BIRADS: Ultrasound™

- Background Echotexture
- Mass Features:
  - Shape
  - Orientation
  - Margins
  - Lesion Boundary

BIRADS: Ultrasound™

- Echo Pattern
- Posterior Acoustic Features
- Surrounding tissue
- Calcifications
- Special Cases
- Vascularity

Breast Ultrasound Physics

Imaging principles you need to know to get great images
Mass characterization requires excellent images.

Excellent images require knowledge of the physical principles of ultrasound.

The user must use this knowledge to optimize each scan and distinguish artifacts from real findings.

Resolution
Frequency
Beam width
Focal Zone

ACR & AIUM Guidelines
Breast ultrasound should be performed with a high-resolution scanner with a center frequency of at least 10 MHz.
Axial Resolution

Wavelength (λ) = length (mm) of 1 cycle
Period = time (in seconds) to complete 1 cycle
Frequency (f) = 1 / period
= 1/0.0000001 = 10,000,000 Hz = 10 MHz

↑ Frequency = ↑ Spatial resolution

Effect of frequency on axial resolution

ACR & AIUM Guidelines

The highest frequency capable of adequate penetration to the depth of interest should be used.
Patient Positioning

- Supine oblique or supine position is preferred to reduce breast thickness and to improve visualization of deeper tissues.

Patient Positioning

- The medial breast is effectively studied with the patient in a supine position.
- One or both arms should be elevated behind the head or neck to stretch the pectoralis muscle for better fixation and immobilization of the breast.

Patient Positioning

- The upper outer quadrant and entire lateral breast are usually best evaluated if the patient is positioned with the ipsilateral shoulder elevated by a pillow or wedge.

Scanning Technique

- When scanning, the transducer should be perpendicular to the skin surface.
- Transducer coupling to the skin should be gentle and give complete contact.
Scanning Technique

- Compression is useful to avoid refraction and scattering from normal structures when sound penetration is insufficient, and to examine tissue elasticity of benign and malignant findings.
- The scanning procedure should involve overlapping scanning planes. These may be parasagittal, transverse, radial, or antiradial.

ACR & AIUM Guidelines

Penetration decreases as frequency increases. The use of broad bandwidth instrumentation is encouraged.
ACR & AIUM Guidelines

Focal zone selection, gain settings, and fields of view should be optimized to obtain high-quality images.

Resolution

Frequency
Beam width
Focal Zone

Lateral Resolution

Elevation focus

Effect of beam width on lateral resolution

Resolution

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Resolution

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Effect of beam width on lateral resolution
A common error in breast ultrasound is improper placement of the focal zone(s). This may obscure subtle margin features, calcifications and introduce low level echoes in cysts.

**ACR & AIUM Guidelines**

Dead zone should be limited to less than 2-3 mm.

Instrument used must provide adjustable focal zones.

The focal zone should be set at the depth of the lesion.

The patient should be positioned to minimize the thickness of the portion of the breast being evaluated.

For evaluation of lesions in, on, or just beneath the skin, a stand-off device or thick layer of gel may be helpful.

Gain settings, as well as focal zone selections should be optimized to obtain high-quality images.

**Contrast Resolution**

Slice thickness
Focal zone
Gain
Most tissues attenuate sound at approximately 1 dB/cm/MHz.
**ACR & AIUM Guidelines**

Gain and TGC settings should be adjusted to allow simple cysts to be distinguished from solid masses.

Gain should not be too low to prevent recognition of internal echoes that are truly present in a mass.

**Artifacts**

Ultrasound images are based on assumptions regarding the interaction of sound with tissue.

Often these assumptions are incorrect.
Echo Assumptions

The beam is narrow and uniform in width.

The beam travels directly to and from the echo-producing interfaces.
Conventional Compound

Harmonic Imaging
ACR & AIUM Guidelines

Doppler frequencies above 5 MHz.
Wall filter of 50 - 100 Hz
Pulse Repetition Frequency (PRF) ~ 1000 Hz

Elastography

Elastography, or tissue stiffness assessment, is among the new feature categories applicable to sonographic analysis of masses, to be included in the Associated Findings section in BI-RADS – Ultrasound, edition 2.
ACR & AIUM Guidelines

To minimize errors in communication or interpretation, if elastography is performed, the color scales should be annotated to denote hardness or softness.

Conclusions

An understand of the principles of ultrasound is essential in the production and analysis of breast masses with ultrasound.

Views / Images

- Lesions should be viewed in two perpendicular projections.
- At least one set of images of a lesion should be obtained without calipers.
- The maximal dimensions of a mass should be included.
- If volume analysis is needed, three-dimensional measurements should be obtained.
Labeling

- The images should be labeled as to right or left breast, the lesion’s location, and the orientation of the probe with respect to the patient.

- The location of the lesion should be recorded: the quadrant should be specified or the location can be indicated by using clock notation, distance from the nipple, or shown on a diagram of the breast.

Correlation

- Correlate with mammographic and other breast imaging studies and physical examination

- Current examination should be compared with prior studies as appropriate.

- When a specific lesion is examined, its precise position should be noted on the image.

Reporting

- Reporting should be in accordance with ACR Standard on Communication: Diagnostic Radiology and contain:
  - Indications for the examination.
  - The position of the lesion(s) as represented on a clock face with its distance from the nipple.
  - A description of any lesion(s) and adjacent features including the size of maximum diameter(s) or extent.
  - An opinion regarding provisional diagnosis(es) and significance of finding(s)