Role of High Resolution Ultrasound Complementary to Digital Mammography

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Abstract

Background: Breast carcinoma is a major cause of mortality among women worldwide. Early detection and cure is the key to reduce the mortality of the disease. This article studied the role of high resolution ultrasound in detection and characterization of lesions to complement mammographic diagnosis and improve patient management. Aims and Objectives: To evaluate the role of complementary high resolution ultrasound, BIRADS scoring and to correlate it with histological diagnosis. Results and Observations: HRUS is excellent in detecting microcalcifications, malignant features of solid masses, differentiating focal asymmetry from masses, differentiating between solid and cystic lesions, simple and complex cysts and detecting satellite lesions and mammographically inaccessible areas for which special views can be done. Conclusions: Every case referred for digital mammography should undergo ultrasound irrespective of the age, symptoms and density of the breast parenchyma and a combined final BIRADS grading should be done. Ultrasound is an excellent imaging modality for breast lesions in expert hands.

Keywords: Carcinoma, digital mammography, high resolution, intraductal, microcalcifications, ultrasound

Résumé

Contexte: Le cancer du sein est une cause majeure de mortalité chez les femmes du monde entier. La détection précocce et la guérison sont la clé pour réduire la mortalité de la maladie. Cet article a étudié le rôle de l’échographie à haute résolution dans la détection et la caractérisation des lésions pour compléter le diagnostic mammographique et améliorer la prise en charge des patients. Buts et objectifs: Évaluer le rôle de l’échographie à haute résolution complémentaire, notation de BIRADS et la corrélérer avec le diagnostic histologique. Résultats et observations: Le HRUS est excellent pour détecter les microcalcifications, les malignités des masses solides, différencier l’asymétrie focale des masses, différencier les lésions solides et kystiques, les kystes simples et complexes et détecter les lésions satellites et les zones mammographiquement inaccessibles. Conclusions: Chaque cas référé pour la mammographie numérique devrait subir une échographie indépendamment de l’âge, des symptômes et de la densité du parenchyma mammaire et un classement final combiné de BIRADS devrait être fait. L’échographie est une excellente modalité d’imagerie pour les lésions mammaires chez les mains expertes.

Mots-clés: Carcinome, mammographie numérique, haute résolution, intracanalaire, microcalcifications, échographie

Introduction

Ultrasonography (USG) of breast is a useful adjuvant modality to X-ray mammography. Its role is well established in differentiating solid from cystic lesions. It also characterizes whether a cyst is simple or complex. Ultrasound (US) is also the modality of choice to characterize palpable lumps in radiographically dense breasts.11 Recently, there is a focus on the advantages of combining high-resolution US imaging findings with those of X-ray mammography in characterization

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of breast lesions. Every case whether symptomatic or asymptomatic referred for digital mammography (DM) should also undergo USG. Radiologists should complement the diagnosis of one modality with other so as not to miss any lesion suspicious or diagnostic of breast cancer.

Breast cancer is the most common malignancy of women worldwide and is a leading cause of death.[2] To reduce the cancer-related mortality, early diagnosis and treatment is a must. Five-year survival of early localized breast cancer can be up to 99%. If the cancer spreads to distant organs, 5-year survival rate drops to 24%.[3] High-resolution US (HRUS) is an efficient modality to detect microcalcifications with a sensitivity of 95%.[4] It can also pinpoint an intraductal lesion in the hands of an experienced and skilled radiologist.

In the present study, findings of USG of breasts when combined with those of DM led to better characterization of lesions as benign or malignant and provided a more accurate imaging diagnosis and Breast Imaging-Reporting and Data System (BIRADS) grade. USG also guided the radiologist to choose an appropriate lesion for biopsy in multicentric and multifocal lesions.

**Aims and objectives**

1. To perform HRUS of each patient referred for DM
2. To analyze US findings and to correlate them with mammographic findings so as to provide a final combined BIRADS score
3. To evaluate additional advantages of HRUS over DM
4. To compare imaging diagnosis with final biopsy diagnosis, wherever available.

**Materials and Methods**

**Technique of imaging the breast**

In all patients, DM was carried out on M/S Wipro GE Healthcare Pvt. Ltd machine – Alpha RT (Model 2013) in the Department of Radiodiagnosis and Imaging, Dayanand Medical College and Hospital, Ludhiana. It was followed by HRUS on (Philips IU22, Model 2011) US machine using linear probe (5–12MHz).

DM is an outpatient procedure preferably done after 1 week of start of menstrual period. During mammography, a qualified radiotechnician positioned the breast in the mammography unit. Breast was placed on a special platform and compressed with a clear plastic paddle. Mediolateral oblique and craniocaudal images were acquired. Supplementary views were taken, whenever necessary.

HRUS was done with 5–12 MHz linear transducer, which has high sensitivity for superficial tissues. Minimum compression was given while performing the procedure. Whole of the breast parenchyma was scanned meticulously in a complete circle starting from 12 o’clock position. Axilla was also scanned in all the patients for any lymphadenopathy.

**Patient preparation**

Before starting the study, proper history was taken. The procedure was explained to the patient in her vernacular language to allay the fear and anxiety.

**Case histories**

**Case 1**

DM of 47-year-old multiparous female showed a high-density irregular lesion causing architectural distortion with microcalcifications in the retroareolar and medial aspect of breast [Figure 1]. It was a BIRADS grade 5 lesion. Complementary US confirmed microcalcifications [Figure 2a and b (magnified view), arrow] and provided additional signs of malignancy such as marked hypoechogeticity and microlobulations of the lesion. A core biopsy was performed in the same setting, which confirmed the lesion to be an invasive ductal carcinoma (IDC). In addition, dilated anechoic ducts were noted in retroareolar region [Figure 2c]. No satellite lesions or axillary lymph nodes were detected [Figure 2d].

**Case 2**

A female presented with blood stained nipple discharge and had a family history of breast cancer. Her right breast DM revealed a lobulated tortuous high-density lesion in the outer and upper quadrant. Few discrete foci of calcifications were also
noted [Figure 3a and b]. No clusters of microcalcifications were seen. It was BIRADS 4c (highly suspicious of malignancy; in view of positive family and clinical history along with a unifocal dilated duct). HRUS revealed a dilated tortuous duct with an intraductal solid mass containing microcalcifications [Figure 3c] and was categorized as grade 5 lesion.

**Case 3**

A 58-year-old woman came for routine screening mammography. Her DM showed predominantly fatty breasts with focal high-density asymmetrical areas. Her left breast had a few irregular periareolar high-density areas [Figure 4]. No microcalcifications were noted. A lymph node with fatty hilum was seen in axilla in the mediolateral oblique view. It was given BIRADS grade 4a. HRUS showed a high-density angulated and spiculated lesion measuring 1.0 cm × 0.8 cm with peripheral increased echogenicity in the upper medial quadrant of left breast [Figure 5a]. Few retroareolar ducts were just prominent [Figure 5b]. It was diagnosed BIRADS 4c. Biopsy revealed a lobular carcinoma.

**Case 4**

A 36-year-old female came for screening mammography. Her DM revealed predominantly fatty breasts with coarse benign scattered calcifications. A smooth marginated oval to round lesion was seen in the upper and outer quadrant [Figure 6]. No microcalcifications or architectural distortion was noted. It was BIRADS grade 0.

As a routine protocol, HRUS was performed, and a mole was seen on the breast skin [Figure 7a]. The mole was limited to skin and subcutaneous fat only [Figure 7b]. DM was repeated keeping the skin lesion along the surface, and the superficial nature of lesion was confirmed [Figure 6b].

**Case 5**

A 37-year-old female came with complaint of diffuse cyclical mastalgia. Her mammogram revealed high-density breasts without any focal lesion, asymmetry, or architectural distortion [Figure 8]. It was BIRADS grade 0. HRUS revealed extensive ductal prominence with caliber varying

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**Figure 4:** Digital mammography of left breast shows few irregular periareolar small high density areas. No microcalcifications are seen. A lymph node with fatty hilum is seen in axilla

**Figure 5:** High-resolution ultrasound shows a high-density angulated lesion measuring 1.1 cm × 0.8 cm with peripheral spiculations and increased echogenicity in the upper medial quadrant of left breast (a). Few retroareolar ducts are just prominent (b) diagnosis confirmed as lobular carcinoma

**Figure 6:** Digital mammography shows a smooth marginated oval to round lesion in the upper and outer quadrant (a). No microcalcifications or architectural distortion noted. Repeat MLO view confirms the superficial nature of the lesion (b)
from 2.4 to 3.5 mm [Figure 9a]. Few ducts showed focal solid lesions [Figure 9b, arrow] and microcalcifications. Twinkling star artifact could be demonstrated in these microcalcifications [Figure 9c and d]. It was reported grade 5, and surgical biopsy confirmed the diagnosis of IDC.

Case 6
A 52-year-old female presented with a hard breast mass. DM revealed a well-defined, smooth marginated, round high-density lesion in periareolar location [Figure 10]. It was graded as BIRADS 3. HRUS revealed a thick-walled cystic lesion with an eccentric, solid, polypoidal, and avascular component [Figure 11]. It was upgraded to BIRADS 4c. Needle aspiration revealed lobular carcinoma.

Case 7
A 34-year-old woman had predominantly dense breasts with mixed fibroglandular tissue. A well-defined macrolobulated/ angular lesion was seen in the upper medial quadrant on DM. No microcalcifications were noted [Figure 12]. It was labeled grade 3. On US, it was an anechoic, thin-walled cyst with distal acoustic enhancement [Figure 13] and thus downgraded to BIRADS grade 2.

Case 8
An already operated case of carcinoma breast presented with diffuse skin thickening. Her mammogram revealed diffuse thickening of skin and nipple retraction without any focal lesion [Figure 14]. On US, skin and subcutaneous fat were echogenic and thickened [Figure 15a] with dilated subcutaneous veins [Figure 15b]. On increasing depth resolution, there was an ill-defined hypoechoic lesion [Figure 15c]. Further examination with convex probe revealed multiple enlarged, hypoechoic, lobulated axillary lymph nodes [Figure 15d] causing vascular compression. Repeat mammogram focusing the axilla revealed enlarged lymph nodes [Figure 16]. Metastatic deposits were confirmed on lymph node biopsy.

**Results and Observations**
A series of eight cases referred to the Department of Radiodiagnosis for DM with breast-related symptoms or for routine screening were analyzed. Out of which, five were multiparous women of age more than 40 years and three were uniparous and <40 years of age. US contributed to the characterization of breast lesions, and a combined sonographic and mammographic BIRADS score was found to be more accurate in diagnosing and labeling a lesion either benign or malignant. US BIRADS grade confirmed the mammographic grade in 1 case, downgraded in 2 cases, and upgraded in
Figure 11: High-resolution ultrasound reveals it to be a thick-walled cystic lesion with an eccentric solid polypoidal component.

Figure 12: Digital mammography in a 34-year-old female with positive family history shows a well-defined macrolobulated/angular lesion in the upper medial quadrant. No microcalcifications are noted.

Figure 13: On ultrasound, it is a clean, anechoic, thin-walled cyst with distal acoustic enhancement confirming it to be a simple benign cyst.

Figure 14: Digital mammography of an operated and treated case of carcinoma breast showing diffuse thickening of skin and nipple retraction without any focal lesion.

Figure 15: Ultrasound shows thickening and increased echogenicity of skin and subcutaneous fat (a). Dilated subcutaneous veins are seen (b). On increasing depth, there is an ill-defined hypoechoic lesion (c). Image taken with convex probe reveals multiple enlarged hypoechoic lobulated axillary lymph nodes (d).

Figure 16: Repeat mammogram focusing the axilla shows enlarged nodes indicating metastases.

5 cases. Core biopsy of the lesions could be done under US guidance. Certain mammographically inaccessible areas could
be examined on sonography. It added to the staging of disease. Tables 1 and 2 show the clinical details and diagnostic workup along with final diagnosis of the cases discussed.

**Discussion**

US is an adjuvant imaging modality to DM. It is easily available, radiation-free, inexpensive, needs no contrast injection, and patient friendly. The only limitation is that it is operator dependent and requires skill and experience for interpretation.

In the last decade, continuous advances in the US technology such as tissue harmonic imaging and frequency compounding made significant improvement in the image quality. Resolution of details has revolutionized sonography. The precursor lesions of breast carcinoma such as ductal carcinoma in situ (DCIS) is the center of attention nowadays. The various sonographic signs of DCIS have been described such as attenuation of echo of the normal breast adipose tissue and horizontal spread in the form of dilated ducts and architectural distortion. The signs of malignant masses are posterior acoustic shadowing and echogenic halo in addition to microcalcifications.

Yang *et al.* in 2014 demonstrated that considering DM as the gold standard; US could achieve a sensitivity of 95%, specificity of 87.8%, and accuracy of 91% in the detection of microcalcifications. Histopathology had a sensitivity of 80%, specificity of 71.4%, and accuracy of 75.3%. They highlighted that US was more sensitive in the detection of microcalcification in breast cancer cases, especially when it is within a mass lesion and is a reliable diagnostic sign of carcinoma.\[^{[4]}\] Similarly, in the present study, HRUS confirmed the malignant nature of breast masses, and a tissue diagnosis from the most suspicious area could be obtained by taking a biopsy in the same setting under US guidance. HRUS could directly visualize the intraductal mass and detect occult microcalcifications. This helped in upgrading the BIRAD score of a lesion in an appropriate clinical setting.

Nagashima *et al.* in 2005 concluded that US examination is an effective method to identify and localize breast microcalcifications, especially when present within the mass and can be used as an alternative to stereotactic localization in the selected patients with early breast cancer.\[^{[5]}\]

Samardar *et al.* in 2002 described that invasive lobular carcinoma is thought to arise from the terminal ductules and invades the normal breast parenchyma in a single “Indian-file” pattern. Because of this pattern, the tumor manifests as a subtle area of distortion or asymmetry. If such lesions are detected at DM, a supplementary breast imaging with additional views and US can be key to diagnosis.\[^{[6]}\] It was also observed in this study that HRUS helped in differentiating focal asymmetry from a mass lesion in a clinically asymptomatic female.

Berg *et al.* opined that over 90% of cancers seen only on US were found in females with more than 50% dense breast tissue, suggesting that women with other risk factors may also benefit from screening USG. Thus, the addition of single screening USG to mammography for women with higher risk of breast cancer results in increased detection of breast cancers that are predominantly small in size.\[^{[7]}\]

US in one of the case in present series which led to the evaluation of an extramammary benign soft-tissue lesion. There is only an occasional case reported in the scientific literature, in which multiple cutaneous neurofibromas were identified, and on mammography, a few projected over the parenchyma. In such cases, a proper clinical examination and USG helped.\[^{[8]}\]

Okello *et al.* concluded that breast US resulted in a significant incremental breast cancer detection rate (of 27%) among symptomatic women with mammographically dense breast tissue. They also recommended that US should routinely be performed in mammographically dense breasts and in lesions with BIRADS score 3 and 4.\[^{[9]}\]

Mujagić *et al.* concluded that in women younger than 50 with dense breasts, the sensitivity of US was significantly higher (33.3%) than mammography, while in women over 50 years with predominantly fatty breasts, this difference was only 4.7%.\[^{[10]}\]

It is observed that DM is not the modality of choice for dense breasts as subtle lesions can be missed. US is the modality to accurately characterize lesions in dense breasts.

| Table 1: Age distribution, Clinical symptoms and History data of patients referred for digital mammography (n=8) |
|---|
| **Age parity** | **Chief Complaints** | **Routine screening** | **Family history** | **Significant past history** | **History of lactation** |
| | Lump | Nipple discharge | Skin changes | | |
| 47 yrs/Mp | + | Brownish | Nil | No | No | No | + |
| 43 yrs/Mp | + | Bloody | Nil | No | Mother had Ca Breast | No | + |
| 58 yrs/Mp | Nil | Nil | Nil | Yes | No | No | + |
| 36 yrs/Up | Nil | Nil | Nil | Yes | No | No | + |
| 37 yrs/Up | - | - | - | - | - | - | - |
| 52 yrs/Mp | + | - | Focal Bulge | - | - | - | + |
| 34 yrs/Up | + | - | Diffuse thickening | - | Sister had Ca Breast | No | + |
| 62 yrs/Mp | - | - | - | - | Operated for Ca Breast 5 yrs back | + | |

Mp=Multiparous, Up=Uniparous
Table 2: Digital mammography, High resolution ultrasound and Final biopsy findings of patients (n=8)

| Investigation | Imaging Features | Case 1                | Case 2                | Case 3                | Case 4                | Case 5                | Case 6                | Case 7                | Case 8                |
|---------------|------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| Digital Mammography Findings | Density          | Fatty                 | Fatty                 | Fatty                 | Fatty                 | Predominantly dense   | Fatty                 | Dense                 | Fatty                 |
| Mass          | Irregular Tubular Tortuous | +                     | -                     | Smooth                | Smooth                | Macrolobulated        | -                     |                       |                       |
| Architectural distortion | +                | +                     | -                     | -                     | -                     | -                     | -                     | -                     | -                     |
| BIRADS        | 5                | 4c                    | 4a                    | 0                     | 0                     | 3                     | 3                     | 0                     |                       |
| Microcalcifications | Hypoechoic       | +                     | +                     | +                     | +                     | -                     | -                     | -                     | -                     |
| Echogenicity   | Hypoechoic       | Isoechoic             | Hypoechoic            | Isoechoic             | Cystic with polypoidal mass | Anechoic cyst        |                       |                       |                       |
| Margins       | Irregular Lobulated | Dilated              | Dilated              | Smooth                | Smooth                | Smooth                | Smooth                | Smooth                | Smooth                |
| BIRADS        | 5                | 4c                    | 4a                    | 0                     | 0                     | 3                     | 3                     | 0                     |                       |
| Advantages of HRUS | Intraductal mass with microcalcifications | 5                     | 5                     | 5                     | 4c                    | 2                     | 0/Large axillary nodes | Screening of mammographically inaccessible areas |                       |
| Final biopsy diagnosis | IDC              | DCIS                  | Lobular carcinoma     | Skin Mole             | DCIS                  | Lobular carcinoma     | Simple cyst           | Metastatic axillary nodes |                       |

IDC=Invasive Ductal Carcinoma, DCIS=Ductal carcinoma in situ
It has been shown by Berg and Gilbreath that US provides a more accurate measurement of the size of a mass than mammography or clinical examination.\(^1\) Masciadri and Ferranti described the US features of simple and complex cysts and opined that US is the modality to differentiate between solid and cystic lesions and can diagnose simple cyst (BIRADS Grade 2) with high accuracy and sensitivity. Complex cysts require cytological correlation.\(^2\) Fornage B also opined that US examination is an adjunct to mammography, as it can measure the primary breast tumor, detect and pathologically confirm additional lesions in a multicentric disease. It can also detect lymph nodal metastasis to axilla, supravacular or intramammary region and contralateral axilla in approximately 90% cases of breast cancer.\(^3\) In the present study, it was observed that US can scan mammographically inaccessible areas.

It is observed that combined use of mammography and USG is appropriate in most instances to characterize various lesions and to avoid unnecessary interventions in cases in which imaging findings are unequivocally benign. Negative findings on combined mammography and sonography are highly reassuring to the patient. US is also an important modality to determine whether a clinically or mammographically apparent lesion is real or artifactual.

**Conclusions**

This study concludes that mammographic screening for breast cancer is important, and its role cannot be underestimated. The role of high-resolution US in certain situations such as dense breasts, differentiation of focal asymmetry from a true lesion, differentiation between solid and cystic lesion, characterization of simple and complex cyst, screening of mammographically inaccessible areas, different lymph node stations, and of course direct visualization of intraductal mass with microcalcifications for guided biopsy is uncomparable to any other modality. It is highly efficient, cost-effective, and quick imaging technique for evaluating breast lesions.

Therefore, every case referred for DM should undergo US irrespective of the age, symptoms, and density of the breast parenchyma, and a combined BIRADS grading should be offered.

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**Conflicts of interest**

There are no conflicts of interest.

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