Elastography

Elastography uses low frequency vibrations during an ultrasound or MRI to measure the stiffness (or elasticity) of organs inside the body. It is particularly useful for detecting the presence and severity of liver disease.

Your doctor or the radiology center where you are receiving the exam will tell you how to prepare. This should include information about fasting before your exam. Unless you are told otherwise, take your regular medications as usual. Tell your doctor if there's a possibility you are pregnant and discuss any recent illnesses, medical conditions, medications you're taking and allergies. Leave jewelry at home and wear loose, comfortable clothing. You may need to wear a hospital gown.

What is Elastography?

Elastography is a non-invasive medical imaging technique that helps determine the stiffness of organs and other structures in your body. It is most commonly used to assess your liver. Elastography directs painless low frequency vibrations into the liver. Ultrasound (US) or magnetic resonance imaging (MRI) measures how quickly these vibrations move through the organ. A computer uses this information to create a visual map showing the stiffness (or elasticity) of the liver.

Stiff liver tissue is usually a sign of disease. Liver disease may cause a buildup of scar tissue (fibrosis). People with liver fibrosis do not always experience symptoms. Left untreated, liver fibrosis may progress to a more serious condition, called cirrhosis. Cirrhosis can severely affect the function of your liver, and it can be fatal.

Elastography may be used instead of a biopsy, to assess if you have liver disease. A liver biopsy uses a needle to obtain a small sample of your liver for examination under a microscope.

What are some common uses of the procedure?

Elastography is used to look for disease in the liver. The technique can:

- detect and assess how severe the liver disease is
- guide treatment decisions
- monitor response to treatment
- guide or replace a liver biopsy
- help predict the risk of complications of liver disease, such as fluid accumulation in the abdomen (ascites).

Elastography is also used to diagnose conditions in other organs such as the breast, thyroid and prostate. It is also used to assess the condition of muscles and tendons.

How should I prepare?

You should wear comfortable, loose-fitting clothing for your ultrasound exam. You may need to remove all clothing and jewelry in the area to be examined.

You may be asked to wear a gown during the procedure.

In general, you should not drink sugary beverages or eat before your exam. Food and sugary beverages are known to affect liver stiffness measurements. You may be asked to eat a fat-free meal on the evening before and to avoid eating for 6-8 hours before your exam. This allows better visualization of your gallbladder. Fasting instructions may vary between facilities. Ask your doctor for specific instructions.

Women should always inform their physician or technologist if there is any possibility that they are pregnant. MRI has been used for scanning patients since the 1980s with no reports of any ill effects on pregnant women or their unborn babies. However, because the unborn baby will be in a strong magnetic field, pregnant women should not have this exam in the first three to four months of pregnancy unless the potential benefit from the MRI exam is assumed to outweigh the potential risks. Pregnant women should not receive injections of gadolinium contrast material except when absolutely necessary for medical treatment. See the MRI Safety page for more information about pregnancy and MRI.

If you have claustrophobia (fear of enclosed spaces) or anxiety, you may want to ask your physician for a prescription for a mild sedative prior to your scheduled examination.

Jewelry and other accessories should be left at home, if possible, or removed prior to the MRI scan. Because they can interfere with the magnetic field of the MRI unit, metal and electronic items are not allowed in the exam room. In addition to affecting the MRI images, these objects can become projectiles within the MRI scanner room and may cause you and/or others nearby harm. These items include:

- jewelry, watches, credit cards and hearing aids, all of which can be damaged
- pins, hairpins, metal zippers and similar metallic items, which can distort MRI images
- removable dental work

- pens, pocket knives and eyeglasses
- body piercings

In most cases, an MRI exam is safe for patients with metal implants, except for a few types. People with the following implants cannot be scanned and should not enter the MRI scanning area:

- cochlear (ear) implant
- some types of clips used for brain aneurysms
- some types of metal coils placed within blood vessels
- nearly all cardiac defibrillators and pacemakers

You should tell the technologist if you have medical or electronic devices in your body. These objects may interfere with the exam or potentially pose a risk, depending on their nature and the strength of the MRI magnet. Many implanted devices will have a pamphlet explaining the MRI risks for that particular device. If you have the pamphlet, it is useful to bring that to the attention of the scheduler before the exam and bring it to your exam in case the radiologist or technologist has any questions. Some implanted devices require a short period of time after placement (usually six weeks) before being safe for MRI examinations. Examples include but are not limited to:

- artificial heart valves
- implanted drug infusion ports
- artificial limbs or metallic joint prostheses
- implanted nerve stimulators
- metal pins, screws, plates, stents or surgical staples

If there is any question of their presence, an x-ray may be taken to detect and identify any metal objects. In general, metal objects used in orthopedic surgery pose no risk during MRI. However, a recently placed artificial joint may require the use of another imaging procedure.

Patients who might have metal objects in certain parts of their bodies may also require an x-ray prior to an MRI. You should notify the technologist or radiologist of any shrapnel, bullets, or other pieces of metal that may be present in your body due to prior accidents. Foreign bodies near and especially lodged in the eyes are particularly important because they may move during the scan, possibly causing blindness. Dyes used in tattoos may contain iron and could heat up during an MRI scan, but this is rare. Tooth fillings and braces usually are not affected by the magnetic field, but they may distort images of the facial area or brain, so you should let the radiologistknow about them.

What does the equipment look like?

MR Elastography

The traditional MRI unit is a large cylinder-shaped tube surrounded by a circular magnet. You will lie on a moveable examination table that slides into the center of the magnet.

Some MRI units, called short-bore systems, are designed so that the magnet does not completely surround you. Some newer MRI machines have a larger diameter bore which can be more comfortable for larger size patients or patients with claustrophobia. Other MRI machines are open on the sides (open MRI). Open units are especially helpful for examining larger patients or those with claustrophobia. Newer open MRI units provide very high quality images for many types of exams. Older open MRI units may not provide this same image quality. Certain types of exams cannot be performed using open MRI. For more information, consult your radiologist.

The computer workstation that processes the imaging information is located in a separate room from the scanner.

MR Elastography cannot be performed using open MRI.

Ultrasound Elastography

Ultrasound scanners consist of a console containing a computer and electronics, a video display screen and a transducer that is used to do the scanning. The transducer is a small hand-held device that resembles a microphone, attached to the scanner by a cord. Some exams may use different transducers (with different capabilities) during a single exam. The transducer sends out high-frequency sound waves (that the human ear cannot hear) into the body and then listens for the returning echoes from the tissues in the body. The principles are similar to sonar used by boats and submarines.

The ultrasound image is immediately visible on a video display screen that looks like a computer or television monitor. The image is created based on the amplitude (loudness), frequency (pitch) and time it takes for the ultrasound signal to return from the area within the patient that is being examined to the transducer (the device placed on the patient's skin to send and receive the returning sound waves), as well as the type of body structure and composition of body tissue through which the sound travels. A small amount of gel is put on the skin to allow the sound waves to travel from the transducer to the examined area within the body and then back again. Ultrasound is an excellent modality for some areas of the body while other areas, especially air-filled lungs, are poorly suited for ultrasound.

How does the procedure work?

An ultrasound (US) probe or MR driver is placed on the surface of the skin. The probe or driver sends painless low frequency vibrations through the body to the organ under examination. This is most commonly the liver. MR or US imaging measures and records how fast the vibrations move through the organ. A computer uses this information to create a visual map showing the stiffness (or elasticity) of the organ.

Ultrasound Elastography

Ultrasound imaging is based on the same principles involved in the sonar used by bats, ships and fishermen. When a sound wave strikes an object, it bounces back, or echoes. By measuring these echo

waves, it is possible to determine how far away the object is as well as the object's size, shape and consistency (whether the object is solid or filled with fluid).

In medicine, ultrasound is used to detect changes in appearance, size or contour of organs, tissues, and vessels or to detect abnormal masses, such as tumors.

In an ultrasound examination, a transducer both sends the sound waves into the body and receives the echoing waves. When the transducer is pressed against the skin, it directs small pulses of inaudible, high-frequency sound waves into the body. As the sound waves bounce off internal organs, fluids and tissues, the sensitive receiver in the transducer records tiny changes in the sound's pitch and direction. These signature waves are instantly measured and displayed by a computer, which in turn creates a real-time picture on the monitor. One or more frames of the moving pictures are typically captured as still images. Short video loops of the images may also be saved.

MR Elastography

Unlike conventional x-ray examinations and computed tomography (CT) scans, MRI does not utilize ionizing radiation. Instead, radiofrequency pulses re-align hydrogen atoms that naturally exist within the body. This does not cause any chemical changes in the tissues. As the hydrogen atoms return to their usual alignment, they emit different amounts of energy depending on the type of body tissue they are in. The MR scanner captures this energy and creates a picture of the tissues scanned based on this information.

The magnetic field is produced by passing an electric current through wire coils in most MRI units. Other coils, located in the machine and in some cases, placed around the part of the body being imaged, send and receive radio waves, producing signals that are detected by the coils. The electric current does not come in contact with the patient.

A computer then processes the signals and generates a series of images, each of which shows a thin slice of the body. The images can then be studied from different angles by the interpreting radiologist.

Frequently, the differentiation of abnormal (diseased) tissue from normal tissues is better with MRI than with other imaging modalities such as x-ray, CT and ultrasound.

How is the procedure performed?

Elastography may be performed on outpatients or inpatients.

Ultrasound Elastography

A clear water-based gel is applied to the area of the body being studied to help the transducer make secure contact with the body and eliminate air pockets between the transducer and the skin that can block the sound waves from passing into your body. The sonographer (ultrasound technologist) or radiologist then places the transducer on the skin in various locations, sweeping over the area of interest or angling the sound beam from a different location to better see an area of concern.

For a liver elastography, the probe is placed between the ribs on the right side of the lower chest wall. A series of 10 painless vibrations are directed through the body to the liver. The elastography part of an

ultrasound exam usually only takes five minutes to complete. However, it may be done as part of a standard liver or abdominal ultrasound that may take around 30 minutes to complete.

MR Elastography

You will be positioned on the moveable examination table. Straps and bolsters may be used to help you stay still and maintain the correct position during imaging.

For liver elastography, a small piece of equipment, called the driver, is placed on the surface of your skin on the right side of the lower chest. Small devices that contain coils capable of sending and receiving radio waves may be placed around or next to the area. You will be placed into the magnet of the MRI unit. The radiologist and technologist will perform the exam while working at a computer outside of the room. As you hold your breath, the driver directs small vibrations toward your liver.

MR elastography takes less than five minutes, but it is often done as part of a standard MRI exam. An MRI of the liver is usually completed within 45 minutes.

What will I experience during and after the procedure?

MR Elastography

You will hold your breath for 10-15 seconds while the driver sends vibrations into your liver. Holding your breath helps produce clear pictures. You will feel the vibrations when the driver is activated but will not feel pain.

Ultrasound Elastography

Ultrasound examinations are painless and easily tolerated by most patients.

The probe is placed between the ribs on the right side of the lower chest wall. A series of 10 painless vibrations are directed through the body to the liver. You will feel the vibrations but will not feel pain.

After your exam, you should be able to resume your normal activities immediately.

Who interprets the results and how do I get them?

A radiologist, a doctor specifically trained to supervise and interpret radiology exams, will analyze your test. This doctor will send a report to the doctor who ordered the exam. This doctor will share the results with you. At some sites, the radiologist may also speak with you after the test.

What are the benefits vs. risks?

Benefits

Ultrasound Elastography and MR Elastography:

- are noninvasive imaging techniques that do not involve exposure to ionizing radiation
- can detect liver disease, such as fibrosis (scarring within the liver) earlier than other imaging tests
- may eliminate the need for a liver biopsy
- assesses a larger portion of the liver than a biopsy
- can help predict the risk of certain liver complications, such as the buildup of fluid within the abdomen (ascites).

Risks

MR Elastography

- The MRI examination poses almost no risk to the average patient when appropriate safety guidelines are followed.
- If sedation is used, there are risks of excessive sedation. However, the technologist or nurse will monitor your vital signs to minimize this risk.
- Although the strong magnetic field is not harmful in itself, implanted medical devices that contain metal may malfunction or cause problems during an MRI exam.
- Nephrogenic systemic fibrosis is currently a recognized, but rare, complication of MRI believed to be caused by the injection of high doses of gadolinium-based contrast material in patients with very poor kidney function. Careful assessment of kidney function before considering a contrast injection minimizes the risk of this very rare complication.
- There is a very slight risk of an allergic reaction if contrast material is injected. Such reactions are usually mild and easily controlled by medication. If you experience allergic symptoms, a radiologist or other physician will be available for immediate assistance.

Ultrasound Elastography

- For standard diagnostic ultrasound, there are no known harmful effects on humans.

What are the limitations of Elastography?

US elastography may not be possible to do in patients with narrowly spaced ribs. The probe needs to be placed as close to the liver as possible to get accurate results. Spaces smaller than the probe prevent this.

US and MR elastography are not recommended for patients who:

- have fluid in the abdomen (ascites); this can impede sending vibrations to the liver
- have acute hepatitis (inflammation in the liver); because hepatitis also causes increased stiffness, the doctor may not be able to tell if any stiffness is caused by fibrosis

- have heart failure; because heart failure also causes increased stiffness, the doctor may not be able to tell if any stiffness is caused by fibrosis
- are severely obese or unable to lie flat on their back
- have a lot of iron deposition within the liver; this may limit accuracy for MRI elastography.

Disclaimer

Note: Images may be shown for illustrative purposes. Do not attempt to draw conclusions or make diagnoses by comparing these images to other medical images, particularly your own. Only qualified physicians should interpret images; the radiologist is the physician expert trained in medical imaging.

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