Nigerian Journal of Health Promotion
ISSN: 0995-3895
Vol. 12, 2019

HEPRAN

Emerging Breast Imaging Technologies Supplemental To Traditional Film-Screen Mammography for Effctive Breast Cancer Detection and Prevention

Ndudi Onyinyechukwu Akalonu
P.O.Box 28 Ulakwo, Owerri, Imo State
EMAIL: ndudi42003@yahoo.com

Abstract
Breast cancer is still claiming lives of many Nigerian women due to its poor, late and at advanced stage detection, when nothing in terms of treatment could be done. So many Nigerian hospitals are still relying on only the traditional film-screen mammography for breast cancer detection and prevention. There are new breast imaging technologies which have been developed and are used widely in combination with the traditional film-screen mammography for early and effective breast cancer detection and prevention. Emerging breast imaging technologies help to detect and prevent breast cancer early. They should be made available and utilizable for women in all Nigerian hospitals. This paper examines the various emerging breast imaging technologies that can be used in Nigeria to supplement traditional film-screen mammography for early and effective breast cancer detection.
Key Words: Breast cancer, breast imaging technologies, emerging, traditional film-screen mammography, supplemental technologies

Introduction

One of the greatest problems confronting breast cancer outcome, is the ever-late detection of the disease. Breast cancer is a malignant, fast spreading disease, which originates from the tissues of the breast (Ogbuji, 2011). Foluso and Oluwatosin (2016) reported that most cases of breast cancer are diagnosed at advanced disease stages, resulting in restricted treatment options and high mortality rates. Studies have shown that in contrast to the developed nations, most of the developing nations including Nigeria have recorded a poor outcome and high fatality rate owing to diagnosis of the breast cancer in advanced and late stages (Hishman & Yip, 2004; Adesunkami, Lawal, Adelusola & Durosimi, 2006; Coughlin & Ekwueme, 2009). Okobia and Osime (2001) stated that the five year survival rate of breast cancer is less than 10 per cent in Nigeria. This is in sharp contrast to the over 70 per cent five year survival rate in Western Europe and North America, where breast cancer is detected and prevented early (Okobia, Bunker, Okonofia & Osime, 2006). Breast cancer patients survive-if detection occurs early. Early diagnosis usually results in treatment before metastasis and signifies a better outcome of management. When identified early, breast cancer is more likely to be prevented, respond to effective treatment and can result in less morbidity, less expensive treatment and a greater probability of surviving. Significant improvements can be made in the lives of cancer patients by detecting breast cancer early and avoiding delays in prevention (Anderson, Braun, & Lim, 2003). According to Kayode, Akande and Osagbemi (2005) this is very important because an excellent prognosis is directly associated with the stage at which the tumor is detected and how localized the lesion is.

Effective breast cancer detection requires early diagnosis in symptomatic women and regular screening in asymptomatic women. These can be done using breast imaging technologies. Breast imaging technologies have a role to play in early detection and prevention of breast cancer. These are diagnostic examination tools that capture or take pictures of the breast tissue. Traditional film-screen mammography is one breast imaging technology that has been used to detect breast cancer in both symptomatic and asymptomatic women. However, cancer is not detected effectively early in all symptomatic and asymptomatic women using only traditional film-screening mammography – a limitation that has led to the inclusion of new breast imaging technologies in the diagnosis and screening of different categories of women for breast cancer. In most Nigerian hospitals the traditional film-screen mammography is still the only available breast imaging modality used for breast cancer detection, for all women (Hlimat, Bola & Olalekan, 2015) despite the fact that there are supplemental modalities that are performing significantly better and replacing the one-size-fits-all approach. Most of health care facilities in Nigeria do not have the third generation state of the art diagnostic equipment that are supplemental to traditional film-screen mammography, and as a result screening, diagnosis, staging of breast cancer for all women is dependent on x-ray and breast tissue biopsy, and mastectomy is still the predominant intervention of breast cancer (Anele, Bowling, Eckert, Gonzalez, Hipfer & Sauder, 2014). By definition a supplemental technology is equipment added to complete the primary equipment and should offer a small incremental improvement in either sensitivity/specificity or both. Traditional film-screen mammography has since early 1990s, helped to detect breast cancer and reduce breast cancer deaths in Nigeria. However, the future of reducing breast cancer deaths lies in even earlier detection in all women who have cancer and emerging imaging technologies for breast cancer detection can make this possible.

In the late 1960s, a breast imaging technique known as mammography was discovered for breast cancer detection. This technique stemmed from the discovery of x-ray and radiation. A mammography is an x-ray picture of the breast that is performed in order to screen for and detect the presence of breast cancer. Mammograms can be used to check for breast cancer in asymptomatic women (that is, those who have no signs or symptoms of the disease). This type of mammogram is called a screening mammogram. Mammographic screening for breast cancer uses x-rays to examine the breast for uncharacteristic masses or lumps. A mammogram can help detect the presence of breast cancer before a woman or a doctor can feel a lump in the breast, so it helps to detect breast cancer early. Mammograms can also be used to check for breast cancer after a lump or other sign or symptom of the disease has been found. This type of mammogram is called a diagnostic mammogram. During a screening or diagnostic mammography, the breast is compressed and a technician takes photos from different angles. A general or screening mammography takes photos of the entire breast, while a diagnostic mammography focuses on a specific lump or area of concern (United States Preventive Services Task Force, 2009).

The first set of mammography that became widely used is the traditional two dimensional (2-D) mammography. This is an x-ray test that takes single pictures or images of the breast from only two angles: front and side. A doctor can examine these images to look for any changes and suspicious areas that could be signs of cancer. During the test, a woman stands in front of the x-ray machine and will place one breast at a time on a flat surface. A paddle will be lowered onto the top of the breast for about 20 to 30 seconds. As the breast is compressed, an x-ray is taken. The paddle will raise and the technician will change the angle of the machine to take another x-ray. The images will be processed, formally on a black and white large sheets of photographic film (this is called: traditional film-screened mammography), but now on a computer file (this is called: 2-D digital mammography) and a doctor will then be able to view and interpret them. Traditional film-screen mammography helps to find breast cancers, but is gradually phasing out or been supplemented with other breast imaging tools, in most countries due to its limitations. Michell, Iqbal, Waan, Evans, Peaock, Lawinki, Douiri, Wilson and Whelehan (2012) reported that traditional film-screen mammography has less detailed and accurate images, distorted and shadowing images of breast tissues, takes pictures from only two angles, does not diagnose cancer in some persons. Despite the success of traditional film-screen mammography, it is recognized as an imperfect imaging tool that has come under strong criticism in recent years for a variety of reasons discussed below.

Traditional film-screen mammography is known to underperform in some women, notable those with dense breast tissue. Breasts contain both dense tissue (glandular tissue and connective tissue, together known as fibro-glandular tissue) and fatty tissue. Fatty tissue appears dark on a mammogram, whereas fibro-glandular tissue appears as white arrears. Because fibro-glandular tissue and tumors are similar density, tumors can be harder to detect in women with dense breasts. Traditional film-screen mammography is recognized as an imperfect imaging tool that performs poorly in women with dense breast tissue – a limitation which has driven demand for supplemental screening techniques.

The American Cancer Society suggests the following guidelines for traditional film-screen mammograms for the average woman: age 40-44 can have the option to start yearly mammograms, age 45-54 should get yearly mammograms, while age 55 and up can get a mammogram every other year or choose to continue with yearly mammograms. This shows that women who are under age 40 are excluded from having film-screen mammography. Mammograms are generally recommended detection tools for older women. Differences in breast tissue density of younger and older women make mammograms virtually ineffective for younger women (Rosenberg & Levy-Schwartz, 2003). Younger women have greater breast tissue density, at this stage of life. To avoid exposing young women early to radiation also make them excluded from mammography. However, reports in Nigeria have shown that the disease can strike well at a younger age. Banjo (2004) reported that in Nigeria the youngest age of breast cancer incidence recorded was 16 years from Lagos. Anele, Bowing, Eckert, Gonzale, Hipfer and Sauder (2014) reported that the peak age of breast cancer incidence was 42.6years and 12 per cent of cases occurred before the age of 30years. The risk of breast cancer below the age of 35 is rather low, but this notwithstanding, women who do develop the disease in their teens, 20s and 30s have a much poorer prognosis than women diagnosed at an older age (Umeh & Rogan-Gibson, 2001). Younger women tend to have a reduced survival rate compared to older women due to their cancers being at advanced stages or having lymph node involvement at diagnosis (Fry & Prentice-Dunn, 2006). Accordingly, it is important to provide breast cancer screening and diagnostic technologies that will help in discovering tumors at a stage where treatment and clinical cure are possible for younger women.

Traditional film-screen mammography can miss small but potentially deadly tumors in some women. American Cancer Society (ACS) (2012) reported that traditional mammography can miss some cancers. Breast cancers may be clinically evident, while occult in traditional film-screen mammography. According to Komen (2018) the main goal of any cancer screening test is to correctly identify everyone who has cancer (called the sensitivity of the test). For example, a sensitivity of 90 percent means 90 percent of people tested who truly have cancer are correctly identified as having cancer. An ideal cancer screening test would also be able to correctly identify all the people who do not have cancer as not having it (called the specificity of the test). For example, a specificity of 90 percent means 90 percent of the people who are healthy are correctly identified as not having cancer. When sensitivity is high, the test picks up even the slightest abnormal finding. Very few cases are missed, but the test will mistake some healthy people as having cancer when they do not (called a false positive result). When specificity is high, there are fewer false positive results. Traditional film-screen mammography has high false-negative results. It can miss about half of breast cancers that are present at the time of screening. This can lead to delays in treatment and a false sense of security for affected women. One cause of false negative results is high breast density. False negative results occur more often among younger women than older women because younger women are more likely to have dense breasts. As a woman ages, her breasts usually become more fatty, and false-negative results become less likely. Anyanwu (2000); Wu and Yu (2003) and Banjo (2004) stated that false-negative for traditional film-screen mammography is higher in the younger women, and this is likely to be happening in Nigeria, where cases of no previous cancer, that later turned to advanced cancer, have been widely reported among younger women. In order to save lives, cancers need to be found at an earlier, more treatable stage, so early detection of small cancers in all women is very important.

Traditional film-screen mammography has high false-positive results. These are more common for younger women, with dense breast, women who have had previous breast biopsies, women with family history of breast cancer, and women who are taking estrogen. Radiologists can see an abnormality (that is, a potential positive) on a film-screen mammogram, but no cancer is actually present. This can lead to anxiety and other forms of psychological distress in affected women. It sometimes leads to follow up of findings that are not cancer, including biopsies. The additional testing required to rule out cancer, can lead to repeated x-ray and exposure to high dose of radiation, which can predispose a woman to cancer. Traditional film-screen mammography requires small doses of radiation, the risk of harm from this radiation exposure is low, but repeated x-rays have the potential to cause cancer. To solve these problems, we need to include breast imaging technologies that can detect cancers with the biological and functional signatures that indicate likelihood to progress to aggressive disease, in the screening of women.

Traditional film-screen mammography is frequently inadequate as a planning tool for lumpectomy. This may explain the report that residual cancer can be found in as many as 30 per cent to 60 per cent of patients after lumpectomy, resulting in a second trip to the operating room (Schilling, Conti, Adler & Tafra, 2008). Traditional film-screen mammography is unable to preoperatively identify which patients are best served by lumpectomy and define the margins for surgery because it cannot identify the metabolic abnormalities in tissue, potentially increasing the number of second surgeries needed for resection of residual disease. There are new breast imaging technologies that could more precisely map the extent of both invasive and noninvasive disease and lead to more precise surgery.

Medical advances have shown that one-third of breast cancers are preventable and a further one-third if diagnosed sufficiently early is potentially curable (Kayode, Akande & Osagbemi, 2005). Emerging breast imaging technologies for detection of breast cancer according to ACS (2012) improves the chances of breast cancer been diagnosed at an early stage and treated sufficiently. Most doctors feel that early detection of breast cancer save many thousands of lives each year. Many more lives of breast cancer patients could be saved in Nigeria, if emerging breast imaging technologies are used in conjunction with the traditional film-screen mammography by women and their health care providers to detect breast cancer early. While traditional film-screen mammography widely has been the front-line imaging modality, other breast imaging technologies are emerging that are offering even more dramatic benefits to women who have breast cancer. Breast tomosynthesis (3D mammography), breast ultrasound, breast magnetic resonance imaging (BMRI), positron emission mammography (PEM) and molecular breast imaging (MBI) are among the several promising supplemental technologies that are improving breast cancer detection and treatment, especially for women at high risk for the disease, such as those with dense breast tissue or genetic predisposition, as well as the newly diagnosed. These are not readily available in most Nigerian health care facilities. This article discusses below, these five emerging breast imaging supplemental technologies that should be made available and used to supplement traditional film-screen mammography for effective breast cancer detection and prevention in a breast cancer challenged country of ours.

Breast tomosyntesis

Breast tomosyntesis, also called 3D mammography is a relatively new and more advanced type of mammography than traditional film-screen and 2-D digital mammography. It is an advanced technology that takes multiple images, or x-rays, of breast tissue to recreate a 3-dimentional picture of the breast. It is different from traditional film-screen mammography, in that traditional film-screen mammography obtains just a single image. According to ACS (2017) during 3D mammography, the breast is compressed once, and a machine takes many low-dose x-rays as it moves over the breast. The x-ray arm sweeps in a slight arc (360 degrees) over the breast, taking multiple pictures. A computer then puts the images together into a 3-dimensional picture. Images from this technology are collected on a digital detector and viewed or read on a computer. It uses high-powered computing to convert breast images into a stack of thin layers. While a traditional film-screen mammogram is much like looking down on the cover of a book, a 3D mammography can be compared to opening the book up and being able to flip through it page by page, seeing everything. It yields more precise, easy-to-read results. Breast tomosynthesis provides doctors with a clearer, more detailed view of breast tissue and can lead to easier, more and earlier breast cancer detection (Bramlet, 2015). The images of the breast taken from multiple angles helps radiologists pinpoint the size, shape, and location of abnormalities. It helps doctors deliver more detail and accuracy providing women with more peace of mind. Breast tomosynthesis increases the detection of invasive breast cancers, positive predictive value (PPV) for a recall and increased positive predictive value (PPV) for biopsy. 3D mammography provides detection accuracy that traditional film-screen mammography alone cannot. It reduces the chances of doctors seeing a false positive. A recent study found that 3D mammography used in conjunction with traditional film-screen mammography detected 80 percent of cancer cases, while traditional film-screen mammography alone detected 59 percent (Northwestern Medicine, 2015). Breast tomosynthesis takes only four minutes to be done. It is suitable for all women, and more beneficial for women with dense breast tissue, breast implants or who have had prior biopsies or surgery.

Breast ultrasound

These days ultrasound is not only used for pregnancy related issues, it is also increasingly used for breast cancer detection. Breast ultrasound uses high-frequency sound waves to produce a computer picture or image of the internal structures and tissues of the breast. It is primarily used to help diagnose or assess the size and shape of breast lumps or other abnormalities a doctor may have found during a physical clinical breast examination, mammogram or breast magnetic resonance imaging (MRI) (Radiological Society of North America, 2018). According to ACS (`2018) breast ultrasound is useful because it can often tell the difference between fluid-filled cysts (which are not usually cancer) and solid masses or lump (which might need further testing to be sure they are not cancer). This ability provides a noninvasive solution to determine whether or not a suspicious area is in fact a benign cyst - a determination that has historically been made only by performing an invasive biopsy. Because ultrasound provides real-time images, it is often used to guide biopsy procedures. It helps guide a biopsy needle into an area of the breast, so that cells or tissues can be taken out and tested for cancer. This can also be done in swollen lymph nodes under the arm.

Breast ultrasound begins with the radiologist or sonographer physically examining the breast. They will then usually ask questions about any lump or breast changes, such as when it was noticed, if other symptoms are present, and how it has progressed. After the physical examination, they will apply a cool, clear, water-based gel to the patient's breast. By limiting air bubbles, this gel increases the ability of sound waves to move through tissues. In some cases, they will place a triangular pillow under the patient's shoulder, causing the body to roll to one side. The patient's arm may also be raised over the head. These positions can make it easier for the sound waves to travel and be received. They may dim the lights in the room to make the computer screen and images easier to see. Once the gel has been evenly spread, they will pass a wand-like device called a transducer over the breast. The transducer sends sound waves through the breast and records their activity. When a sound wave hits a tissue or structure, it is bounced back. Information about how long it takes for the wave to bounce back, its amplitude or loudness, and the pitch or frequency, is sent from the transducer to a computer that translates it into an image called a sonogram. They will look at all the tissues and structures of the breast and take still shot pictures at several different sites and angles. They will usually take multiple pictures of the lump and surrounding area. Short moving videos may also be recorded. After the breast, the armpit region will also be examined for swollen or hard lymph glands and nodes. After the test is complete, the person will be given a tissue to wipe off the gel and will be given privacy to get dressed (Huizen & Chun, 2017).

Breast ultrasound is often used as an initial and early diagnostic tool for evaluating breast lumps. Many studies have shown that it can help supplement traditional film-screen mammography by detecting breast cancers that may not be visible with mammography. Breast ultrasound is complementary to the mammography technique. The combination of the two screening tests offers a sensibility of 92 per cent and specificity of 96 per cent (Tsina & Simon, 2014). Breast ultrasound can be offered as a screening tool for women who: are at high risk for breast cancer and unable to undergo a magnetic resonance imaging examination, are pregnant - breastfeeding or should not be exposed to x-ray (which are necessary for a mammogram), have increased breast density (when the breasts have a lot of glandular and connective tissue and not much fatty tissue). Breast ultrasound is widely available, safe, easy to have, noninvasive, painless and does not use or expose a person to radiation. It is usually completed within few minutes and also costs less than a lot of other breast imaging methods.

Breast magnetic resonance imaging (Breast-MRI)

Breast magnetic resonance imaging (B-MRI) is a noninvasive diagnostic examination that uses a combination of radio waves, strong magnets and a computer to make detailed images or pictures of the inside of the breast. It uses strong magnetic fields instead of ionizing radiation (x-rays), to capture detailed, multiple, cross-sectional images of the breast tissue (ACS, 2017). B- MRI creates pictures of soft tissue parts of the breast that are sometimes hard to see using other imaging tests. It takes pictures from many angles, as if someone were looking at a slice of the body from the front, from the side, or from above the head. These images are combined to create detailed, computer-generated pictures of the tissue inside the breasts. It offers valuable information about many breast conditions that cannot be obtained by other imaging modalities, such as mammography or ultrasound. B-MRI is an integral component of breast imaging protocols, and its importance has increased in recent years. The emerging role of MRI in breast imaging has been appreciated by many authors. Of all the available modalities for the detection of breast cancer, B-MRI has been shown to have the highest sensitivity (Greenwood, Freimanis, Caperntier & Joe, 2018). MRI is able to detect cancers that are clinically, mammographically, and sonographically occult (Lehman, Isaacs & Schnall, 2007). The overall sensitivity of MRI for breast cancer is relatively high, with estimates ranging from 85 per cent to 100 per cent, while in cases of invasive ductal carcinoma, its sensitivity approaches 100 per cent (Fahrettin, Hayri, Ummugulsim, Hatice, Ozlem, Melit & M-Halit, 2012).

Just as mammograms are done using x-ray machines specially designed for the breasts, breast MRI also requires special equipment. The B-MRI machine is called an MRI with dedicated breast coils (ACS, 2017). It is a large, cylindrical (tube or donut-shaped) machine that creates a strong magnetic field around the patient. The magnetic field, along with radio waves, alters the hydrogen atoms' natural alignment in the body. Computers are then used to form a two-dimensional (2D) image of the breasts based on the activity of the hydrogen atoms. Cross-sectional views can be obtained to reveal further details. A magnetic field is created and pulses of radio waves are sent from a scanner. The radio waves knock the nuclei of the atoms in the breasts out of their normal position. As the nuclei realign into proper position, they send out radio signals. These signals are received by a computer that analyzes and converts them into an image of the part of the body being examined. This image appears on a viewing monitor.

Some B-MRI machines look like narrow tunnels, while others are more spacious or wider. The most useful MRI exams for breast imaging use a contrast material that's injected into a vein in the arm before or during the exam. This helps to clearly show breast tissue details. The contrast material used for an MRI exam is called gadolinium (ACS, 2017).According to American Society of Clinical Oncology (ASCO) (2018) for a breast MRI, the radiologist will help position the patient on a padded table specially designed for a breast MRI. She will lie face down on her stomach with her arms at her side and her head on a headrest. The table has openings for her breasts so they can be scanned without being squeezed or compressed. The table will then slide into the MRI machine. She will need to lie very still during the 2 to 6 imaging sequences. Each sequence will last up to 15 minutes. She will know that the machine is taking images because she will hear extremely loud tapping and knocking sounds. She will be allowed to relax slightly between each imaging sequence but will need to maintain her body position as much as possible. It is advised to scan both breasts simultaneously to compare the affected breast with the contra-lateral breast (Fahrettin et al, 2012). During the exam, the technologist will be in a nearby room, separated by a window. The technologist will be able to see her. And she will be able to communicate with her at all times through an intercom system. The breast imaging session will last between 30 to 60 minutes (ASCO, 2018).

B-MRI is used to: look for, or screen breast cancer in women who are at a high risk for the disease; diagnose and evaluate breast tumors (it may identify a small mass within a woman's breast better than a mammogram or ultrasound can. This is particularly true for women with very dense, non-fatty breast tissue); learn more about a cancer that is found by feeling the breast but not seen on a mammogram or ultrasound; stage or find out more about the size of the tumor and extent of the spread after an initial breast cancer diagnosis; monitor how well chemotherapy is working to treat the cancer; evaluate the area where the cancerous breast tissue was removed as a part of follow-up care; learn if breast implants have ruptured; provide guidance for biopsy if a suspicious lesion is seen (ASCO, 2018). B-MRI can successfully image the dense breast tissue common in younger women, and it can successfully image breast implants. Both of these are difficult to image using traditional film-screen mammography. B-MRI, used with mammography and breast ultrasound, can be a useful diagnostic tool. Recent research has found that B-MRI can locate some small breast lesions sometimes missed by mammography. Since MRIs do not use radiation, they may be used to screen women younger than 40 and to increase the number of screenings per year for women at high risk for breast cancer.

Positron emission mammography (PEM)

Positron emission mammography (PEM) is a new nuclear medicine imaging modality used to detect or characterize breast cancer. PEM uses an injected positron emitting isotope and a dedicated scanner to locate breast tumors. It uses a pair of dedicated gamma radiation detectors placed above and below the breast and mild breast compression to detect coincident gamma rays after administration of fluorine-18 fluorodeoxyglucose (^{18}F-FDG), the positron-emitting radionuclide used in whole-body PET studies for the detection of metastatic disease (Hendrick, 2010). The technology of PEM and PET are similar in that they both provide functional imaging employing ^{18}F-FDG. However, PEM is optimized for small body parts and utilizes gentle immobilization of the breast to attain higher spatial resolution (1–2 mm for PEM vs 4–6 mm for PET), as well as minimize the radiation dose by reducing breast thickness (Shannon & Zeeshan, 2013). PEM was approved by the US Food and Drug Administration and has been introduced into clinical use as a diagnostic adjunct to mammography and breast ultrasonography.

One of the defining features of PEM is that it has very high resolution and can identify the location and metabolic activity of extremely small cancers (as small as a grain of rice), for patients unable to undergo Breast MRI – for example, patients with pacemakers or defibrillators. PEM can also be particularly useful for staging a malignancy. It can also be used to monitor a patient's response to chemotherapy or detect disease recurrences. An ideal goal for any molecular imaging approach would be to provide a map of the extent of both invasive and noninvasive disease to assist the surgeon in undertaking more precise excision of involved breast tissue and to more accurately monitor for recurrence. An advantage of the PEM technology is that it uses mammographic positioning, which allows for direct correlation of PEM images with mammography for both initial and recurrence imaging. Positron emission mammography can also provide a tomographic image that may further assist the surgeon in determining the ideal approach to ensure negative margins. Another molecular imaging goal would be to provide assistance in determining the extent of disease (e.g., lymph node involvement).

Relative to traditional film-screen mammography, PEM's advantage lies in its ability to detect small hyper-metabolic lesions. PEM can detect lesions measuring <2 cm as a result of its higher spatial resolution of up to 2.4 mm. Even in very small tumors measuring <1 cm, the imaging sensitivity of PEM has been reported to be 60 per cent to 70 per cent (Tejerina, Rabadán, De-Lara, Roselló & Tejerina, 2012). PEM can depict breast cancers not detected mammographically. The sensitivity of PEM can only be comparable to that of B-MRI, particularly in small tumors (Eo, Chun, Paeng, Kang, Lee, Han, Noh, Chung & Lee, 2012). When PEM has been directly compared with MRI, the reported sensitivity of PEM was 93 per cent for known index lesions and 85 per cent for unsuspected additional lesions, which is equivalent to that of B-MRI. In another study, PEM and MRI were both shown to have index lesion sensitivity of 92.8 per cent. (Schilling, Narayanan, Kalinyak, The, Velasquez, Kahn, Saady, Mahal & Chrystal, 2011). PEM cannot provide the anatomical detail that is provided by MRI. PEM is not recommended for routine use or for breast cancer screening in part due to higher radiation dose compared to other modalities (Drukteinis, Mooney, Flowers & Gatenby, 2013). Due to the radiation dose received by a patient during a PEM scan, it is likely that PEM can be employed as an alternative for women who are not candidates for MRI in Nigeria. PEM should be considered a strong adjunct to conventional imaging in those patients unable to undergo MRI who qualifies for staging of newly diagnosed malignancy.

Molecular breast imaging (MBI)

Molecular breast imaging (MBI) is an emerging imaging technology that uses a radioactive tracer and special gamma camera to detect breast cancer. According to American Society of Breast Surgeons Foundation (2018) rather than simply taking a picture of a breast, molecular breast imaging is a type of functional imaging. This means the pictures it creates show differences in the activity of the tissue rather than just the appearance, so it can find tumors that may look the same as background tissue on a mammogram. Brightness on the image correlates with how rapidly the cells that are visualized are growing or dividing. MBI uses a radioactive tracer that "lights up" any areas of cancer inside the breast. This tracer is injected into the body through a vein in the arm, the same radiotracer that has been used for many years in cardiac stress testing. Breast cancer cells tend to take up the radioactive substance much more than normal cells do. A special camera called a nuclear medicine scanner then scans the breast, looking for any areas where the radioactive substance is concentrated.

The breast imaging machine looks a lot like a mammogram machine. MBI is performed by having the patient sit in a chair facing the system which looks similar to a mammogram machine. One breast at a time will be placed on the flat surface of a gamma camera and a second camera will be lowered on the top of the breast. The degree of compression that is used for this test is much less than is used for standard mammograms and does not usually make someone uncomfortable. Each breast is imaged for approximately 10 minutes (American Society of Breast Surgeons Foundation, 2018). A radiologist interprets the test. If a high concentration of the tracer is seen in one area, a doctor may recommend additional testing and perhaps an image-guided biopsy for further evaluation.

MBI is one option for improving cancer detection in women with dense breasts, although it is not yet widely available. In addition to its role in screening for breast cancer, MBI can be used to evaluate a questionable area on another breast imaging test. Although the radiation exposure of MBI is low, the dose is higher than that of a mammography. For most women, the risk of radiation is outweighed by the potential benefits of the test. Allergic reactions to the tracer are extremely rare. MBI has Food and Drug Administration clearance, which is an acceptance for lower-risk medical devices. Recent studies have shown that in women with dense breasts who present for routine screening, the addition of MBI to mammography increases the number of cancers detected from 3 per 1000 women screened to 9 per 1000 (American Society of Breast Surgeons Foundation, 2018). This has made MBI a compelling alternative to ultrasound and/or MRI as a supplementary screening tool, particularly for women with dense breasts. Compared to ultrasound, MBI has a lower recall rate for additional testing. Compared to MRI, MBI is a quicker test, far less expensive, better tolerated by patients and easier for radiologists to interpret.

Key studies have confirmed that MBI has a high sensitivity for the detection of small breast lesions. O, Connor, Philips, Hruska and Rhodes (2007) reported that in patients with suspected breast cancer, MBI has an overall sensitivity of 90 per cent, with a sensitivity of 82 per cent for lesions less than 10 mm in size. Sensitivity was lowest for tumors less than 5 mm in size. Tumor detection does not appear to be dependent on tumor type, but rather on tumor size. Studies using MBI and breast-specific γ-imaging have shown that these methods have comparable sensitivity to breast MRI (Brem, Fishman, Rapelyea, 2007). A large clinical trial compared MBI with screening mammography in over 1000 women with mammographically dense breast tissue and increased risk of breast cancer had showed that MBI detected two-to three-times more cancers than mammography (Hruska, Rodes, Philips, Whalay, Alabin & O'Connor, 2008). In addition, MBI appears to have slightly better specificity than mammography in this trial. MBI provides high-resolution functional images of the breast and its potential applications range from evaluation of the extent of disease to a role as an adjunct screening technique in certain high-risk populations. MBI is highly complementary to existing anatomical techniques, such as mammography. Studies show combining molecular breast imaging and a mammogram results in finding 3 times more breast cancers than a mammogram alone. Molecular breast imaging may be used in women for whom an MRI is recommended, but cannot be performed, such as those with allergies to the contrast material.

Conclusion

This paper has attempted to awaken the consciousness of owners of public and private health care facilities, women and health care practitioners to new breast imaging technologies that have great potentials to supplement traditional film-screen mammography for effective breast cancer detection and prevention in Nigeria. With emerging breast imaging technologies, it is no longer necessary to take a one-size-fit-all approach for breast cancer screening and diagnosis. Breast imaging can now be tailored to the individual patient. In the light of this, women can now choose the best option for their unique needs instead of being restricted to traditional film-screen mammography. The paper established the need to supplement traditional film-screen mammography and examined the emerging breast imaging technologies that should be used to supplement traditional film-screen mammography. Such technologies include 3D tomosynthesis, breast ultrasound, breast magnetic resonance imaging, positron emission mammography and molecular breast imaging.

Recommendations

1. The owners of public and private health care facilities should procure emerging breast imaging technologies such as 3D tomosynthesis, breast ultrasound, breast magnetic resonance imaging, positron emission mammography and molecular breast imaging and use them to supplement traditional film-screen mammography in their health care facilities.
2. The government should cover the screening and diagnostic cost of these emerging breast imaging technologies in their national health insurance scheme in order to make it affordable for Nigerian women.
3. Women and their health care providers should be encouraged to utilize these breast emerging technologies when provided, for early and effective breast cancer detection and prevention.

References

Adesunkanmi, A. R., Lawal, O. O., Adelusola, K. A & Durosimi, M. A. (2006). The severity, outcome and challenges of breast cancer in Nigeria. *Breast, 15* (3), 399-409.

American Cancer Society. (2012). *Breast cancer: Early detection, diagnosis and staging topics*. Atlanta Georgia. American Cancer Society.

American Cancer Society. (2017). *Breast MRI scan*. Atlanta Georgia. American Cancer Society.

American Cancer Society. (2017). *Mammogram basics*. Atlanta Georgia. American Cancer Society.

American Cancer Society. (2018). *Breast ultrasound*. Atlanta Georgia. American Cancer Society.

American Society of Breast Surgeons Foundation. (2018). Molecular breast imaging. American Society of Breast Surgeons Foundation.

American Society of Clinical Oncology. (2018). Breast MRI. American Society of Clinical Oncology.

Anele, A., Bowing, M., Eckert, G., Gonzalez, E., Hipfer, H & Sauder, C. (2014). Treatment of breast cancer: Imo state verses Indiana-USA women-comparative analytical study. *Journal of West African College of Surgery, 4(4), 39-69.*

Anyanwu, S. N. (2000). Breast cancer in eastern Nigeria: A ten year review. *West African Journal of Medicine, 19*, 120-125.

Banjo, A. A. (2004). Overview of breast cancer and cervical cancer in Nigeria: Are there regional variations? Paper presented at international workshop on new trends in the management of breast and cervical cancers, Lagos, Nigeria.

Bramlet, K. (2015).*What you should know about 3D mammography*. The University of Texas MD Anderson Cancer Center.

Brem, F., Fishman, M & Rapelyea, J. (2007). Detection of ductal carcinoma in situ with mammography, breast specific γ imaging, and magnetic resonance imaging; a comparative study. *Academic Radiology, 14,* 945-950.

Drukteinis, J.S., Mooney, B. P., Flowers, C. I & Gatenby, R. A. (2013). Beyond mammography: New frontier in breast cancer screening. *The American Journal of Medicine. 126* (6), 472–479.

Coughlin, S. S & Ekwueme, D. U. (2009). Breast cancer as a global health concern. *Cancer Epidemiology, 33* (5), 315-318.

Eo, J. S., Chun, I. K., Paeng, J. C., Kang, K. W., Lee, S. M., Han, W., Noh, D. Y., Chung, J. K & Lee, D. S. (2012). Imaging sensitivity of dedicated positron emission mammography in relation to tumor size. *Breast, 21*(1), 66–71.

Fahrettin, K., Hayri, O., Ummugulsim, B., Hatice, G., Ozlem,U., Melit, K & M-Halit, Y. (2012). Diagnostic magnetic resonance imaging of the breast. *The Eurasian Journal of Medicine, 44* (2), 106–114.

Foluso, I & Oluwatosin, O. (2016). A vision for improved cancer screening in Nigeria. *Elsevier, 4*(6), 359-360.

Fry, R. B & Prentice-Dunn, S. (2006). Effects of a psychosocial intervention on breast self-examination attitudes and behaviours. *Health Education Research, 21*, 287-295.

Greenwood, H., Freimanis, R., Caperntier, B & Joe, B. (2018). Clinical breast magnetic resonance imaging: Technique, indications and future applications. *Elservier, 39* (1), 45-59.

Hendrick., R. E. (2010). Radiation doses and cancer risks from breast imaging studies. *Radiology. 257*(1), 246–253.

Hisham, A. N & Yip, C. H. (2004). Overview of breast cancer in Malaysian women: A problem with late diagnosis. *Asian Journal of Surgery, 27* (2), 130-133.

Hlimat, J. A., Bola, B. O & Olalekan, I. O. (2015). A five year audit of mammography in a tertiary hospital, north central Nigeria. Nigerian Medical Journal, 56 (3), 213-217.

Hruska, C., Rodes, D., Philips, S., Whalay, D., Alabin, T & O'Connor, M. (2008). Molecular breast imaging for breast cancer screening in women with mammographically dense breasts and increased risk. *European Journal of Nuclear Medical Molecular Imaging, 35*(2), 200.

Huizen, J & Chun, C. (2017). *Breast ultrasound: uses and what to expect*. Medical News Today.

Kayode, A., Akande, T & Osagbemi, G. K. (2005). Knowledge, attitude and practice of breast self-examination in women with high school teachers in Illorin, Nigeria. *European Journal of Scientific Research, 10*, 42-47.

Komen, S.G. (2018). Digital vs. film screening mammography. Retrieved from https://ww5.komen.org/breastcancer.

Lehman, C., Isaacs, C & Schnall, M. (2007). Cancer yield of mammography, MR, and US in high-risk women: Prospective multi-institution breast cancer screen study. *Radiology, 244,* 381-388.

Michell, M., Iqbal, A., Wasan, R., Evans, D., Peaock, C., Lawinki, C., Douiri, A., Wilson & Whelehan, P. (2012). A comparison of the accuracy of film-screen mammography, full-field digital mammography and digital breast tomosynthesis. *Clinical Radiology, 1*(1), 1-6.

O'Connor, M., Philips, S., Hruska, C & Rhodes, D. (2007). Molecular breast imaging: advantages and limitations of a scintimammographic technique in patients with small breast tumors. *Breast Journal, 13*(3).

Northwestern Medicine .(2015). Why choose `3D mammography?. Northwestern Medicine.

Okobia, M. N & Osime, U. (2001). *C*linicopathological study of carcinoma of the breast in Benin City. *African Journal of Reproductive Health, 5,* 56-62.

Okobia, M. N., Bunker, C. H., Okonofua, F.E & Osime, U. (2006). Knowledge, attitude and practice of Nigerian women towards breast cancer: A cross-sectional study. *World Journal of Surgeon Oncology, 4*, 11.

Radiological Society of North America. (2018). Ultrasound-breast. Retrieved from https://www.radiologyinfo.org/en/info.

Rosenberg, R & Levy-Schwartz, R. (2003). Breast cancer in women younger than 40 years. *International Journal of Fertility, 48*: 200-205.

Schilling, K., Conti, P., Adler., L & Tafra, L. (2008). The role of positron emission mammography in breast cancer imaging and management. *Applied Radiology, 37(4), 126-136.*

Schilling, K., Narayanan, D., Kalinyak, J., The, J., Velasquez, M. V., Kahn, S., Saady, M., Mahal, R & Chrystal, L. (2011). Positron emission mammography in breast cancer presurgical planning: comparisons with magnetic resonance imaging. *European Journal of Nuclear Medical Molecular Imaging, 38*(1), 23–36.

Shannon, B. G & Zeeshan, A. S. (2013). Clinical utility of positron emission mammography. *Proceedings from the Baylor University Medical Centre, 26*(3), 314-319.

Tejerina, B. A., Rabadán, D. F., De-Lara, G. A., Roselló, J. A & Tejerina, G. A. (2012). Breast imaging: how we manage diagnostic technology at a multidisciplinary breast center. *Journal of Oncology, 2012*, 213–421.

Tsina, G & Simon, P. (2014). Breast Magnetic Resonance Imaging and Its Impact on the Surgical Treatment of Breast Cancer. *Obstetrics and Gynecology International, 2014 (21), 1-5.*

Umeh, K & Rogan-Gibson, J. (2001). Perceptions of threat, benefits and barriers in breast self-examination amongst young asymptomatic women. *British Journal of Health Psychology, 6*, 361-372.

United States Preventive Services Taskforce. (2009). *Breast cancer screening*. The Author.

Wu, T. Y & Yu, M. T. (2003). Reliability and validity of the mammography screening beliefs questionnaire among Chinese American women. *Cancer Nursing, 26*, 131-142.