

## 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* (<https://www.radiologyinfo.org/en/info/fatty-liver-disease>)). People with liver fibrosis do not always experience symptoms. Left untreated, liver fibrosis may progress to a more serious condition, called *cirrhosis* (<https://www.radiologyinfo.org/en/info/cirrhosisliver>). Cirrhosis can severely affect the function of your liver, and it can be fatal.

Elastography may be used instead of a *biopsy* (<https://www.radiologyinfo.org/en/info/biopgen>), 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?

Wear comfortable, loose-fitting clothing. You may need to remove all clothing and jewelry in the area to be examined.

You may need to change into a gown for 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 3-4 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 tell their doctor and technologist if they are pregnant. MRI has been used since the 1980s with no reports of any ill effects on pregnant women or their unborn babies. However, the baby will be in a strong magnetic field. Therefore, pregnant women should not have an MRI in the first trimester unless the benefit of the exam clearly outweighs any potential risks. Pregnant women should not receive gadolinium contrast unless absolutely necessary. *See the MRI Safety During Pregnancy* (<https://www.radiologyinfo.org/en/info/safety-mri-pregnancy>) page for more information about pregnancy and MRI.

If you have claustrophobia (fear of enclosed spaces) or anxiety, ask your doctor to prescribe a mild sedative prior to the date of your exam.

Leave all jewelry and other accessories at home or remove them prior to the MRI scan. Metal and electronic items are not allowed in the exam room. They can interfere with the magnetic field of the MRI unit, cause burns, or become harmful projectiles. 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, pocketknives, and eyeglasses
- body piercings
- mobile phones, electronic watches, and tracking devices.

In most cases, an MRI exam is safe for patients with metal implants, except for a few types. People with the following implants may not be scanned and should not enter the MRI scanning area without first being evaluated for safety:

- some cochlear (ear) implants
- some types of clips used for brain aneurysms
- some types of metal coils placed within blood vessels
- some older cardiac defibrillators and pacemakers
- vagal nerve stimulators

Tell the technologist if you have medical or electronic devices in your body. These devices may interfere with the exam or pose a risk. Many implanted devices will have a pamphlet explaining the MRI risks for that device. If you have the pamphlet, bring it to the attention of the scheduler before the exam. MRI cannot be performed without confirmation and documentation of the type of implant and MRI compatibility. You should also bring any pamphlet to your exam in case the radiologist or technologist has any questions.

If there is any question, an x-ray can detect and identify any metal objects. Metal objects used in orthopedic surgery generally pose no risk during MRI. However, a recently placed artificial joint may require the use of a different imaging exam.

Tell the technologist or radiologist about any shrapnel, bullets, or other metal that may be in your body. Foreign bodies near and especially lodged in the eyes are very important because they may move or heat up during the scan and cause blindness. Dyes used

in tattoos may contain iron and could heat up during an MRI scan. This is rare. The magnetic field will usually not affect tooth fillings, braces, eyeshadows, and other cosmetics. However, these items may distort images of the facial area or brain. Tell the radiologist 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 table that slides into a tunnel towards 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 patients or those with claustrophobia. "Open" MRI units are open on the sides. They are especially helpful for examining larger patients or those with claustrophobia. Open MRI units can provide high quality images for many types of exams. Open MRI may not be used for certain exams. For more information, consult your radiologist.

MR Elastography currently cannot be performed using open MRI.

### Ultrasound Elastography

Ultrasound machines consist of a computer console, video monitor and an attached transducer. The transducer is a small hand-held device that resembles a microphone. Some exams may use different transducers (with different capabilities) during a single exam. The transducer sends out inaudible, high-frequency sound waves into the body and listens for the returning echoes. The same principles apply to sonar used by boats and submarines.

The technologist applies a small amount of gel to the area under examination and places the transducer there. The gel allows sound waves to travel back and forth between the transducer and the area under examination. The ultrasound image is immediately visible on a video monitor. The computer creates the image based on the loudness (amplitude), pitch (frequency), and time it takes for the ultrasound signal to return to the transducer. It also considers what type of body structure and/or tissue the sound is traveling through.

## 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 uses the same principles as the sonar that bats, ships, and fishermen use. 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 its size, shape, and consistency. This includes whether the object is solid or filled with fluid.

Doctors use ultrasound to detect changes in the appearance of organs, tissues, and vessels and to detect abnormal masses, such as tumors.

In an ultrasound exam, a transducer both sends the sound waves and records the echoing (returning) waves. When the transducer is pressed against the skin, it sends 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. A computer instantly measures these signature waves and displays them as real-time pictures on a monitor. The

technologist typically captures one or more frames of the moving pictures as still images. They may also save short video loops of the images.

### **MR Elastography**

Unlike x-ray and computed tomography (CT) exams, MRI does not use radiation. Instead, radio waves 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 tissue they are in. The scanner captures this energy and creates a picture using this information.

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

A computer processes the signals and creates a series of images, each of which shows a thin slice of the body. The radiologist can study these images from different angles.

MRI is often able to tell the difference between diseased tissue and normal tissue better than x-ray, CT, and ultrasound.

### **How is the procedure performed?**

Elastography may be performed on outpatients or inpatients.

#### **Ultrasound Elastography**

The technologist applies a clear water-based gel to the body area under examination. This helps the transducer make secure contact with the body. It also helps eliminate air pockets between the transducer and the skin that can block the sound waves from passing into your body. The technologist or radiologist places the transducer on the skin in various locations, sweeping over the area of interest. They may also angle 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**

The technologist will position you on the moveable exam table. They may use straps and bolsters to help you stay still and maintain your position.

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

Most ultrasound exams are painless, fast, and easily tolerated.

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 exam poses almost no risk to the average patient when appropriate safety guidelines are followed.
- If sedation is used, there is a risk of using too much. However, your vital signs will be monitored to minimize this risk.
- The strong magnetic field is not harmful to you. However, it may cause implanted medical devices to malfunction or distort the images.
- There is a very slight risk of an allergic reaction if your exam uses contrast material. Such reactions are usually mild and controlled by medication. If you have an allergic reaction, a doctor will be available for immediate assistance.
- Although there are no known health effects, evidence has shown that very small amounts of gadolinium can remain in the body, particularly the brain, after multiple MRI exams. This is most likely to occur in patients receiving multiple MRI exams over their lifetime for monitoring chronic or high-risk health conditions. The contrast agent is mostly eliminated from the body through the kidneys. If you are a patient in this category, consult with your doctor about the possibility of gadolinium retention, as this effect varies from patient to patient.

#### Ultrasound Elastography

- Standard diagnostic ultrasound has 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 or acute alcoholic 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; however, once the inflammation has improved (over a few weeks), elastography can be performed
- 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.

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