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Ultrasonography / Échographie

Current Status of Breast Ultrasound

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Abstract

Ultrasound (US) has a significant role in diagnostic breast imaging. It is most commonly used as an adjunctive test in characterizing lesions detected by other imaging modalities or by clinical examination. US is recognized as the modality of choice in the evaluation of women who are symptomatic and younger than 30 years of age, pregnant, or lactating. Combined mammography and US appear to have a role in screening high-risk populations. The use of standard Breast Imaging Reporting and Data System US lexicon is helpful in guiding the differentiation between benign and malignant sonographic signs. Biopsy is warranted when benign features are absent or for any feature consistent with malignancy, despite other benign findings. Whole breast and axillary US are useful in assessing tumour extension, multifocality, and the status of axillary lymph nodes. US is the modality of choice for guiding interventional breast procedures. The role of US as a guidance tool for nonoperative breast treatment is being investigated.

Résumé

L’échographie joue un rôle important dans l’imagerie diagnostique des seins. Elle est souvent utilisée comme examen d’appoint afin de caractériser les lésions décelées par d’autres techniques d’imagerie ou lors d’un examen clinique. Elle est reconnue comme la technique de choix pour l’évaluation des femmes qui présentent des symptômes et qui ont moins de 30 ans, qui sont enceintes ou qui allaitent. La combinaison de la mammographie et de l’échographie semble pouvoir jouer un rôle dans le dépistage de la maladie chez les groupes à risque élevé. L’usage du lexique de l’échographie mammaire normalisé selon le Breast Imaging Reporting and Data System permet de différencier les signes de tumeurs malignes et bénignes à l’échographie. La biopsie est justifiée en cas d’absence de caractéristiques propres aux tumeurs bénignes ou de présence de toute caractéristique associée à la malignité, même si d’autres signes indiquent la bénignité. L’échographie mammaire et de la région axillaire aide à évaluer l’étendue tumorale, sa nature multifocale et l’état des nœuds lymphatiques axillaires. L’échographie est la méthode à privilégier pour orienter les techniques interventionnelles dans la région des seins. On étudie actuellement le rôle qu’elle pourrait jouer dans l’orientation des traitements de nature non chirurgicale dans cette même région.

Key Words: Breast cancer; Benign breast disease; Ultrasound; Breast US; Mammography; Axillary nodes; Breast cancer screening; Breast imaging; BI-RADS; Breast biopsy

Introduction

With improvement of technique, ultrasound (US) plays a significant role in breast imaging as a diagnostic tool when further investigating abnormalities seen on other imaging modalities or in patients with symptoms. Combined mammography and US appear to have a role in screening high-risk populations. This article will describe the current status of the use of breast US in both diagnostic and screening settings.

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Technical Requirements

The sonographic examination of breast tissue presents several technical challenges. Breast tissue is heterogeneous, with curved interfaces that result in reflection, scattering, and defocusing of the incident beam. The US system used also must be capable of detecting superficial, deep, and retro-areolar lesions. For these reasons, high-resolution, real-time linear arrays, with a centre frequency of at least 10 MHz or higher and the capability of electronic focal zone adjustment are recommended for standard use. The standard breast US field of view should reach the chest wall but not beyond (Figure 1). Because fat is the most hypoechoic structure of normal breast tissue, it serves as the reference against which the echogenicity of breast lesions are compared.

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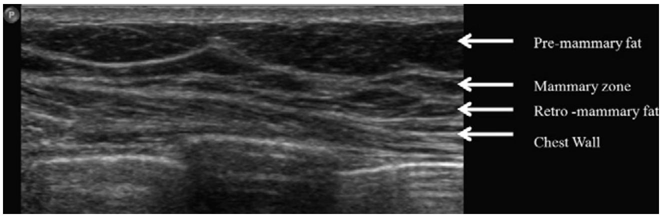

Figure 1. Transverse sonographic image of normal breast tissue. Pre-, intra-, and retromammary fat appears as the most hypoechoic structure.

Breast Imaging Reporting and Data System Lexicon

Breast Imaging Reporting and Data System (BI-RADS) lexicon initially was used only in mammography. In an attempt to standardize the description and reporting of breast lesions in all modalities, the American College of Radiology published, in 2003, an extended version of the 3rd edition, which includes new sections on breast US and magnetic resonance imaging (MRI) [1]. The breast US descriptors are based on shape, orientation, margin, boundary, echo pattern, posterior acoustic features, and surrounding tissue, as well as special features, such as intramammary lymph nodes. Hong et al [2] assessed the use of BI-RADS lexicon descriptors in correlation with pathology results. The sonographic descriptors of mass margin, shape, orientation, lesion boundary, echo pattern, and posterior acoustic features were significantly different for malignant and benign masses. The researcher concluded that the sonographic BI-RADS lexicon was useful in differentiating between benign and malignant solid masses.

The BI-RADS lexicon requires the breast imaging report be summarized into 1 of 7 possible categories: BI-RADS 0, further assessment required; BI-RADS 1, negative study; BI-RADS 2, benign finding (risk of malignancy similar to that of the surrounding parenchyma); BI-RADS 3, probably benign finding (less than 2% risk of malignancies should be followed up at 6, 12, and 24 months, and then classified as benign category 2 after showing stability for 24 months or biopsied if concerning changes or growth are seen); BI-RADS 4, lesion is suspicious for malignancy (biopsy is offered); BI-RADS 5 lesions are highly suggestive of malignancy; and BI-RADS 6 lesions are biopsy-proven malignant before surgery is obtained (it is suggested that appropriate actions should be taken for these categories).

Distinguishing Benign Masses from Malignant Lesions

Originally, breast US was used to distinguish cysts from solid masses that then were usually further assessed with biopsy. With improved equipment and techniques, it is now possible, in a large number of cases, to distinguish benign from malignant features of cystic and solid lesions, and thus reduce the number of unnecessary biopsies. Occasionally, there are pathognomonic sonographic characteristics that suggest a specific diagnosis (such as in the case of an intramammary node) that will not require further management.

Evaluation of Cysts

Breast cysts are categorized as simple, complicated, or complex. Simple cysts are anechoic, well-circumscribed, round or ovoid masses with thin walls and increased through transmission of sound. They are considered benign (BI-RADS 2) and do not require intervention. Painful cysts can be aspirated.

Complicated cysts contain low-level internal echoes or debris that may layer and shift with changes in patient position. The risk of malignancy among complicated breast cysts is less than 2%, and they can be managed as BI-RADS 3 category and be followed up. If a complicated cyst is symptomatic or enlarging, then needle aspiration is suggested [3,4].

Complex breast cysts are defined as cysts with thick walls and/or thick septations (>0.5 mm), intracystic masses, or other discrete solid components (Figure 2). A Doppler study may demonstrate intramural blood flow, which is indicative of a solid component to the cyst. Because complex cysts are associated with a greater than 2% risk of malignancy, they require a biopsy [3,5]. Uncertainty regarding the nature of a breast mass should be resolved with the performance of US-guided aspiration or core biopsy.

A cluster of microcysts (usually composed of cysts that measure between 1–7 mm, with less than 0.5-mm thickness of intervening septations) is a relatively common incidental finding and represents the dilatation of the acini of the terminal duct lobular unit. Berg [6] reported that, in the absence of a solid component, clustered microcysts are likely benign and could be followed up annually.

Evaluation of Solid Lesions

Solid lesions are classified as benign, indeterminate, or malignant. In 1995, Stavros et al [7] reported sonographic criteria that classified solid lesions as benign, indeterminate,

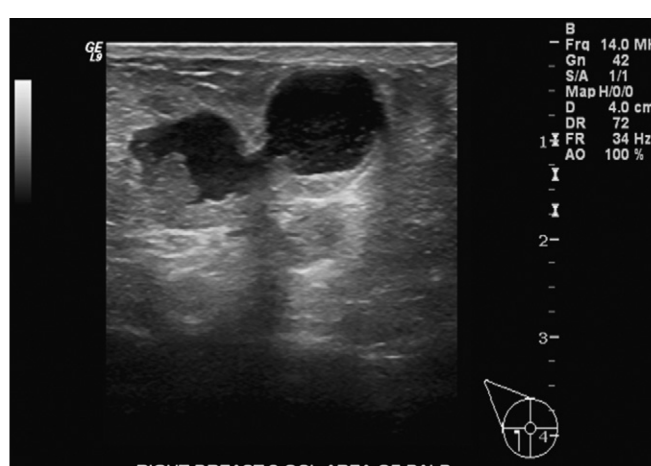

Figure 2. Sagittal sonographic image, showing complex cystic mass with solid component and wall thickening. A 78-year-old woman presented with a palpable lump. Pathology results showed invasive ductal carcinoma, not otherwise specified.

or malignant. Benign lesions exhibit no malignant features and, in addition, manifest one or more of the following benign features: (1) intense uniform hyperechogenicity (in comparison with the fat); (2) wider than tall orientation (long axis parallel to the chest wall), with thin, echogenic capsule; and (3) gentle lobulations (not more than 3), with thin, echogenic capsule. If any of the following characteristics were present, marked hypoechogenicity, spiculated contour, taller-than-wide orientation (long axis not parallel to the chest wall), angular margins, posterior acoustic shadowing, punctate calcifications, duct extension, branch pattern, or microlobulations, then the mass was classified as malignant. A mass with neither benign nor malignant characteristics was classified as indeterminate. All lesions were biopsied. Of 424 lesions that were prospectively classified as benign based on the above criteria, only 2 were found to be malignant at biopsy (negative predictive value of 99.5%). Of the 125 lesions found to be malignant at biopsy, 123 were classified as malignant or indeterminate (positive predictive value of 98.4%). The researchers concluded that lesions that appear benign on US based on the suggested criteria can be followed up because they have less than 1% rate of malignancy. Further biopsy is required if a lesion is classified as indeterminate or malignant. Similar results are reported by other studies [8,9]. It is important to realize that, even if the overall appearance of a lesion favors a benign entity, the presence of a single malignant feature necessitates biopsy (Figure 3).

Before discounting the possibility of a malignant lesion, the current mammographic study should be compared with all previous mammograms. An apparently new or progressing solid lesion on mammogram should undergo biopsy regardless of benign features, whereas stability in the appearance of a lesion with benign features over a period of at least 2 years may not require follow-up [10]. Multiplicity of benign-appearing lesions, especially if bilateral, contributes to the level of confidence in a probably benign assessment [11]. In women with known breast cancer, biopsy should be considered for a benign-appearing solid mass [11].

The sonographic criteria for benign solid lesions have traditionally been used only for nonpalpable lesions. Graf et al [12] investigated 152 patients with palpable breast lesions that exhibited benign features. These patients were either monitored for disease progression for at least 2 years or underwent biopsy of the lesion. They concluded that the sonographic criteria indicative of a benign lesion when applied to nonpalpable breast masses could also be applied to palpable solid lesions. Such masses should be managed as BI-RADS 3 category lesions. Shin et al [13] suggested a similar approach.

Sonographic Appearance of Common Breast Lesions

Fibroadenoma

Fibroadenoma is the most common solid lesion of the breast. Approximately 30% present with typical benign sonographic characteristics and can be followed up (Figure 4) [14]. Multiple fibroadenomas can be seen in 15% of patients with fibroadenoma. There is substantial overlap in the sonographic characteristics of fibroadenoma and phyllodes tumours. In contrast with a benign fibroadenoma, a phyllodes tumour may grow rapidly and can be either benign or malignant. Phyllodes tumour usually require wide surgical excision if tumour recurrence is to be avoided. An enlarging fibroadenoma on follow-up, therefore, should be biopsied to exclude the possibility of phyllodes tumour [15].

Fat Necrosis

Fat necrosis of the breast is a common, benign, inflammatory process that usually results from an injury. On

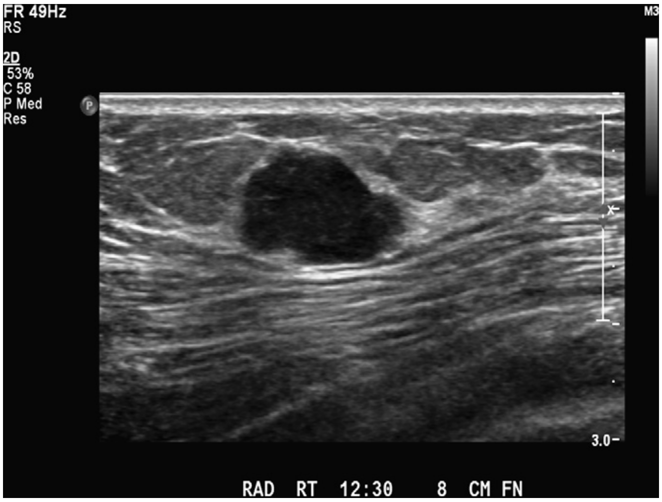

Figure 3. Radian sonographic image, showing a hypoechoic mass that is wider than tall, with microlobulated borders, and no evidence of echogenic capsule. A 62-year-old woman who was called back for the assessment of an abnormality seen on screening mammogram. Pathology results confirmed invasive ductal carcinoma, not otherwise specified.

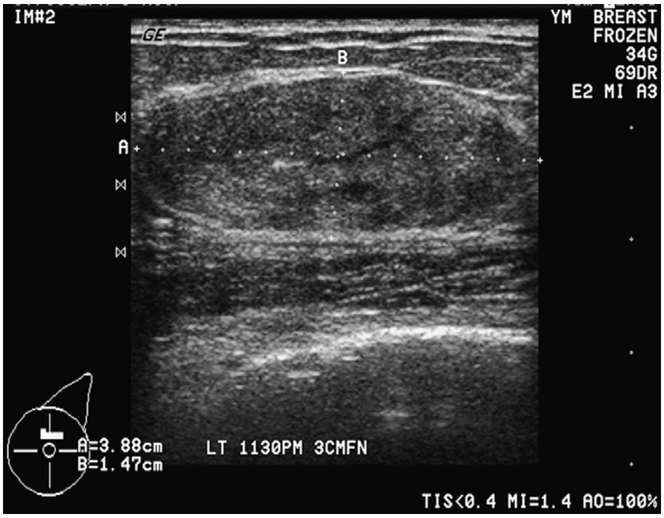

Figure 4. Transverse sonographic image, showing an oval shape, isoechoic mass with thin, echogenic capsule. A 52-year-old woman underwent short-term follow-up. Biopsy was offered because of interval growth and proved fibroadenoma.

imaging studies, the appearance of fat necrosis varies from typically benign to suggestive of malignancy. The pathophysiology of fat necrosis explains its imaging spectrum from hemorrhage at early stage through inflammation, necrosis, and peripheral fibrosis followed by scarring and calcifications. Mammography is superior to US at demonstrating the fat component as low density compared with the fibroglandular tissue. US findings can often be misleading, with a range of appearances that include benign and malignant characteristics. Correlation of a suggestive clinical history with a benign mammographic image may avert biopsy in a large number of cases (Figure 5) [16]. In patients with a history of breast cancer, fat necrosis should be carefully differentiated from tumour recurrence. Biopsy is required when there is uncertainty.

Papilloma

Papilloma is a benign ductal neoplasm usually located at the retroareolar region. The most common presentation on US is of an intraductal mass. Internal duct flow may be present and permit the clinician to distinguish a papilloma from intraductal debris. Current literature indicates excision, even if the lesion is benign on core biopsy. Localization for surgical excision can be offered without core biopsy if the appearance is sonographically typical (Figure 6) [17].

Radial Scar

Radial scar is considered to be a benign lesion, which histopathologically resembles tubular carcinoma and is believed by many to be a precursor for breast cancer. It requires surgical excision for definite diagnosis. The sonographic features of radial scar include mainly diminished echogenicity and parenchymal distortion (Figure 7). It is not uncommon for radial scar to be seen on US and not on a mammogram. There are no specific US features that accurately distinguish radial scar from malignant lesions [18].

Inflammatory Breast Disease

Inflammatory breast disease comprises infectious, noninfectious, and malignant etiologies. The presence of an ill-defined fluid collection on US favors a benign condition, such as mastitis; whereas extensive skin thickening and axillary lymphadenopathy favors malignancy, such as inflammatory breast cancer or lymphoma (Figure 8) [19]. Clinical correlation is required, and aspiration can be obtained for both treatment and diagnosis. Lactation is a common cause of mastitis and abscess formation. US is useful in facilitating the diagnosis and guiding aspiration of collections, with a maximum diameter of less than 3 cm [20]. When an inflammatory breast cancer is suspected, punch skin biopsy is usually required to prove invasion into dermal lymphatics.

Ductal Carcinoma In Situ

Mammography is the modality of choice in the evaluation of ductal carcinoma in situ (DCIS). US may be beneficial in the assessment of DCIS that presents without calcifications or in the evaluation of the extent of disease in women with dense breasts. Large clusters of microcalcifications can be visualized and biopsied under US, especially when stereotactic-guided biopsy is not possible. Dilated ducts with indistinct borders are the most common US findings in DCIS

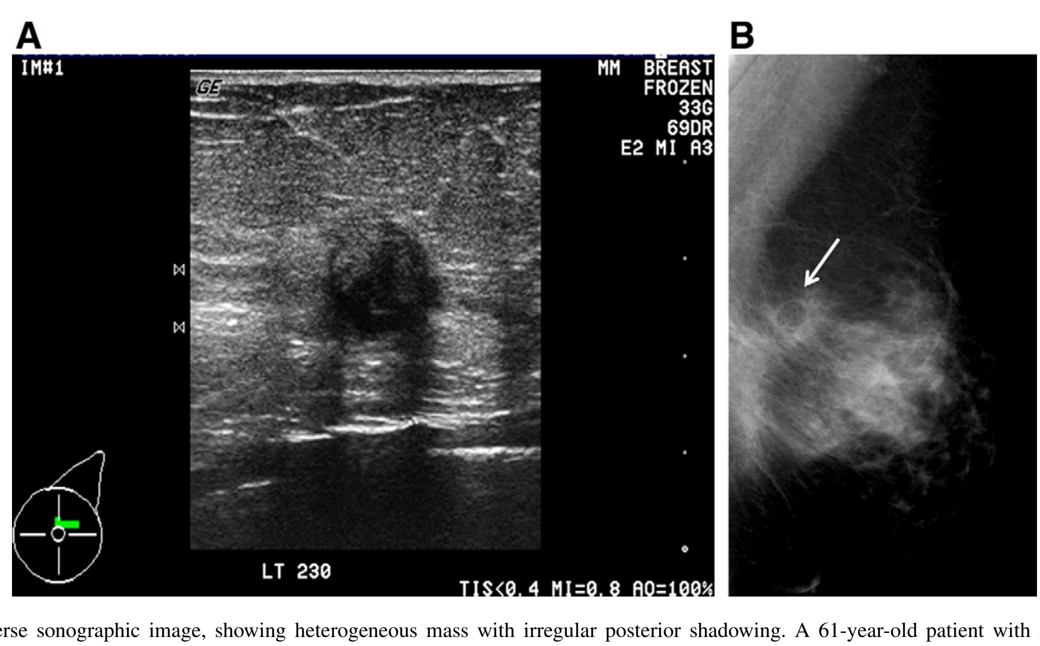

Figure 5. Transverse sonographic image, showing heterogeneous mass with irregular posterior shadowing. A 61-year-old patient with a history of breast reduction, presented with painful left breast (A). Mediolateral oblique mammographic image (B), showing a lucent lesion, which correlates to the ultrasound finding (arrow). Surgery was performed because of symptoms, and pathology confirmed fat necrosis.

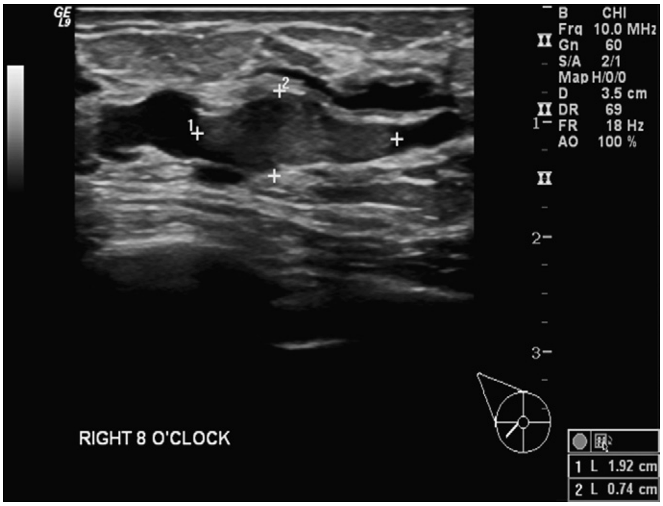

Figure 6. Transverse sonographic image, showing an intraductal echogenic mass. A 46-year-old woman presented with nipple discharge. Excisional biopsy proved benign intraductal papilloma.

(Figure 9). The presence of invasion should be suspected when a solid component is present [21].

The Role of US in Treatment Planning, Surgery, and Post-treatment Follow-up

Preoperative whole-breast US has proven to be beneficial in establishing the extent of unilateral (multifocality, same quadrant; or multicentricity, different quadrants) and bilateral disease. This may influence the type and extent of surgical intervention [22]. This is particularly important when lesions are mammographically occult, such as with lobular carcinoma [23], and assessment with MRI is not possible. Moon et al [24] reported preoperative bilateral whole-breast US found new malignant multifocal, multicentric, or contralateral disease not detected by mammography or by examination in 18% of patients (Figure 10).

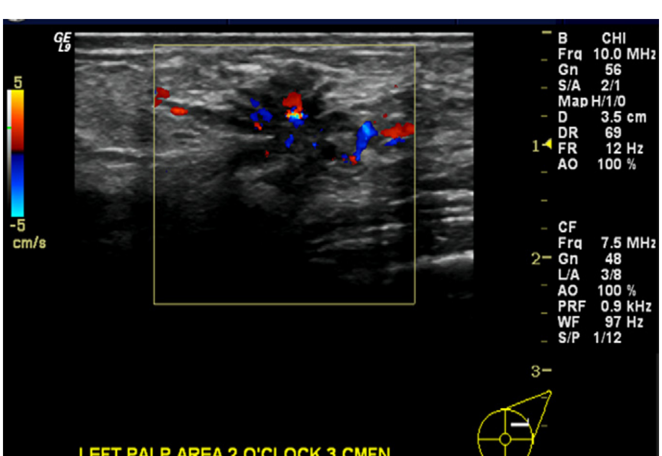

Figure 7. Transverse Doppler image, showing a hypoechoic area with marked distortion and increased blood flow. A 24-year-old woman presented with a palpable lump. Pathology results proved radial scar.

Figure 8. Anti-radian sonographic image, demonstrating marked skin thickening along the medial aspect of the left breast. A 52-year-old patient presented with skin oedema. Biopsy results revealed primary breast lymphoma.

Most patients with invasive breast cancer without clinically suspicious lymph nodes are undergoing sentinel lymph node assessment to exclude metastatic involvement. Results of several studies have shown that preoperative axillary US and fine-needle aspiration (FNA) cytology or core biopsy can reduce the number of the more time-consuming sentinel lymph node evaluation and second surgeries [25]. Lymph node with cortical thickening of 2–3 mm appears to be a threshold beyond which US-guided biopsy should be offered (Figure 11) [26,27]. US of the parasternal region is helpful in the assessment of the status of the internal mammary lymph nodes. Metastatic internal mammary nodes from breast origin can be found in about 20% of cases and are usually located in the anterior upper 4 intercostals spaces and measure more than 6 mm [28].

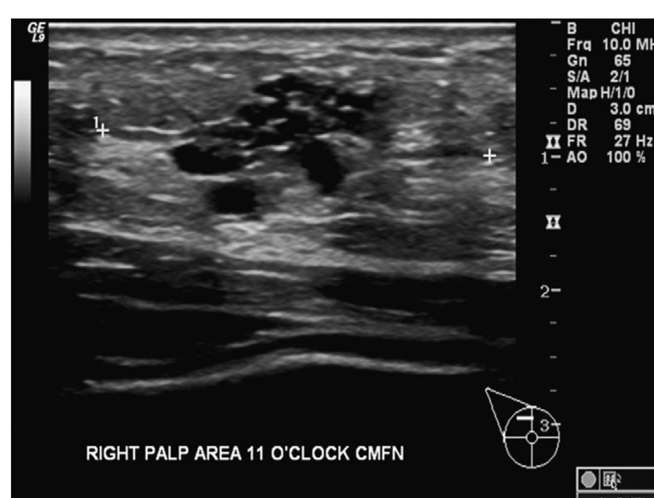

Figure 9. Transverse sonographic image, showing dilated irregular ducts within the retroareolar region. A 46-year-old woman presented with palpable lump. Pathology results proved high-grade ductal carcinoma in situ.

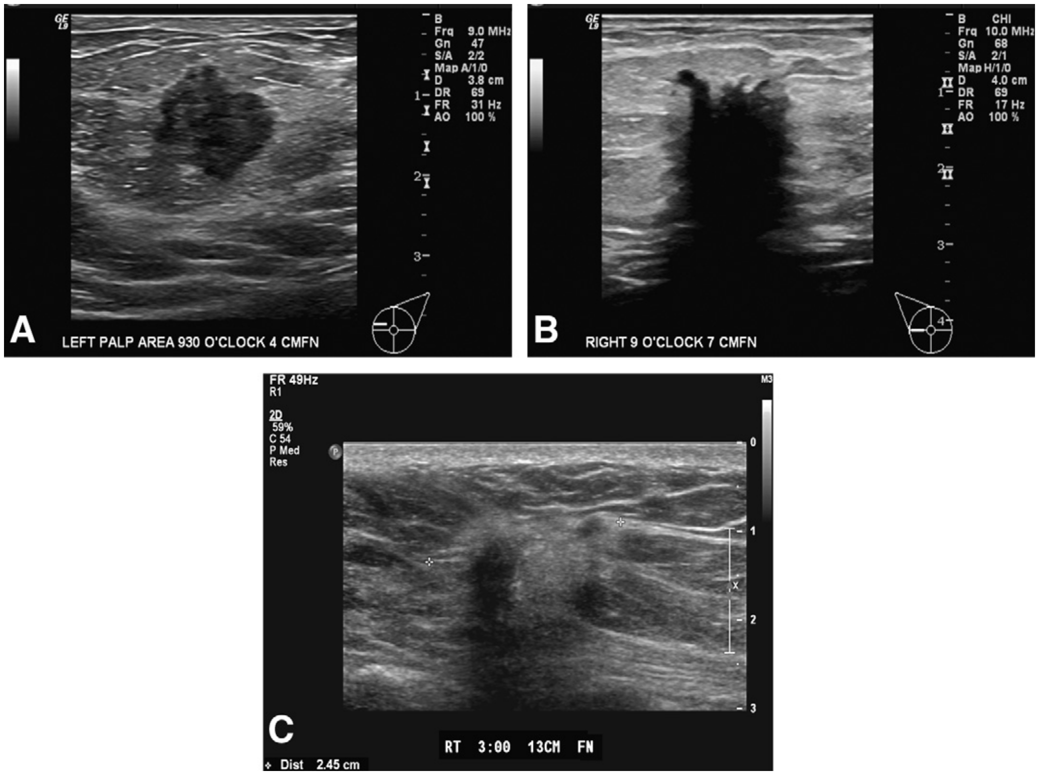

Figure 10. Transverse ultrasound (US) images. (A and B) Images showing lesions that were also detected on mammogram. Transverse sonographic image, showing a third lesion discovered on subsequent whole-breast US when using a different US machine (C). A 72-year-old woman presented with a palpable lump on the left breast. Pathology results proved invasive ductal carcinomas with prominent lobular features in all 3 lesions.

The management of locally advanced breast cancer (LABC) (stage III) requires a combined treatment approach that involves surgery, radiation, and systemic therapy. Neoadjuvant chemotherapy before surgery is now the common treatment approach. MRI has a major role in staging of these cancers. US plays a role in identifying patients with LABC and allows monitoring of their response to neoadjuvant chemotherapy, especially when MRI is not possible (Figure 12) [29]. US has a significant role in the postoperative assessment of patients with breast cancer. It is helpful in evaluating postoperative recurrent breast masses and post-surgical complications, such as seroma, infection, and fat necrosis, as well as exclusion of recurrent disease (Figure 13).

US-guided Interventional Procedures

Sonographically guided 14-gauge automated core biopsy was first described by Parker et al [30] in 1993. The researchers reported 100% concordance between the diagnoses obtained by core biopsy and surgical excision of lesions in the 49 patients who underwent both. Furthermore, in 132 who underwent biopsy and follow-up, no cancers occurred in the 12−36-month period of monitoring. It is recommended that, when possible, core biopsy will be obtained under sonographic guidance because of patient comfort, efficiency, low cost, absence of ionizing radiation, and real-time visualization of the needle and target. The use of FNA biopsy of solid lesions has been reported by several researchers to be inferior to core biopsy in terms of diagnostic accuracy [31,32]. FNA biopsy is still appropriate for the investigation of cystic lesions. When FNA of a complex cystic mass is performed and a solid component remains visible at US, core-needle biopsy of the residual solid lesion should be performed immediately after the aspiration

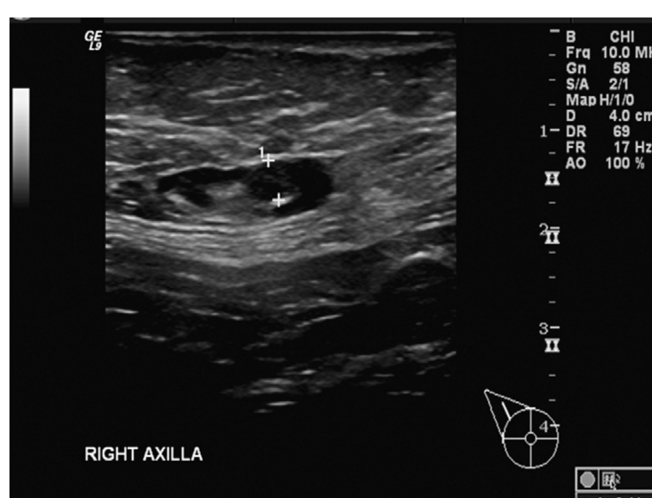

Figure 11. Sagittal ultrasound image, showing an axillary node with cortical thickening of more than 3 mm. A 54-year-old patient with known breast cancer. Biopsy results proved breast malignancy involvement of lymphoid tissue.

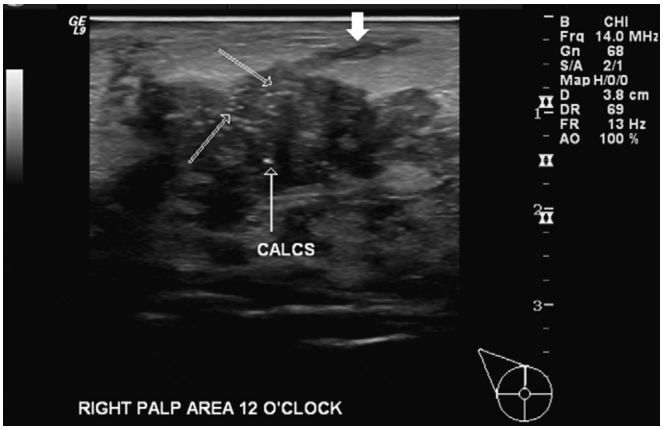

Figure 12. Sagittal sonographic image, showing extensive hypoechoic mass with skin invasion (short arrow) and microcalcifications (long arrows). A 28-year-old lactating patient presented with a palpable lump. Biopsy specimen results revealed high-grade invasive ductal carcinoma, not otherwise specified. The patient was treated with neoadjuvant therapy with good response.

procedure because it may be the only component of a malignancy [5].

Other US-guided biopsy devices, such as vacuum-assisted devices, have been developed; however, they have not been proven to yield a significant difference in outcome compared with core biopsy device [33,34]. The pathology results from biopsy should be compared with imaging findings to determine concordance, and the conclusion should be communicated to the referring physician (Figure 14) [35]. When performing a biopsy or aspiration of a small lesion, it is important to leave a radiopaque marker that can be identified subsequently. Also, after treatment with neoadjuvant chemotherapy, in particular, if lumpectomy is contemplated, then a marker should be placed because the lesion may become occult [36].

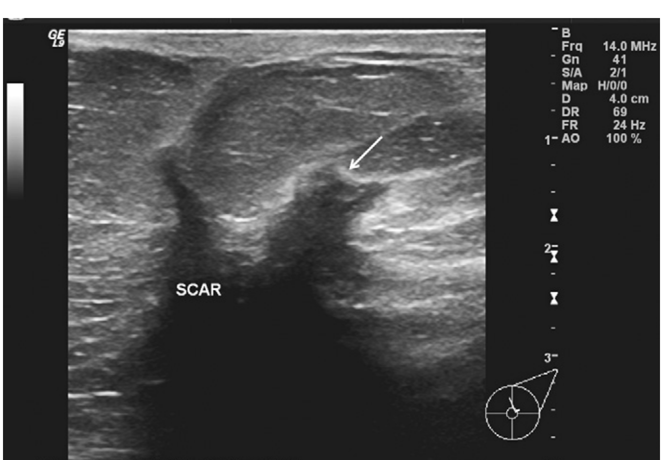

Figure 13. Sagittal sonographic image, showing irregular, hypoechoic mass located at the region of the lumpectomy scar (arrow). A 64-year-old woman underwent left lumpectomy 4 years before the current study. Ultrasound was obtained in addition to mammogram as part of her routine surveillance. Pathology showed invasive cancer with histologic features similar to her primary disease, which indicated recurrence.

Axillary nodes can be sampled by using FNA or core biopsy. Biopsy of lymph nodes should be targeted to the cortex. The hilum should be avoided to reduce the risk of bleeding [37,38]. Lesions that are diagnosed by imaging and that require surgery are usually localized before surgery by using wire and/or injection of methylene blue. This can be performed by using US guidance if the lesion is reasonably well seen on US.

Breast lesion management has evolved towards a minimally invasive approach [39]. The next challenge is to treat benign and malignant breast lesions without surgery. Several new minimally invasive procedures, including radiofrequency ablation, interstitial laser ablation, focused US ablation, cryotherapy, and vacuum-assisted devices are currently under investigation and may provide treatment options that are comparable with that of traditional surgical therapies [40–44].

Targeted US for MRI-detected Breast Lesions

With the increased use of MRI in breast imaging, there is often a need to further evaluate lesions detected on MRI. MRI-guided procedures are very expensive. US is a common adjunct modality in identification, characterization, and biopsy of lesions detected by MRI. Destounis et al [45] reported that targeted US of MRI-detected breast abnormality changed management in 20% (36 of 182) of patients (Figure 15).

Male Breast

The male breast is primarily composed of fatty tissue, with few branching ducts and connective tissue. Lobules are

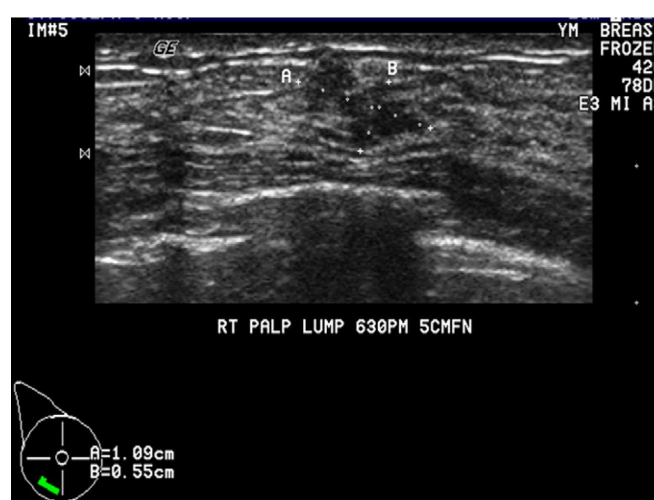

Figure 14. Anti-radian sonographic image, showing hypoechoic mass with irregular borders. A 26-year-old woman with a strong family history of breast cancer, presented with a palpable lump. The lesion was reported as BI-RADS 5. Initial biopsy specimen results were normal. Surgical excision was recommended because of discordance. Pathology results proved invasive ductal carcinoma, not otherwise specified.

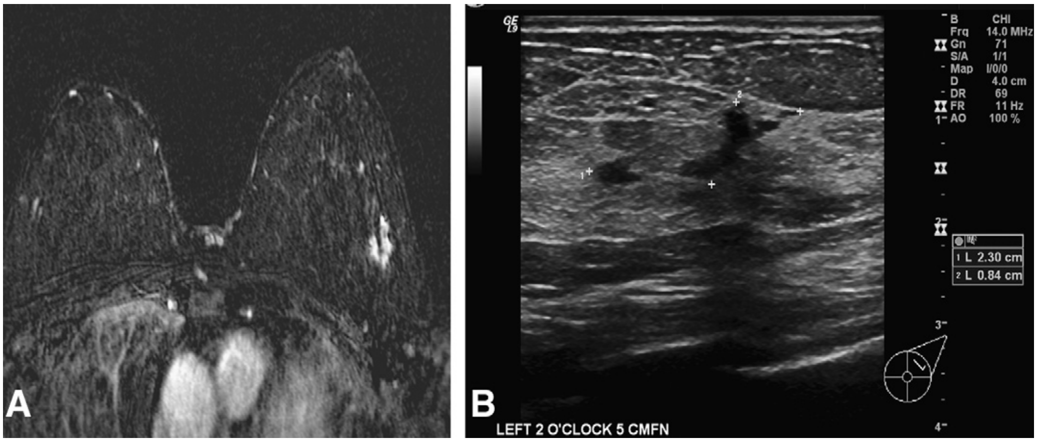

Figure 15. (A) Postcontrast axial T1-weighted magnetic resonance image (MRI), showing an abnormal enhancing lesion located within the left upper outer quadrant. A 54-year-old patient found to have metastatic adenocarcinoma that involved the left axillary node of unknown origin. Mammogram and ultrasound (US) were obtained first and revealed no abnormalities. (B) Anti-radian sonographic image of a second-look US, showing a crescent-shape hypoechoic area in the region that correlates to the MRI finding. Pathology revealed invasive ductal carcinoma, not otherwise specified.

typically absent from the male breast, which may be the reason that lobular carcinoma and fibroadenoma are rare in men. The breast tissue in men may respond to hormonal stimulation, with growth of ducts and connective tissue that results in gynecomastia. The typical mammographic appearance of gynecomastia usually confirms the diagnosis. The sonographic appearance of gynecomastia is of a fairly symmetric star-shaped mass that arises directly from the retroareolar surface without causing any overlying skin thickening or nipple retraction. Breast cancer in men resembles that seen in woman clinically and sonographically, and should be managed in a similar way. Fibroadenoma and cystic masses are rare in men, therefore, any discrete breast masses should be biopsied unless they appear typically benign (Figure 16) [46,47].

Advanced US Technology

Routine breast US uses B-mode grey-scale imaging. Harmonic, compound, and Doppler imaging can also be used to help characterize lesions. New technical developments, such as breast elastography, three-dimensional (3D) US, and computer-aided diagnosis (CAD), are now available on some machines.

3D Breast US

The 3D US images are reconstructed from a single sweep of the US beam across the lesion of interest. 3D US, therefore, can evaluate the entire surface and volume of the mass. The utility of this technology was evaluated by Cho et al [48] who compared the ability to characterize masses by using 2-dimensional versus 3D static US images. Their conclusion was that there are no significant differences in the performance of radiologists in characterization of solid breast masses when using 1 technique versus the other.

US Elastography

Elastography is a dynamic technique that uses US to provide an estimation of viscoelastic properties of tissue by measuring the degree of distortion upon the application of an external force. The diagnostic value of using US elastography to differentiate benign from malignant breast lesions

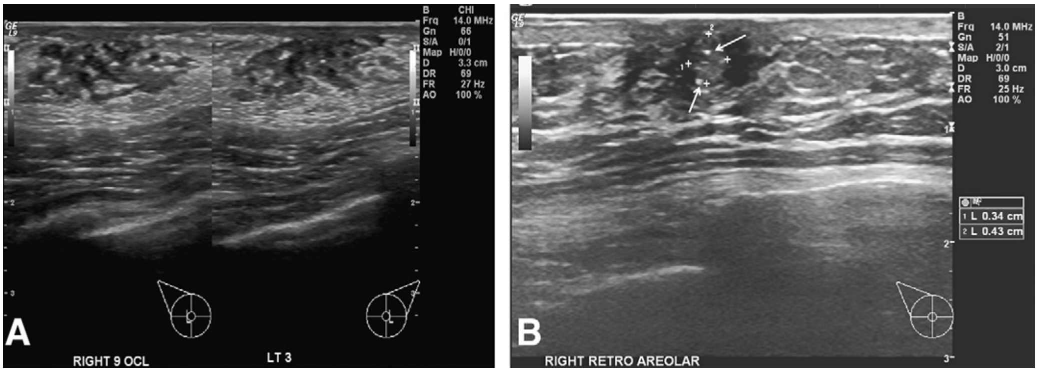

Figure 16. Bilateral sagittal sonographic images, revealing bilateral symmetric gynecomastia. (A) A 14-year-old boy presented with bilateral palpable retroareolar masses. Transverse sonographic image, demonstrating a retroareolar irregular mass that contains microcalcifications (arrows). (B) A 71-year-old man with Paget disease of the nipple.

based on their stiffness vs elasticity is still being investigated. Itoh et al [49] reported the outcome of the use of conventional US and real-time US elastography of 111 lesions (59 benign, 52 malignant). They showed that elastography had 86.5% sensitivity, 89.8% specificity, and 88.3% accuracy in detection of malignant lesions, whereas conventional US had 71.2% sensitivity, 96.6% specificity, and 84.7% accuracy. Their conclusion was that US elastography had almost the same diagnostic performance as conventional US. The researchers expect that with future improvements in the technology, this modality will become a valuable tool in the diagnosis of breast disease.

Breast US CAD

Sonographic images of the breast can be analysed on a CAD module based on shape, margin, texture, and posterior acoustic characteristics. The CAD software allows automatic reporting by using the BI-RADS lexicon. Gruszauskas et al [50] investigated the ability of the US CAD in differentiating benign from malignant lesions among 508 patients and found that the sensitivity of the use of CAD was high but that the specificity was relatively low. Their conclusion was that further studies are required to assess this technique [50].

Contrast US

Angiogenesis present in malignant breast masses provides the pathophysiologic basis for the use of contrast media in US. Rapid contrast uptake and rapid washout distinguishes benign from malignant lesions. Contrast US imaging uses injection of microbubbles during real-time imaging. The role of contrast breast US is still being investigated. Ricci et al [51] showed that contrast US seems to be a reliable method to differentiate breast lesions, because it provides typical enhancement patterns and perfusion curves correlate well with MRI wash in–wash out curves.

Screening US

Although mammography is an effective screening modality, it is less sensitive in detecting cancer in dense breast tissue. Breast US has limitations as a potential screening tool because it requires a well-trained skilled operator, the techniques are not standardized, and breast US may not detect microcalcifications. There are insufficient data on the use of screening US in the general population. Some studies reported reasonable results when using US breast screening, but most data are available from diagnostic populations and screening studies limited to women with dense breasts and increased risk for breast cancer. The results among these groups show that US may detect about 4 additional breast cancers per 1000 women, but there is higher false-positive rate by adding US than with mammography alone [52–54]. It is well accepted among researchers that US should only be used as an adjunctive test to mammography and should not be used alone. Combined mammography and breast US surveillance maybe an option for those who refuse or cannot have breast MRI.

Several companies have developed automated US systems that enable fast scanning of the entire breast. A larger field of view is obtained with these systems compared with that generated with a hand-held US transducer, and they are used as an adjunct to mammography. Kelly et al [55] report breast cancer detection in 6425 studies when using automated US with mammography, doubled from 3.6 per 1000 with mammography alone to 7.2 per 1000. They also showed that the number of detected invasive cancers, measuring 10 mm or less, tripled, from 7 to 21, when automated breast US supplemented mammography. Specificity based on recalls was 89.9% for automated US, 95.15% for mammography, and 98.7% for combined mammography and automated US.

Summary

Breast US is a very important modality in the assessment of breast cancer. It plays a major role as a diagnostic tool in the enhanced characterization of lesions detected by other imaging modalities or in symptomatic patients but should always be used as an adjunctive tool to mammography in patients older than 30 years, unless the patient is pregnant or lactating. Combined mammography and US have a role in screening high-risk patients. The use of BI-RADS US lexicon is helpful in distinguishing benign from malignant features, and unnecessary biopsy can be avoided in a significant number of cases. Biopsy is always required when 1 or more malignant features are present, even if a lesion appears benign. Whole-breast and axillary US are recommended in evaluating the extension of malignancy and lymph node involvement. Breast lesions and axillary lymph nodes can be safely and accurately biopsied under US guidance. Discordance between pathology results and imaging results should be communicated to the clinicians. The role of US as a guidance tool in nonoperative treatment is being investigated. Elastography, 3D, CAD US, and automated whole-breast screening US are techniques that may have an impact on future clinical performance.

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