Chapter

1

Introduction to Ultrasonography

1.1 What is ultrasound?

Ultrasound is the name given to high-frequency sound waves. Diagnostic ultrasound, also called sonography or diagnostic medical sonography, is an imaging method that uses high-frequency sound waves to produce images of structures within your body. These images can provide valuable information for diagnosing and treating a variety of diseases and conditions. Most ultrasound examinations are performed using a device outside your body, although some may involve placing a device inside your body.

Ultrasound:- Extreme, Increase, high.

Sound:- Vibrations that can travel through any medium.

Definition:- *The vibrations are of the same physical nature as sound, but with a frequency above the range of human hearing. It is the type of sound waves that have a higher frequency than audible sound, i.e., human ears can hear sound waves with frequencies ranging from 20Hz to 20,000Hz. Ultrasound frequencies range from 20,000Hz to 300,000Hz.*

Frequency of audible sound: 20 Hz – 20,000 Hz

Ultrasound frequency: 20000 Hz – 300000 Hz

1,000 HZ = 1 kilo HZ

10,000 HZ = 1 Mega Hz

300,000 HZ = 30 MHZ

Hertz (**HZ**): Amount of frequency OR vibration per second. S.I. Unit of sound.

Frequency: Number of waves per second.

Properties of ultrasound waves

1. They travel in straight direction.
2. They cannot travel in air or vacuum, bones.
3. When these collide with hard material, this comeback and produce white image.

4. These can partially travel from soft objects which produce lighter image.
5. These completely pass from liquid area and produce a black image.

Advantages of ultrasound

1. It is not expensive.
2. It doesn't cause irritation and is painless.
3. It is neither erosive nor invasive.
4. It does not damage tissues of the body.
5. It gives 100% accurate result if the technician is expert.

Some key points about ultrasound imaging

1. **How it works**
   - During an ultrasound examination, a small handheld device called a transducer is used to transmit high-frequency sound waves into the body.
   - These sound waves bounce off internal structures and are reflected back to the transducer, which converts them into images that can be viewed on a screen in real time.
2. **Uses**
   - Ultrasound is used to visualize various organs and structures in the body, including the heart, liver, kidneys, bladder, uterus, ovaries, and blood vessels.
   - It is commonly used during pregnancy to monitor fetal growth and development, as well as to assess the health of the placenta and amniotic fluid.
3. **Types of ultrasound**
   - There are several types of ultrasound examinations, including:
   - *Abdominal ultrasound*: to visualize organs in the abdomen, such as the liver, gallbladder, and kidneys.
   - *Pelvic ultrasound*: to examine the reproductive organs in both men and women.
   - *Transvaginal ultrasound*: a type of pelvic ultrasound that is performed with a probe inserted into the vagina for better visualization of the uterus and ovaries.
   - *Doppler ultrasound*: to assess blood flow in the arteries and veins.
   - *Obstetric ultrasound*: to monitor fetal development during pregnancy.
4. **Safety**
   - Ultrasound is considered safe and noninvasive, with no known harmful effects on humans when used appropriately.
   - It does not use ionizing radiation, unlike X-rays or CT scans.
5. **Limitations**
   - While ultrasound is a valuable imaging tool, it has limitations. It may not provide detailed images of structures that are obscured by gas or bone, and it may not be able to detect all abnormalities.

6. **Preparation**
   - Preparation for an ultrasound examination depends on the specific type of ultrasound being performed and the area of the body being imaged.
   - Patients may be asked to fast for certain abdominal ultrasounds or to drink water to fill the bladder for pelvic ultrasounds.

7. **Interpretation**
   - Ultrasound images are interpreted by radiologists or healthcare providers trained in medical imaging.
   - The findings from an ultrasound examination are used to diagnose and monitor various medical conditions.

Ultrasound is a versatile and widely used imaging technique that provides valuable information for diagnosing and monitoring a variety of medical conditions. It is safe, noninvasive, and does not expose patients to ionizing radiation, making it a preferred imaging modality in many situations.

1.2 Ultrasound Machine

An ultrasound machine, also known as a sonography machine, is a medical device used to create images of internal body structures using high-frequency sound waves. These images, called sonograms, are used providers to diagnose and monitor various medical conditions.

Features found in an ultrasound machines

1. **Transducer Options**: Ultrasound machines come with different types of transducers (probes) that are specialized for imaging different parts of the body and for different purposes. Common types include convex (abdominal), linear (vascular, musculoskeletal), phased array (cardiac), and endocavitary (transvaginal, transrectal).
2. **Real-time Imaging**: One of the key features of ultrasound is its ability to provide real-time imaging, allowing healthcare providers to see structures in motion and assess function (e.g., heart valves, fetal movement).
3. **2D, 3D, and 4D Imaging**: Most modern ultrasound machines offer 2D imaging, which provides flat, two-dimensional images. Some machines also offer 3D imaging, which creates three-dimensional images of the anatomy. 4D imaging adds the element of time, creating a moving, real-time 3D image (commonly used in obstetrics).
4. **Doppler Imaging**: Doppler ultrasound allows for the assessment of blood flow in vessels and the heart. It can detect the direction and speed of blood flow, helping to diagnose conditions such as deep vein thrombosis (DVT) or heart valve abnormalities.
5. **Color Doppler**: Color Doppler adds color to the Doppler image, making it easier to visualize blood flow patterns. Different colors represent blood flow in different directions (e.g., red for flow toward the transducer, blue for flow away from the transducer).
6. **Power Doppler**: Power Doppler is more sensitive than color Doppler and is used to detect low-velocity blood flow, making it useful for assessing blood flow in small vessels or in areas with slow flow.
7. **Tissue Harmonics Imaging**: Tissue harmonics imaging uses harmonic frequencies to improve image quality and contrast resolution, particularly in difficult-to-image patients (e.g., obese patients).
8. **Elastography**: Elastography is a technique that measures the stiffness or elasticity of tissues. It is used to assess liver fibrosis, breast lesions, and other conditions where tissue stiffness is relevant.

9. **Image Storage and Archiving**: Modern ultrasound machines have the capability to store images digitally and integrate with electronic medical record (EMR) systems for easy access and review.
10. **Portable and Point-of-Care Ultrasound**: Some ultrasound machines are designed to be portable, allowing for imaging at the bedside or in remote locations. These machines are often used in emergency settings, intensive care units (ICUs), and in rural healthcare settings.
11. **Advanced Applications**: Some ultrasound machines offer advanced imaging modes and applications, such as contrast-enhanced ultrasound (CEUS), which uses microbubble contrast agents to improve imaging of blood flow and tissue perfusion.
12. **User Interface**: The user interface of ultrasound machines varies, but most have intuitive controls and presets for different types of exams.

Components of an ultrasound machine

Transducer: The transducer is the handheld device that emits and receives ultrasound waves. It converts electrical energy into sound waves and vice versa. Different types of transducers are used for different applications, such as abdominal, vascular, cardiac, or obstetric imaging.

Probe Connector: The probe connector is where the transducer is connected to the ultrasound machine. It allows for the exchange of signals between the transducer and the machine.

Control Panel: The control panel contains the controls and settings for the ultrasound machine. This includes settings for depth of penetration, frequency of the ultrasound waves, and image quality adjustments.

Monitor: The monitor displays the real-time ultrasound images produced by the transducer. It allows the sonographer or healthcare provider to visualize internal structures and make diagnostic decisions.

Keyboard/Touchscreen: The keyboard or touchscreen interface allows the operator to input patient information, adjust settings, and navigate through the imaging options.

Trackball/Touchpad: Some ultrasound machines have a trackball or touchpad for navigation and image manipulation. This allows the operator to zoom in or out, rotate images, and adjust the focus.

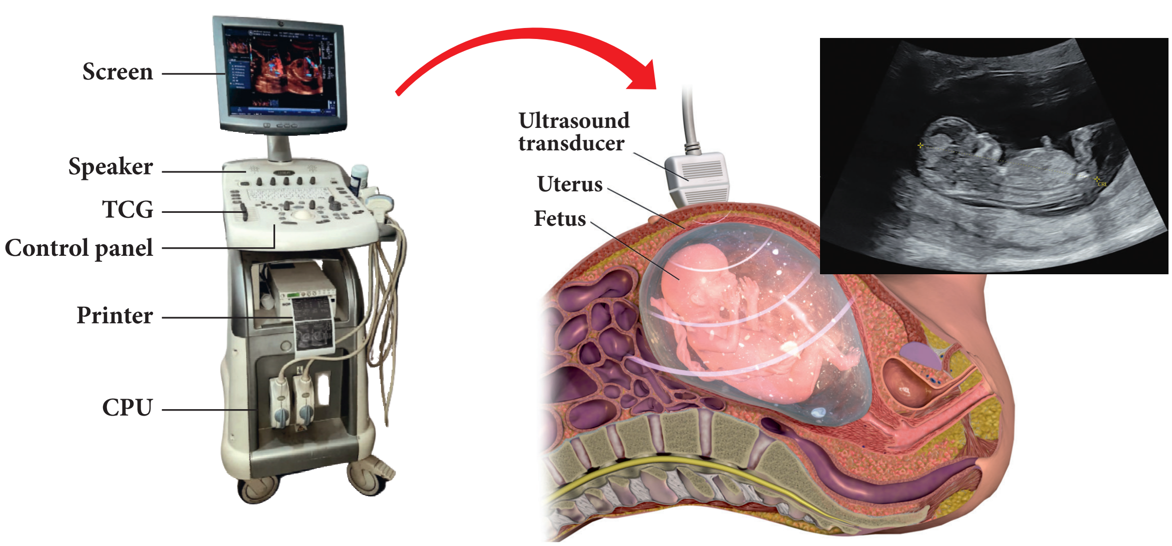

Figure 1.1 USG machine and its functional parts.

Storage and Connectivity: Modern ultrasound machines have storage capabilities to save images and patient data. They also have connectivity options to transfer images to other devices or to store them in electronic medical records (EMRs).

Power Supply: Ultrasound machines require a stable power supply to operate. They may be powered by electricity or have a battery backup for use in areas with unreliable power sources.

Printer: Some ultrasound machines have a built-in printer to print hard copies of ultrasound images for patient records or referral.

Software: The software in an ultrasound machine controls the operation of the machine and processes the ultrasound signals to produce images. It may include advanced imaging modes and features for specific applications.

Buttons available on the keyboard of an ultrasound machine

1. **Power Button**: Turns the ultrasound machine on or off.
2. **Freeze Button**: Pauses the real-time image, allowing the operator to capture a still image.
3. **Cine Loop Button**: Records a short video clip of the real-time image.
4. **Depth Button:** Adjusts the depth of penetration of the ultrasound waves.
5. **Gain Button:** Adjusts the overall brightness of the image.
6. **Zoom Button:** Zooms in or out on the image.
7. **Focus Button:** Adjusts the focal point of the ultrasound beam.
8. **Save Button:** Saves the current image or video clip.
9. **Measurements Button:** Allows the operator to take measurements of structures in the image, such as distances or angles.
10. **Preset Buttons:** Allows the operator to quickly switch between pre-set imaging settings for different types of examinations (e.g., abdominal, obstetric, cardiac).
11. **Image Review Buttons:** Allows the operator to review saved images or video clips.
12. **Patient Information Input:** Allows the operator to input patient information, such as name, age, and exam date.
13. **Report Generation:** Allows the operator to generate a report based on the findings of the ultrasound examination.
14. **System Setup:** Allows the operator to access and adjust various system settings, such as image quality, transducer settings, and Doppler settings.
15. **M. mode:** The M-mode (Motion mode) button on an ultrasound machine allows the operator to switch to M-mode imaging. It commonly used in cardiac imaging to assess the motion of the heart valves, chambers, and walls. It can help visualize the timing and coordination of heart contractions, as well as detect abnormalities in heart function. M-mode is also used in obstetric imaging to assess fetal heart motion and activity.
16. **B. mode:** The B-mode (Brightness mode) button on an ultrasound machine is used to switch to B-mode imaging, which is the standard two-dimensional imaging mode used in ultrasound. In B-mode, the ultrasound machine creates a two-dimensional, grayscale image of the internal structures of the body based on the echoes of the ultrasound waves.
17. **T.G.C:** The TGC (time gain compensation) is controlled by a row of toggles (pin like), TGC allows the gain to be adjusted differently at different depth. The depth is determined by the time it takes the signal to return to the transducer, that's why it is called time gain compensation hence the amount of gain in the near field might be decreased to darken area of soft tissue, while increasing the gain in the far field to brighten the deeper structure of the heart, making it appear clearer on the screen.

Coupling gel

Although gel is not a part of ultrasound machine but it is an important agent.

Coupling gel, also known as **ultrasound gel**, is a clear, water-based gel used in ultrasound examinations to create a medium through which sound waves can travel between the transducer and the skin.

Purpose

Coupling gel is used to eliminate air pockets between the ultrasound transducer and the skin. Air is a poor conductor of sound waves and can interfere with the transmission of ultrasound waves, leading to poor image quality.

Composition

Coupling gel is typically made of water, propylene glycol, glycerin, or a similar viscous substance. It is formulated to be non-greasy, water-soluble, and easily removed from the skin.

Application

Before performing an ultrasound examination, a small amount of coupling gel is applied to the skin over the area to be examined. The gel helps the ultrasound waves to pass through the skin and into the body, where they bounce off internal structures and create images.

Benefits

Coupling gel improves the acoustic coupling between the transducer and the skin, resulting in clearer and more detailed ultrasound images. It also helps to reduce friction between the transducer and the skin, making the examination more comfortable for the patient.

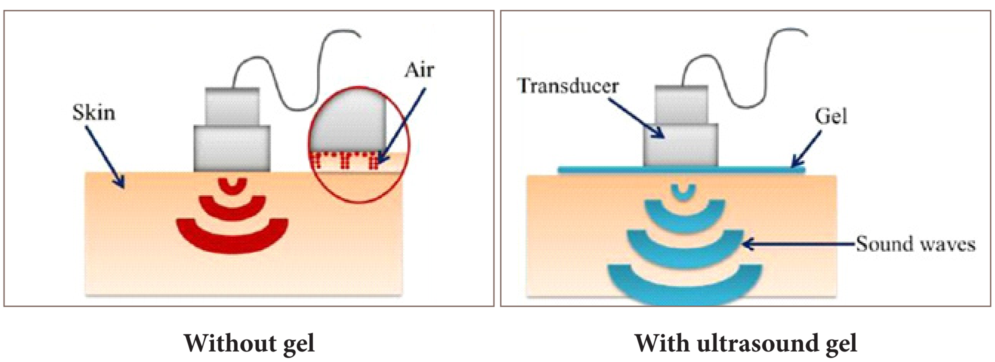

Figure 1.2 Difference sound frequency quality with or without coupling agent.

1.3 Transducer

A **transducer**, also known as a **probe**, is a key component of an ultrasound machine used to send and receive ultrasound waves. It is a handheld device that is placed on the skin over the area being examined. The probe contains one or more crystals that vibrate when an electrical current is applied, producing sound waves at a frequency higher than the human ear can hear. These sound waves travel into the body and bounce off tissues, organs, and other structures, creating echoes that are detected by the same crystals in the probe. The echoes are then converted into electrical signals, which are processed by the ultrasound machine to create real-time images of the internal structures. Probes come in various shapes and sizes, each designed for specific types of imaging, such as abdominal, cardiac, vascular, or obstetric ultrasound.

Components of an ultrasound probe

1. **Piezoelectric Crystals**: These crystals are the core components of the probe. When an electrical current is applied to them, they vibrate and emit ultrasound waves. Conversely, when ultrasound waves strike the crystals, they generate electrical signals that are used to create images.
2. **Matching Layer**: This layer is placed between the piezoelectric crystals and the patient's skin. Its purpose is to match the acoustic impedance of the crystals to that of the skin, allowing for optimal transmission of ultrasound waves.
3. **Backing Material:** This material is located behind the piezoelectric crystals and helps to absorb and reduce the reflection of ultrasound waves, improving the quality of the images.
4. **Acoustic Lens:** Some probes are equipped with an acoustic lens to focus the ultrasound beam, improving the resolution and clarity of the images.
5. **Wear Plate:** This is a protective layer that covers the face of the probe and helps to prevent damage to the crystals.
6. **Cable:** The probe is connected to the ultrasound machine via a cable that carries electrical signals to and from the crystals.
7. **Housing:** The probe is housed in a casing that protects its internal components and allows for easy handling during examinations.

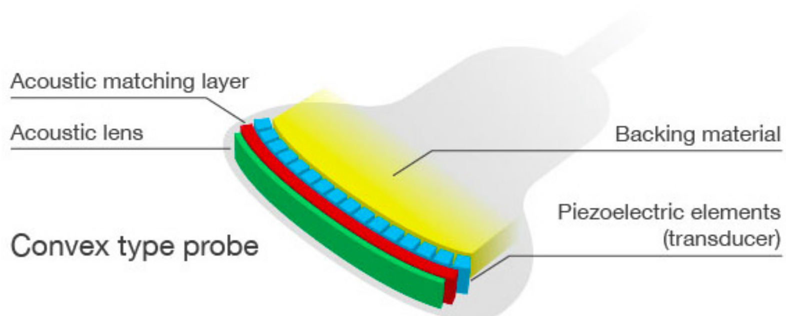

Figure 1.3 Model of ultrasound curvilinear transducer probe.

Piezoelectric crystals

Piezoelectric crystals are a type of material that exhibits the piezoelectric effect, which means they can generate an electric charge in response to mechanical stress or pressure, and vice versa. These crystals are commonly used in ultrasound transducers (probes) to convert electrical energy into mechanical vibrations (sound waves) and vice versa.

Material Composition

Piezoelectric crystals are typically made from certain types of ceramics, such as lead zirconate titanate (PZT), or certain polymers, such as polyvinylidene fluoride (PVDF). These materials have a crystalline structure that allows them to exhibit the piezoelectric effect.

Generation of Ultrasound Waves

When an electrical voltage is applied to piezoelectric crystals, they deform or vibrate, generating mechanical waves in the form of ultrasound. This process is known as the direct piezoelectric effect.

Reception of Ultrasound Waves

Conversely, when ultrasound waves strike piezoelectric crystals, they cause the crystals to deform or vibrate, generating an electrical signal. This process is known as the inverse piezoelectric effect.

Use in Ultrasound Transducers

In ultrasound transducers, piezoelectric crystals are arranged in an array and sandwiched between electrodes. When an electrical voltage is applied to the electrodes, the crystals vibrate, emitting ultrasound waves into the body. When ultrasound waves return and strike the crystals, they generate electrical signals that are used to create images.

Frequency and Size

The frequency of the ultrasound waves generated by piezoelectric crystals depends on the size and thickness of the crystals. Higher frequencies are typically used for imaging superficial structures, while lower frequencies penetrate deeper into the body.

Function of transducer

1. **Emitting Ultrasound Waves:** The probe contains piezoelectric crystals that convert electrical energy into mechanical vibrations (ultrasound waves). These waves are emitted into the body and travel through the tissues.
2. **Receiving Echoes:** When the ultrasound waves encounter interfaces between tissues of different densities, such as between muscle and bone, some of the waves are reflected back to the probe as echoes. The probe's crystals detect these echoes and convert them into electrical signals.
3. **Creating Images:** The electrical signals from the probe are sent to the ultrasound machine, where they are processed and used to create real-time images of the internal structures. The machine calculates the distance to each tissue interface based on the time it takes for the ultrasound waves to travel to and from the probe.
4. **Adjusting Frequency and Depth:** The probe can be adjusted to emit ultrasound waves at different frequencies and depths. Higher frequencies provide better resolution for superficial structures, while lower frequencies penetrate deeper into the body.
5. **Specialized Imaging Modes:** Some probes have additional functions, such as Doppler imaging, which uses the Doppler effect to measure the direction and speed of blood flow, and 3D/4D imaging, which creates three-dimensional images of the fetus in obstetric ultrasound.
6. **Optimizing Image Quality:** Proper placement and movement of the probe are essential for obtaining clear and accurate images. The sonographer (ultrasound technician) adjusts the probe to ensure optimal contact with the skin and to obtain the best possible image quality.

Types of ultrasound probe

Ultrasound probes, come in various types and configurations to suit different imaging needs. Here are some common types of ultrasound probes:

1. **Convex (Curvilinear) Probe:** This type of probe is used for abdominal and obstetric imaging. It has a curved shape that allows for a wider field of view, making it suitable for imaging large organs such as the liver, kidneys, and uterus.
2. **Linear Probe:** Linear probes are used for high-resolution imaging of superficial structures such as the thyroid, breast, and musculoskeletal system. They have a flat, rectangular shape that provides a detailed image of superficial tissues.
3. **Phased Array Probe:** Phased array probes are used for cardiac imaging and vascular studies. They have a small footprint and use electronic beam steering to obtain images of structures that are difficult to access with other probes.

4. **Endocavitary Probe:** Endocavitary probes are designed for imaging within body cavities such as the vagina (transvaginal) or rectum (transrectal). They are used for pelvic imaging and to evaluate the prostate gland.
5. **Intraoperative Probe:** Intraoperative probes are used during surgical procedures to provide real-time imaging guidance. They are designed to be sterile and are used in conjunction with a sterile cover.
6. **Microconvex Probe:** Microconvex probes are similar to convex probes but are smaller in size. They are used for imaging in areas where space is limited, such as the thyroid and pediatric abdomen.
7. **3D/4D Probe** (**Volume probe**): These probes are used for three-dimensional (3D) and four-dimensional (4D) imaging, which provide a detailed view of the fetal anatomy in obstetric ultrasound.
8. **Doppler Probe:** Doppler probes are used to assess blood flow within vessels. They use the Doppler effect to detect the direction and speed of blood flow, providing information about vascular health and function.

These are just a few examples of the types of ultrasound probes available. Each type of probe is designed for specific applications and provides unique imaging capabilities to meet the needs of different clinical scenarios.

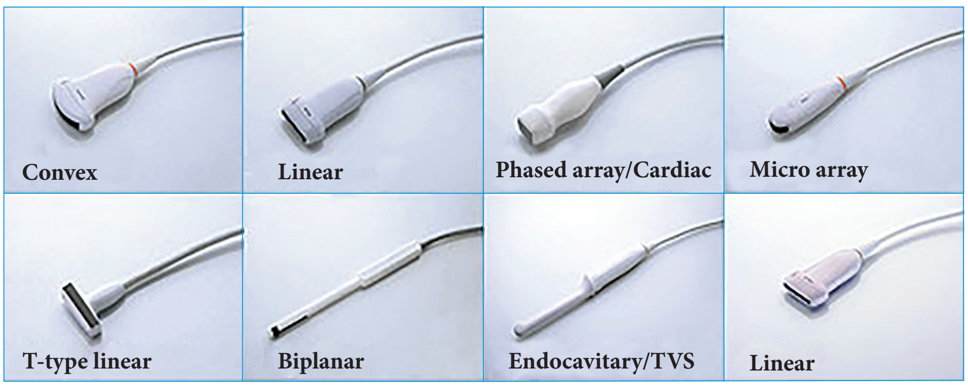

Figure 1.4 Types of probe.

1.3.4 Selection of Probe

The selection of a probe for an ultrasound examination depends on several factors, including the area of the body being examined, the depth of the structures being imaged, and the specific clinical question or purpose of the exam. Here are some general guidelines for selecting a probe for ultrasound imaging:

Frequency

- Ultrasound probes are available in different frequencies, typically ranging from 2 to 18 MHz.
- Lower frequencies (2-5 MHz) penetrate deeper into the body and are suitable for imaging
- Deep structures, such as abdominal organs or the fetus during pregnancy.
- Higher frequencies (7-18 MHz) provide better resolution for superficial structures, such as the thyroid gland or superficial masses.

Type of Examination

- For abdominal imaging, a curvilinear or convex probe is commonly used due to its wide field of view and deep penetration.
- For obstetric and gynecological imaging, a transabdominal or endovaginal probe may be used, depending on the stage of pregnancy or the specific area of interest.
- For cardiac imaging, a phased array probe is often used to visualize the heart and its structures.

Patient Size

- For larger patients or deeper structures, a lower frequency probe may be more suitable to
- Achieve adequate penetration.
- For pediatric or neonatal patients, a higher frequency probe may be used to obtain better resolution of smaller structures.

Specific Applications

- Some probes are designed for specific applications, such as musculoskeletal imaging, breast imaging, or vascular imaging.
- These probes may have specialized features, such as a smaller footprint or higher frequency, to optimize imaging in these areas.

1.4 Sonographic Descriptive Terms

Sonographic descriptive terms are used to describe the characteristics and appearance of structures seen on ultrasound images. These terms help standardize communication among healthcare providers and ensure accurate interpretation of ultrasound findings.

Sonographic descriptive terms

Echogenicity

Ability of an organ to produce image. Refers to the brightness or darkness of a structure on ultrasound.

Terms include

Echogenic	Structures that produces echoes, e.g. fatty liver, chronic renal disease.
Hypoechoic	Darker than surrounding tissue, e.g. hepatic adenoma, thyroid adenoma.
Hyperechoic	Brighter than surrounding tissue, e.g. cavernous hemangioma, angiomyolipoma.
Isoechoic	Similar brightness to surrounding tissue, e.g. focal nodular hyperplasia.
Anechoic	Without echoes, e.g. gallbladder, simple cyst.

Texture

Describes the pattern or consistency of a structure on ultrasound. Terms include homogeneous (uniform texture), heterogeneous (irregular texture), and cystic (fluid-filled with smooth borders).

Margins

Refers to the edges of a structure seen on ultrasound. Terms include well-defined (clearly outlined edges) and ill-defined (indistinct or blurry edges).

Size

Refers to the measurements of a structure on ultrasound. Measurements are typically taken in three dimensions (length, width, height).

Location

Describes the position of a structure within an organ or body part. Terms include central (located in the center), peripheral (located on the outer edge), and eccentric (located off-center).

Shape

Describes the form or outline of a structure on ultrasound. Terms include round, oval, tubular, and irregular.

Echotexture

Refers to the overall pattern of echogenicity within a structure. Terms include fine echotexture (fine or smooth pattern), coarse echotexture (coarse or irregular pattern), and nodular echotexture (containing nodules or lumps).

Heterogeneous	Of differing composition	e.g. graves' disease Diffuse liver metastasis
Homogeneous	Of uniform composition	e.g.: normal Liver normal testicle

Enhancement

Refers to increased brightness seen beyond a fluid-filled structure, indicating increased transmission of sound waves. This can occur behind cysts or fluid-filled structures.

Shadowing

Refers to a dark area seen beyond a solid structure, indicating that the sound waves are not passing through the structure. This can occur behind gallstones or bone.

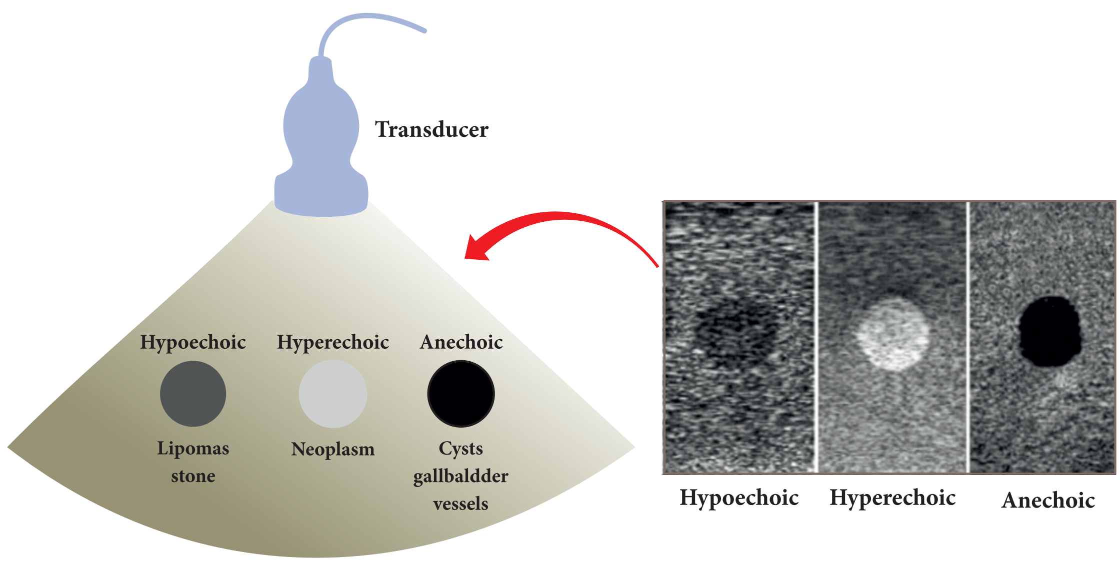

Figure 1.5 Differentiation of Hypo, Hyper and Anechoic Echogenicity.

The normal echogenicity of the abdominal organs from greatest(brightest) to least (darkest) is as follows:

Renal sinus → Pancreas → Spleen → Liver → Renal cortex → Renal pyramids → Gallbladder

SELF TEST

Q1. What is the frequency range of ultrasound waves typically used in medical imaging?

a. 1-10 Hz
b. 20-20,000 Hz
c. 1-10 MHz
d. 20-20,000 MHz

Q2. Which of the following tissues would most likely have the highest ultrasound propagation speed?

a. Bone
b. Muscle
c. Fat
d. Air

Q3. Which property of a material is most important for determining the attenuation of ultrasound waves?

a. Density
b. Elasticity
c. Temperature
d. Viscosity

Q4. How do ultrasound waves interact differently with tissues of varying densities?

a. They reflect more from denser tissues.
b. They refract more through denser tissues.
c. They attenuate more in denser tissues.
d. They scatter more in denser tissues.

Q5. What is the principle behind using ultrasound waves for imaging?

a. Absorption
b. Reflection
c. Refraction
d. Diffraction

Q6. Which of the following is a limitation of ultrasound imaging?

a. It uses ionizing radiation.
b. It cannot penetrate bone.
c. It is expensive.
d. It has poor spatial resolution.

Q7. How does the speed of ultrasound waves change as they pass from soft tissue to bone?

a. It increases.
b. It decreases.
c. It remains the same.
d. It fluctuates.

Q8. In Doppler ultrasound, what does the frequency shift of reflected ultrasound waves indicate?

a. Blood flow velocity
b. Tissue density
c. Depth of the structure
d. Absorption coefficient

Q9. What is the term for the phenomenon where ultrasound waves are scattered or reflected at interfaces between tissues of different densities?

a. Absorption
b. Refraction
c. Diffraction
d. Backscatter

Q10. Which of the following is an advantage of ultrasound imaging over other imaging modalities?

a. It provides high-resolution images of bone structures.
b. It does not use ionizing radiation.
c. It is suitable for imaging deep tissues.
d. It can visualize soft tissue elasticity.

Q11. What is the purpose of the transducer in an ultrasound machine?

a. To produce sound waves
b. To receive sound waves
c. To convert sound waves into electrical signals
d. All of the above

Q12. Which of the following imaging modes provides a real-time, two-dimensional image in ultrasound?

a. M-mode
b. Doppler mode
c. B-mode
d. 3D mode

Q13. What does the Doppler mode in an ultrasound machine measure?

a. Blood flow
b. Tissue elasticity
c. Depth of penetration
d. Image contrast

Q14. What is the purpose of the freeze button on an ultrasound machine?

a. To save an image
b. To pause the image for measurement
c. To switch to a different imaging mode
d. To turn off the machine

Q15. Which of the following is *not* a common component of an ultrasound machine?

a. Keyboard
b. Monitor
c. Trackball
d. Stethoscope

Q16. What is the purpose of the gain control on an ultrasound machine?

a. To adjust the brightness of the image
b. To adjust the depth of penetration
c. To adjust the focus of the image
d. To adjust the frequency of the sound waves

Q17. Which imaging mode is used to assess the motion of structures over time, such as heart valves?

a. B-mode
b. M-mode
c. Doppler mode
d. 3D mode

Q18. What does the power button on an ultrasound machine do?

a. Turns the machine on or off
b. Adjusts the power of the sound waves
c. Changes the imaging mode
d. Saves the image

Q19. What is the purpose of coupling gel in ultrasound imaging?

a. To improve image quality
b. To reduce friction between the transducer and the skin
c. To eliminate air pockets between the transducer and the skin
d. To sterilize the skin before ultrasound examination

Q20. Which of the following is a component of an ultrasound machine?

a. Transducer
b. Coupling gel
c. Monitor
d. All of the above

Q21. Coupling gel is typically made of:

a. Oil
b. Alcohol
c. Water-based substance
d. Silicone

Q22. How does coupling gel improve ultrasound image quality?

a. By enhancing the conductivity of sound waves between the transducer and the skin
b. By reducing the frequency of sound waves
c. By increasing the depth of penetration of sound waves
d. By decreasing the speed of sound waves

Q23. What should be checked before using coupling gel for an ultrasound examination?

a. Expiration date
b. Color of the gel
c. Thickness of the gel
d. Manufacturer's address

Q24. Which of the following is true about coupling gel?

a. It is only used for invasive ultrasound procedures
b. It should be applied in a thick layer to improve image quality
c. It is used to reduce the transmission of sound waves
d. It is easily removed from the skin after the examination

Q25. Where should coupling gel be stored?

a. In direct sunlight
b. In a cool, dry place
c. In the refrigerator
d. Anywhere is fine

Q26. Coupling gel is used to:

a. Improve the sensitivity of the transducer

b. Reduce the risk of infection during ultrasound procedures

c. Enhance the transmission of sound waves between the transducer and the skin

d. None of the above

Q27. What is the main function of an ultrasound transducer?

a. To emit X-rays

b. To emit and receive ultrasound waves

c. To measure blood pressure

d To measure temperature

Q28. Which of the following materials is commonly used in piezoelectric crystals in ultrasound transducers?

a. Lead

b. Silver

c. Quartz

d. Copper

Q29. Which type of ultrasound transducer is used for imaging large organs such as the liver and uterus?

a. Convex (Curvilinear) Probe

b. Linear Probe

c. Phased Array Probe

d. Endocavitary Probe

Q30. What is the purpose of the matching layer in an ultrasound transducer?

a. To protect the crystals

b. To improve the resolution of the image

c. To match the acoustic impedance between the crystals and the skin

d. To reduce the frequency of the ultrasound waves

Q31. How does a phased array transducer differ from a linear or convex transducer?

a. It is used for cardiac imaging only

b. It has a smaller footprint

c. It uses electronic beam steering

d. It is used for imaging superficial structures only

Q32. Which type of transducer is used for imaging within body cavities such as the vagina or rectum?

a. Linear Probe

b. Phased Array Probe

c. Endocavitary Probe

d. Microconvex Probe

Q33. What is the purpose of a Doppler transducer?

a. To measure blood pressure

b. To detect the direction and speed of blood flow

c. To measure temperature

d. To emit and receive ultrasound waves

Q34. What is the function of the backing material in an ultrasound transducer?

a. To protect the crystals

b. To improve the resolution of the image

c. To reduce the frequency of the ultrasound waves

d. To absorb and reduce the reflection of ultrasound waves

Q35. What term is used to describe a structure that appears darker than the surrounding tissue on ultrasound?

a. Hyperechoic

b. Hypoechoic

c. Isoechoic

d. Anechoic

Q36. Which term describes a structure with irregular texture on ultrasound?

a. Homogeneous

b. Heterogeneous

c. Cystic

d. Solid

Q37. What term is used to describe a structure with clear, well-defined edges on ultrasound?

a. Well-marginated

b. Ill-defined

c. Indistinct

d. Irregular

Q38. Which term describes a structure that is located off-center within an organ?

a. Central

b. Peripheral

c. Eccentric

d. Symmetric

Q39. What term is used to describe a structure with a smooth, uniform pattern of echogenicity on ultrasound?

a. Coarse echotexture

b. Nodular echotexture

c. Fine echotexture

d. Heterogeneous echotexture

Q40. Which term describes the increased brightness seen beyond a fluid-filled structure on ultrasound?

a. Shadowing

b. Enhancement

c. Hyperechoic

d. Hypoechoic

Q41. What term is used to describe a structure that appears brighter than the surrounding tissue on ultrasound?

a. Hypoechoic

b. Hyperechoic

c. Isoechoic

d. Anechoic

Q42. Which term describes a structure with a round or oval shape on ultrasound?

a. Tubular

b. Irregular

c. Round

d. Nodular