DETECTING BREAST CANCER: 2D VS 3D IMAGING

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BACKGROUND OF THE BREAST CANCER AWARENESS MONTH

The month of October has become synonymous with an increased awareness of breast cancer. The amount of information presented on the media about breast cancer during the month of October is frequently overwhelming and often confusing. We should not be *more* aware of breast cancer during October, simply because the incidence of breast cancer is the same all year around. However, October serves as a yearly wake-up call to the importance of being proactive in the detection and treatment of breast cancer. It has also become a calendar event for organising fund-raising activities for breast cancer treatment and research.

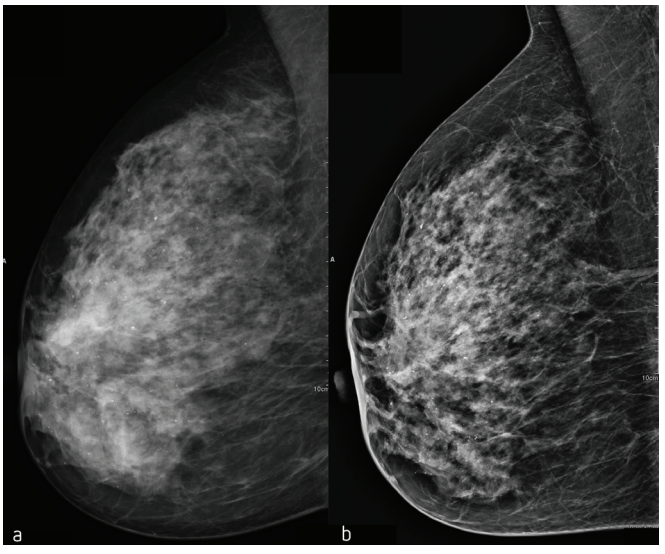

Figure 1. CR Mammogram (a) versus FFD Mammogram (b). Note the superior image clarity in (b).

The concept of having a Breast Cancer Awareness Month was born in 1985 through cooperation between the American Cancer Society and Astra Zeneca, a pharmaceutical company that was developing breast cancer medicines. Initially, the aim was to promote screening with mammography for the early detection of breast cancer and to institute treatment early. In 1993, the Breast Cancer Research Foundation was created in the US to source funds for research in breast cancer; the foundation and similar societies throughout the world use the month of October to promote awareness through education and to organise events to raise funds for breast cancer research.

The month of October sees an abundance of educational and promotional information appearing in all the media from governmental and private organisations that is aimed at enhancing the public awareness of the importance of detecting breast cancer early and how this is done. Organisations use this month to promote the use of well-established technologies for breast cancer detection. Unfortunately, this month is also used by some companies to showcase newly acquired "innovative" technologies that have no scientifically proven clinical advantage.

The article below outlines the well-established and scientifically proven technologies, as well as the newer ones, and guides the reader on which test should be performed based on patient age and clinical background.

WHY IS BREAST IMAGING IMPORTANT?

The answer is short and simple: it reduces the mortality of breast cancer.

Breast cancer is one of the leading causes of death in women worldwide.[1] In 2002, Duffy *et al* reported that breast cancer

screening reduced the mortality from breast cancer by 45%.[2] This statistic was derived at a time when only mammography was used and the quality of mammography was far inferior to the image quality obtained by mammography today. With modern mammographic methods, we should improve on the above quoted findings. However, with the development of multiple new techniques for breast cancer screening, it is becoming increasingly important to select the right technique based on the patients' needs. Having multiple technologies at hand is often leading to a degree of confusion that may delay diagnosis and treatment.

TECHNOLOGIES AVAILABLE FOR BREAST CANCER DETECTION

MAMMOGRAPHY

Mammography is overall still the best tool for breast cancer screening, however, it is important to know its limitations and when to use ancillary imaging techniques to improve diagnostic accuracy.

Mammographic images have seen big improvements in quality resulting from technological development over the past two decades. The shift from conventional film/screen mammography to digital mammography resulted in improvement in image quality and reduction of radiation exposure. Digital mammography underwent further development from Computed Radiography (CR) Mammography to Full Field Digital (FFD) Mammography. The introduction of FFD mammograms brought about the biggest overall improvement in image quality and in diagnostic accuracy.

When referring to mammography today, we should no longer consider performing film/screen mammograms or CR mammograms as they are diagnostically inferior to FFD mammograms (Fig 1). Only FFD mammograms should be performed today.

FFD mammograms are low dose X-ray images of the breast that depict internal structure based on tissue density. There are two main types of normal tissue in the breast, breast glands and ducts which are dense, and fat which is low density. The overall density of the breast reflects the proportion of glands/ducts to fat. Very glandular breasts are dense, while very fatty breasts are non-dense.

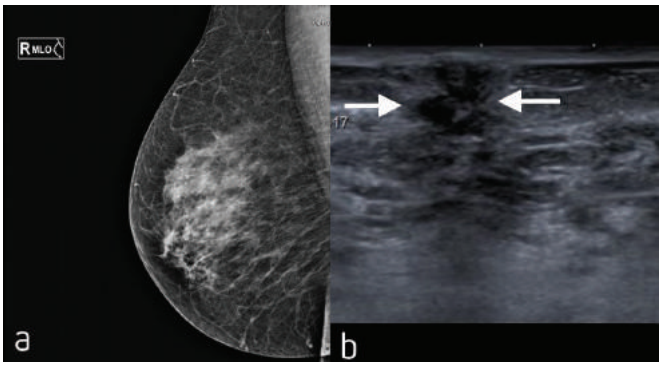

Figure 2. FFD Mammogram showing a moderately dense breast that obscures a clinically noted medial breast nodule (a) and ancillary imaging with ultrasound (b) confirming the presence of a small cancer (arrows).

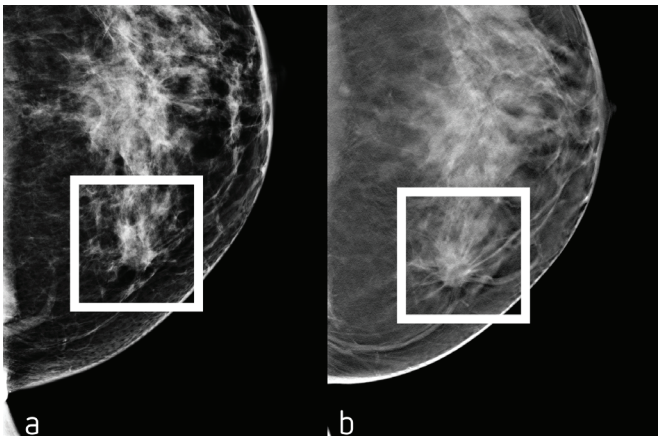

Figure 3. FFD (2D) Mammogram (a) versus Tomosynthesis (b): Tomosynthesis may be used as an ancillary test to evaluate abnormalities detected on FFD mammograms; note cancer (in box) seen on both images.

Cancers are dense on mammograms and are hence better seen on a fatty background than on a glandular background. In the case of very dense breasts, which may account for 20-40% of the screening population, cancers may be difficult to detect and may require additional imaging methods to ensure an accurate diagnosis.

The most cost-effective and efficient ancillary imaging method for dense breasts, when combined FFD mammograms, is breast ultrasound (Fig 2). This is quick and poses no additional radiation exposure to the patient. It can also be used to guide immediate biopsy to expedite further management.

Recent years have seen the development of breast Tomosynthesis ("3D mammograms"), which is a further development of digital mammographic technology; this system obtains image slices through the breast to reduce overlap of glandular tissue (Fig 3). Tomosynthesis is beneficial when combined with FFD mammography for dense breasts, but since it is done following FFD mammography, this results in doubling of the radiation exposure dose to the patient. Besides, proceeding to a breast ultrasound instead of Tomosynthesis often delivers the same results, while reducing the radiation exposure and cost. Ultrasound also has the added advantage of allowing efficient and immediate biopsy that expedites management.

To date, the use of Tomosynthesis alone has not be clinically accepted as a primary screening method for breast cancer.

BREAST ULTRASOUND

Breast ultrasound is a valuable adjunct to FFD mammography when screening for breast cancer.[3] Combining the two tests increases diagnostic accuracy particularly in dense breasts.

Breast ultrasound alone may be used for screening younger women (<40 years of age), particularly for those who have very dense breasts and for those who have breast implants.

Beast ultrasound is a test that requires *direct hands-on intervention by a breast radiologist.* The radiologist should be experienced in performing breast ultrasound, should be aware of any relevant clinical symptoms or findings before performing the scan,

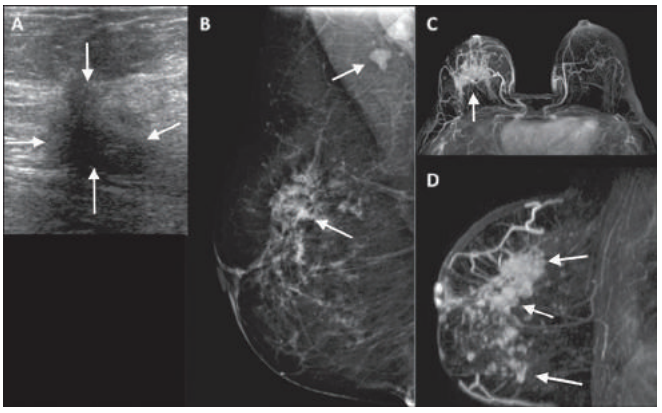

Figure 4. Breast Ultrasound (A), FFD Mammogram (B) and Breast MRI (C and D): The images show a less common type of breast cancer, an invasive lobular cancer; this type of cancer is poorly seen on FFD mammograms (B) but is detected by breast ultrasound (A). However, its full extent can only be seen on Breast MRI (C and D); it involves the whole right breast (arrows). Breast MRI is the only test that accurately assesses the extent of lobular breast cancer.

should ensure full coverage of all breast tissue and axillary regions and should maintain open communication with the patient during the scan as she may provide information that could be relevant to the procedure. The radiologist should be aware of all mammographic findings and should have correlated those findings with previous exams prior to performing an adjunct breast ultrasound scan.

Any attempts at saving radiologist time by employing ultrasound technologists or automated breast ultrasound scanners (ABUS or 3D scanners) results in loss of this open clinical encounter, with the ensuing risk of loosing valuable information from the diagnostic process. The radiologist should have direct access to the patient, must review previous mammograms and must perform the ultrasound scan to ensure that all sources of data are integrated to deliver the most accurate diagnosis.

ABUS scanners have been in the market for the past 10 years; they have not yet been shown to be reliable enough to replace normal breast ultrasound for breast cancer screening. There are numerous issues that limit the value of ABUS as a diagnostic test: (1) There are risks that the scan will not cover the whole breast, particularly the axillary regions; (2) in saving radiologist's time, it reduces communication between the patient and the radiologist, which may result in clinical findings such as skin puckering, nipple discharge or a nodule being missed; (3) artefacts that occur during a normal ultrasound scan can be minimised by an experienced radiologist through changes in scanning angle and scanner settings; this is not possible with ABUS. If a scan is performed by technologist or a machine (in case of ABUS), mammographic and clinical data are not integrated to improve the accuracy of the ultrasound scan.

BREAST MRI

Breast MRI is the most sensitive test for detecting breast abnormalities. Certain types of breast cancer, such as early ductal carcinoma-in-situ and lobular breast cancer can only be reliably detected by MRI. Breast MRI, however, requires an expensive scanner, has prolonged examination times in an uncomfortable position and requires the use of an injection of contrast material. Breast MRI also detects many benign nodules as well as malignant ones, which may occasionally result in unnecessary further investigation. Still, breast MRI remains the best test to use for dense breasts (Fig 4). Breast MRI is still considered to be too costly and time-consuming to be used as a routine breast cancer screening tool; it is an excellent method for diagnostic workup of equivocal findings and for imaging certain types of breast cancer.

SELECTING PATIENTS BASED ON AGE

When deciding on the best test for breast cancer screening one starts by checking the patient's age.

For patients aged 40 years or older, breast cancer screening should start with a FFD mammogram. This should be reviewed immediately by a breast radiologist, who then proceeds to a direct hands-on breast ultrasound if any mammographically equivocal or suspicious findings are detected. Interaction between the radiologist and the patient is important at this stage as it may contribute significant information to the diagnostic process and will help reduce the patient's stress. Proceeding to Tomosynthesis before performing an ultrasound may lead to unnecessary radiation exposure. Proceeding to a breast MRI or an ultrasound-guided biopsy may also be more efficient than employing Tomosynthesis.

For patients under the age of 40 years, a breast ultrasound should be the first examination with direct, hands-on intervention by a breast radiologist to ensure that both clinical and ultrasound findings are integrated into the final report and treatment recommendations. Further investigations, if doubts arise on the ultrasound, may include ultrasound-guided biopsy or breast MRI. Mammograms are occasionally performed in this age group, but they often contribute less information since many of these patients have dense breast.

CONCLUSION

In summary, FFD mammograms (2D mammograms) are fundamental to all breast cancer screening programs, particularly since these programs are recommended for women aged 40 years and older. They are the best tool we have for detecting breast cancer. Direct hands-on breast ultrasound (2D ultrasound) performed by an experienced breast specialist contributes important data when combined with FFD mammograms and expedites management while avoiding additional radiation exposure.

Tomosynthesis (3D mammograms) should only be used as an ancillary test if findings on 2D mammograms and 2D breast ultrasound are still unclear. Automated Breast Ultrasound (ABUS or 3D ultrasound) does not replace direct hands-on 2D breast ultrasound as it will lead to loss of valuable diagnostic information that may delay treatment.

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