Ultra sound physics

US imaging uses ultra high frequency sound waves to produce cross-sectional images of the body. The basic component of the US probe is the piezo electric crystal . Excitation of this crystal by electrical signals causes it to emit ultra-high-frequency sound waves;this is the piezoelectric effect. Sound waves are reflected back to the crystal by the various tissues of the body. These reflected sound waves (echoes)act on the piezoelectric crystal in the US probe to produce an electric signal, again by the piezo electric effect. Analysis of this electric signal by a computer produces a cross-sectional image. Solid organs, fluid-filled structures and tissue interfaces produce varying degrees of sound wave reflection and are said to be of different echogenicity.

In an US image, hyper echoic tissues reflect most of the sound beam &are shown as white or light grey such as the bone &gas, they don't allow the sound waves to pass beyond them.

Hypo echoic tissues reflect less sound wave &are seen as dark grey.

Anechoic such as Pure fluid is (reflects virtually no sound) and is black on US images e.g.UB, GB , ascetis, amniotic fluid.

Because virtually all sound is transmitted through a fluid-containing area, tissues distally receive more sound waves and appear lighter.

This effect is known as 'acoustic enhancement' and is seen in tissues distal to the gallbladder, the urinary bladder and simple cysts. The reverse effect, known as 'acoustic shadowing', occurs with gas-containing bowel, gallstones, renal stones and breast

malignancy. the tissue distal to it will receive less or no sound waves & appear as a dark band behind the calcification

US scanning is applicable to:

· Solid organs, including liver, kidneys, spleen and pancreas
· Urinary tract
· Obstetrics and gynaecology
· Small organs including thyroid and testes
· Breast
· Musculoskeletal system

. biopsy guidance of various body organs

Highfrequency US

A recent advance is the development of small ultrasound probes which may be placed very close to the region of interest, thus producing highly detailed images but with a limited range of a few centimetres

Intra cavitory U/S:

·Transvaginal US (TVUS): accurate assessment of gynaecological problems and of early pregnancy up to about 12 weeks' gestation

·Transrectal US (TRUS): guidance of prostate biopsy; staging of rectal cancer

· Endoscopic US (EUS): assessment of tumours of the upper gastrointestinal tract and pancreas

·Transoesophageal echocardiography (TOE):TOE removes the problem of overlying ribs and lung, which can obscure the heart and aorta when performing conventional echocardiography.

Advantages of US over other imaging modalities include:

· Lack of ionizing radiation, a particular advantage in pregnancy and paediatrics
· Relatively low cost
· Portability of equipment.
.Availability
.Real time imaging

Disadvantages and limitations of US

· US is highly operator dependent: unlike CT and MRI, which produce cross-sectional images in a reasonably programmed fashion, US relies on the operator to produce and interpret images at the time of examination.
· US cannot penetrate gas or bone.
· Bowel gas may obscure structures deep in the abdomen, such as the pancreas or renal arteries

Doppler US

the influence of a moving object on sound waves, known as the Doppler effect. An object travelling towards the listener causes sound waves to be compressed giving a higher frequency; an object travelling away from the listener gives a lower frequency. The Doppler effect has been applied to US imaging. Flowing blood causes an alteration to the frequency of sound waves returning to the US probe. This frequency change or shift is calculated allowing quantitation of blood flow. The combination of conventional two-dimensional US imaging with Doppler US is known as Duplex US . Colour Doppler is used in many areas of US including

1. echocardiography
2. Color Doppler is also used to confirm blood flow within

organs(e.g. testis to exclude torsion) and to

3.assess the vascularity of tumor

4. vascular US detect venous thrombosis, arterial stenosis and occlusion, particularly in the carotid arteries

5. In pregnant mother to know sign of fetal distress & placental in sufficiency

6. In kidney transplant

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