensitivity of tomosynthesis was attributed to higher conspicuity of the cancers presenting as spiculated masses and distortions. Without tomosynthesis 2/84 patients who had diagnostic mammograms would have had false negatives.²

Noroozian, et al, in a small reader study, evaluated mammographic spot views and digital breast tomosynthesis images of 30 malignant and 37 benign masses and found that mean mass visibility was slightly better with tomosynthesis. All readers found that the masses were more obvious on tomosynthesis. The readers recommended more biopsies based on tomosynthesis. There was a mean increase of 1.8 true positives for every 1.3 false positive assessments.³

Conclusion

Tomosynthesis is useful for diagnostic mammography and may prove to be superior to conventional mammographic spot images for the recalled patient.

References

1. Berkowitz JE, Gatewood OM, Gayler BW. Equivocal mammographic findings: evaluation with spot compression. *Radiology*. 1989;171:369-371.

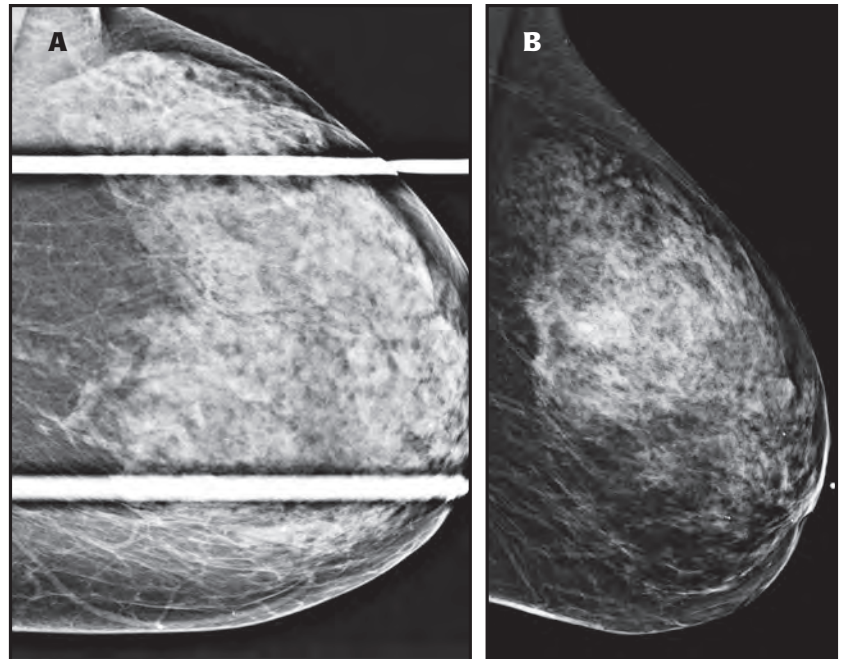


Figure 2. The patient's spot view and lateral view (A and B).

2. Skanne P, Guillen R, Bjorndal H, et al. Digital breast tomosynthesis (Tomosynthesis): Initial experience in a clinical setting. *Acta Radiol*. 2012;53:524-9.

3. Noroozian M, Hadjiiski L, Rahnama-Moghadam S, Klien KA, et al. Digital breast tomosynthesis is comparable to mammographic spot views for mass characterization. 2012 Jan;262:61-68. Epub 2011 Oct 13.

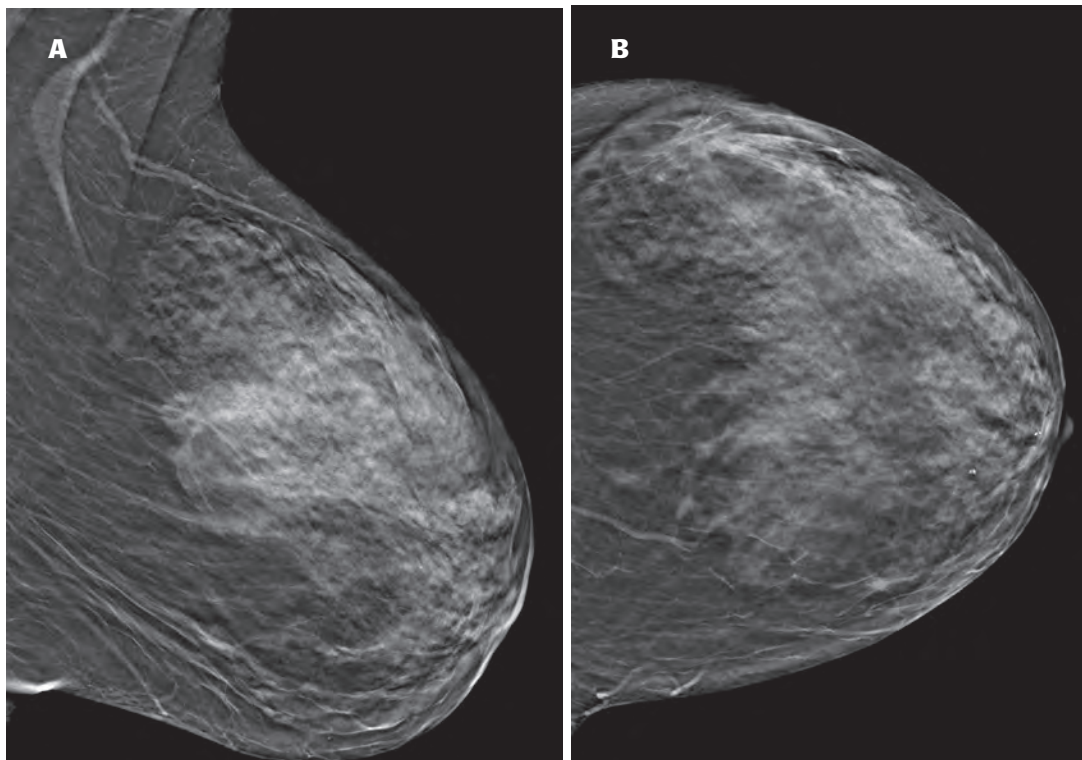


Figure 3. The 3D images (A and B) clearly show a spiculated mass in the CC and MLO projections.

Stage 1 breast cancer diagnosed by tomosynthesis in dense breasts

Liva Andrejeva, MD, Mahdavi Raghu, MD, and Liane Philpotts, MD

CASE SUMMARY

A 74-year-old female presented for routine screening mammography. She has undergone screening mammography yearly for the past several years, and her mammogram last year was interpreted as normal. She underwent a surgical right breast biopsy 32 years ago that yielded benign results, and no family history of breast cancer. She has used hormone replacement therapy since menopause.

DIAGNOSIS

Stage T1c, N0, M0 stage 1 left breast cancer

IMAGING FINDINGS

A 2-dimensional (2D) mammogram reveals heterogeneously dense breast tissue without focal masses or asymmetries and without changes when compared to earlier mammograms (Figure 1).

A 3-dimensional (3D) mammogram reveals an area of architectural distortion in the lateral aspect of the left breast, seen on the CC tomosynthesis view only (Figure 2), estimated to be at the 3 o'clock position based on its tomosynthesis slice number.

The patient was asked to return for additional mammographic views and an ultrasound. CC and MLO spot-compression views demonstrate no definite

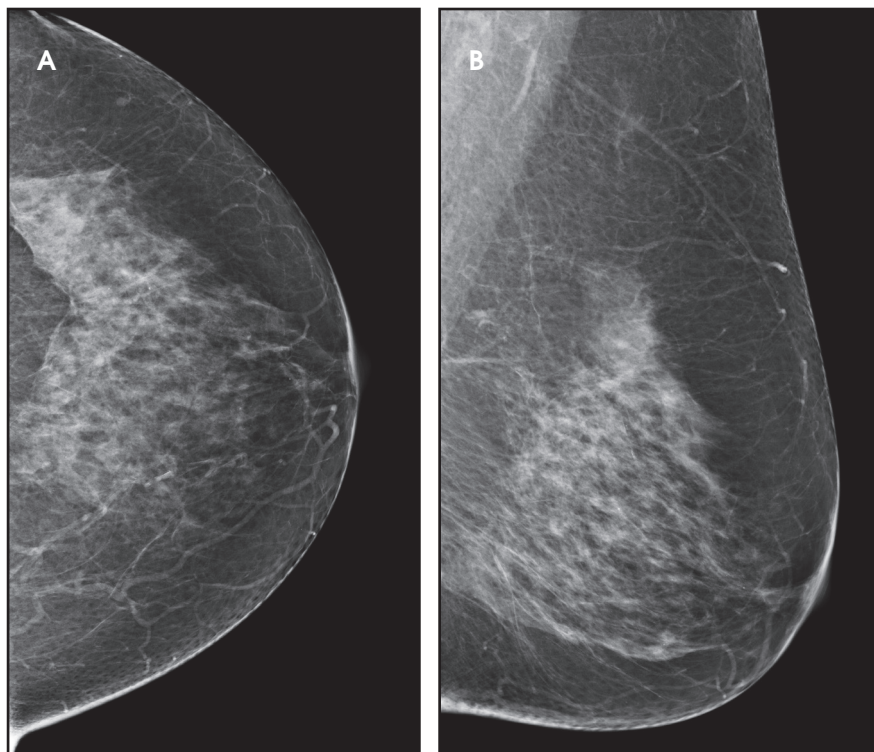


FIGURE 1. Left screening 2D MLO (A) and CC (B) screening views demonstrate dense breast tissue, but no definite abnormality.

abnormality in this area (Figure 3), but a targeted ultrasound reveals a 5.5-mm spiculated mass at the 3 o'clock position (Figure 4).

DISCUSSION

Pathology results yielded an infiltrating and in-situ carcinoma, with the

well-differentiated infiltrating component measuring 1.1 cm and demonstrating tubulolobular features, nuclear grade 2, ER/PR receptor positive, HER 2/neu receptor negative. The grade 2 in-situ component measured 0.3 cm. Other associated findings included a radial scar, multifocal atypical ductal

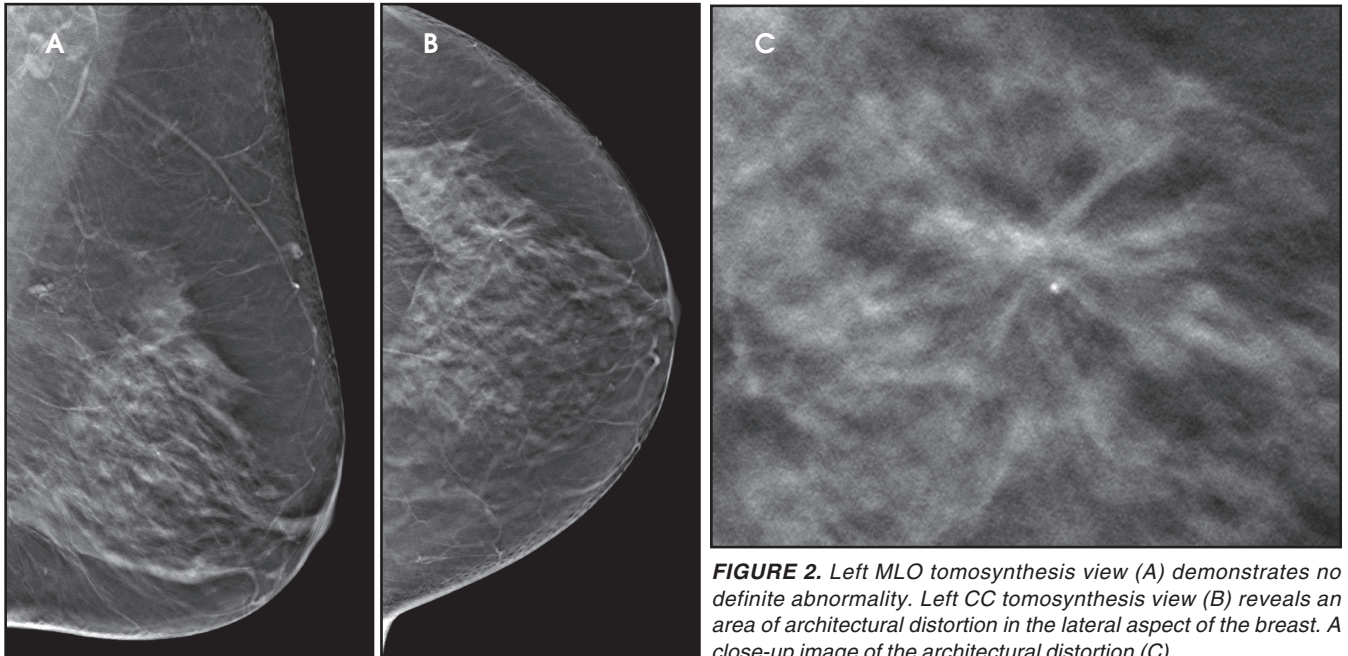


FIGURE 2. Left MLO tomosynthesis view (A) demonstrates no definite abnormality. Left CC tomosynthesis view (B) reveals an area of architectural distortion in the lateral aspect of the breast. A close-up image of the architectural distortion (C).

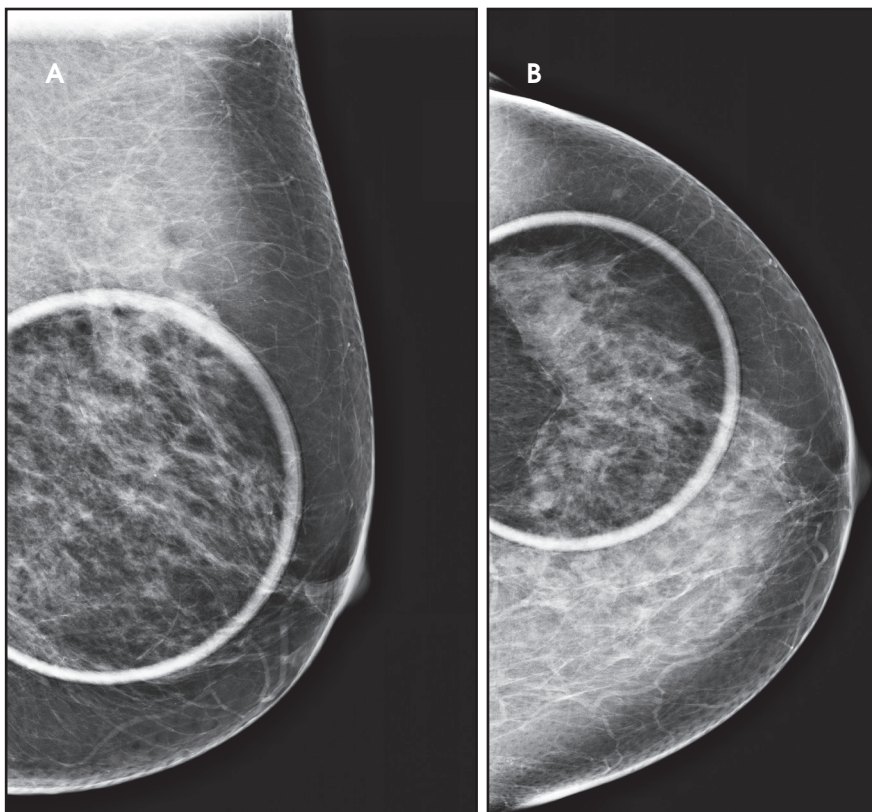


FIGURE 3. Spot MLO (A) and spot CC (B) views demonstrate no definite abnormality.

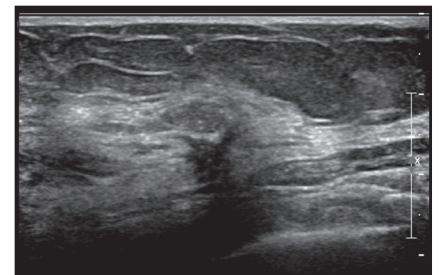


FIGURE 4. Ultrasound of the 3 o'clock region of the left breast demonstrates an irregular hypoechoic lesion.

hyperplasia, and lobular intraepithelial neoplasia. Two left-axillary sentinel lymph nodes were negative for metastatic carcinoma.

The patient underwent a mammographically-guided needle localization and a lumpectomy (Figures 5 and 6), followed by whole breast radiation therapy. She was advised to cease hormone replacement therapy.

Breast tomosynthesis enabled us to detect a small, early stage carcinoma in this patient with dense breast tissue, while there was no abnormality detected on conventional 2D digital

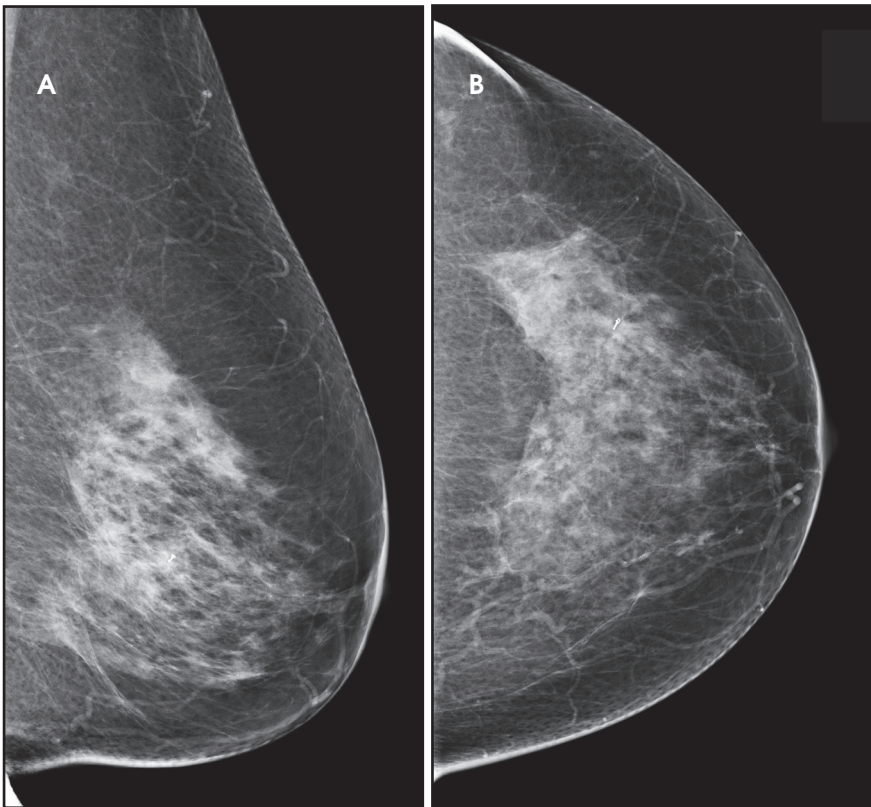


FIGURE 5. Post-biopsy ML (A) and CC (B) views demonstrate the biopsy-marking clip to be in the area of the architectural distortion.



FIGURE 6. CC view of the left breast obtained following wire localization demonstrates the wire in optimal position.

mammography. Findings seen in one view only on conventional 2D mammography frequently present a significant challenge. In this instance, the finding was seen on the CC tomosynthesis view only and we were able to localize this finding to the 3 o'clock position in the breast secondary to its tomosynthesis slice position.

Digital breast tomosynthesis is a novel technique that allows the visualization of fibroglandular breast tissue in multiple planes rather than in just 2 planes of conventional 2D mammography, thereby enabling the radiologist to better evaluate the configuration of areas of fibroglandular tissue. As all radiologists who read mammograms know, breast tissue has an extremely varied appearance with no 2 breasts being alike. The detection of early malignant changes within normal fibroglandular tissue, particularly in dense breasts, has been a longstanding challenge. Tomosynthesis may assist us in discerning small areas of distortion and spiculation within tissue that appears unremarkable on 2D mammography.¹

CONCLUSION

Three-dimensional breast tomosynthesis may allow the detection of small cancers, which could otherwise remain unseen until they become significantly larger or even palpable. It may be superior to spot compression views in the evaluation of asymmetries and architectural distortion.

REFERENCES

1. Svahn, TM, Chakraborty, DP, Ikeda D, et. al. Breast tomosynthesis and digital mammography: A comparison of diagnostic accuracy. *BR J Radiol.* 2012;85:e1079-1082.

Dr. Andrejeva is an Assistant Professor and Attending Radiologist, Dr. Madhavi Raghu is an Assistant Professor and Attending Radiologist, and Dr. Liane Philpotts is a Professor and Attending Radiologist, Breast Center, Smilow Cancer Hospital at the Yale-New Haven Hospital, New Haven, CT.