

The Clinical Application of Additional Mammography for a Diagnostic Population: Algorithm according to the Lesion Type, Location, and Patient Characteristics

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The purpose of this article is to demonstrate imaging techniques and interpretations of additional mammography and to provide algorithms of clinical applications of additional mammography in terms of lesion and patient characteristics. From 2007 to 2011, we reviewed additional mammography as well as screening mammography, ultrasound, or breast magnetic resonance imaging and clinical and pathological reports. We included spot compression view, magnification view, lateral view, exaggerated craniocaudal view, tangential view, rolled view, and Eklund view as additional mammography. In a diagnostic population, additional mammography has significant advantages for detection and diagnosis of breast lesions. Therefore, additional mammography should not be overlooked and replaced by other breast imaging modalities such as ultrasound or breast magnetic resonance imaging.

Index words: Breast; Additional mammography; Algorithm

Introduction

Mammography is the standard of reference for the detection of breast carcinoma. There are two main types of mammography: screening and additional (diagnostic). Screening mammography is a general screening test for women with no symptoms and consists of two views of each breast; craniocaudal (CC) and mediolateral oblique (MLO) views. Additional mammography is performed if the screening mammography identifies a suspicious area or if a person feels a lump in the breast or

has other unusual symptoms. Additional mammography usually takes more views of the breast from other angles or special coned views of certain areas and it has been important in further assessing identified abnormality on screening mammography.

However, additional mammography has been replaced by ultrasound or breast magnetic resonance imaging (MRI) because of feasibility and difficult interpretation of mammography and the role of additional mammography has been overlooked. However, mammography still has essential roles to discriminate between normal and pathologic tissues and diagnosis of breast lesions.

The purpose of this article is to demonstrate imaging techniques and interpretations of additional mammography and to provide algorithms of clinical applications

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of additional mammography in terms of lesion and patient characteristics.

Imaging Techniques and Interpretation of Additional Mammography

1. Spot compression view

Spot compression views, with or without magnification, are a mainstay of diagnostic breast imaging for evaluation of asymmetric densities or margins of masses (Fig. 1). Spot compression views have many synonyms such as compression mammography, spot view, cone view or focal compression view. Small compression plate or cone is needed to compress a small area for better tissue separation and visualization of a small lesion in question. They reduce noise from scattered radiation, reduce superimposition of overlapping tissue, and improve the effective spatial resolution of the detector to enhance tissue contrast, margin visibility, and image detail (1).

Spot compression views should be obtained in both CC and MLO projections. Obtaining spot compression views in both projections is important because some cancers may not appear mass-like on a spot compression view in one projection but may obviously appear in the other projection (2). They have better definition

of lesions against a fatty background.

2. Magnification view

Magnification views zoom in images of the region of interest by 1.5–2 times and have been used to evaluate microcalcifications, tiny specks of calcium in the breast that may indicate a small cancer (Fig. 2). Magnification views produce better spatial resolution and signal-to-noise ratio than does contact (non-magnification) mammography (3). A small magnification table and spot or full compression paddle are needed to bring the breast closer to the X-ray source and further away from the film plate.

Fischer et al. (4) reported that zoomed images of a digital contact mammography were equivalent to magnification view for the interpretation of microcalcifications. Diagnostic performance of the radiologist evaluating microcalcifications with zoomed from digital contact mammography (X 2.0) was similar to that with magnification view (X 1.8), although image quality and confidence levels were better with magnification views (5).

3. Lateral view

Lateral views may be performed for evaluation of sedimentation of calcifications (milk of calcium) and lo-

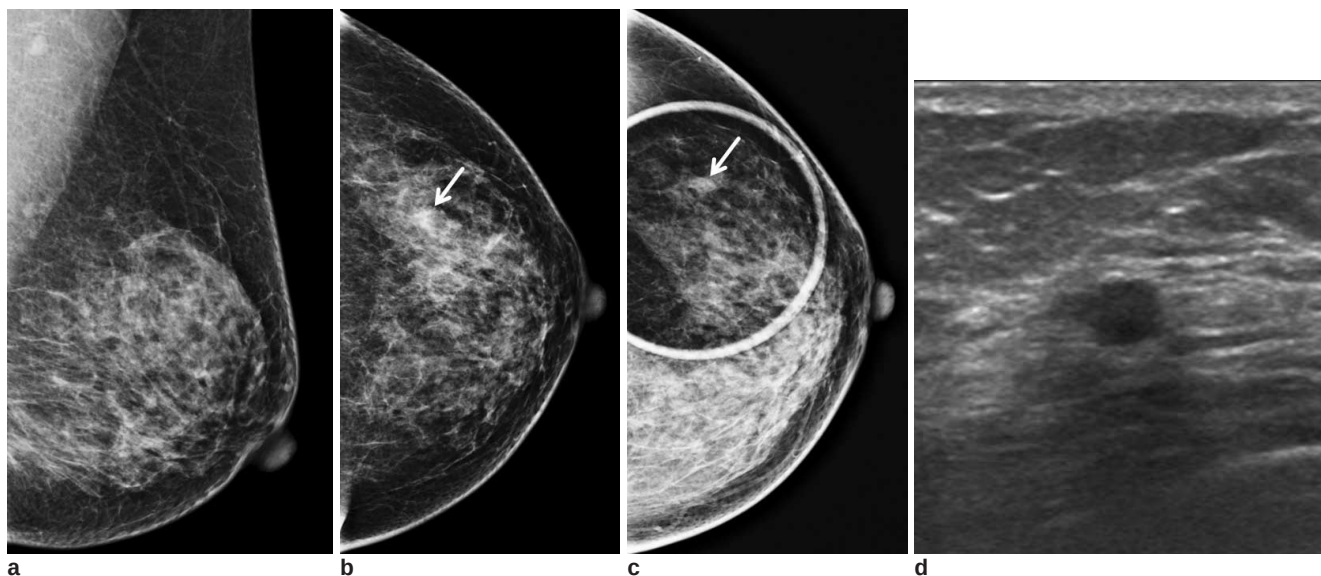


Fig. 1. A 48-year-old woman with screening mammography.

a, b. Left MLO and CC views showed an asymmetric density in left upper outer breast.

c. Spot compression view showed an oval shaped, obscure margined, isodense mass in left outer breast.

d. Ultrasonography showed a complicated cyst at left 2 O'clock direction.

calization of a breast lesion before surgery (Fig. 3). If a lesion is seen only on the CC view, it may be obscured on the MLO view or may be located in medial or inferior portion that is most likely to miss the lesion on MLO view. Obtaining a true lateral view may reveal the lesion. A true lateral view is very useful for localizing the lesion (Fig. 4).

The true lateral view may be either a mediolateral (ML) or lateromedial (LM) view and the X-ray tube should be set in a 90-degree lateral projection for lateral view. The ML view is taken from the center of the chest outward and the LM view is taken from the outer side of the breast inward toward the center of the chest. If no oblique projection is taken, the ML position may be preferable to the LM view since the lateral side of the breast, where pathological changes are most commonly found, is then closest to the film. However, if the lesion

is located in the medial breast, then a LM view may provide better visualization of the lesion, since it will be closer to the film or digital receptor.

Lesions in the lateral breast project higher on the MLO view than they are actually located in the breast, because the MLO view is obtained at an oblique angle. Likewise, lesions in the medial breast project lower on the MLO view than they are actually located in the breast. Thus, lesions that shift lower in position on the ML view are located in the lateral breast while lesions that shift higher in position on the ML view are located in the medial breast (2).

4. Exaggerated craniocaudal (CC) view

Exaggerated CC view is also called as “Cleopatra” view and have been used to evaluate lateral tissue of breast (prominent axillary tail of Spence). It can be per-

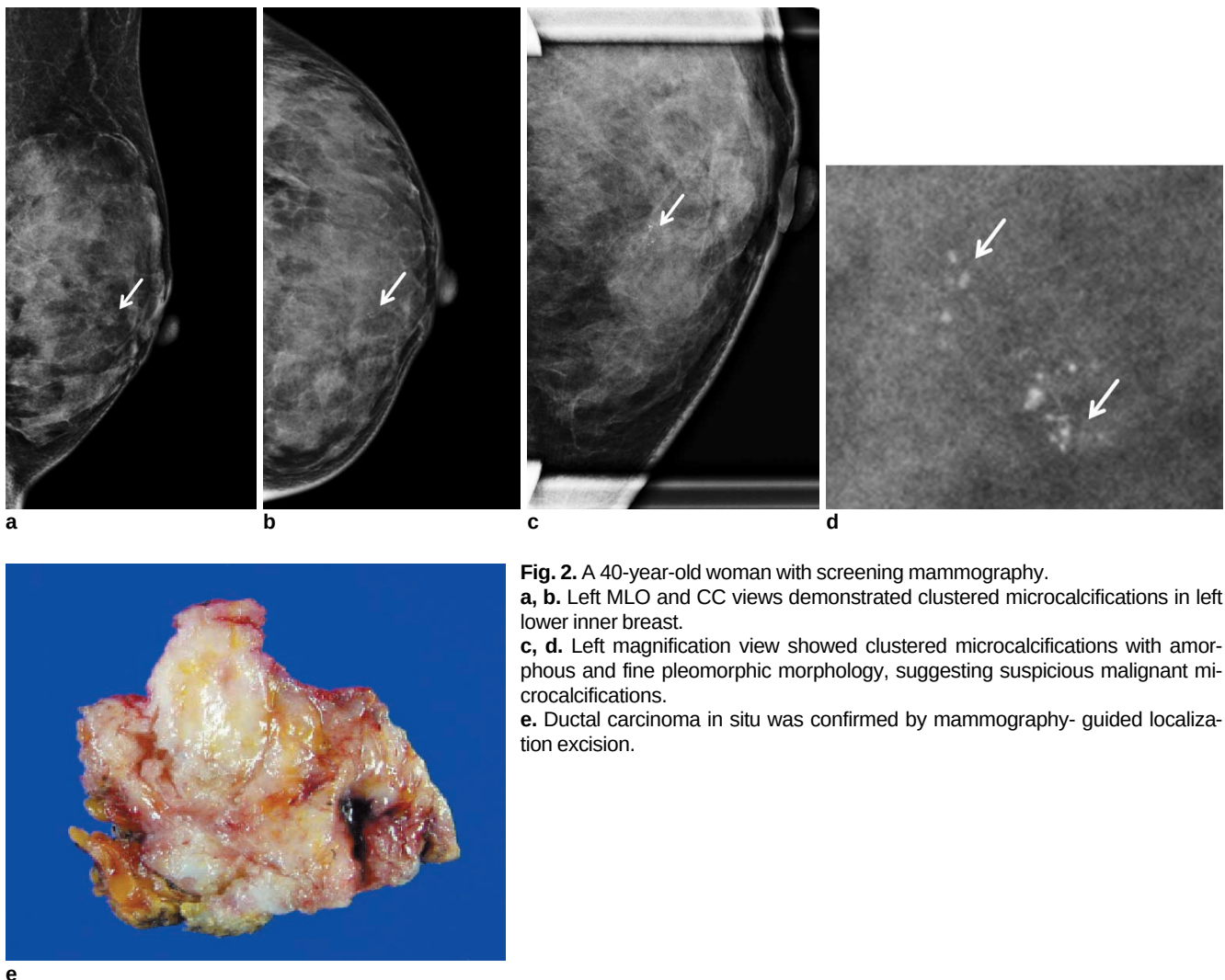


Fig. 2. A 40-year-old woman with screening mammography.
a, b. Left MLO and CC views demonstrated clustered microcalcifications in left lower inner breast.
c, d. Left magnification view showed clustered microcalcifications with amorphous and fine pleomorphic morphology, suggesting suspicious malignant microcalcifications.
e. Ductal carcinoma in situ was confirmed by mammography-guided localization excision.

formed by asking the patient to rotate so that the film holder can be placed at the mid-axillary line and small amount of pectoral muscle image is included on an optimal exaggerated CC view. If a lesion is seen only on the MLO view, it may be obscured on the CC view or may be far lateral, since this area may not be visualized on the CC view. An exaggerated CC lateral view is frequently helpful because most breast cancers are located in the lateral breast (Fig. 5).

5. Tangential view

Skin calcifications are not necessarily depicted at the level of the skin when views are obtained in two planes, such calcifications may be mistaken for intramammary calcifications. The question as to whether clusters of microcalcifications are intracutaneous or intramammary in location can be answered by obtaining tangential views.

Tangential views to prove the intracutaneous location

of skin calcifications was described by Berkowitz et al. (6) and Bassett (7), each of whom reported using a grid with conventional mammography to place a radiopaque marker over the area assumed to contain the microcalcifications. X-ray beam is tangential to the radiopaque marker and the view is subsequently obtained in a second plane then confirm that the microcalcifications are located directly in the area of the marker (Fig. 6). At least theoretically, this method bears the risk of obscuring the microcalcifications by the radiopaque marker in the second plane. The patient's breast remains compressed until the conventional films have been developed and the marker has been placed on the skin, which may involve several minutes of uncomfortable compression. Furthermore, the breast may be dislocated if compression is insufficient, producing a false-negative result with regard to the detection of skin calcifications.

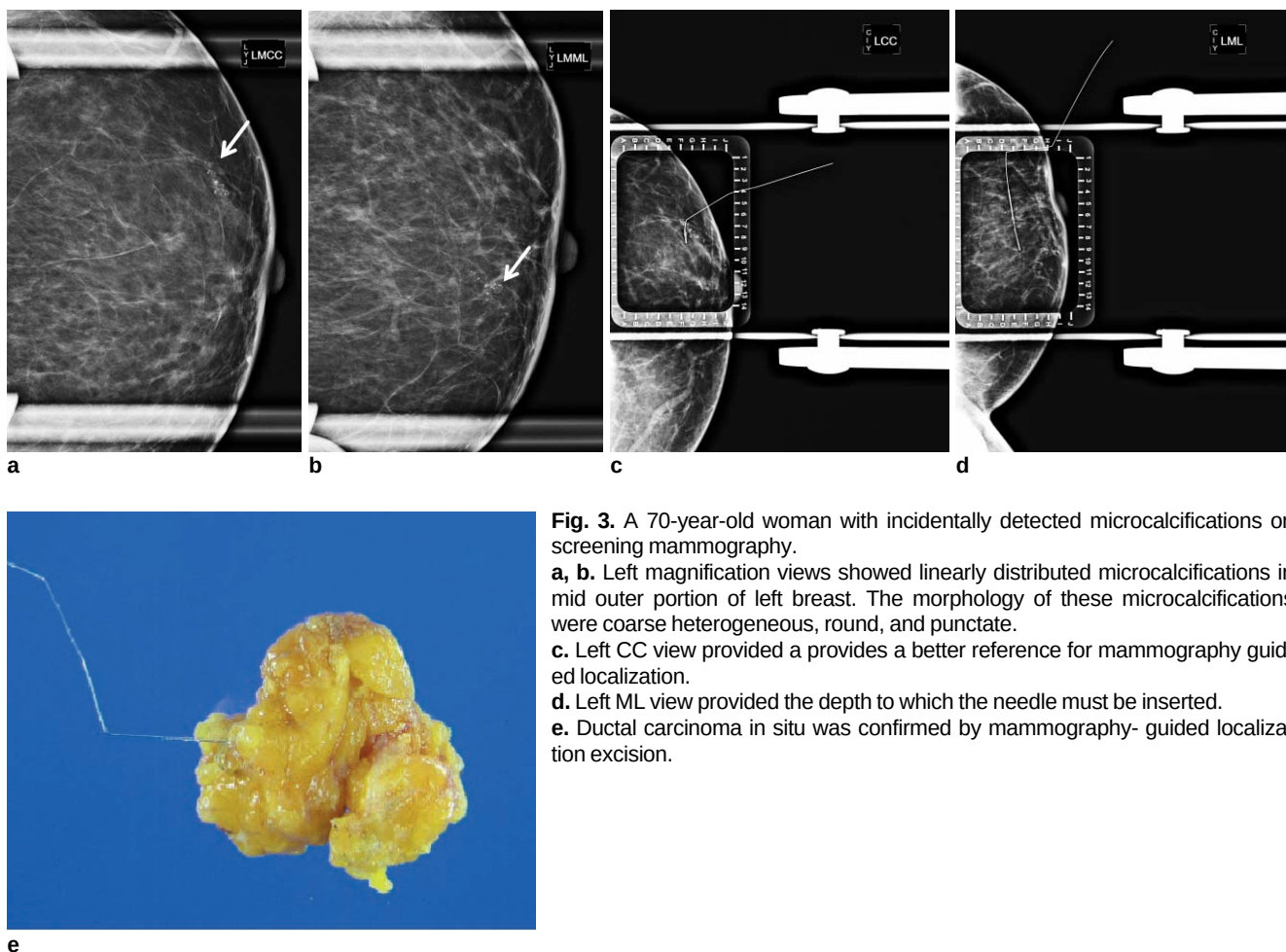


Fig. 3. A 70-year-old woman with incidentally detected microcalcifications on screening mammography.

a, b. Left magnification views showed linearly distributed microcalcifications in mid outer portion of left breast. The morphology of these microcalcifications were coarse heterogeneous, round, and punctate.

c. Left CC view provided a better reference for mammography guided localization.

d. Left ML view provided the depth to which the needle must be inserted.

e. Ductal carcinoma in situ was confirmed by mammography-guided localization excision.

6. Rolled view

Rolled view has been used to solve summation artifacts mimicking architectural distortion, mass, or focal

asymmetry lead to misdiagnosis. Rolled view are taken by changing the positioning of the breast but not obliquity of the X-ray beams (8). This technique is per-



Fig. 4. A 59-year-old woman with screening mammography.

a. There was no abnormal finding on RMLO view 2 years ago.

b. RMLO view showed newly developed asymmetric density in right upper breast.

c. Right spot compression view also showed asymmetric density.

d. On ML view, asymmetric density was disappeared, suggesting grandular summation.

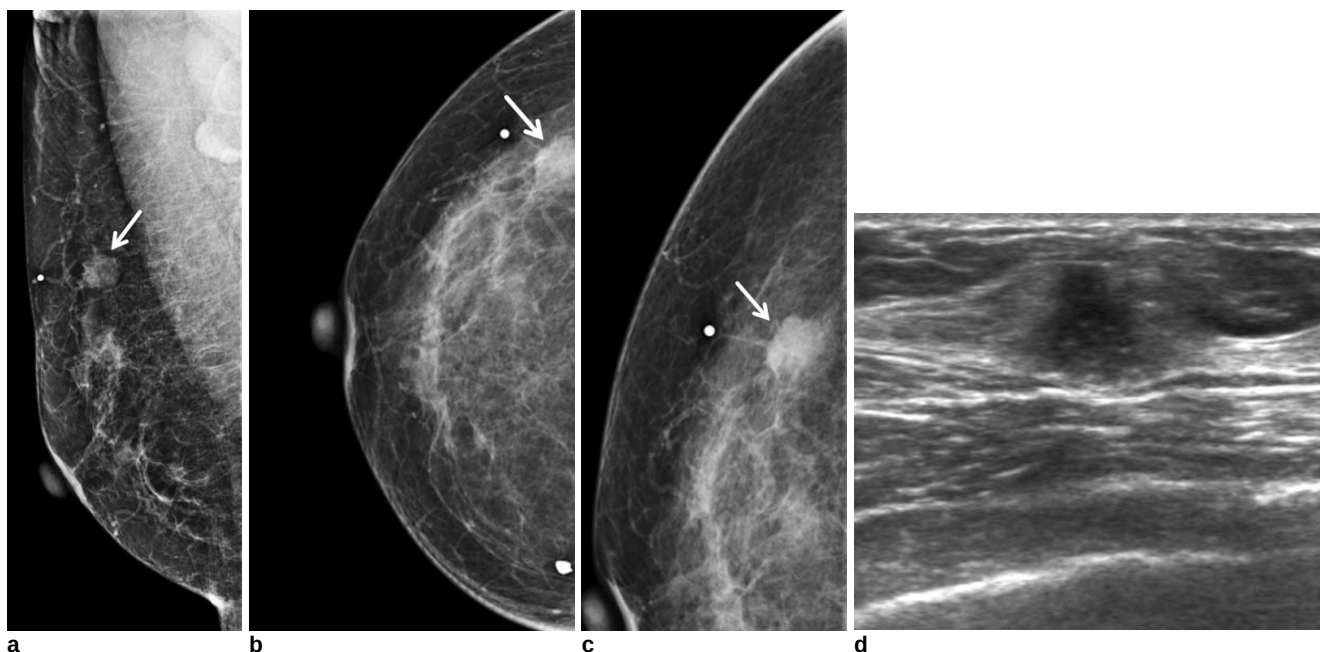


Fig. 5. A 41-year-old woman with palpable mass in right breast.

a. RMLO view showed an irregular shaped, indistinct margined, hyperdense mass in right upper breast.

b. The mass was partially included on RCC view.

c. On right exaggerated CC view, the mass was completely included.

d. Ultrasonography showed a hypoechoic mass in right 10 o'clock and the mass was revealed as invasive ductal carcinoma.

formed in either the CC or the MLO position. In the CC position, the breast is rolled in either the medial or lateral direction. For example, while the upper part of the breast is rolled medially (from lateral to medial), the inner part changes its position laterally along the X-axis of the breast. In the MLO position, the breast is rolled in either the inferior or superior direction. While the

lateral part is rolled inferiorly (from superior to inferior), the medial part changes its position in the opposite direction.

Spot compression view may be used as additional work-up for the same purpose of rolled view, however, spot compression view may not solve the mammographic abnormality in deep areas adjacent to pectoral

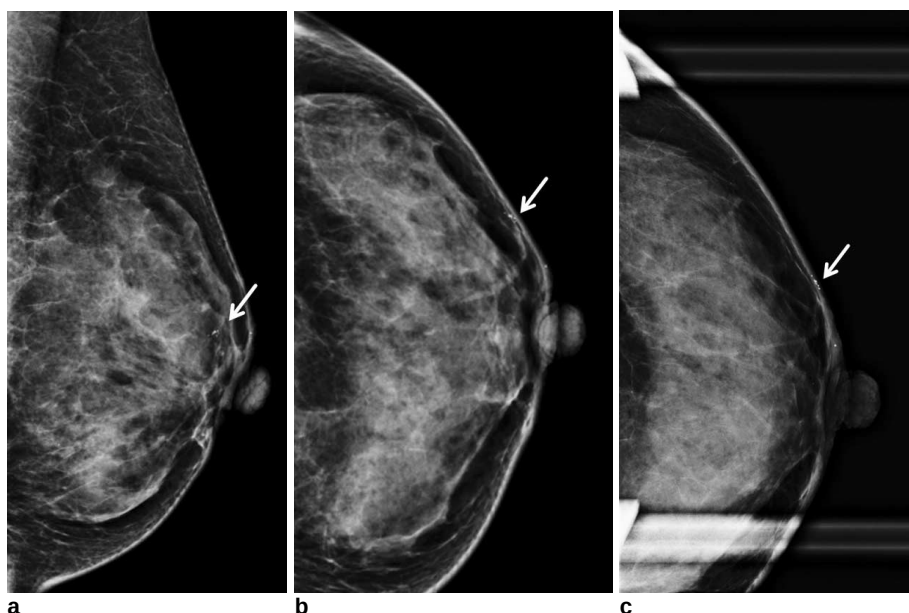


Fig. 6. A 39-year-old woman with microcalcifications on screening mammography.

a, b. Left MLO and CC views showed clustered microcalcifications in upper outer quadrant of left breast.

c. On tangential view, these microcalcifications were located at skin layer, suggesting benign microcalcifications.

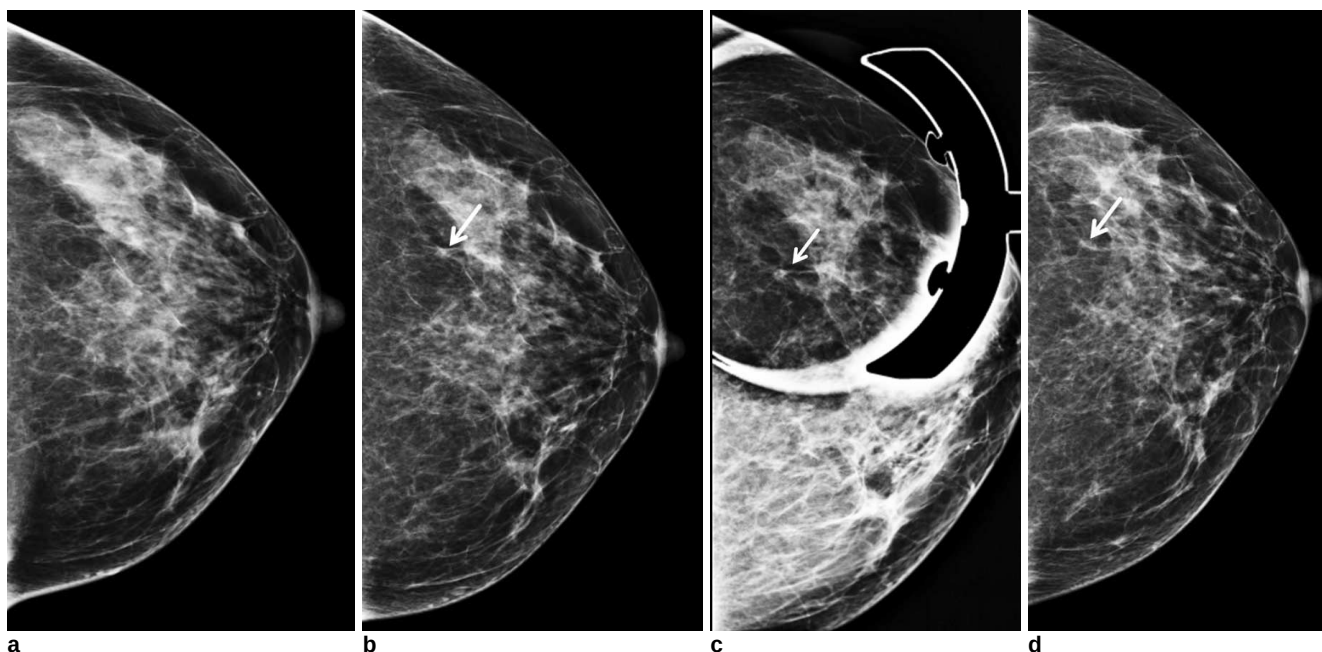


Fig. 7. A 54-year-old woman with newly developed asymmetry on screening mammography.

a. Left CC view showed no abnormal finding.

b. Left CC view obtained after 2 years showed asymmetry in left outer breast.

c. On spot compression view, asymmetry was still seen.

d. On left rolled view, asymmetry was disappeared, suggesting normal glandular summation.

muscle, because it cannot move sufficient amounts of breast tissue. Furthermore, the radiologist may lose anatomic orientation on spot views because of the smallness of the area and the edges of the spot compression device may cause loss of information in adjacent areas (9). In comparison, the rolled view can show the entire glandular tissue of the breast (Fig. 7).

7. Eklund view (Implant displacement view)

Eklund view or implant displacement view have been used for women with silicone or saline implants. The X-rays used for mammographic imaging of the breasts cannot penetrate silicone or saline implants well enough to image the overlying or underlying breast tissue. Therefore, some breast tissue (approximately 25%) will not be seen on the mammography, as it will be covered up by the implant (Fig. 8). In order to visualize as much breast tissue as possible, women with implants undergo four Eklund views as well as the four standard diagnostic mammographic images by pushing back the implant against the chest wall and pulling breast forward over it. This allows better imaging of the forward most part of each breast. These views are not as suc-

cessful in women who have contractures (formation of hard scar tissue around the implants) and are easiest to obtain in a woman whose implants are placed underneath (behind) the chest muscle.

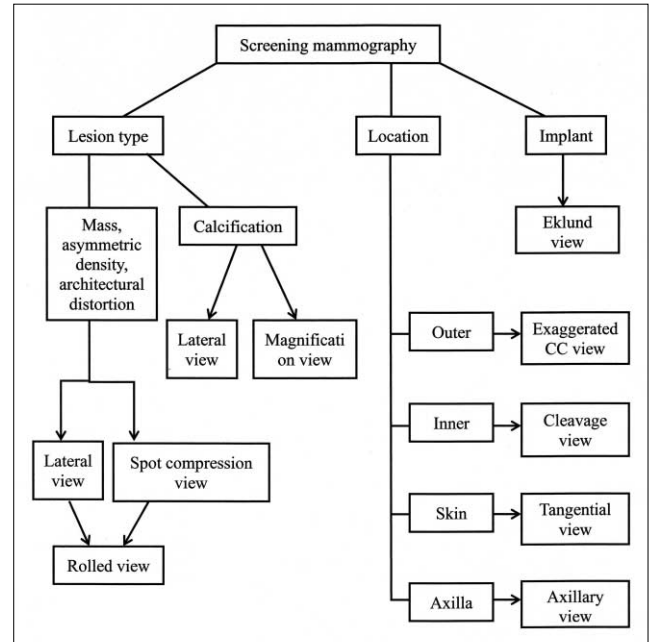


Fig. 9. Algorithm according to the lesion type, location, and patient characteristics

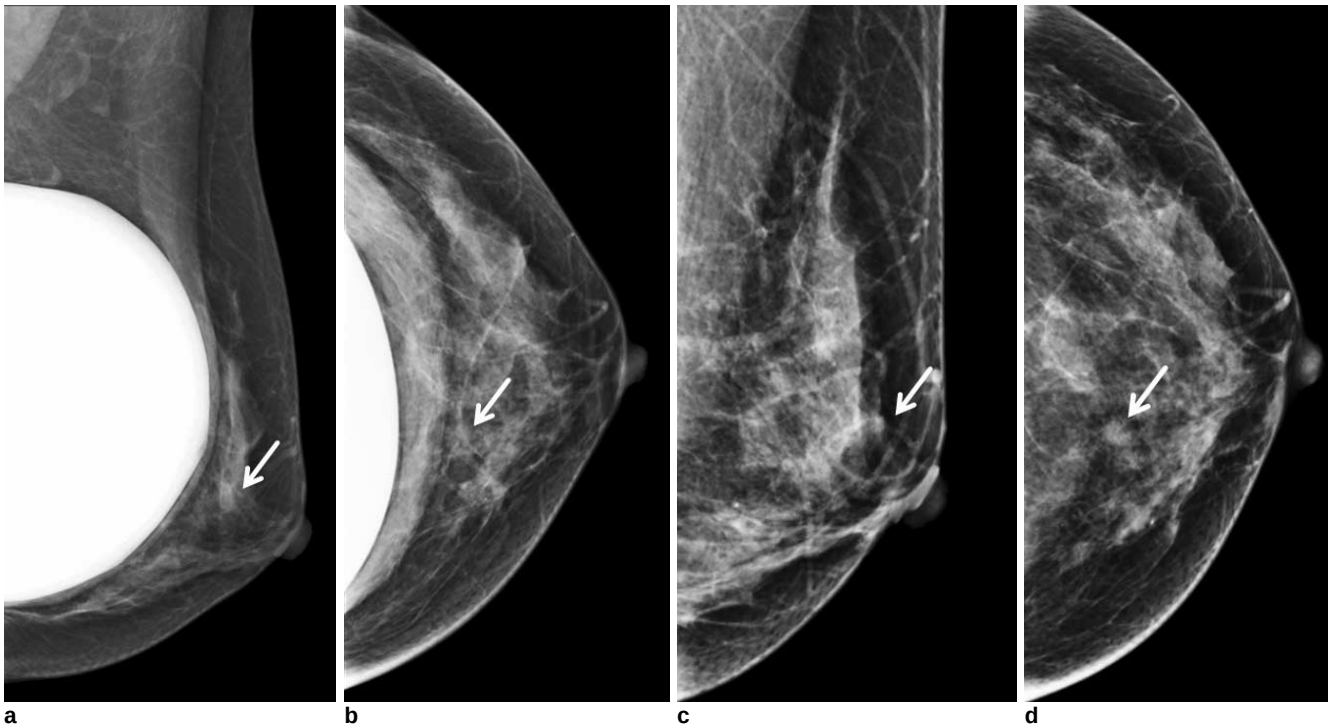


Fig. 8. A 41-year-old woman with silicon bag insertion.

a, b. Left MLO and CC views showed a focal asymmetry in upper inner quadrant of left breast.

c, d. On left Eklund views, a focal asymmetry was more prominently seen in left breast.

e. Ultrasonography showed a round shaped, partially indistinct margined, isoechoic mass in 12 O'clock direction of left breast.

8. Algorithms of clinical application of additional mammography

Based on screening mammography, lesion types can be classified as two groups. Mass, asymmetric density or architectural distortion are the first group and calcifications are the second group. Lesion locations are classified into outer, inner, skin or axilla. Algorithms (Fig. 9) according to the lesion type, location, and patient characteristics provide immediate decisions about selection of additional mammography.

If lesion is visible on only CC view, think about possibility of inner lesion and do spot compression view or rolled view. If lesion is visible on only MLO view, think about possibility of outer lesion and do lateral view, spot compression view or exaggerated CC view.

Conclusion

Digital mammography offers advantages over film mammography. It has easier access to images and computer-aided diagnosis, thus, improves transmission, retrieval, and storage of images (10). The accuracy of digital mammography was significantly higher than that of film mammography in women under the age of 50 years, women with radiographically dense breasts, and premenopausal or perimenopausal women (11). Based on these results, advanced mammography techniques can improve diagnostic performance of diagnosis of breast cancer and mammography is still promising imaging modality even though ultrasound or breast MRI has been widely used. Ultrasound examination is operator-dependent and limited to detect an isoechoic mass in fatty breasts or microcalcifications. In addition, breast MRI is limited for detection of less enhancing malignancies or DCIS cases (12).

Additional mammography is an X-ray exam of the breasts that is performed in order to evaluate a breast complaint or abnormality detected by physical exam or routine screening mammography. Additional mammography is obtained in various directions, techniques, or locations, and cheaper than ultrasound or MRI. Also additional mammography is superior to ultrasound or MRI for detection of microcalcifications or lesions in fat-

ty breasts. Therefore, additional mammography is not an old-fashioned traditional technique but complementary and interactive recommendation to overcome the limitations of ultrasound or breast MRI. As compared with ultrasound or breast MRI, additional mammography is a less time-consuming and cost effective imaging modality.

Additional mammography has significant roles for detection and diagnosis of breast lesions, and should not be overlooked and replaced by ultrasound or breast MRI.

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추가유방촬영의 임상적 적용: 병변특성과 위치, 환자의 특성에 따른 알고리즘의 제시

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이 연구의 목적은 추가 유방촬영의 영상 기술과 영상 해석을 설명하고, 병변과 환자 특성의 측면에서 추가 유방촬영의 임상적 적용을 위한 알고리즘을 제시하고자 한다. 2007년부터 2011년도까지, 우리는 검진 유방촬영과 초음파, 유방 자기 공명 영상, 임상 보고서, 병리 보고서와 함께 추가 유방촬영을 검토하였다. 우리는 국소압박촬영, 확대촬영, 90° 측면촬영, 강조상하촬영, 접선촬영, 회전촬영, 삽입물 전위촬영을 추가 유방촬영에 본 연구에 포함시켰다. 진단적인 측면에서, 추가 유방촬영은 유방 병변의 발견과 진단을 위해 중요한 이점이 있다. 그러므로, 추가 유방촬영은 간과되어서는 안되며, 초음파나 자기 진단 공명과 같은 다른 영상 장치로 대체되어서는 안된다.

Index words: Breast; Additional mammography; Algorithm