SONOGRAPHIC EVALUATION OF BENIGN AND MALIGNANT BREAST MASSES

INTRODUCTION

Ultrasound is an essential breast imaging tool. Initially, the role of breast ultrasound was solely to distinguish cysts from solid masses. However, with major advances in ultrasound technology during the past 20 years, ultrasound can also now distinguish benign and malignant solid breast masses. Ultrasound is now used to evaluate masses seen on mammography and magnetic resonance imaging (MRI) and may also be used to evaluate clinical breast symptoms such as palpable masses, focal pain and suspicious nipple discharge. Moreover, ultrasound is the imaging modality of choice for image guided breast biopsies. Knowledge of the specific benign and malignant ultrasound characteristics of breast masses is imperative for accurate diagnosis and optimal patient management.

SIMPLE CYSTS, COMPLICATED CYSTS, AND CLUSTERED MICROCYSTS

Figure 1. Oval cyst identified on screening ultrasound in a 59-year-old woman. The cyst is anechoic with a circumscribed margin, an imperceptible wall, and posterior acoustic enhancement, meeting all the criteria for a simple cyst.

The ultrasound definition of a simple cyst includes a round or oval, circumscribed anechoic mass with a thin imperceptible wall (Fig. 1). Simple cysts may have a single thin septation. Posterior acoustic enhancement should also be present, although this feature may be minimized if spatial compounding is used. If a cyst identified on ultrasound meets all of these criteria for a simple cyst it is considered benign. The diagnostic accuracy of a simple cyst evaluated with ultrasound is nearly 100% (1-3).

If a cystic appearing mass does not meet the strict criteria for a simple cyst, it is considered a
complicated cyst. Complicated cysts are predominately cystic on ultrasound, but have internal echoes, an indistinct margin, and/or lack posterior acoustic enhancement. Complicated cysts may demonstrate a fluid-debris level that may shift slowly if the patient changes position. Complicated cysts should not contain a mural nodule or any solid component.

Figure 2a. 55-year-old woman with a new mass on screening mammography (not shown). Targeted ultrasound demonstrates an round hypoechoic mass with internal echoes and mild posterior acoustic enhancement. Ultrasound guided cyst aspiration confirmed a benign cyst.

Figure 2b. 64-year-old with a new mass in the breast also identified on screening mammography (not shown). Ultrasound demonstrates an oval hypoechoic wider-than-tall mass. Despite the benign ultrasound appearance, this was a new finding on mammography and ultrasound guided biopsy was performed. Pathology demonstrated DCIS.

Careful evaluation of a complicated cyst is essential because in rare cases ductal carcinoma in situ (DCIS), as well as invasive carcinomas, including mucinous and medullary subtypes, may mimic the
appearance of a complicated cyst (Fig. 2). Color Doppler interrogation of a complicated cyst should not
demonstrate internal vascuarity. A mass that has the appearance of a complicated cyst on gray-scale
ultrasound, but exhibits increased vascularity on color Doppler, is suspicious for malignancy and should
be biopsied.

Figure 3. Clustered microcyst identified on screening ultrasound in the right breast of a 42-year-old-
woman. Note the tiny (2-3 mm) anechoic spaces with multiple thin intervening septations (arrow).
Clustered microcysts consist of a cluster of tiny (less than 2-3 mm in size) anechoic foci with thin (less
than 0.5 mm in thickness), intervening septations (Fig. 3). If there is no discrete solid component or
thickened wall these lesions can be classified as probably benign and are likely secondary to fibrocystic
changes and apocrine metaplasia (4).

Simple and complicated cysts are very common findings on breast ultrasound. Simple cysts warrant a
benign final assessment score based on the Breast Imaging Reporting and Data System (BI-RADS) and do
not require any additional follow-up.

Multiple combined studies evaluating more than 1200 complicated cysts and 216 complicated microcysts
have demonstrated a malignancy rate of 0%-0.44% for complicated cysts and 0%-0.8% for clustered
microcysts (5-11). Therefore, solitary complicated cysts and clustered microcysts may be classified as BI-
RADS 3 or probably benign, usually requiring short interval ultrasound follow-up at six months or,
occasionally, ultrasound guided aspiration. However, when multiple and bilateral complicated cysts and
simple cysts are present (ie, at least three cysts with at least one cyst in each breast), complicated cysts
can usually be assessed as benign, requiring no additional follow-up (5).

COMPLEX MASSES
Figure 4. Suspicious complex cystic mass with a mural nodule and echogenic focus (arrow) suspicious for a microcalcification in a 48-year-old woman. Ultrasound guided core needle biopsy demonstrated a benign papilloma, confirmed with excisional biopsy.

If a cystic mass has a solid component such as a mural nodule, a thickened wall or a thickened septation it should be classified as a complex mass. These findings are often due to inflammation and/or hemorrhage. A mural nodule may also be secondary to adherence of blood and proteinaceous material along the wall of a benign cyst. However, in some cases, an invasive carcinoma, including intracystic papillary carcinomas, may have a similar appearance (1)(Fig. 4). Increased vascularity on color Doppler evaluation within the thickened wall, septation or mural nodule is suspicious for malignancy although some malignancies will not have demonstrable vascular flow. Ultrasound guided aspiration or biopsy should be considered for any complex mass.

The differential diagnosis for a complex mass also includes infectious abscess. These masses are almost always clinically apparent as patients usually present with marked breast pain, a palpable mass, erythema and/or fever. If a patient has a history of pregnancy and lactation an abscess is classified as a puerperal abscess. Puerperal abscesses are more common than non-puerperal abscesses.

Figure 5. 18-year-old pregnant patient with right breast erythema and pain. Ultrasound demonstrates an oval complex fluid filled mass with a thickened wall and echogenic foci with dirty shadowing (arrow). These findings are consistent with an air/gas containing abscess, which resolved after aspiration and antibiotic treatment.

On ultrasound, abscesses are usually large complex masses with associated hypervascularity, thickened walls and internal echoes. The presence of echogenic material with dirty shadowing indicates the
presence of gas (Fig. 5). Abscesses should be treated with both ultrasound guided aspiration and antibiotic treatment(12). Puerperal abscesses can be followed clinically to resolution and require repeat ultrasound only if there is an incomplete response to antibiotic treatment. Non-puerperal abscess require both clinical and ultrasound follow-up after completion of antibiotic treatment to exclude the possibility of an underlying malignancy.

SOLID MASSES

**BENIGN SOLID MASSES**

Figure 6. Oval circumscribed hypoechic mass in a 53-year-old woman seen on screening ultrasound. Ultrasound demonstrates a homogeneous hypoechoic wider-than-tall mass consistent with a fibroadenoma. This was classified as BI-RADS 3, probably benign and has been stable on 6 and 12 month follow-up ultrasound examinations.

Benign solid masses should have a circumscribed margin and a thin echogenic capsule on ultrasound. These masses should also be oval and homogeneous, with a wider–than–tall orientation parallel to the skin, and should not have posterior acoustic shadowing(5, 13)(Fig. 6). Two or three gentle lobulations may also be present. Benign solid masses are usually isoechoic or hypoechoic compared to adjacent fat. Associated large and coarse echogenic calcifications (greater than 5 mm) may also be present. If a solid mass exhibits these benign features short interval follow-up ultrasound may be performed and biopsy can often be avoided. Benign appearing hypoechoic masses on ultrasound are usually fibroadenomas, although other benign entities such as stromal fibrosis, adenosis and focal fibrocystic changes may also have a similar appearance.

**MALIGNANT SOLID MASSES**

Ultrasound features of invasive ductal and lobular carcinoma include irregular shape and spiculated, angular, indistinct or micro-lobulated margins (1-2 mm).
Figure 7. 63-year-old woman with a newly palpable mass identified on mammography (not shown). Targeted ultrasound demonstrates an irregular 2.3 cm hypoechoic mass with angular margins and ductal extension (arrow). Ultrasound guided core needle biopsy demonstrated invasive lobular carcinoma. Malignant masses are also usually hypoechoic and not parallel to the skin with a "taller-than-wide" orientation(13). Posterior acoustic shadowing is also commonly seen. Additional associated ultrasound features include ductal extension, thickening of Cooper's ligaments, architectural distortion of surrounding tissue and skin thickening(5). Careful sonographic technique is important because a mass may initially appear oval and circumscribed, although a thorough evaluation of the entire lesion may reveal a subtle angular margin or ductal extension (Fig. 7). The presence of a single malignant feature despite multiple associated benign features warrants biopsy.

Figure 8a. 63-year-old woman with a palpable mass in the right upper outer quadrant. Targeted ultrasound of the palpable abnormality demonstrates a highly suspicious (BI-RADS 5) irregular hypoechoic mass with posterior acoustic shadowing. This mass corresponded to an irregular mass also
seen on mammography (not shown).

Figure 8b. Ultrasound of the surrounding tissue in the same patient demonstrates tumor filled duct with echogenic microcalcifications (arrow).

Suspicious microcalcifications first identified on mammography may also be identified with ultrasound. Ultrasound can detect clusters of microcalcifications, particularly those greater than 10 mm in size. Malignant microcalcifications are more likely than benign microcalcifications to be seen on ultrasound because they are usually surrounded by a hypoechoic mass or are contained within an abnormal duct (14, 15)(Fig. 8).

The benefit of ultrasound evaluation of large clusters of suspicious microcalcifications is to identify the solid component, which may then be targeted during ultrasound guided core needle biopsy. In these cases, pathology often demonstrates DCIS or invasive carcinoma.

LYMPH NODES

Lymph nodes are common findings in the breast and axilla. Intramammary lymph nodes are usually found in the upper outer quadrant(16) but may be present in in any quadrant. Benign intra-mammary lymph nodes usually measure 3-10 mm in longest diameter. Normal axillary lymph nodes may be greater than 2 cm in greatest diameter. Regardless of location and size the ultrasound features of benign lymph nodes include a reniform (kidney bean) shape, a circumscribed margin, a thin hypoechoic cortex and an echogenic fatty hilum. A lymph node can be confirmed with color Doppler interrogation demonstrating increased flow within the fatty hilum.
Figure 9. 70-year-old woman with a history of chronic lymphocytic lymphoma. Gray-scale ultrasound of the right axilla demonstrates multiple enlarged and abnormal appearing hypoechoic lymph nodes with a asymmetric and thickened hypoechoic cortices and minimal central echogenic hilar fat. Abnormal lymph nodes may have a round shape and a thickened hypoechoic cortex. The size of a lymph node has little utility for determining the presence of malignancy (17). However, focal cortical thickness of greater than 3 mm has been shown to be a useful predictor of malignancy (18, 19). Microcalcifications may also be present. Coarse calcifications are benign often secondary to granulomatous disease, while fine microcalcifications may be due to an underlying malignancy (Fig. 9). Color Doppler demonstration of irregular cortical vascularity is also suspicious for malignancy. The fatty hilum may be absent or eccentric in location, although the presence of hilar fat does not exclude malignancy. The differential diagnosis of an abnormal appearing intra-mammary or axillary lymph node includes a normal reactive lymph node, metastatic disease (usually secondary to a primary breast cancer), lymphoma and leukemia. Abnormal axillary lymph nodes may also be due to granulomatous disease, rheumatoid arthritis and sarcoidosis. It is important to note that malignant lymph nodes may also have a normal ultrasound appearance.

**INTRADUCTAL MASSES**

An intraductal mass may be seen incidentally on ultrasound or be identified during the work up of a mammographic finding or suspicious nipple discharge. Nipple discharge is suspicious if it is spontaneous and unilateral, as well as bloody, clear or serosanguinous in color. Intraductal masses are usually round or oval.
Figure 10. 63-year-old woman with left bloody nipple discharge. Ultrasound demonstrates an intra-ductal filling defect (arrow). Surgical duct excision demonstrated DCIS within a papilloma. They may be seen within a dilated fluid filled duct but occasionally may be elongated, filling the entire duct with little surrounding fluid. These masses may be hypo-, iso- or hyperechoic and are usually present in the retroreolar breast, but may be identified in the periphery if associated with a focally dilated duct. Echogenic foci secondary to calcifications may also be present (Fig. 10). Intraductal masses are most often secondary to cellular/proteinaceous debris (which can mimic the appearance of a true mass) or a benign papilloma. However, DCIS or invasive carcinoma may also present as an intraductal mass. The presence of increased vascularity within an intraductal mass excludes the possibility of cellular debris, although the absence of increased vascularity does not exclude a solid mass and biopsy is usually necessary to exclude an underlying carcinoma.

LIPOMAS AND FOCAL FIBROSIS

Figure 11. 52-year-old screening ultrasound demonstrates a focal echogenic oval circumscribed mass
consistent with a benign lipoma or focal fibrosis.

Figure 12. 68-year-old woman with a remote history of left breast cancer, status post bilateral mastectomies, presenting with a palpable lump in the right breast. Ultrasound demonstrates a heterogeneous predominately echogenic mass with indistinct margins and central hypoechoic region (arrow). Ultrasound guided core needle biopsy demonstrated a recurrent invasive ductal carcinoma. Focal echogenic masses may occasionally be seen on ultrasound. These masses are often small lipomas or focal fibrosis. Benign echogenic masses should be homogeneous and round or oval, without associated increased vascularity (Fig. 11). In their landmark study, Stavros et al(13) found that all 42 hyperechoic masses proved to be benign with a corresponding negative predictive value of 100%. However, subsequent studies demonstrate that echogenic breast cancers do exist (20) and careful sonographic evaluation and mammographic correlation is necessary. Echogenic masses with irregular margins, non-parallel orientation and focal hypoechoic areas are suspicious for malignancy and require biopsy (Fig. 12).

CONCLUSION
Benign and malignant masses have a variable appearance on ultrasound and there is considerable overlap between benign and malignant features. It is important to note that a mass with a single malignant ultrasound feature, despite the presence of multiple benign features, precludes a benign classification and requires biopsy. Therefore, the ultrasound classification of a mass should be based on the most suspicious finding. Furthermore, although knowledge of specific benign and suspicious ultrasound features can improve diagnostic accuracy, ultrasound should not override a suspicious clinical or other imaging finding. Careful correlation of ultrasound findings with physical exam, mammography or MRI is essential for optimal diagnosis.

REFERENCES


