Ultrasound Imaging

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Ultrasound, also called ultrasound scanning or sonography, is an imaging method that uses sound waves to create an image of a part of the body. A computer program is used to analyze the echoes of sound waves sent into the body and generates an image on screen. 1

Unlike mammograms, which use radiation (x-rays), ultrasounds expose the body region of interest to high-frequency sound waves. Ultrasound images are captured in real time; that is, not only do they show the structure of a particular part of the body, but they can also show movement of the body's internal organs as well as blood flowing through vessels.2

View a documentary on breast ultrasound.

Below is a list of the information included on this page:

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- What to Expect
- Test Results
- Doppler Ultrasound
- Ultrasound for Breast Cancer
- Ultrasound for Uterine and Ovarian Cancer
- Benefits and Disadvantages
- Frequently Asked Questions (FAQ)

How It Works

Amplitude: strength of the signal**What instruments are used?**
Ultrasound scanners consist of a stand with a computer and electronics, a display screen to show the image, and a hand-held transducer that is used to scan the body. The transducer emits high-frequency sound waves and receives the returning waves (echoes). The computer collects the echoes and creates an image on the screen.2 In creating the final image, the computer analyzes several characteristics of the returned sound waves:

- **Frequency**: the number of waves received per second
- **Time Delay**: the time it takes for the signal to return from the targeted region to the transducer

How does ultrasound work?
Ultrasound imaging is based on the same principles of physics that bats use to locate their prey. When the transducer emits a sound wave and it hits an object, the wave bounces off the object. By measuring the echo waves, the computer can determine how far away the object is, its size, shape, uniformity, and consistency (whether the object is solid, fluid-filled, or a mixture).2

Ultrasound uses sound waves. The waves bounce off of different kinds of tissues differently. They can be used to identify

possible cancer and guide treatments.

What To Expect

For most ultrasound exams, the patient lies face-up on the examination table. A clear gel is applied to the area being examined. The gel allows the transducer to have ideal contact with the body by eliminating all air pockets. The physician will then firmly press the transducer against the skin and slowly move it around the area of interest. After the ultrasound scanning is complete, the gel will be wiped off the patient's skin and the patient can leave. 2

Image courtesy of Brent Burbridge, MD Saskatoon Medical Imaging, Saskatoon Canada.

In some ultrasound exams, physicians insert the transducer inside the body to obtain useful results. In these cases, the transducer is attached to a probe and then placed into one of the body's openings. For example, a transesophageal echocardiogram is taken by placing the transducer into the esophagus to get an image of the heart. A transrectal ultrasound involves placing the transducer into a man's rectum to obtain images of the prostate. In a transvaginal ultrasound, the transducer is inserted into a woman's vagina to view the uterus and ovaries. 2

Preparation

If you are getting an ultrasound, wear loose-fitting, comfortable clothes. All clothing and jewelry covering the area being examined will have to be removed. In some cases, you may be asked to wear a gown for the procedure. 2

Results

Besides allowing visualization of a lesion, an ultrasound is also the only non-invasive way to determine if a suspicious lump is a benign, fluid-filled cyst, or whether it is a solid cancerous mass. A cyst cannot be correctly diagnosed with only a physical exam or mammography. Ultrasounds are also helpful because they can be used to help guide a needle during a biopsy. 3 Research with women who have either breasts that are too dense for mammograms, or are at an increased risk for breast cancer, has shown that ultrasounds can also distinguish between benign and malignant masses. 4, 5

Ultrasounds are good exams to gain important information about a suspicious mass. However, they are not used for primary screening because of several factors. Because a well trained professional must administer the exam and interpret the results, they are expensive and the interpretation can vary on the evaluator. There is also a higher incidence of incorrectly identifying a mass as cancerous, a false positive, than with mammography. 6, 7 Additionally, ultrasounds are unable to detect microcalcifications (small mineral deposits in the breast that indicate the possibility of malignancy). 4 All cancers do not show up on ultrasounds, and in some cases, an ultrasound will not provide enough information for a physician to decide whether or not a mass is malignant, and a biopsy will be recommended.

The images below show examples of ultrasound results.
Left- liver containing metastatic cancer growths; Right- an ovary containing a large irregularly shaped mass.

Image courtesy of Brent Burbridge, MD Saskatoon Medical Imaging, Saskatoon Canada

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In the detection of breast cancer, ultrasound imaging is an extremely useful tool, but is not a substitute for mammography.8, 9Learn more about breast ultrasound.

Doppler

A Doppler ultrasound which is often included as a part of an ultrasound breast exam, allows visualization of blood flow (or lack of blood flow) in a breast mass. It allows the physician to assess the blood supply in a breast lesion.8 There are three types of Doppler ultrasounds:

- **Color Doppler**- the computer uses measurements from the ultrasound machine to produce an image with many colors so that the speed and direction of blood flow can be seen.
- **Power Doppler**- this is a recently developed technique that is more sensitive than the color Doppler. The

power Doppler can provide more information and detail about blood flow, and is exceptionally good for visualization of vessels located inside organs.
- **Spectral Doppler**- this imaging technique provides a graphic display of blood flow in terms of distance traveled per unit of time.

Doppler ultrasounds are important in the diagnosis of breast lesions because a malignant (cancerous) mass is likely to have blood flow irregularities.2, 10

Shown below is a normal Doppler ultrasound of a liver

Image courtesy of Brent Burbridge MD, Saskatoon Medical Imaging, Saskatoon Canada

For Specific Cancers: Breast

Breast ultrasounds are used mainly to further examine breast abnormalities detected by a physician during a physical exam or mammogram. 8, 11

The single most important factor affecting the accuracy of ultrasounds is breast density. In a study of 3,626 women with dense breasts, ultrasounds were used instead of physical exams to detect abnormalities. This study found that the number of breast cancer cases found by ultrasound was 17% higher than those found by physical exams. 12

The images below show ultrasound results for a normal breast (left) and a breast containing a cyst (right)

Image courtesy of Brent Burbridge, MD Saskatoon Medical Imaging, Saskatoon Canada.

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Over 50% of women under the age of 50, and about 33% of women over 50 have dense breasts.8 Young women have breasts that are dense and full of milk glands, sometimes making mammograms difficult to interpret. For this reason, many physicians will recommend that women under the age of 30 who have a lump in their breast get an ultrasound exam before a mammogram.13

Ultrasound is also used today for women with breast implants. Since there is very little tissue around a silicone implant to be x-rayed, mammograms are not always useful to detect abnormalities. Ultrasounds are also used as an alternative imaging method for pregnant women because they should not be exposed to x-rays.8

For Specific Cancers: Uterine And Ovarian

Transvaginal (endovaginal) ultrasound screening provides high-resolution images of the uterus and ovaries. This allows the entire uterus to be observed for cancer of the endometrium. Ovarian cancer can be detected before the lesions are palpable. The procedure involves the insertion of a small probe into the vagina. The probe then sends out ultrasound waves that are used to generate an image of the tissues.14 Signs of possible cancer that can be detected this way include: masses and altered (low-velocity) blood flow.15

Three-dimensional (as opposed to two-dimensional) Doppler imaging has been shown in trials to significantly improve the specificity of the screening. This technique allowed benign masses to be distinguished from malignant ones with more accuracy.15

Currently, transvaginal ultrasound screening does not have high enough specificity and sensitivity to significantly decrease mortality in the general population. The costs are high and ovarian cancer is not very prevalent. However, the screening is recommended for women at high risk of developing ovarian cancer, such as those with a family history of breast and ovarian cancer and/or those who carry a BRCA-1 or -2 mutation.16

Benefits And Disadvantages

Benefits of ultrasound:

- Can detect lesions in women with dense breasts when mammograms cannot.8
- Can help identify the nature of a lesion that is unclear from a mammogram.8

- Widely available, and less expensive than a mammogram.17
- The only way to tell the difference between a cyst and a solid mass without using a needle to draw out fluid (non-invasive).17
- Patient is never exposed to radiation during an ultrasound, allowing pregnant women to use this imaging technique.3
- Can use ultrasound to detect blood flow through vessels.2
- Most ultrasound exams are quick and painless.2
- Ultrasounds do not cause any health problems, and there are no known harmful effects to humans.2

Disadvantages of ultrasound:

- Ultrasound results may identify a potential area of concern that is not malignant. These false-positive results could lead to more procedures, including biopsies, that are not necessary 8. Preliminary data from a trial being conducted showed that there was a higher rate of false-positive results with ultrasounds than with mammography (2.4%-12.9% for ultrasound and 0.7%-6% for mammography).4
- Although ultrasound is often used in an attempt to prevent an invasive measure for diagnosis, sometimes it is unable to determine whether or not a mass is malignant, and a biopsy will be recommended.8
- Many cancers cannot be detected via an ultrasound.8
- Calcifications that are visible on mammograms are typically not visible on ultrasound scans. This may prevent early diagnosis of a portion of breast cancers that begin with calcifications.18
- Ultrasounds are not available everywhere, and not all insurance plans cover them.8
- An ultrasound requires a highly experienced and skilled operator to detect a malignant lump, as well as good equipment. If the cancerous tissue is not detected at the time of the scan, it will not be caught as early as possible. The ACR-accredited facilities database is a good way to determine the expertise of a facility in ultrasound imaging.4, 8

Frequently Asked Questions

What is an ultrasound?

Ultrasound, also known as a sonography, is an imaging technique used to detect many different kinds of cancers. It uses sound waves and their echoes to image the body's internal structures. A computer collects the sound wave data and produces an image that allows the radiologist to look for abnormalities. Ultrasound is also commonly used to view the fetus inside a pregnant mother.

What can an ultrasound do that a mammogram can't?

An ultrasound is very good at diagnosing abnormalities detected on a mammogram. It can determine whether a lesion is a fluid filled cyst or a solid mass. Cysts are much more likely to be benign than solid masses. Ultrasounds are also better than mammography when examining dense breasts.

How are ultrasounds helpful in examining dense breasts?

Dense breast tissue shows up white on a mammogram and fatty tissue shows up as black. Cancerous tissue also shows up as white on a mammogram. Therefore it is sometimes hard to distinguish dense tissue from cancerous tissue. On an ultrasound cancerous tissue shows up black and dense tissue is still white, therefore cancers are easier to distinguish.

What are dense breasts?

Breast density is based on the amount of glandular and fibrous tissue it has. Dense breasts contain high amounts of fibrous and glandular tissue and low amounts of fatty tissue. Dense breasts do not increase risk for breast cancer. Usually women 35 or younger have dense breasts.

Can I get an ultrasound instead of a mammogram?

Ultrasound does not replace mammography as a screening technique for breast cancer. In most cases it is used in combination with mammography when the results of a mammogram show more accurate testing is needed or if there are significant symptoms present. If there are no lumps or other symptoms a mammogram is enough to stay ahead of breast cancer. The following question describes when an ultrasound would be used as a screening tool.

When is ultrasound used instead of/along with mammography?

- In women with dense breasts ultrasound provides an alternative view of the breast that is easier to interpret
- In pregnant women to protect the fetus from mammography radiation exposure
- In women with breast implants, the implants may distort the image produced by mammography

- In women at high risk for breast cancer because of family history

Will the procedure hurt?

Ultrasound is a painless, non-invasive exam. The device used for an ultrasound, called a transducer, simply rubs against the patients skin over the area being examined.

How accurate is ultrasound?

A recent study showed when mammography and ultrasound are used in combination they have a sensitivity of 98.1% in detecting cancerous lesions. Ultrasound and mammography in combination greatly reduce the chances of false positives and negatives. Watch a video about sensitivity and specificity.

What is a false negative result?

A false negative is when a medical test is determined to be 'negative' (i.e. no cancer) but the person being tested does have cancer. Watch a video about false negatives.

What is a false positive result?

A false positive is when a medical test mistakenly detects cancer when the person being tested does NOT have cancer. Watch a video about false positives.

How should I prepare for an ultrasound?

You will probably be asked to undress from the waist up and put on a gown, so it is best to wear a two piece outfit. Other than that there is no special procedure for an ultrasound.

Is ultrasound safe if I am pregnant or breast feeding?

Yes. Ultrasound is a very safe, non-invasive exam. If you are pregnant you should get an ultrasound instead of a mammogram to protect the fetus from radiation.

What does an ultrasound result look like?

Can I get an ultrasound instead of a mammogram?

An ultrasound is usually only used when the results of a mammogram show more accurate testing is needed or if there are significant symptoms present. If there are no lumps or other symptoms a mammogram is enough to stay ahead of breast cancer.

Where can I get a quality ultrasound?

You can find an accredited ultrasound facility on the American College of Radiology website.

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