RADY 5002: Part B - Q&A

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Word count (excluding images, captions, tables and reference list): 1204

Question 1: Select a breast image associated with an artifact from a text/article/workplace. Discuss whether the artifact is obscuring or aiding in the diagnosis. Explain how better to optimise the image.

Despite the continued improvement of ultrasound image quality, sonographers continue to encounter artifacts, which are structures seen on an ultrasound image that do not accurately represent the tissue being scanned (Baker et al., 2001). Sonographers must be able to recognise artifacts as they can both obscure pathologies from being visualised and aid in diagnosing a particular condition during the sonographic investigation of the breast and other areas of the body (Scanlan, 1991). One such artifact type that a sonographer may encounter is reverberation artifacts, which occur when the ultrasound beam passes through two reflective planes and is repeatedly reflected between the interfaces (Scanlan, 1991). In breast ultrasound, reverberation artifacts can occur within the anechoic lumen of breast cysts. In this instance, part of the ultrasound signal is returned to the transducer, and part of the beam is bounced back and forth between the walls of the echogenic walls of the cyst, forming multiple parallel lines inside the lesion (Baker et al., 2001). In Figure 1, a lesion is seen within the normal tissue of the patient's breast. However, the parallel echogenic lines caused by a reverberation artifact within the cyst give the artifactual appearance of solid or complex material along the nondependent wall of the typically anechoic cyst (Baker et al., 2001). A sonographer can optimise an ultrasound image that displays a reverberation artifact by angling the transducer. Because reverberation occurs perpendicular to the ultrasound beam, changing the angle of ultrasound insonation into the breast lesion seen in Figure 1 minimises the effect of the artifact (Scanlan, 1991).

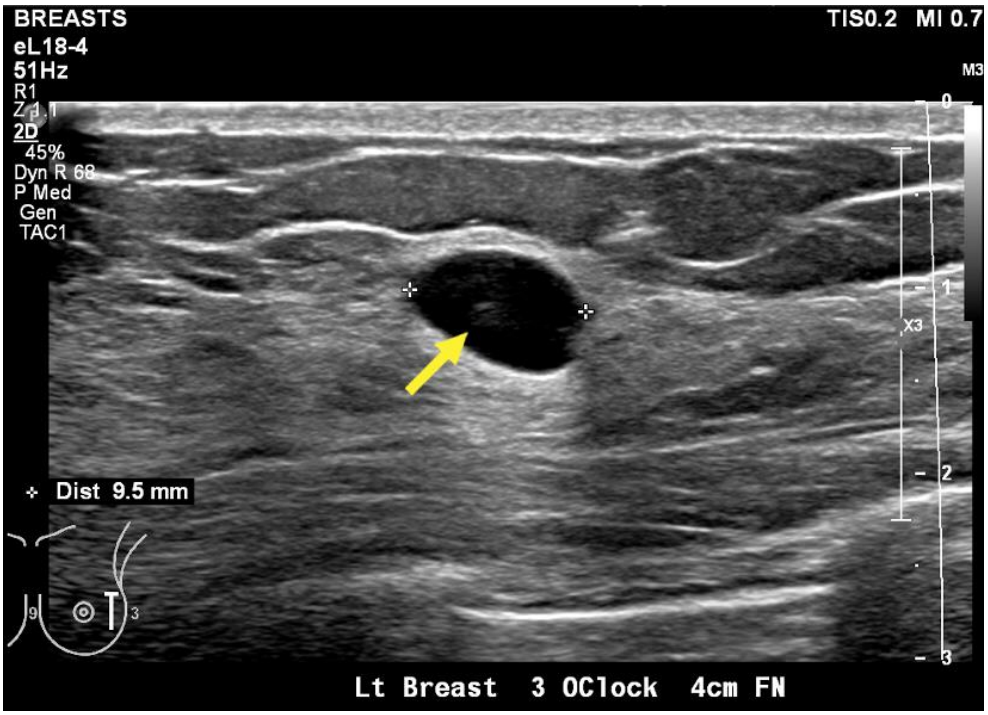


Figure 1: Ultrasound image of a breast showing a simple cyst with a reverberation artefact (arrow). Image used with permission from author's workplace, 2023.

Question 2: What are the standard parameters to be used while labelling a breast lesion on an ultrasound image?

According to the Australasian Society for Ultrasound in Medicine (2018), it is vital that ultrasound images of breast lesions are labelled according to the current Standards of Practice for Breast Imaging to ensure accurate lesion follow-up, localization for procedures and comparison with other imaging modalities (Gokhale, 2009). Therefore, when labelling a breast lesion on an ultrasound image the sonographer must ensure that they annotate the image with the evaluated breast (right or left), the clock face position of the lesion, the transducer orientation (radial, antiradical, longitudinal or transverse) and the distance of the lesion from the nipple in centimetres (Australasian Society for Ultrasound in Medicine, 2018; Gokhale, 2009). An example of a correctly annotated image is provided below (refer to Figure 2).

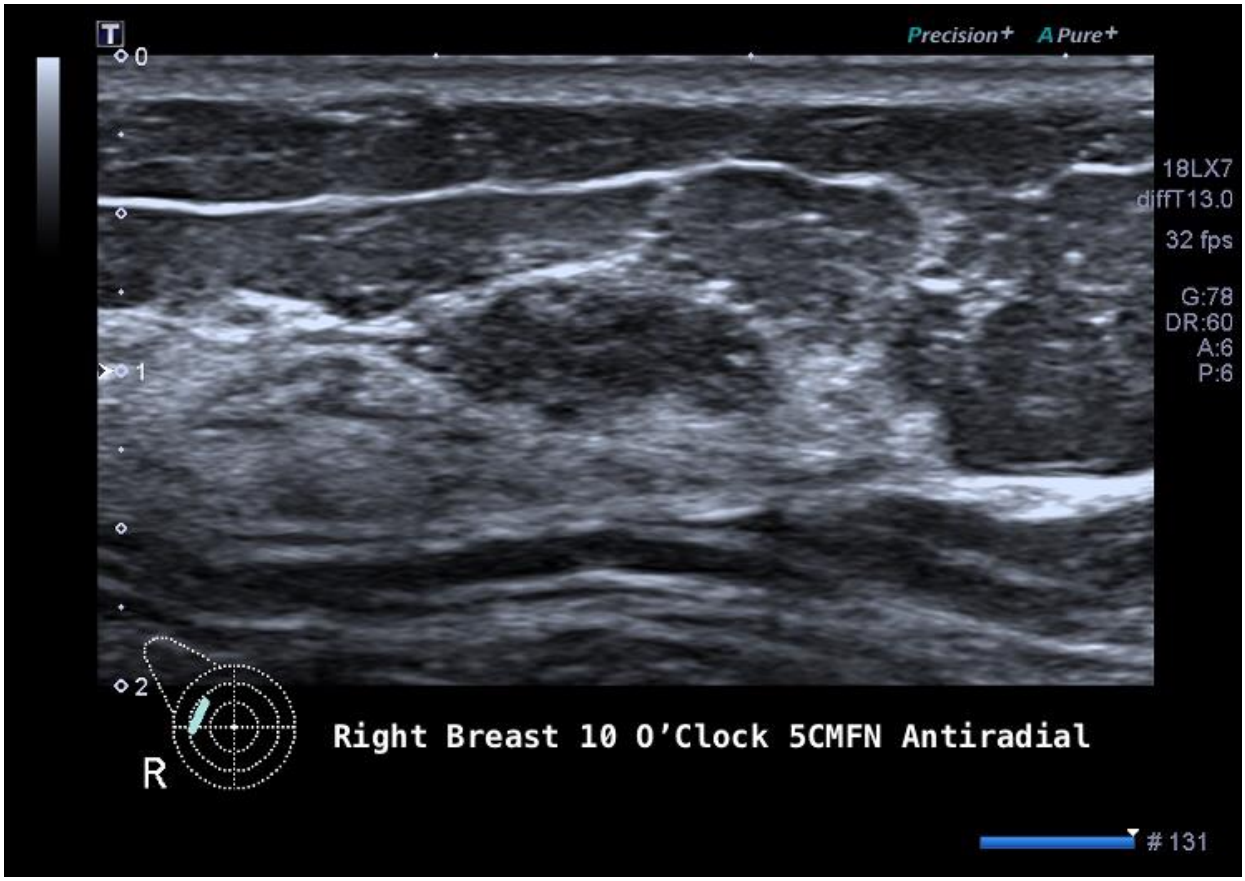
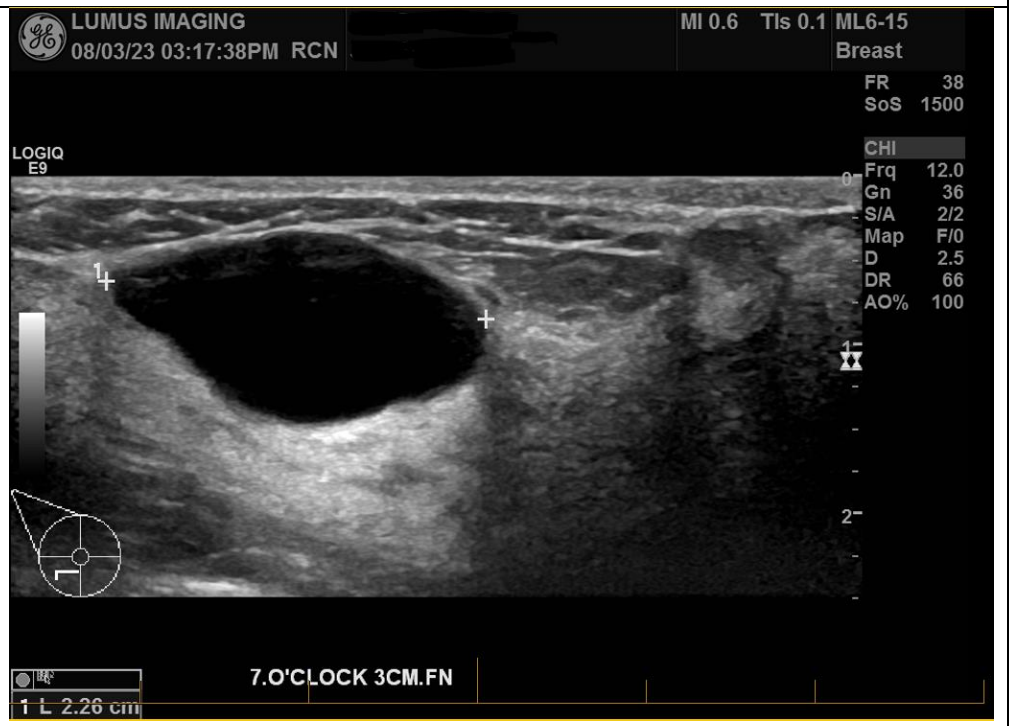


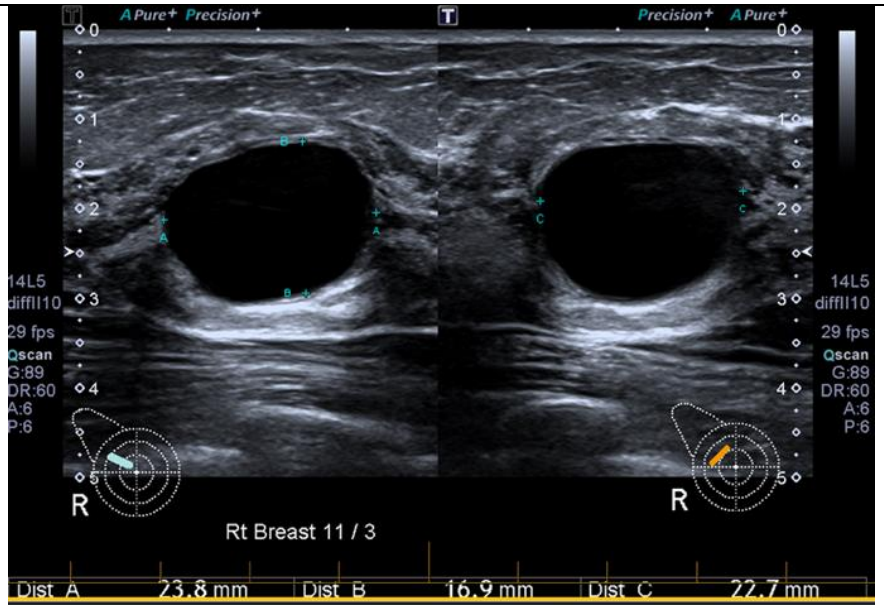
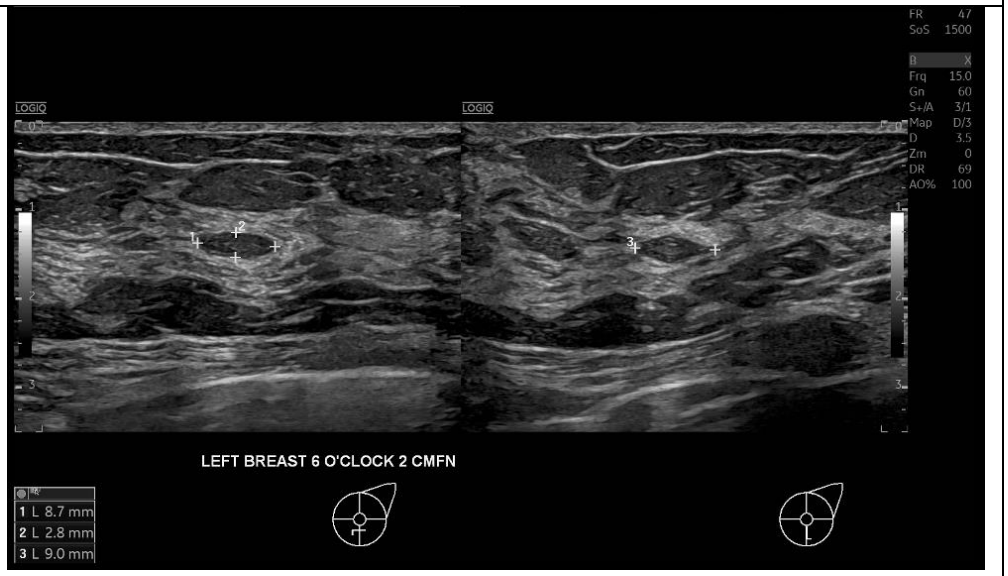
Figure 2: Ultrasound image of a breast lesion correctly annotated in accordance with the current Standards of Practice for Breast Imaging. Image used with permission from author's workplace, 2023.

Question 3: What are the sonographic characteristics of benign versus malignant lesions. Use image/s as examples to elaborate.

In a landmark study by Stavros et al. (1995), the authors described several criteria that could potentially distinguish between benign and malignant breast lesions on grayscale ultrasound imaging. According to this research, benign breast lesions may demonstrate two or three gentle lobulations, an ellipsoidal shape, a thin capsule, and a homogeneous echogenic echotexture (refer to Table 1) (Gokhale, 2009). Furthermore, malignant breast lesions are characterised by features such as taller-than-wide orientation, spiculation, angular margins, calcifications, and posterior acoustic shadowing (refer to Table 2) (Stavros et al., 1995). Using these criteria to distinguish between benign and malignant breast lesions, Stavros et al. (1995) were able to diagnose malignancy with a sensitivity of 98.4%. Several studies have subsequently validated the results of this initial research which has contributed to the development of the Breast Imaging and Reporting Data System (BI-RADS) (Mainiero et al., 2005). In Australia, the Breast Imaging Advisory Committee has recommended that BIRADS categories be used to classify and manage breast lesions, whereby lesions with one or more malignant or indeterminant characteristics are biopsied and followed up according to a standardised approach for all patients (Sedgwick, 2011; Graf et al., 2007).

Table 1: The sonographic characteristics of a benign breast lesion including a description of the feature and an example ultrasound image showing a lesion with that characteristic (Gokhale, 2009; Stavros et al., 1995).

Benign Characteristic	**Description**	**Example Ultrasound Image***
Shape: Round or oval shape and smooth.	The lesion is round or oval in shape with fewer than three gentle lobulations.	

Margin: Well-circumscribed.	The border of the lesion is easily distinguished. It is contained by a thin capsule.	
Orientation: Parallel.	The maximum diameter of the lesion is in the transverse plane (the lesion is wider than it is tall)	

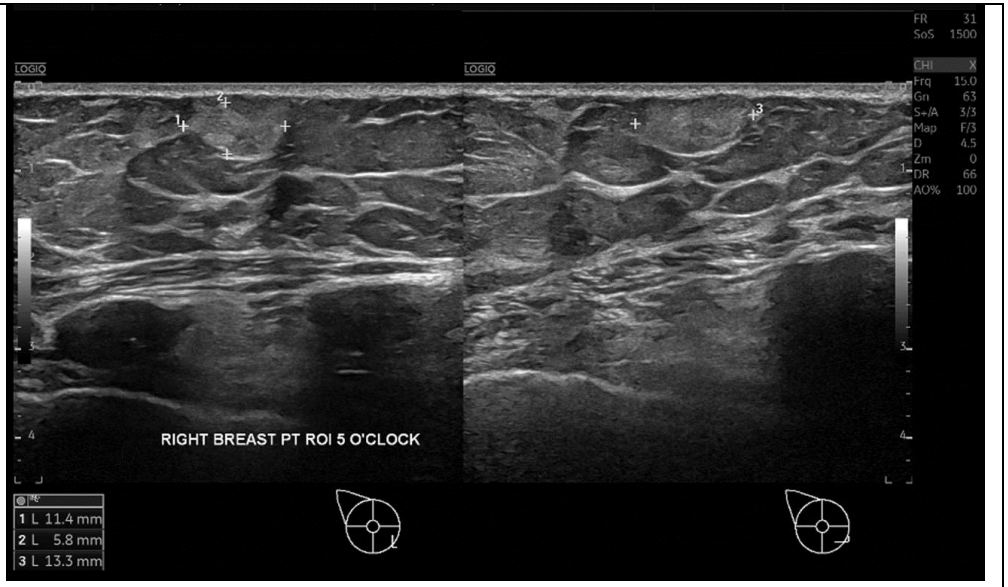
Echogenicity: Hyperechoic, isoechoic or mildly hypoechoic.	The lesion appears hyperechoic, isoechoic or mildly hypoechoic compared to fat within the breast.	
Absence of any malignant findings.	The lesions do not demonstrate any of the features listed in Table 2.	

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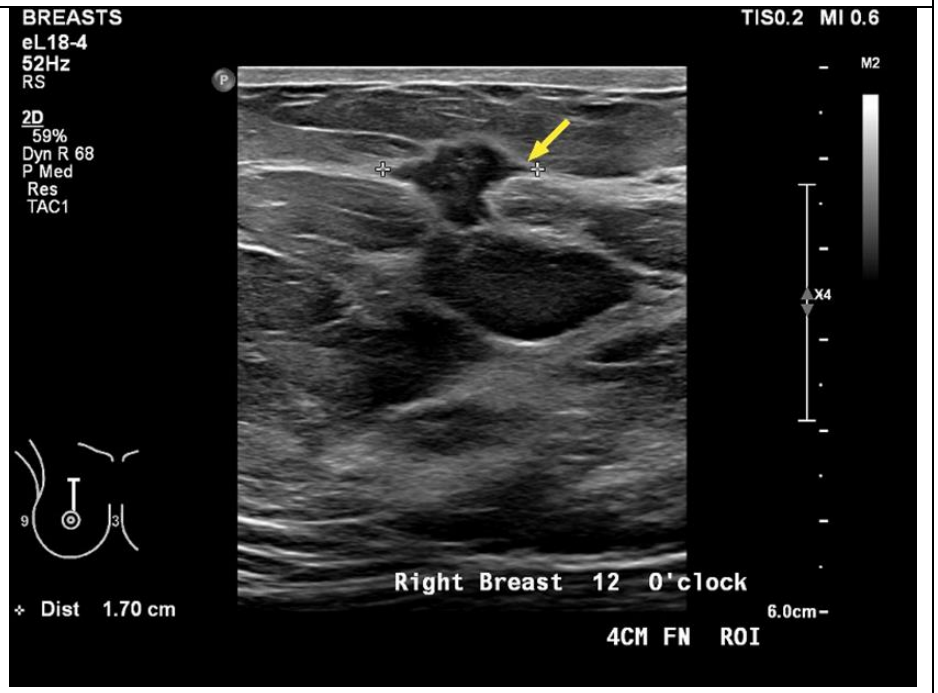
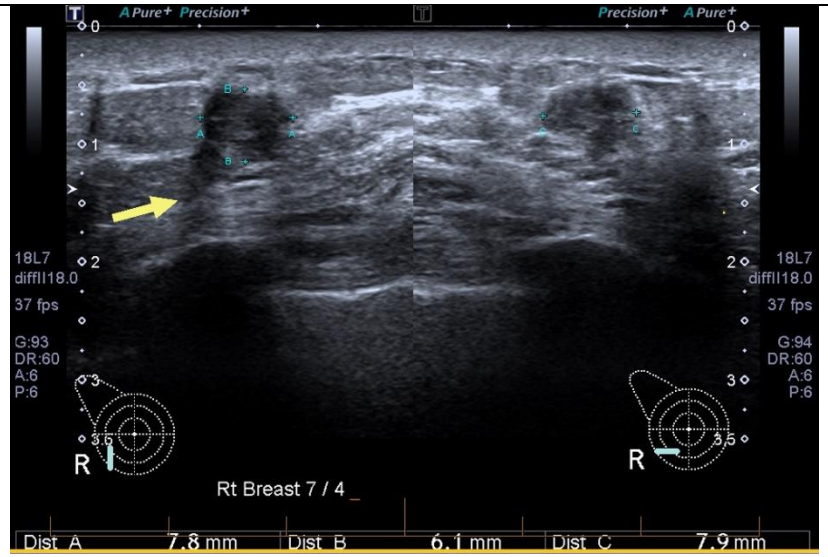
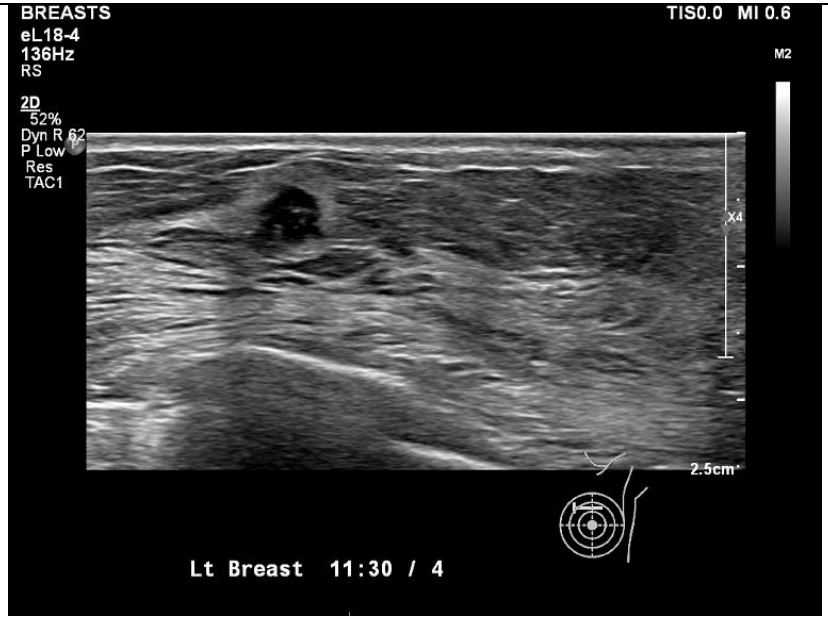
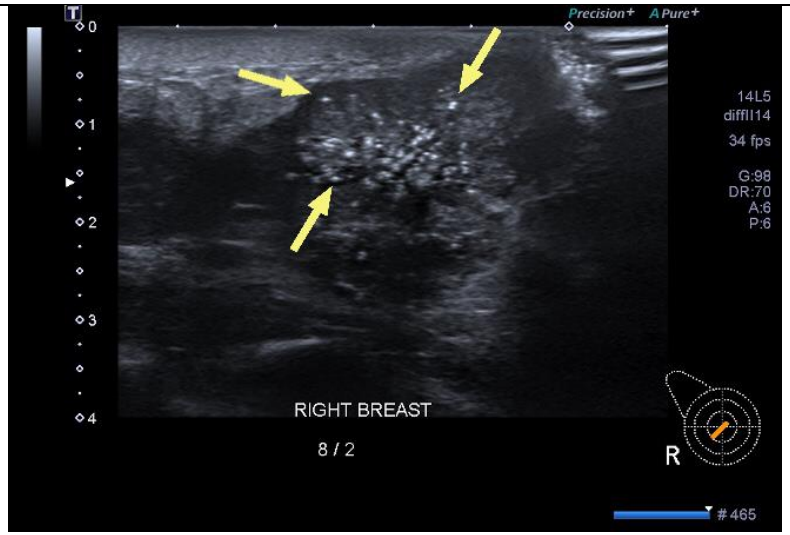
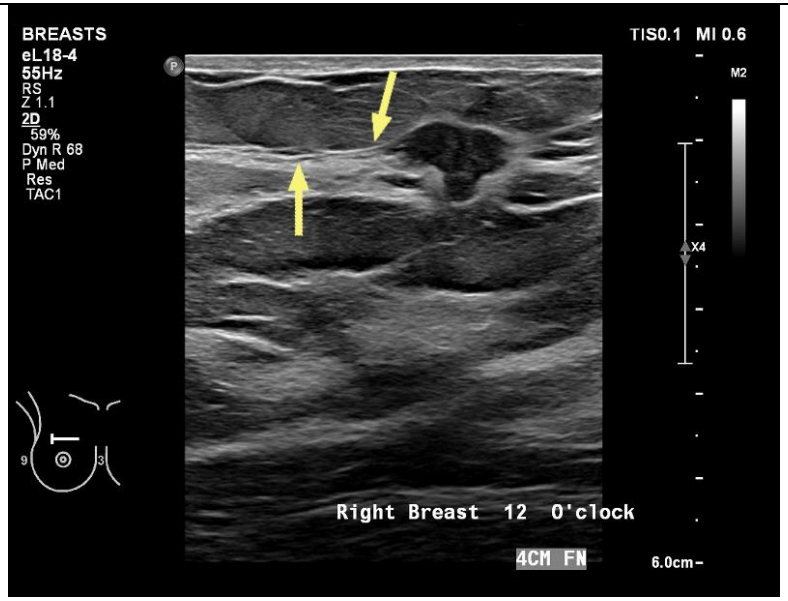
Table 2: The sonographic characteristics of a malignant breast lesion including a description of the feature, the probability that the characteristic was able to predict malignancy in the study conducted by Stavros et al. (1995), and an example ultrasound image showing a lesion with that characteristic (Gokhale, 2009; Stavros et al., 1995).

Malignant Characteristic	**Description**	**Positive Predictive Value**	**Example Ultrasound Image***
Margin: Spiculated.	The margin of the lesion is not well-defined whereby there is stellate distortion of the tissue potentially caused by intrusion of breast cancer into surrounding tissue.	91.8	

Orientation: Not parallel.	The lesion appears taller than wide.	81.2	
Margin: Angular/irregular.	The margins of the lesion is not smooth meaning that the lesion appears to be angular, lobulated or otherwise irregular.	67.5	

Posterior features: Acoustic shadowing.	The lesion shows posterior features such as shadowing which indicate that it is solid as opposed to cystic.	64.9	
Echogenicity: Hypoechoic.	The lesion appears hypoechoic compared to fat within the breast.	60.1	

Calcifications	The lesion contains calcifications.	59.6	
Ductal extension	The lesion appears to have branches that extend into the ducts of the breast.	50.8	

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Question 4: What visible changes (physical changes as seen by the naked eye) should you observe and document when performing a breast ultrasound, and what underlying pathologies can these changes signify?

During a breast ultrasound examination, the sonographer should observe and document changes to the breast tissue which are visible to the naked eye, including changes to the size/symmetry of the breasts, the contour of the breast, the nipple (including inversion), and the skin over the breast (Gokhale, 2009). Relevant skin changes may include irregular thickness, pigmentation and vascularisation, and conditions such as erythema (redness) and telangiectasia (dilated/broken blood vessels) (Gokhale, 2009; Giordano & Hortobagyi, 2003). Visible changes to the breast are potentially the result of numerous underlying pathologies. For example, erythema (abnormal skin redness) may result from a benign condition such as contact dermatitis or, in rare cases, due to inflammatory breast cancer, where cancer cells within the skin of the breast cause the build-up of lymph fluid within the skin. Less than half of inflammatory breast cancer cases will present with a discrete breast lesion, with the only symptoms being visible changes to the skin, size, and contour of the breast (Giordano & Hortobagyi, 2003). This example highlights the importance of accurately documenting visible breast changes noticed by the patient or the sonographer on the ultrasound worksheet, as these features potentially affect the clinical decisions the radiologist makes regarding the cause and management of the patient's symptoms (Necas, 2017). A table summarising some of the possible underlying pathologies indicated by visible changes to the breast tissue is found below (see Table 3).

Table 3: Summary of some of the possible underlying pathologies which can cause visible changes to the breasts that a sonographer must document (Guirguis et al., 2021; Gokhale, 2009; Giordano & Hortobagyi, 2003).

Visible Change	**Possible Underlying Pathologies**
Breast size/symmetry: • Increased/decreased size • Increased density • Asymmetry (ie. Lowering of one breast)	• Scarring/scar tissue • Post-radiation therapy changes • Breast cyst/s • Fat necrosis • Fibroadenoma/s • Mastitis • Cell hyperplasia in the breast ducts/lobules
Contour: • Dimpling • Puckering • Visible lumps	• Scarring/scar tissue • Breast cyst/s • Fat necrosis • Fibroadenoma/s

	• Mastitis • Cell hyperplasia in the breast ducts/lobules • Inflammatory breast cancer
Skin: • Erythema • Skin thickening/dimpling • Prominent veins • Hyperpigmentation/telangiectasia • Scarring • Superficial skin lesions (ie. moles, warts, blisters)	• Inflammatory breast cancer • Post-radiation therapy changes • Pseudoangiomatous stromal hyperplasia (PASH) • Mondor's disease • Other tumours/malignancies • Mastitis • Mastectomy/lumpectomy
Nipple: • Inversion • Crusting • Retraction • Flattening	• Malignancy of the breast • Paget's disease • Erosive adenomatosis of the nipple • Florid papillomatosis • Intraductal papillomas • Post-surgery changes • Fat necrosis • Fibrocystic disease • Mondor's disease

Question 5: What is the significance of microcalcifications? Discuss the limitations of ultrasound in imaging microcalcifications.

Research conducted by the Australian Institute of Health and Welfare (2021) shows that breast cancer is the most diagnosed cancer in Australian women. Therefore, the detection of breast neoplasms via medical imaging modalities such as ultrasound and mammography is vital to reduce the burden of breast cancer on the Australian healthcare system (Bonfiglio et al., 2018).

Research indicates that microcalcifications (MCs), defined as calcium deposits between 0.1 and 1.0 mm, are the first indication of malignant breast disease in more than 40% of cases (Chang et al., 2005). While MCs are routinely seen on both mammograms and breast ultrasounds, they are more difficult to distinguish on ultrasound images (Bonfiglio et al., 2018). Because they are very small, the normal fibroglandular tissue of the breast can interfere with sonographic visualisation of MCs (Ouyang et al., 2019). That is, image artefacts such as speckle (caused by small structures within the breast scattering the ultrasound waves) make differentiating isolated MCs within normal breast tissue challenging (Ouyang et al., 2019). Hence, it is easier to visualise MCs when they are located inside a solid mass, which provide a hypoechoic background and improve the visualisation of the bright echoes associated with MCs on ultrasound (Ouyang et al., 2019).

The size, number, distribution, and morphology of MCs provide crucial information regarding the malignancy and benignity of breast lesions (refer to Figure 3) (Ouyang et al., 2019; Henrot et al., 2014). Conventional ultrasound systems rely on two-dimensional (2D) imaging, displaying a cross-section of the scanned tissue (Ouyang et al., 2019). Thus, individual MCs which are part of a larger cluster potentially appear superimposed onto one another on 2D ultrasound images (Ouyang et al., 2019). Breast ultrasound cannot be used to determine the malignancy of MCs within the breast due to the loss of spatial information regarding the pattern of MCs within the breast, which is essential for elucidating MC pathology (Henrot et al., 2014). Consequently, conventional ultrasound systems can only identify the existence of MCs in tissue breast, and mammograms are currently considered more efficacious at identifying MCs than breast ultrasound due to these limitations (Oberst et al., 2021). To overcome this limitation, researchers have proposed that 3D ultrasound could significantly enhance the characterisation of malignant breast lesions using ultrasound by allowing for the spatial relationship between MCs to be visualised and evaluated (Oberst et al., 2021). Thus, advances in ultrasound imaging could improve the efficacy of ultrasound in detecting MCs.

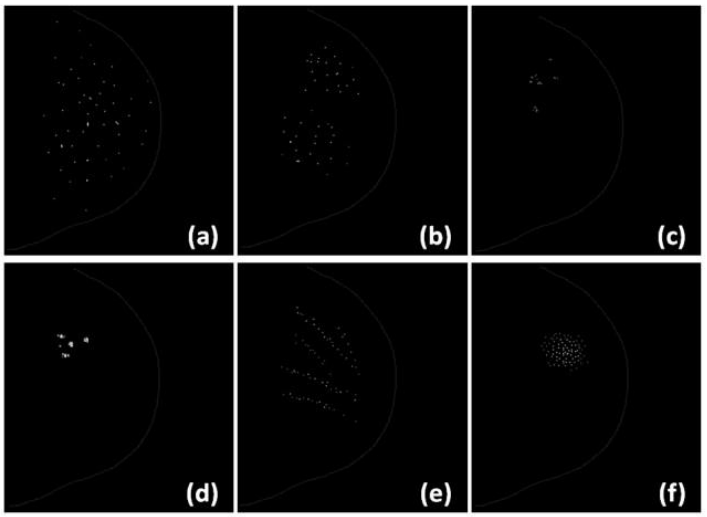

Figure 3: Representative drawings of six patterns of microcalcifications (MCs) which typically occur in the breast. Images (a) and (b) represent breast MCs patterns that are associated with a low risk of malignancy, (c) and (d) with an intermediate risk of malignancy, and (e) and (f) with a high risk of malignancy. Image from the study conducted by Ouyang et al.,

References

Australasian Society for Ultrasound in Medicine. (2018). Guidelines on Breast Ultrasound Examination and Reporting. Guidelines on Breast Ultrasound Examination and Reporting. Retrieved March 30, 2023, from https://www.asum.com.au/standards-of-practice/breast/.

Baker, J. A., Soo, M. S., & Rosen, E. L. (2001). Artifacts and pitfalls in sonographic imaging of the breast. *American Journal of Roentgenology*, *176*(5), 1261–1266. https://doi.org/10.2214/ajr.176.5.1761261

Bonfiglio, R., Scimeca, M., Urbano, N., Bonanno, E., & Schillaci, O. (2018). Breast Microcalcifications: Biological and diagnostic perspectives. *Future Oncology*, *14*(30), 3097–3099. https://doi.org/10.2217/fon-2018-0624

Chang, F., Huang, F., Wang, P., Chen, R., & Moon, K. (2005). Microcalcification detection in 3-D breast ultrasound. *2005 IEEE Engineering in Medicine and Biology 27th Annual Conference*. https://doi.org/10.1109/iembs.2005.1615937

Australian Institute of Health and Welfare. (2021). *Cancer in Australia 2021 (133).* https://www.aihw.gov.au/reports/cancer/cancer-in-australia-2021/summary

Giordano, H., & Hortobagyi, N. (2003). Inflammatory breast cancer: Clinical progress and the main problems that must be addressed. *Breast Cancer Research*, *5*(6). https://doi.org/10.1186/bcr608

Gokhale, S. (2009). Ultrasound characterization of breast masses. *Indian Journal of Radiology and Imaging*, *19*(03), 242–247. https://doi.org/10.4103/0971-3026.54878

Guirguis, S. *et al.* (2021) "Mimickers of breast malignancy: Imaging findings, pathologic concordance and clinical management," *Insights into Imaging*, 12(1). Available at: https://doi.org/10.1186/s13244-021-00991-x.

Graf, O., Helbich, T. H., Hopf, G., Graf, C., & Sickles, A. (2007). Probably benign breast masses at US: Is follow-up an acceptable alternative to biopsy? *Radiology*, *244*(1), 87–93. https://doi.org/10.1148/radiol.2441060258

Henrot, P., Leroux, A., Barlier, C., & Génin, P. (2014). Breast microcalcifications: The lesions in anatomical pathology. *Diagnostic and Interventional Imaging*, *95*(2), 141–152. https://doi.org/10.1016/j.diii.2013.12.011

Hooley, J., Scoutt, M., & Philpotts, E. (2013). Breast Ultrasonography: State of the art. *Radiology*, *268*(3), 642–659. https://doi.org/10.1148/radiol.13121606

Mainiero, B., Goldkamp, A., Lazarus, E., Livingston, L., Koelliker, L., Schepps, B., & Mayo-Smith, W. (2005). Characterization of breast masses with sonography. *Journal of Ultrasound in Medicine*, *24*(2), 161–167. https://doi.org/10.7863/jum.2005.24.2.161

Necas, M. (2017) "The Clinical Ultrasound Report: Guideline for sonographers," *Australasian Journal of Ultrasound in Medicine*, 21(1), pp. 9–23. Available at: https://doi.org/10.1002/ajum.12075.

Ouyang, Y., Zhou, Z., Wu, W., Tian, J., Xu, F., Wu, S., & Tsui, P. (2019). A review of ultrasound detection methods for breast microcalcification. *Mathematical Biosciences and Engineering*, *16*(4), 1761–1785. https://doi.org/10.3934/mbe.2019085

Sedgwick, E. (2011). The Breast Ultrasound Lexicon: Breast Imaging Reporting and Data System (BI-RADS). *Seminars in Roentgenology*, *46*(4), 245–251. https://doi.org/10.1053/j.ro.2011.04.001

Scanlan, A. (1991). Sonographic artifacts and their origins. *American Journal of Roentgenology*, *156*(6), 1267–1272. https://doi.org/10.2214/ajr.156.6.2028876

Stavros, T., Thickman, D., Rapp, L., Dennis, A., Parker, H., & Sisney, A. (1995). Solid breast nodules: Use of sonography to distinguish between benign and malignant lesions. *Radiology*, *196*(1), 123–134. https://doi.org/10.1148/radiology.196.1.7784555

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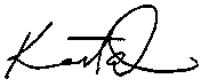

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