

Understanding Cancer

**A SERIES OF SIMPLE EDUCATIONAL VIDEOS
FOR THE GENERAL PUBLIC**



By Dr Hafsa Waseela Abbas

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Understanding Cancer

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Part 12: Diagnosis - Ultrasound scan

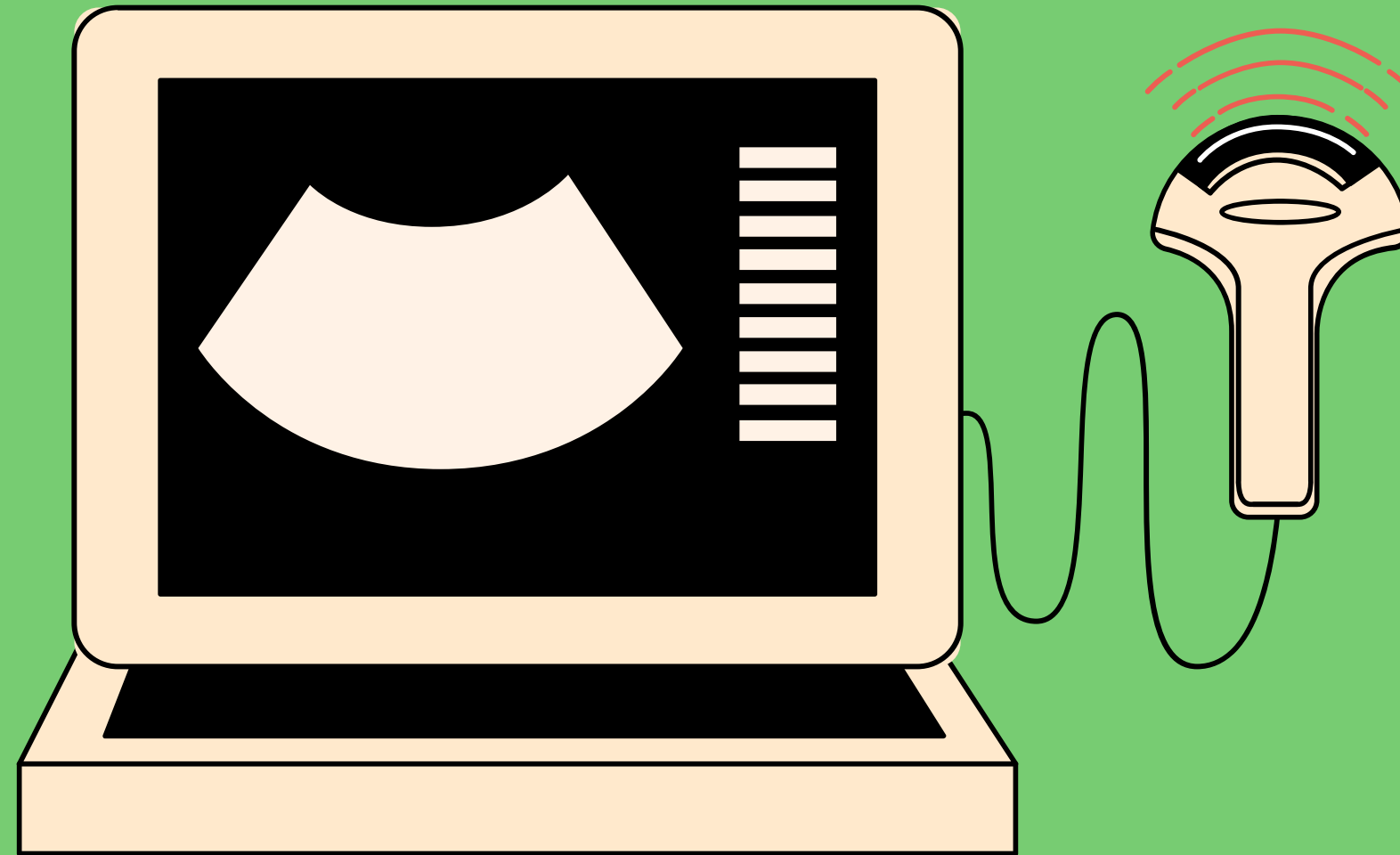
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What is an ultrasound scan?



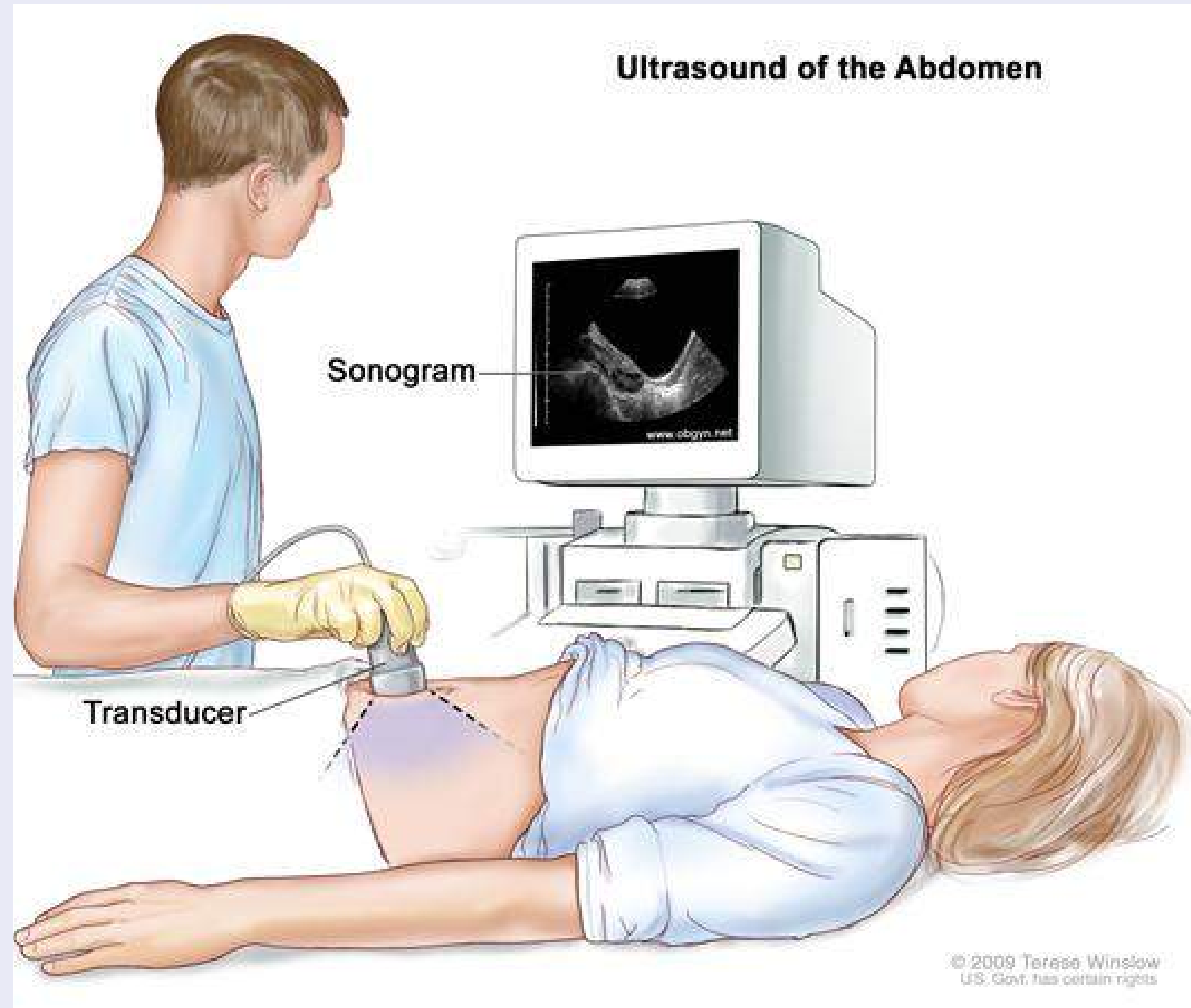
An ultrasound scan is a type of scan that uses sound waves that have high frequency to form an image inside the body.



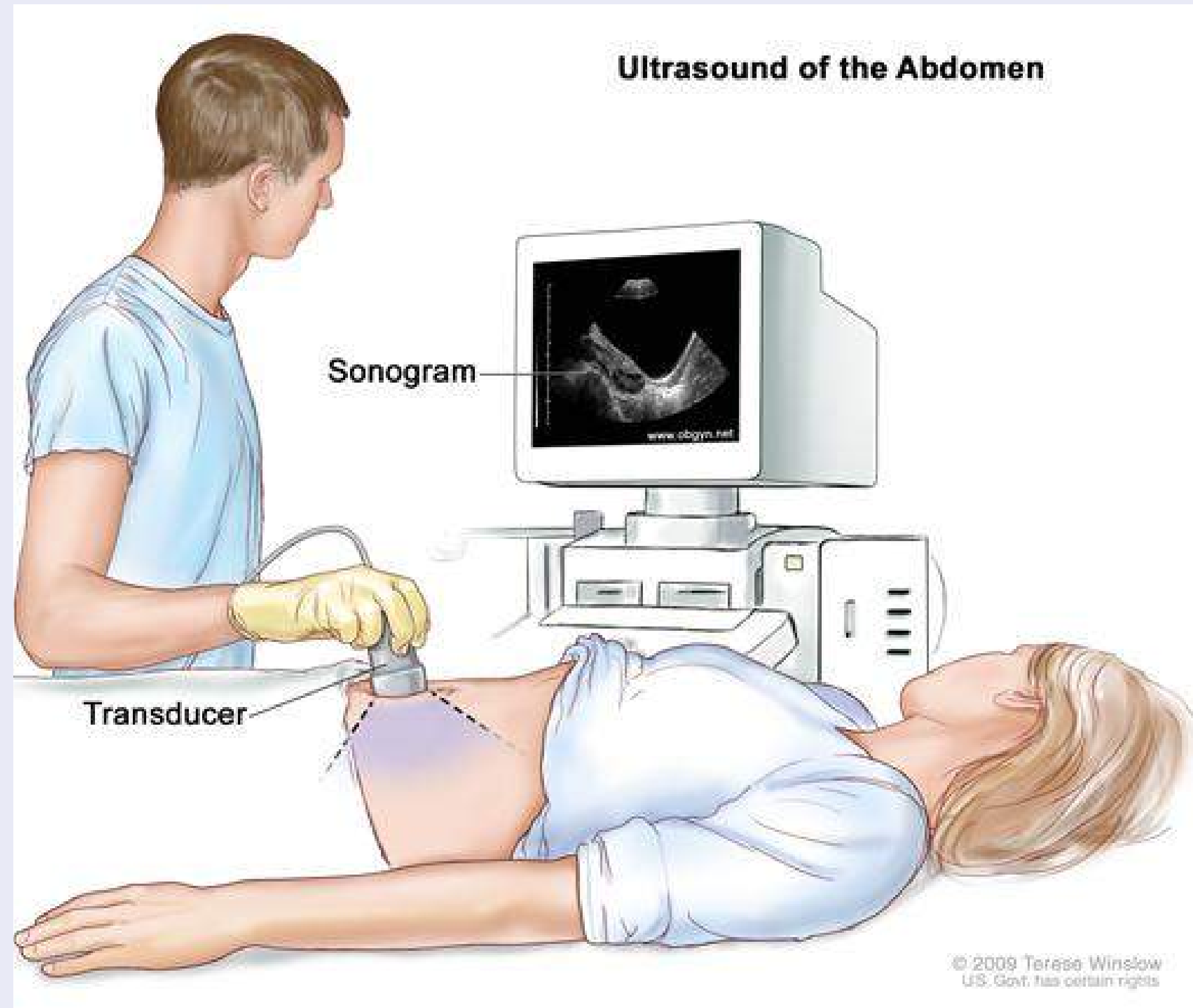


It is also called a sonogram.

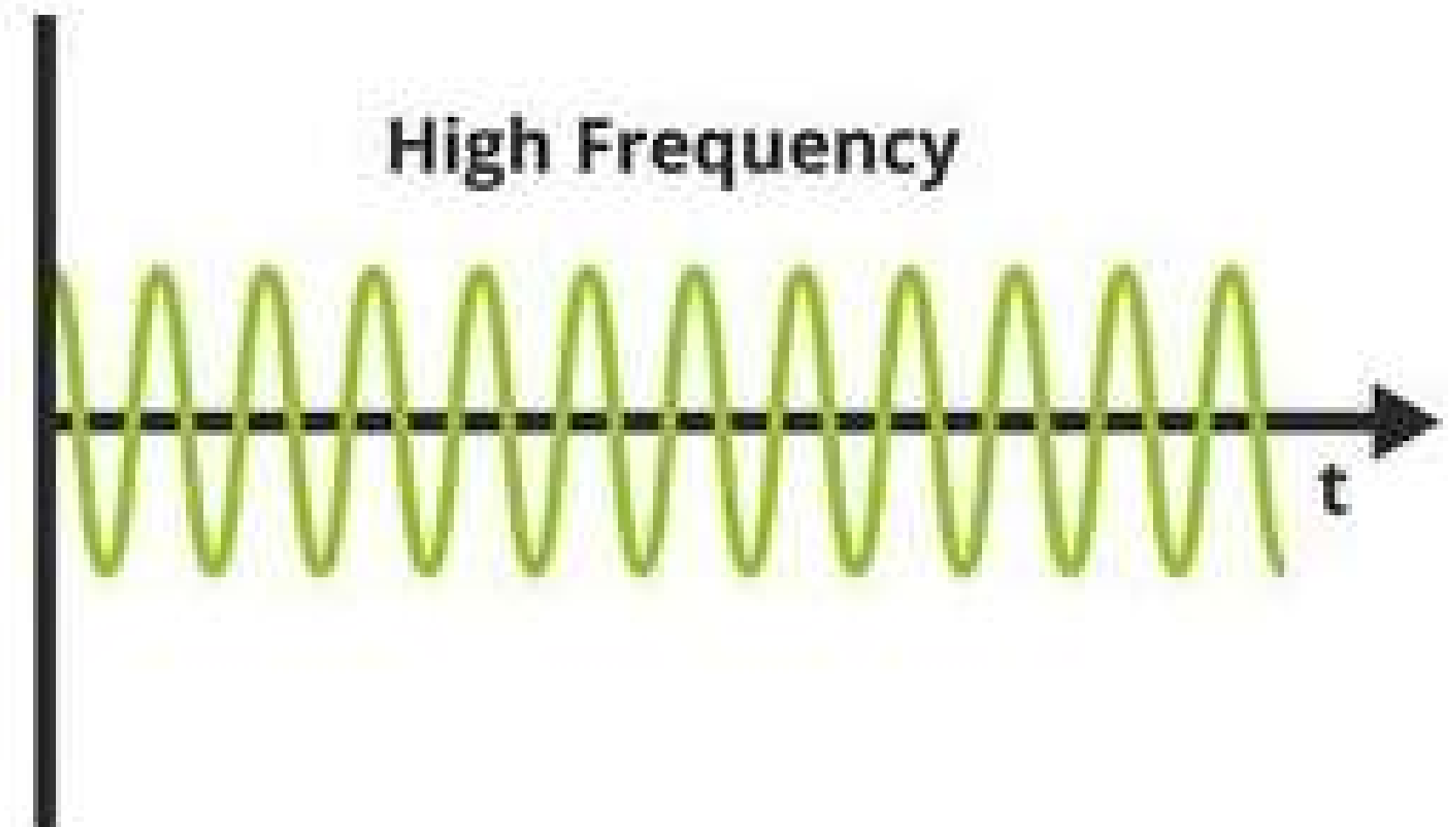
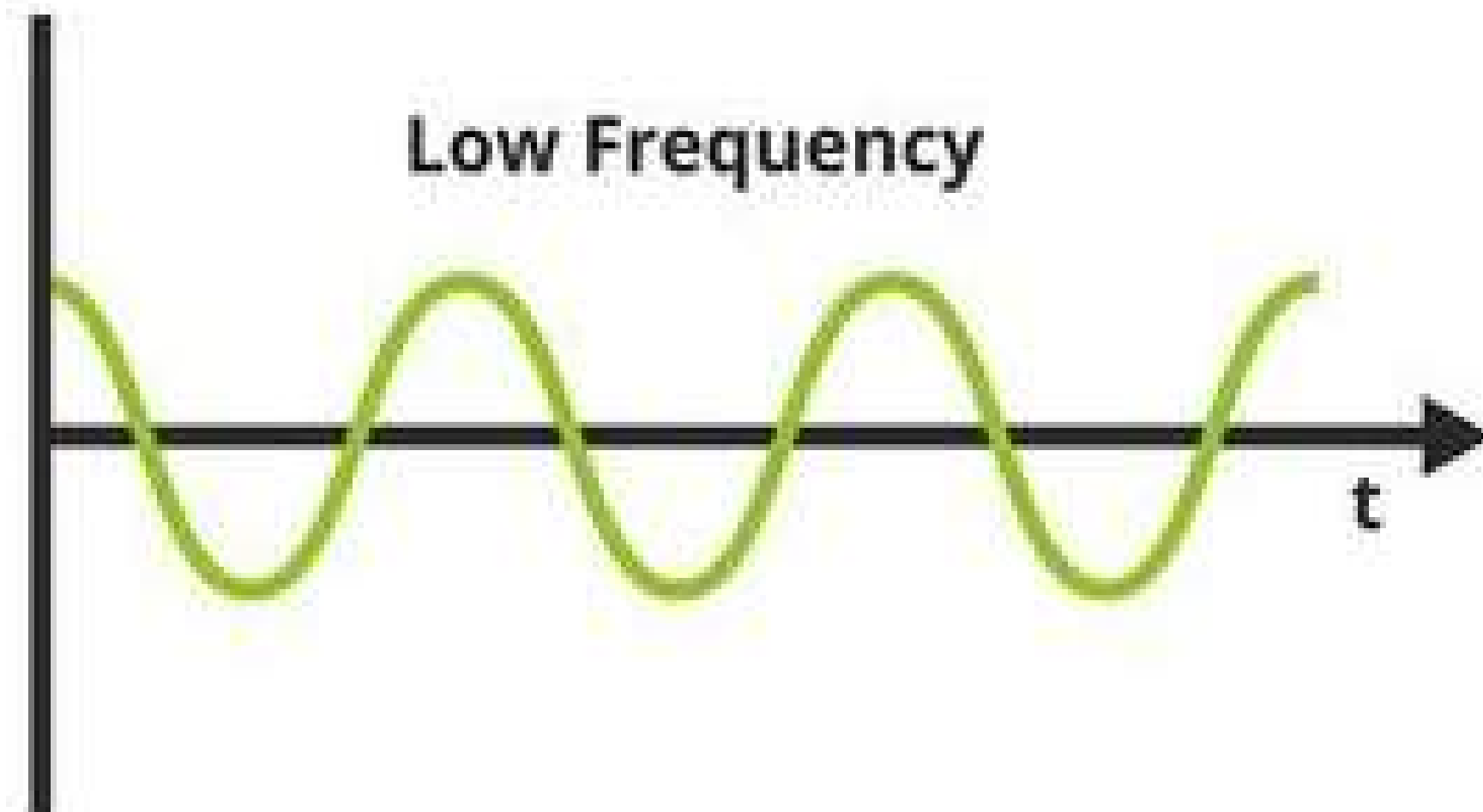
It takes place in a hospital and is performed by a doctor who is a specialist in examining x-rays (radiologist).



***It is also performed
by a trained
technologist who
specialises in
ultrasound
(sonographer).***



A frequency is the number of waves that passes in a unit time at a fixed point.



***It is higher than human
hearing 20 - 20,000 Hz.***

***It is measured in Hertz
and even higher
frequencies Megahertz
(MHz).***



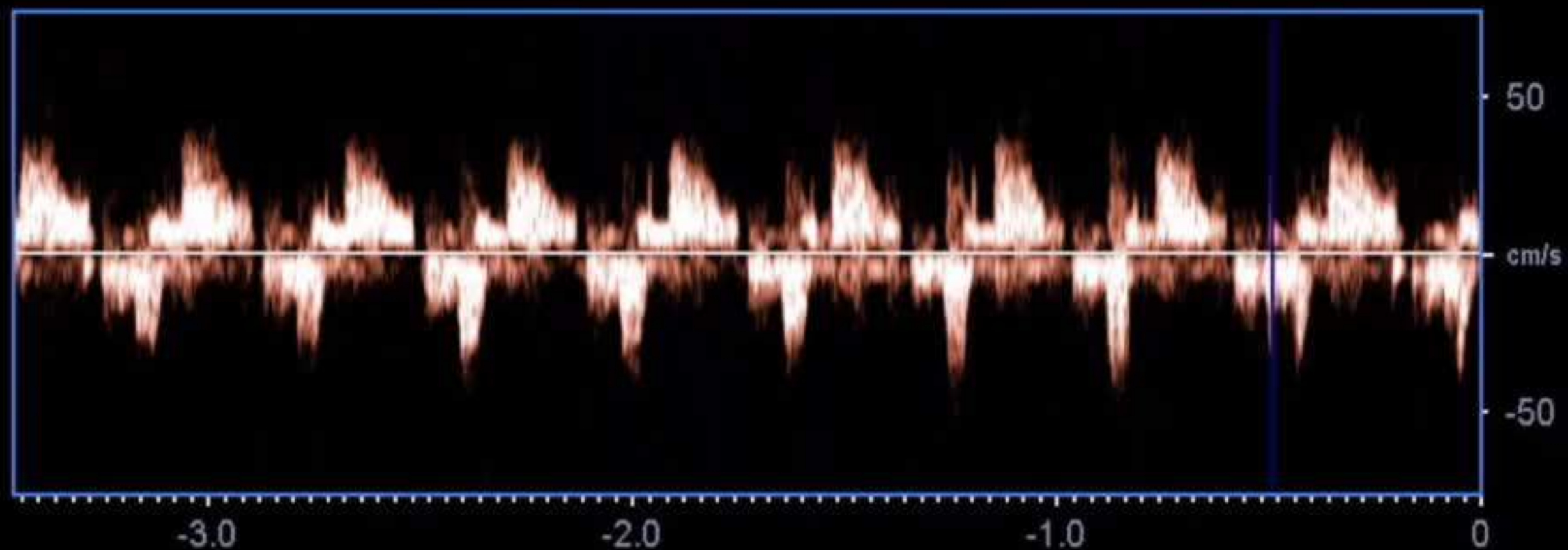
Ultrasound images are displayed as:

- ***2D***
- ***3D***
- ***4D (3D in motion)***



MI:1.5
6C1
T5.0
13 fps
Qscan
G:77
DR:55
A:2
P:3

0° $\nless 2.5$
6.0cm



DG:25 / 5.0k / F:158



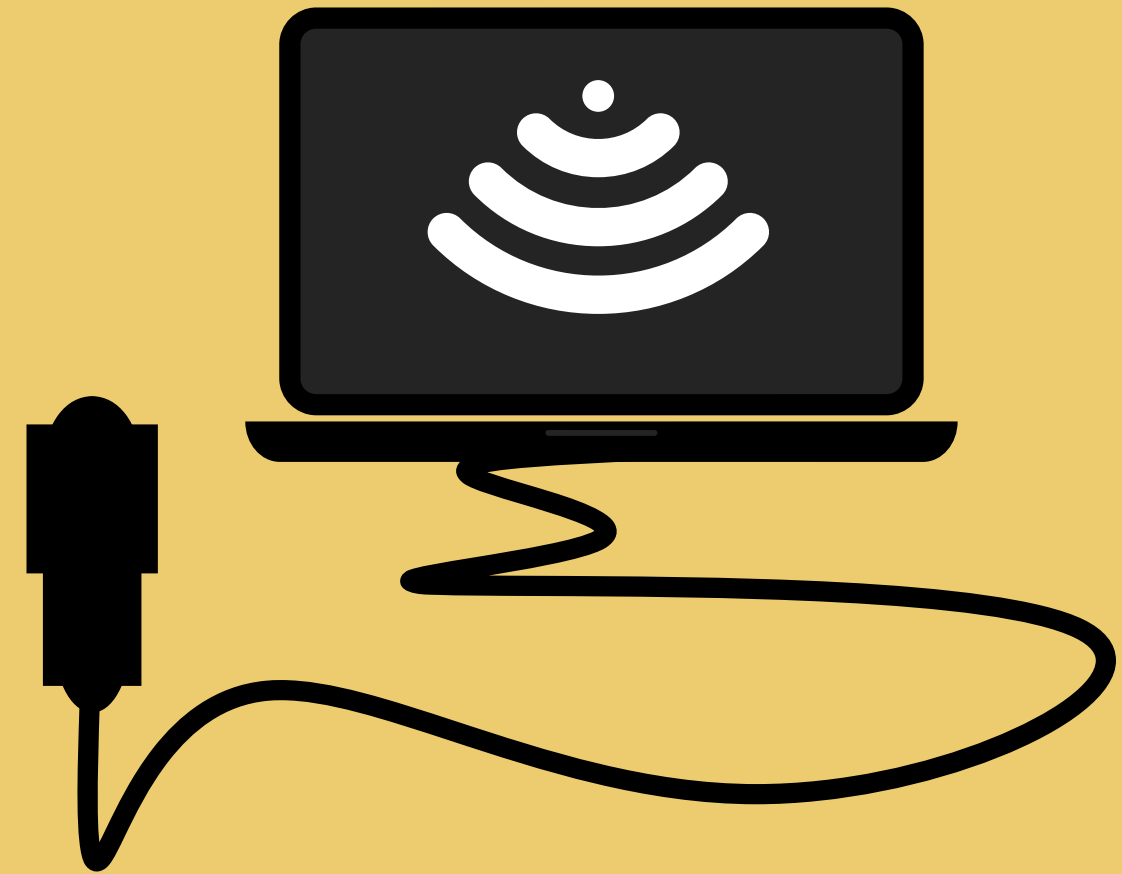
Who invented the ultrasound scan?

Lazzaro Spallanzani, a physiologist and biologist published the first paper on ultrasound in 1794.

He studied bats and discovered they use sound to move rather than sight. This is called echolocation.

Types of ultrasound

- **Diagnostic**
- **Therapeutic**



Ultrasound scan

Diagnostic ultrasound

It is used to see inside the body.



Ultrasound scan

Diagnostic ultrasound



There are two types:

Anatomical ultrasound

***It produces images of organs and other structure
inside the body.***

Ultrasound scan

Diagnostic ultrasound

There are two types:

Functional ultrasound

To see and measure the movement, speed and direction of speed of the blood vessels in the heart and in the body.

Is it soft or hard tissue?

Ultrasound scan

Diagnostic ultrasound

***The images create information to help
understand how things are functioning within
the body.***

Ultrasound scan

Diagnostic ultrasound

EXAMPLE 1

Doppler helps detect
the blocking of the
blood flow in the brain.



Ultrasound scan

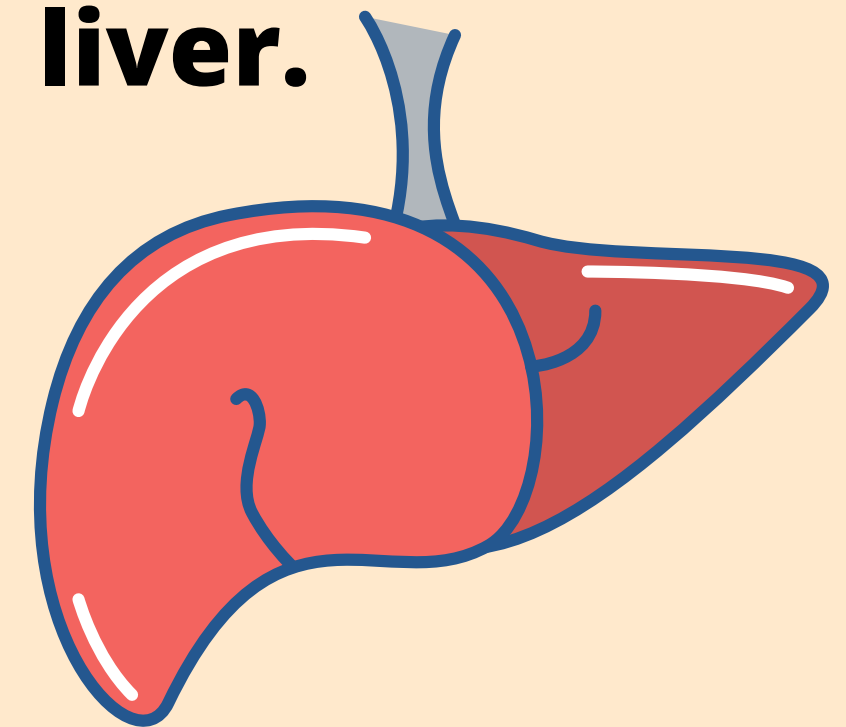
Diagnostic ultrasound

EXAMPLE 2

Elastography measures how stiff the tissues are.

This helps to tell the difference between healthy tissues and tumour cells using black and white and colour coded map.

It is a good test for liver fibrosis where there is a build up of scar tissue due to inflammation in the liver.



Ultrasound

Colon cancer (large intestine)



There is thickening of the wall of the colon.

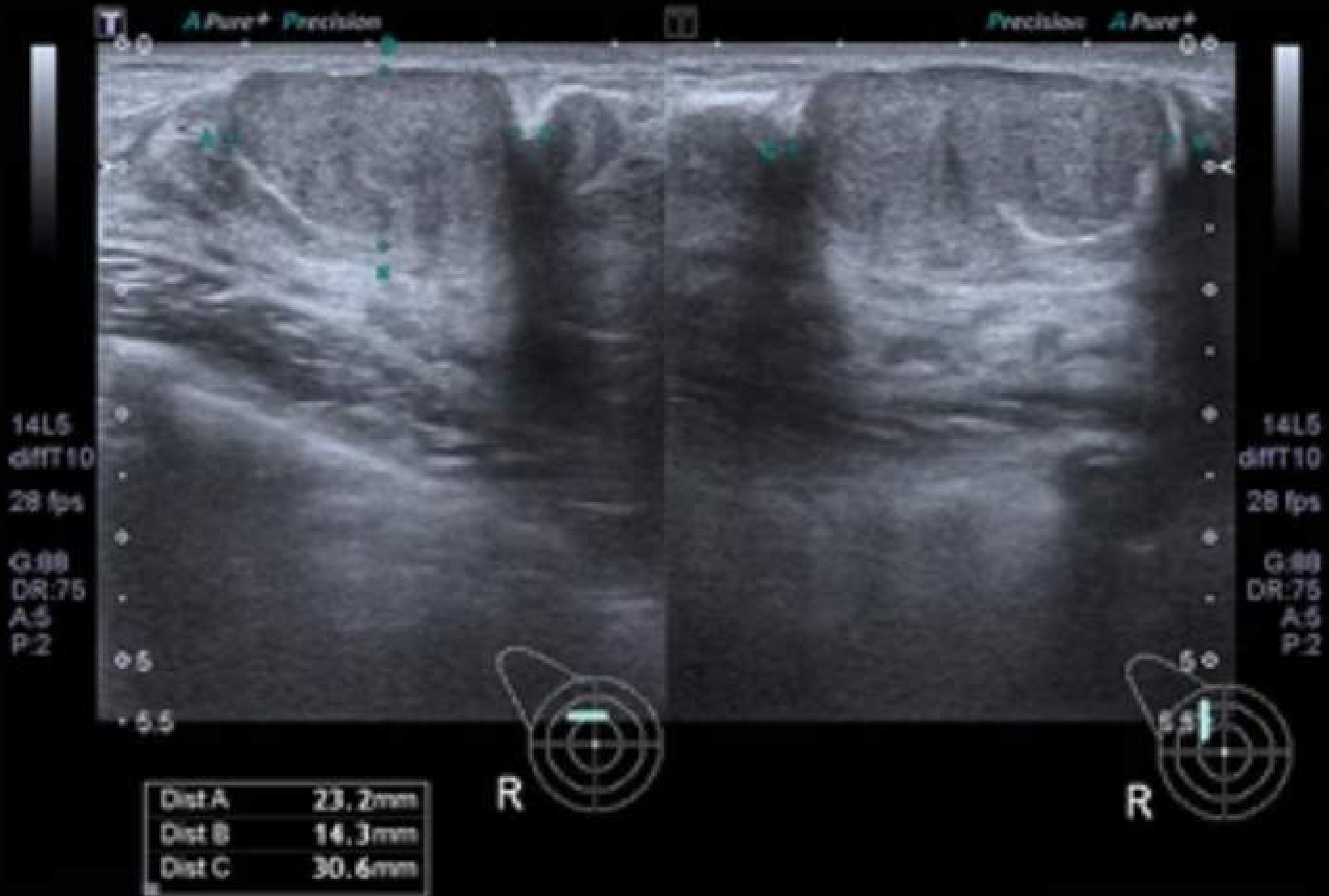
Transverse

Breast cancer

Your doctor may suggest to do an ultrasound if the patient is under 35.

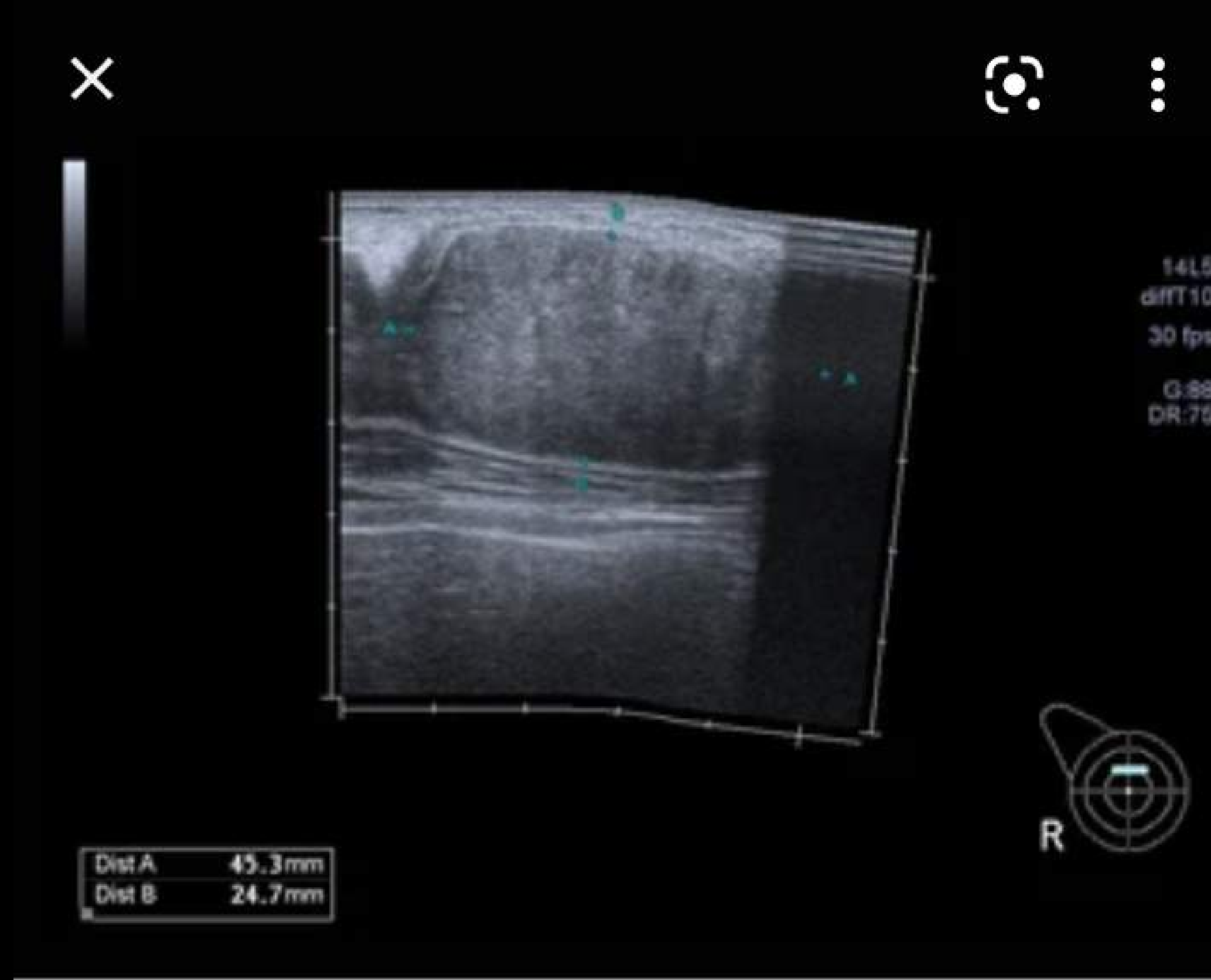
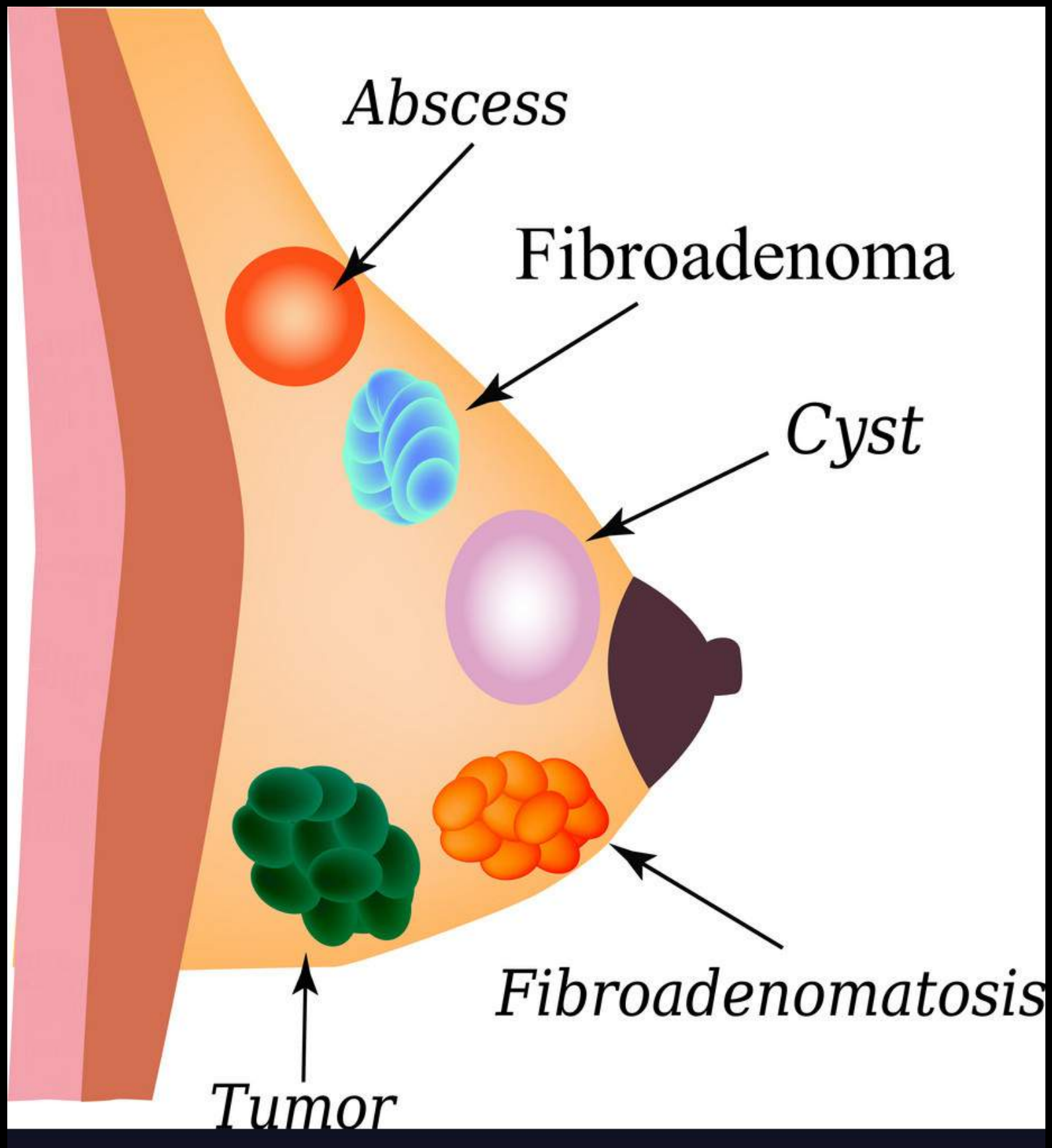
This is because they have dense breasts.
Ultrasound is more effective than
mammogram.

Breast cancer



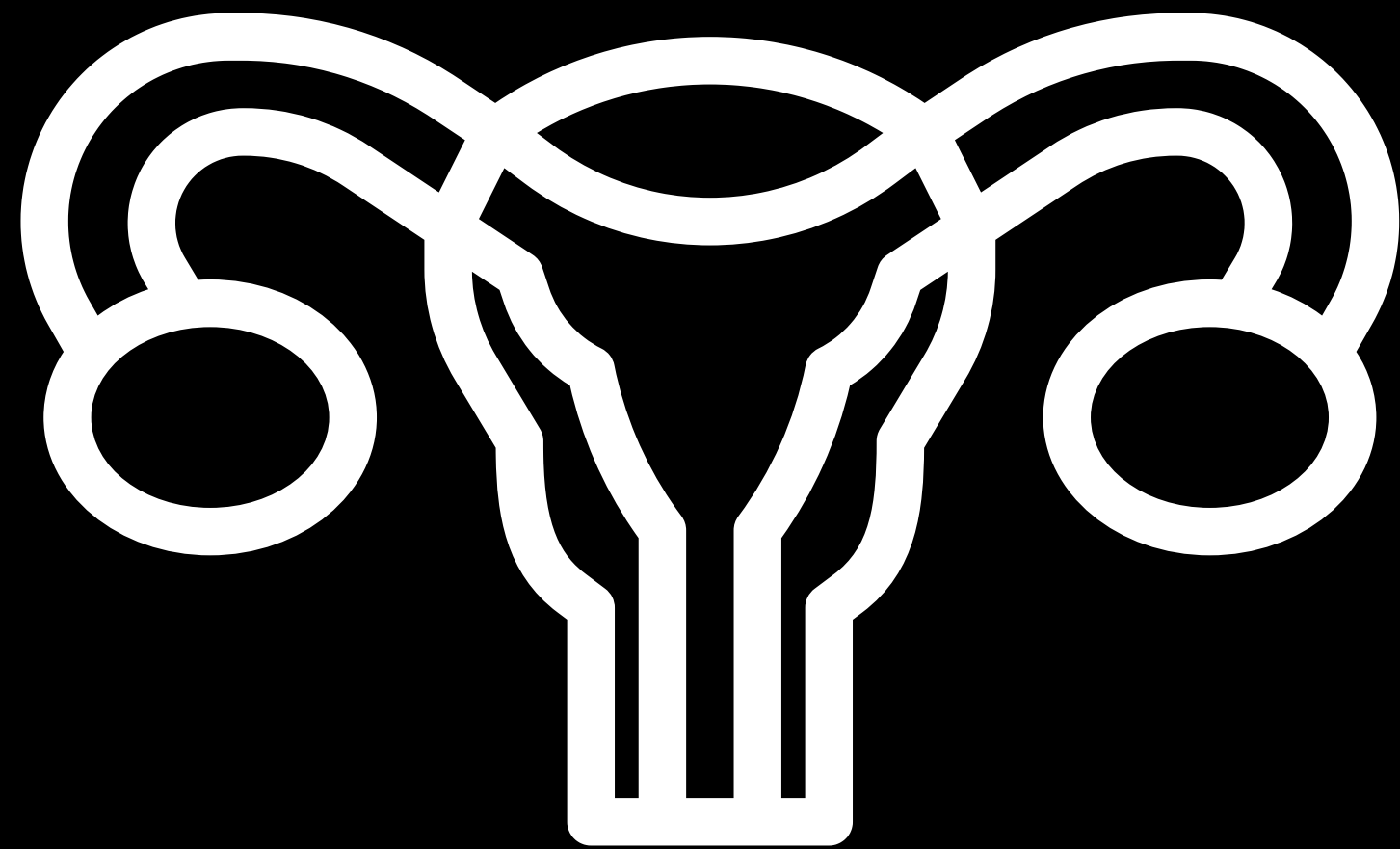
Breast cancer

It can show inside of the breasts for any lumps (solid or liquid) or any abnormal changes.



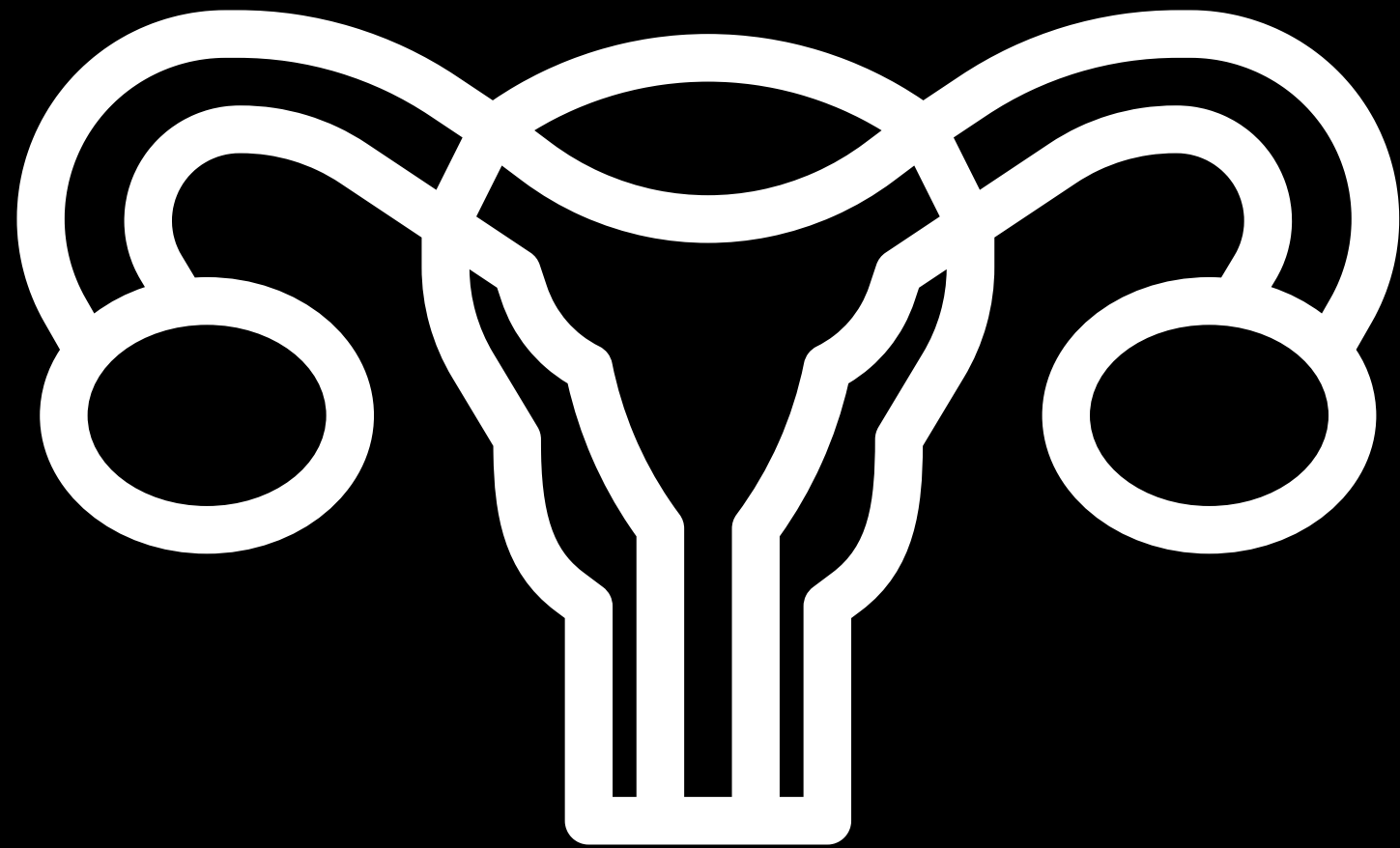
Fibroadenoma is the most common type of benign breast tumour

Ovarian cancer



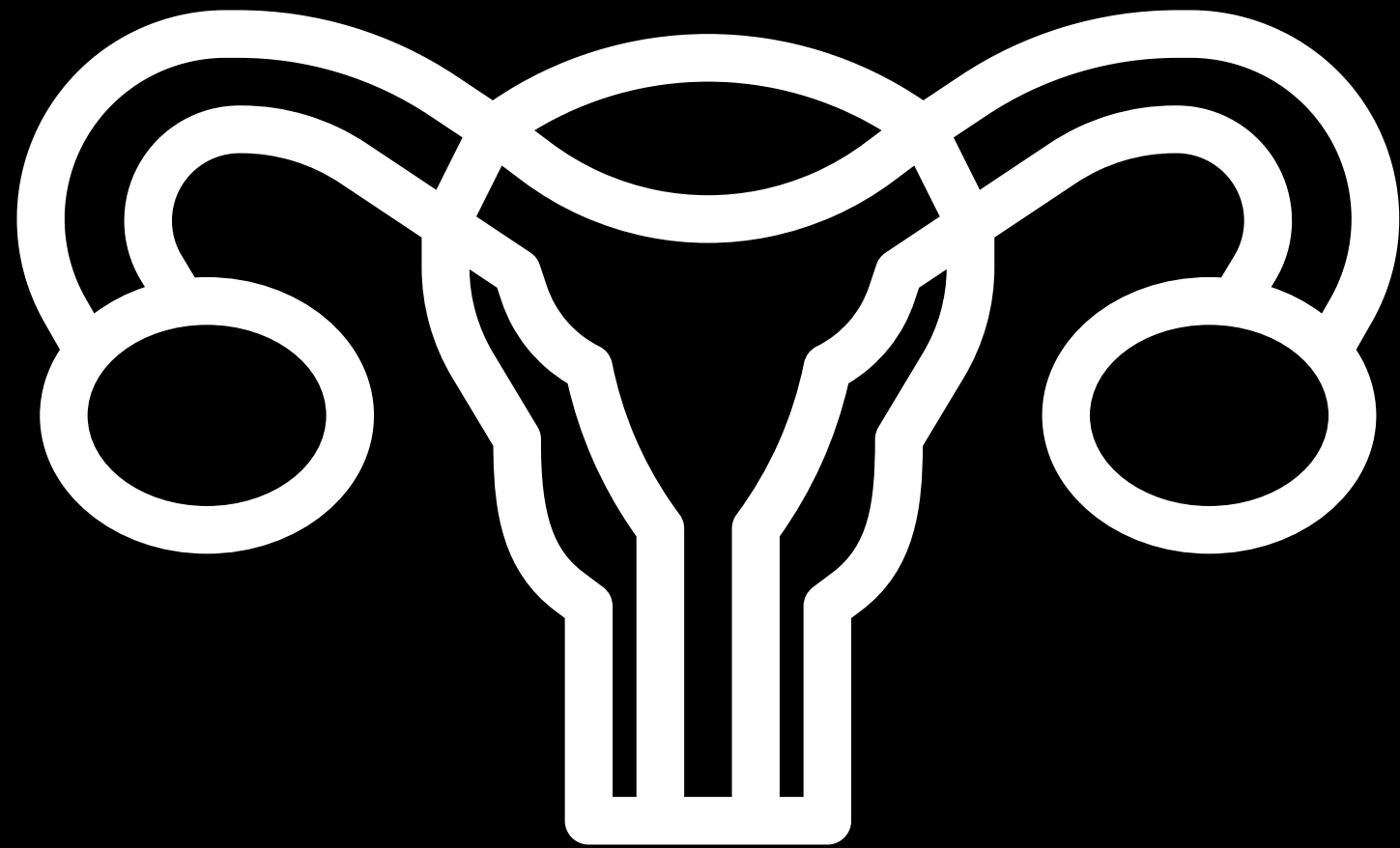
This is arranged if the blood test CA125 is high.

Ovarian cancer



It shows any changes to the ovaries that may suggest cancer or if there is a build up of fluid or any other conditions.

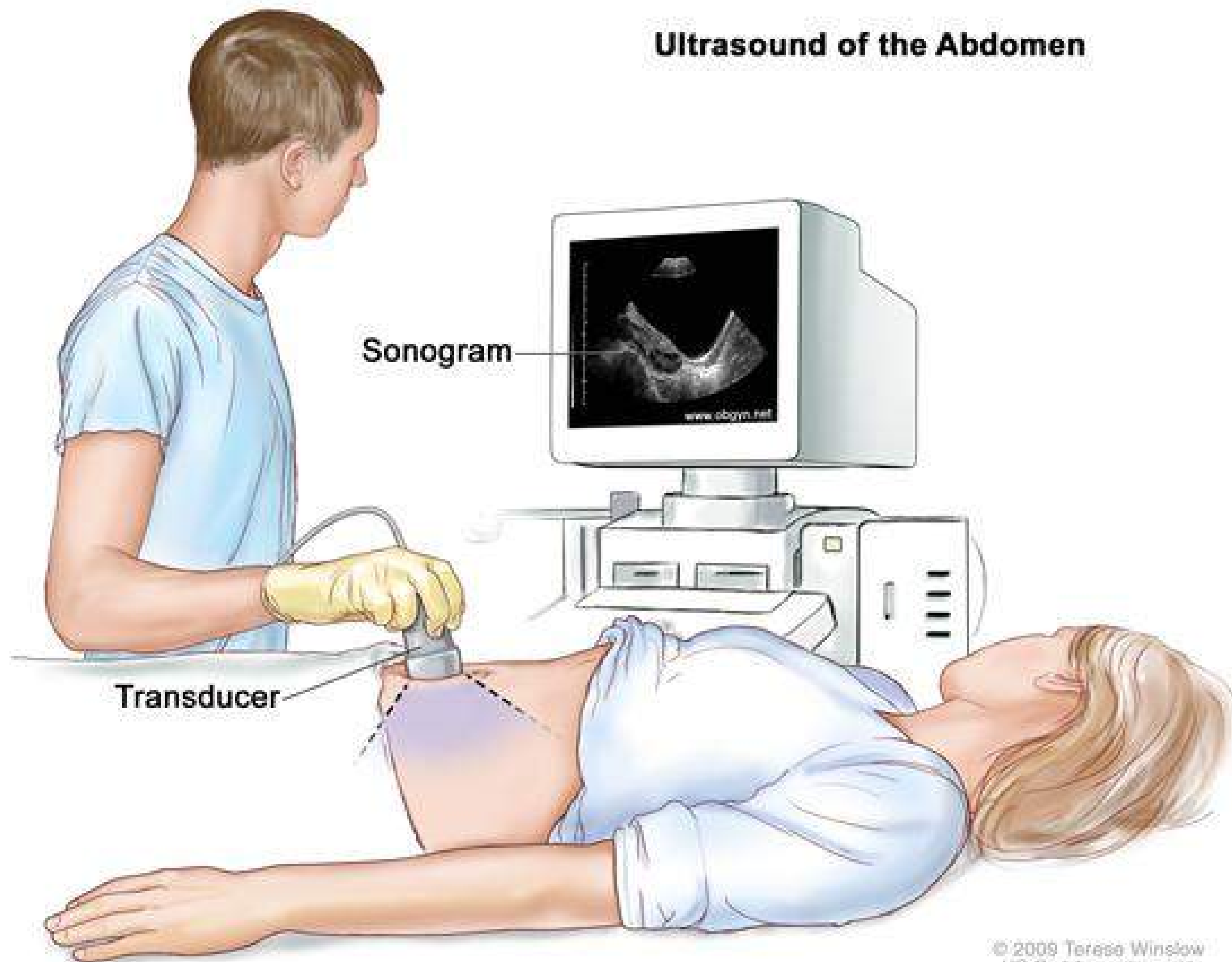
Ovarian cancer



First method:

A small probe goes over the stomach to create an image of the ovaries.

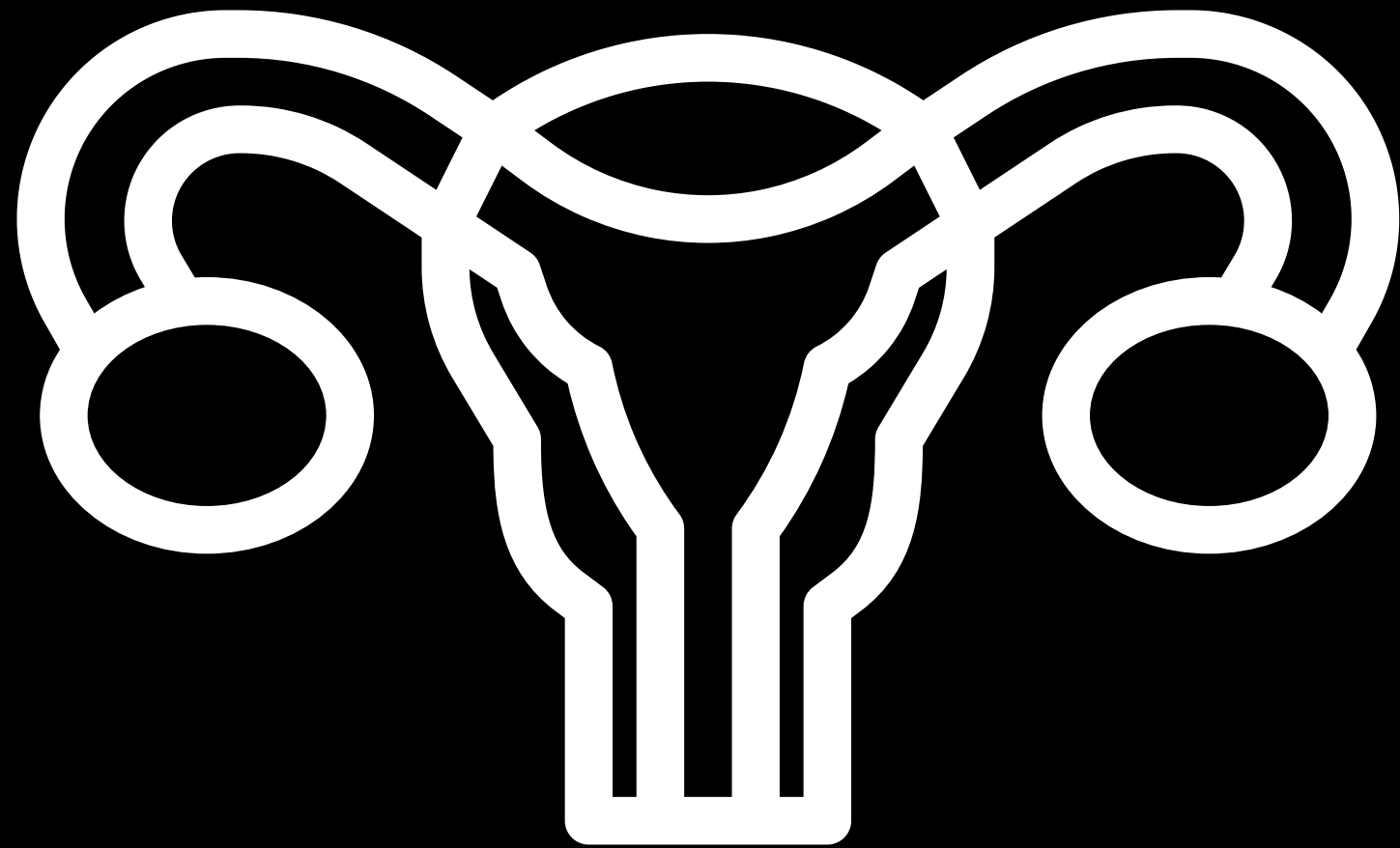
Ultrasound of the Abdomen



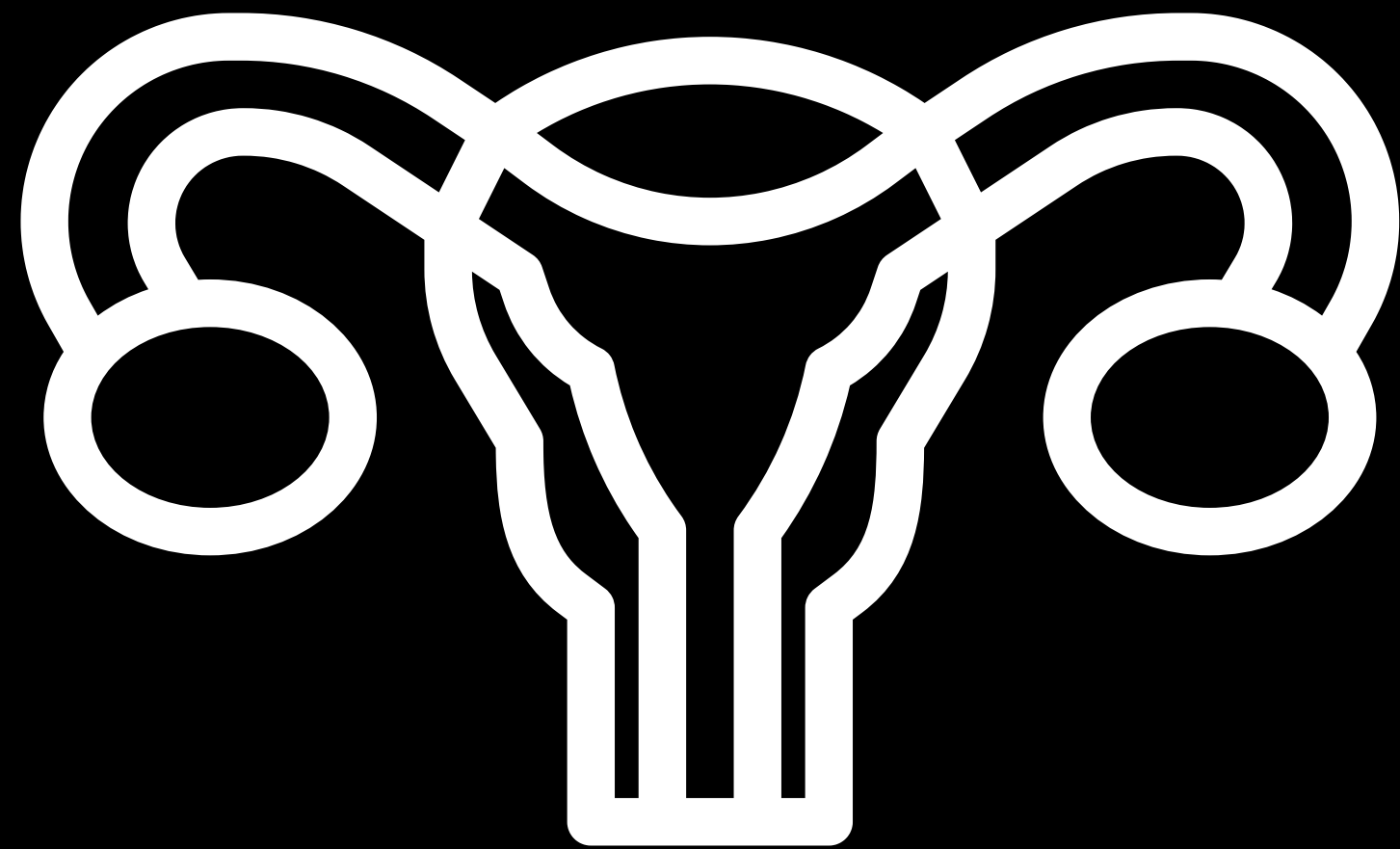
Ovarian cancer

Second method:

A probe is passed into the vagina to give a clear image



Ovarian cancer



Further tests are booked with a specialist doctor to confirm the cause.

Ultrasound scan

Diagnostic ultrasound

PREGNANCY

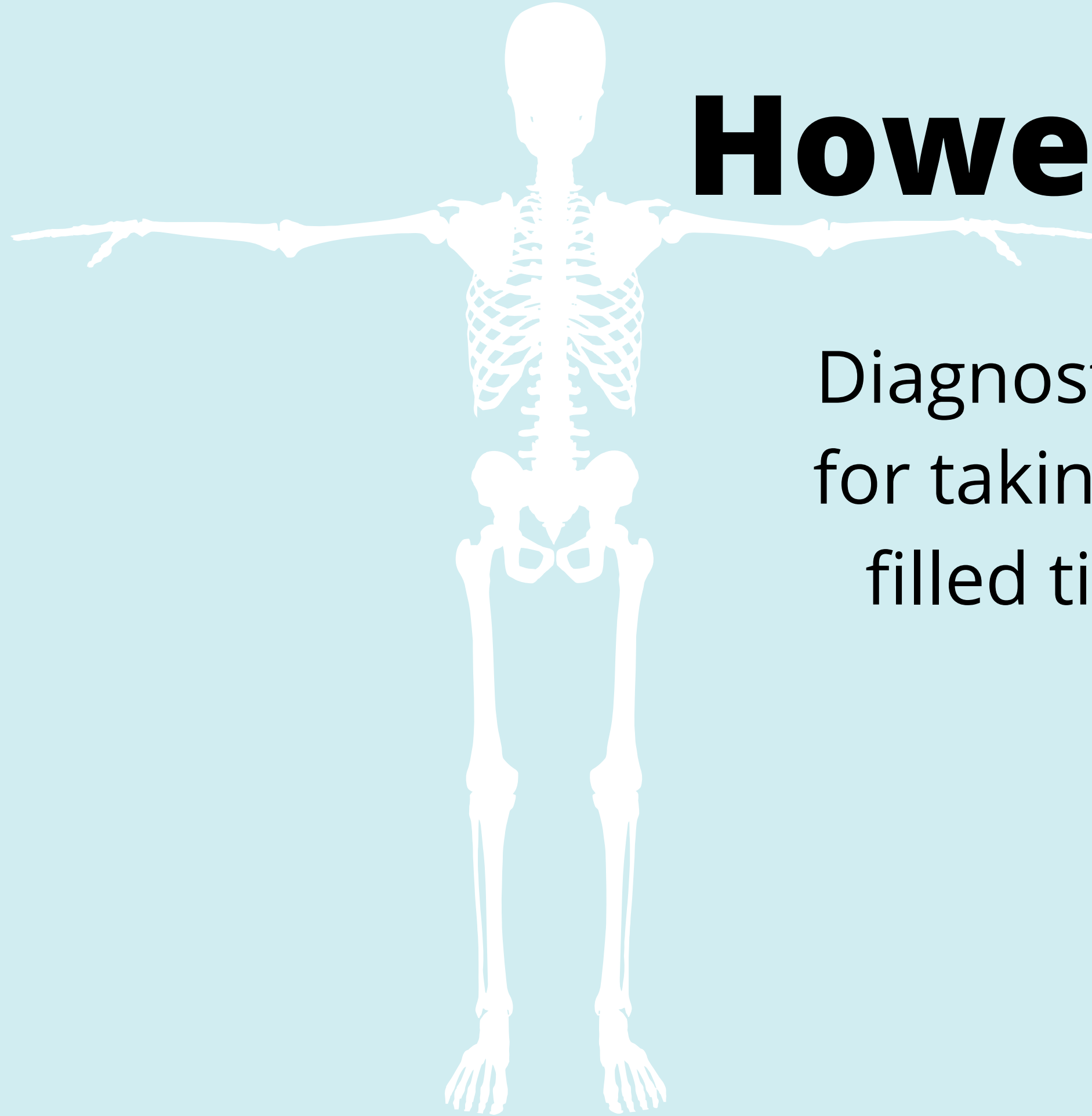
Monitor growth and development of the foetus.



- A probe in the target area acts as a guide during surgery.
- Ultrasound also helps in needle biopsy to select a target e.g. in breast cancer



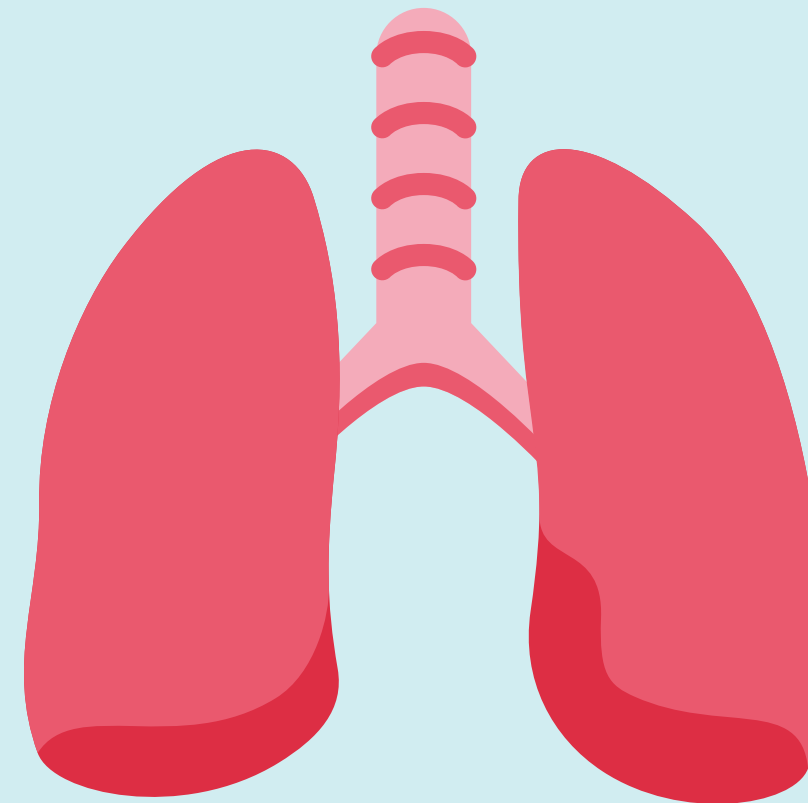
**Other uses of
diagnostic
ultrasound
scan.**



However...



Diagnostic ultrasound is not good for taking images of bone and air-filled tissues such as the lungs.



Ultrasound scan

Therapeutic ultrasound

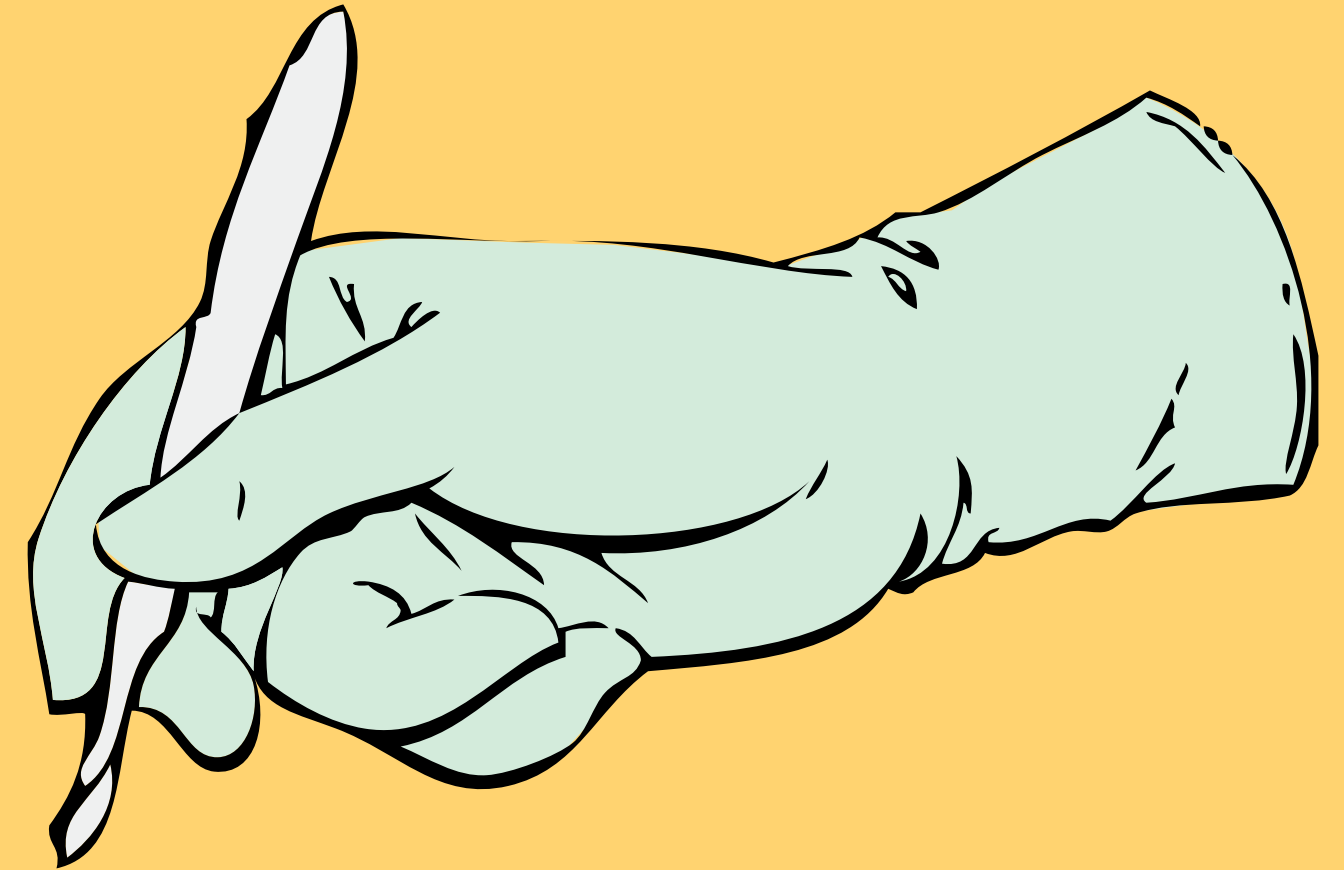
It is used to treat, guide and
determine effect of
treatment.



Ultrasound scan

Therapeutic ultrasound

It does not produce images
nor form cuts into the skin
nor scars.

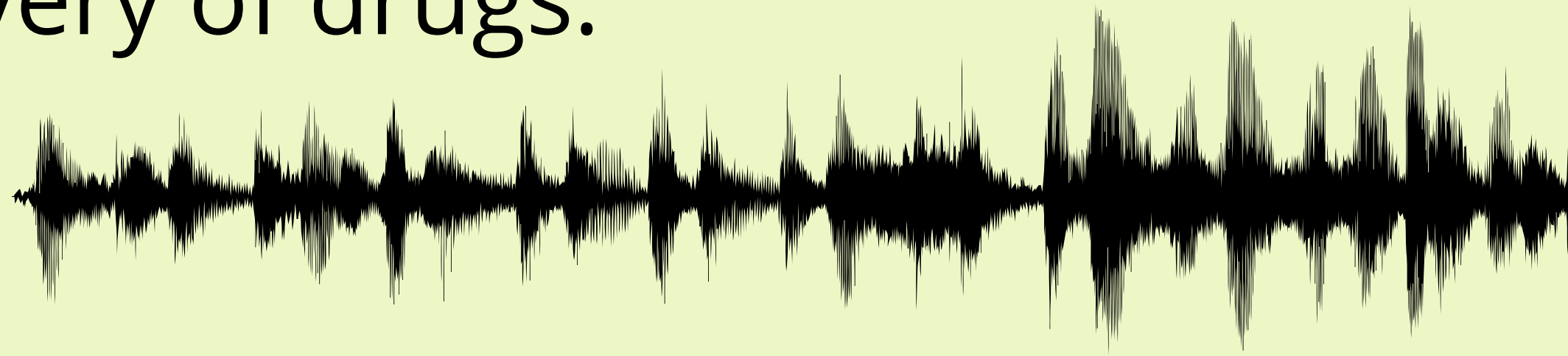


Ultrasound scan

Therapeutic ultrasound

It uses sound waves to communicate with tissues to either change or destroy by:

- Moving
- Heating
- Melting
- Delivery of drugs.

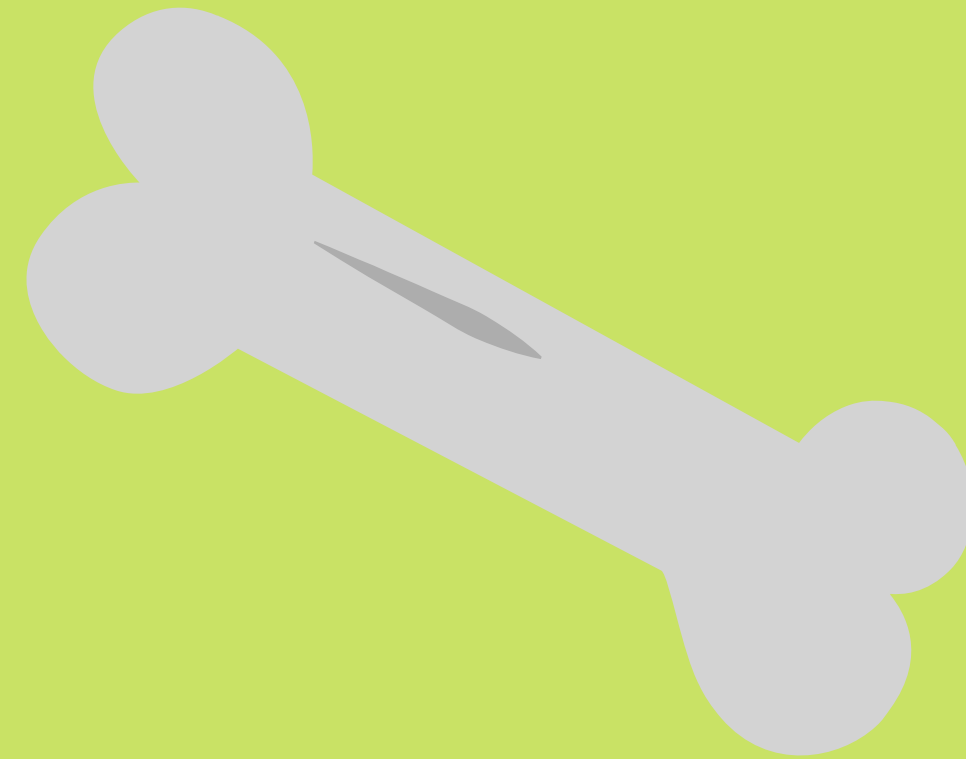


Ultrasound scan

Therapeutic ultrasound

EXAMPLE 1: High Intensity Focused Ultrasound (HIFU)

It is currently used to lower pain in advanced bone cancer where it affects the prostate gland and female reproductive system.



Ultrasound scan

Therapeutic ultrasound

EXAMPLE 1: High Intensity Focused Ultrasound (HIFU)

It is further investigated for:

- The effect on tumours without tearing the skin or cause damage to tissues.*
- How it can stop bleeding and close wounds.*
- How it can allow medications pass through the blood brain area.*



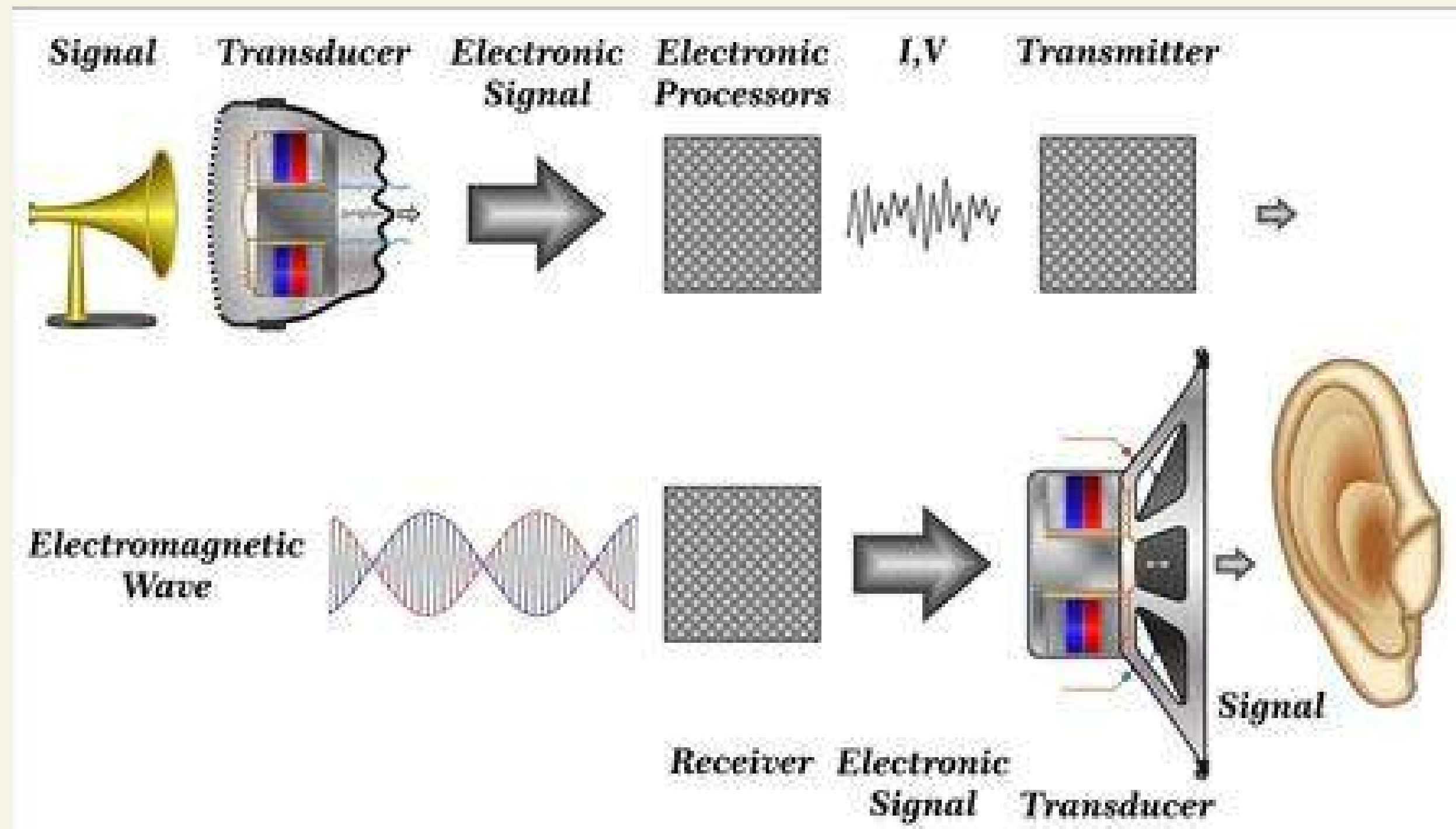
How does an ultrasound scan work?

1) The sonographer applies gel to the skin.



How does an ultrasound scan work?

2) This prevents air between the transducer and the skin which can block ultrasound waves.



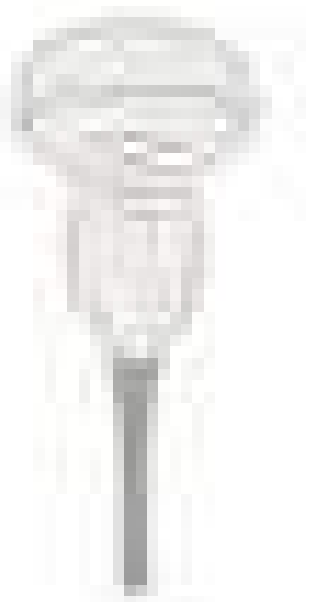
Transducers

They are probes that produces sound waves. Most are placed on the skin.

Others are added inside the digestive system or blood vessels or vagina to bring great quality images.



Types of Transducers



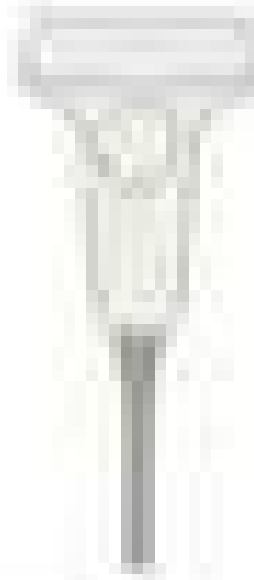
convex



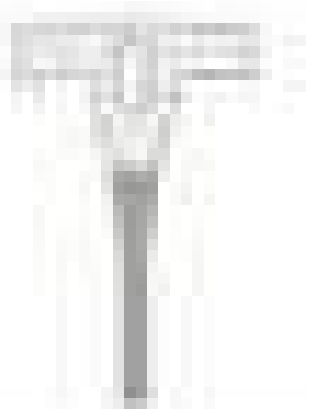
micro convex



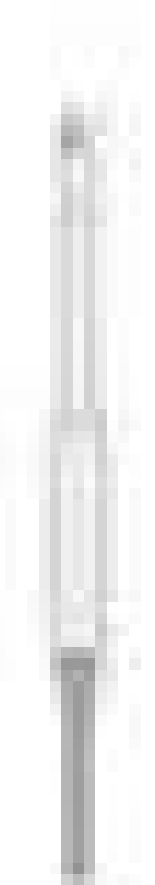
phased array



linear



l-type linear



biplanar



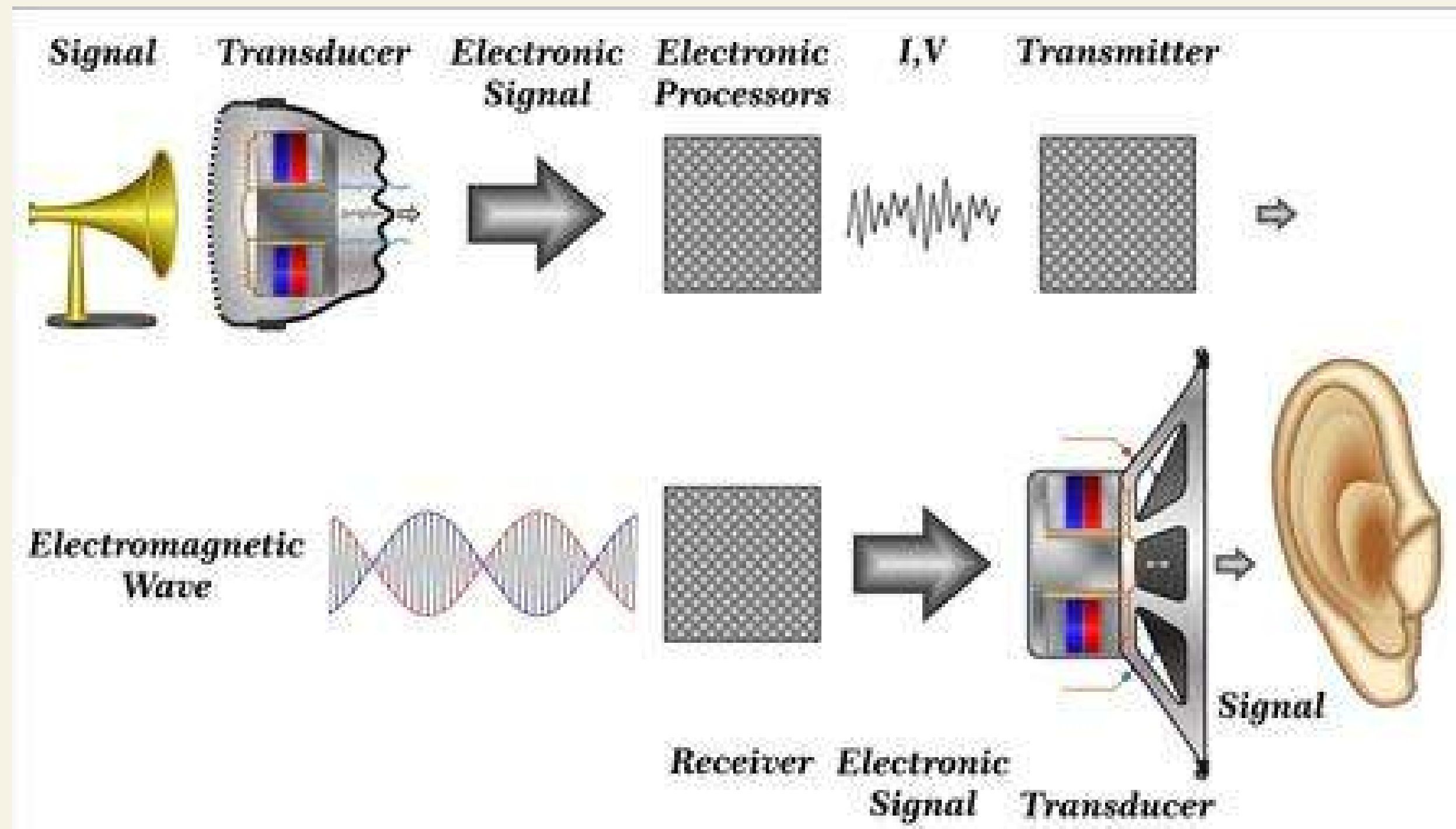
endocavitary



intrarectal

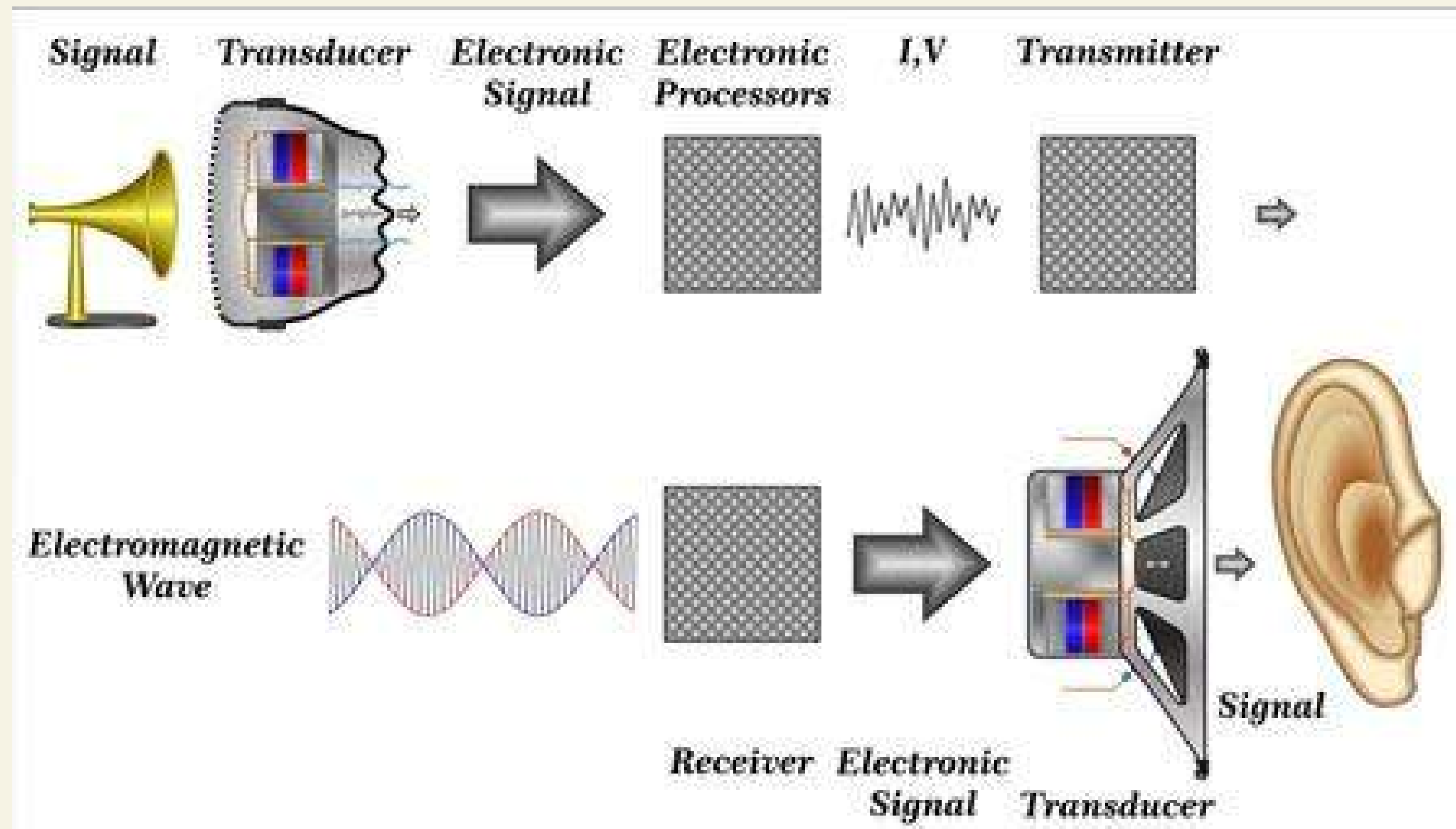
How does an ultrasound scan work?

3) The transducer can give out (emit) ultrasound waves and also detect the echoes given back.



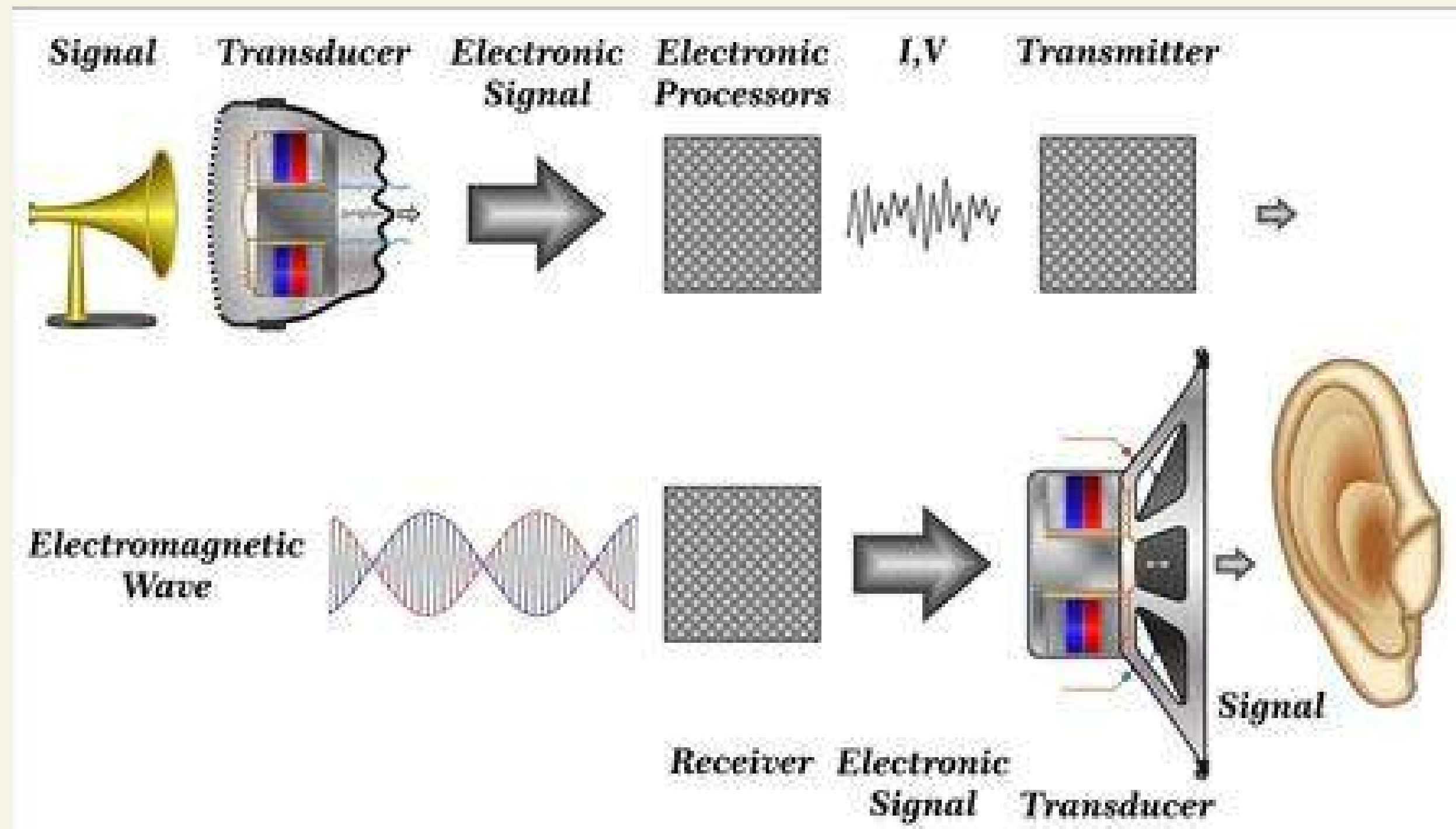
How does an ultrasound scan work?

4) The transducer are made of ceramic crystals called piezoelectrics.



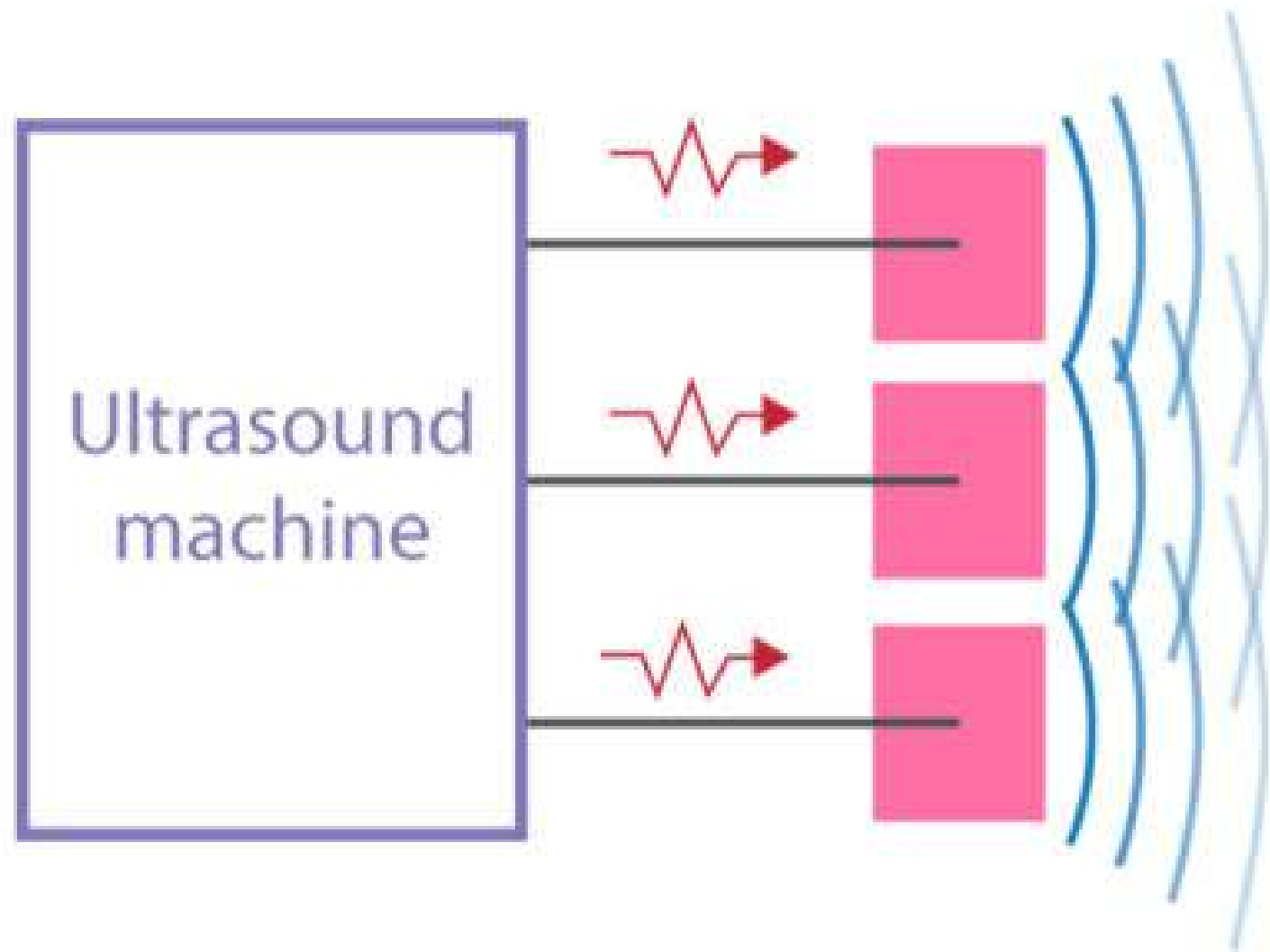
How does an ultrasound scan work?

5) This material can produce sound waves when electricity causes electric field to form is added.

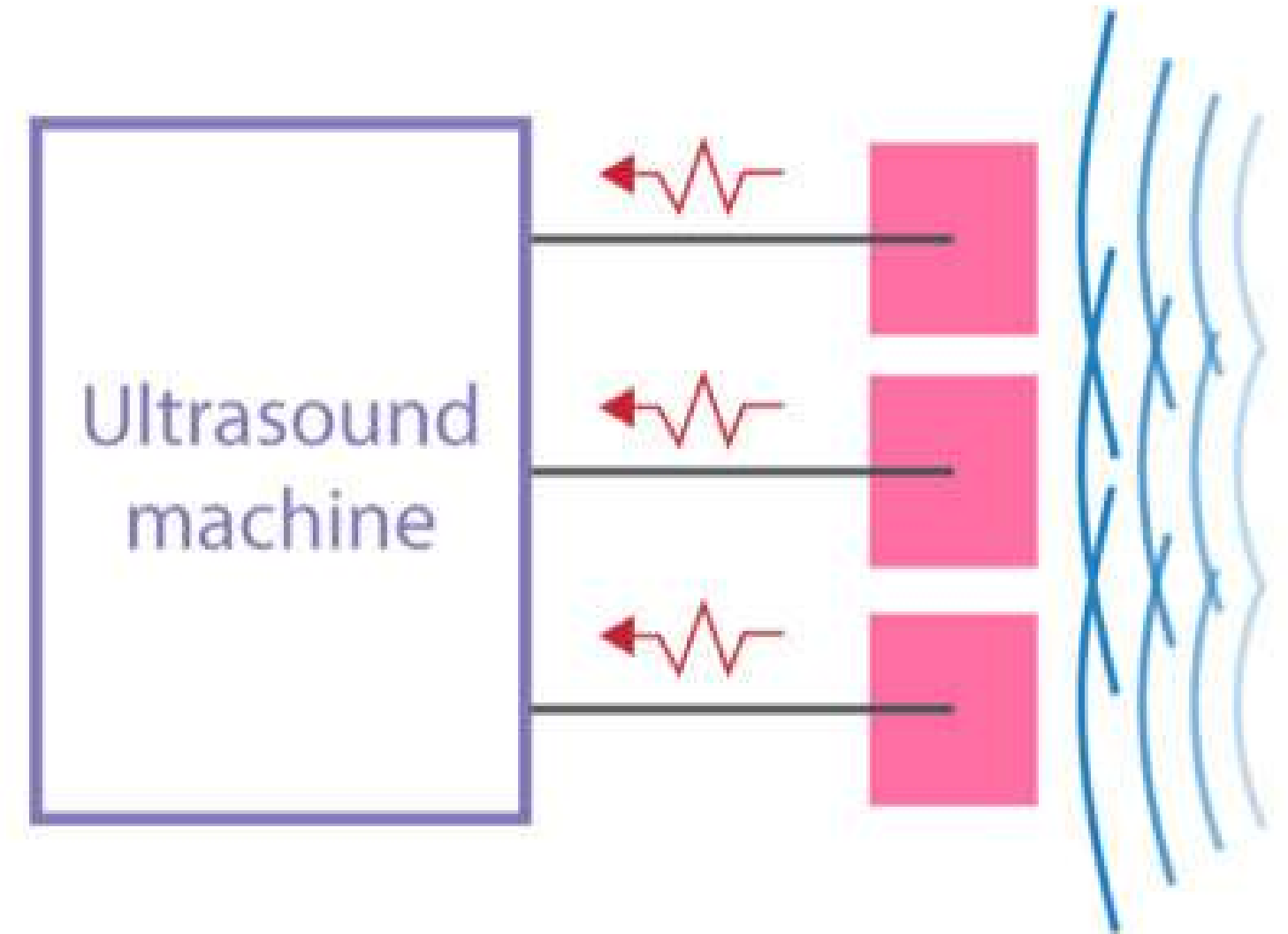


Piezoelectric crystals

■ Piezoelectric crystal  Electrical current



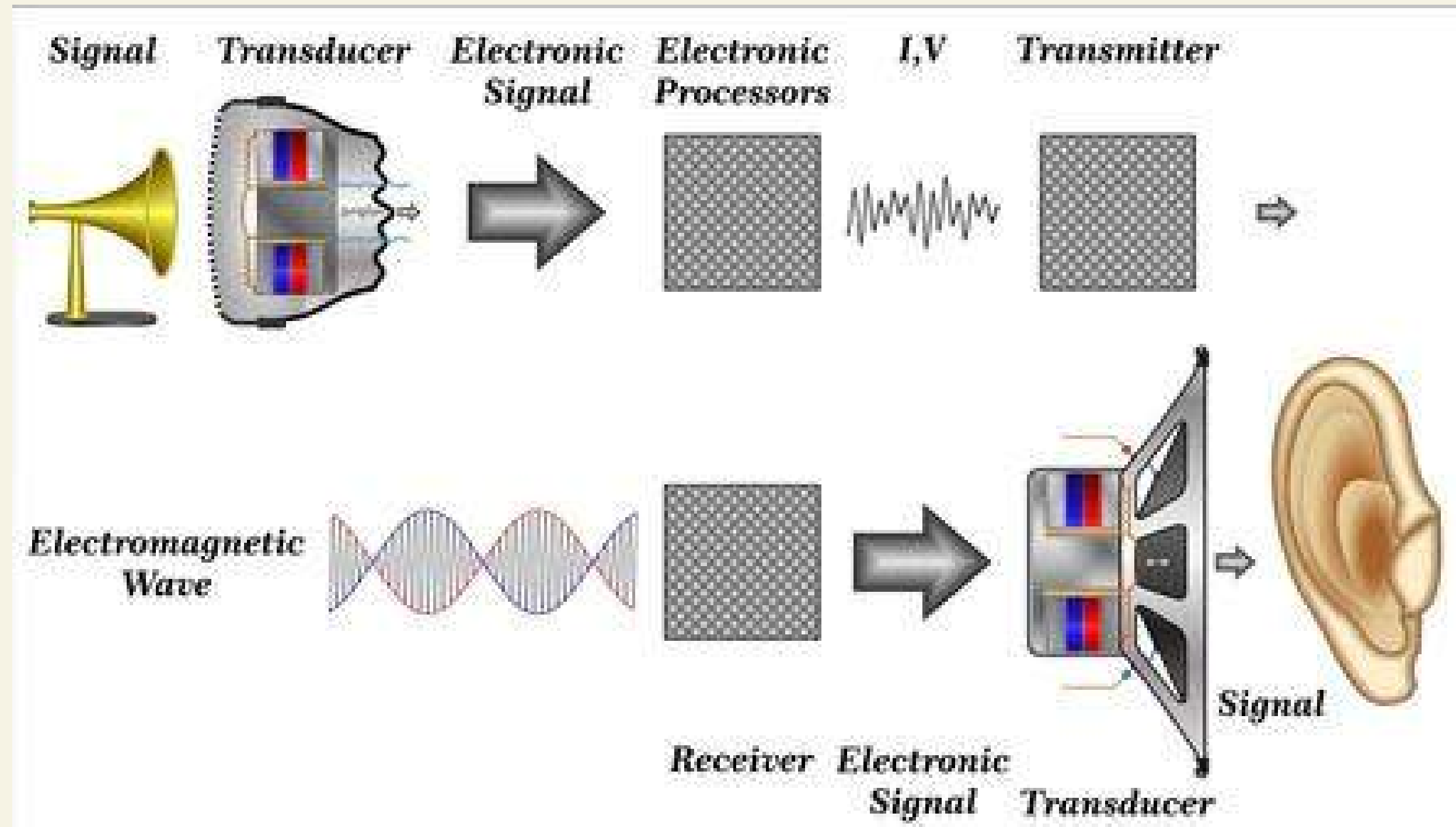
Application of an electrical current to the crystal causes it to vibrate and thus generate ultrasound waves.



Reflected sound waves hit the crystals, causing it to vibrate and generate electrical current that is analyzed by the ultrasound machine.

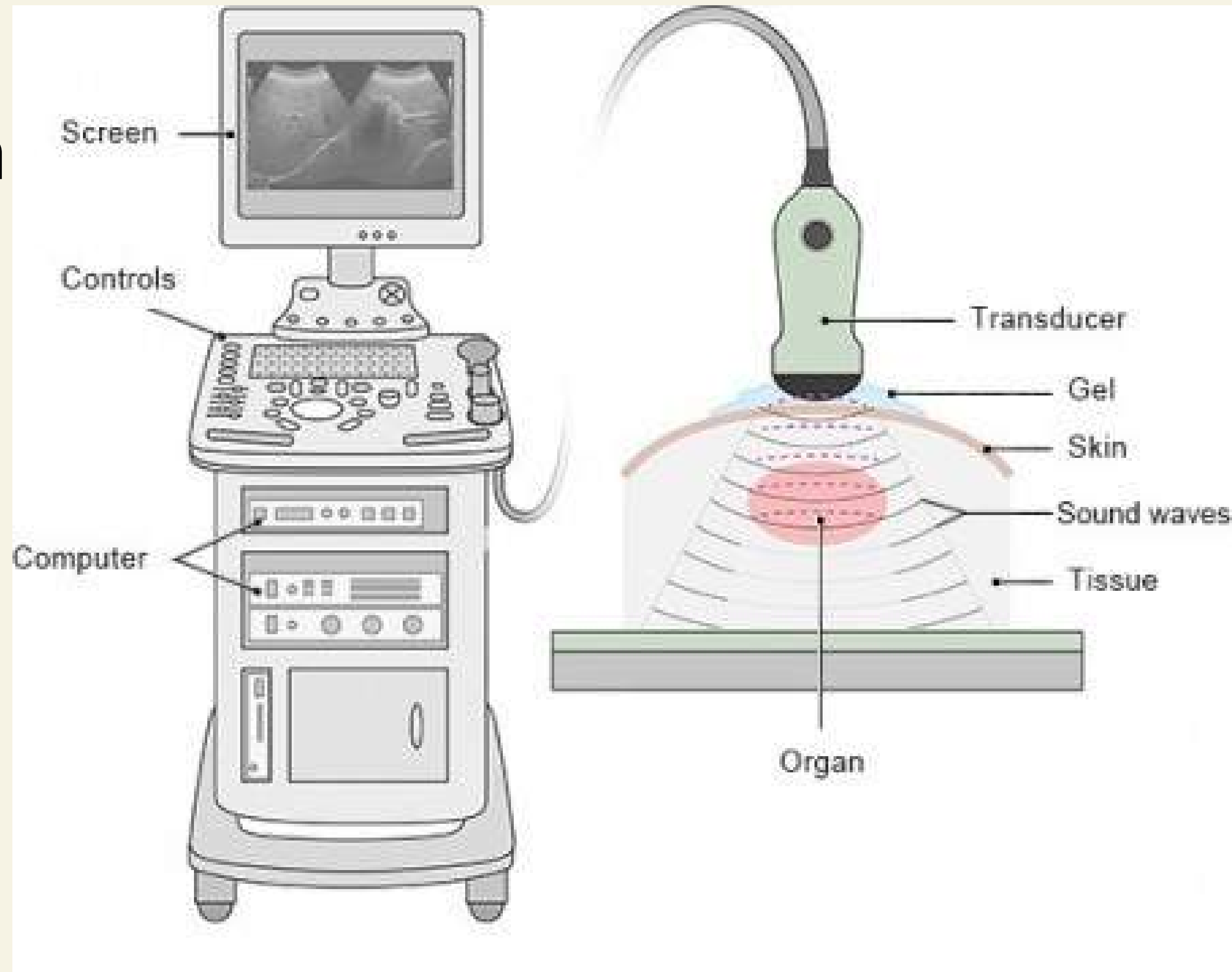
How does an ultrasound scan work?

6) The transducer sends out a beam of sound waves into the body.



How does an ultrasound scan work?

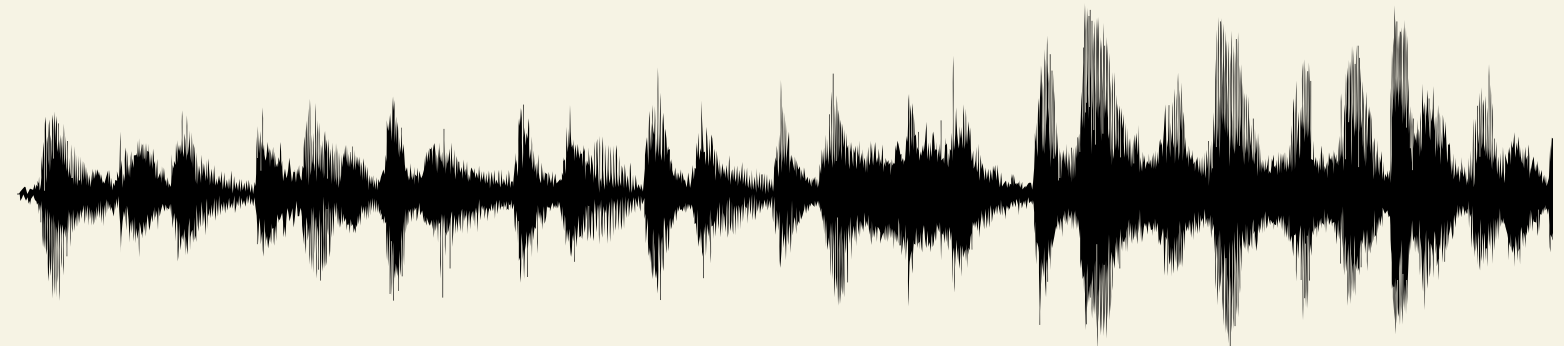
7) The sound waves are reflected back as echoes to the transducer by boundaries between fluid and soft tissues (non-bony) or bone.



How does an ultrasound scan work?

9) The ultrasound scanner calculates the distance from the transducer to the tissue boundary based on:

- **SPEED OF SOUND**
- **TIME OF ECHO REFLECTION**



How does an ultrasound scan work?

10) The distances creates two-dimensional (2D) images of tissues and organs.



The process

Before the ultrasound

The appointment letter will state any preparation regarding eating and drinking.



The process

Before the ultrasound

Removal of any metal objects takes place to not interfere with the waves e.g.

- Jewellery and piercing.
- Dentures (false teeth)
- Wigs
- Hearing aid



The process

Before the ultrasound scan

The patient may be asked to wear a hospital gown or clothes that has no metal objects e.g.:

- Buttons
- belts
- wired bras
- Zips



The process

What happens during the ultrasound?

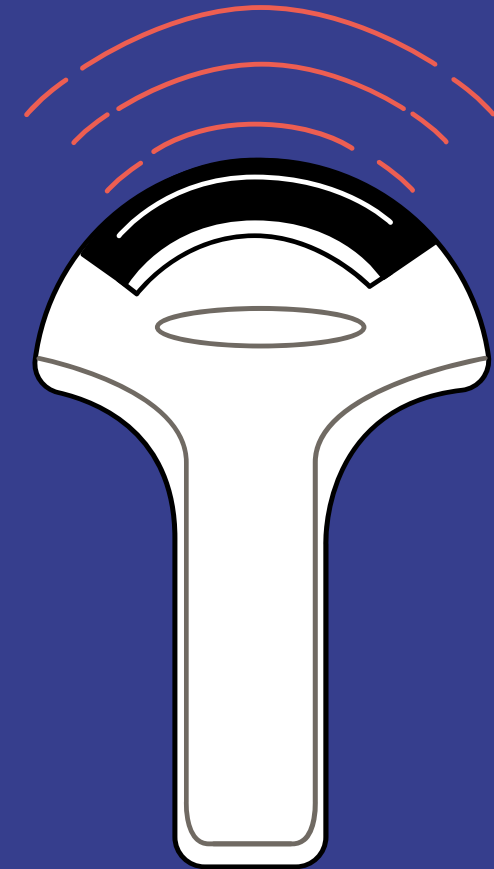
The patient will lie in position depending on what is being investigated.

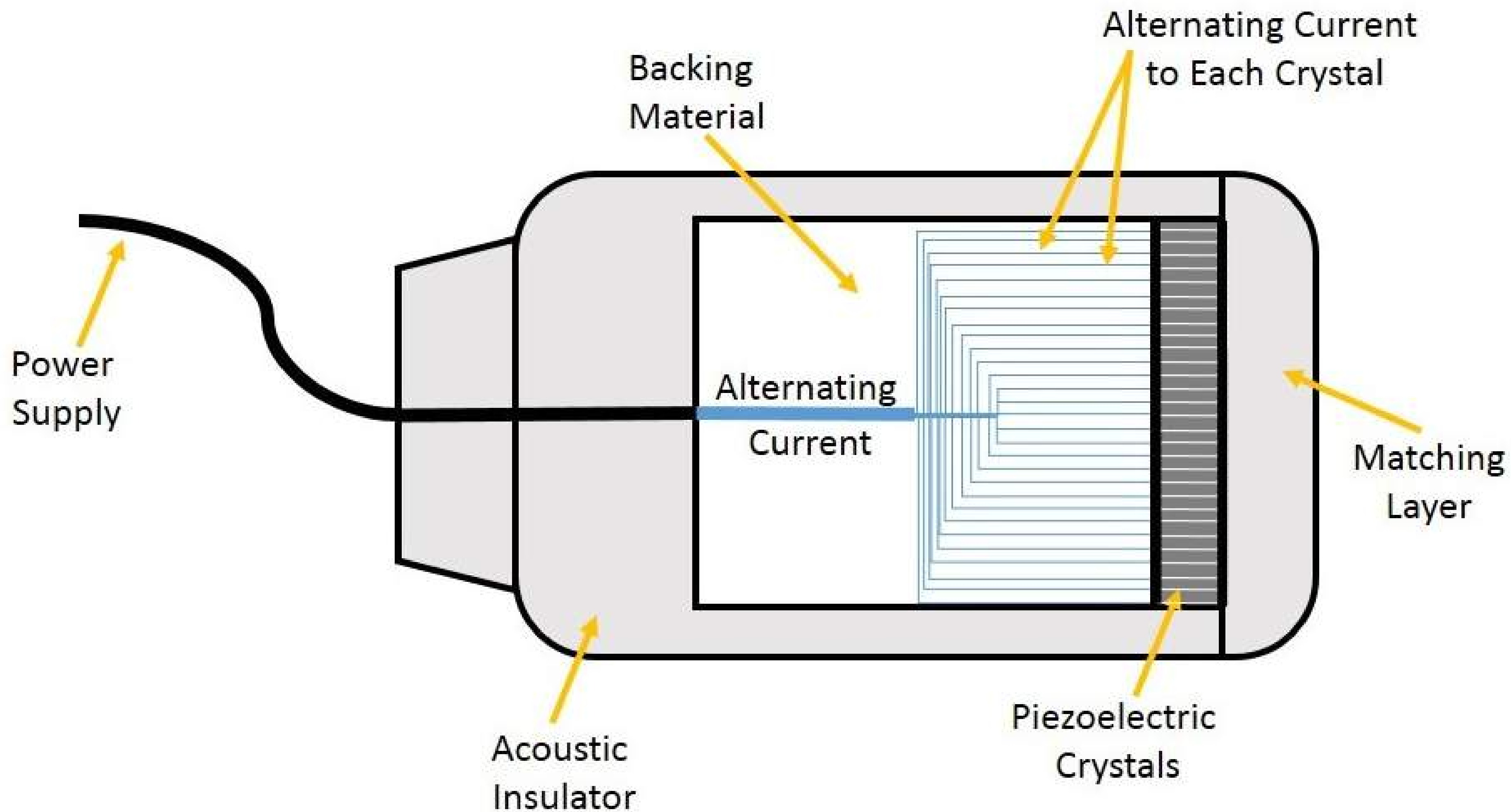


The process

What happens during the ultrasound?

Gel is added to the area
before adding the
transducer.

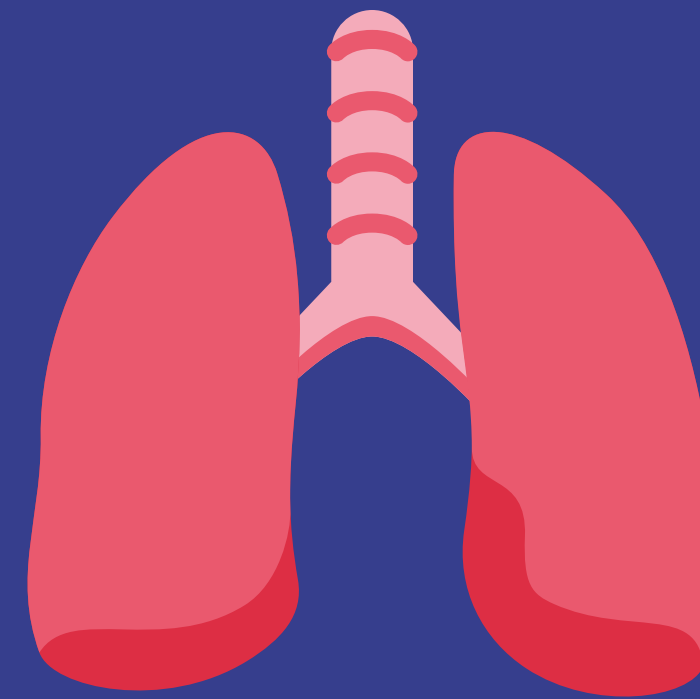




The process

What happens during the ultrasound?

The patient needs to remain still and breathe normally unless told to hold the breathe at specific stages.



The process

What happens during an ultrasound scan?

Most ultrasound scans last between 15 and 45 minutes.



The process

After the scan

Once the scan is done, the patient can resume as normal.



The process

After the scan

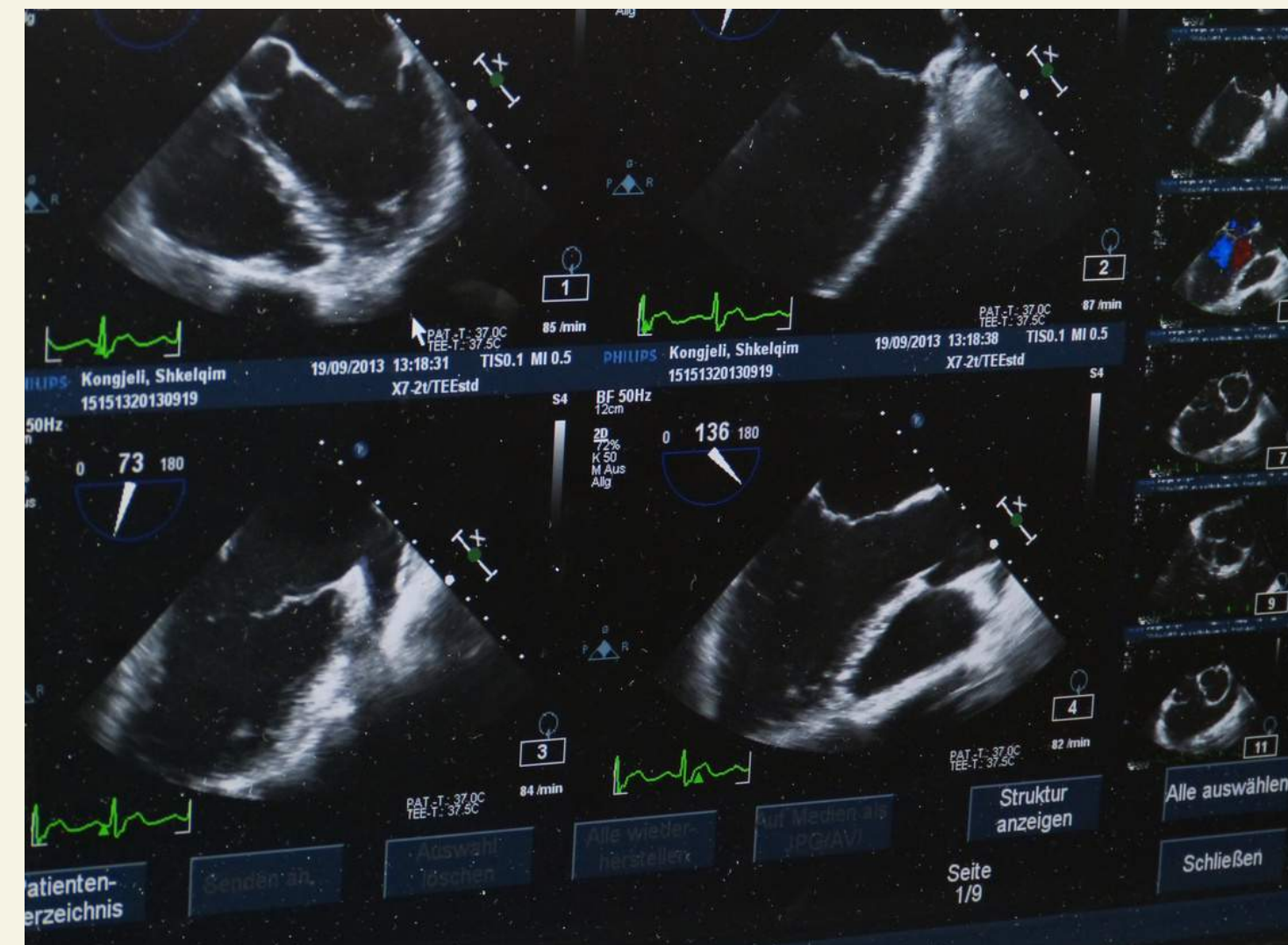
However, if a sedative is used, they need to be taken home by a family or friend.



The process

After the scan

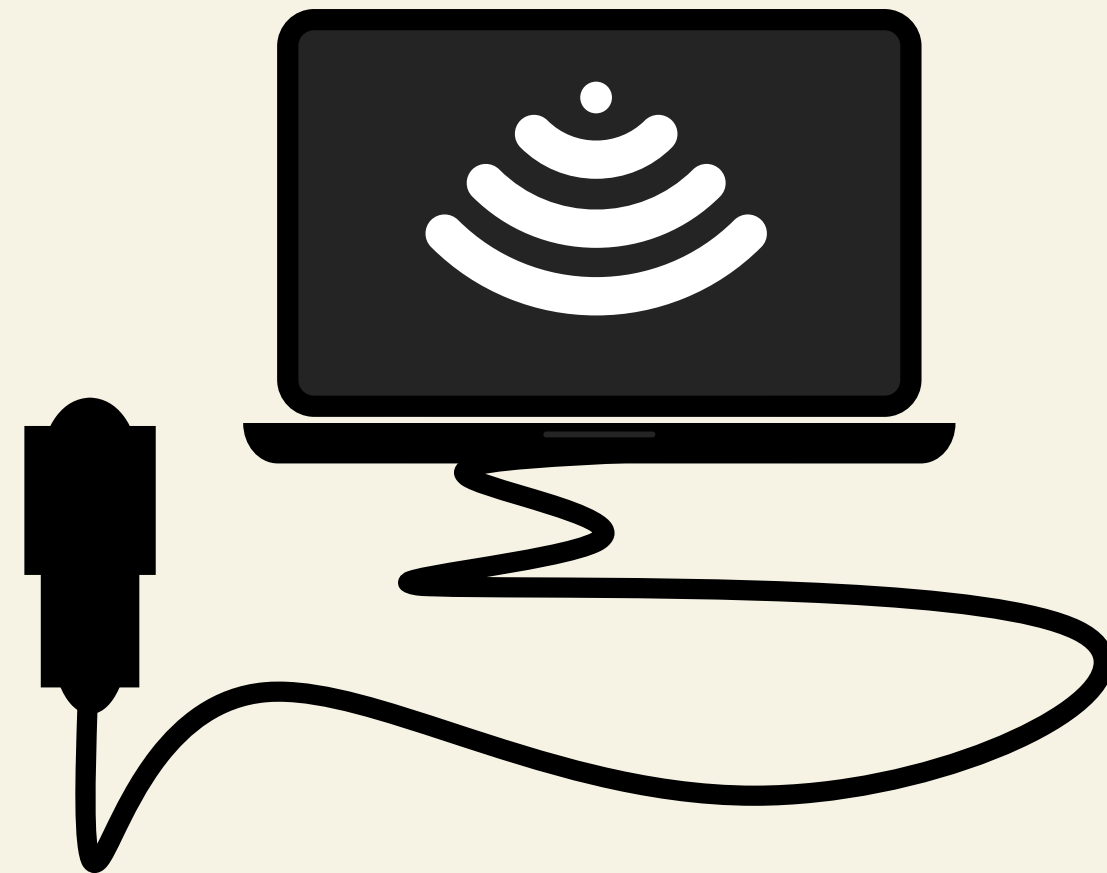
The images will be examined by a radiologist.



The process

After the scan

A radiologist is a doctor who examine the image and creates a report.



Precautions

It is a safe procedure.
It does not produce X-rays.

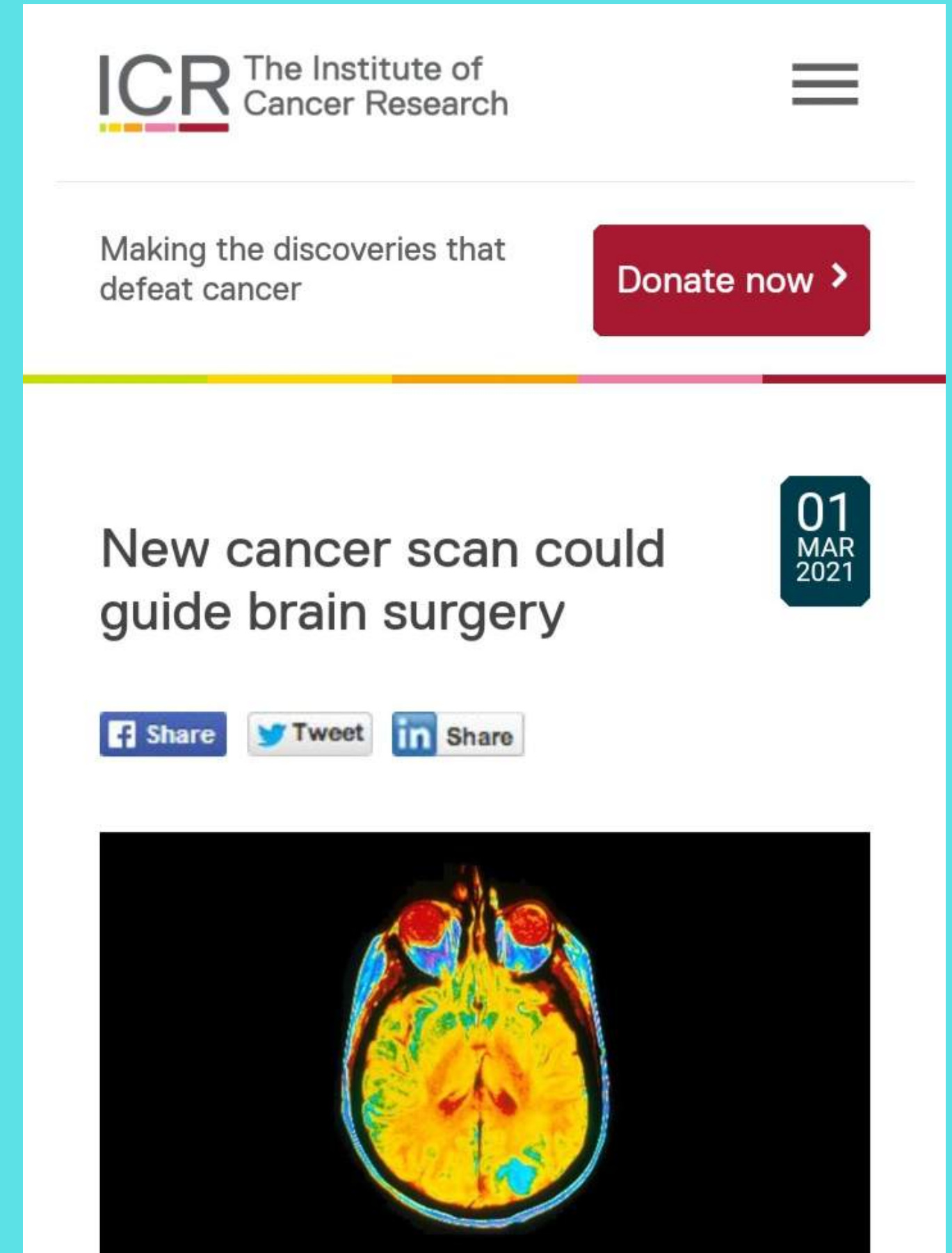


New development - Shear wave elastography

Source: Institute of Cancer Research.

A new ultrasound technique called shear wave elastography detects any cancer left after surgical treatment in brain tumours.

It measures how stretched and stiff are the tissues. Vibrations or shear wavea are made and detected.

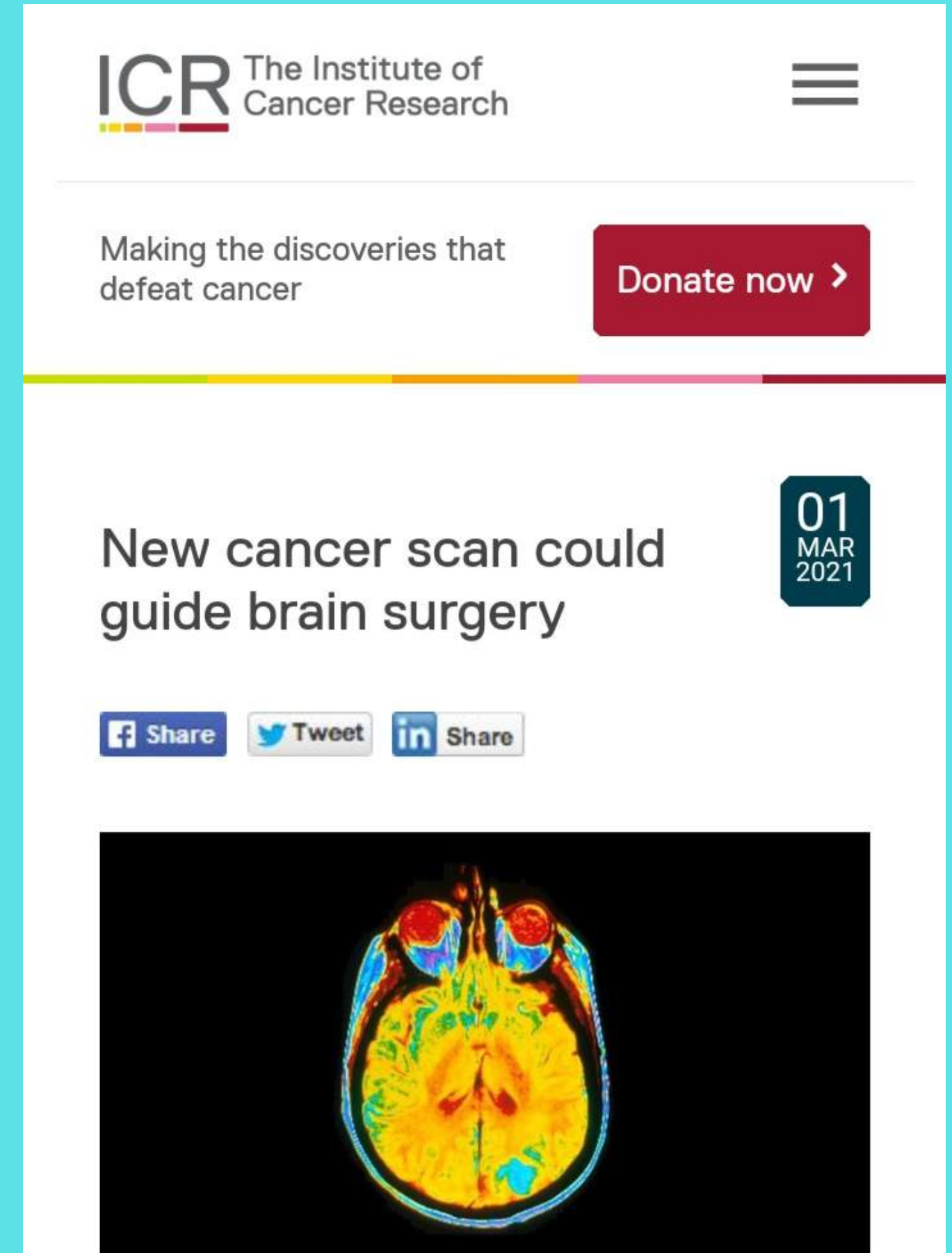


New development - Shear wave elastography

Source: Institute of Cancer Research.

The waves move faster through stiffer tissues.

Brain tumours are stiffer than normal tissues.



New development - Shear wave elastography

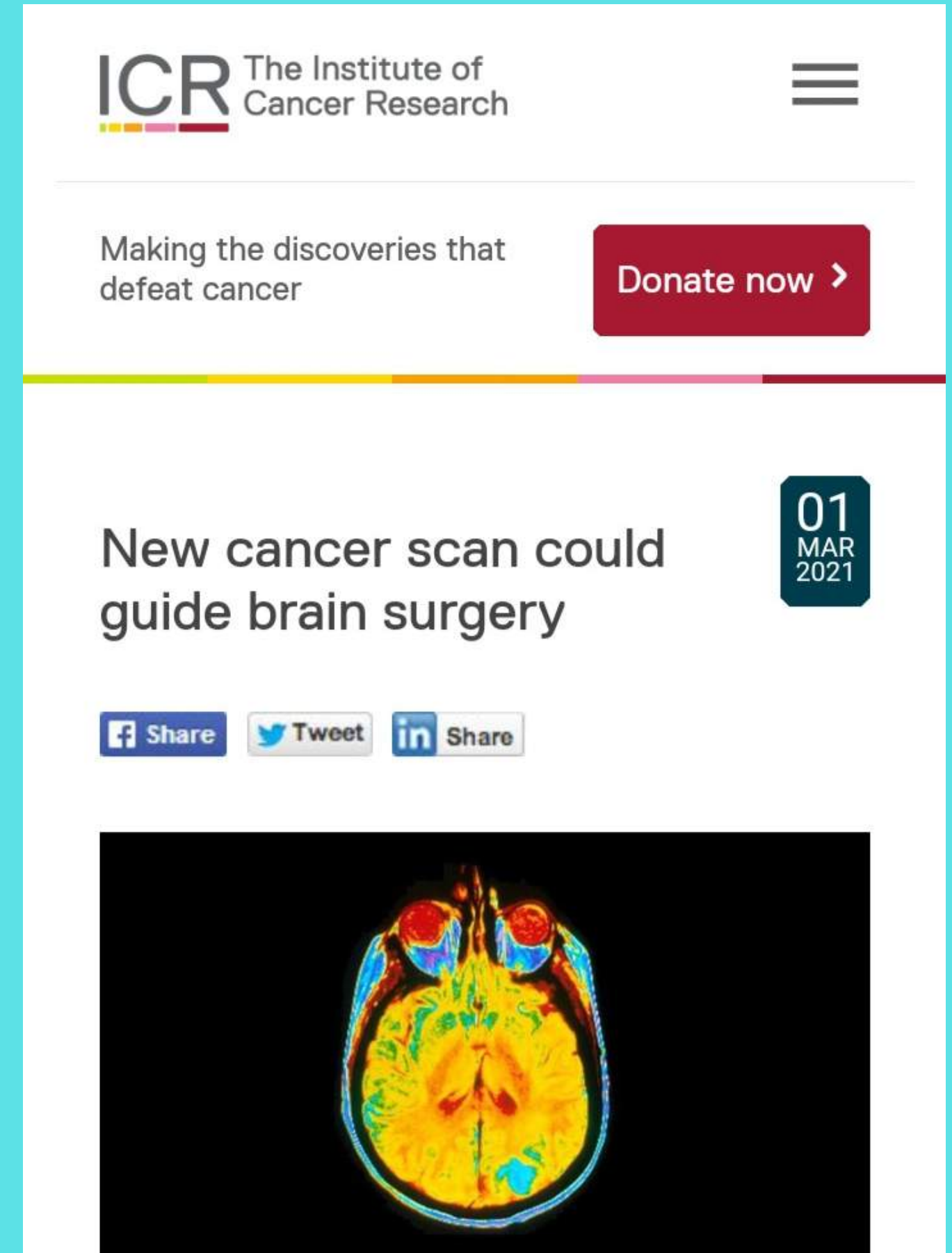
Source: Institute of Cancer Research.

Advantages:

More sensitive, faster and affordable than MRI scans.

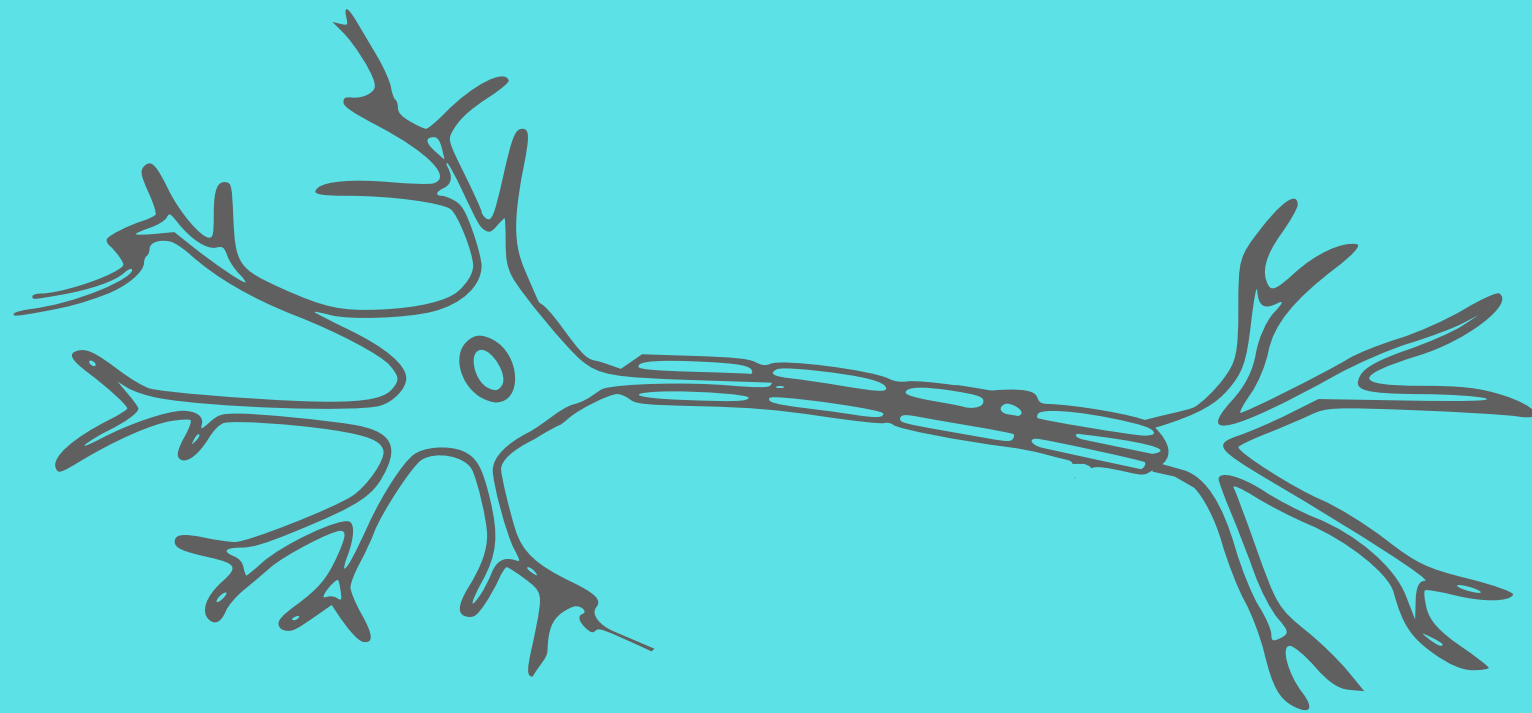
(94% sensitivity compared to 77% of normal ultrasound and 36% for surgeon).

This decreases chances of relapse where the cancer can come back. It is useful in combination with a surgeon.



New development - Detecting nerve cells on and off!

A team used focused ultrasound to develop a way on how to turn nerve cells on and off without surgery!



Source: Science Daily

Science News

from research organizations

New tool activates deep brain neurons by combining ultrasound, genetics

It is the first work to show that sonothermogenetics can control behavior by stimulating a specific target deep in the brain

Date: May 28, 2021

Source: Washington University in St. Louis

Summary: A team has developed a new brain stimulation technique using focused ultrasound that is able to turn specific types of neurons in the brain on and off and precisely control motor activity without surgical device implantation.

Share:



FULL STORY

New development - Detecting vessels in the brain!

Source: Nature Communications

Functional ultrasound provides information about the brain on how well it is functioning with high resolution and detail!

The GPS of the brain is called the vascular brain positioning system (BPS).



nature communications

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Article | [Open Access](#) | Published: 28 March 2019

Functional ultrasound imaging of the brain reveals propagation of task-related brain activity in behaving primates

Alexandre Dizeux , Marc Gesnik, [...]Mickael Tanter 

Nature Communications **10**,
Article number: 1400 (2019) | [Cite this article](#)

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New development - Detecting vessels in the brain!

Source: Nature Communications

Ultrafast ultrasound imaging increased sensitivity to image small cerebral vessels and map the brain to see how well the nerve cells are active!



nature communications

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Article | [Open Access](#) | Published: 28 March 2019

Functional ultrasound imaging of the brain reveals propagation of task-related brain activity in behaving primates

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These are a few examples of many more research conducted on ultrasound to aid in diagnosing cancer and other conditions!

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Part 13: Diagnosis - PET scan

UPCOMING VIDEO RELEASING SOON!

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Oxford Handbook of Oncology

Canva

Shutterstock images

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Nature Communications

Sciencedaily.com

The Institute of Cancer Research

International Ultrasound Services

ECG and Echo learning

***Thank
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