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RECENT ADVANCEMENTS IN BREAST MAMMOGRAPHY

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ABSTRACT

The most devastating loss of life from breast cancer occurs between the ages of 30 to 50. Fortunately, women today have more options available to them to help in the detection of breast cancer than in the past decades. Unfortunately, education and awareness of these options and their effectiveness in detecting breast cancer at different stages in life are woefully deficient. The goal of mammography is the detection, characterization, and evaluation of findings suggestive of breast cancer and other breast diseases. Annual screening mammography of age-appropriate asymptomatic women is currently the only imaging modality that has been proven to significantly reduce breast cancer mortality. A screening mammogram is an X-ray examination of the breast of an asymptomatic woman. A diagnostic mammogram is an X-ray examination of the breast of a patient with signs or symptoms of breast disease, a possible abnormality detected on screening mammography or other imaging, or who has prior mammography findings requiring imaging follow-up. It is essential that all mammography be performed and interpreted with the highest quality possible.

KEYWORDS: Mammography, digital mammography, computer-aided detection, breast tomosynthesis.

INTRODUCTION

The Achilles Heel of screening mammography is the detection of cancer in women with radiographic dense breasts. While nearly all cancers will be apparent in fatty breasts, only half will be visible in extremely dense breast.[1] This results, at least in large part, from the masking or camouflaging of noncalcified cancers by surrounding dense tissue. The goal of mammography is the detection, characterization, and evaluation of findings suggestive of breast cancer and other breast diseases. Annual screening mammography of age-appropriate

asymptomatic women is currently the only imaging modality that has been proven to significantly reduce breast cancer mortality. Mammography is specialized medical imaging that uses a low-dose x-ray system to see inside the breasts.[2, 3]

A mammography exam, called a mammogram, aids in the early detection and diagnosis of breast diseases in women. A screening mammogram is an X-ray examination of the breast of an asymptomatic woman. A diagnostic mammogram is an X-ray examination of the breast of a patient with signs or symptoms of breast disease, a possible abnormality detected on screening mammography or other imaging, or who has prior mammography findings requiring imaging follow-up.[4]

The most devastating loss of life from breast cancer impacts women between the ages of 30 and 50. For women between the ages of 40 and 44, breast cancer is the leading cause of death, according to the American Cancer Society. Yet the November 10, 2003 issue of the AMA journal, *American Medical News,* reports little evidence documenting that mammography saves lives from breast cancer for premenopausal women, which are many of the women who fall into these age ranges.[5]

Critic point out that a large number of women need to be screened to locate cancer. The death rate from breast cancer has decreased by almost 30% due to mammography screening. There is clear evidence which shows that early diagnosis and treatment of breast cancer can significantly increase the chance of survival for patients. The earlier the cancer is detected, better the chances that a proper treatment can be arranged. At present, there are no effective ways to prevent breast cancer, because its cause remains unidentified. However, efficient identification of breast cancer in its early stages can give a woman a better chance of full improvement. Therefore, early detection of breast cancer can play an important role in reducing the associated morbidity and death rates.[6]

Mammography and Women Under 50[7]

Mammography has been the state-of-the-art screening test for several decades. However, considerable controversy remains regarding its value, particularly in women under the age of 50. (1, 8-10) Results from the widely accepted BCDDP study documented that the overall ability of mammograms to detect cancer was only 70 percent. This means that 30 percent of mammograms found to be negative for potentially cancerous lesions are actually positive.

False Positive Rate High

The false positive rate of mammograms—those patients without cancer but with a positive finding on testing—turned out to be another problem. Only one biopsy in six was found to be positive for cancer when done on the basis of a positive mammogram or breast examination. The combined false positive rate was determined to be as high as 89 percent. Identifying and performing biopsies on these clinically insignificant lesions represents over diagnosis and over treatment. Further, the physical and psychological stress associated with mammogram findings is not a small concern nor are the additional costs.

Too Many Mammograms Performed?

Recent data from the University of Washington and Harvard University reveals that over a period of a single decade, one out of every two women will have a false positive result as the result of mammography, and of those, nearly 20 percent will undergo an unnecessary breast biopsy.

Contrary to what many health-related agencies advise, recent findings seem to demonstrate that too many rather than too few mammograms are performed every year in the United States. Further, estimates show that for every $100 spent on the cost of mammograms, $33 goes to the unproductive and unnecessary expense of false positive results.

Mammograms for Women Over the Age of 70[8]

A recent article from Duke University Medical Center reports that women over 70 are over-screened for both breast and cervical cancers. The authors estimated the cost in the year 2000 for women over the age of 70 for the unnecessary mammograms they received was approximately $460 million. The article went on to point out that clinical guidelines for women over the age of 70 are ambiguous and based on almost no clinical research.

Mammography and Younger Women

For younger women, mammography is more likely to miss breast cancers that are rapidly growing, especially in women with dense breast tissue who are at a significantly increased risk for developing breast cancer. At least 10 percent of breast cancers cannot be identified by mammography, even when they are palpable.

The Prevalence, Fear and Risk Factors of Breast Cancer[9]

According to the American Cancer Society (ACS), breast cancer is the leading cause of death in women between the ages of 40 and 44. Although breast cancer has only 10 percent the morbidity and mortality of coronary heart disease, it is generally more feared. ACS statistics further document that every year in the United States there are approximately 200,000 new cases of breast cancer and more than 40,000 deaths. Not included in this number are more than 47,000 new cases of carcinoma in situ breast cancer, which is better known as DCIS (ductal carcinoma in situ) or LCIS (lobular carcinoma in situ) and is a very early form of breast cancer.

DCIS and LCIS are very mild cancerous lesions that only become malignant in about 2 percent of cases. For this reason many physicians do not consider DCIS and LCIS true cancers. The risk of breast cancer at age 25 is less than one in 19,000 whereas by age 35 it is one in 217. Yet, the statistic people are most familiar with is that one in eight women will eventually develop breast cancer. It is important to appreciate that this number is a cumulative risk that only applies to women who have reached the age of 90. The hereditary breast cancer genes, referred to as BRCA 1 and 2 genes, are known to be associated with both breast and ovarian cancers, but only account for 5 to 10 percent of all breast cancer. Newer, less well-known factors are estimated to account for another 10 percent of all breast cancers. In at least 70 percent of cases, however, the cause of breast cancer is yet unknown.

Generally Accepted Risk Factors[10]

The risk for breast cancer is increased if you:

- ✓ Had your first period before age 12
- ✓ Went through menopause after age 50
- ✓ Had your first child after age 30 or never were pregnant
- ✓ Were on hormone replacement therapy or birth control pills
- ✓ Consume one or more alcoholic drinks per day
- ✓ Have a family history of breast cancer
- ✓ Are found to have inherited the breast cancer genes
- ✓ Are postmenopausal and gained weight (not so for premenopausal women)
- ✓ Have elevated levels of insulin as seen with syndrome X or type 2 diabetes, which are conditions associated with central obesity and increased levels of insulin-like growth factor-1.[11]

Popular myths regarding what causes breast cancer include antiperspirants, wearing a wire bra, and having had an abortion.

ADVANCES IN MAMMOGRAPHY

Three recent advances in mammography include digital mammography, computer-aided detection and breast tomosynthesis.[12]

Digital mammography, also called full-field digital mammography (FFDM), is a mammography system in which the x-ray film is replaced by electronics that convert x-rays into mammographic pictures of the breast. These systems are similar to those found in digital cameras and their efficiency enables better pictures with a lower radiation dose. These images of the breast are transferred to a computer for review by the radiologist and for long term storage. The patient's experience during a digital mammogram is similar to having a conventional film mammogram.

Computer-aided detection (CAD) systems search digitized mammographic images for abnormal areas of density, mass, or calcification that may indicate the presence of cancer. The CAD system highlights these areas on the images, alerting the radiologist to carefully assess this area. The use of computers in processing and analyzing biomedical images allows more accurate diagnose by a radiologist. Humans are susceptible to committing errors and their analysis is usually subjective and qualitative. Objective and quantitative analysis facilitated by the application of computers to biomedical image analysis leads to a more accurate diagnostic decision by the physician.[4] Computer-aided detection (CADe) is designed to provide the radiologist with visual prompts on series of mammograms. It works by marking a mammogram with marks that indicate regions where the detection algorithm recognizes a suspicious entity that warrants further investigation, thereby complementing the radiologists' interpretation.

Breast tomosynthesis, also called three-dimensional (3-D) breast imaging, is a mammography system where the x-ray tube moves in an arc over the breast during the exposure. It creates a series of thin slices through the breast that allow for improved detection of cancer and fewer patients recalled for additional imaging.

BENEFITS[5]

Imaging of the breast improves a physician's ability to detect small tumors. When cancers are small, the woman has more treatment options. The use of screening mammography increases the detection of small abnormal tissue growths confined to the milk ducts in the breast, called ductal carcinoma in situ (DCIS). These early tumors cannot harm patients if they are removed at this stage and mammography is an excellent way to detect these tumors. It is also useful for detecting all types of breast cancer, including invasive ductal and invasive lobular cancer. No radiation remains in a patient's body after an x-ray examination. X-rays usually have no side effects in the typical diagnostic range for this exam.

RISKS[10]

There is always a slight chance of cancer from excessive exposure to radiation. However, the benefit of an accurate diagnosis far outweighs the risk. The effective radiation dose for this procedure varies. See the Safety page for more information about radiation dose. False Positive Mammograms. Five percent to 15 percent of screening mammograms require more testing such as additional mammograms or ultrasound. Most of these tests turn out to be normal. If there is an abnormal finding, a follow-up or biopsy may have to be performed. Most of the biopsies confirm that no cancer was present. It is estimated that a woman who has yearly mammograms between ages 40 and 49 has about a 30 percent chance of having a false-positive mammogram at some point in that decade and about a 7 percent to 8 percent chance of having a breast biopsy within the 10-year period. Women should always inform their physician or x-ray technologist if there is any possibility that they are pregnant.

Minimizing Radiation Exposure[4]

Special care is taken during x-ray examinations to use the lowest radiation dose possible while producing the best images for evaluation. National and international radiology protection organizations continually review and update the technique standards used by radiology professionals. Modern x-ray systems have very controlled x-ray beams and dose control methods to minimize stray (scatter) radiation. This ensures that those parts of a patient's body not being imaged receive minimal radiation exposure.

LIMITATIONS[13]

Initial mammographic images themselves are not usually enough to determine the existence of a benign or malignant disease with certainty. If a finding or spot seems suspicious, your radiologist may recommend further diagnostic studies. Interpretations of mammograms can

be difficult because a normal breast looks different for each woman. Also, the appearance of an image may be compromised if there is powder or salve on the breasts or if you have undergone breast surgery. Because some breast cancers are hard to visualize, a radiologist may want to compare the image to views from previous examinations. It is very important to realize that not all breast cancers can be seen on mammography.

Increased breast density has attracted attention from a number of state legislatures for multiple reasons, including: Increased breast density makes it difficult to see a cancer on mammography.

Increased breast density may increase the risk of getting breast cancer.
Breast implants can also impede accurate mammogram readings because both silicone and saline implants are not transparent on x-rays and can block a clear view of the tissues behind them, especially if the implant has been placed in front of, rather than beneath, the chest muscles. Experienced technologists and radiologists know how to carefully compress the breasts to improve the view without rupturing the implant.

While mammography is the best screening tool for breast cancer available today, mammograms do not detect all breast cancers. This is called a false negative result. On the other hand, when a mammogram looks abnormal and no cancer is present, this is called a false-positive result.

COMBINING DIGITAL MAMMOGRAPHY WITH OTHER IMAGING TECHNOLOGY[6]

Digital imaging allows the potential to co-register systems' different technologies to produce fused images. Screening breast ultrasound detects mammographically occult cancers in women with dense breasts. ACRIN 6666 trial showed a 4.2/1000 improvement in cancer detection with the addition of physician-performed hand-held ultrasound screening of high risk women with dense breasts. However, there are potential limitations of whole breast ultrasound screening by physician due to the time necessary to perform the examination and resources available. In Berg's study, the mean scanning time was approximately 20 minutes.
Automated ultrasound scanning methods have appeal. Methods to combine simultaneous mammography and automated ultrasound would have the theoretical advantage of the improved sensitivity of ultrasound with an automated approach and the ability to

simultaneously correlate the sonographic findings with the mammographic findings. Screening and diagnostic scanning could occur simultaneously.

CONCLUSION

While mammography is the best screening tool for breast cancer available today, mammograms do not detect all breast cancers. This is called a false negative result. On the other hand, when a mammogram looks abnormal and no cancer is present, this is called a false-positive result. Research is being done on a variety of breast imaging techniques that can contribute to the early detection of breast cancer and improve the accuracy in distinguishing non-cancerous breast conditions from breast cancers.

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