### Ultrasound (US)

In diagnostic ultrasound examinations, very high frequency sound is directed into the body from a transducer placed in contact with the skin. In order to make good acoustic contact, the skin is smeared with a jelly-like substance. As the sound travels through the body, it is reflected by the tissue interfaces to produce echoes which are picked up by the same transducer and converted into an electrical signal.

Fluid is a good conductor of sound, and ultrasound is, therefore, a particularly good imaging modality for diagnosing cysts, examining fluid-filled structures such as the bladder and biliary system, and demonstrating the fetus in its amniotic sac. Echogenic structures like the gallbladder produce acoustic shadows behind them, whereas non-echogenic structures like cysts produce acoustic enhancement behind them.

### Properties of US examination

There is no ionizing radiation, is available & cost effectiveness is low. At the energies & doses currently used in diagnostic US, no harmful effect on any tissues have been demonstrated. Unlike other imaging modalities, there is no specific projections & sections can be taken in any plain & is operator dependant. Are capable of highly detailed information & very small lesion can be demonstrated.

Recently small probes are developed & fine detail of particular organ of interest can be obtained e.g trans rectal probe & trans vaginal probes can be used for detecting detail image in formations of prostate & female pelvic organs respectively. 3D & 4D US has been developed recently & is used primarily in obstetrical examination.

### Doppler US examinations

The principle is that when sound reflected from mobile structures shows variation in frequency which is received by the transducer, this is called frequency shift. This shift in frequency can be converted to audible sound (e.g listening to fetal heart using Doppler probe), color in color Doppler or spectral waveform in spectral Doppler.

**Clinical use of Doppler US**

1. To detect venous thrombosis.
2. Arterial stenosis or occlusion.
3. To assess Vasculature & tumor blood flow.
4. In obstetric to determine fetal blood flow through umbilical artery & to assess placental insufficiency & fetal distress.
5. With Doppler echocardiography it is possible to demonstrate regurgitation through incompetent valve & pressure gradient can be calculated across the valves.

### Isotope scan

Isotope; those element that has same atomic no. (protons), but they are differ from each other in atomic mass (no. of neutrons).

**Radio isotope (radioactive isotope);** is one with unstable nucleus which emits characteristic radiation during its decay to a stable form. Technetium-99m is a meta stable nuclear isomer of technetium-99, symbolized as 99mTc, this emit Gamma ray when disintegrate & convert to stable form technetium-99.

Radionuclide image depend on the fact that certain substance concentrate selectively in different parts in the body & radionuclide can be tagged to these substance (radiotracer) to
direct them to those specific sites e.g TC 99mm labeled with phosphate to image bone, with macroaggregates of albumin to image lung perfusion

**Medically used radioactive isotope**

They should have short physical & biological half life. The radio pharmaceuticals should have no undesirable biological effects & should rapidly eliminated from the body after completion of investigation. In isotope scan, the patient become the source of radiation & emit radiation from patients body detected by gamma camera & computer aided image will produces

**SPECT (single photon emission tomography)**

It is isotope based imaging technique, its relation to conventional isotope scan, is similar to relation of conventional X-ray to CT scan. Because SPECT permits accurate localization in 3D space, it can be used to provide information about localized function in internal organs, such as functional cardiac or brain imaging

Because SPECT acquisition is very similar to planar gamma camera imaging, the same radiopharmaceuticals may be used. If a patient is examined in another type of nuclear medicine scan but the images are non-diagnostic, it may be possible to proceed straight to SPECT by moving the patient to a SPECT instrument, or even by simply reconfiguring the camera for SPECT image acquisition while the patient remains on the table

To acquire SPECT images, the gamma camera is rotated around the patient. Projections are acquired at defined points during the rotation, typically every 3–6 degrees. In most cases, a full 360-degree rotation is used to obtain an optimal reconstruction.

**PET scan (Positron Emission Tomography)**

Positron emission tomography (PET) uses short-lived positron emitting isotopes, which are produced by a cyclotron immediately before use. Two gamma rays are produced from the annihilation of each positron and can be detected by a specialized gamma camera. The resulting images reflect the distribution of the isotope.

By using isotopes of biologically important elements such as carbon or oxygen, PET can be used to study physiological processes such as blood perfusion of tissues, and metabolism of substances such as glucose. Changes in metabolism of diseased tissue can also be studied. A cyclotron is needed to produce the necessary isotopes.

The most commonly used agent is F-18 fluoro-deoxyclocose (FDG). This is analog to glucose & is taken by the cells in proportion to glucose metabolism which is increased in tumor cells. Because muscle activity result in in the uptake of FDG, the patient should rest quietly in the interval between injection of the injection FDG scan.

The images should be interpreted carefully as non cancerous conditions may show uptake resembling cancer. FDG PET is a strictly functional modality and lacks anatomic landmarks for precise morphologic orientation. Co registration of PET scans (functional and morphologic information) with computed tomographic (CT) scans (anatomic information) using a combined PET-CT scanner (fusion image) improves the overall sensitivity and specificity of information provided by PET or CT alone

FDG is not specific for neoplastic processes; it accumulates physiologically in various normal organs such as the cerebral-cerebellar cortex at the base of the skull and in the myocardium, liver, kidneys, renal pelvis, bone marrow, and urinary bladder. There is also minimal uptake in the mediastinum and bilaterally in the lower cervical and psoas muscles.

[See the slideshow for the images.]