Hyperechoic breast nodules: Not always benign

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Learning objectives

1. To illustrate the spectrum of hyperechoic lesions of the breast.
2. To emphasize that, occasionally, breast cancer can appear as a hyperechoic breast nodule.
3. To outline the sonographic features of hyperechoic nodules that should raise the suspicion of malignancy.

Background

Solid breast lesions are commonly detected because of their hypoechogenicity to the surrounding tissue. However, rarely, breast lesions may present with hyperechogenicity - which is defined as having increased echogenicity relative to fat [1] or equal to fibroglandular tissue [2]. In their landmark study, Stavros and coll. [1] found that the sonographic characteristic of sonographic nodules with the highest negative predictive value for malignancy was marked hyperechogenicity. However, according to our experience and to the literature, occasionally, breast cancer can be hyperechoic.

Imaging findings OR Procedure details

1. BENIGN HYPERECHOIC LESIONS

1.1 Hamartoma

*Definition*: well-circumscribed lesion composed of variable amount of glandular, fatty and fibrous tissue.

*Clinical presentation*: occasionally, palpable mass [3].

*Mammography*: mass containing radiolucent fat interchanged with dense fibrous connective tissue, sharply marginated and surrounded by a thin radiopaque pseudocapsule [3-5].

*Sonography*: oval, well-circumscribed lesion with peripheral halo [4]. The internal echo-texture depends on the relative amount and distribution of fat, epithelial elements and fibrous tissue and is usually hypoechoic, isoechoic or mixed echogenicity; however,
12% to 43% of hamartomas may appear hyperechoic [3-6](Fig.1 on page 6). Retrotumor acoustic phenomena are mostly absent; however, posterior enhancement, mixture of enhancement and shadowing and bilateral edge shadowing can be identified [4].

_Hyperechogenicity - underlying cause(s):_ interfaces of fibrous and adipose tissue surrounding and insinuating itself between adenomatous portions.

### 1.2 Focal fibrosis

**Definition:** circumscribed fibrous tissue proliferation of the mammary stroma with associated obliteration of the lobular-ductal parenchyma.

**Clinical presentation:** rare, palpable mass [7].

**Mammography:** well-circumscribed mass or, occasionally, ill-defined lesion indistinguishable from breast cancer [7].

**Sonography:** hypoechoic solid lesion or _localized area of hyperechogenicity_ with ill-defined margins [7](Fig.2 on page 7).

_Hyperechogenicity - underlying cause(s):_ thickly clustered fibrous streaks without interposed fat tissue, creating multiple juxtaposed irregular interfaces of varying acoustic impedance [1].

### 1.3 Lipoma

**Definition:** proliferation of adipose cells forming a mass, that is well circumscribed by a thin capsule of connective tissue. Generally superficial, located at the periphery of the breast parenchyma.

**Clinical presentation:** palpable mass, usually tender, mobile and deformable under the fingers [8].

**Mammography:** radiolucent lesion surrounded by a thin radiopaque capsule [8].

**Sonography:** oval, well-circumscribed hypoechoic nodule, similar in echotexture to subcutaneous fat [8]. _Less frequently_, lipoma can present as a _hyperechoic nodule_ [8] (Fig.3 on page 8).

_Hyperechogenicity - underlying cause(s):_ packed small adipocites creating multiple acoustic interfaces.
1.4 Angiolipoma

**Definition:** rare variant of lipoma with vascular proliferation among mature adipocytes. Typically superficial within the subcutaneous tissues.

**Clinical presentation:** painless breast mass [9].

**Mammography:** oval or round, isodense well-circumscribed mass [10-12].

**Sonography:** typically well-circumscribed, **homogeneously hyperechoic mass** with smooth margins, without manifestation of shadowing or posterior acoustic enhancement [10-13](Fig.4 on page 9).

**Hyperechogenicity - underlying cause(s):** combination of adipocytes and a vascular component.

1.5 Hemangioma

**Definition:** vascular, superficial tumor, located either subdermally or within the subcutaneous tissue.

**Mammography:** well-circumscribed, macrolobulated lesion that may contain calcification.

**Sonography:** lobulated or oval mass with well-defined margins, predominantly hypoechoic, or isoechoic, or complex in echotexture [12,14-17]. However, up to **33% of hemangiomas can show hyperechoic echotexture with distal attenuation** [12,15](Fig.5 on page 10). Hyperechoic echotexture has been associated with microlobulations or indistinct margins [15]. At Power Doppler examination, hemangioma can show a single vascular pole, or multiple peripheral or internal vessels [12,16,17].

**Hyperechogenicity - underlying cause(s):** presence of multiple, small vascular channels, creating innumerable, tiny juxtaposed acoustic interfaces.

2. MALIGNANT HYPERECHOIC LESIONS

2.1 Invasive Ductal Carcinoma (IDC)

**Definition:** most common type of breast cancer, accounting for 75% of invasive neoplasms [18]. Neoplastic proliferation of epithelial cells originating from the terminal ducto-lobular unit.
**Clinical presentation:** palpable firm mass, nipple discharge, skin or nipple retraction.

**Mammography:** spiculated opacity, or asymmetric density, or architectural distortion. IDC can be mammographically occult, in particular in dense breast tissue [19].

**Sonography:** typically hypoechoic mass [20], with irregular shape, spiculated margins and posterior acoustic shadowing. Rarely, IDC can appear as hyperechoic (Fig. 6 on page 11, Fig.7 on page 12, Fig.8 on page 13, Fig.9 on page 14) or mixed echogenicity lesion [21]. In our experience, of 1296 IDC diagnosed at sonographically-guided core-needle biopsy performed at our Department of Radiology, 6 (0.4%) presented as hyperechoic mass.

**Hyperechogenicity - underlying cause(s):** tumor heterogeneity in cellularity (cribriform pattern, tubular structure, solid nests and scirrhous pattern of cancer cells) [22]; presence of an extremely thick echogenic border containing strands of collagen fibre, proliferating tumor cells and fatty inclusions surrounding a minimal, nearly imperceptible hypoechoic central core of fibro-hyalinosis with sparse tumor cells [23].

### 2.2 Invasive Lobular Carcinoma (ILC)

**Definition:** second most common type of breast cancer, accounting for about 15% of all invasive neoplasms [18]. The typical histological feature is strands of small malignant cells infiltrating the surrounding parenchyma along and around ducts.

**Clinical presentation:** subtle findings such as vague skin thickening and retraction, often involving the nipple [24].

**Mammography:** indistinct mass with a density similar to that of adjacent fibroglandular tissue and without desmoplastic reaction, or architectural distortion; rarely associated with suspicious calcifications [24]. False-negative rate on mammography higher than that for IDC [24].

**Sonography:** hypoechoic mass with spiculated margins and posterior shadowing. Atypical features such as "taller-than-wide" morphology, absence of a definable mass and hyperechogenicity (Fig. 10 on page 15) are relatively common [24,25]. In the series by Cawson and coll.[26], 21 of 37 (57%) ILC were hyperechoic or had a significant hyperechoic component. ILC were about 10 times more likely to be hyperechoic than IDC. Waterman and coll.[27] supported these results reporting that hyper- and iso-echoic patterns are more frequent in ILCs than in tumors of other histologic differentiation.

**Hyperechogenicity - underlying cause(s):** tendency to infiltrate as rows of single cells into surrounding parenchyma and in concentric rings around normal ducts. ILC infiltration into surrounding structures can lead to an increase in reflective surfaces, resulting in increased internal echoes on ultrasound.
3. MISCELLANEOUS

Uncommon benign hyperechoic lesions include silicone, hibernoma [28](Fig. 11 on page 16), flogosis(Fig. 12 on page 17), fat necrosis [3,29](Fig. 13 on page 18), infection and pseudoangiomatous stromal hyperplasia [30].

Rare malignant hyperechoic lesions include liposarcoma, angiosarcoma [31], metastases [32,33], lymphoma [34] and intramammary metastatic lymphnode (Fig. 14 on page 19).

4. DIFFERENTIATION BETWEEN BENIGN AND MALIGNANT HYPERECHOIC LESIONS

The existence of hyperechoic cancers of the breast is apparently in contrast with the studies by Stavros and coll.[1] and Hong and coll.[35], who found that hyperechogenicity is a very reliable predictor of benignity. However, it is important to emphasize that, if focal areas of isoechogenicity or hypoechogenicity exist within a hyperchoic mass, such lesion should not be considered homogeneously hyperechoic and that it might be a malignant nodule. In fact, hyperechoic malignant lesions are not usually uniformly echogenic [1](Fig. 6 on page 11). In addition, malignant lesions of the breast usually show "taller-than-wide" morphology (Fig.7 on page 12), irregular shape, spiculated margin, posterior acoustic shadowing (Fig.8 on page 13) and abundant vascularization [1,35] (Fig.9 on page 14).

Appreciation of these ancillary findings can be helpful in suggesting the malignant nature of the lesion.

Images for this section:
**Fig. 1:** Hamartoma. 52-year-old woman with a palpable mass in the upper-inner quadrant of the right breast. The correlative sonogram shows an oval, well-circumscribed hyperechoic mass during sonographically-guided 14-G automated core-needle-biopsy (CNB). Pathologic diagnosis: hamartoma.
Fig. 2: Focal fibrosis. 47-year-old woman with previous history of breast cancer in her left breast. Mammography (not shown) demonstrated an opacity in the upper-outer quadrant of the right breast, which was not present in the mammography performed 1 year before. Correlative sonogram shows a focal area of mildly inhomogeneous hyperechogenicity (cursors). Pathologic diagnosis at 14-G CNB: fibrosis; mammographic and sonographic findings are unchanged at 24-months follow-up.
Fig. 3: Lipoma. 35-year-old woman with strong family history of breast cancer. Sonogram shows an oval, well-defined uniformly hyperechoic lesion (cursors) in the subcutaneous fat in the lower-outer quadrant of the left breast. Pathologic diagnosis at 14-G CNB: lipoma.
Fig. 4: Angiolipoma. 60-year-old woman with a palpable lump in the lower-inner quadrant of the right breast. The correlative sonogram shows a well-circumscribed, uniformly hyperechoic lesion ( cursors) with smooth margins, and no retroacoustic features, located in the subcutaneous tissue. Pathologic diagnosis at 14-G CNB: angiolipoma.
Fig. 5: Hemangioma. 56-year-old woman at high familiar risk for breast cancer. Breast MR (not shown) demonstrated an oval mass-like lesion with smooth margins showing strong and early enhancement in the inner-lower quadrant of the left breast. Second-look sonography demonstrated an oval hyperechoic lesion (cursors), located within the subcutaneous tissue. Pathologic diagnosis at 14-G CNB: capillary hemangioma.
Fig. 6: Invasive ductal carcinoma (grade 3); hypoechoic core. 68-year-old woman. Six-month follow-up monolateral left mammogram (not shown) demonstrated interval increase in size of a round opacity in the upper-inner quadrant of the left breast. The correlative sonogram demonstrates a predominantly hyperechoic nodule, with ill-defined margins (cursors). Note that the lesion is not uniformly hyperechoic, because of the presence of a central hypoechoic focal area (arrow), which suggests the malignant nature of the lesion.
Fig. 7: Invasive ductal carcinoma with mucinous differentiation (grade 1); "taller-than-wide" morphology. 67-year-old woman. Sonogram shows a predominantly hyperechoic nodule (cursors) with "taller-than-wide" morphology and poor-defined margins, in the lower-outer quadrant of the right breast. These features should raise the suspicion of malignancy.
Fig. 8: Invasive ductal carcinoma (grade 2); posterior acoustic shadowing. 52-year-old woman. Sonogram shows a predominantly hyperechoic nodule with hypoechoic focal area (arrow), irregular margins and mild posterior acoustic shadowing (arrowheads), in the upper quadrants of the left breast. These features should suggest the malignant nature of the lesion.
Fig. 9: Invasive ductal carcinoma (grade 1); abundant vascularization. 59-year-old woman with palpable lump in her left breast. Mammography (not shown) demonstrated a spiculated opacity in the central area of the left breast. The correlative color-Doppler image shows a hyperechoic nodule, with ill-defined margins and peripheral, apical vessels, suspicious for breast cancer.
Fig. 10: Invasive lobular carcinoma (grade 2). 54-year-old woman with an area of subtle thickening in the outer quadrants of her right breast, corresponding to an ill-defined area of increased opacity on mammography (not shown). The correlative sonogram shows an area of altered, hyperechoic echotexture without identifiable margins (arrows), with posterior acoustic shadowing (arrowheads).
**Fig. 11:** Hibernoma. 43-year-old woman with history of ovarian cancer. A CT-PET (not shown) demonstrated an abnormal uptake in the right breast. Mammography (not shown) did not demonstrate suspicious findings in the same area. Sonogram showed a hyperechoic lesion with poorly-defined margins, in the lower-inner quadrant of the right breast (cursors). Breast MRI (not shown) demonstrated an enhancing mass with wash-out enhancement pattern in the same area. Pathologic diagnosis at 14-G CNB: hibernoma.
Fig. 12: Granulomatous chronic flogosis. 56-year-old woman with history of sonographically guided CNB in the outer quadrants of the right breast six years before, followed by coal injection (histologic diagnosis: benign proliferative changes). Mammography (not shown) demonstrated an area of increased density in the higher-outer quadrant of the right breast. The correlative sonogram demonstrated two predominantly hyperechoic roundish nodules with spiculated margins (arrows). Pathologic diagnosis at 14-G CNB: foreign body granulomatous flogosis and steatonecrosis; imaging findings are unchanged at 4-year follow-up.
Fig. 13: Steatonecrosis. 64-year-old woman, with strong family history of breast cancer, reporting history of trauma in her left breast (about 9 months before). Mammography (not shown) demonstrated an area of focal asymmetric density in the upper-inner quadrant of the left breast. Correlative sonography demonstrated an hyperechoic mass with poorly defined margins ( cursors), located in the subcutaneous tissue. Pathologic diagnosis at 14-G CNB: steatonecrosis.
**Fig. 14:** Intramammary metastatic lymphnode. 43-year-old woman with invasive lobular carcinoma in the lower-inner quadrant of the left breast. Sonogram demonstrates the presence of a lobulated, predominantly hyperechoic mass in the higher-outer quadrant of the same breast (cursors). Pathologic diagnosis at 14-G CNB: fragments of adipose tissue, lymphocytes and aggregates of atypical epithelial cells, consistent with metastatic lymphnode.
Conclusion

Hyperechoic lesions constitute an heterogeneous group of breast lesions (Table 1 on page 21). Hyperechogenicity is considered a very reliable predictor of benignity. However, malignant tumors that present as hyperechoic masses do exist. These lesions, however, are not usually uniformly echogenic, but contain focal hypoechoic areas. This finding, in particular when associated with other sonographic features of malignancy (irregular shape, "taller-than-wide" morphology, spiculated margin, posterior acoustic shadowing, abundant vascularization) should raise the suspicion of a malignant nodule (Table 2 on page 22).

Images for this section:

<table>
<thead>
<tr>
<th>HYPERECHOIC LESIONS OF THE BREAST</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>POSSIBLE CAUSE OF HYPERECHOGENICITY</strong></td>
</tr>
<tr>
<td>-----------------------------------</td>
</tr>
<tr>
<td><strong>FAT-CONTAINING LESIONS</strong></td>
</tr>
<tr>
<td><strong>FIBROSIS-CONTAINING LESIONS</strong></td>
</tr>
<tr>
<td><strong>VASCULAR LESIONS</strong></td>
</tr>
<tr>
<td><strong>HIGH-CELLULARITY LESIONS</strong></td>
</tr>
</tbody>
</table>
Fig. 1: Table 1: Benign and malignant hyperechoic lesions of the breast. PASH=pseudo-angiomatous stromal hyperplasia; IDC=invasive ductal carcinoma; ILC=invasive lobular carcinoma.

<table>
<thead>
<tr>
<th>1. FOCAL HYPO-ECHOIC AREA</th>
<th>2. “TALLER-THAN-WIDE” MORPHOLOGY</th>
<th>3. IRREGULAR SHAPE AND SPICULATED MARGINS</th>
<th>4. POST. ACOUSTIC SHADOWING</th>
<th>5. VASCULARIZATION</th>
</tr>
</thead>
</table>

Fig. 2: Table 2: Sonographic features raising the suspicion of malignancy in case of a hyperechoic lesion of the breast.
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