Digital Breast Tomosynthesis in Breast Lesion Imaging: A Comprehensive Review of Diagnostic Utility and Clinical Impact

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Abstract

Background: Digital Breast Tomosynthesis (DBT) has emerged as a transformative advancement in breast imaging, offering a three-dimensional reconstruction of breast tissue that addresses the limitations of traditional two-dimensional digital mammography. By minimizing the problem of tissue overlap, DBT enhances lesion conspicuity and improves diagnostic confidence, particularly in women with dense breast tissue. This review explores the diagnostic utility and clinical impact of DBT across various aspects of breast lesion evaluation and cancer screening. DBT has demonstrated significant benefits in breast cancer screening, notably in reducing recall rates and increasing cancer detection rates (CDR), especially for invasive cancers. Its improved tissue separation and multiplanar imaging capabilities enhance the detection of subtle abnormalities such as architectural distortion and asymmetries, which are frequently masked on conventional mammography. In women with dense breasts, DBT plays a crucial role in uncovering lesions that might otherwise go unnoticed, offering a more sensitive and specific diagnostic tool. For lesion evaluation, DBT provides superior localization, enabling better assessment of lesion margins, shape, and spatial relationships. It aids in distinguishing benign from malignant calcifications by offering clearer visualization of their distribution and morphology. While benign calcifications typically present as round and scattered, malignant ones often appear linear or segmental with pleomorphic characteristics. Additionally, DBT enhances the interpretation of architectural distortion by revealing the distorted fibroglandular structure more clearly and confirming its presence on multiple slices, thereby reducing false positives.

Conclusion: Digital Breast Tomosynthesis significantly advances breast lesion imaging by improving detection, reducing unnecessary recalls, and enhancing diagnostic accuracy, particularly in women with dense breasts. Its ability to clarify lesion morphology, calcification patterns, and architectural distortions underscores its growing value in routine breast imaging and screening programs. As clinical evidence continues to evolve, DBT is poised to become an integral component of personalized breast cancer diagnostics

Keywords: *Digital Breast Tomosynthesis, Breast Lesion Imaging, Diagnostic Utility*

Introduction

Digital Breast Tomosynthesis (DBT), a relatively recent innovation in breast imaging, has introduced a three-dimensional approach to visualizing breast tissue, overcoming many of the diagnostic limitations associated with conventional two-dimensional (2D) digital mammography. Traditional mammography often suffers from the superimposition of breast tissues, especially in women with dense breasts, which can obscure small lesions or generate false positives due to overlapping structures [1,2]. DBT solves this issue by acquiring multiple low-dose X-ray images at different angles and reconstructing them into thin slices, allowing for improved lesion conspicuity and better characterization of breast abnormalities [3].

The implementation of DBT has gained traction globally, both in screening and diagnostic settings. Numerous studies have validated its potential to enhance cancer detection rates (CDR) and reduce unnecessary recalls, contributing to more accurate patient management [4,5]. Its incorporation into clinical practice is especially beneficial in high-density breast populations, where traditional mammography is less sensitive [6].

In addition to screening benefits, DBT significantly enhances lesion evaluation, offering clearer visualization of masses, asymmetries, architectural distortions, and calcifications. This allows for more reliable interpretation and reduces the need for additional imaging [7]. Furthermore, DBT supports better lesion localization, which is vital for biopsy planning and surgical interventions.

This review provides a comprehensive assessment of DBT's role in breast lesion imaging. It covers its advantages in screening and diagnostic accuracy, detailed analysis of lesion types, and evaluates how DBT influences the Breast Imaging-Reporting and Data System (BI-RADS) classification of mammographically detected lesions.

Technique Overview

Digital Breast Tomosynthesis (DBT) is an advanced imaging technique that captures multiple low-dose X-ray projections of the breast from different angles during a short scan. These projections are then reconstructed into a series of thin (typically 1 mm) slices, offering a quasi–three-dimensional (3D) representation of the breast [1,2]. This overcomes one of the major limitations of conventional digital mammography — tissue overlap — which can obscure or mimic breast lesions, leading to missed cancers or unnecessary recalls [3].

During DBT acquisition, the X-ray tube moves in an arc around the compressed breast, capturing a set of images over a limited angular range, usually between ±15° to ±50°. These images are reconstructed using filtered back projection or iterative reconstruction algorithms to create tomographic slices. Radiologists can scroll through these slices in a cine loop or review them interactively, which facilitates detection and characterization of lesions that would otherwise be hidden or distorted on 2D images [4,5].

Most DBT systems also offer synthetic 2D images reconstructed from the tomosynthesis dataset, reducing the need for an additional 2D acquisition and thus minimizing radiation exposure. The total dose from DBT combined with synthetic 2D mammography remains within acceptable safety limits and is comparable to conventional 2D mammography alone [6].

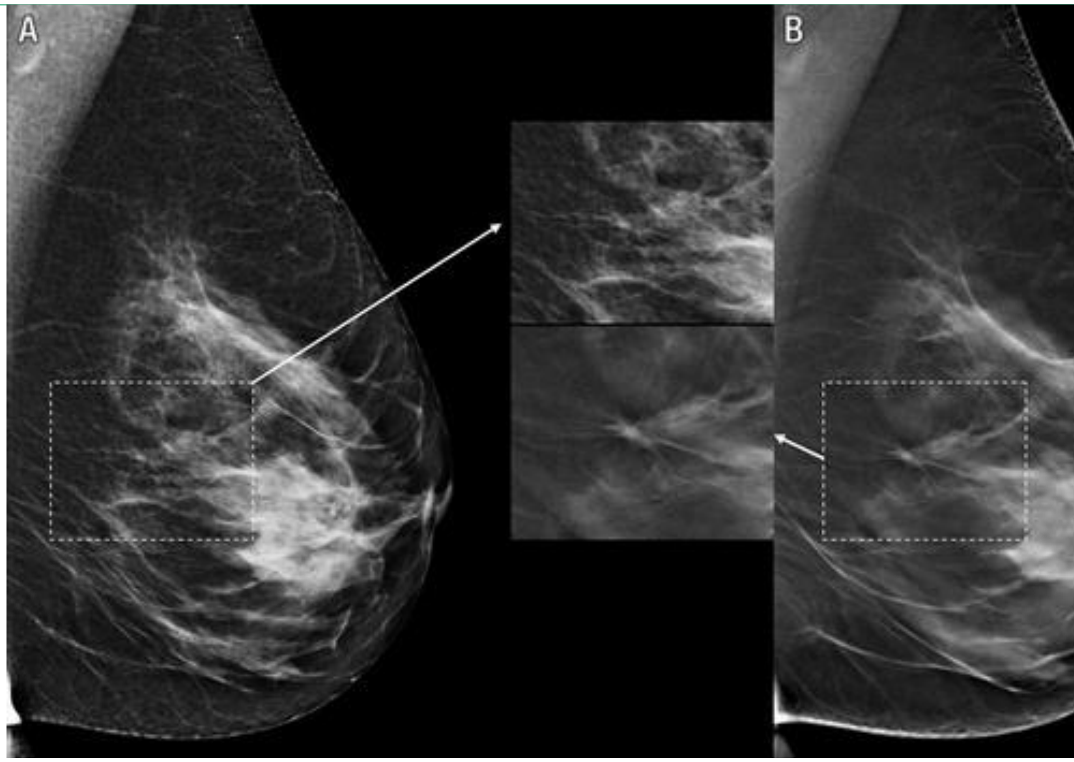

Figure 1: Mediolateral oblique views of left breast in 57-year-old woman recalled after mammographic screening because of a spiculated mass seen only at mammography plus tomosynthesis. *A,* Mammogram shows normal findings (BIRADS 1). *B,* Tomosynthesis image demonstrates spiculated mass (BIRADS 4). An 8-mm invasive ductal carcinoma was diagnosed at histologic examination. [6].

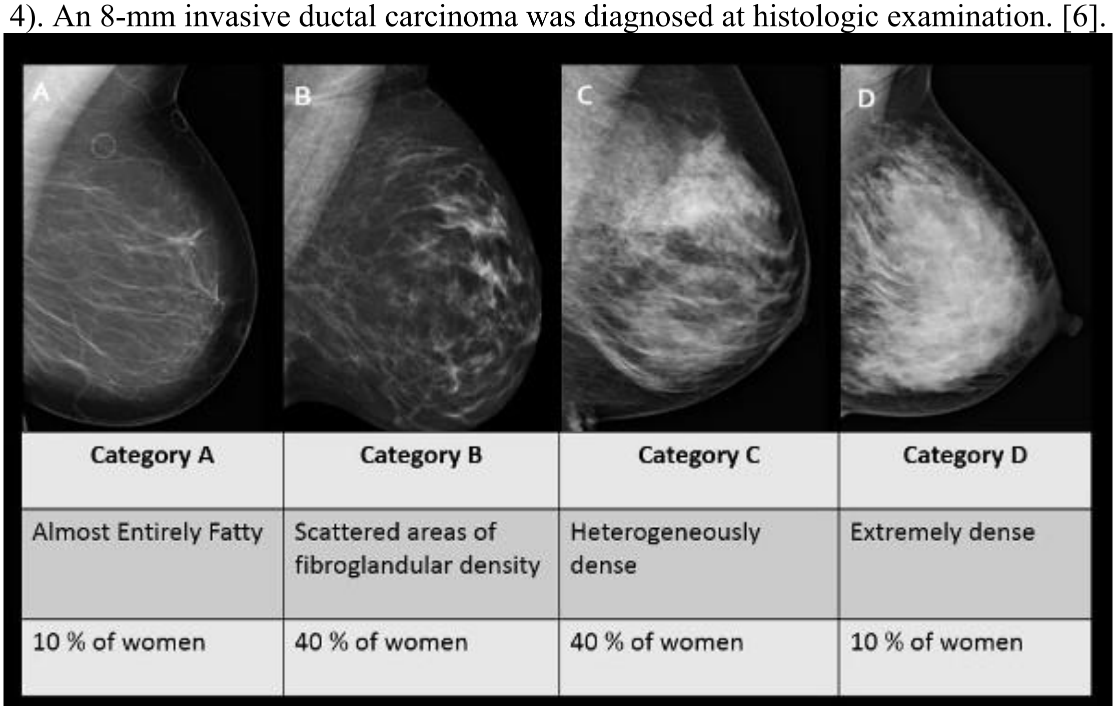

Figure 2: Illustration of breast composition according to BI-RADS 5th edition (a)The breasts are almost entirely fatty(b)There are scattered areas of fibroglandular density(c)The breasts are heterogeneously dense, which may obscure small masses (d) extremely dense [6].

Advantages in Breast Cancer Screening

DBT significantly improves breast cancer screening outcomes. One of its most consistent findings across studies is a substantial **reduction in recall rates**, which lowers patient anxiety and healthcare costs [7].

DBT also **increases cancer detection rates (CDR)**, particularly for **invasive cancers**, with increases ranging from 27% to 40% depending on population and setting [4,8].

DBT's greatest advantage is seen in **women with dense breast tissue**, where conventional mammography is least effective. Dense tissue not only increases cancer risk but also hampers lesion visibility due to the overlapping fibroglandular structures [9]. DBT enhances contrast resolution and allows for visualization of small or obscured lesions by slicing through the density layer-by-layer [10].

Studies such as the **STORM and Oslo Tomosynthesis Screening Trials** have highlighted these benefits. In the STORM-2 trial, DBT used in combination with synthetic 2D mammography yielded significantly fewer false positives while maintaining high sensitivity for malignancy [8].

Given these improvements, DBT is now being integrated into national screening guidelines in multiple countries, either as a standalone tool with synthetic 2D or in combination with standard mammography. Early adoption in the U.S. and several European regions has demonstrated increased diagnostic yield and fewer unnecessary diagnostic interventions [10].

Advantage of DBT in Lesion Evaluation

Lesion Localization

Digital Breast Tomosynthesis (DBT) significantly improves lesion localization by providing depth resolution and separating overlapping structures within the breast. Unlike 2D mammography, which compresses all breast tissue into a single plane, DBT allows radiologists to scroll through reconstructed slices and identify the precise location and extent of a lesion in the craniocaudal and mediolateral oblique projections [11]. This enhancement is particularly valuable in dense breasts, where traditional mammography may miss subtle findings obscured by fibroglandular tissue [12].

Accurate lesion localization improves confidence in distinguishing true lesions from summation artifacts. It also facilitates targeted ultrasound and biopsy procedures, reducing unnecessary recalls and additional imaging [13]. In diagnostic settings, DBT helps determine whether a finding corresponds to a known mass, a benign structure, or a suspicious abnormality requiring further assessment.

Lesion Margins and Morphologic Clarity

Beyond localization, DBT enhances evaluation of lesion morphology, including margin characteristics, shape, and internal architecture. Margins such as spiculated, ill-defined, or microlobulated borders are more conspicuous with DBT, aiding in the differentiation between benign and malignant lesions [14]. Masses that appear indeterminate on 2D mammography often show their true shape and extent in DBT slices, leading to more accurate BI-RADS classification.

Studies have shown that DBT improves the visibility of masses by up to 50% compared to 2D mammography alone, particularly for lesions located posteriorly or near the chest wall [15]. In cases with multiple lesions or complex overlapping structures, DBT provides better discrimination between adjacent densities, revealing separate masses or confirming multifocal disease.

Reduction in False Positives

The reduction in overlapping tissue artifacts also leads to fewer false positives, particularly in the evaluation of asymmetric densities and focal areas of glandular prominence. DBT enables more definitive exclusion of a mass when a finding is simply a summation artifact, which reduces the psychological and economic burden of unnecessary workups [16].

In summary, DBT’s superior lesion localization and morphologic analysis contribute directly to improved diagnostic accuracy, efficient workup planning, and more reliable categorization of suspicious findings.

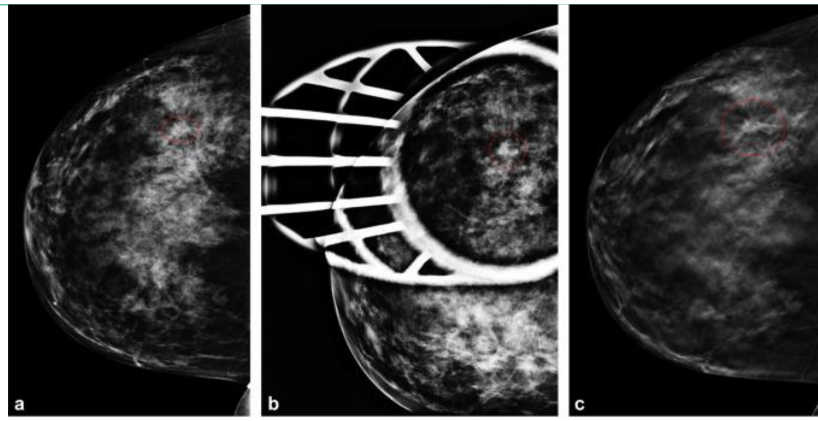

Figure 3: (a)Screening mammogram (CC view) of dense breasts showing lateral asymmetric focal density in the right breast, (b)confirmed on the lateral spot compression image. (c) Tomosynthesis reveals spiculated margins. Subsequent analysis led to diagnosis of IDC [2].

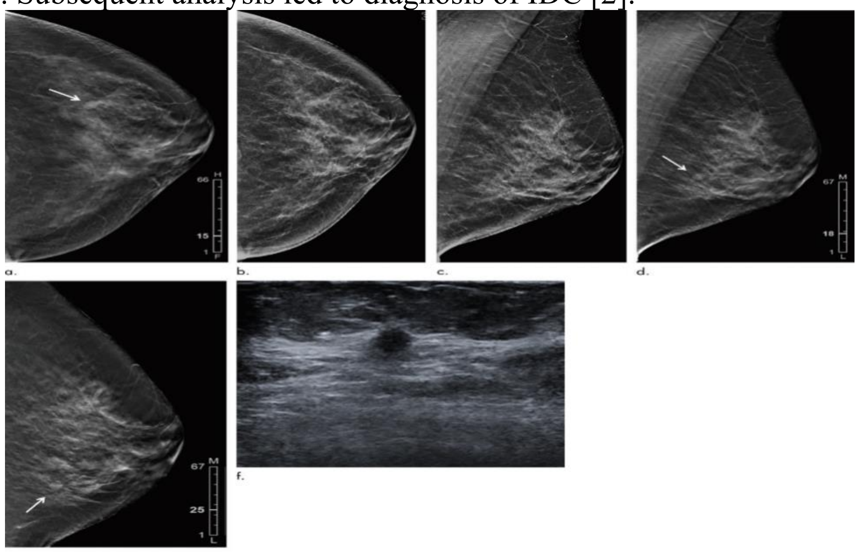

Figure 4 Images in 57-year-old woman with cancer detected only with digital breast tomosynthesis (DBT). **(a–c)** Craniocaudal DBT image (**a**) demonstrates a spiculated mass (arrow) not visible on synthetic craniocaudal (**b**) or mediolateral oblique (**c**) mammograms. **(d)** On the basis of the location in the DBT craniocaudal stack, the mass (arrow) can be localized on DBT image obtained in mediolateral oblique projection. **(e)** The mass (arrow) is better demonstrated on DBT images in mediolateral projection. **(f)** US examination shows that finding corresponds to an irregular, hypoechoic mass. Pathologic examination of biopsy specimen revealed invasive ductal carcinoma [16].

Evaluation of Calcifications: Benign vs. Malignant Features in DBT

Calcifications are a critical component in the detection of early-stage breast cancer, particularly ductal carcinoma in situ (DCIS). However, their interpretation of conventional mammography is often limited by superimposed tissue and image contrast challenges. **Digital Breast Tomosynthesis (DBT)** offers improved assessment of calcification morphology and distribution, aiding in the differentiation between benign and malignant types [17].

Detection and Visibility of Calcifications in DBT

While some early studies raised concerns about DBT's sensitivity for microcalcifications due to image reconstruction techniques, subsequent research has shown that calcifications are reliably detected when thin-slice reconstruction and high-resolution displays are used [18]. DBT improves visibility of calcifications by reducing noise and overlapping tissue, allowing radiologists to confirm whether calcifications are grouped or dispersed across multiple slices [19].

Benign Calcifications

Benign calcifications often exhibit round, punctate, or coarse appearances with diffuse or scattered distributions. Common examples include vascular calcifications, skin calcifications, and milk of calcium, which tend to be readily distinguished on DBT due to enhanced depth perception and localization [20]. The layered appearance of milk of calcium, in particular, becomes more apparent on tomosynthesis, reducing false positives on screening exams [21].

Malignant Calcifications

Malignant calcifications are typically characterized by irregular, fine linear, fine pleomorphic, or branching forms. DBT allows these morphologic features to be assessed across adjacent slices, which helps confirm the suspicious nature of calcifications and detect subtle patterns indicative of malignancy [22]. Segmental or linear distribution—suggestive of ductal spread—is more easily delineated in tomosynthesis, improving early detection of DCIS [23].

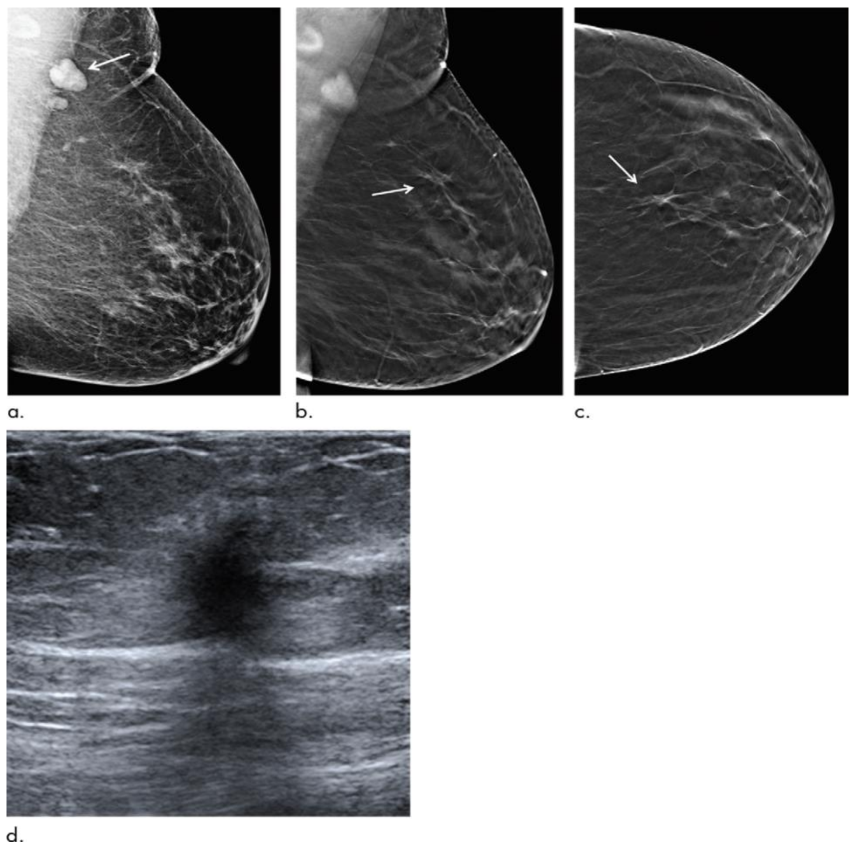

Figure 5 in 62-year-old woman with an enlarged axillary lymph node at screening mammography (**a)** Full-field digital mammogram in mediolateral oblique view demonstrates an enlarged low left axillary lymph node (arrow) (**b, c)** DBT images show subtle architectural distortion (arrow) in superior part of breast on mediolateral oblique view (**b**) and in central part of breast on craniocaudal view (**c**) **(d)** US examination demonstrates a suspicious hypoechoic mass at the 12 o'clock location. Pathologic examination of biopsy specimen revealed invasive lobular carcinoma. [16].

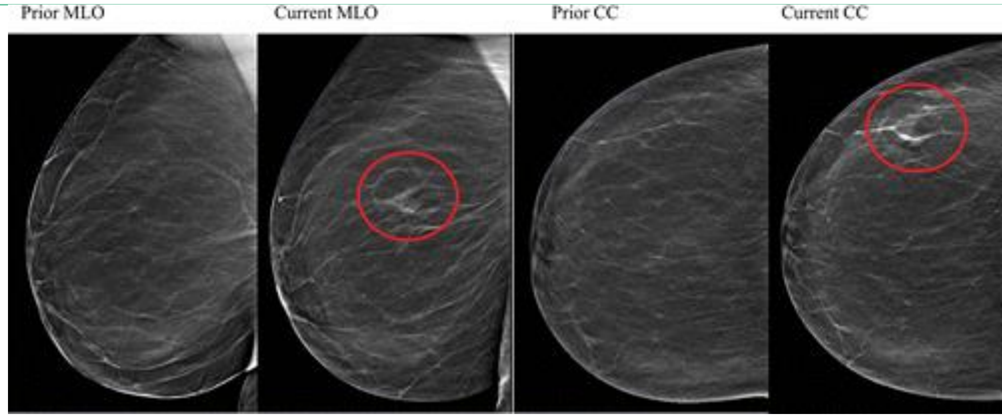

Figure 6 Images in 68-year-old woman recalled from annual screening mammography for a developing asymmetry in the upper-outer right breast, which is seen on the current mediolateral oblique (MLO) and craniocaudal (CC) views (circles). This finding persisted on subsequent spot compression views (not shown), and there was no US correlate. Tomosynthesis-guided biopsy yielded invasive ductal carcinoma and high-grade ductal carcinoma in situ. [16].

Figure 6 Images in 48-year-old man who presented with palpable lump in right breast. **(a, b)** Image from digital breast tomosynthesis (DBT) in mediolateral view (**a**) demonstrates area of fat necrosis

(arrow) not well seen on full-field digital mammogram in mediolateral view (**b**). Patient reported being in a motor vehicle collision several months earlier, with direct trauma to the breast. No further workup was needed due to the typical appearance of fat necrosis on DBT image. [16].

Morphologic Assessment and BI-RADS Categorization

DBT contributes to more accurate BI-RADS classification of calcifications by refining the assessment of shape, distribution, and extent. This helps to avoid both overcalling benign lesions and underestimating malignant ones [24]. By reducing ambiguity, DBT leads to more appropriate decisions regarding follow-up imaging or biopsy, supporting individualized patient care.

Limitations in Calcification Evaluation

Although DBT enhances the evaluation of many calcifications, limitations remain. Tiny microcalcifications can still be difficult to assess in dense tissue or low-dose protocols. In such cases, spot magnification views with 2D mammography may still be necessary for final characterization [25].

DBT offers a substantial improvement in the analysis of calcifications by enhancing visibility, localization, and morphologic evaluation, leading to better diagnostic decisions in both screening and diagnostic settings.

Architectural Distortion and Asymmetries – Enhanced Detection with DBT

Architectural Distortion: Definition and Diagnostic Challenges

Architectural distortion (AD) is one of the most challenging findings in breast imaging. It refers to the disruption of the normal breast parenchymal pattern without a discrete mass, often presenting as radiating lines or focal retraction of tissue. On 2D mammography, AD is frequently obscured by overlapping fibroglandular tissue or mimicked by summation artifacts, leading to both underdiagnosis and false positives [26].

DBT's Role in Detecting Architectural Distortion

Digital Breast Tomosynthesis (DBT) significantly enhances the detection and characterization of architectural distortion. By eliminating tissue overlap and allowing visualization of the breast in thin slices, DBT reveals the presence and extent of architectural disruption more clearly than standard mammography [27]. Radiologists can scroll through reconstructed slices to confirm the presence of true distortion and localize it in three dimensions [28].

DBT has been shown to detect 19% to 65% more ADs than 2D mammography alone, with a higher positive predictive value for malignancy [29]. Suspicious ADs on DBT often correlate with invasive lobular carcinoma, radial scars, or early-stage malignancies that lack mass-forming characteristics [30].

Impact on Management and Biopsy Decision

The improved visualization of AD on DBT leads to more accurate BI-RADS categorization and facilitates earlier detection of subtle cancers. This enables timely referral for biopsy and more precise targeting during tomosynthesis-guided procedures [31].

Asymmetries: True vs. Artifact

Asymmetries represent another common diagnostic dilemma, particularly when evaluating focal or global differences in breast density. Many of these are artifactual and due to tissue overlap or positioning. DBT improves diagnostic confidence by helping radiologists differentiate true asymmetries from artifacts. On DBT, asymmetries that resolve across slices are often dismissed as benign summation effects, reducing unnecessary recalls [32].

In contrast, DBT enhances evaluation of persistent asymmetries by confirming their presence across multiple planes, allowing better assessment of shape, margins, and internal composition. This facilitates distinction between developing asymmetries and subtle masses that may need further imaging or biopsy [33].

Clinical Outcomes and Reader Performance

Reader studies have shown that the addition of DBT significantly improves radiologists' accuracy in interpreting ADs and asymmetries, with increased inter-reader agreement and fewer equivocal findings [34]. This translates to fewer diagnostic mammograms and a reduced need for additional ultrasound evaluations [35].

Integration into Screening and Diagnostic Algorithms

Due to its high sensitivity for subtle non-mass findings, DBT is increasingly recommended as part of both screening and diagnostic protocols, particularly in women with dense breasts or equivocal 2D findings [36]. Some protocols now prioritize DBT when AD or asymmetry is suspected on initial mammography, streamlining the diagnostic pathway. The improved detection and evaluation of architectural distortions and asymmetries is one of DBT's most clinically impactful contributions. By increasing diagnostic accuracy, reducing ambiguity, and facilitating early cancer detection, DBT strengthens the overall reliability of breast imaging and supports more informed decision-making.

Role of Digital Tomosynthesis in Changing the BI-RADS Categorization of Mammographically Detected Breast Lesions

The Breast Imaging Reporting and Data System (BI-RADS) is a standardized framework established by the American College of Radiology to guide breast imaging interpretation, risk stratification, and clinical management. Categorization relies heavily on imaging features such as lesion morphology, margin definition, and distribution patterns, all of which are subject to the quality and limitations of the imaging modality used. With the advent of Digital Breast Tomosynthesis (DBT), substantial changes in BI-RADS classification have been observed due to enhanced lesion visualization, improved margin clarity, and reduced tissue overlap [37].

Impact on BI-RADS 0: Need for Additional Imaging

BI-RADS 0 indicates an incomplete assessment requiring further imaging. Studies have shown that DBT reduces the frequency of BI-RADS 0 assessments by resolving ambiguities caused by tissue superimposition. Many findings initially considered indeterminate on 2D mammography are reclassified to a definitive category after DBT review, thus reducing recall rates and streamlining diagnostic pathways [38].

Reclassification from BI-RADS 3 to BI-RADS 2 or 4

DBT plays a pivotal role in clarifying features of lesions previously categorized as BI-RADS 3 (probably benign). With better margin visibility and shape analysis, some of these lesions can confidently be downgraded to BI-RADS 2 (benign), eliminating unnecessary short-interval follow-ups [39]. Conversely, suspicious features such as spiculated margins or architectural distortion, which may be underappreciated on 2D images, are more evident with DBT and can justify upgrading to BI-RADS 4 (suspicious), prompting biopsy [40].

Lesion Margin Analysis and Shape Reassessment

Accurate margin assessment is essential in BI-RADS categorization. DBT enhances margin evaluation by removing overlapping tissue, allowing for better visualization of spiculated, indistinct, or microlobulated borders—all features suggestive of malignancy. This improved delineation may justify upgrading BI-RADS 3 lesions to BI-RADS 4A or 4B categories [41].

Assessment of Architectural Distortion and Non-Mass Findings

Architectural distortion often results in underestimation or ambiguous categorization in standard mammography. With DBT, these distortions become more evident and spatially localized, leading to higher BI-RADS scores and early biopsy decisions. This is particularly important for detecting invasive lobular carcinoma, which commonly presents without a mass [30, 42].

Reduction of False Positives and Avoidance of Unnecessary Biopsies

One of the strengths of DBT is its ability to rule out pseudo-lesions and benign asymmetries caused by tissue overlap, thus reducing false-positive findings. Lesions appearing suspicious on 2D mammography but resolved on DBT can be safely downgraded, often shifting a BI-RADS 4 back to BI-RADS 2 or 3 and avoiding unnecessary biopsies [43].

Reclassification of Calcification Patterns

Although DBT has limitations in detecting some microcalcifications, it improves visualization of distribution patterns and associated features, allowing for more informed categorization. Segmental or linear calcifications that may not be well appreciated on 2D views can be more accurately classified with DBT, impacting BI-RADS scoring [22, 23].

Influence on BI-RADS 5 Categorization

In select cases, DBT enhances the visualization of classic malignant features—spiculated masses, complex architectural distortion, and associated skin or nipple retraction—providing higher diagnostic confidence for BI-RADS 5 (highly suggestive of malignancy). This facilitates quicker triage to biopsy and surgical planning [43].

Improved Inter-reader Agreement and Diagnostic Consistency

Several studies report improved inter-observer agreement in BI-RADS assessments when DBT is used, especially for masses and asymmetries. Radiologists show greater consistency in assigning categories with DBT compared to 2D mammography alone, which contributes to standardized care and reduced variability in patient management [43].

BI-RADS 4 Subcategorization Refinement

The subcategorization of BI-RADS 4 lesions into 4A (low suspicion), 4B (moderate), and 4C (high suspicion) is essential for risk stratification. DBT facilitates this stratification by revealing subtle differences in morphology and internal architecture, enabling more precise clinical decision-making and tailored patient counseling [43].

The addition of DBT to conventional mammography for BIRADS III–IV lesions significantly enhanced diagnostic performance, with sensitivity, specificity, PPV, NPV, and accuracy improving [49].

The integration of DBT into breast imaging significantly influences BI-RADS categorization by refining lesion characterization and eliminating ambiguity caused by tissue overlap. By enabling both upgrades and downgrades in BI-RADS scores, DBT supports accurate risk assessment, reduces unnecessary procedures, and improves the overall quality of breast cancer diagnostics [43].

Reduction in Interobserver Variability

DBT reduces interobserver variability in BI-RADS categorization by providing enhanced lesion detail and eliminating ambiguity caused by overlapping tissues. In conventional 2D mammography, discrepancies in BI-RADS scoring are common, especially for non-mass findings like architectural distortion or asymmetric densities. With DBT, radiologists across varying experience levels demonstrate higher agreement in categorizing lesions, particularly in distinguishing BI-RADS 1–2 from higher categories [44]. This consistency is critical in screening programs and multidisciplinary settings.

DBT for Challenging Case Scenarios

In technically challenging mammographic cases — such as postoperative changes, dense glandular backgrounds, or overlapping parenchymal patterns — DBT proves especially useful in refining BI-RADS categories. For example, surgical scars or fat necrosis, which may appear suspicious on 2D views, are more clearly characterized on DBT, often allowing for a benign (BI-RADS 2) categorization without further imaging [45]. In dense breasts, DBT helps radiologists confidently differentiate new lesions from dense parenchyma, avoiding unnecessary BI-RADS 3 or 4 assignments.

Influence on Short-Term Follow-Up Decisions

Short-term follow-up imaging (typically assigned to BI-RADS 3) is often used conservatively to monitor non-specific findings. However, with the improved morphologic evaluation from DBT, many such cases can be downgraded at the time of initial assessment. This spares patients the psychological burden and logistical inconvenience of follow-up imaging. Conversely, findings that appear benign on 2D mammography but demonstrate subtle irregularities on DBT may be appropriately upgraded and biopsied earlier [46].

Educational and Training Implications

The integration of DBT into BI-RADS-based reporting necessitates radiologist training and familiarity with its image interpretation nuances. Structured training in DBT interpretation has been shown to improve reader performance and reduce BI-RADS misclassification. Radiology residents and breast imaging fellows trained in DBT often demonstrate higher diagnostic confidence and fewer ambiguous assessments in both screening and diagnostic contexts [47].

Summary of Clinical Impact on BI-RADS Categorization

In sum, DBT enhances the accuracy, consistency, and confidence of BI-RADS categorization across all lesion types. It minimizes unnecessary BI-RADS 0 and 3 assignments, improves stratification of BI-RADS 4 lesions, and supports informed decision-making for patient management. As clinical adoption grows and training becomes standardized, DBT is poised to redefine the diagnostic reliability of BI-RADS-based breast imaging [48].

Conclusion

Digital Breast Tomosynthesis (DBT) has significantly advanced the field of breast imaging by overcoming the limitations of traditional 2D mammography. Its ability to generate thin-slice, quasi-3D images enhances lesion detection, improves localization, and allows more accurate assessment of masses, calcifications, asymmetries, and architectural distortions.

In screening programs, DBT has been shown to reduce recall rates and increase cancer detection, particularly in women with dense breast tissue. In diagnostic settings, it improves the clarity of findings and supports more accurate BI-RADS categorization, leading to more appropriate follow-up and fewer unnecessary biopsies.

A key strength of DBT lies in its ability to shift BI-RADS categories by resolving equivocal findings, increasing confidence in benign assessments, and enabling earlier identification of suspicious lesions. This helps streamline patient management and reduces variability among readers.

Overall, DBT has established itself as a valuable tool in both screening and diagnostic breast imaging, offering improved accuracy, efficiency, and patient outcomes. As clinical experience grows and technology continues to evolve, DBT will likely become even more integral to routine breast cancer care.

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