

Appendix 1

According to the criteria of ACR BI-RADS fifth edition, detailed descriptions of imaging features were showed as follows (29).

Breast background echotexture

1. Breast background echotexture (BEP) contains fat and fibro-glandular parenchyma (homogeneous, heterogeneous). Homogeneous echotexture consists of fat or fibro-glandular homogeneous. Heterogeneity can be either focal or diffuse. The breast echotexture is characterized by multiple small areas of increased and decreased echogenicity, and may be accompanied with shadowing.
2. The qualitative parameters of breast parenchyma and fat adjacent to lesions were measuring in the maximal diameter of the tumor's image. The mean diameter of three measuring was obtained. Each mean diameter should be obtained through three measuring as following.

Shape

1. *Oval* A mass that is elliptical or egg-shaped (may include two or three undulations, i.e., gently lobulated or macro-lobulated).
2. *Round* A round mass is one that is spherical, ball-shaped, circular, or globular. It has an anteroposterior diameter equal to its transverse diameter; to qualify as a round mass, it must be circular in perpendicular projections.
3. *Irregular* The lesion shape is neither round nor oval.

Orientation

1. *Parallel* The long axis of the mass parallels the skin line. Masses that are only slightly obliquely oriented might be considered parallel.
2. *Not Parallel* The long axis of the mass is not parallel to the skin line. The anterior-posterior or vertical dimension is greater than the transverse or horizontal dimension. These masses can also be obliquely oriented to the skin line. Round masses are not parallel in their orientation.

Margin

1. *Circumscribed* A circumscribed margin is one that is well defined, with an abrupt transition between the lesion and the surrounding tissue. For a mass to be described as circumscribed at US, its entire margin must be sharply defined. Most circumscribed lesions have round or oval shapes.
2. *Indistinct* There is no clear demarcation of the entire margin or any portion of the margin from the surrounding tissue.
3. *Angular* Some or all of the margin has sharp corners, often forming acute angles.
4. *Micro-lobulated* The margin is characterized by short-cycle undulations, but the significant feature is that the margin of the mass is not circumscribed.

Echogenic pattern

1. *Hypoechoic* The term "hypoechoic" is defined relative to subcutaneous fat; hypoechoic masses, less echogenic than fat, are characterized by low-level echoes throughout.
2. *Isoechoic* Iso-echogenicity is defined as having the same echogenicity as subcutaneous fat.
3. *Hyperchoic* Hyper-echogenicity is defined as having increased echogenicity relative to fat or equal to fibro-glandular tissue.
4. *Complex Cystic and Solid* A complex mass contains both anechoic (cystic or fluid) and echogenic (solid) components.
5. *Heterogeneous* A mixture of echogenic patterns within a solid mass.

Posterior Features

1. *No Posterior Features* No shadowing or enhancement is present deep to the mass; the echogenicity of the area immediately behind the mass is not different from that of the adjacent tissue at the same depth.
2. *Enhancement* *Sound transmission* is unimpeded in its passage through the mass. Enhancement appears as a column that is more echogenic (whiter) deep to the mass.
3. *Shadowing* It is attenuation of the acoustic transmission. Sonographically, the area posterior to the mass appears darker.
4. *Combined Pattern* Some lesions have more than one pattern of posterior attenuation.

Calcifications

1. *Calcifications in a mass*
2. *Calcifications outside of a mass* Calcifications situated in fat or fibro-glandular tissue.
3. *Intraductal Calcifications*
4. *None calcification*

Vascularity distribution

1. *Absent* Cysts are the most common avascular lesions. Some solid masses also have little or no vascularity.
2. *Vessels in Rim* The blood vessels may be marginal, forming part or all of a rim around a mass.
3. *Internal Vascularity* Blood vessels are present within the mass. Vessels may penetrate the margin of the mass, or display an orderly or disorderly pattern within the mass.

Vascularity grade

1. Grade I non-vascularity;
2. Grade II less than 1 mm in diameter;
3. Grade III a main vessel was seen in the area and/or several small vessels were visualized;
4. Grade IV 4 or more vessels were visualized.

Lymph-Node-Metastasis-Reported

1. *No* Ultrasound doctor didn't report lymph node metastasis.
2. *Yes* Ultrasound doctor reported lymph node metastasis.

Tumor size

The largest diameter is merely chosen as the feature. The largest measurement should represent the longest axis of a lesion.

References

29. Mendelson EB, Böhm-Vélez M, Berg WA, Whitman GJ, Feldman MI, Madjar H, Rizzatto G, Baker JA, Zuley M, Stavros A, Comstock C, Van Duyn Wear V. ACR BI-RADS® Ultrasound. In: ACR BI-RADS® Atlas, Breast Imaging Reporting and Data System. Reston, VA, American College of Radiology; 2013.

Table S1 The P values of ten features between the training and validation cohorts

Features	P value
Age	0.966
BMI	0.520
Shape	0.342
Weight	0.760
Orientation	0.332
Margin	0.295
Tumor size	0.128
BI-RADS category	0.707
Vascularity distribution	0.392
Vascularity grade	0.117

BMI, body mass index; BI-RADS, Breast Imaging Reporting and Data System.