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Digital Breast Tomosynthesis: Update on Technology, Evidence, and Clinical Practice

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Abstract

Digital breast tomosynthesis (DBT) has been widely adopted in breast imaging in both screening and diagnostic settings. The benefits of DBT are well established. Compared with two-dimensional digital mammography (DM), DBT preferentially increases detection of invasive cancers without increased detection of in-situ cancers, maximizing identification of biologically significant disease, while mitigating overdiagnosis. The higher sensitivity of DBT for architectural distortion allows increased diagnosis of invasive cancers overall and particularly improves the visibility of invasive lobular cancers. Implementation of DBT has decreased the number of recalls for false-positive findings at screening, contributing to improved specificity at diagnostic evaluation. Integration of DBT in diagnostic examinations has also resulted in an increased percentage of biopsies with positive results, improving diagnostic confidence. Although individual DBT examinations have a longer interpretation time compared with that for DM, DBT has streamlined the diagnostic workflow and minimized the need for short-term follow-up examinations, redistributing much-needed time resources to screening. Yet DBT has limitations. Although improvements in cancer detection and recall rates are seen for patients in a large spectrum of age groups and breast density categories, these benefits are minimal in women with extremely dense breast tissue, and the extent of these benefits may vary by practice environment and by geographic location. Although DBT allows detection of more invasive cancers than does DM, its incremental yield is lower than that of US and MRI. Current understanding of the biologic profile of DBT-detected cancers is limited. Whether DBT improves breast cancer-specific mortality remains a key question that requires further investigation.

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Introduction

Since its initial approval by the U.S. Food and Drug Administration (FDA) in 2011, digital breast tomosynthesis (DBT) has been rapidly integrated into routine mammographic screening and has been shown to improve overall screening performance compared with digital mammography (DM) (1–3). The improved cancer detection and reduced number of screening recall examinations have also been shown to be preserved with the use of synthetic mammography (SM) instead of DM (4,5). Similarly, increased accuracy and reader confidence have been demonstrated with the use of DBT in the diagnostic setting (6,7).

Yet there remain challenges and unanswered questions as DBT becomes increasingly incorporated into clinical practice, and a more nuanced understanding of clinical outcomes is needed. For example, despite known improvements in screening benchmarks with DBT, the benefits of the modality vary throughout screening rounds and according to patient breast density, and are reduced in fatty and extremely dense breasts. Although women with fatty breasts benefit from a lower recall rate with DBT, for those with extremely dense breast tissue, the benefit is minimal (1). Although there is growing evidence that the benefits of DBT are sustainable over time, the magnitude of these benefits likely varies (1,8). DBT has allowed increased detection of small node-negative invasive cancers by mitigating tissue obscuration, but its long-term effect on mortality is currently unknown. In addition, the role of DBT must be evaluated in the context of supplemental screening modalities such as US and MRI in women who undergo multimodality screening. Finally, there are ongoing efforts to improve the efficiency, efficacy, safety, and quality assurance of DBT. Although vendors of imaging equipment have galvanized continued technical innovation to improve accuracy, reduce radiation dose, and diversify their systems, standardization and quality assurance have also become increasingly challenging and complex.

Therefore, the purpose of this article is to provide an update on the state of the field by examining current practice guidelines, discussing emerging data, considering vendor diversification, and exploring technical advances and clinical implications. A better understanding of the current status and progress of DBT will help inform our future practice in the best use of this important technology to optimize patient care.

Current Scope

DBT gained rapid early acceptance on the basis of retrospective data that consistently showed improved detection of cancer (15%–53%) and decreased recall (15%–37%) rates (Table 1) (9–18). Despite validation of these results in prospective trials, a current lack of long-term outcomes and randomized trials has precluded the endorsement of DBT as the standard of care for evaluation for breast cancer in some clinical guidelines (19). Nevertheless, DBT has been rapidly disseminated in the United States, in part supported by consumer confidence and demand. According to the Mammography Quality Standards Act (MQSA) National Statistics (20), 71.5% of all certified breast imaging facilities and 41.1% of all accredited mammography units in the United States have DBT capability as of August 2020. Dedicated Current Procedural Terminology (CPT) codes for DBT became available in 2015, simplifying the billing issues that plagued the early clinical adoption of DBT and

paving the way for further integration (21). However, worldwide adoption of DBT has been relatively slow, often with cost-effectiveness as a primary concern, particularly in parts of the world where resources are limited (22). This uneven adoption highlights the unresolved question of whether an upgrade from conventional two-dimensional mammography to DBT provides an advantage sufficient enough to save more lives.

Screening Outcomes and Guidelines

Cancer Detection Rates

The initial evidence for screening with DBT emerged in retrospective studies (9–18) performed during early adoption of the technology into clinical practice (Table 1). Although these studies have consistently shown an increase in detection of cancer, particularly invasive cancer, the majority of data are from first-round screening only, and questions of overestimation and sustainability of the advantage of cancer detection with DBT have been raised. Emerging longitudinal data from prospective studies (2,23) are shedding light on longer-term use, but results are mixed. Although studies (8,24–26) have shown a continued benefit from the use of DBT over consecutive rounds of screening, the extent of this gain varies, and the expected increase in cancer detection is not significant in some studies.

Neither of the two studies (8,25) with the longest consecutive use of DBT to date (each reporting on more than five rounds of annual screening) showed a statistically significant increase in cancer detection. One study (8) in which cancer detection rates with DBT were compared with those for DM showed six versus 5.1 cancers per 1000 examinations, respectively ($P = .25$), and the other (27) showed cancer detection rates of 5.24 versus 4.6 per 1000 examinations, respectively ($P = .37$). Nevertheless, sustained preferential detection of invasive cancers is demonstrated in most studies across age groups and breast density categories (23,27). Women who underwent their first DBT examination had a higher yield of cancer than did those who underwent at least one prior DBT examination (6.1 vs 4.4–5.7 per 1000 examinations, respectively) ($P < .05$) (25). Similarly, more nuanced differences were also observed in women who underwent screening with varying combinations of DBT and DM over time. In a large population-based study (28), cancer detection rates in women who underwent consecutive biennial screening with DM after DM, DBT after DM, and DBT after DBT were 4.6, 9.9, and 8.3 per 1000 examinations, respectively. Outcomes incorporating SM are discussed later as a part of technical considerations.

Mortality Benefit

The ultimate goal of screening is to reduce breast cancer mortality. Although we assume DBT, at minimum, shows a reduction in breast cancer mortality similar to that seen in the large randomized controlled trials (29–32) in which screening mammography was evaluated, whether it confers further mortality benefit through detection of additional cancers when compared with DM is less clear. Therefore, a better understanding of the types of cancers detected at DBT is essential. Because DBT simultaneously accentuates detection of masses and architectural distortions (more often true-positive results), and decreases recall of patients with asymmetries that are often areas of tissue summation (more often false-positive results), it enhances both the sensitivity and specificity of cancer detection (Fig 1) (15). DBT

has not been shown to increase detection of in situ cancers, mitigating the potential issue of overdiagnosis (2,33).

Although DBT has been consistently shown to allow preferential detection of invasive cancers, most studies have also shown that these cancers may tend to be more indolent. Early data have shown, to a varying extent, that DBT-detected cancers are often smaller (<1 cm) than DM-detected cancers (42.0%–50.0% vs 33.1%–41.6%, respectively; $P < .001$), of lower histologic grade (grade 1, 37.9%–43.5% vs 25.6%–26.1%, respectively; $P < .001$), and less likely to be node positive (11.2% vs 19.0%) (23, 24, 28,34). Cancers detected only with DBT, in particular, are more likely to be grade 1 tumors (DBT-only vs all cancers, respectively, 41.7% vs 12.1%; $P < .001$), of the luminal A–like subtype (45.8% vs 13.5%, respectively; $P < .001$), and associated with low proliferative indices (Ki-67 < 14%) (45.8% vs 17.0%, respectively; $P < .001$) (35). However, these findings have not been consistently reproduced in the more recent longitudinal studies (2,8,24), and the full prognostic implications of DBT require further study. Although improved depiction of small spiculated masses with DBT optimizes visualization of the size and shape of tumors that are typical of more indolent cancers, not all cancers or spiculated masses detected with DBT are indolent (36).

In a prospective study (2) of women undergoing consecutive biennial screening examinations, those who underwent prior DBT screening were found to have significantly fewer grade 1 (but not grade 2 or 3) invasive cancers (DM after DBT vs DM after DM; 0.5 vs 1.3 per 1000 women; $P = .001$). However, interval cancer rates did not vary between the two groups, which suggests that there are potentially important biologic differences between the screening-detected and interval cancers (2).

Without data from randomized controlled trials with long-term follow-up, the interval cancer rate serves as a surrogate measure of screening efficacy and is an indirect indicator of mortality benefit. True interval cancers are aggressive tumors with rapid growth that outpaces the frequency of screening. Interval cancers are known to have poor survival outcomes (37,38). Early experience with DBT led to anticipation of a curtailed interval cancer rate, given the significant increase in detection of invasive cancers. However, no change in the interval cancer rate has been reflected in published results (2,8,24,33,39,40) so far, although the available studies may have been statistically underpowered, and more robust data are likely needed (Table 2).

Studies (2,39) performed specifically to evaluate interval cancers have also reported no difference in tumor size, grade, nodal status, or histopathologic characteristics between interval cancers found after DBT or DM screening examinations with negative results. These findings suggest potential modality-based limitations of mammography intrinsic to anatomic imaging (as opposed to functional imaging). However, further studies with longer-term follow-up are needed, and a small number of large randomized controlled trials are currently underway, including the much anticipated Tomosynthesis Mammographic Imaging Screening Trial (TMIST) (41–43). Results from TMIST, which will compare reduction in the incidence of advanced cancers in each arm of the study, will help us understand the

biologic profiles of DBT- and DM-detected breast cancers and their long-term outcomes and hence will allow better understanding of the effect of DBT (42).

Multimodality Screening

US is currently the most common supplemental imaging modality used in women with dense breast tissue because of its wide availability. Mammographic sensitivity, including DBT sensitivity, is limited in women with dense breasts, particularly in those with extremely dense breast tissue (1,44). Mammographic density is also an independent risk factor for developing breast cancer; women with extremely dense breasts have been shown to have a four- to sixfold higher risk of developing breast cancer when compared with women with fatty breasts (45). Multiple studies have shown that supplemental US screening after mammography (DM) can increase the cancer detection rate by 3.2–4.3 per 1000 women with dense breasts (46–48).

The incremental gain of US has also been shown to be sustainable throughout multiple years of screening. For example, the large prospective multicentered American College of Radiology Imaging Network (ACRIN) 6666 trial (48) showed incremental cancer detection rates of 5.3, 3.7, and 3.7 per 1000 women in years 1, 2, and 3. Similarly, in a retrospective study (49) performed after the Connecticut breast density legislation came into effect, US showed incremental cancer detection rates of 4.0, 3.3, 3.1, and 3.3 per 1000 women in years 1–4. The additional cancers detected with US have also tended to be invasive, small (median size, 9–10 mm) (48,50), and node negative (86%–96%) (51,52). In the large randomized controlled Japan Strategic Anti-cancer Randomized Trial (J-START) (52), supplemental US screening not only improved sensitivity (91.1% vs 77.0%; $P = .0004$) and early cancer detection (71.3% vs 52.0% of stage 0 or 1 cancers; $P = .0194$) but also significantly lowered the interval cancer detection rate (0.05% vs 0.10%; $P = .034$).

However, if DBT is used, the added benefit of supplemental US is likely lower. The prospective Adjunct Screening with Tomosynthesis or Ultrasound in Women with Mammography-Negative Dense Breasts (ASTOUND) trial to evaluate the incremental cancer yield of DBT versus US in mammography showed that DBT allowed detection of more than one-half of the additional cancers found with US in women with dense breasts and DM results that were negative for cancer, with fewer incremental false-positive results (DBT vs US, incremental cancer detection rates: 2.83–4 vs 4.9–7.1 per 1000 women; $P = .006$ –.015; incremental false-positive recall rate: 0.3% vs 1.0%, respectively; $P < .001$) (53,54).

The added cancer detection with US is accompanied by an increase in false-positive findings and lower positive predictive values for biopsy compared with mammography, although the false-positive rate tends to improve in subsequent rounds of screening. In the ACRIN 6666 trial, the absolute increase in the false-positive rate was 15.1% during the initial round of screening when US was added to mammography, which decreased to 7.4% in subsequent rounds because of the availability of prior US examinations (48). In the same study, the positive predictive value for lesions detected only with US (hereafter, US-only lesions) was 38.1%, compared with 11.7% for mammography (48).

In addition, handheld US is operator dependent, which is reflected in variable cancer detection rates reported with technologist-versus physician-performed handheld US (2.5 vs 5.3 per 1000 examinations, respectively) (47,48,51,55). Although automated breast US may help to address operator dependence and streamline imaging, challenges include incomplete coverage of larger breasts, longer interpretation time due to the increased number of images, and automated breast US recalls that require immediate handheld US examination for further assessment. For all of these reasons, automated breast US is currently not widely implemented, and screening data are less robust compared with those of handheld US.

Finally, despite increased cancer detection with supplemental US in addition to mammography, approximately 8% of cancers are not detected with US or mammography (48), and the cost-effectiveness of supplemental US remains uncertain (56).

Therefore, parallel investigation of breast MRI has been ongoing to bridge the gap in screening with mammography and US. Despite the decreased tissue masking and increased visibility with DBT, the incremental gain in the cancer detection rate when compared with DM has been modest (0.7–2.7 per 1000 examinations), and sensitivity for detection of biologically aggressive tumor subtypes is limited (30%–40%) (13, 57,58).

Dynamic contrast-enhanced MRI, on the other hand, has been shown to allow preferential detection of more invasive and higher-grade tumors when compared with mammography, owing to the high sensitivity that is intrinsic to functional imaging (59). In the ACRIN 6666 study, the sensitivity of MRI in addition to DM and US was 100%, compared with 76% with DM and US and 52% with DM alone. Although US performed in addition to DM allowed 3.7 additional cancers per 1000 examinations to be detected, MRI allowed 14.8 additional cancers per 1000 examinations to be identified, nine of which were only detected with MRI (48). The supplemental cancer yield of MRI in addition to DM is also maintained when DBT is used. In a study (60) evaluating the performance of screening MRI in women at higher-than-average risk of breast cancer, there was no significant difference between the supplemental cancer detection rate of MRI after negative DM versus that after DBT (11 vs 16 cancers per 1000 examinations, respectively; $P = .23$). Multiple studies (61–64) have shown that if MRI is performed in addition to mammography, US does not provide further cancer yield but significantly increases false-positive results. Therefore, there has been growing interest in using MRI to screen women with dense breast tissue to better overcome the limitations of mammography.

In a recent prospective trial (65) in women with extremely dense breast tissue ($n = 40\ 373$; age range, 50–75 years), the incremental cancer detection rate of supplemental MRI was 16.5 per 1000 women, which resulted in a 50% reduction in the interval cancer rate.

To expand the role of MRI in screening, abbreviated MRI has been developed to curtail time and cost and increase the feasibility of wider use. In a multicenter study evaluating women with dense breasts who underwent both DBT and abbreviated MRI in two rounds of annual screening (1444 women with heterogeneously or extremely dense breasts; age range, 40–75 years), abbreviated MRI allowed detection of significantly more invasive cancers than did DBT (11.8 vs 4.8 invasive cancers per 1000 women, respectively; $P = .002$), with no interval

cancers observed during follow-up. However, while abbreviated MRI has higher sensitivity than does DBT in dense breasts (95.7% vs 39.1%, respectively), DBT retains higher specificity than that of abbreviated MRI (97.4% vs 86.7%, respectively) (66). Finally, an alternative to MRI and another promising technique that is under investigation for supplemental imaging is contrast-enhanced mammography, which has been shown to have similar sensitivity and specificity when compared with MRI and has been integrated with DBT, with the potential to improve characterization of lesions (67–69).

Screening Environment

Screening outcomes with DBT vary widely according to the screening environment. A meta-analysis (70) of DBT outcomes across continents that included a large number of participants ($n = 1\,009\,790$) showed significantly higher pooled incremental cancer detection rates in European and Scandinavian studies than those in U.S. studies (2.4 vs 1.1 cancers per 1000 examinations, respectively; $P < .001$), and a significantly higher reduction in recall rates in U.S. studies compared with those in European or Scandinavian studies (–2.9% vs 0.5%, respectively; $P < .001$). This illustrates that the effect of a technology is dependent on the context of its clinical environment. DBT improves the cancer detection rate to a greater extent in Europe and Scandinavia than it does in the United States, in part because of typically biennial screening in Europe and Scandinavia as opposed to annual screening in the United States. DBT reduces recall rates to a greater extent in the United States, where the baseline recall rates are relatively high (pooled baseline recall rates of the United States vs Europe, 11.3% vs 3.5%) (70).

Further differences likely also exist, given population differences in breast cancer prevalence. In the screening environment of the United States, no differences were shown with adoption of DBT when comparing practice types. A large prospective study in the United States (26), in which 104 radiologists throughout 53 facilities participated as a part of the Breast Cancer Surveillance Consortium (BCSC), showed that DBT improved recall rates similarly for both academic breast radiologists and private practice radiologists who interpret breast examinations. Improvements in the recall rate may vary according to the degree of DBT integration. Although most studies in the United States at institutions with full DBT integration show significantly decreased screening recall rates (8,25), there is evidence that DBT may not lead to a significant change in the recall rate in hybrid practice environments where both DBT and DM are used (71,72).

DBT Screening Guidelines

Despite the benefits of improved cancer detection and decreased recall, DBT is largely considered to be optional in current breast cancer screening guidelines because of insufficient data supporting improvement in disease-specific mortality.

The nuances of screening with DBT are implicit in the opening statement of the most recent version of the National Comprehensive Cancer Network (NCCN) guidelines for breast cancer screening (73): “The NCCN panel emphasizes adopting strategies and research to reduce the harm of screening (false positives and overdiagnosis) rather than raising the age to initiate screening to potentially delay these issues. This includes newer imaging

modalities that improve the detection of breast cancer with fewer recalls (eg, tomosynthesis). Research to better define the biology of breast cancer is needed so that lesions that are not destined to progress are either not treated or are treated less aggressively.” Accordingly, the NCCN guidelines recommend that DBT be considered at annual screening mammography in women of average risk for cancer beginning at the age of 40 years, and in annual screening among high-risk women starting at the age of 30 years in the appropriate clinical scenario (73).

The American College of Radiology (ACR) Appropriateness Criteria (74) similarly recommend either DM or DBT as appropriate for routine screening. Furthermore, the European Commission Initiative on Breast Cancer (ECIBC) guidelines for breast cancer screening (2020) also deem the use of DBT as conditional. The Commission stresses that integration of DBT must be considered in the context of organized screening programs, with cost as a mandatory consideration, because resources vary throughout Europe. Radiation dose is also an additional mandatory consideration and can be mitigated with SM. Accordingly, either DBT or DM is currently recommended in women at average risk of cancer, who are invited to biennial screening starting at the age of 45 years, regardless of mammographic density; and concurrent use of DBT and DM is not recommended to minimize radiation (75). These guidelines are echoed in recommendations from the European Society of Breast Imaging, on the basis of similar questions of clinically relevant reduction in the interval cancer rate and cost-benefit concerns that are currently insufficiently evaluated (76).

Diagnostic Outcomes and Guidelines

Reducing Additional Views

The improved lesion conspicuity and depiction of margins that DBT offers have not only allowed better detection of cancer at screening, but have also helped to streamline diagnostic evaluation. With DBT, the need for additional views has decreased for noncalcified findings, although magnification views are still required to fully assess microcalcifications. Authors of multiple studies (6,77,78) have found improved accuracy in evaluation of noncalcified breast lesions with DBT when compared with two-dimensional spot compression views. This has been shown both in screening recalls and evaluation of symptoms (77). In a large 15-reader study (79) in the diagnostic setting, DBT was found to improve overall accuracy when compared with DM, and improved individual performance for 14 of 15 radiologists (area under the curve, 0.927 vs 0.872, respectively; $P = .008$). In this study, DBT not only reduced the need for additional views ($\chi^2 = 17.63$; $P < .001$), but also improved sensitivity, specificity, and positive and negative predictive values when compared with DM (0.93, 0.75, 0.64, 0.96 vs 0.9, 0.56, 0.49, 0.92, respectively) (79). Further studies have also shown that the use of DBT in the diagnostic setting has led to a reduced need for US and biopsy, which further simplifies workup (79,80). Therefore, diagnostic examinations with DBT are more expedient, more accurate, and lower in radiation dose when compared with DM, which both benefits the patient and improves clinical outcomes and workflow.

Positive Predictive Value of Biopsy

The likelihood of malignancy in lesions recommended for biopsy is higher after DBT than after DM diagnostic assessment. Multiple studies have found that diagnostic DBT leads to an improved positive predictive value for biopsy while maintaining the cancer detection rate and improving patient selection for biopsy (81,82). In a prospective study (81) of women ($n = 30\,933$) who were recalled for additional imaging in the U.K. National Health Services Breast Cancer Screening Program, the use of DBT in diagnostic evaluation of recalled women decreased the biopsy rate from 69% to 36% and increased the positive biopsy rate from 24.9% to 47.7% ($P < .001$). Similarly, in a single-institution study in which the performance metrics of diagnostic examinations before and after integration of DBT (22 883 DM examinations vs 22 824 DBT and DM examinations), the DBT group was found to have a lower abnormal interpretation rate and higher positive predictive value (39.6% vs 33.8%, respectively; $P < .001$), with DBT examinations associated with a significantly higher proportional invasive cancer yield (83.7% vs 72.3%, respectively; $P < .001$) (82).

The increase in positive predictive value at diagnostic assessment is, in part, a result of a downstream shift in lesion distribution at diagnostic examinations because of changes in screening recall with DBT.

Some studies (7,15) have shown a relative decrease in Breast Imaging Reporting and Database System (BI-RADS) 3 classifications and a concomitant increase in BI-RADS 1 or 2 and 4 or 5 classifications with the use of DBT, while others have shown no significant change in the rate of BI-RADS 3 classifications (83,84). However, in all studies (7,15,83,84), the authors found a significant decrease in the number of patients for whom short-interval follow-up was recommended after DBT. Hence, another advantage of DBT is that fewer follow-up studies result from diagnostic examinations, freeing up resources and improving examination cost-effectiveness.

Architectural Distortion

Architectural distortions are better visualized with DBT than with DM. Although DBT has decreased the overall recall rate, recall for architectural distortion has increased with the use of DBT (15). One study (84) showed that architectural distortion was approximately 50% more common with DBT than with DM (0.14% vs 0.07%, respectively; $P < .001$), thus increasing identification of both benign and malignant lesions. Unexplained architectural distortion in a patient without a history of surgery or trauma requires tissue diagnosis, because it is often associated with malignancy. However, multiple studies (84–86) have shown that not all architectural distortions are equal. For instance, architectural distortions detected only with DBT are less likely to be malignant than those also detected with DM (10.2% vs 43.4%, respectively; $P < .001$). Architectural distortions with US correlates are also more likely to be malignant than those without correlates (66.5% vs 29.2%, respectively; $P < .001$). However, architectural distortions detected only with DBT, with or without US correlates, still have substantial malignancy rates (12.1% vs 7.7%; $P = .645$). For these reasons, biopsy is usually appropriate for well-visualized architectural distortions, despite US findings. (86).

DBT detection of architectural distortions contributes to improved sensitivity for detection of invasive cancers, especially for invasive lobular cancers, which are historically elusive and often occult on DM images. Studies have shown that invasive lobular carcinomas are highly associated with architectural distortions (up to 87%) and are less likely to manifest as high-attenuating masses alone; therefore, they are well accentuated at DBT (87,88). Multiple studies (89–91) have shown a higher detection rate of invasive lobular carcinomas with DBT than that with DM. In addition, the literature shows higher accuracy in evaluation of the extent of the disease for invasive lobular carcinomas, which are frequently multifocal or multicentric and bilateral. On the other hand, DBT also contributes to increased detection and biopsy of nonmalignant architectural distortions, most commonly radial scars, which account for at least 33.2% of architectural distortions detected with DBT (84). The management of radial scars typically includes surgical excision because of a possibility of upgrading to malignancy at surgery, but surveillance may also be appropriate when factors such as sampling method, the presence of atypia, and radiologic-pathologic correlation are taken into consideration (92).

Workflow Efficiency

Efficiency is a common concern with DBT because of its increased interpretation time. DBT screening examinations have been shown to require 47% longer interpretation time than DM examinations (average minutes per study, 2.8 minutes vs 1.9 minutes, respectively, even for experienced readers) (93). Yet a concurrent increase in the number of screening examinations and a decrease in diagnostic examinations has also been observed with DBT (94). This redistribution of examinations is in keeping with the previously discussed decreased need for diagnostic evaluations due to decreased recall rates. Such a shift may result in an overall decrease in the number of more time-intensive practice-level diagnostic examinations, helping to balance out the longer interpretation times per case (93).

DBT Diagnostic Guidelines

DBT has been helpful in diagnostic assessment in practice settings with both full and partial integration of the modality for screening. For example, DBT has contributed to a significant increase in detection of architectural distortions, many of which are only visible with DBT (84). Screening recalls based on DM examinations in a hybrid practice also often benefit from DBT diagnostic workup with increased accuracy (95). Although DBT is not required for diagnostic evaluation of breast findings, it is a valuable tool when it is available. In fact, the 2020 European Commission Initiative on Breast Cancer (ECIBC) guidelines for screening recalls due to lesions suspected to be cancer in women at average risk suggest the use of DBT over that of DM, although DBT is not currently mandated for screening (75). This approach takes full advantage of the higher sensitivity and specificity associated with DBT but limits the scope of use to the diagnostic setting only, where the cancer yield is higher than that in the screening setting, and aims to optimize cost-effectiveness. In comparison, the current ACR Appropriateness Criteria (96) in the United States do not explicitly comment on use of DBT in the context of screening recall, but recommend either DM or DBT as appropriate for diagnostic evaluation in symptomatic women aged 30 years or older for common manifestations such as a palpable mass, nipple discharge, or focal noncyclical pain.

Technical Considerations

Synthetic Mammography

SM is derived from source projection images of tomosynthesis, which are rendered into a maximum intensity projection–like image to simulate two-dimensional digital mammography. The purpose of SM is to replace DM in the two-dimensional component of the DBT examination to curtail radiation exposure. This approach reduces the overall radiation dose by approximately one-half (97). In a recent study (98) in which the radiation dose per patient per screening examination in a real-life clinical workflow (two views per breast) was measured with the use of the Selenia Dimensions mammography system (Hologic), DBT and SM had a significantly lower entrance dose and mean glandular dose when compared with DM (entrance dose, 14.8 vs 21.8 mGy, respectively; $P < .0001$) (mean glandular dose, 3.84 vs 5.59 mGy, respectively; $P < .0001$) (98).

Overall clinical outcomes with SM have been promising, and improvement in cancer detection and reduction in recall rates with DBT are similar when DBT and DM are compared with DBT and SM (4,5). However, recent estimates also show that only approximately one-half of facilities with SM capability currently use DBT with SM without DM, suggesting persistent concerns about the technical limitations of SM (99). Compared with DM, SM has been shown to have significantly lower imaging resolution in phantom studies (SM vs DM, 5 vs 11 line pairs per millimeter) and may allow fine microcalcifications or small low-attenuation masses to be missed, despite better conspicuity of medium to large calcifications (100,101). This measurable loss of resolution has also been indirectly observed in the clinical setting, where decreased recall rates for microcalcifications and decreased detection of small-volume ductal carcinoma in situ have been reported, despite smaller reader studies that show otherwise (4,102–104). In particular, in a 5-year longitudinal study of DBT and DM in years 1–4 and DBT and SM in year 5, sensitivity with DBT was superior to that with DM in years 1–4 but decreased in year 5 to equal to that of DM (8). Whether this is a clinically significant loss is controversial. Some investigators (4,5) have argued that these findings may even be permissible in light of potential overdiagnosis, particularly in the larger context of overall maintained cancer detection and recall rates. It is possible that SM as a lower-resolution technique is nevertheless sufficient for adequate cancer depiction, and it is certainly worthwhile, given the substantial reduction in radiation. Further study with more robust data and longer-term follow-up is needed to determine if relevant disease may be missed with SM.

Vendor Diversification

The market share has been dominated by vendors who received early FDA approval, and the lion's share of available clinical research outcomes of DBT are based on early systems in use. However, as of 2020, there are now four FDA-approved DBT systems in the United States. (Table 3). Although all vendors have achieved diagnostic quality imaging, each vendor has a unique technical approach, and systems vary in parameters including x-ray tube motion, filter material, detector material, pixel size, and pixel binning, as well as in reconstruction algorithms. Whether these differences result in clinical differences in cancer detection is unknown. However, in general, a wide-angle scan provides better depth

resolution, and a narrow-angle scan improves in-plane resolution. On the other hand, wider angle scanning means that more projection images are acquired, which requires longer scanning time, rendering the examination more vulnerable to motion. In a phantom study (105) evaluating the performance of five DBT systems, although adequate geometric accuracy was achieved with all systems (within 0.5%), there were noticeable differences in technical image quality that were quantifiable by artifact extent, in-plane resolution, and the relative noise power spectrum among the DBT systems (Fig 2). These findings are consistent with visually perceivable differences in vendor-specific images in clinical practice (Figs 3–5). Although vendor diversification has promoted further integration of DBT technology, quality assurance and standardization have become more challenging yet increasingly necessary to ensure reproducible benefits in clinical practice. This is an active area of research, but DBT-specific quality assurance guidelines have been put in place by both the European Reference Organization for Quality Assured Breast Screening and Diagnostic Services (EUREF) and by the U.S. FDA Mammography Quality Standards Act (MQSA) (106,107).

Technical Innovations

DBT continues to advance with technical improvements. One of the intrinsic limitations of DBT is poor depth resolution due to limited angle sampling and nonisotropic imaging. For this reason, tumors may appear more conspicuous in one projection than in another (Fig 6). This may be improved with wide-angle tomography, which, when compared with narrow-angle tomography, not only has higher depth resolution, but also better blurring of out-of-plane structures, allowing sharper discrimination of masses. However, in-plane resolution is limited, and wide-angle DBT is inferior to narrow-angle DBT at depiction of calcifications.

Another approach to improving depth resolution is to improve overall image resolution, which is made possible by the recent development of high-resolution tomography with decreased pixel size from 140 μm to 70 μm . Interestingly, this may also mitigate the concern of loss of resolution with SM (Fig 7). SM derived from high-resolution tomography is expected to be able to show microcalcifications better than conventional SM does at the cost of a slightly higher dose of radiation. In addition, clinical data are needed for validation (Fig 8).

The increased interpretation time of DBT may be addressed with slab viewing with adjustable thickness of the slab, allowing quicker coverage of the entire breast volume (Fig 9), although it is unknown how this approach may affect interpretative performance. Finally, artificial intelligence or deep learning–based computer-aided detection tools are now being used to improve both accuracy and efficiency, resulting in a decrease in reading time by 52.7% in one study (3). In addition to optimizing cancer detection, deep learning is also being investigated for topics such as quantification of breast density, radiomics analysis, risk stratification, and radiation reduction.

DBT Lexicon

The DBT supplement to the 2013 ACR BI-RADS manual on mammography was published in 2019 to provide guidance on standardizing language and practice in the use of

tomosynthesis in clinical care (108). Some terms are no longer deemed appropriate. For example, while tomosynthesis was frequently referred to as three-dimensional mammography, the term should no longer be used, because images are not truly three-dimensional owing to the z-axis being derived from planar data. The preferred terminology for tomosynthesis includes “DBT,” “tomosynthesis,” or “tomo.” Synthetic mammography should be referred to as “SM.” Finally, conventional two-dimensional (2D) full-field digital mammography may be referred to as either “DM” or “2D.” The document also provides guidance in interpretation. For global assessment of breast density, assessment should be made with standard DM or SM, but not with DBT sections. As with DM, classification of breast density should be based on the denser breast if the two breasts differ. For lesion location, standard nomenclature indicating the quadrant, clock-face location, depth, and distance from the nipple should be supplemented with specific in-plane section numbers to facilitate easy identification of abnormalities, particularly if they are only visible with DBT. Clarifications are also provided for certain lesion types in the context of DBT. Notably, an *asymmetry* is defined as a finding visible on only one mammographic (tomographic) projection. Recommendation is also made to carefully evaluate any circumscribed mass at DBT unless there are multiple bilateral circumscribed masses or long-term stability in the size and shape of masses over 2 years (Fig 10). Finally, full-field DM magnification views remain the standard for evaluation of microcalcifications.

Conclusion

DBT has shown sustainable improvement in detection of invasive cancer and recall rates, to varying extents, depending on the clinical environment. SM has allowed a significant decrease in radiation dose while maintaining the clinical benefits of DBT. Achieving greater accuracy at screening and diagnostic evaluation both increases cancer yield and decreases undue harm and anxiety associated with unnecessary recalls and biopsies. Although DBT increases detection of all invasive cancers, there is a trend toward detection of more indolent cancers, and long-term implications for breast cancer mortality are currently unknown. DBT is the latest technological advancement for mammography and is poised to become the standard of care in population-based screening. Further data are needed to better understand the full effect of DBT and to help define its place in the increasingly complex discipline of breast cancer care.

Abbreviations:

ACR	American College of Radiology
ACRIN	American College of Radiology Imaging Network
BI-RADS	Breast Imaging Reporting and Data System
DBT	digital breast tomosynthesis
DM	digital mammography
ER	estrogen receptor

FDA	Food and Drug Administration
HER	human epidermal growth factor
NCCN	National Comprehensive Cancer Network
PR	progesterone receptor
SM	synthetic mammography

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SA-CME LEARNING OBJECTIVES

After completing this journal-based SA-CME activity, participants will be able to:

- Discuss clinical outcomes of digital breast tomosynthesis (DBT).
- Explore DBT vendor diversification and clinical implications.
- Describe technical advances and clinical utilities of DBT.

TEACHING POINTS

- The supplemental cancer yield of MRI in addition to DM is also maintained when DBT is used.
- DBT improves the cancer detection rate to a greater extent in Europe and Scandinavia than it does in the United States, in part because of typically biennial screening in Europe and Scandinavia as opposed to annual screening in the United States. DBT reduces recall rates to a greater extent in the United States, where the baseline recall rates are relatively high.
- Despite the benefits of improved cancer detection and decreased recall, DBT is largely considered to be optional in current breast cancer screening guidelines because of insufficient data supporting improvement in disease-specific mortality.
- Architectural distortions detected only with DBT are less likely to be malignant than those also detected with DM (10.2% vs 43.4%, respectively; $P < .001$). Architectural distortions with US correlates are also more likely to be malignant than those without correlates (66.5% vs 29.2%, respectively; $P < .001$). However, architectural distortions detected only with DBT, with or without US correlates, still have substantial malignancy rates (12.1% vs 7.7%; $P = .645$) For these reasons, biopsy is usually appropriate for well-visualized architectural distortions, despite US findings.
- A wide-angle scan provides better depth resolution, and a narrow-angle scan improves in-plane resolution.

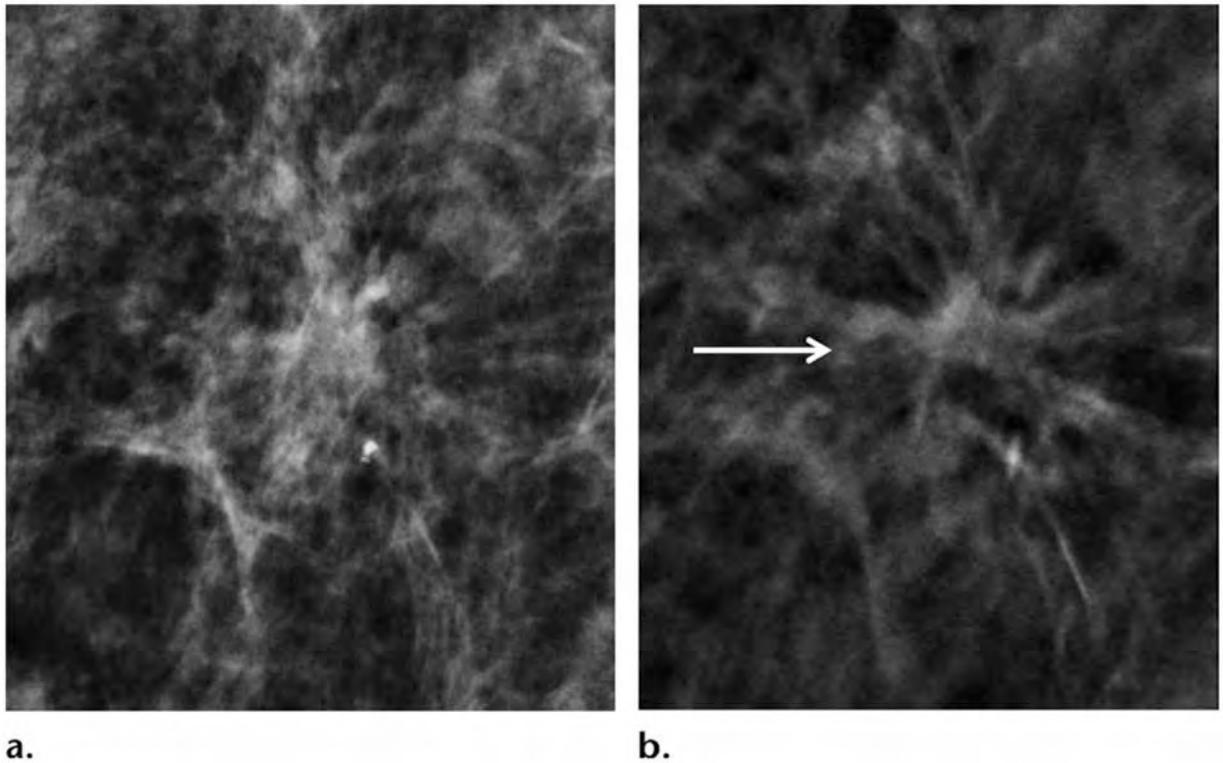


Figure 1. Screening-detected grade 1 node-negative estrogen receptor positive (ER+), progesterone receptor positive (PR+) human epidermal growth factor receptor 2 negative (HER2-) breast cancer in a 44-year-old woman. **(a)** Two-dimensional mammogram shows that the cancer is obscured. **(b)** Mediolateral oblique projection in-plane DBT image clearly shows the cancer (arrow), with improved lesion conspicuity and depiction of tumor margins.

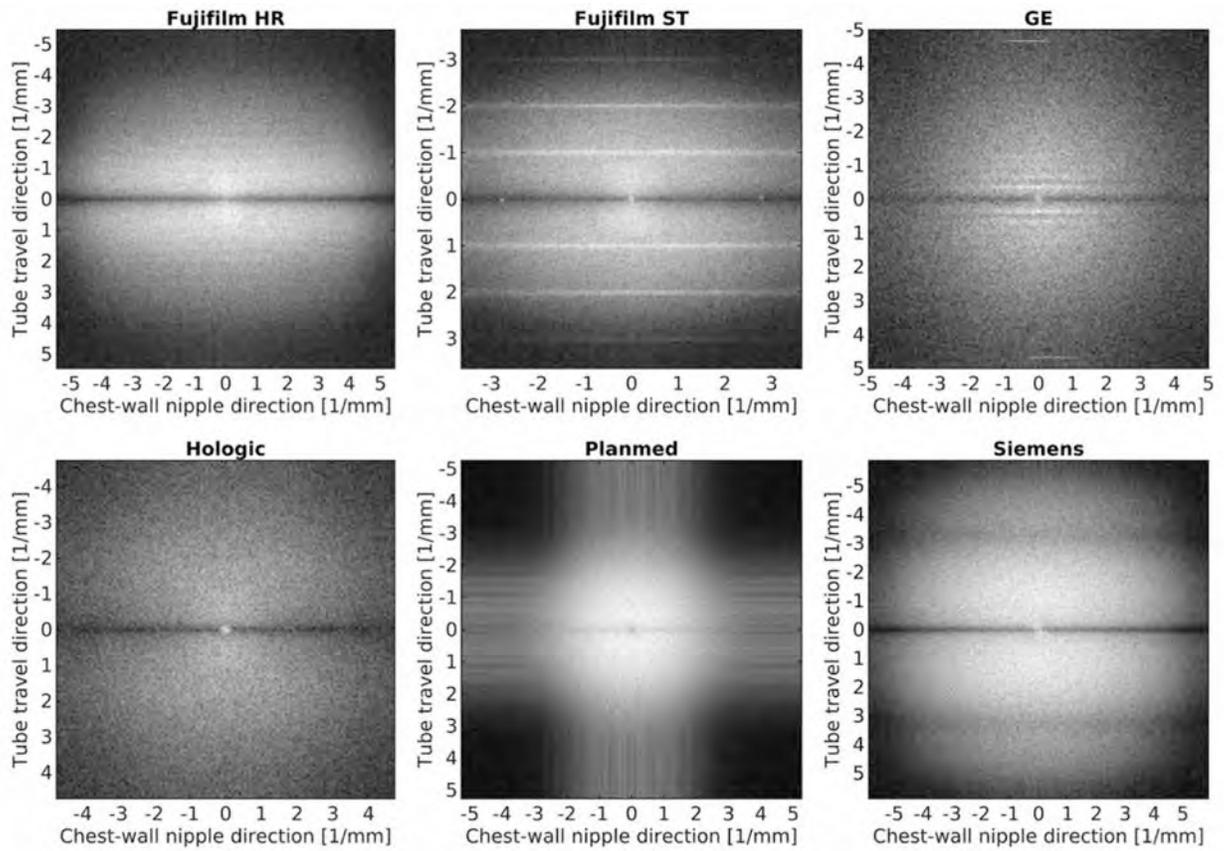


Figure 2. Images show distinct visual representations of the logarithm of two-dimensional noise power spectra calculated from the center of the reconstructed plane for each studied DBT system. (Reprinted, with permission, from reference 105.)

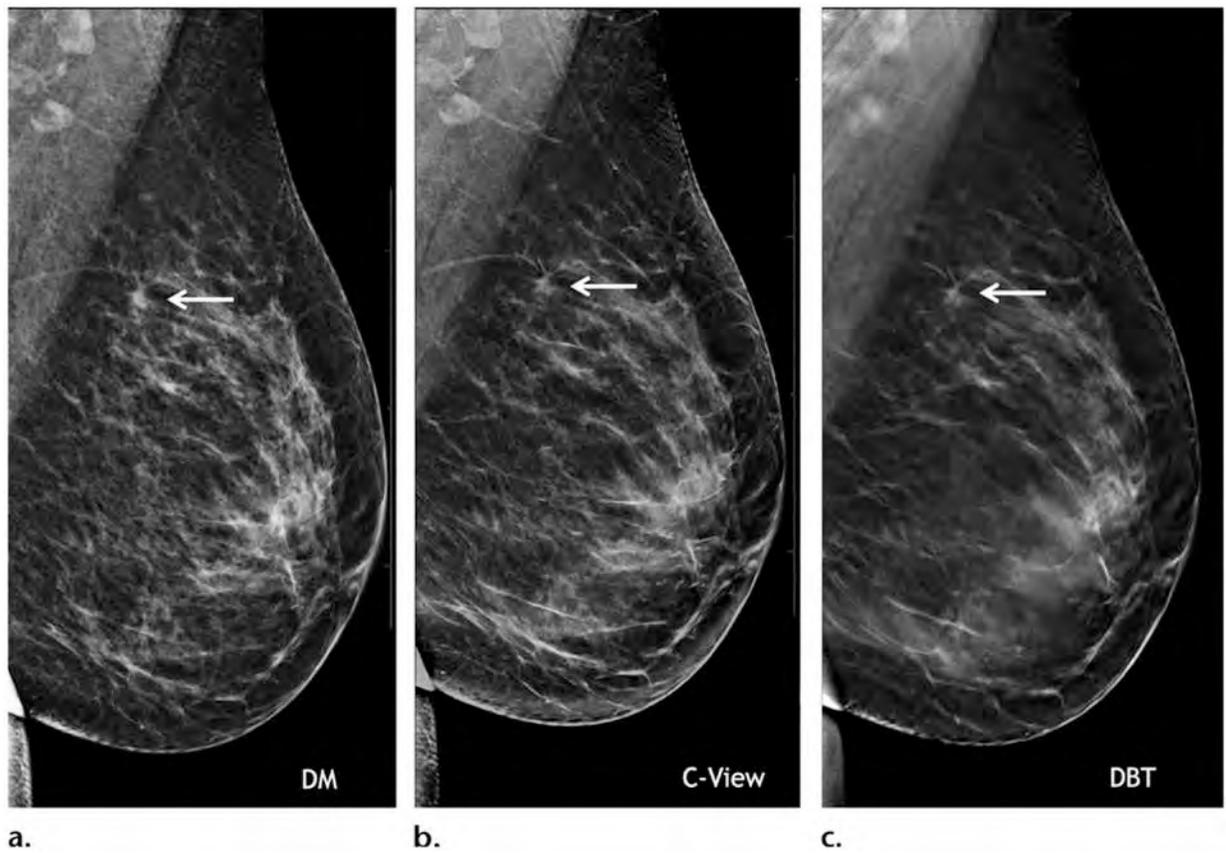


Figure 3. Images from the Hologic Dimensions DBT system, which was approved by the FDA in 2011. Mediolateral oblique two-dimensional mammogram (**a**), synthetic C-view image (**b**), and in-plane DBT image (**c**) of the left breast in a 40-year-old woman at baseline screening show diagnostic-quality images of a small spiculated mass (arrow) that was biopsy proven to be a grade 1 ER+/PR+/HER2- invasive ductal carcinoma.

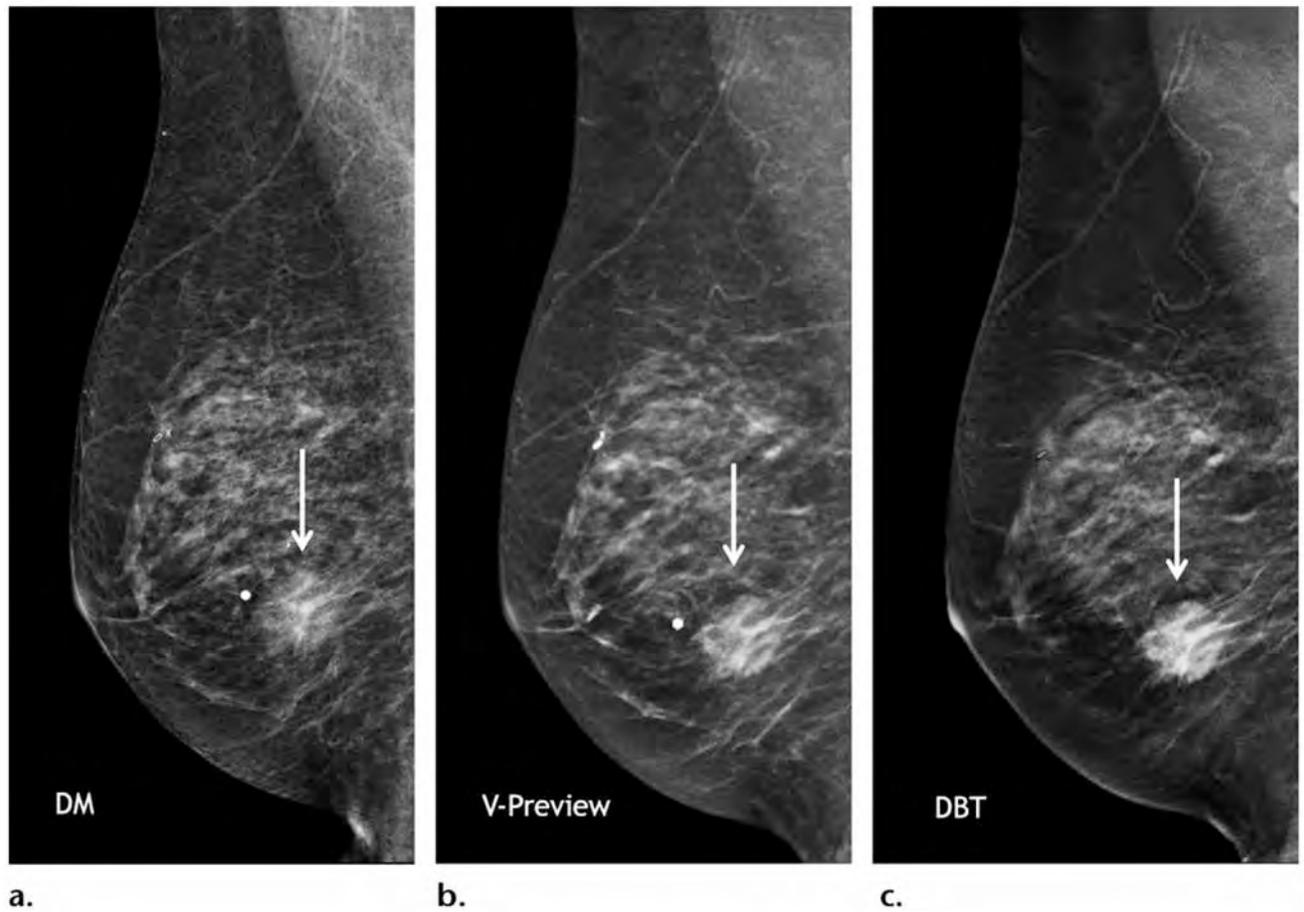


Figure 4. Images from the GE SenoClaire DBT system, which was approved by the FDA in 2014. Mediolateral oblique diagnostic-quality two-dimensional (a), synthetic V-preview (b), and DBT (c) images of the right breast in a 78-year-old woman at diagnostic imaging show an irregular mass in the inferior breast (arrow), which is consistent with a biopsy proven ER +/PR+/HER2- invasive lobular carcinoma.

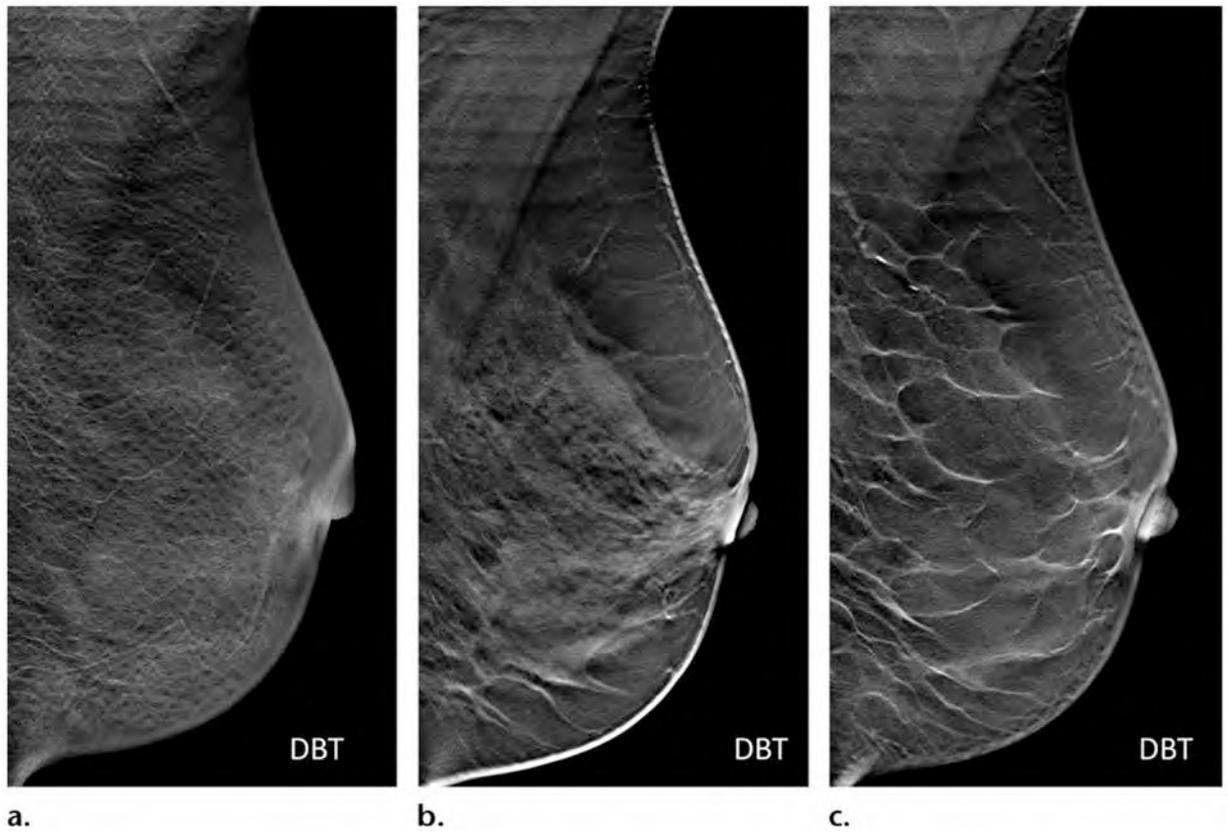


Figure 5. Images from the Siemens Mammomat Inspiration system, which was FDA approved in 2015. Mediolateral oblique DBT images at various depths through a normal left breast in a 50-year-old woman at a screening examination show diagnostic image quality.

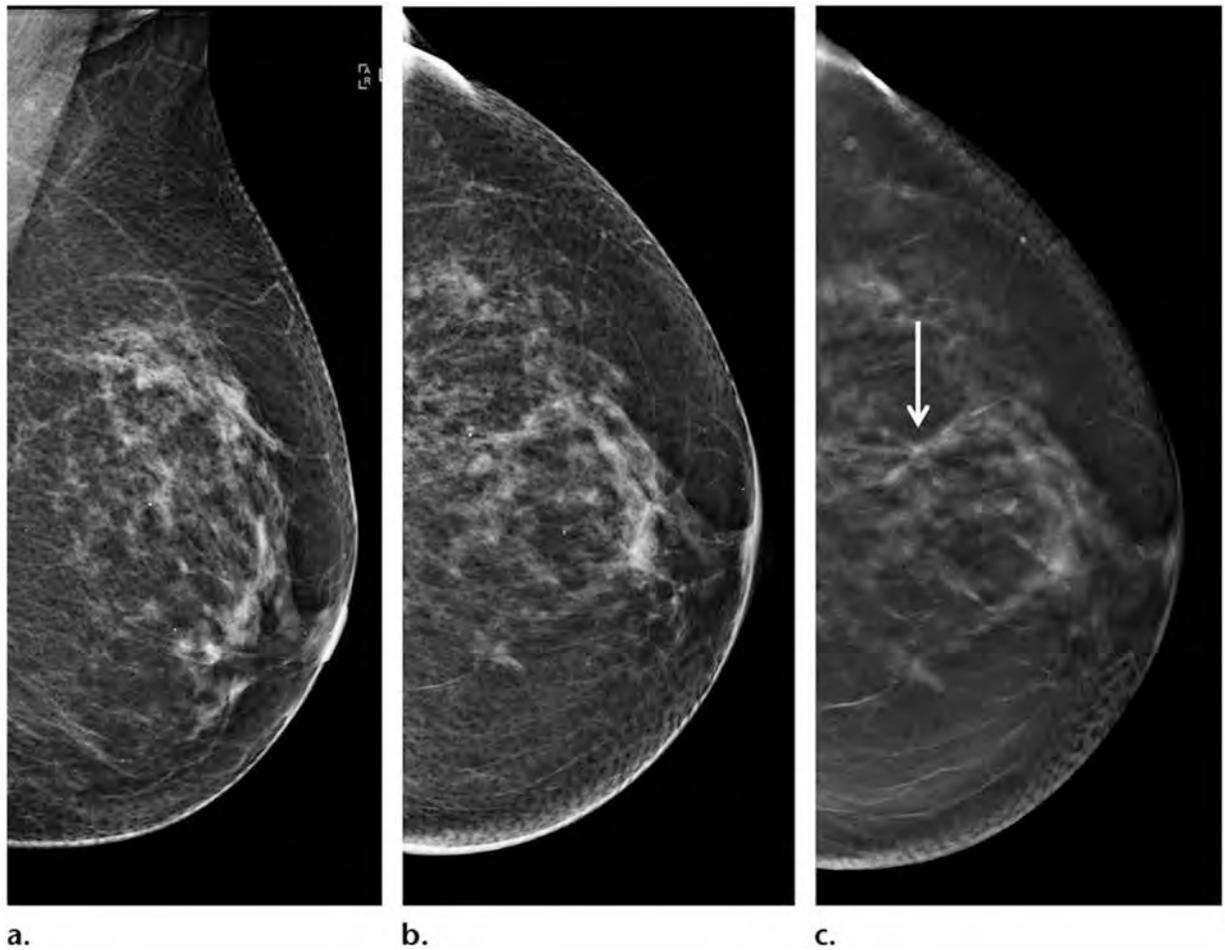


Figure 6. Small spiculated grade 1 node-negative ER+/PR+/HER2- invasive ductal carcinoma in a 62-year-old woman. (a, b) Mediolateral oblique (a) and craniocaudal (b) two-dimensional mammograms show that the tumor is occult. (c) In-plane craniocaudal DBT image shows that the tumor is visible (arrow), but it is occult on other DBT views (not shown). Note that cancers may be better seen or only seen in one projection at DBT because of nonisotropic imaging; therefore, findings suspected to be cancer on only one DBT view require complete workup.

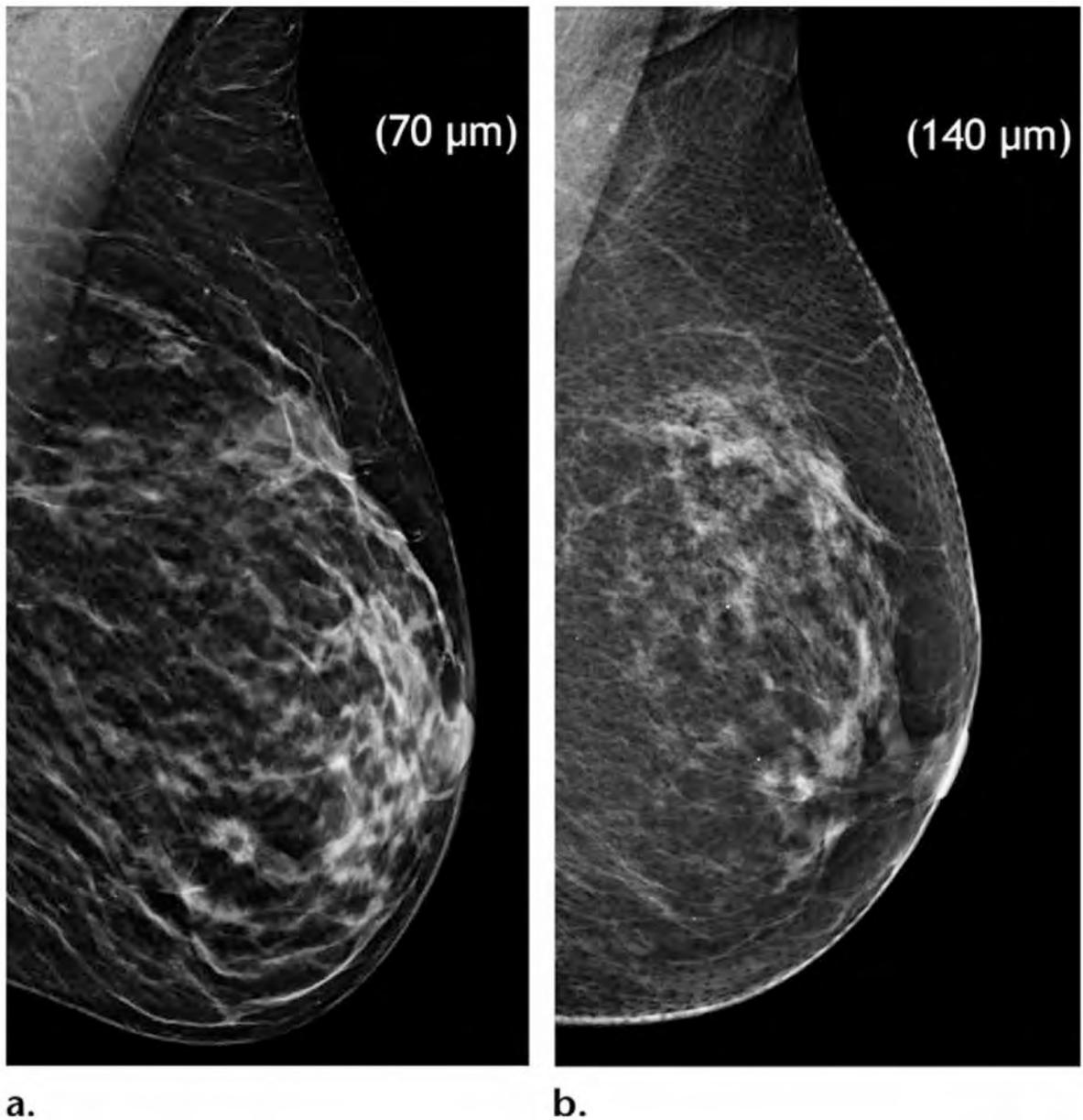


Figure 7. Juxtaposition of mediolateral oblique views of the left breast in two separate patients. High-resolution (70- μm pixel size) (**a**) and standard-resolution (140- μm pixel size) (**b**) SM images show that glandular details are seen to greater advantage on **a** than on **b**. High-resolution acquisition may compensate for the loss of resolution on SM images but is associated with a slightly higher dose of radiation.

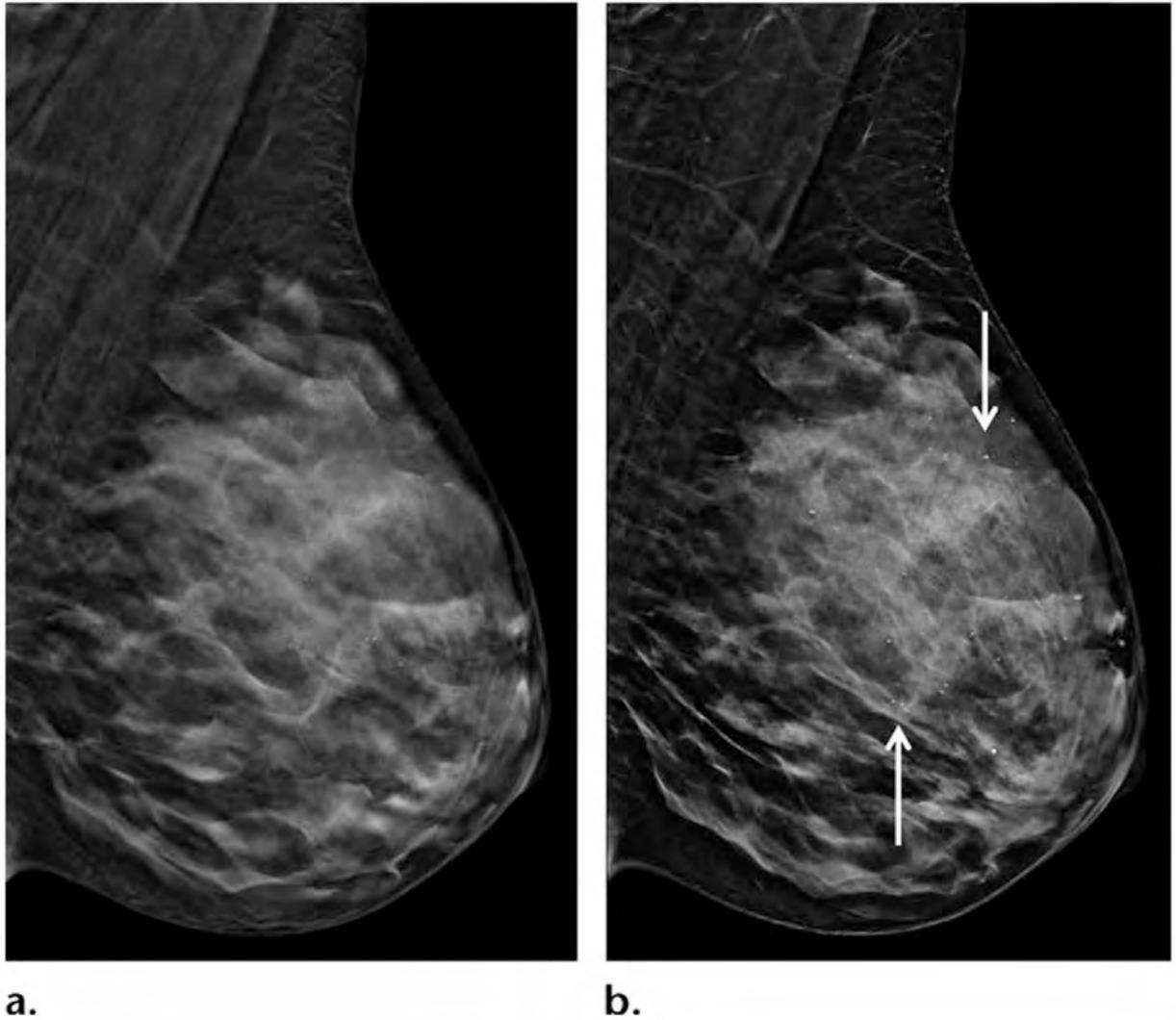


Figure 8. High-resolution DBT (**a**) and SM (**b**) images in mediolateral oblique projection of the left breast in a 45-year-old woman show excellent image quality because of improved resolution (70- μ m pixel size). There are scattered punctate microcalcifications in the left breast, shown with great clarity and without significant artifacts on **b** (arrows).

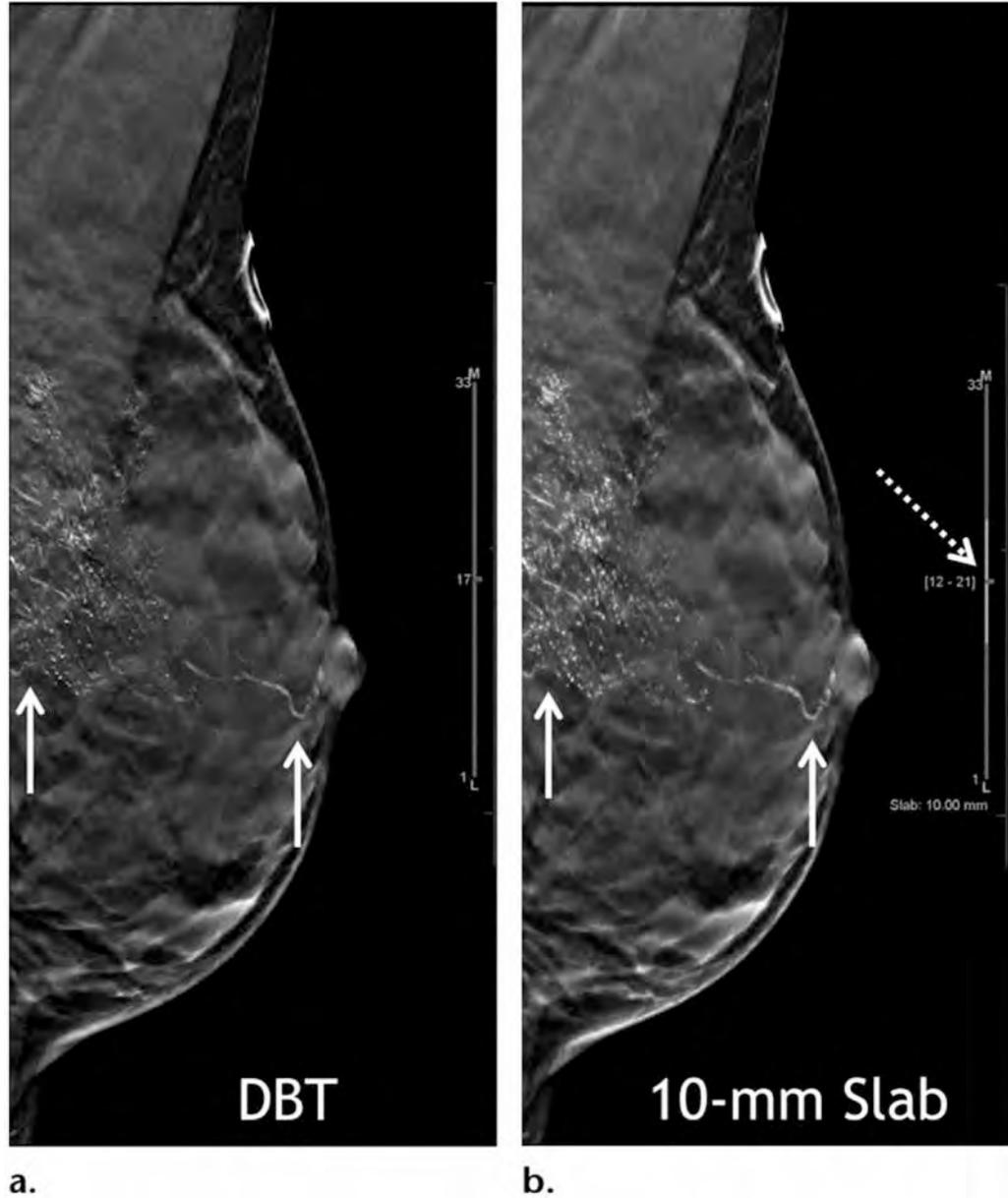


Figure 9. High-grade ductal carcinoma in situ at baseline screening in a 40-year-old woman. Mediolateral oblique in-plane DBT (**a**) and 10-mm slab (**b**) images show segmentally distributed fine linear branching calcifications in the left breast (solid arrows). Currently the standard section thickness for DBT reconstruction images is 1 mm. Slab viewing is possible (dashed arrow in **b**) with adjustable slab thickness to allow quicker review. In this patient, slab viewing also allows a maximum intensity projection–like capture of the overall extent of the abnormality. Stereotactic biopsy was performed and yielded a diagnosis of high-grade ductal carcinoma in situ.

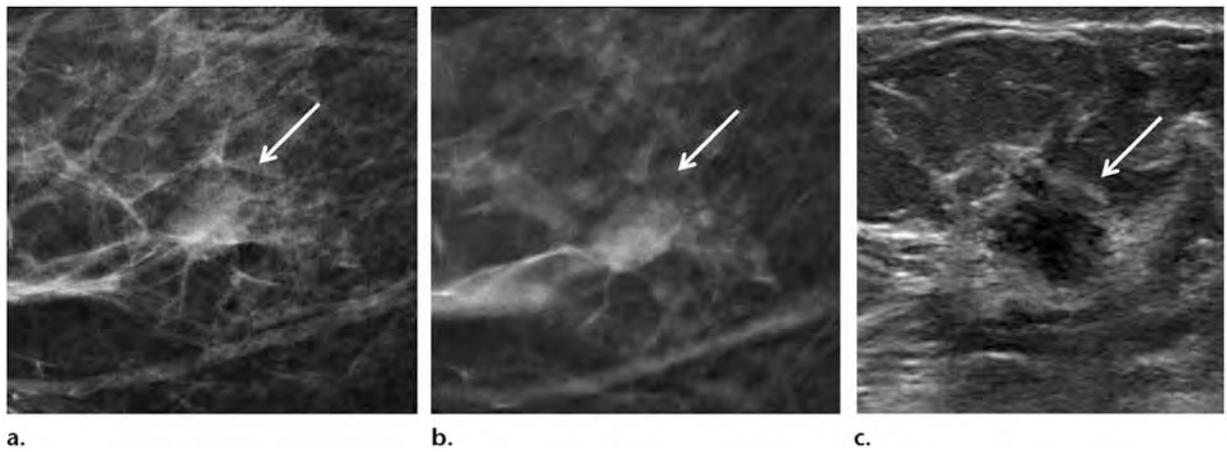


Figure 10.

Invasive ductal carcinoma in a 56-year-old woman at screening mammography. **(a, b)** Craniocaudal projection two-dimensional mammogram **(a)** and in-plane DBT image **(b)** show scattered fibroglandular tissue and a circumscribed solitary right breast mass (arrow). **(c)** Subsequent US image shows a corresponding mass with irregular borders (arrow). Biopsy was performed and yielded a grade 2 ER+/PR+/HER2+ node-negative invasive ductal carcinoma.

Screening Outcomes with Combined DBT and DM Compared with DM Alone in Representative Retrospective Studies Published in 2013–2016

Table 1:

Study and Year	No. of Examinations			Cancer Detection Rate			Recall Rate	
	DBT/DM	DM	DBT/DM*	DM*	PValue	DBT/DM [†]	DM [†]	PValue
Rose, 2013 (9)	9499	13 856	5.4	4.0	.07	5.5	8.7	<.001
Haas, 2013(10)	6100	7058	5.7	5.2	.7	8.4	12	<.01
Greenberg, 2014(11)	23 149	54 684	6.3	4.9	.0056	13.6	16.2	<.0001
McCarthy, 2014(12)	15 571	10 728	5.5	4.6	.02	8.8	10.4	<.001
Friedewald, 2014 (13)	173 663	281 187	5.4	4.2	<.001	9.1	10.7	<.001
Durand, 2015 (14)	8591	9364	5.9	5.7	.88	7.8	12.3	<.0001
Lourenco, 2015 (15)	12 921	12 577	5.4	4.6	.44	6.4	9.3	<.0001
McDonald, 2015 (16)	15 571	10 728	5.4	4.6	.41	8.8	10.4	<.001
Sharpe, 2016 (17)	5703	80 149	5.4	3.4	.0001	6.1	7.5	<.018
Conant, 2016 (18)	559 998	142 883	5.9	4.4	.0026	8.7	10.4	<.0001
All	830 766	623 214

Note.—Numbers in parentheses are reference numbers. Study populations may overlap in studies from the same institution.

* Number per 1000 examinations.

[†]Numbers are percentages.

Table 2:
Interval Cancer Rates at DBT and DM Screening in Studies Published in 2018–2020

Study and Year	Screening Interval		Rate of Interval Cancer (No.)*		
	No. of Rounds	Frequency	DBT	DM	PValue
Skaane, 2018 (39)	2	Biennial	2.1	2.0	.73
Houssami, 2018 (40)	2	Biennial	1.23	1.6	NA
Bahl, 2018 (25)	3	Annual	1.1	1.1	.84
Hovda, 2020 (2)	2	Biennial	2	1.5	.12
Conant, 2020 (8)	5	Annual	0.6	0.9	.30
Bernardi, 2020 (33)	1	Biennial	1.1	1.36	NA

Note.—Numbers in parentheses are reference numbers. NA = not available.

* Per 1000 examinations.

Table 3:

FDA-approved DBT Systems in the United States

Vendor	Tube Motion	Detector	Angular Range	Scan Angle (degrees)	No. of Projections	Scan Time (sec)	Detector	Pixel Size (μm)	SM
Hologic	Continuous	Rotating ($\pm 2.1^\circ$)	15	15	4	aSe	140 (reg)/ 70 (HR)	C-view	
GE	Step and shoot	Stationary	25	9	10	CsI-aSi	100	V-preview	
Siemens	Continuous	Stationary	50	25	22	aSe	85	Insight-2D	
Fuji	Continuous	Stationary	15 (reg)/ 40 (HR)	15	4	aSe	150 (reg)/ 100 (HR)	None	

Note.—aSe = amorphous selenium, CsI/aSi = cesium iodide/amorphous silicon, HR = high resolution, reg = regular.

QUESTIONNAIRE

A15(25) Part 1 of 2

Digital Breast Tomosynthesis: Update on Technology, Evidence, and Clinical Practice

INSTRUCTIONS

- Read through the article and answer the multiple-choice questions provided below.
- **Some questions may have more than one correct answer;** in which case you must mark **all** the correct answers.

Abstract

Question 1: How does digital breast tomosynthesis (DBT) preferentially improve cancer detection?

- A:** By increasing detection of both in situ and invasive cancers equally
- B:** By increasing detection of invasive cancers without increased detection of in-situ cancers
- C:** By mitigating overdiagnosis

Question 2: TRUE or FALSE?

"The higher sensitivity of DBT for architectural distortion allows increased diagnosis of invasive cancers overall and particularly improves the visibility of invasive lobular cancers.

- A:** TRUE
- B:** FALSE

Question 3: Which population segment shows reduced benefits from DBT screening, according to current findings?

- A:** Women with fatty breast tissue
- B:** Women with extremely dense breast tissue
- C:** Women aged 30 and under
- D:** Post-menopausal women

Question 4: What remains as one of the key questions that requires further investigation?

- A:** To determine if interpretation time and cost can be reduced
- B:** To determine if extremely dense breasts can be better visualised
- C:** To determine if DBT improves breast cancer-specific mortality

Introduction

Question 5: Which of the following statements are TRUE?

- A:** There is growing evidence that the benefits of DBT are sustainable over time and the magnitude of these benefits do not vary
- B:** DBT has allowed increased detection of small node-negative invasive cancers by mitigating tissue obscuration, but its long-term effect on mortality is currently unknown
- C:** Efforts to improve the efficiency, efficacy, safety, and quality assurance of DBT are sporadic

Question 6: Fill in the missing words.

Although women with breasts benefit from a recall rate with DBT, for those with breast tissue, the benefit is minimal.

- A:** Dense / lower / fatty
- B:** Fatty / lower / dense
- C:** Fatty / lower / extremely dense

Question 7: What group of cancers are more likely to be identified by DBT?

- A:** Non-invasive cancers
- B:** Node-positive cancers
- C:** Small node-negative invasive cancers
- D:** In-situ carcinomas

Current scope

Question 8: TRUE or FALSE?

"Despite validation of these results in prospective trials, a current lack of long-term outcomes and randomized trials has precluded the endorsement of DBT as the standard of care for evaluation for breast cancer in some clinical guidelines".

- A:** TRUE
- B:** FALSE

Screening Outcomes and Guidelines Cancer detection rates

Question 9: Which of the following statements are TRUE regarding cancer detection rates?

- A:** Emerging longitudinal data from prospective studies are shedding light on longer-term use, but results are mixed
- B:** Both of the two studies with the longest consecutive use of DBT to date (each reporting on more than five rounds of annual screening) showed a statistically significant increase in cancer detection
- C:** Nevertheless, sustained preferential detection of invasive cancers is demonstrated in most studies across age groups and breast density categories

Mortality benefit

Question 10: Fill in the missing words. “DBT simultaneously accentuates detection of masses and architectural distortions (more oftenresults) and decreases recall of patients with asymmetries that are often areas of tissue summation (more oftenresults), it enhances both the sensitivity and specificity of cancer detection”.

- A: False-positive / true positive
- B: True positive / true positive
- C: True positive / false positive

Question 11: Early data have shown to a varying extent that DBT- detected cancers are?

- A: Often smaller than DM-detected cancers
- B: Of lower histologic grade
- C: More likely to be node positive

Question 12: Is it **TRUE** that studies performed specifically to evaluate interval cancers have also reported no difference in tumour size, grade, nodal status, or histopathologic characteristics between interval cancers found after DBT or DM screening examinations with negative results?

- A: YES
- B: NO

Multimodality screening

Question 13: Which supplemental modality increases cancer detection rates in women with dense breast tissue after mammography?

- A: X-ray
- B: Ultrasound
- C: CT scan
- D: PET scan

Question 14: Which of the following statements are **TRUE** regarding the use of US?

- A: The incremental gain of US has not been shown to be sustainable throughout multiple years of screening
- B: If DBT is used, the added benefit of supplemental US is likely higher
- C: The added cancer detection with US is accompanied by an increase in false-positive findings and lower positive predictive values for biopsy compared with mammography, although the false-positive rate tends to improve in subsequent rounds of screening

Question 15: With reference to MRI?

- A: Dynamic contrast-enhanced MRI, on the other hand, has been shown to allow preferential detection of more invasive and higher-grade tumors when compared with mammography, owing to the high sensitivity that is intrinsic to functional imaging
- B: In the ACRIN 6666 study, the sensitivity of MRI in addition to DM and US was 100%, compared with 76% with DM and US and 52% with DM alone
- C: Although US performed in addition to DM allowed 3.7 additional cancers per 1000 examinations to be detected, MRI allowed 14.8 additional cancers per 1000 examinations to be identified, nine of which were only detected with MRI
- D: Multiple studies (61–64) have shown that if MRI is performed in addition to mammography, US does not provide further cancer yield but significantly increases false-positive results

THE END

QUESTIONNAIRE

A15(25) Part 2 of 2

Digital Breast Tomosynthesis: Update on Technology, Evidence, and Clinical Practice

INSTRUCTIONS

- Read through the article and answer the multiple-choice questions provided below.
- **Some questions may have more than one correct answer;** in which case you must mark **all** the correct answers.

Question 1: Is the following statement **TRUE** or **FALSE**?
“An alternative to MRI and another promising technique that is under investigation for supplemental imaging is contrast-enhanced mammography, which has been shown to have similar sensitivity and specificity when compared with MRI and has been integrated with DBT, with the potential to improve characterization of lesions”.

- A:** TRUE
- B:** FALSE

Screening environment

Question 2: In terms of cancer detection, how does the performance of DBT differ between the U.S. and Europe?

- A:** DBT is less effective in Europe due to longer screening intervals
- B:** DBT improves cancer detection more in Europe due to biennial screening
- C:** DBT has no effect on cancer detection in Europe
- D:** DBT increases cancer detection similarly across all countries

Question 3: What impact does DBT have on recall rates, particularly in U.S. clinical settings?

- A:** Increases recall rates significantly
- B:** Reduces recall rates more in the U.S. due to relatively high baseline rates
- C:** Increases recall rates only in dense breast cases
- D:** No impact on recall rates

DBT screening guidelines

Question 4: What aspect of breast cancer screening do current DBT guidelines prioritize according to the National Comprehensive Cancer Network (NCCN)?

- A:** Raising the age to start screening
- B:** Reducing harm from false positives and overdiagnosis
- C:** Increasing the frequency of screening

Question 5: What standard does the American College of Radiology (ACR) Appropriateness Criteria recommend in breast cancer screening?

- A:** Exclusive use of DM
- B:** Use of either DM or DBT in routine screening
- C:** Exclusive use of DBT

Diagnostic outcomes and guidelines

Question 6: The improved lesion conspicuity and depiction of margins that DBT offers have

- A:** Allowed better detection of cancer at screening
- B:** Helped to streamline diagnostic evaluation
- C:** Increased the need for additional views for noncalcified findings

Question 7: Is it **TRUE** that the likelihood of malignancy in lesions recommended for biopsy is higher after DBT than after DM diagnostic assessment?

- A:** YES
- B:** NO

Question 8: Which of the following statements are **TRUE** with reference to architectural distortion?

- A:** Although DBT has decreased the overall recall rate, recall for architectural distortion has increased with the use of DBT
- B:** One study showed that architectural distortion was approximately 50% more common with DBT than with DM (0.14% vs 0.07%, respectively; $P < .001$), thus increasing identification of both benign and malignant lesions
- C:** Multiple studies (84–86) have shown that ALL architectural distortions are equal

Technical Considerations

Question 9: What is a benefit of synthetic mammography (SM) over digital mammography (DM) when used with DBT?

- A:** Increased patient comfort
- B:** Reduced radiation exposure
- C:** Higher image resolution
- D:** Lower screening cost

Question 10: According to recent studies, what is a noted disadvantage of using synthetic mammography (SM)?

- A:** Significantly lower imaging resolution
- B:** Higher cost of implementation
- C:** Increased radiation dose

Vendor diversification

Question 11: What type of scan offers better depth resolution in DBT?

- A: Narrow-angle scan
- B: Wide-angle scan
- C: None of the above, it is the pixel size that matters

Teaching points Figures

Question 12: In which figure does the two-dimensional mammogram show that the cancer is obscured, but DBT clearly shows the cancer with improved lesion conspicuity and depiction of tumour margins?

- A: Figure 4
- B: Figure 1
- C: Figure 7

Question 13: In which figure is the point made that cancers may be better seen or only seen in one projection at DBT because of nonisotropic imaging; therefore, findings suspected to be cancer on only one DBT view require complete workup?

- A: Figure 8
- B: Figure 2
- C: Figure 6

Question 14: The fact that high-resolution acquisition may compensate for the loss of resolution on SM images but is associated with a slightly higher dose of radiation, is highlighted in what figure?

- A: Figure 3
- B: Figure 9
- C: Figure 7

Question 15: In what figure does slab viewing also allow a maximum intensity projection—like capture of the overall extent of the abnormality?

- A: Figure 9
- B: Figure 6
- C: Figure 10

THE END



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ANSWER SHEET

A15(25)

Digital Breast Tomosynthesis: Update on Technology, Evidence, and Clinical Practice

*Time spent on activity		hour					min																	
PART 1										PART 2														
	A	B	C	D	E		A	B	C	D	E		A	B	C	D	E		A	B	C	D	E	
1					9							1						9						
2					10							2						10						
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4					12							4						12						
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7					15							7						15						
8												8												

How relevant was the content of this activity to your scope of practice?			
Not at all	Somewhat	Mostly	Extremely

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