

Improving Methods for Breast Cancer Detection and Diagnosis

The National Cancer Institute (NCI) is funding numerous research projects to improve conventional mammography (an x-ray technique to visualize the internal structure of the breast) and develop other imaging technologies to detect, diagnose, and characterize breast tumors.

High-quality mammography is the most effective technology presently available for breast cancer screening. Efforts to improve mammography focus on refining the technology and improving how it is administered and x-ray films are interpreted. NCI is funding research to reduce the already low radiation dosage of mammography; enhance mammogram image quality; develop statistical techniques for computer-assisted interpretation of images; enable long-distance, electronic image transmission technology (telemammography/teleradiology) for clinical consultations; and improve image-guided techniques to assist with breast biopsies. (A breast biopsy is the removal of cells or tissues to look at under a microscope to check for signs of disease). NCI also supports research on technologies that do not use x-rays, such as magnetic resonance imaging (MRI), ultrasound, and breast-specific positron emission tomography (PET) to detect breast cancer. The following information describes the latest imaging techniques that are in use or being studied.

Ultrasound

Ultrasound, also called sonography, is an imaging technique in which high-frequency sound waves that cannot be heard by humans are bounced off tissues and internal organs. Their echoes produce a picture called a sonogram. Ultrasound imaging of the breast is used to distinguish between solid tumors and fluid-filled cysts. Ultrasound can also be used to evaluate lumps that are hard to see on a mammogram. Sometimes, ultrasound is used as part of other diagnostic procedures, such as fine needle aspiration (also called needle biopsy). Fine needle aspiration is the removal of tissue or fluid with a needle for examination under a microscope to check for signs of disease.

During an ultrasound examination, the clinician spreads a thin coating of lubricating jelly over the area to be imaged to improve conduction of the sound waves. A hand-held device called a transducer directs the



sound waves through the skin toward specific tissues. As the sound waves are reflected back from the tissues within the breast, the patterns formed by the waves create a two-dimensional image of the breast on a computer.

Ultrasound is not used for routine breast cancer screening because it does not consistently detect certain early signs of cancer such as microcalcifications (tiny deposits of calcium in the breast that cannot be felt but can be seen on a conventional mammogram). A cluster of microcalcifications may indicate that cancer is present.

Digital Mammography

Digital mammography is a technique for recording x-ray images in computer code instead of on x-ray film, as with conventional mammography. The images are displayed on a computer monitor and can be enhanced (lightened or darkened) before they are printed on film. Images can also be manipulated; the radiologist (a doctor who specializes in creating and interpreting pictures of areas inside the body) can magnify or zoom in on an area. From the patient's perspective, the procedure for a mammogram with a digital system is the same as for conventional mammography.

Digital mammography may have some advantages over conventional mammography. The images can be stored and retrieved electronically, which makes long-distance consultations with other mammography specialists easier. Because the images can be adjusted by the radiologist, subtle differences between tissues may be noted. The improved accuracy of digital mammography may reduce the number of followup procedures. Despite these benefits, studies have not yet shown that digital mammography is more effective in finding cancer than conventional mammography.

The first digital mammography system received U.S. Food and Drug Administration (FDA) approval in 2000. An example of a digital mammography system is the Senographe® 2000D. Women considering digital mammography should talk with their doctor or contact a local FDA-certified mammography center to find out if this technique is available at that location. Only facilities that have been certified to practice conventional mammography and have FDA approval for digital mammography may offer the digital system. A list of conventional mammography facilities is available by calling the Cancer Information Service at 1-800-4-CANCER (1-800-422-6237), or by visiting the FDA Web site at <http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfMQSA/mqsa.cfm> on the Internet.

Computer-Aided Detection

Computer-aided detection (CAD) involves the use of computers to bring suspicious areas on a mammogram to the radiologist's attention. It is used after the radiologist has done the initial review of the mammogram.

In 1998, the FDA approved a breast imaging device that uses CAD technology. Others are in development. An example of a breast imaging device that uses CAD technology is the ImageChecker®. This device scans the mammogram with a laser beam and converts it into a digital signal that is processed by a computer. The image is then displayed on a video monitor, with suspicious areas highlighted for the radiologist to review. The radiologist can compare the digital image with the conventional mammogram to see if any of the highlighted areas were missed on the initial review and require further evaluation. CAD technology may improve the accuracy of screening mammography. The incorporation of CAD technology to digital mammography is under evaluation.

MRI

In magnetic resonance imaging (MRI), a magnet linked to a computer creates detailed pictures of areas inside the body without the use of radiation. Each MRI produces hundreds of images of the breast from side-to-side, top-to-bottom, and front-to-back. The images are then interpreted by a radiologist.

During an MRI of the breast, the patient lies on her stomach on the scanning table. The breast hangs into a depression or hollow in the table, which contains coils that detect the magnetic signal. The table is moved into a tube-like machine that contains the magnet. After an initial series of images has been taken, the patient may be given a contrast agent intravenously (by injection into a vein). The contrast agent is not radioactive; it is sometimes used to improve the visibility of a tumor. Additional images are then taken. The entire imaging session takes about 1 hour.

Breast MRI is not used for routine breast cancer screening, but clinical trials (research studies with people) are being performed to determine if MRI is valuable for screening certain women, such as young women at high risk for breast cancer. MRI cannot always accurately distinguish between cancer and benign (noncancerous) breast conditions. Like ultrasound, MRI cannot detect microcalcifications.

MRI is used primarily to evaluate breast implants for leaks or ruptures, and to assess abnormal areas that are seen on a mammogram or are felt after breast surgery or radiation therapy. It can be used after breast cancer is diagnosed to determine the extent of the tumor in the breast. MRI is also sometimes useful in imaging dense breast tissue, which is often found in younger women, and in viewing breast abnormalities that can be felt but are not visible with conventional mammography or ultrasound.

PET Scan

The positron emission tomography (PET) scan creates computerized images of chemical changes that take place in tissue. The patient is given an injection of a substance that consists of a combination of a sugar and a small

amount of radioactive material. The radioactive sugar can help in locating a tumor, because cancer cells take up or absorb sugar faster than other tissues in the body.

After receiving the radioactive drug, the patient lies still for about 45 minutes while the drug circulates throughout the body. If a tumor is present, the radioactive sugar will accumulate in the tumor. The patient then lies on a table, which gradually moves through the PET scanner 6 to 7 times during a 45-minute period. The PET scanner is used to detect the radiation. A computer translates this information into the images that are interpreted by a radiologist.

PET scans may play a role in determining whether a breast mass is cancerous. However, PET scans are more accurate in detecting larger and more aggressive tumors than they are in locating tumors that are smaller than 8 mm and/or less aggressive. They may also detect cancer when other imaging techniques show normal results. PET scans may be helpful in evaluating and staging recurrent disease (cancer that has come back).

An NCI-sponsored clinical trial is evaluating the usefulness of PET scan results in women who have breast cancer compared with the findings from other imaging and diagnostic techniques. This trial is also studying the effectiveness of PET scans in tracking the response of a tumor to treatment.

Electrical Impedance Scanning

Different types of tissue have different electrical impedance levels (electrical impedance is a measurement of how fast electricity travels through a given material). Some types of tissue have high electrical impedance, while others have low electrical impedance. Breast tissue that is cancerous has a much lower electrical impedance (conducts electricity much better) than normal breast tissue. Electrical impedance scanning devices are used along with conventional mammography to detect breast cancer. The T-Scan 2000, also known as the T-Scan, is an example of such a device. The FDA approved the T-Scan 2000 in 1999.

The electrical impedance scanning device, which does not emit any radiation, consists of a hand-held scanning probe and a computer screen that displays two-dimensional images of the breast. An electrode patch, similar to that used for an electrocardiogram, is placed on the patient's arm. A very small amount of electric current, about the same amount used by a small penlight battery, is transmitted through the patch and into the body. The current travels through the breast, where it is measured by the scanning probe placed over the breast. An image is generated from the measurements of electrical impedance. Because breast cancer cells conduct electricity better than normal breast cells and tend to have lower electrical impedance, breast tumors may appear as bright white spots on the computer screen.

This device can confirm the location of abnormal areas that were detected by a conventional mammogram. The scanner sends the image directly to a computer, allowing the radiologist to move the probe around the breast to get the best view of the area being examined. The device may reduce the number of biopsies needed to determine whether a mass is cancerous. It may also improve the identification of women who should have a biopsy.

The scanner is not approved as a screening device for breast cancer, and is not used when mammography or other findings clearly indicate the need for a biopsy. This device has not been studied with patients who have implanted electronic devices, such as pacemakers. It is not recommended for use on such patients.

Image-Guided Breast Biopsy Techniques

Imaging techniques play an important role in helping doctors perform breast biopsies, especially of abnormal areas that cannot be felt but can be seen on a conventional mammogram or with ultrasound. One type of needle biopsy, the stereotactic-guided biopsy, involves the precise location of the abnormal area in three dimensions using conventional mammography. (Stereotactic refers to the use of a computer and scanning devices to create three-dimensional images.) A needle is then inserted into the breast and a tissue sample is obtained. Additional samples can be obtained by moving the needle within the abnormal area.

Another type of needle biopsy uses a different system, known as the Mammotome® breast biopsy system. The FDA approved Mammotome in 1996; the hand-held version of the Mammotome received FDA clearance in September 1999. A large needle is inserted into the suspicious area using ultrasound or stereotactic guidance. The Mammotome is then used to gently vacuum tissue from the suspicious area. Additional tissue samples can be obtained by rotating the needle. This procedure can be performed with the patient lying on her stomach on a table. If the hand-held device is used, the patient may lie on her back or in a seated position.

There have been no reports of serious complications resulting from the Mammotome breast biopsy system. Women interested in this procedure should talk with their doctor.

Ductal Lavage

Ductal lavage is an investigational technique for collecting samples of cells from breast ducts for analysis under a microscope. A saline (salt water) solution is introduced into a milk duct through a catheter (a thin, flexible tube) that is inserted into the opening of the duct on the surface of the nipple. Fluid, which contains cells from the duct, is withdrawn through the catheter. The cells are checked under a microscope to identify changes that may indicate cancer or changes that may increase the risk for breast cancer. The usefulness of ductal lavage is still under study.

Imaging Clinical Trials

In March 1999, the NCI began funding the American College of Radiology Imaging Network (ACRIN) as part of the NCI's Clinical Trials Cooperative Group Program. (A cooperative group is a group of physicians, hospitals, or both that works with the NCI to identify important questions in cancer research and design clinical trials to answer these questions.) The Cooperative Group program is designed to promote and support clinical trials of new cancer treatments, explore methods of cancer prevention and early detection, and study quality of life issues and rehabilitation during and after treatment. ACRIN is dedicated to increasing the number and quality of clinical trials that involve imaging technologies to detect and diagnose cancer. The NCI actively participates in the planning, review, and monitoring of clinical trials that are organized by ACRIN.

People interested in taking part in a clinical trial should talk with their doctor. Information about clinical trials is available from the Cancer Information Service (CIS) (see below) at 1-800-4-CANCER. Information specialists at the CIS use PDQ®, NCI's cancer information database, to identify and provide detailed information about specific ongoing clinical trials. Patients also have the option of searching for clinical trials on their own. The clinical trials page of the NCI's Cancer.gov Web site provides general information about clinical trials and links to PDQ. This page is located at <http://www.cancer.gov/clinicaltrials> on the Internet.

People considering clinical trials may be interested in the NCI fact sheet *Clinical Trials: Questions and Answers*. This fact sheet describes how research studies are carried out and explains their possible benefits and risks. This resource is available by calling the CIS, or at <http://www.cancer.gov/cancertopics/factsheet/Information/clinical-trials> on the Internet.

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Related NCI materials and Web pages:

- National Cancer Institute Fact Sheet 2.11, *Clinical Trials: Questions and Answers* (<http://www.cancer.gov/cancertopics/factsheet/Information/clinical-trials>)
- Breast Cancer Home Page (<http://www.cancer.gov/cancertopics/types/breast>)
- Clinical Trials Home Page (<http://www.cancer.gov/clinicaltrials>)

How can we help?

We offer comprehensive research-based information for patients and their families, health professionals, cancer researchers, advocates, and the public.

- **Call** NCI's Cancer Information Service at 1-800-4-CANCER (1-800-422-6237)
- **Visit** us at <http://www.cancer.gov> or <http://www.cancer.gov/espanol>
- **Chat** using LiveHelp, NCI's instant messaging service, at <http://www.cancer.gov/livehelp>

- **E-mail** us at cancergovstaff@mail.nih.gov
- **Order** publications at <http://www.cancer.gov/publications> or by calling 1-800-4-CANCER
- **Get help** with quitting smoking at 1-877-44U-QUIT (1-877-448-7848)

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