



Breast Imaging

Usefulness of digital breast tomosynthesis for non-calcified benign breast masses

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A B S T R A C T

Digital breast tomosynthesis (DBT) is a new modality that assists in detection of breast cancer. However, benign masses are also detected more easily by DBT and may require further workup. This article reviews typical imaging features of non-calcified benign masses on DBT. We also discuss the management of these benign masses. Knowledge of the imaging features of benign masses on DBT is required to minimize unnecessary callbacks.

1. Introduction

Breast screening by mammography is widely acknowledged as the most effective method of detecting early breast cancer and reducing breast cancer mortality. However, a major limitation of conventional two-dimensional (2D) mammography is the potential for overlap of tissues within the breast. Digital breast tomosynthesis (DBT) may address this limitation of conventional 2D mammography. DBT reduces the masking effect of overlapping fibroglandular tissue, thereby improving detection of breast cancer in comparison to 2D mammography [1–3]. DBT can be used for breast examination in various clinical scenarios. In the diagnostic setting, DBT can improve lesion detection and reader performance beyond that achieved by standard 2D mammography.

DBT can decrease false-positive summation shadows, and contribute to reduced recalls. However, DBT also identifies more benign masses and handling these previously undetected masses can be challenging. If too many patients with benign masses detected by DBT are recalled, this could offset the reduction in recalls, resulting in undesirable outcomes [4].

Accordingly, it is important to distinguish benign masses from malignant masses on DBT, which means that radiologists should be familiar with the DBT imaging features of non-calcified benign masses. However, to our knowledge, the DBT features of benign breast masses have not been systematically evaluated. Therefore, we reviewed the typical and important imaging features of non-calcified benign breast masses on DBT. In this article, we also present the management of

benign and indeterminate/suspicious masses. In our study, we subjectively found the delineation of masses better with DBT, especially in benign masses, which may theoretically obviate the need for subsequent ultrasonography.

2. DBT technique

When DBT is performed, the breast is compressed and held between the compression paddle and detector, similar to the procedure for 2D mammography. The X-ray tube moves in an arc overhead, obtaining a series of low-dose projection images at preset intervals, each from a different angle. DBT systems can acquire images in standard mammography orientations (i.e., craniocaudal and mediolateral oblique).

After acquisition of DBT images, reconstruction can be employed to create slices as thin as 1 mm in the plane parallel to the detector. This allows three-dimensional (3D) estimation of the location of a lesion in the breast after it is identified on the projection images. Images are displayed on a proprietary workstation as 2D image sections. This allows the radiologist to scroll through the images individually and manipulate the section thickness to as thin as 1-mm intervals [5].

Thus, DBT has several advantages. It was reported that DBT showed similar or better performance for analysis of lesion margins compared with 2D mammography spot compression views, suggesting that DBT could replace mammography [6]. Also, combined-mode imaging can be performed to acquire 2D mammography and DBT images during the same examination without altering breast compression [5]. Moreover, DBT can provide information on the location of a lesion without the

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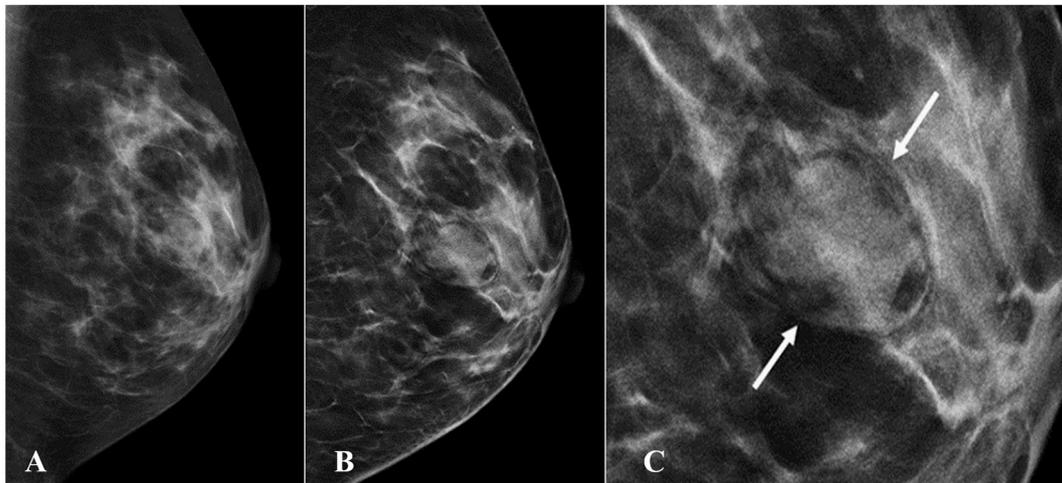


Fig. 1. 43-Year-old woman with a palpable breast mass.
 (A) On mediolateral oblique (MLO) mammogram, the mass is not seen clearly.
 (B) DBT image and (C) close-up view clearly show an oval mass (arrows) with an apparent capsule that contains both radiolucent tissue and dense tissue. These features are characteristic of a hamartoma. Because the DBT findings indicate that the mass is benign, further imaging or clinical follow-up is not required.

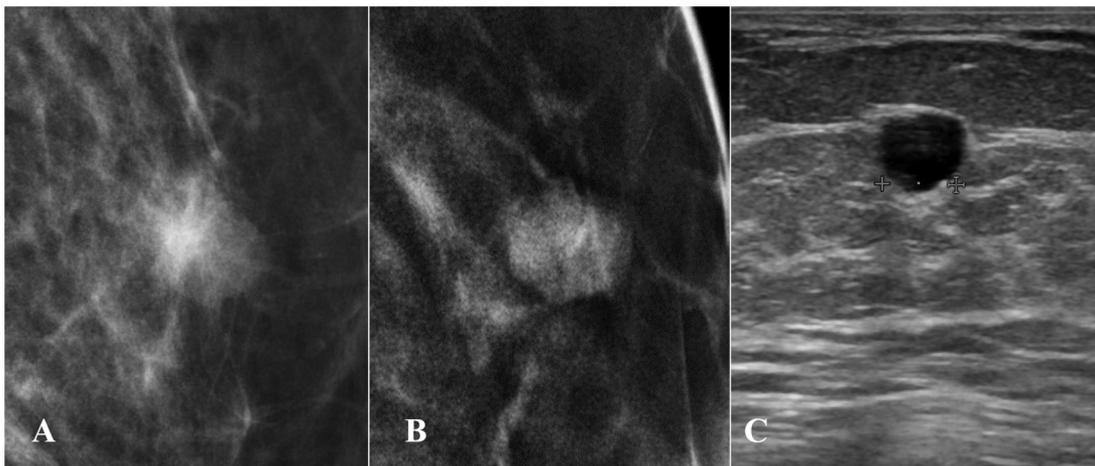


Fig. 2. 59-Year-old woman with a simple cyst.
 (A) MLO screening mammogram (close-up view) shows a small irregular mass.
 (B) On DBT image (close-up view), an oval circumscribed mass is seen.
 (C) Ultrasound revealed an anechoic circumscribed mass with posterior acoustic enhancement, which are the typical sonographic features of a cyst.

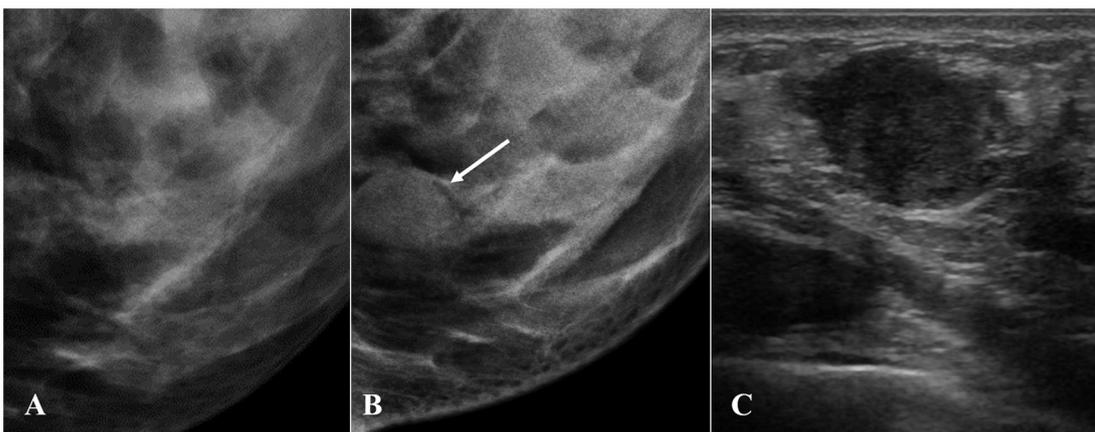


Fig. 3. 33-Year-old woman with invasive carcinoma.
 (A) MLO mammogram (close-up view) shows no abnormality.
 (B) DBT image (close-up view) shows a partially circumscribed mass (arrow).
 (C) Targeted ultrasound demonstrated a round predominantly circumscribed mass, and biopsy revealed invasive carcinoma.

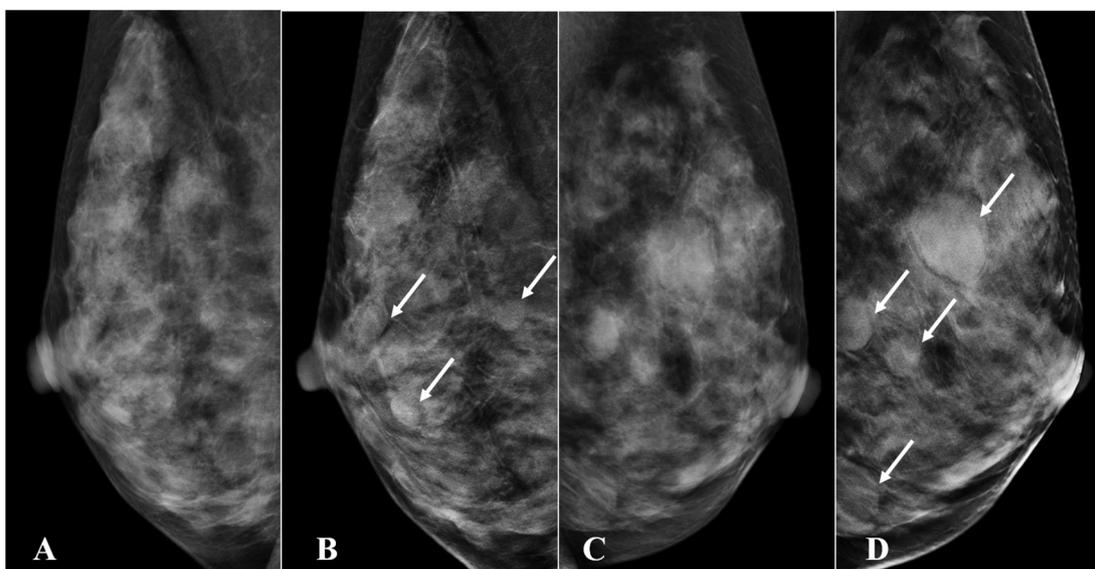


Fig. 4. 46-Year-old woman with multiple cysts. (A) and (C) On MLO mammograms, multiple masses are not well or are incompletely characterized, but these shapes and margins are not seen clearly. (B) and (D) DBT images reveal bilateral and multiple masses that are mostly circumscribed (arrows). These imaging findings are suggestive of benign masses, such as cysts or fibroadenomas, and the patient may continue with routine screening.

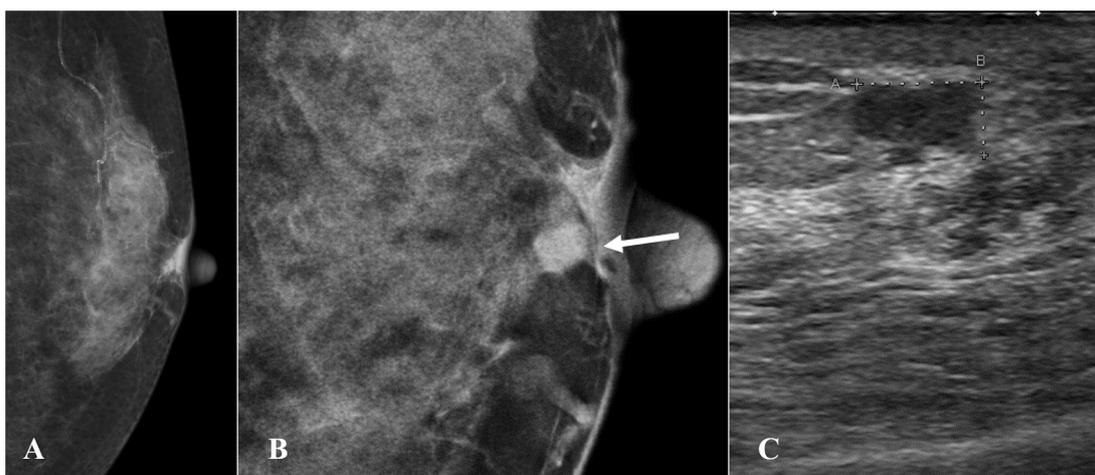


Fig. 5. 68-Year-old woman with non-invasive carcinoma. (A) The mass is not seen clearly on MLO mammogram. (B) On DBT image (close-up view), there is a small circumscribed solitary mass (arrow) with a high density relative to the surrounding breast tissue. These imaging findings suggest the possibility of malignancy. (C) Targeted ultrasound demonstrated a small hypoechoic mass, and biopsy revealed non-invasive carcinoma.

need for imaging in two positions [7].

On the other hand, there are several problems with DBT, such as a higher radiation dose, longer reading time, and greater cost for digital storage [7,8].

3. Assessment of non-calcified benign masses on DBT

3.1. Shape and margin of circumscribed masses

Masses are characterized by their shape and margin. According to the Breast Imaging Reporting and Data System (BI-RADS) descriptors, the shape can be round, oval, or irregular. The margins can be circumscribed, obscured, microlobulated, indistinct, and spiculated [9]. Of these descriptions, a mass that is an irregular shape with spiculated margins is the most concerning for malignancy. Whereas, a mass that is a round shape with circumscribed margins is more likely benign.

These features are often better depicted by DBT and can facilitate characterization of a mass by eliminating the confounding effect of overlapping structures (Fig. 1). In our study, we found delineation of masses indeed subjectively better, especially in benign masses, which may theoretically obviate the need for subsequent ultrasonography.

In addition, DBT can be used to accurately reclassify the mass compared with the screening diagnosis (Fig. 2). In our study, we found that masses which were irregular on 2D mammography tended to be depicted as round or oval masses by DBT, especially benign lesions.

Although a circumscribed margin is usually considered to indicate a benign mass, some malignant tumors also present as circumscribed masses on 2D mammography [10]. For example, triple-negative cancers and cancers with BRCA 1/2 mutation are likely to show circumscribed margins similar to those of benign masses [11,12]. Thus, improved visualization of the partially or completely smooth margins of some malignant masses on DBT may possibly lead to misdiagnosis (Fig. 3).

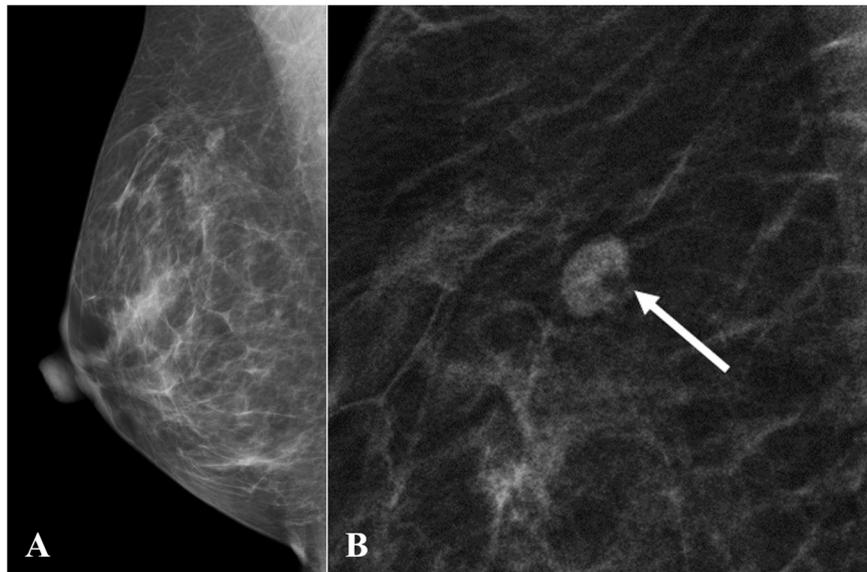


Fig. 6. 48-Year-old woman with an intramammary lymph node.
 (A) MLO screening mammogram shows a small oval mass.
 (B) DBT image (close-up view) reveals a fatty hilum (arrow) inside a mass with circumscribed margins. These imaging findings are characteristic of a lymph node and further evaluation is not required.

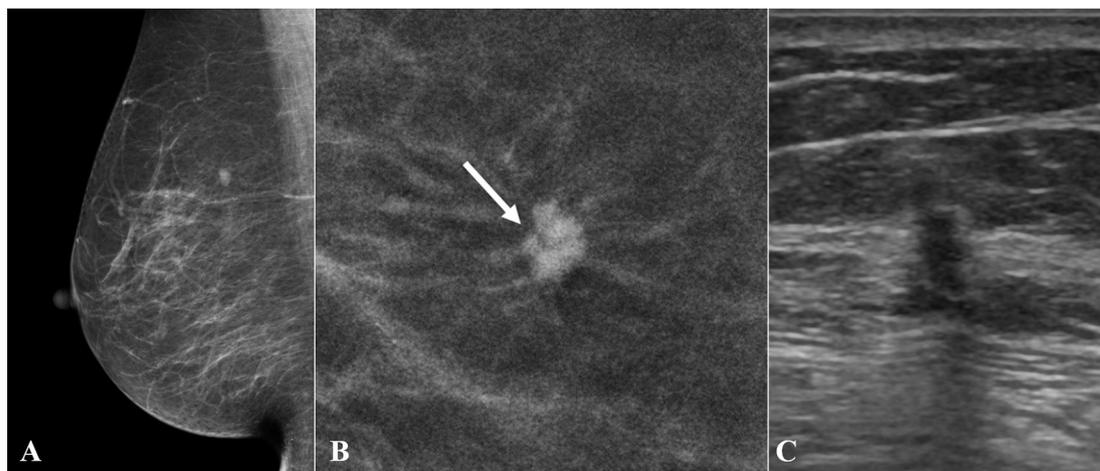


Fig. 7. 60-Year-old woman with invasive carcinoma.
 (A) There is a small oval mass on MLO mammogram.
 (B) DBT image (close-up view) reveals an irregular mass containing a radiolucent region (arrow) that represents fat. The mass is not encapsulated and has irregular margins. These imaging findings are suggestive of malignancy.
 (C) Targeted ultrasound demonstrated an irregular hypoechoic mass, and biopsy showed invasive carcinoma.

Accordingly, differentiation between benign and malignant masses with circumscribed margins on DBT may require use of other modalities, such as ultrasonography or magnetic resonance imaging (MRI), as well as histopathological examination, if necessary [13].

3.2. Number of circumscribed masses

The bilateral and multiple rules for mammographic and sonographic findings are particularly important when performing DBT because more masses may be detected. Although thorough assessment of the shape and margin of each individual mass is always necessary, most masses will be benign [4]. For example, cysts and fibroadenomas are often visualized as multiple, circumscribed, round or oval masses of varying sizes. Detection of multiple circumscribed masses with a similar appearance on DBT may be an indicator of benignity.

If multiple or bilateral circumscribed masses are detected, these are

likely to be cysts or fibroadenomas (Fig. 4). Recall imaging is not recommended for these masses, and the patient should continue routine annual screening [13,14].

3.3. Size and density of circumscribed masses

A number of small circumscribed masses are often detected by DBT, but these are usually benign masses, such as cysts or fibroadenomas (Fig. 4). Even though DBT has visualized small circumscribed masses better than 2D mammography, these masses are not assured of being benign and it was unclear whether further evaluation could be abbreviated [13]. In our study, the minimum size diagnosed with malignancy among circumscribed masses newly detected by DBT was 5 mm. Therefore, if multiple masses or low density masses are less than 5 mm in diameter, we think that these lesions may be evaluated as benign and routine screening can be continued.

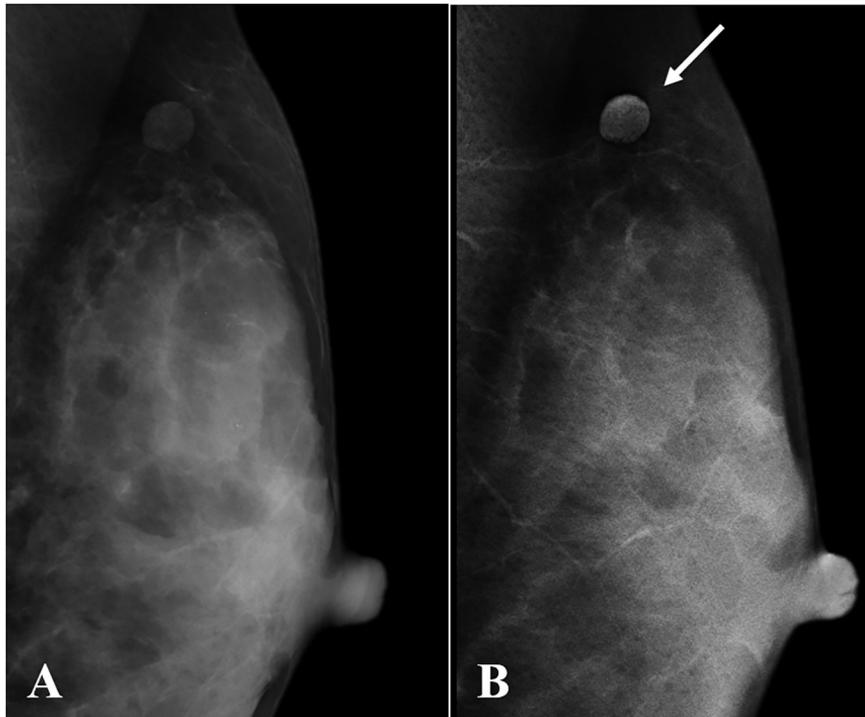


Fig. 8. 55-Year-old woman with a skin mass.
 (A) MLO screening mammogram shows a round circumscribed mass.
 (B) An inner-numbered DBT image displays air trapped around the mass (arrow) more clearly, and the lesion is better defined and localized. This mass is a skin mole and additional imaging is not required.

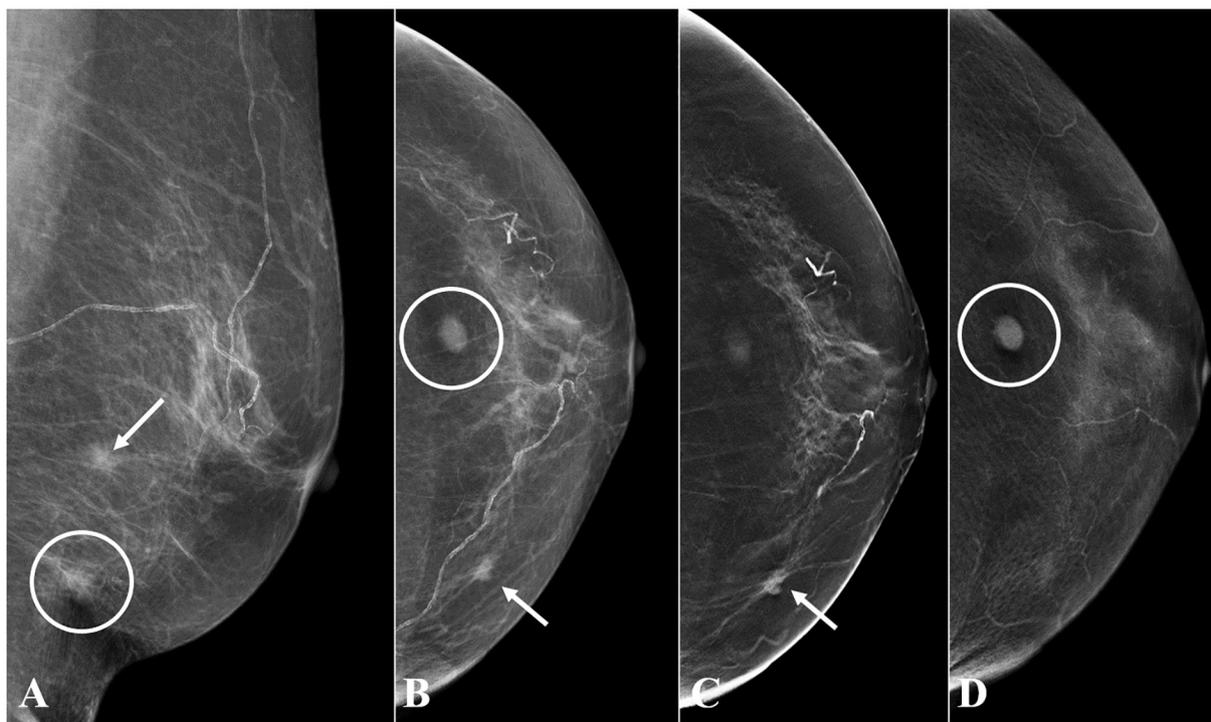


Fig. 9. 82-Year-old woman with invasive carcinoma and a skin mass.
 (A) On MLO mammogram, an irregular mass (arrow) is seen in the middle of the breast and there is a round mass with obscure margins (circle) in the lower part of the breast. The relationship between the two masses is unclear.
 (B) Craniocaudal (CC) mammogram shows an irregular mass (arrow) in the inner region of the breast and a round mass (circle) in the central region of the breast.
 (C) A middle-numbered DBT image depicts the irregular mass more clearly (arrow). Biopsy revealed invasive carcinoma.
 (D) A lowest-numbered DBT image shows a round circumscribed mass associated with air trapping (circle). It is obviously a skin mass and unrelated to the carcinoma, because it is located far from the irregular mass.

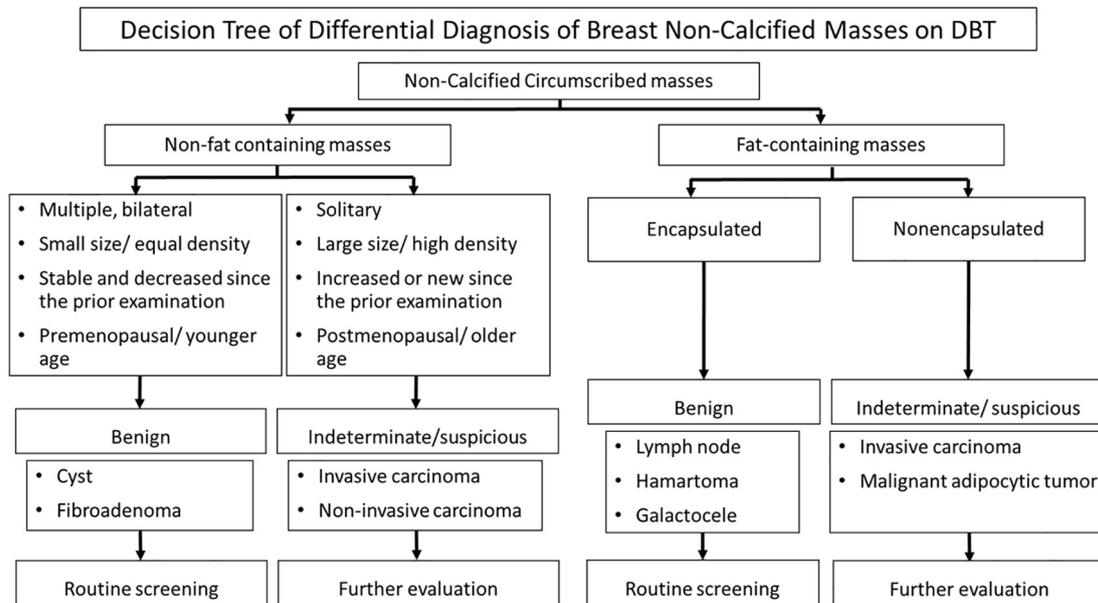


Fig. 10. Decision tree for differential diagnosis of non-calciified circumscribed breast masses.

It was recently reported that circumscribed malignant masses are significantly larger and denser than benign masses on DBT, which can assist in the differentiation of these masses. Therefore, it is useful to assess the density of a mass on DBT despite the thin slice images [13]. If a solitary high density mass is seen, the possibility of breast cancer must be considered (Fig. 5).

3.4. Additional information for differential diagnosis

Circumscribed masses detected by DBT are usually assumed to be benign. However, the possibility of breast cancer must be considered when a new mass is found in a postmenopausal woman.

If the mass is unchanged in size or has become smaller since the previous examination, it can generally be considered benign. On the other hand, if the mass increases in size after follow-up for a short period, other modalities should be employed, including ultrasonography, MRI, or biopsy, considering the possibility of high-grade tumor such as triple-negative cancer.

3.5. Fat-containing circumscribed masses

Thin-slice images obtained with DBT allow more detailed assessment of the internal architecture than is possible with 2D mammography, which means that more fat-containing lesions will be discovered [15]. Encapsulated fat-containing masses detected by mammography are usually benign, and these lesions include hamartomas, galactoceles, and lymph nodes (Fig. 6). It is important to recognize that most encapsulated fat-containing masses detected by 2D mammography and DBT are likely to be benign.

While intralesional fat is generally associated with benign masses, DBT may detect fat within malignant tumors, underscoring the importance of performing careful analysis of the shape and margins of each lesion [4]. The breast is mainly composed of adipose tissue, so fat is often incorporated by a cancer as it grows into and around parenchymal elements. This characteristic of tumor growth is better visualized by DBT because it employs thin-slice images. Therefore, all nonencapsulated fat-containing masses on DBT must be viewed with suspicion and receive further evaluation (Fig. 7).

3.6. Localization of circumscribed masses in the skin

DBT can also provide useful information about the location of lesions. Although skin masses are sometimes mistaken for intramammary masses on 2D mammography, DBT can confirm the superficial location of a mass in the initial images and clearly demonstrate that it lies within the skin (Figs. 8 and 9). Thus, skin masses can be better defined and localized by DBT, avoiding the need for further intervention [8].

3.7. Short summary

DBT can more clearly show the existence, shape, margin, number, size, density, fat, and location of benign masses. Fig. 10 shows the decision tree for making a differential diagnosis between benign or malignant non-calciified circumscribed masses for guiding management.

4. Conclusion

Knowledge of the DBT imaging features of non-calciified benign breast masses is essential to achieve accurate diagnosis and optimum clinical management, and is especially important for avoiding inappropriate invasive procedures. However, if imaging findings do not unequivocally confirm that a mass is benign, the possibility of malignancy should always be considered to avoid delayed diagnosis.

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