Mammography [1]

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Mammography or mastography is an imaging technology developed in the twentieth century for the detection of breast cancer and other breast abnormalities. Breast cancer is an abnormal growth in breast tissue that can spread to other parts of the body and cause death. Breast cancer affects about twelve percent of women worldwide. In the twenty-first century, mammography is one of the most accurate tools for screening and diagnosing breast cancer. A mammogram is the image that is created after sending low-level X-rays through breast tissue while a digital recorder captures the image. A radiologist analyzes the mammogram to diagnose any abnormalities. A Senographe is the instrument used to create the mammogram to screen for breast cancer and other breast diseases. Mammography enabled physicians to diagnose breast cancer in the early stages, significantly decreasing the number of deaths from breast cancer.

Mammography is a technique that uses X-rays to screen breasts for possible abnormalities. In 1895, Wilhelm Conrad Röentgen, at the Universität of Würzburg in Würzburg, Germany, discovered how to make a fluorescent tube emit a different kind of light that could pass through objects. Röentgen used the tube to take the first X-ray photographic plate image of his wife's hand. The background of that image was black, the ring and the bones appeared white, while the tissue of the hand was dark grey. The objects with higher density, bones and metal ring, blocked the X-ray and thus appeared white, while less dense muscle tissue let the X-rays pass through and appeared transparent close to the background of the image. That image showed that X-rays could pass through tissues and discover anomalies, including bone fractures and calcifications of tissues. Röentgen received the Nobel Prize in Physics in 1901 for his discovery of X-rays.

Until 1913, Albert Solomon, at the Royal Surgical University Clinic in Berlin, Germany, first used X-rays to examine breast tissue obtained from the morgue. He found tumors in the breast tissue, which appeared as micro calcifications associated with breast carcinoma. He concluded that X-rays could reveal abnormalities in breasts. Solomon's work did not get attention from the scientific community, and the field of mammography did not develop for the next seventeen years.

In 1930, Stafford Leak Warren, at the University of Rochester in Rochester, New York, used X-rays on live patients to screen for breast abnormalities. He conducted a study in which 119 women participated. The women's primary physicians had diagnosed symptoms of breast cancer or other breast abnormalities and the women were to undergo surgery regardless of mammography results. Warren used mammography to see if he could detect any abnormalities before the surgery and then checked his results after surgery through biopsy, or sampling of tissue for cancer. Before the surgery, Warren asked women to lay down on their side and lift up their arm then he took an X-ray image of the breast tissue. He used a new type of fine-grained double emulsion Kodak film, and different intensifying screens to diminish scattering of radiation [2]. After the imaging procedure, Warren identified breast cancer in fifty-eight women. After surgery, biopsy revealed that fifty-four of the fifty-eight women in whom Warren diagnosed with breast cancer had breast cancer. In addition, four women who Warren had identified as healthy had breast cancer.

After Warren published his experiment in 1930, other scientists began studying X-ray imaging for breast cancer and proposed possible improvements to his technique. In 1937, Nymphus Frederick Hicken first used the term mammography in his article "Mammography: The Röentgenographic Diagnosis of Breast Tumors by Means of Contrast Media." In 1949, Raul Leborgne, at the Pereira Rossell Hospital, in Montevideo, Uruguay, suggested that compression of the breast during screening produced better quality images because it increases the surface area and the tissue is thinner. With that improvement, Leborgne was able to distinguish between a cancerous mass and a benign mass in breasts, as they had different densities and appearances on the mammogram.

Ten years later, Robert Egan, at M. D. Anderson Hospital and Tumor Institute, in Houston, Texas, improved mammography technology further by using industrial film that required less X-ray energy and produced better quality images. X-rays are a form of radiation [2] that in high doses can cause cancer, so lower dose procedures are safer for the patients. The industrial film allowed for better contrast, so physicians could more easily identify abnormalities in the breast tissue. The cancerous tumors appeared white on the mammogram, as they had higher densities than regular breast tissue, which appeared dark grey. Egan examined the breasts of 1,000 women who were healthy and did not suspect breast cancer and found breast cancer in 238 of them.

After Egan's introduction of better film, many physicians started using mammography as a diagnostic tool. A group of researchers from New York created a massive randomized study to test whether mammography was useful in preventing deaths from breast cancer by diagnosing the cancer early. The study monitored over 60,000 women aged forty to sixty-four over three years and six
months. The results of the study indicated that the group that had mammograms, twice a month, had a significantly lower death rate by thirty-three per cent than the group of women that did not receive mammograms. Those results prompted women to get regular mammograms and physicians to look for ways to improve mammography further.

In 1965, Charles Gros in Strasbourg, France, in cooperation with the Compagnie Générale de Radiologie in Issy-les-Moulineaux, France, created the first prototype of an instrument dedicated to mammography, called the GCR Senographe. It incorporated all the important features that other scientists developed. The Senographe flattened out the breasts, used industrial film, and projected a lower dose of X-ray radiation than Warren's instrument. The Senographe improved the image quality of a mammogram. Soon the Senographe became widely used by radiologists as the instrument for mammography. In 1976, the American Cancer Society, or ACS, started recommending mammography as a screening method for the early detection of breast cancer, because it reduces breast cancer deaths. At the time, ACS stated that women under fifty might benefit from mammograms and recommended yearly mammograms for women aged fifty and older.

As mammography became a common screening tool for breast cancer, there were many regulations proposed to control the quality of screening. In 1992, the US Congress approved the Mammography Quality Standards Act, or MQSA. That act specified imaging and radiation standards for mammography, as well as a protocol that all radiologists had to follow to provide women with most accurate information about their health. As per the MQSA the facilities that provided mammography services to people must be certified by the US Food and Drug Administration, or FDA, and undergo an annual MQSA inspection. In 1993, the American College of Radiology developed a Breast Imaging and Reporting Data System, or BI-RADS, which standardized the way physicians conveyed mammography results. It introduced a scale from zero to five, where one meant that there was no cancer detected, and five meant that cancer was likely present in the breasts. A score of zero meant that no mammogram was completed.

In 2000, the FDA approved digital mammography as a diagnostic tool for breast cancer. Using digital mammography, physicians could more quickly complete a mammogram and expose their patients to lower doses of radiation due to a faster imaging procedure as well as better equipment. Physicians can view digital mammograms on a computer and can analyze results immediately, rather than waiting for film to develop, which could take several days. In the 2005 article “Diagnostic Performance of Digital versus Film Mammography for Breast-Cancer Screening” Etta Pisano’s group from thirty-three centers in the US showed that digital and film mammography were similarly accurate for women aged fifty and older, and digital mammography was more accurate for women under fifty. After Etta Pisano’s study, digital mammography became the norm for many hospitals. In 2009, just nine years after the implementation of digital mammography, the ACS reported that the death rate from breast cancer had decreased by thirty-one percent since its peak in 1991. However, many women who got mammograms annually got a false positive mammography result, which meant that the mammography wrongfully showed a cancerous mass. Many of those women underwent treatments for a cancer they did not have, which resulted in physical and emotional trauma.

In 2011, the implementation of digital tomosynthesis or 3D imaging mammography improved the accuracy of mammography. Digital tomosynthesis imaging uses a lower radiation dose, and enables the user to view breasts in three dimensions, as well as looking at each layer of breast tissue separately instead of the whole breast at once. A 2016 article by Elizabeth McDonald, "Effectiveness of Digital Breast Tomosynthesis Compared with Digital Mammography," published in the Journal of the American Medical Association Oncology states that tomosynthesis imaging is more accurate than 2D imaging. Tomosynthesis analyzes different layers of the breasts and reduces the number of false positive results. Although approved by the FDA in 2011, digital tomosynthesis is not the standard of breast imaging technology as of 2017.

To reduce breast cancer mortality, the ACS created guidelines for women of different ages about how often they should receive mammograms. From the 1980s to 2016, the ACS guidelines changed six times. The guidelines changed often because many women received false positive results after getting annual mammograms for multiple years in a row. The ACS guidelines as of 2017 recommend annual mammograms for women aged forty-five to fifty-four and a mammogram every two years for women aged fifty-five and older. According to the ACS 2017 guidelines, do not advise women younger than forty to get mammograms, as that can result in unnecessary radiation exposure.

There are also multiple other risks in obtaining regular mammograms. Some physicians advocate against annual mammograms due to the risk of over-diagnosis and false positive results. A review by Peter Gotzsche and Karsten Jørgensen showed that for every 2,000 women who get annual mammograms, one person receives an early diagnosis of breast cancer. Ten other women will be over diagnosed and treated for breast cancer unnecessarily, and 200 other women will get at least one false positive result, which will cause them emotional distress and suffering.

Sources
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Subject

Topic
Technologies [28]