B.SC. IN RADIOLOGY AND IMAGING TECHNIQUES

3rd Year

Prepared By

Paramedical & Allied Science Dept.

Radiology and Imaging Techniques

MIDNAPORE CITY COLLEGE

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Department of Paramedical and Allied Health Sciences

Bachelor of Radiology and Imaging Techniques

3rd Year

Paper Title: Equipments Of Advanced Modalities (Practical)

Paper Code: Paper –I

Syllabus:

A. **Mammography system:**
History Imaging requirements- Mammography system construction/types accessories - tube, compression, grids, AEC etc.- nature of X-Ray beam suitableaccessories for immobilization - film processing - image quality - image recording devices - interventional procedures - accessories-biopsy equipment attachments - radiation dose- mammo tomogram-Sonomammography-future developments.

B. **Ultrasonography/ Doppler systems:** Basic acoustics principle- Basic physics of sound propagation in different medi production of Ultrasound (piezoelectric effect), ultrasound terminologies -interaction of ultrasound with matter - ultrasound properties propagation in tissue, absorption, scattering, reflection and refraction- acoustic impedenc epiezo electric effect - transducer - Pulsar - receiver - beam/sensitivity and gain-generators- A, B and M scanning & echo modes- transducers-techniques of sonography-equipment selection- display methods - ultrasound image formation -data storage and display - image and artifacts - doppler instrumentation - doppler equation - transducer - quality assurance and performance tests - bio effects and safety considerations. Types of machines -portable systems- acoustic coupling agents- ingredients/preparation.

C. **CT scan systems:**
History- generations of scanners-CT technology -helical/spiral & multi slice C.T-ultra fast scanners-system components - performance parameters - image quality and methods of image reconstruction- radiation dose measurements and technical aspects of Q.A -calibration and image acquisition-

D. **MRI Scanners: History:** basic physical principle - Physical principles **- N11R** signals- instrumentation- hard ware-MR system components- magnet system- Magnetic shielding- RF shielding- bioeffects of MRI- site selection and safety reconstruction system - different coils used -NMR signals advantage -imaging methods - pulse imaging sequences - spectroscopy param ters -calibration and image acquisition - reconstructions- 3D images- - image contrast - factors affecting image quality - artifacts - difference between CT and MRI images- host computer -viewing archiving- hard copy - image formation and storage device.

Syllabus:

E. **Angiography and Cine Studies /DSA**:
Angiography equipments history -Conventional angiography X-Ray equipment - Equipment construction-principle - DSA system basics - digital techniques -subtraction process-procedures for subtraction - care, choice and installation of the equipment - equipment, pitfalls and complications -pressure injectors-contrast media -accessories-catheters, guide wires-uses of serial imaging devices-cine camera - video-recorder - film processing-radiation protection.

F. **Nuclear Medicine Equipments:**
Nuclear Physics - basics in Nuclear Medicine- Nuclear medicine equipments -Gamma Cameras- rectilinear scanners- radioisotope generators-SPECT-CT & PET-CT-introduction-basic physics and principle involved- equipments basic structure--differences- fusion techniques- image formation-storage devices- advantages-limitations.

G. **Recent Advances in Imaging Systems:**
Mobile units of Computer Radiography & Digital Radiography system. 3D/4D Sonography systems
128 slice & higher slice C.T equipments. 3 Tesla & higher T 1v1RI scanners
Image processing & Display systems-Recent advances, concepts and applications in processing of images in digital form using computer based systems.
Bone Densitometry

H. **Picture Archiving and Communication Systems (PACS):**
Newer advancements - updates - systems designs-transfer restrictions.

MAMMOGRAPHY SYSTEM

Angled Tube Head
Due to the anode heel effect, the x-ray beam is not uniform in the direction parallel to the anode-cathode axis of the x-ray tube. This property is used in mammography by aligning the cathode over the chest wall end (higher energy beam to image thicker area) and the anode over the nipple end (lower energy beam can penetrate thinner area).

C-Arm Design
The x-ray set is a c-arm. The whole gantry rotates so that the tube and breast table remain opposite each other.

Fixed Focus-Detector Distance (FDD)
The set is designed for a single examination and the focus-detector distance (FDD) or focus-to-film distance (FFD) of 65-66cm is considered optimum. This set FDD is a compromise between lower patient doses (lower doses with higher FFDs) and higher film doses (lower exposures with higher FFDs). Also, higher FDDs require longer exposures for a fixed mA resulting in more movement unsharpness.

Compression Device
The maximum force applied should be no greater than 200 N (approx. 20 kg weight). Standard compression forces are normally between 100 – 150 N. The compression plate is angled so that more of the breast is in contact with the compression paddle.

Fixed Field Size
Unlike in general radiography, only one type of examination is done meaning collimation creating fixed field sizes are all that are required.

Grids
Moving anti-scatter grids are used in normal mammography imaging. For magnification views, the breast support table is above the film to give magnification factors of around 1.8. In this case the large air gap between the breast and the film works to reduce scatter and so no grid is needed.

Automatic Exposure Control (AEC)
In screen-film mammography a separate AEC was required placed behind the cassette. With the currently used digital mammography the detectors act as the AEC. In screen-film radiography an AEC is required to ensure a suitable exposure to prevent under- or over-exposed film. In digital radiography, however, windowing can negate the effects of unsuitably exposed film and the AEC is more to ensure a suitable radiation dose for the patient and for the working parameters of the digital detector.

Target / filter material
- Need good differentiation of low contrast structures

	Contrast	**Radiation dose**
Highest	MoMo	MoMo
	MoRh	MoRh
	RhRh	RhRh
Lowest	WRh	WRh

- Need very high spatial resolution for micro-calcifications

Target
Need material that produces characteristic x-rays with energies of 17-20 keV (20-30 keV for larger breasts) to produce the best contrast. The commonly used material is Molybdenum (characteristic x-rays at 17.5 and 19.6 keV).

Filter
A filter with a k-edge of an energy just above the characteristic energies is used to remove the higher energy x-ray photons and make the beam as monoenergetic as possible. Molybdenum has a k-edge of 20 keV, just high enough so that the large increase in attenuation (k-edge) doesn't fall into the characteristic energies produced at the molybdenum target.

Alternatives
Mostly MoMo (molybdenum target, molybdenum filter) but this does not give high enough energies for larger breasts.

- **Rhodium** has a k-edge at 23.3 keV and we can use a molybdenum target and rhodium filter (MoRh) to increase the amount of x-rays with energies in the range of 20 – 23.3 keV.
- **Rhodium** characteristic x-rays are at 20.2 – 22.7 keV. When used as a target this produces a beam with a mean energy that is higher than for MoMo and for MoRh.
- **Tungsten** (W) target and **Rhodium** filter. The x-ray output is reduced as no characteristic x-rays are produced (and, therefore, longer exposure times) but tungsten is much cheaper. It is mostly used in breasts with implants or that have been treated with radiotherapy as they are much larger and denser.

The mean energy of the spectrum decreases from WRh to MoMo. Lower energy photons have a higher probability of interacting with matter and, therefore, produces better contrast. However, the lower the energy, the greater the absorption, the more energy is deposited in the matter, and the higher the dose.

Summary
- General use: MoMo
- Dense breasts: MoRh or RhRh

Spatial Resolution
A very high resolution is required to see microcalcifications. This is achieved via:
- Focal spot size
- Compression
- Anti-scatter grid

Small Focal Spot Sizes
Broad focal spot size = 0.3 mm
Fine focus focal spot size = 0.1 to 0.15 mm
From a point source, objects are easily resolved as separate on the film. However, with increasing focal spot size, the radiation comes from all parts of the source. The radiation creating the image does not provide a sharp image but has blurring at the edges. If the objects are too close together they can appear as one or an extra 'object' can be created.

Compression
Typical compression force is 100 – 150 N
The compression force:
- Lowers patient radiation dose as the attenuation of the compressed breast is lower and a lower exposure can be used
- Reduces scatter as the breast is less thick so there is less probability of scatter happening within the tissue
- Spreads the tissues out so that there is less overlaying of features
- Reduces geometric unsharpness by moving tissue closer to the image receptor
- Reduces movement unsharpness by holding the breast still
- The compressed breast is of more uniform attenuation

Anti-Scatter Grids
In mammography, moving grids are used for all contact (broad focus) images. For magnification images using a fine focal spot size or an air gap technique is used to reduce the amount of scattered radiation reaching the receptor meaning a grid is not required.

Altering Parameters
Parameters need to be altered to provide optimal imaging of different breasts. Two factors need to be taken into consideration:
1. Thickness of breast
2. Composition of breast

1. Thickness
In large breasts:
- More radiation absorbed – higher doses needed

- More scatter
- Increased beam hardening (lower contrast)
- Longer exposure needed at 28 kV MoMo, therefore, movement artefacts may occur

Thinnest breasts: MoMo at 25 kV
Thickest breasts: MoRh or even WRh for very thick breasts at 32 kV

2. Composition

With more dense breasts, higher doses are needed due to extra attenuation and more beam hardening. Due to beam hardening, the AEC may cut off the exposure prematurely (the measured exposure will be of a higher intensity). To ensure this doesn't happen, one of two methods may be used:

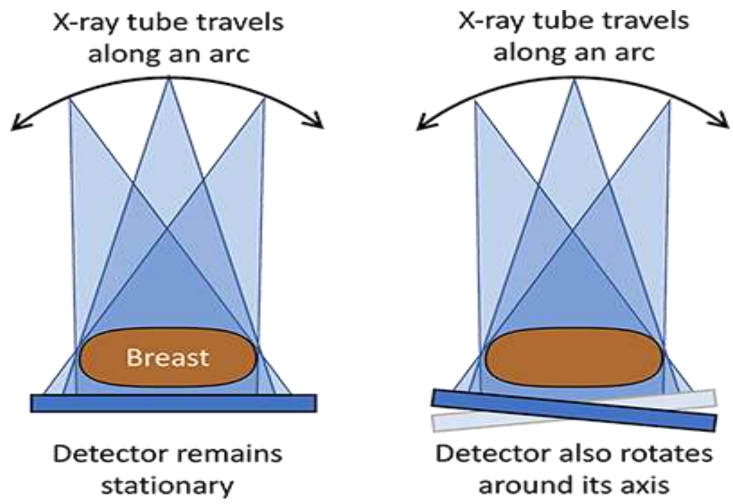
1. A pre-exposure determines whether the breast is as dense as expected for this thickness by looking at the dose rate and beam hardening.
2. Adjustment on dose rate based on measuring the dose detected at the start of the examination and then adjusting the dose and exposure time as necessary.

Tomosynthesis

Superimposed tissue can mask pathology and, often, the pathology in breast disease can be very subtle. Breast tomography uses digital radiography to reconstruct planar images of sections of the breast. There are two main methods of acquiring breast tomosynthesis:

1. The x-ray tube traverses along an arc acquiring images as it travels and the detector remains stationary
2. The x-ray tube traverses along an arc and the detector also rotates

The images are then reconstructed using filtered back projection or iterative reconstruction.



Pros

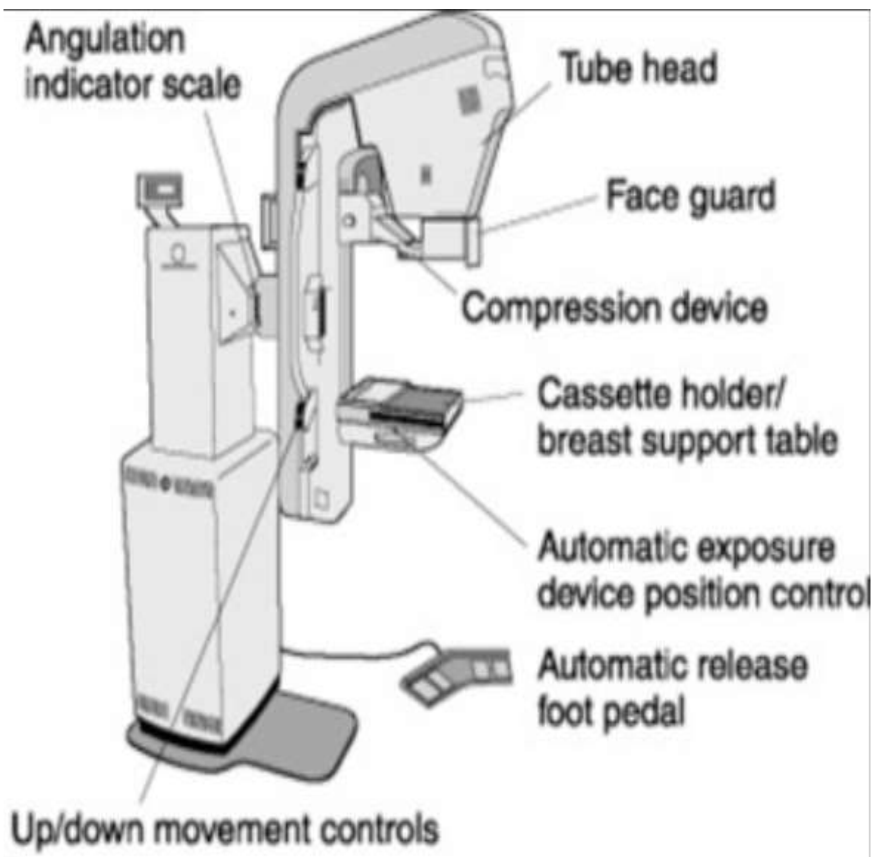
- Provides enhanced lesion detection
- Reduces false positive recalls
- Allows more precise lesion localisation

Cons

- Higher radiation dose (approximately double)
- High contrast objects (e.g. surgical clips) can cause significant artefacts
- Longer interpretation time
- Requires substantially more data storage.

AUTOMATIC EXPOSURE CONTROL

Automatic exposure control (AEC) system employs phototimers to measure the X-ray intensity and quality. Usually, they are kept closer to the image receptor, to minimize the object to image distance (OID), thereby improving spatial resolution. There are two types of AEC available, namely, (i) ionization chamber type and (ii) solid state diode type. Each type will have single or multiple detectors along the chest wall-nipple axis. The detectors are filtered differentially to assess the beam quality. It will also assess the level of compression and type target/filter combination that is employed. In general, thick, dense breast is best imaged with Rh/Rh combination, whereas thin, fatty breast is best imaged with Mo/Mo combination. AEC must be accurate and reproducible with lesser radiation dose. It should hold the optical density within 0.1 OD, when the voltage is varied from 23–32 kVp, for a breast thickness of 2–8 cm, regardless of compression.



ULTRASONOGRAPHY/ DOPPLER SYSTEMS:

Ultrasound is a medical imaging technique that uses high-frequency sound waves to produce images of structures within the body. Here are the basics:

How Ultrasound Works

1. **Sound Waves:** Ultrasound machines generate high-frequency sound waves, typically between 1 to 18 megahertz (MHz).
2. **Transducer:** A handheld device called a transducer is used to send and receive these sound waves. It is placed on the skin over the area being examined, often with a gel to improve contact.
3. **Echoes:** The sound waves travel into the body and bounce back (echo) when they hit different tissues and structures.
4. **Image Formation:** The echoes are captured by the transducer and sent to a computer, which processes them to create real-time images of the internal structures.

The physics of ultrasound involves the generation, propagation, interaction, and detection of high-frequency sound waves. Here are the fundamental concepts:

Sound Waves

- **Nature of Sound:** Sound waves are mechanical vibrations that travel through a medium (such as tissue). They are longitudinal waves, meaning the particle displacement is parallel to the direction of wave propagation.
- **Frequency and Wavelength:** The frequency (f) of a sound wave is the number of cycles per second, measured in Hertz (Hz). The wavelength (λ) is the distance between successive peaks of the wave, and it is inversely related to frequency ($\lambda = c/f$), where c is the speed of sound in the medium.

Speed of Sound

- **Medium Dependence:** The speed of sound (c) varies depending on the medium through which it travels. In human tissues, the average speed is approximately 1540 meters per second (m/s). In air, it is about 343 m/s, and in bone, it can be as high as 4080 m/s.

- **Factors:** The speed of sound is influenced by the medium's density and stiffness. Higher density and stiffness result in higher sound speeds.

Generation of Ultrasound

- **Piezoelectric Effect:** Ultrasound transducers use piezoelectric crystals that generate sound waves when subjected to an electric current. The same crystals can detect the returning echoes, converting them back into electrical signals.
- **Pulse-Echo Method:** Ultrasound machines typically emit short pulses of sound waves and then listen for the echoes. This allows for the determination of the distance and structure of the reflecting surfaces.

Attenuation

- **Loss of Intensity:** As sound waves travel through tissue, they lose intensity due to absorption, reflection, and scattering. Attenuation increases with frequency, which is why lower frequencies are used for deeper imaging.
- **Absorption:** Conversion of sound energy into heat.
- **Reflection and Scattering:** Redirection of sound waves when encountering different tissue interfaces or small structures.

Reflection and Impedance

- **Acoustic Impedance (Z):** The product of the density (ρ) of a medium and the speed of sound in that medium ($Z = \rho c$). Differences in acoustic impedance between tissues result in reflections, which are crucial for creating images.
- **Reflection Coefficient:** Determines the proportion of sound reflected at an interface between two media with different impedances.

Doppler Effect

- **Frequency Shift:** When sound waves reflect off moving objects, such as blood cells, their frequency shifts. This shift is used in Doppler ultrasound to measure the velocity and direction of blood flow.

- **Applications:** Essential for assessing blood flow in vessels and the heart.

Resolution

- **Axial Resolution:** The ability to distinguish between two structures along the path of the sound beam. It depends on the pulse length and is improved with higher frequencies.
- **Lateral Resolution:** The ability to distinguish between two structures perpendicular to the sound beam. It depends on the width of the sound beam, which can be focused to improve resolution.

Safety and Biological Effects

- **Mechanical Index (MI):** A measure of the potential for mechanical bioeffects, such as cavitation.
- **Thermal Index (TI):** Indicates the potential for tissue heating. Ultrasound is generally considered safe, but prolonged exposure at high intensities can cause heating.

COMPONENTS:

<u>TRANSDUCER</u>

ë Transducer is a device that converts energy from one form to another energy.

ë Ultasound transducer converts electrical energy into sound energy and vice versa.

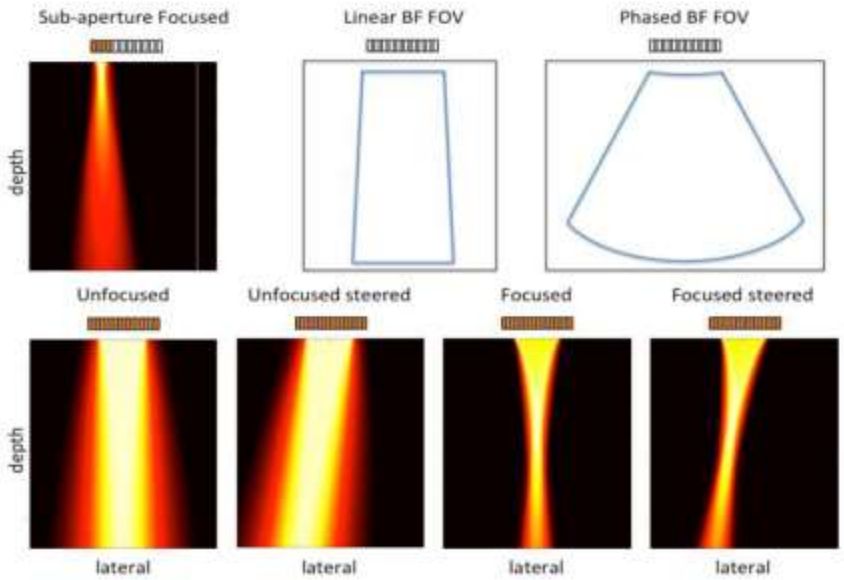
ë It works on the principle of the piezoelectric effect.

Types Of Transducers

1. Linear transducer
   i. Vascular examination
   ii. Breast
   iii. Small parts
   iv. Thyroid
2. Phased array transducer
   i. Cardiac examinations
   ii. Abdominal examinations
   iii. Brain examinations
3. Convex transducer
   i. Abdominal
   ii. Vascular
   iii. Nerve
   iv. Musculoskeletal
4. Pencil transducer
5. Endocavitary transducer

BEAM FORMER

- The beam former controls the timing of the signals sent to the individual elements for steering and focusing of the beam.
- The beam former also controls apodization, which is used to decrease the risk of grating lobes.
- The beam former works to decrease the risk of grating lobes through a process called apodization.



RECEIVER

Processes the return echo coming back from the patient in this order:

- Amplification: Increases or decreases all echoes equally.
- Compensation: adjusts the strength of echoes differently.
- Compression: to decrease the difference between the largest and smallest amplitudes within the signal.
- Demodulation: Makes signal easier for the system to process; includes rectification and smoothing.
- Rejection: Eliminates low-level echoes that do not contribute to useful information on the image.

AMPLIFIER

ë It ensures the electrical signals travel in the correct direction.

- It makes sure the pulser voltages go to the transducer and the received voltages from the transducer go to the signal processor.

SCAN CONVERTER

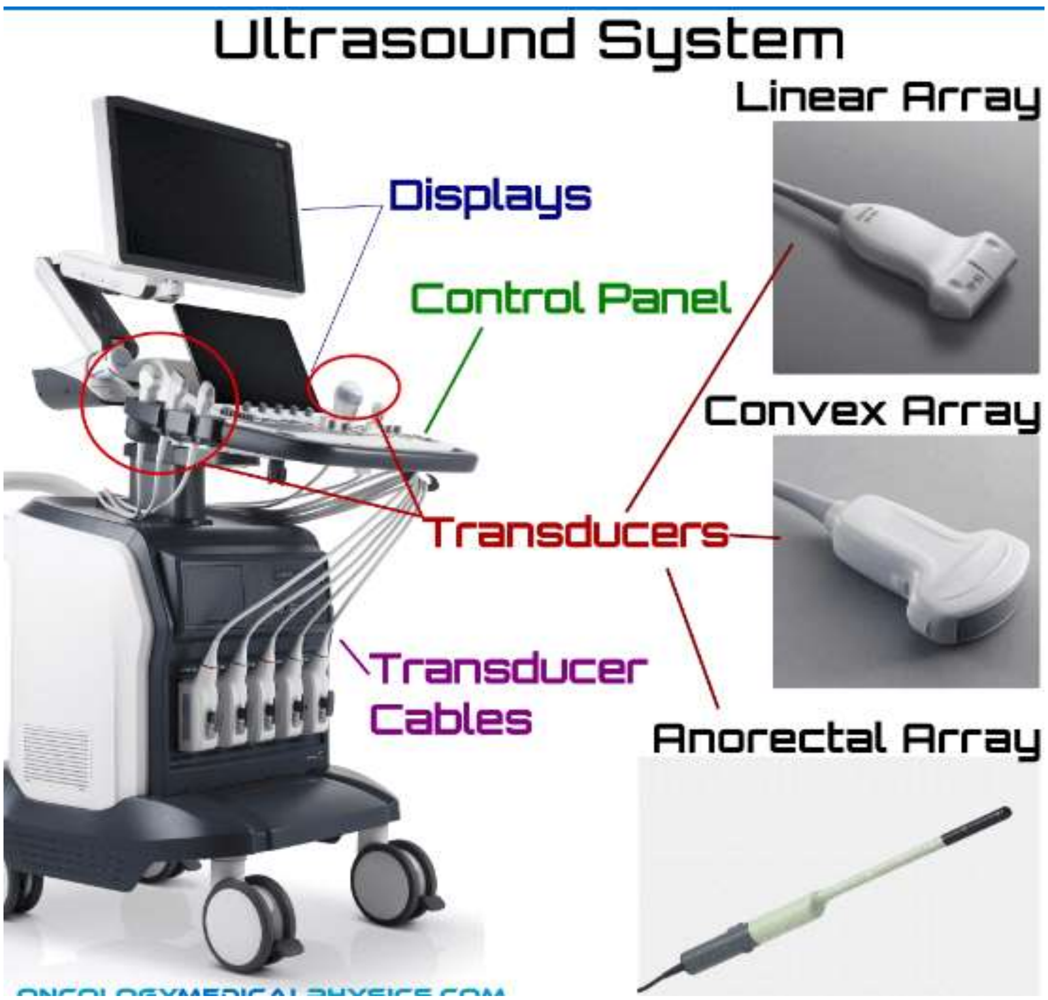
- It is the part of the machine that makes grayscale imaging possible and is responsible for the storage of the image data.
- Signals travel from the receiver to the analog-to-digital converter then to the scan converter, and then to the digital-to-analog converter.
- After the signal is converted to a digital form, it can be processed by the computer.

DISPLAY SYSTEM

- There are two displays used as ultrasound monitors: the cathode ray tube (CRl) or the liquid crystal display (LCD).
- CRT: Electron gun shoots a stream of electrons to a phosphor-coated screen.
- The beam is steered using magnetic fields. Only seen on older equipment.
- LCD: Liquid crystal display, also called a flat-panel display.
- Two polarized filters in front of a light source.
- Sandwiched between the filters are liquid crystals that twist/untwist with the application of electricity to determine if the backlighting gets through or not.

Cathode ray tube

Liquid crystal display



EQUIPMENT FOR COMPUTED TOMOGRAPHY

Computed tomography (CT) - is a special form of tomography in which a computer is used to make a mathematical reconstruction of a tomographic plane or slice. It generates images in transaxial section, i.e, perpendicular to the axis of rotation of the X-ray tube. The computed tomography scanner was invented by Sir Godfrey N Hounsfield in 1970 and was initially named as computerized axial tomography (CAT). The first commercial machine was designed to study the head (1973), and later it was modified to scan any part of the body (1975). Nobel prize was given to the discovery in 1979, for both GN Hounsfield (UK) and Alan M Cormack (USA). In 1963, Alan Cormack built laboratory model for image reconstruction.

Scanning Principle

The basic principle behind CT is that the internal structure of an object can be reconstructed from multiple projections of the object. To carry out the reconstruction, the linear attenuation coefficient (μ) of the object is considered as base. An X-ray tube emitting a fan beam from a small focus is coupled to a radiation detector. These two are moved together on a carriage, so that a plane of interest is scanned. The tube potential is about 120–140 kVp and the X-ray beam is pulsed at the rate of 100 pulses per second. The beam is heavily filtered and the detectors are individually collimated and are made either with solid state crystal or with xenon gas ionization chambers. Each detector is calibrated and measures the intensity of the transmitted X-ray beam. Such measured transmissions are called projections. During the scan, about 100,000 measurements are made and recorded in the computer. The above measurements are reconstructed with the help of an algorithm and the final image is displayed on a TV monitor.

Equipment For Computed Tomography

CT scanners are available as single slice scanner, helical scanner and multislice scanner in the market. In general, all the scanners possess a (i) control console, (ii) computer, (iii) gantry and (iv) couch. Recent developments has brought slip ring technology and multidetector array in day-to-day use.

Control Console

There are 3 consoles in CT, one for the technologist to operate the imaging system, one for the technologist to post process images and the other for the physician to view images.

Computer

The computer is used to solve more than 2,50,000 equations with the help of microprocessor/array processor and has primary memory. The software includes plot of CT numbers, mean and standard deviation of CT values of ROI, subtraction techniques, planner and volumetric quantitative analysis and reconstruction of images in coronal, sagittal and oblique planes.

Gantry

CT gantry has the following gadgets: (i) X-ray tube, (ii) collimation and filtration, (iii) detector, and (iv) high voltage generator.

X-Ray Tube

X-ray is produced by an X-ray tube. The three main parts of any X-ray tube are the anode, cathode and the filament. When the filament is heated, electrons are ejected from its surface. A large voltage between the cathode and the anode force electrons to accelerate towards the anode. The electrons hitting the anode (tungsten) produce Bremstrahlung radiation at an efficiency of only 1 percent. The other 99 percent of the electrons energy is converted into heat.

Stationary anode—Used in eary scanners, oil cooled, large focal spot giving rise to higher potential radiation.

Rotating anode—Aircooled, small focal spot requires large heat capacity and fast cooling rates.

Collimation

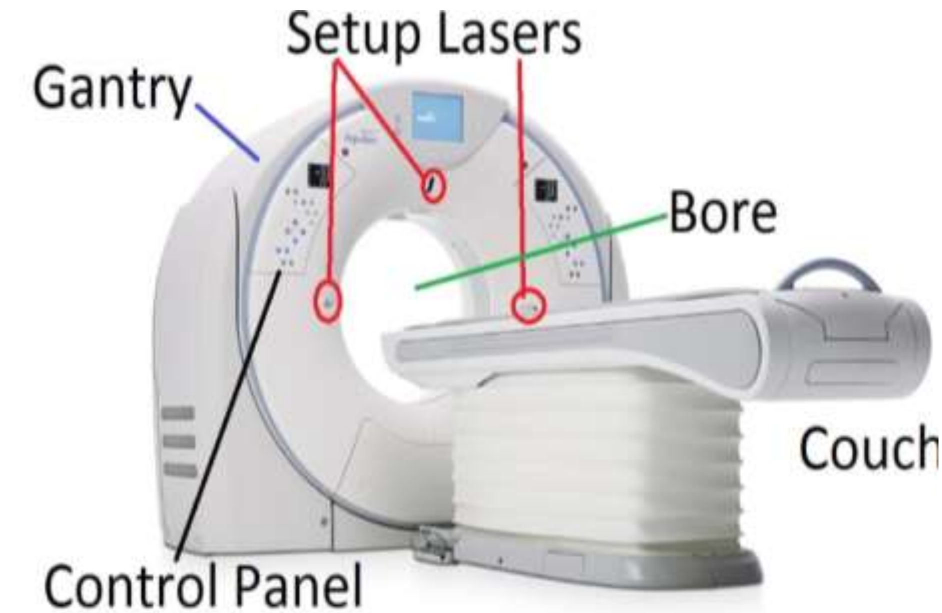
Important Component for Reducing Patient Dose and Improving Image Quality by Reducing Scatter Radiation.

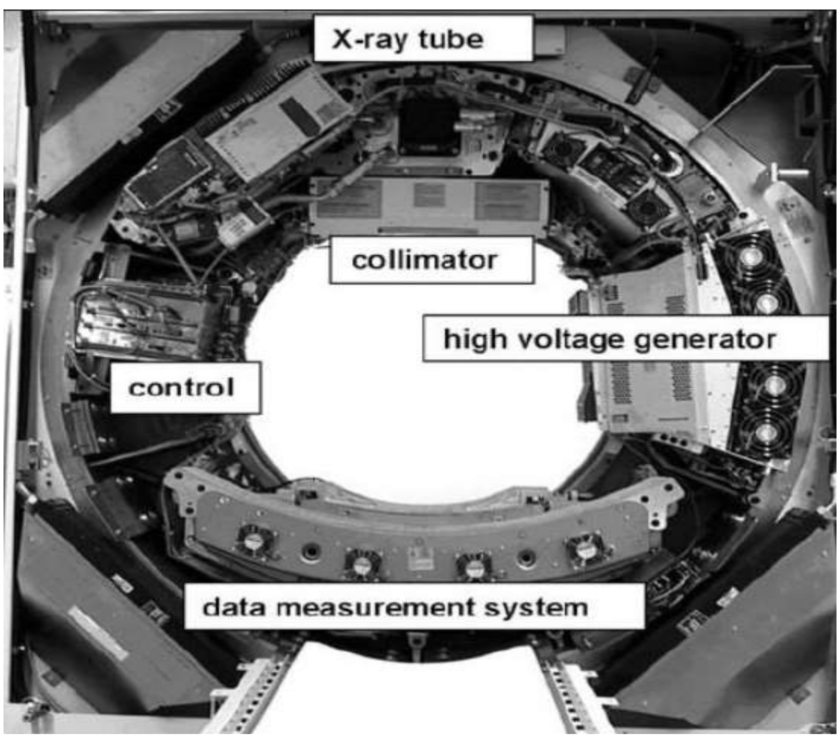
Filtration

There are two types of filtration utilized in CT. Mathematical filters such as bone or soft tissue algorithms are included into the CT reconstruction process to enhance resolution of a particular anatomical region of interest. Inherent tube filtration and filters made of aluminium or Teflon are utilized in CT to shape the beam intensity by filtering out low energy photons that contribute to the production of scatter. Special filters called “bow-tie” filters absorb low energy photons before reaching the patient.

Detectors

The requirements of CT scan detector are (i) small with good resolution (600–900 for Single slice, width < 1.5 mm), (ii) high detection efficiency, (iii) fast response, negligible after glow, (iv) wide dynamic range and (v) stable noise free response. Currently, two types of detectors are in use, namely, (i) ionization chamber: Xenon gas filled detectors (single slice) and (ii) solid state detector: Scintillation detectors with photo multipliers or photodiodes (Multislice).





MRI SCANNERS

The magnetic resonance imaging (MRI) was discovered in 1970, by Paul C Lauterbur, Stony Brook, at New York. He jointly used a radiofrequency (RF) and spatial magnetic field gradients to generate images that display magnetic properties of the proton, reflecting clinically relevant information. Basically, it is a nuclear magnetic resonance (NMR) technique, applied for human imaging. Nobel prize in medicine (2003), was awarded for the above discovery, which was shared by Sir Peter Mansfield, and Paul C Lauterbur.

The special feature of MRI includes (i) high contrast sensitivity to soft tissues differences, (ii) inherent safety to the patient (non-ionizing radiation), (iii) to examine anatomic and physiologic properties of the patient, and (iv) imaging of blood flow without contrast. The limitations includes (i) high equipment cost, (ii) scan acquisition complexity, (iii) long imaging time, (iv) image artifacts, and (v) patient claustrophobia.

Basics Principle:

MRI uses strong magnetic fields and radio waves to generate images of organs and tissues within the body.

Four basic steps are involved in getting an MR image—

1. Placing the patient in the magnet
2. Sending Radiofrequency (RF) pulse by coil
3. Receiving signals from the patient by coil
4. Transformation of signals into image by complex processing in the computers.

Now let us understand these steps at molecular level. Present MR imaging is based on proton imaging. Proton is a positively charged particle in the nucleus of every atom. Since hydrogen ion (H+) has only one particle, i.e. proton, it is equivalent to a proton. Most of the signal on clinical MR images comes from water molecules that are mostly composed of hydrogen.

MRI Equipments

1. Main Magnet

- **Superconducting Magnet**: The heart of the MRI system, usually made of materials like niobium-titanium, which requires cooling with liquid helium to maintain superconductivity.
- **Permanent Magnet**: Used in lower-field MRI machines, these don't require cooling but provide lower imaging power.

2. Gradient Coils

- These coils are used to spatially encode the MRI signal by producing gradient magnetic fields along the X, Y, and Z axes.
- They help in determining the location of the MRI signals and are essential for slice selection, phase encoding, and frequency encoding.

3. RF (Radio Frequency) Coils

- **Transmit Coils**: Send RF pulses into the body to excite the hydrogen atoms.
- **Receive Coils**: Detect the signals emitted by the hydrogen atoms as they return to their normal state.
- **Surface Coils**: Specialized coils placed near the body part of interest to enhance signal reception.

4. RF Shielding

- Ensures that the MRI room is protected from external RF interference, which could distort the images.

5. Patient Table

- The motorized table on which the patient lies. It moves into and out of the magnet bore.

6. Computer System

- **Image Reconstruction System**: Processes the data received from the RF coils to create detailed images.

- **Control Console**: Used by the MRI technician to operate the MRI machine, adjust imaging parameters, and monitor the scanning process.

7. Cooling System

- **Cryogens (Liquid Helium)**: Used to cool the superconducting magnet to maintain its superconductive state.
- **Chillers**: Assist in cooling the gradient amplifiers and other components.

8. Safety Equipment

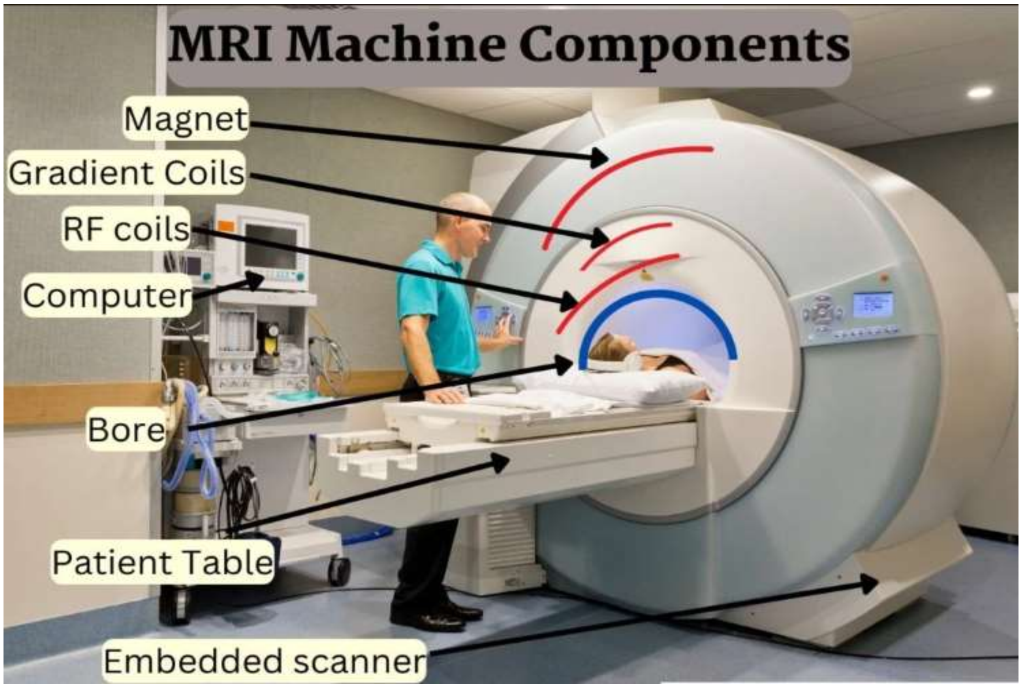
- **Patient Monitoring Devices**: Monitors vital signs like heart rate and oxygen levels during the scan.
- **Emergency Stop Buttons**: In case of emergencies, the MRI can be quickly shut down.
- **Quench Button**: Used to rapidly shut down the superconducting magnet by releasing the liquid helium, usually in life-threatening situations.

9. MRI Compatible Accessories

- **Earplugs/Headphones**: To protect the patient's hearing from loud noises generated during scanning.
- **Positioning Pads**: For patient comfort and to ensure the correct positioning during the scan.
- **Contrast Agents**: Sometimes injected into the patient to enhance the visibility of certain tissues.

10. Advanced Imaging Options

- **Functional MRI (fMRI)**: Captures brain activity by detecting changes in blood flow.
- **Magnetic Resonance Angiography (MRA)**: Specializes in imaging blood vessels.
- **Spectroscopy**: Analyzes the chemical composition of tissues.



ANGIOGRAPHY AND CINE STUDIES /DSA:

Digital subtraction angiography (DSA) is a special method of fluoroscopy, which gives image of the vessels that are filled with contrast. Digital images are obtained before and after injection of contrast medium, to differentiate vascular pathology from surrounding anatomy. It is a noninvasive procedure, that provides improved image quality with lesser use of contrast medium.

DSA Equipment

Digital subtraction angiography equipment is basically a fluoroscopy X-ray machine with II tube or CCD camera or flat panel DR system. The signal as image frames are acquired, digitized with ADC and stored in random access memory (RAM). There are two memories, one for the mask image and the other for the contrast image. The image content is subtracted in a arithmetic unit, processed and converted back into a analog signal by DAC. Then, the signal is displayed in a high resolution monitor. Images can be stored on a magnetic hard disk and computer needs large memory of the order of 512 MB–1GB. The acquisition and processing is controlled by the CPU of the computer.

DSA Equipment Components

1. **X-ray Generator and Tube**:

    - Generates X-rays required for imaging.
    - High-frequency generators provide stable and high-quality imaging.
2. **Image Intensifier or Flat-Panel Detector**:
    - Converts X-ray photons into visible light (image intensifier) or digital signals (flat-panel detector).
    - Flat-panel detectors are more common in modern DSA systems due to better image quality and reduced radiation dose.
3. **Digital Image Processor**:
    - Processes the images acquired from the detectors.
    - Performs subtraction of pre-contrast images from post-contrast images to highlight blood vessels.
4. **Contrast Injector**:
    - Delivers contrast media into the patient's bloodstream to enhance the visibility of blood vessels.
    - Can be manual or automatic injectors with programmable flow rates.
5. **C-arm or Angiographic Table**:
    - A C-shaped arm that holds the X-ray tube and detector, allowing for flexible positioning around the patient.
    - The angiographic table supports and positions the patient during the procedure.
6. **Workstation and Monitors**:
    - A computer system that controls the DSA procedure, processes images, and stores data.
    - High-resolution monitors display real-time and processed images for the radiologist.
7. **Catheters and Guidewires**:
    - Used to navigate through the vascular system to the area of interest.
    - Different types and sizes of catheters and guidewires are selected based on the procedure.
8. **Radiation Protection Equipment**:
    - Includes lead aprons, thyroid shields, and lead glasses to protect staff from radiation exposure.
9. **Patient Monitoring Systems**:
    - Vital signs monitoring systems to ensure patient safety during the procedure.

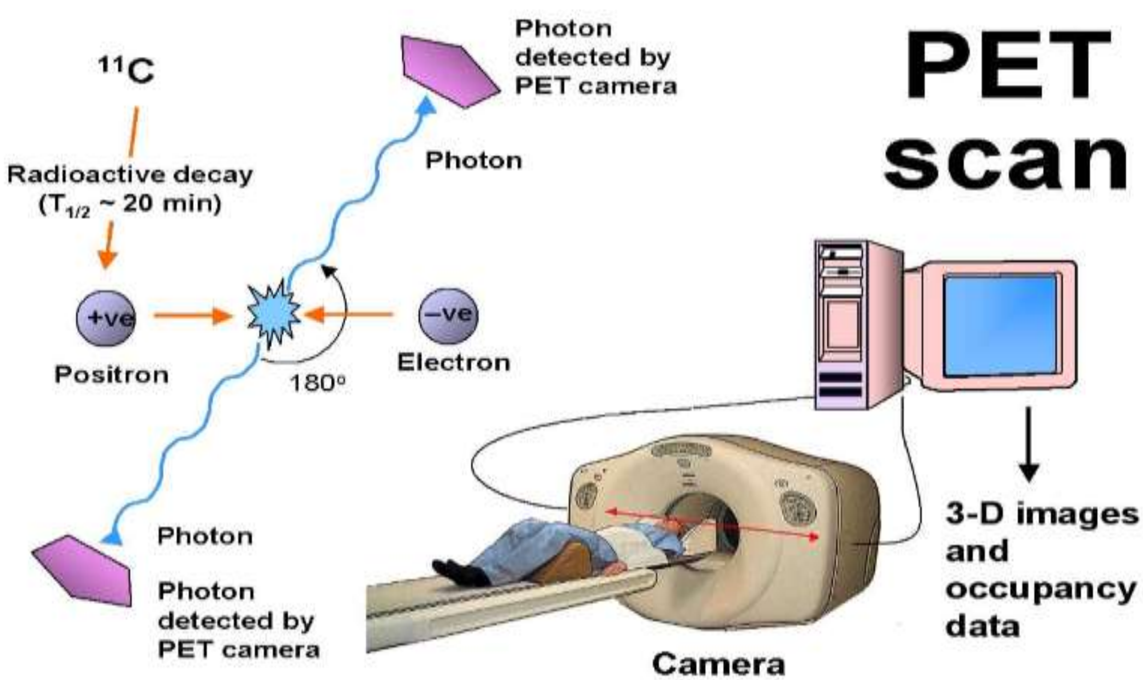

Dual High Definition LED Monitors
1k x 1k High Resolution Technology
Laser Aimer
Elegant Integrated Keyboard
Integrated DICOM Solution
Integrated Circular collimator
Electrically controlled vertical movement
Twin Wheel with Cable Deflector
Hermetically sealed Normal/High Level Fluoroscopy Exposure foot switch
Microprocessor controlled High Frequency Generator

PET CT

Positron Emission Tomography-Computed Tomography (PET-CT) is a hybrid imaging technique that combines the functional imaging of PET with the anatomical detail of CT.

Components of PET-CT

1. **Positron Emission Tomography (PET)**:
   - **Radiotracer**: PET involves the use of radiotracers, which are radioactive substances that emit positrons. The most commonly used radiotracer is Fluorodeoxyglucose (FDG), a glucose analog labeled with Fluorine-18.
   - **Detection**: When the radiotracer is injected into the body, it accumulates in areas with high metabolic activity. As the radiotracer decays, it emits positrons, which collide with electrons, producing gamma rays. These gamma rays are detected by the PET scanner to create images of metabolic activity.
2. **Computed Tomography (CT)**:
   - **X-ray Imaging**: CT uses X-rays to produce detailed cross-sectional images of the body's internal structures. The CT component provides high-resolution anatomical details that help localize and characterize lesions identified in the PET scan.



SPECT

Single Photon Emission Computed Tomography (SPECT) is a nuclear medicine imaging technique that provides three-dimensional (3D) images of functional processes in the body. It is similar to PET but uses different types of radiopharmaceuticals and detectors.

Key Components of SPECT

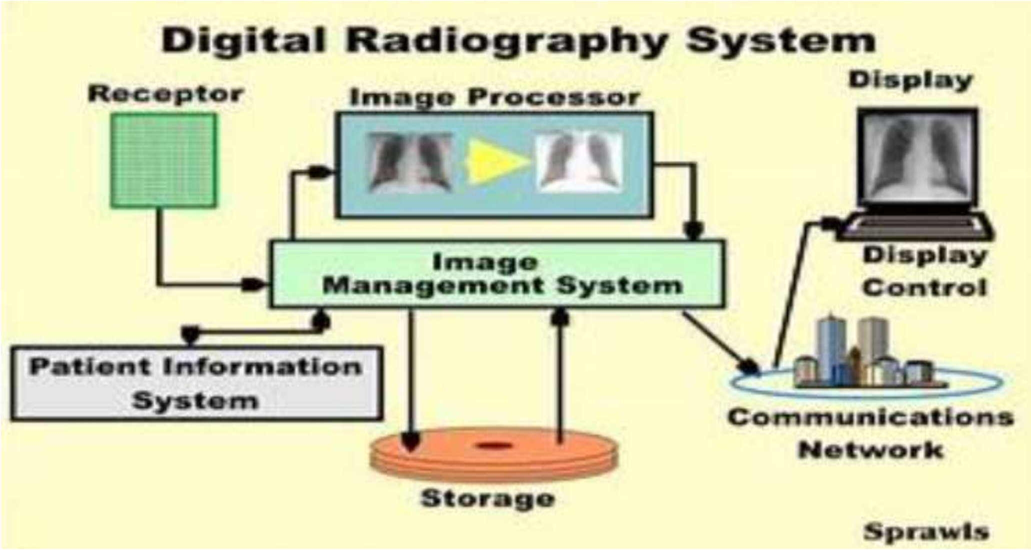
1. **Radiopharmaceuticals**:
    - SPECT uses gamma-emitting radioisotopes, such as Technetium-99m (Tc-99m), Iodine-123 (I-123), and Thallium-201 (Tl-201).
    - The radiopharmaceutical is introduced into the body via injection, ingestion, or inhalation. It accumulates in specific tissues or organs based on the compound's properties.
2. **Gamma Camera**:
    - The gamma camera is the primary detection device in SPECT. It rotates around the patient to capture gamma rays emitted by the radiopharmaceutical from different angles.
    - Modern SPECT systems often use multiple gamma cameras (heads) to improve image acquisition speed and quality.
3. **Computer System**:
    - The computer system processes the detected gamma rays to reconstruct 3D images of the radiopharmaceutical distribution within the body.

Component of SPECT

RECENT ADVANCES IN IMAGING SYSTEMS

1. Digital Radiography (DR)

- **Flat-Panel Detectors (FPD):**
  - FPDs are key components in DR systems, replacing traditional film and phosphor plates with digital sensors. They use a matrix of thin-film transistors (TFT) and scintillators to directly convert X-rays into digital signals, allowing for real-time image acquisition and immediate availability of images.
  - **Advantages:** Improved image quality, reduced radiation exposure, and instant image preview and adjustment. The ability to manipulate images (zoom, enhance contrast) digitally reduces the need for repeat exposures.
  - **Developments:** Continuous improvements in FPD technology have focused on increasing sensitivity (Detective Quantum Efficiency, DQE), reducing noise, and enhancing spatial resolution.



- **Wireless DR:**
  - Wireless FPDs remove the physical tether between the detector and the X-ray system, offering more flexibility in positioning and greater

ease of use. This is especially valuable in trauma settings, operating rooms, and intensive care units where mobility is critical.

- **Battery Life & Durability:** Modern wireless DR systems feature long-lasting batteries, quick recharge options, and robust designs to withstand the rigors of frequent use in demanding environments.

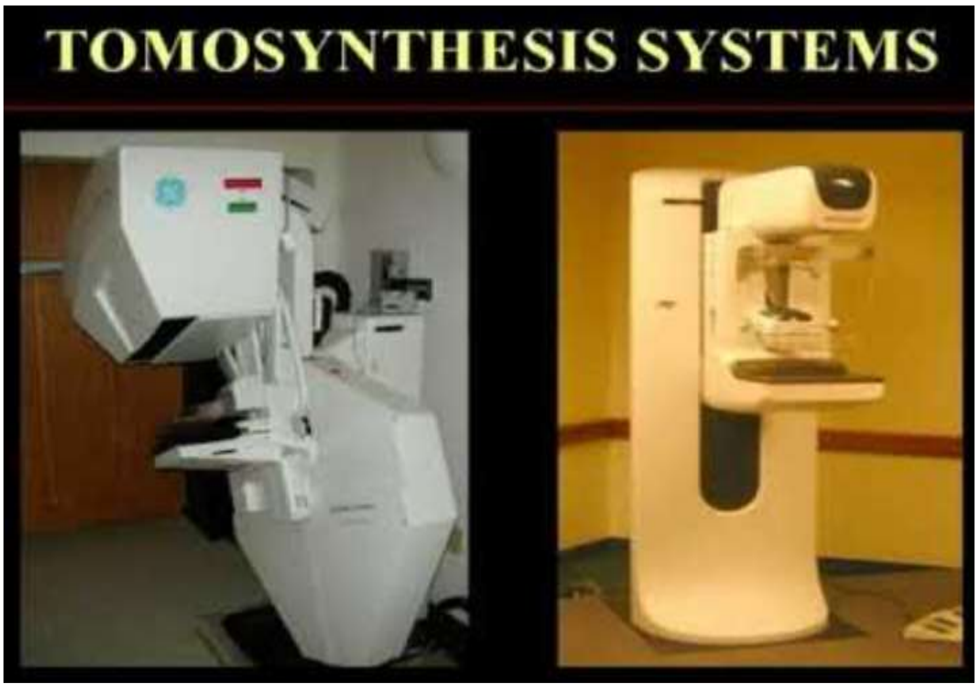
2. Artificial Intelligence (AI) and Machine Learning

- **AI-Powered Image Analysis:**
  - AI algorithms, particularly those based on deep learning, have been trained on large datasets of radiographic images to detect patterns indicative of various diseases. These algorithms assist radiologists by flagging potential areas of concern, such as tumors, fractures, or infections.
  - **Clinical Impact:** AI helps reduce diagnostic errors, streamline workflows, and manage the increasing volume of imaging studies. It is also being used to prioritize urgent cases, ensuring that critical conditions are addressed promptly.
  - **Regulatory Approvals:** Several AI-based tools have received regulatory approvals (e.g., FDA) for use in clinical practice, reflecting their growing importance in radiography.
- **Deep Learning in Image Reconstruction:**
  - Deep learning techniques are employed to improve image reconstruction, particularly in scenarios with low-dose imaging. These algorithms can enhance image quality by reducing noise, sharpening details, and compensating for lower radiation doses, making radiography safer without compromising diagnostic accuracy.

3. Tomosynthesis

- **Principle:** Tomosynthesis involves acquiring multiple images of an object from different angles and then reconstructing these into a 3D image. This is particularly useful in breast imaging, where overlapping tissue in 2D images can obscure lesions.

- **Application in Mammography:**
    - 3D mammography, or digital breast tomosynthesis (DBT), has been shown to improve cancer detection rates, especially in dense breast tissue. It reduces the need for additional imaging by providing clearer, more detailed views of breast structures.
- **Adoption:** Tomosynthesis is being integrated into routine breast screening programs worldwide, and its applications are expanding into other areas like orthopedic imaging and chest imaging.



4. Dual-Energy Imaging

- **Functionality:** Dual-energy radiography uses two X-ray beams at different energy levels to capture images. The two images are then combined to enhance the contrast between different types of tissues or materials.
- **Clinical Applications:**
    - **Bone and Soft Tissue Differentiation:** Particularly useful in musculoskeletal imaging, dual-energy systems can effectively differentiate between bone and soft tissue, making it easier to detect fractures that are otherwise obscured.

- **Detection of Calcifications:** In chest radiography, dual-energy imaging improves the detection of pulmonary nodules and calcifications, aiding in the early diagnosis of conditions like lung cancer.

5. Photon-Counting Detectors

- **Technology:** Unlike traditional detectors that measure the total energy deposited by X-rays, photon-counting detectors (PCDs) count individual photons and measure their energy. This allows for images with superior resolution and contrast.
- **Advantages:** PCDs offer higher spatial resolution, reduced image noise, and the ability to discriminate between different tissues and materials based on their X-ray absorption spectra. This leads to better diagnostic accuracy, particularly in detecting subtle lesions or fine details.
- **Current Use:** Though still emerging, photon-counting technology is being explored in areas like mammography, where it could significantly improve the detection of microcalcifications, and in vascular imaging, where it enhances the visualization of small vessels.

6. Hybrid Imaging Systems

- **Integration of Modalities:** Hybrid imaging systems combine traditional radiography with other imaging modalities like computed tomography (CT) or magnetic resonance imaging (MRI). This integration allows for comprehensive diagnostic imaging in a single session.
- **Examples:**
  - **SPECT/CT or PET/CT:** These systems combine nuclear medicine imaging with CT to provide both functional and anatomical information, useful in oncology and cardiology.
  - **Fusion of Ultrasound with Radiography:** Some systems are integrating ultrasound with radiography to provide real-time imaging guidance for interventions.

7. Portable and Handheld X-ray Systems

- **Evolution:** The latest portable X-ray systems are lighter, more compact, and capable of delivering high-quality images. They are especially useful in emergency and trauma care, where immediate imaging at the point of care is essential.

- **Technological Improvements:** These systems now feature advanced detectors, better battery life, and wireless capabilities, allowing for quick image acquisition and transmission to PACS (Picture Archiving and Communication Systems) for immediate review.
- **Usage in Remote Areas:** Portable X-ray machines are increasingly used in rural or underserved areas, disaster zones, and in-home healthcare, making diagnostic imaging more accessible to populations with limited access to large medical facilities.

8. Spectral Imaging

- **Technology:** Spectral imaging, often implemented in conjunction with photon-counting detectors, utilizes multiple energy spectra to differentiate between various tissues and materials within the body.
- **Benefits:**
    - **Material Decomposition:** Spectral imaging allows for the differentiation between iodine, calcium, fat, and water, enhancing diagnostic capabilities, particularly in oncology, cardiology, and vascular imaging.
    - **Contrast Reduction:** Spectral imaging reduces the need for high doses of contrast agents, which is beneficial for patients with renal impairment or allergies to contrast media.

9. Low-Dose Imaging Techniques

- **Importance:** Reducing radiation exposure is a critical goal in radiography, especially for pediatric patients and those requiring frequent imaging.
- **Technological Advances:**
    - **Iterative Reconstruction Techniques:** These techniques improve image quality by reducing noise and artifacts, enabling lower radiation doses without sacrificing diagnostic accuracy.
    - **Dose Tracking and Management:** Modern radiography systems include software that tracks cumulative radiation doses and adjusts

imaging protocols to minimize exposure, particularly important in managing patient safety.

10. 3D Printing in Radiology

- **Use of Radiographic Data:** Radiographic images, particularly from CT or MRI, can be converted into 3D models that are then printed using 3D printing technology.
- **Applications:**
  - **Surgical Planning:** Custom 3D models of patient anatomy help surgeons plan complex procedures with greater precision.
  - **Patient Education:** 3D models provide a tangible representation of anatomy and pathology, helping patients better understand their condition and the planned surgical intervention.
  - **Custom Implants and Prosthetics:** 3D printing based on radiographic data allows for the creation of patient-specific implants and prosthetics, improving fit and functionality.

Picture Archiving and Communication Systems (PACS)

PACS (picture archiving and communication system) is an evolving healthcare technology for the short and long-term storage, retrieval, management, distribution and presentation of medical image.

PACS Basics

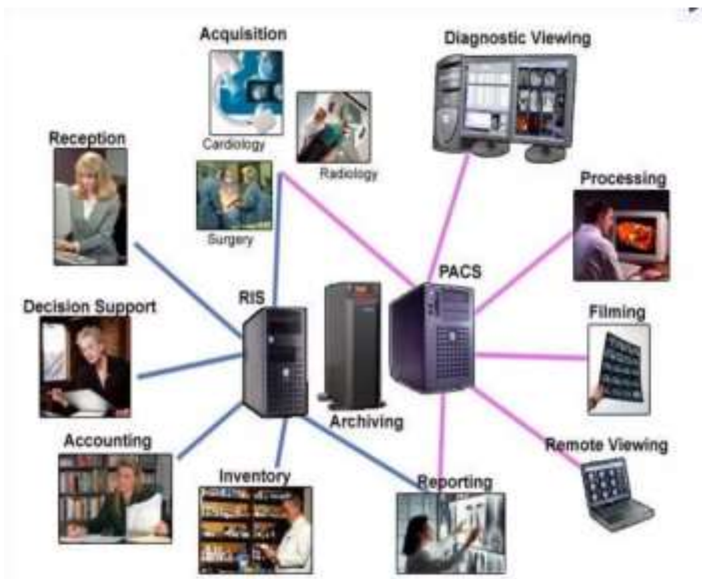
- Initially, hospitals Purchased film digitizer so routine X-ray could be converted to the digital format.
- Now digital image go from the scanning device directly into the PACS.
- PACS usually has a central server that serves as the image repository and multiple client computers linked with a local or wide area network (LAN or WAN).
- Image are stored using the digital imaging and communications in medicine (DICOM) standard.
- PACS is made possible by faster processors, higher capability disk drives, higher resolution monitor, more robust hospital information system, better servers and faster network speeds. PACS is also integrated with voice

recognition systems to expedite report turnaround.

- Input into PACS can also occur from DICOM complaint CD or DVD brought from another facility or teleradiology site via satellite.
- Most diagnostic monitors are still gray skills as they have better resolution (3-5 megapixels), compared to color.Newer “medical monitors” have 2,048 X 2,560 pixel resolution.
- PACS is now important for cardiologist who perform image producing procedures.
- It is estimated that about 90% of large technique hospital have PACS but used by small community hospitals is far lower.
- PACS Was initially associated with expensive work station using? Think client technology. Now the trend is for thin or smart client that permit clinician to access PACS via a web browser from the office or home.

PACS key Components

- **Digital acquisition devices.** The devices that are the Sources of the images. Digital angiography, fluoroscopy and mammography are the newcomers to PACS.
- **The network.** Ties the PACS component together.
- **Database server.** High speed and robust central computer to process information.

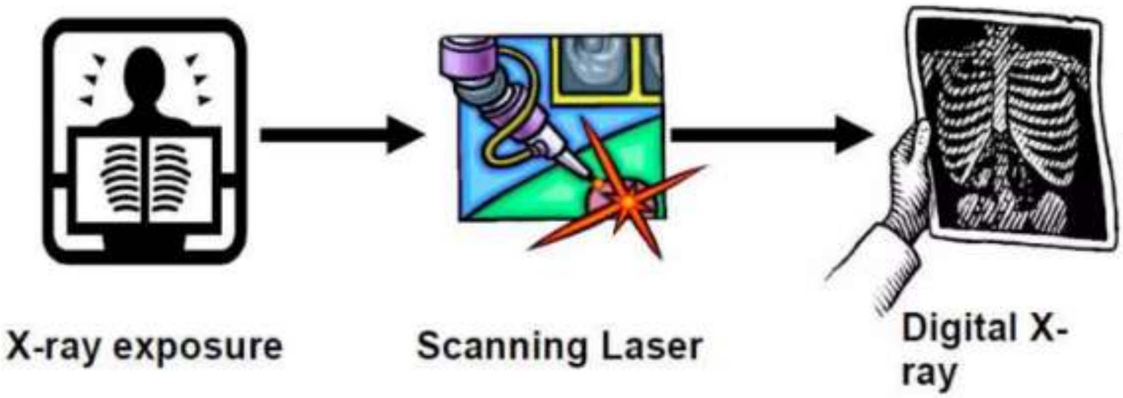


- **Archival server.** Responsible for storing images. A server enables short term (First retrieval) and long term (slower retrieval) storage.

- **Radiology information system (RIS).** System that Maintains patient demographics, scheduling, billing information and interpretation.
- **Workstation or shop copy Display.** Contains the software and hardware to access the PACS. Replace the standard light box or view box.

Types of digital detectors.

1) **Computed radiography (CR).** After X ray exposure to a special Cassette, a laser reader scan the image and converts into a digital image. The image is erased on the cassette so it can be used repeatedly.



2) **Digital radiography dr.** does not require an intermediate step of laser scaling. It is important to note that many facilities with digital systems or PACS still print hard copies or have some non digital services. This could be due to physician resistance, lack of resources, or the fact that it has taken longer for certain imaging services, such as mammography, to go digital. Full PACS means that images are processed from ultrasonography (USG), magnetic resonance imaging (MRI), position emission tomography (PET), computed tomography (CT) and routine radiography. Mini PACS on the other hand, is more limited and processes images from only one modality.

PACS advantages

- He replaces a standard x ray field archieve which means a much smaller X-ray storage space can be converted into revenue generating services and it reduces the need for file clerk.
- Allows for remote viewing and reporting; to also include Tele radiology
- Accelerates the incorporation of medical images into an electronic health

record.

- Images Can be achieved and transported on portable media. USB drive and Apple's iPhone.
- Other specialists that generate images may join Paca's, such as Cardiologists, Ophthalmologist Gastroenterologist and Dermatologist.
- PACS can be web based and use "service oriented architecture" Such that each image has its own URL. This would allow access to images from multiple hospitals in a network.
- Online conventional X-Rays, digital films have a zoom feature and can be manipulated in innumerable ways.
- Improves productivity by allowing multiple Clinicians to view the same image from different location.
- Rapid retrieval of digital images from interpretations and comparison with previous studies.
- Radiologists can view an image back and forth like a movie known as stick mode.
- Quicker reporting back to the requesting clinician.

PACS disadvantage.

- Post although innovations such as open source and rental PACS are alternatives.
- Integration with hospital and radiology information systems and EHR.
- Bandwidth limits.
- Workstation limit.
- Viewing digital images a little slower than routine X-ray Films.
- Black and white computer monitors not as bright as traditional X-ray view boxes. This may be an issue with radiologists, but not the average physician.

Key components.

- PACS is the logical result of digitizing x-rays, developing better monitor and improving medical information networks and electronic health records.
- PACS is well accepted by radiologists and referring physicians because of the use of retrieval and the quality of the images.
- PACA is a type of teleradiology in that images can be viewed remotely by multiple clinicians on the same network.
- Coast and integration are the only significant barriers to the widespread adoption of PACS.

MIDNAPORE CITY COLLEGE

Department of Paramedical and Allied Health Sciences

Bachelor of Radiology and Imaging Techniques

3rd Year

Paper Title: Modern Imaging Techniques And Recent Trends In Imaging (Practical)

Paper Code: Paper –III

Syllabus:

A. Computed Tomography Protocols:

i. **Head:** Routine head, Sinuses, Facial / orbit, Temporal bones,Trauma head, Vascular head (CTA), Cross sectional anatomy
   a. **Neck:** Soft tissue neck, Larynx and vocal cords, Vascular neck (CTA) Cross sectional anatomy

ii. **Spine and Musculoskeletal:** Lumber, Cervical, Thoracic, Spinal trauma, Upper extremity, Lower Extremity, Pelvic Girdle, Hips, Musculoskeletal trauma, Cross Sectional anatomy.

iii. **Chest:** Routine chest, HRCT, Vascular chest (e.g., PE), Chest trauma, Airway (trachea, bronchus), Heart (e.g., cardiac scoring, Angiography), Cross sectional anatomy

iv. **Abdomen:** Routine abdomen, Liver (multi-phase), I(jdneys (with contrast), Pancreas, Adrenals, GI tract, Abdominal trauma, Vascular abdomen (CTA), Cross sectional anatomy

v. **Pelvis:** Routine pelvis, Bladder, Pelvic trauma, Vascular pelvis (CTA), Colorectal studies, Cross sectional anatomy

vi. **Special Procedures:** Biopsies, Drainage/ aspirations

vii. **Image Display and Post Processing:** Geometric measurements (e.g. stent graft, distance), ROI, Retrospective reconstruction.

B. Ultrasonography Protocol:

i. **Head** & **Neck:** Soft tissue neck, Larynx and vocal cords, Arteries and veins, Cross sectional anatomy

ii. **Abdomen:** Routine abdomen, Liver, Kidneys, Pancreas, Adrenals, GI tract, Abdominal trauma Arteries & Veins, Cross sectional anatomy

iii. **Pelvis:** Routine pelvis, Bladder, Pelvic trauma, Colorectal studies, Cross sectional anatomy

iv. **Upper limb** & **Lower limb:** Aarteries and veins

v. **Special Procedures:**
Biopsies, Drainage / aspiration

Syllabus:

- **Digital Radiography Techniques:**
  - i. Computed radiography
  - ii. Digital radiography
  - iii. PACS
  - iv. DSA
  - v. Mammography
  - vi. Dental radiography
  - vii. Macro radiography
  - viii. Digital x ray techniques of whole body
- **Magnetic Resonance Imaging:**
  - i. Head and Neck: Routine brain, Internal auditory canal, Orbit, Pituitary, Vascular head, Cranial nerves, Posterior fossa, Head trauma,Sinuses, Soft tissue neck, Vascular neck
  - ii. Spine: Thoracic, Lumbar, Cervical, Sacrum / coccyx, Spinal trauma,Bony pelvis
  - iii. Thorax: Brachia} plexus, Mediastinum, Cardiovascular, Breast, Aorta, Heart and great vessels
  - iv. Abdomen and Pelvis: Liver/ spleen/ pancreas*, Kidneys Adrenals MRCP, Vascular, Male pelvis, Female pelvis
  - v. Musculoskeletal System: Upper limb, Lower limb

COMPUTED TOMOGRAPHY PROTOCOLS

HEAD:-

Indications

The following are common indications for which non-contrast head CT (CT head without intravenous contrast) is usually appropriate :

- altered mental status in specific scenarios
- cerebrovascular disease in specific scenarios
- dementia, initial imaging
- head trauma in specific scenarios
- headache in specific scenarios
- seizures in specific scenarios

Additional indications for non-contrast head CT include the following :

- surgery-related indications
- skull lesions (such as craniosynostosis, fibrous dysplasia, Paget disease, tumors)
- detection or evaluation of calcification

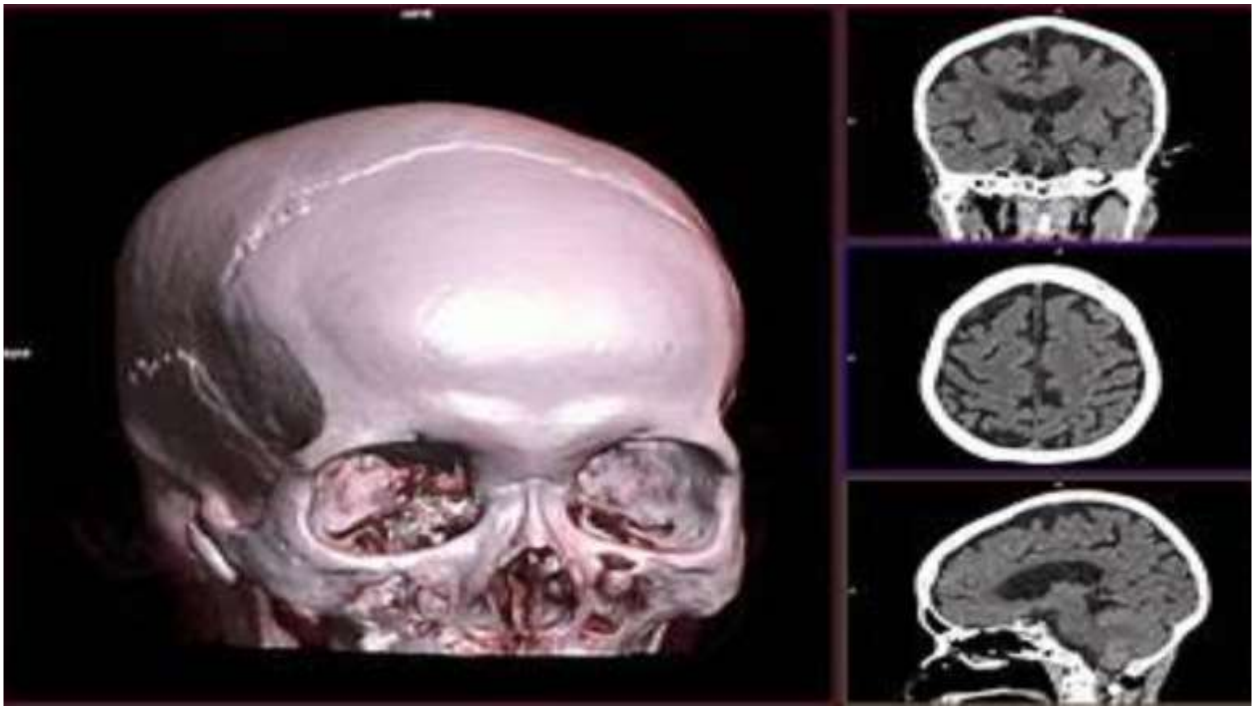
Technique

- **patient preparation**
  - remove metallic objects including earrings, necklaces and metallic removable dental prosthetics
- **patient position**
  - head first
  - supine with their arms by their side
- **tube voltage**
  - 120 kVp
- **scout**
  - AP and Lateral
  - C2 to vertex
- **scan extent**
  - C2 to vertex
- **scan direction**
  - caudocranial
- **scan geometry**
  - slice thickness: <1 mm
  - slice increment: 0.5 mm

- **respiration phase**
  - suspended
- **contrast medium**
  - positive non-ionic iodinated contrast agent as per local protocol
- **contrast injection protocol**
  - non-contrast performed first
  - delayed phase post-contrast acquisition
    - 50 cc hand injection or 1 cc/s pressure injection ± saline chaser
    - delayed acquisition: >5 minutes post-contrast injection
- **multiplanar reconstructions**
  - 3 mm axial, sagittal and coronal brain reformats
  - 3 mm axial, sagittal and coronal bone reformats

The technique for performing a CT of the head depends on the scanner available and falls into two broad camps:

- step-and-shoot (sequential)
- volumetric acquisition (helical)



Routine Head CT

Indications: Evaluation of stroke, hemorrhage, trauma, tumors, or neurological symptoms.

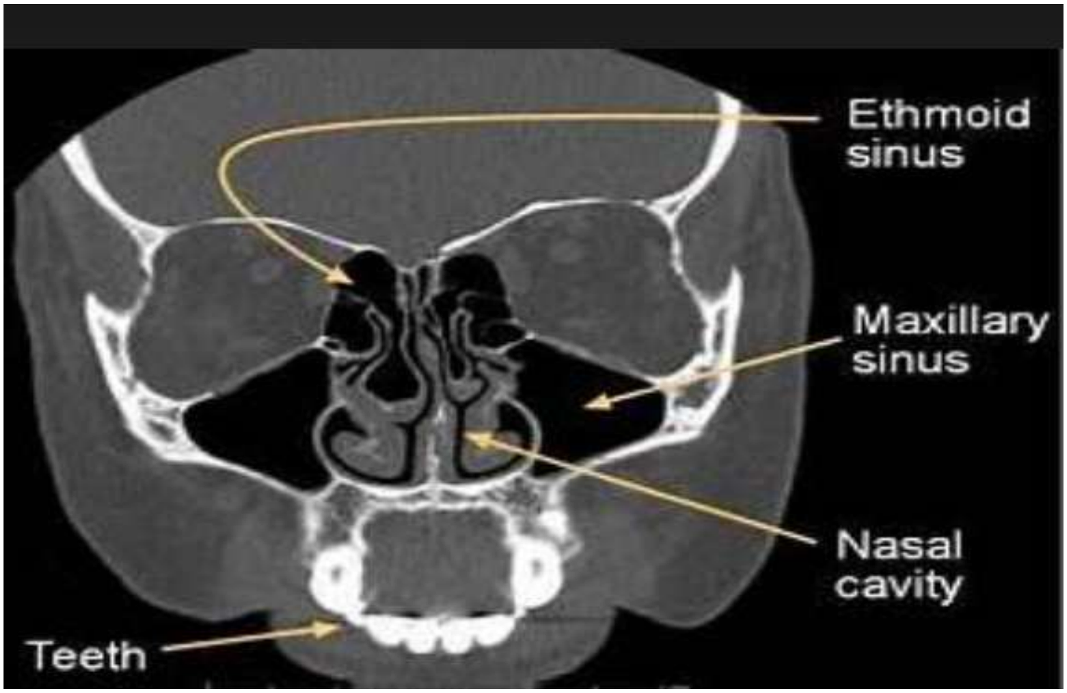
1. **Patient Positioning**

   - Supine with head in the headrest.
   - Head aligned and immobilized to reduce motion artifacts.
2. **Scan Parameters**
   - **Slice Thickness**: 5 mm for general overview, 1-2 mm for detailed evaluation.
   - **Helical or Axial Scanning**: Helical preferred for speed and reconstruction capabilities.
   - **Field of View (FOV)**: Small enough to cover the entire head, typically 22-25 cm.
3. **Contrast**
   - **Non-Contrast**: Standard for initial evaluation.
   - **Contrast-Enhanced**: If a tumor, infection, or vascular lesion is suspected (typically 80-100 mL of iodinated contrast medium).
4. **Reconstruction**
   - **Bone Window**: For evaluation of the skull.
   - **Soft Tissue Window**: For brain parenchyma evaluation.
   - **Reformats**: Axial, coronal, and sagittal planes.

Sinus CT

Indications: Chronic sinusitis, suspected sinus tumors, or pre-surgical planning.

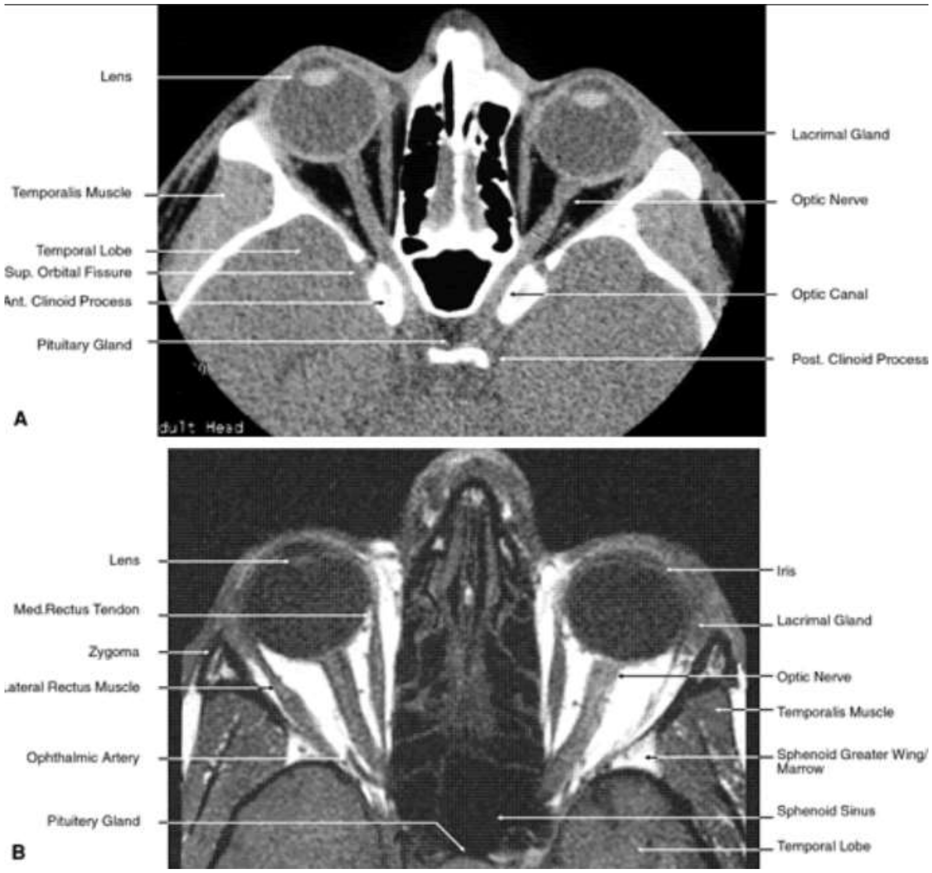
1. **Patient Positioning**
   - Supine with head tilted back slightly to include all sinuses.
2. **Scan Parameters**
   - **Slice Thickness**: 1-3 mm.
   - **Helical Scanning**: Preferred for speed and multi-planar reconstructions.
   - **FOV**: Just large enough to cover the sinuses, typically 18-20 cm.
3. **Contrast**
   - **Non-Contrast**: Standard for sinus imaging.
   - **Contrast-Enhanced**: Only if a tumor or extensive infection is suspected.
4. **Reconstruction**
   - **Bone Window**: For detailed sinus anatomy.
   - **Soft Tissue Window**: For mucosal and soft tissue evaluation.
   - **Reformats**: Axial, coronal, and sagittal planes.



Facial/Orbit CT

Indications: Trauma, orbital fractures, tumors, or infections.

1. **Patient Positioning**
    - Supine with head positioned to avoid motion artifacts.
2. **Scan Parameters**
    - **Slice Thickness**: 1-2 mm.
    - **Helical Scanning**: Preferred for high-resolution and multi-planar reconstructions.
    - **FOV**: 18-20 cm to include facial structures and orbits.
3. **Contrast**
    - **Non-Contrast**: Standard for initial trauma evaluation.
    - **Contrast-Enhanced**: If infection, tumors, or vascular abnormalities are suspected.
4. **Reconstruction**
    - **Bone Window**: For detailed evaluation of facial bones and orbits.
    - **Soft Tissue Window**: For muscles, fat, and orbital contents.
    - **Reformats**: Axial, coronal, and sagittal planes.

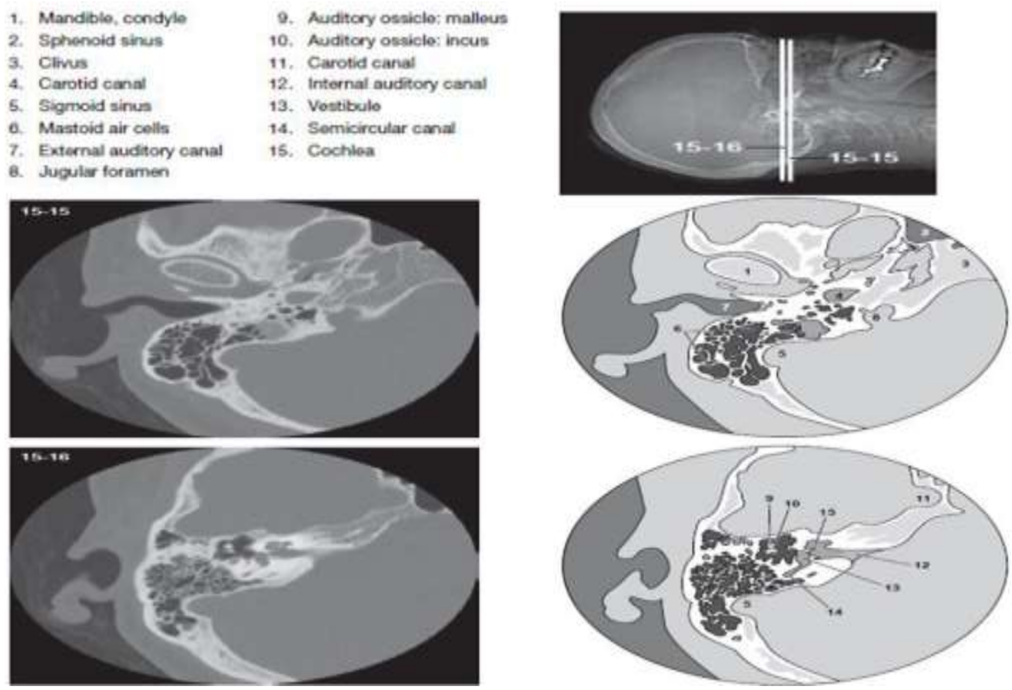


Temporal Bones CT

Indications: Hearing loss, cholesteatoma, infections, or congenital abnormalities.

1. **Patient Positioning**
   - Supine with head immobilized.
2. **Scan Parameters**
   - **Slice Thickness**: 0.5-1 mm for high-resolution imaging.
   - **Helical Scanning**: Preferred for fine detail and multi-planar reconstructions.
   - **FOV**: Small to include only the temporal bones, typically 10-12 cm.
3. **Contrast**
   - **Non-Contrast**: Standard for initial evaluation.
   - **Contrast-Enhanced**: If tumors or vascular lesions are suspected.
4. **Reconstruction**
   - **Bone Window**: For detailed evaluation of the ossicles and temporal bone anatomy.
   - **Soft Tissue Window**: For inner ear structures and surrounding soft

tissues.
- **Reformats**: Axial, coronal, and oblique planes.



Trauma Head CT

Indications: Acute head trauma, suspected skull fractures, intracranial hemorrhage.

1. **Patient Positioning**
   - Supine with head immobilized.
2. **Scan Parameters**
   - **Slice Thickness**: 5 mm for rapid overview, 1-2 mm for detailed evaluation.
   - **Helical Scanning**: Preferred for speed.
   - **FOV**: Cover the entire head, typically 22-25 cm.
3. **Contrast**
   - **Non-Contrast**: Standard for acute trauma.
   - **Contrast-Enhanced**: If vascular injury or secondary complications are suspected.
4. **Reconstruction**
   - **Bone Window**: For skull fractures.
   - **Soft Tissue Window**: For brain parenchyma and hemorrhage.
   - **Reformats**: Axial, coronal, and sagittal planes.

Vascular Head CT (CTA)

Indications: Suspected aneurysms, arteriovenous malformations (AVMs), or stroke.

1. **Patient Positioning**
   - Supine with head immobilized.
2. **Scan Parameters**
   - **Slice Thickness**: 0.5-1 mm for high-resolution imaging.
   - **Helical Scanning**: Essential for capturing arterial phase.
   - **FOV**: Cover the intracranial vessels, typically 18-22 cm.
3. **Contrast**
   - **Contrast-Enhanced**: Rapid injection of iodinated contrast medium (typically 80-100 mL) using a power injector at 4-5 mL/sec.
4. **Reconstruction**
   - **Arterial Phase Imaging**: To visualize arteries and any vascular abnormalities.
   - **Bone Subtraction**: Techniques to remove bony structures and highlight vessels.
   - **Reformats**: Axial, coronal, sagittal, and 3D reconstructions.

SOFT TISSUE NECK CT

Indications: Evaluation of masses, infections, abscesses, inflammatory conditions, or lymphadenopathy.

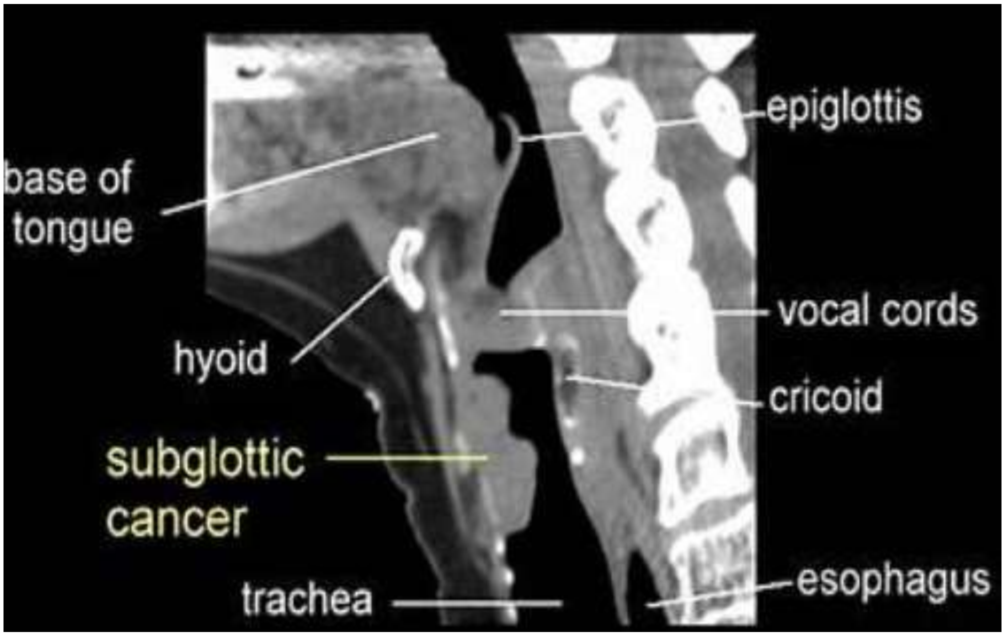
1. **Patient Positioning**
   - Supine with the neck extended slightly to reduce artifacts from the shoulders.
2. **Scan Parameters**
   - **Slice Thickness**: 3-5 mm.
   - **Helical Scanning**: Preferred for speed and multi-planar reconstructions.
   - **Field of View (FOV)**: Large enough to cover from the skull base to the thoracic inlet, typically 24 cm.

3. **Contrast**
    - **Contrast-Enhanced**: Standard to differentiate vascular structures and enhance soft tissue contrast (typically 80-100 mL of iodinated contrast medium).
    - **Injection Rate**: 2-3 mL/sec.
4. **Reconstruction**
    - **Soft Tissue Window**: For evaluation of soft tissues and structures.
    - **Bone Window**: For evaluation of bony structures.
    - **Reformats**: Axial, coronal, and sagittal planes.

LARYNX AND VOCAL CORDS CT

Indications: Evaluation of hoarseness, vocal cord paralysis, tumors, or structural abnormalities.

1. **Patient Positioning**
    - Supine with the neck extended slightly to reduce artifacts from the shoulders.
2. **Scan Parameters**
    - **Slice Thickness**: 1-2 mm for detailed evaluation of small structures.
    - **Helical Scanning**: Preferred for speed and multi-planar reconstructions.
    - **FOV**: Small enough to cover the larynx and vocal cords, typically 18-20 cm.
3. **Contrast**
    - **Contrast-Enhanced**: Standard to enhance visualization of mucosal surfaces and differentiate soft tissue structures (typically 80-100 mL of iodinated contrast medium).
    - **Injection Rate**: 2-3 mL/sec.
4. **Reconstruction**
    - **Soft Tissue Window**: For detailed evaluation of the larynx and vocal cords.
    - **Bone Window**: For evaluation of cartilage and bony structures.
    - **Reformats**: Axial, coronal, and sagittal planes, with focus on the glottic and supraglottic regions.



VASCULAR NECK CT (CTA)

Indications: Evaluation of carotid artery disease, aneurysms, dissections, or vascular malformations.

1. **Patient Positioning**
   - Supine with the neck extended slightly to reduce artifacts from the shoulders.
2. **Scan Parameters**
   - **Slice Thickness**: 0.5-1 mm for high-resolution imaging of vascular structures.
   - **Helical Scanning**: Essential for capturing the arterial phase.
   - **FOV**: Large enough to cover from the aortic arch to the skull base, typically 24 cm.
3. **Contrast**
   - **Contrast-Enhanced**: Rapid injection of iodinated contrast medium (typically 80-100 mL) using a power injector at 4-5 mL/sec.
   - **Timing**: Bolus tracking or timing bolus technique to capture the arterial phase.
4. **Reconstruction**
   - **Arterial Phase Imaging**: To visualize arteries and any vascular abnormalities.
   - **Bone Subtraction**: Techniques to remove bony structures and

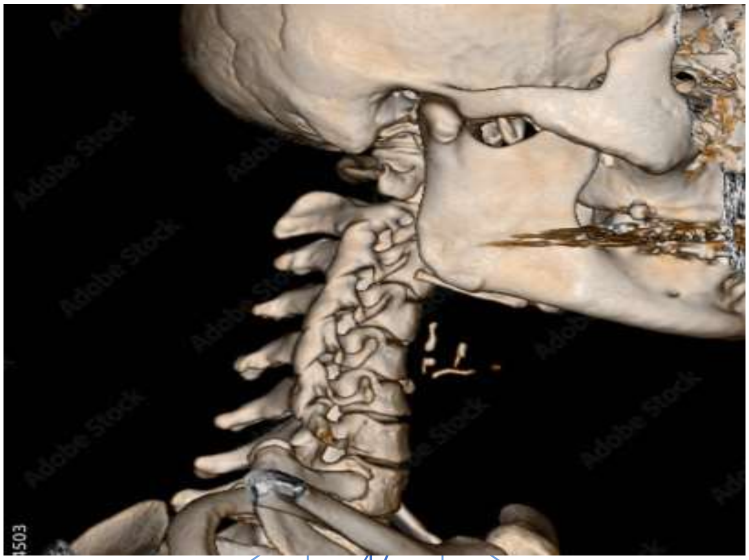
highlight vessels.
- **Reformats**: Axial, coronal, sagittal, and 3D reconstructions.

CT Protocols for Spine and Musculoskeletal Imaging

CERVICAL SPINE CT

Indications: Evaluation of cervical spine trauma, fractures, degenerative changes, or tumors.

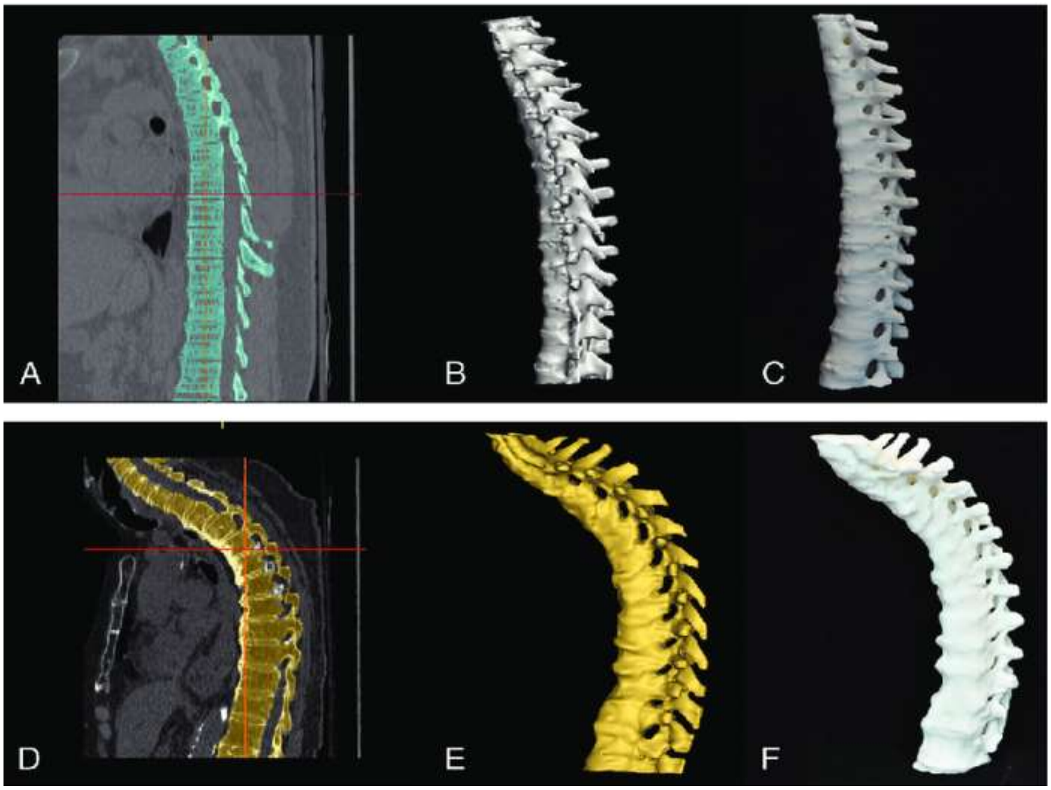
1. **Patient Positioning**
   - Supine with the neck slightly extended.
2. **Scan Parameters**
   - **Slice Thickness**: 1-2 mm.
   - **Mode**: Helical scanning.
   - **FOV**: From the skull base to T1 vertebra, typically 12-15 cm.
3. **Contrast**
   - **Non-Contrast**: Standard for trauma and initial evaluation.
   - **Contrast-Enhanced**: If infection, tumor, or vascular abnormalities are suspected.
4. **Reconstruction**
   - **Bone Window**: For detailed evaluation of vertebrae and bony structures.
   - **Soft Tissue Window**: For evaluation of the spinal cord and surrounding soft tissues.
   - **Reformats**: Axial, coronal, and sagittal planes.



THORACIC SPINE CT

Indications: Evaluation of thoracic spine fractures, tumors, infections, or degenerative changes.

1. **Patient Positioning**
   - Supine with arms raised above the head if possible.
2. **Scan Parameters**
   - **Slice Thickness**: 2-3 mm.
   - **Mode**: Helical scanning.
   - **FOV**: From the cervical spine to the lumbar spine, typically 12-15 cm.
3. **Contrast**
   - **Non-Contrast**: Standard for initial evaluation.
   - **Contrast-Enhanced**: If infection, tumor, or vascular abnormalities are suspected.
4. **Reconstruction**
   - **Bone Window**: For detailed evaluation of vertebrae and bony structures.
   - **Soft Tissue Window**: For evaluation of the spinal cord and surrounding soft tissues.
   - **Reformats**: Axial, coronal, and sagittal planes.

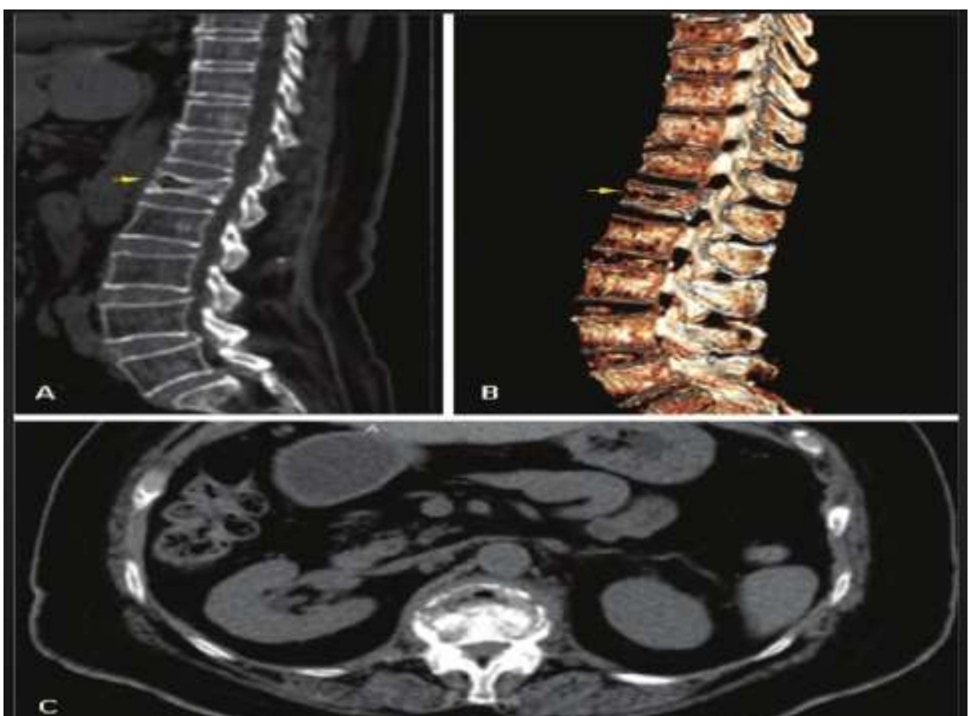


LUMBAR SPINE CT

Indications: Evaluation of lumbar spine pathology such as

- disc herniation,
- stenosis,
- fractures,
- or tumors.

1. **Patient Positioning**
   - Supine with knees slightly bent to flatten the lumbar spine against the table.
2. **Scan Parameters**
   - **Slice Thickness**: 2-3 mm.
   - **Mode**: Helical scanning.
   - **Field of View (FOV)**: Focused on the lumbar spine, typically 12-15 cm.
3. **Contrast**
   - **Non-Contrast**: Standard for initial evaluation.
   - **Contrast-Enhanced**: If infection or tumor is suspected (typically 80-100 mL of iodinated contrast).
4. **Reconstruction**
   - **Bone Window**: For evaluation of vertebrae and bony structures.
   - **Soft Tissue Window**: For evaluation of spinal cord and surrounding soft tissues.
   - **Reformats**: Axial, coronal, and sagittal planes.



SPINAL TRAUMA CT

Indications: Evaluation of acute spinal trauma, fractures, dislocations.

1. **Patient Positioning**
   - Supine with minimal movement to avoid exacerbating any injury.
2. **Scan Parameters**
   - **Slice Thickness**: 1-2 mm.
   - **Mode**: Helical scanning for rapid acquisition.
   - **FOV**: From the skull base to the sacrum, depending on the region affected.
3. **Contrast**
   - **Non-Contrast**: Standard for acute trauma.
   - **Contrast-Enhanced**: If vascular injury or soft tissue complications are suspected.
4. **Reconstruction**
   - **Bone Window**: For detailed evaluation of fractures and bony structures.
   - **Soft Tissue Window**: For evaluation of the spinal cord and soft tissues.
   - **Reformats**: Axial, coronal, and sagittal planes.

UPPER EXTREMITY CT

Indications: Evaluation of fractures, dislocations, tumors, or infections in the upper extremity.

1. **Patient Positioning**
   - Supine with the affected arm extended or positioned appropriately.
2. **Scan Parameters**
   - **Slice Thickness**: 1-2 mm.
   - **Mode**: Helical scanning.
   - **FOV**: Focused on the specific area of interest, typically 12-15 cm.
3. **Contrast**
   - **Non-Contrast**: Standard for initial evaluation.
   - **Contrast-Enhanced**: If infection, tumor, or vascular abnormalities are suspected.

4. **Reconstruction**
    - **Bone Window**: For detailed evaluation of bony structures.
    - **Soft Tissue Window**: For evaluation of muscles, tendons, and ligaments.
    - **Reformats**: Axial, coronal, and sagittal planes.

LOWER EXTREMITY CT

Indications: Evaluation of fractures, dislocations, tumors, or infections in the lower extremity.

1. **Patient Positioning**
    - Supine with the affected leg extended.
2. **Scan Parameters**
    - **Slice Thickness**: 1-2 mm.
    - **Mode**: Helical scanning.
    - **FOV**: Focused on the specific area of interest, typically 12-15 cm.
3. **Contrast**
    - **Non-Contrast**: Standard for initial evaluation.

  - **Contrast-Enhanced**: If infection, tumor, or vascular abnormalities are suspected.

4. **Reconstruction**
   - **Bone Window**: For detailed evaluation of bony structures.
   - **Soft Tissue Window**: For evaluation of muscles, tendons, and ligaments.
   - **Reformats**: Axial, coronal, and sagittal planes.

PELVIC GIRDLE AND HIPS CT

Indications: Evaluation of pelvic fractures, hip dislocations, tumors, or infections.

1. **Patient Positioning**
   - Supine with legs extended.
2. **Scan Parameters**
   - **Slice Thickness**: 2-3 mm.
   - **Mode**: Helical scanning.
   - **FOV**: Large enough to cover the pelvis and hips, typically 24 cm.
3. **Contrast**
   - **Non-Contrast**: Standard for initial evaluation.
   - **Contrast-Enhanced**: If infection, tumor, or vascular abnormalities are suspected.
4. **Reconstruction**
   - **Bone Window**: For detailed evaluation of pelvic bones and hip joints.
   - **Soft Tissue Window**: For evaluation of muscles, tendons, and ligaments.
   - **Reformats**: Axial, coronal, and sagittal planes.

MUSCULOSKELETAL TRAUMA CT

Indications: Evaluation of fractures, dislocations, and soft tissue injuries.

1. **Patient Positioning**
    - Supine or appropriate position to best visualize the injured area.
2. **Scan Parameters**
    - **Slice Thickness**: 1-2 mm.
    - **Mode**: Helical scanning for rapid acquisition.
    - **FOV**: Focused on the specific area of trauma.
3. **Contrast**
    - **Non-Contrast**: Standard for initial trauma evaluation.
    - **Contrast-Enhanced**: If soft tissue injury or vascular complications are suspected.
4. **Reconstruction**
    - **Bone Window**: For detailed evaluation of fractures.
    - **Soft Tissue Window**: For evaluation of muscles, tendons, ligaments, and vessels.
    - **Reformats**: Axial, coronal, and sagittal planes.

CT PROTOCOLS FOR CHEST IMAGING

ROUTINE CHEST CT

Indications: Evaluation of

- lung nodules,
- infections,
- tumors,
- interstitial lung disease,
- or other thoracic pathology.

1. **Patient Positioning**
    - Supine with arms raised above the head.
2. **Scan Parameters**
    - **Slice Thickness**: 5 mm for routine scans.
    - **Mode**: Helical scanning.
    - **Field of View (FOV)**: From the lung apices to the costophrenic angles, typically 35-40 cm.
3. **Contrast**
    - **Non-Contrast**: Often used for initial evaluation.
    - **Contrast-Enhanced**: If vascular structures, tumors, or infections are being evaluated (typically 80-100 mL of iodinated contrast medium).

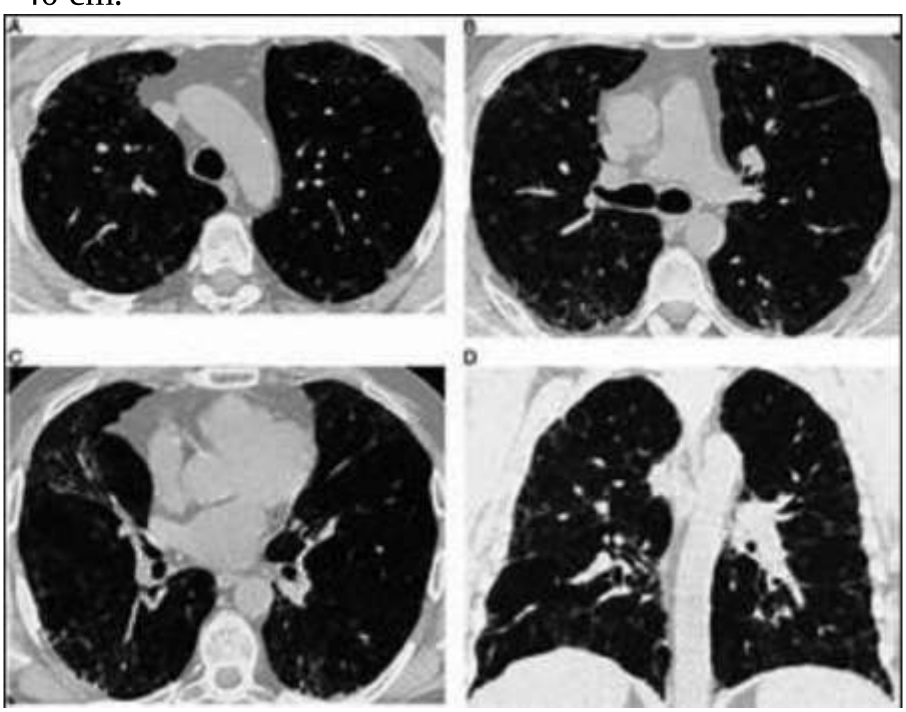
4. **Reconstruction**
    - **Soft Tissue Window**: For evaluation of mediastinal structures.
    - **Lung Window**: For evaluation of lung parenchyma.
    - **Reformats**: Axial, coronal, and sagittal planes.

HIGH-RESOLUTION CT (HRCT) OF THE CHEST

Indications: Detailed evaluation of

- interstitial lung disease,
- fibrosis,
- emphysema,
- or small airway disease.

1. **Patient Positioning**
    - Supine with arms raised above the head.
2. **Scan Parameters**
    - **Slice Thickness**: 1-2 mm.
    - **Mode**: Axial (non-helical) scanning with high spatial resolution.
    - **FOV**: From the lung apices to the costophrenic angles, typically 35-40 cm.



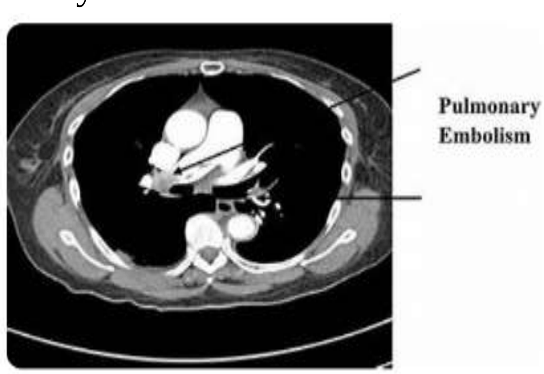
3. **Contrast**
   - **Non-Contrast**: Standard for HRCT to avoid confounding enhancement of small airways.

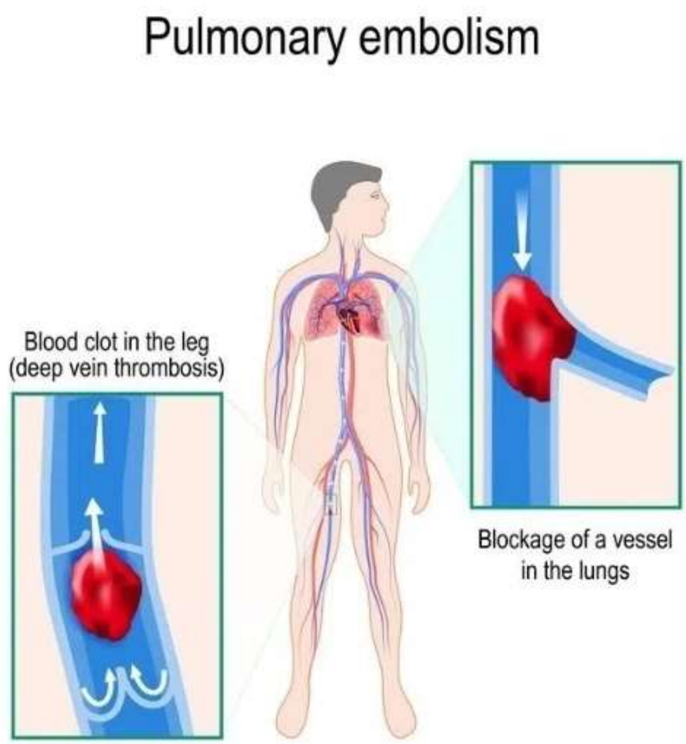
4. **Reconstruction**
   - **Lung Window**: For detailed evaluation of lung parenchyma.
   - **Reformats**: Axial slices with overlapping reconstructions for 3D evaluation.

VASCULAR CHEST CT (E.G., PULMONARY EMBOLISM)

Indications: Suspected pulmonary embolism (PE) or other vascular abnormalities.

1. **Patient Positioning**
   - Supine with arms raised above the head.
2. **Scan Parameters**
   - **Slice Thickness**: 1-2 mm.
   - **Mode**: Helical scanning with fast acquisition.
   - **FOV**: From the lung apices to the costophrenic angles, typically 35-40 cm.
3. **Contrast**
   - **Contrast-Enhanced**: Rapid injection of 80-100 mL iodinated contrast medium using a power injector at 4-5 mL/sec, with timing to capture the pulmonary arterial phase.
4. **Reconstruction**
   - **Soft Tissue Window**: For evaluation of vascular structures.
   - **Lung Window**: For evaluation of lung parenchyma.
   - **Reformats**: Axial, coronal, and sagittal planes, with specific attention to the pulmonary arteries.





CHEST TRAUMA CT

Indications: Evaluation of blunt or penetrating trauma, rib fractures, pneumothorax, hemothorax, or soft tissue injuries.

1. **Patient Positioning**
   - Supine with arms raised if possible; adjust based on patient condition.
2. **Scan Parameters**
   - **Slice Thickness**: 2-3 mm.
   - **Mode**: Helical scanning for rapid acquisition.
   - **FOV**: From the lung apices to the costophrenic angles, typically 35-40 cm.
3. **Contrast**
   - **Non-Contrast**: Initial assessment.
   - **Contrast-Enhanced**: If vascular injury or internal bleeding is suspected.
4. **Reconstruction**
   - **Soft Tissue Window**: For evaluation of mediastinal structures and chest wall.

- **Lung Window**: For evaluation of lung parenchyma and pleural spaces.
- **Bone Window**: For evaluation of rib fractures and bony structures.
- **Reformats**: Axial, coronal, and sagittal planes.

AIRWAY CT (TRACHEA AND BRONCHUS)

Indications: Evaluation of tracheal or bronchial stenosis, tumors, or other airway abnormalities.

1. **Patient Positioning**
    - Supine with arms raised above the head.
2. **Scan Parameters**
    - **Slice Thickness**: 1-2 mm.
    - **Mode**: Helical scanning.
    - **FOV**: From the lung apices to the carina, typically 35-40 cm.
3. **Contrast**
    - **Non-Contrast**: Often sufficient.
    - **Contrast-Enhanced**: If needed to differentiate vascular from airway structures.
4. **Reconstruction**
    - **Soft Tissue Window**: For evaluation of airway and surrounding structures.
    - **Lung Window**: For evaluation of lung parenchyma.
    - **Reformats**: Axial, coronal, and sagittal planes, with 3D reconstructions if necessary.

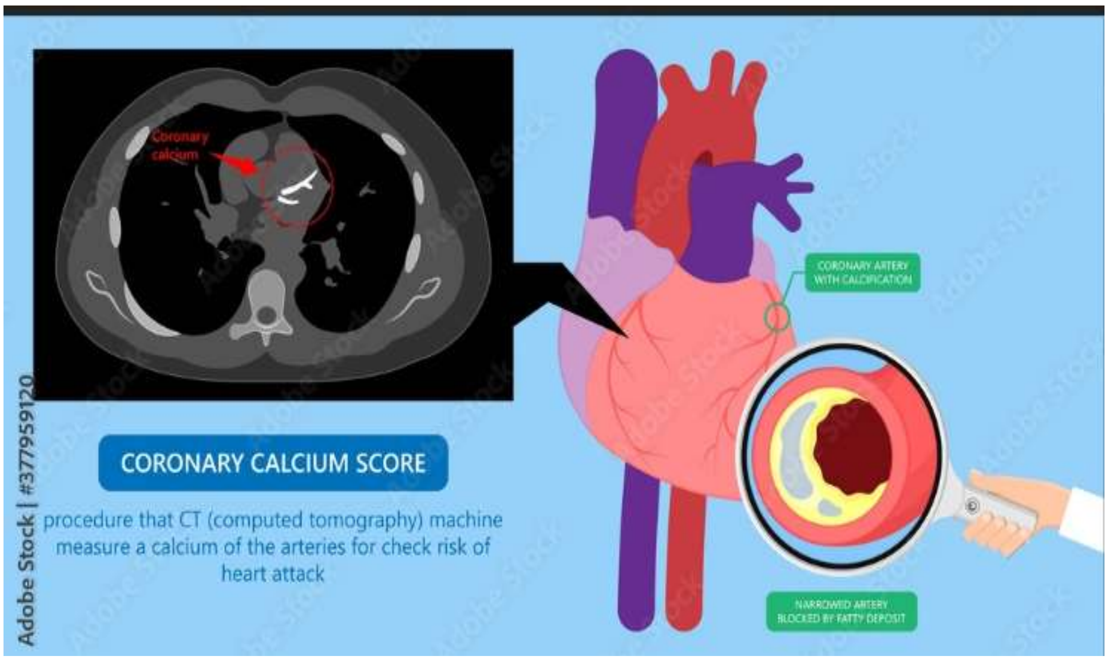
CARDIAC CT (E.G., CARDIAC SCORING, ANGIOGRAPHY)

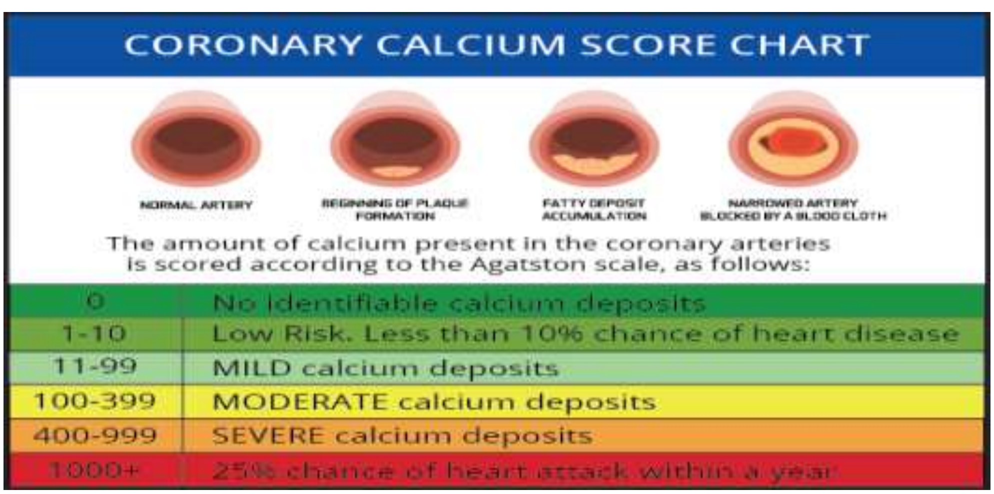
Indications: Evaluation of coronary artery disease, cardiac anatomy, and function.

1. **Patient Positioning**
    - Supine with arms raised above the head.
2. **Scan Parameters**

- **Slice Thickness**: 0.5-1 mm for high-resolution imaging.
- **Mode**: ECG-gated helical scanning.
- **FOV**: Focused on the heart, typically 12-15 cm.

3. **Contrast**
   - **Contrast-Enhanced**: Rapid injection of 80-100 mL iodinated contrast medium using a power injector at 4-5 mL/sec, with timing synchronized to the cardiac cycle.
4. **Reconstruction**
   - **Soft Tissue Window**: For detailed evaluation of coronary arteries and cardiac structures.
   - **Bone Window**: For evaluation of coronary calcium scoring.
   - **Reformats**: Axial, coronal, sagittal, and specific cardiac planes (e.g., short axis, long axis, 4-chamber view).





0	No identifiable calcium deposits
1-10	Low Risk. Less than 10% chance of heart disease
11-99	MILD calcium deposits
100-399	MODERATE calcium deposits
400-999	SEVERE calcium deposits
1000+	25% chance of heart attack within a year

CROSS-SECTIONAL ANATOMY CT

Indications: Comprehensive evaluation of anatomical structures in the thorax for diagnostic purposes.

1. **Patient Positioning**
   - Supine with arms raised above the head.
2. **Scan Parameters**
   - **Slice Thickness**: 1-5 mm depending on the region and detail required.
   - **Mode**: Helical scanning.
   - **FOV**: Adjusted to the specific area of interest, typically 35-40 cm.
3. **Contrast**
   - **Non-Contrast**: For general anatomical evaluation.
   - **Contrast-Enhanced**: If detailed vascular or soft tissue differentiation is needed.
4. **Reconstruction**
   - **Soft Tissue Window**: For evaluation of mediastinal structures and soft tissues.
   - **Lung Window**: For evaluation of lung parenchyma.
   - **Bone Window**: For evaluation of bony structures.
   - **Reformats**: Axial, coronal, and sagittal planes, as well as specific views as needed.

CT PROTOCOLS FOR ABDOMEN IMAGING

ROUTINE ABDOMEN CT

Indications: Evaluation of abdominal pain, masses, infections, and other general abdominal pathology.

1. **Patient Positioning**
   - Supine with arms above the head.
2. **Scan Parameters**
   - **Slice Thickness**: 5 mm.
   - **Mode**: Helical scanning.
   - **Field of View (FOV)**: From the diaphragm to the pelvis, typically 35-

40 cm.

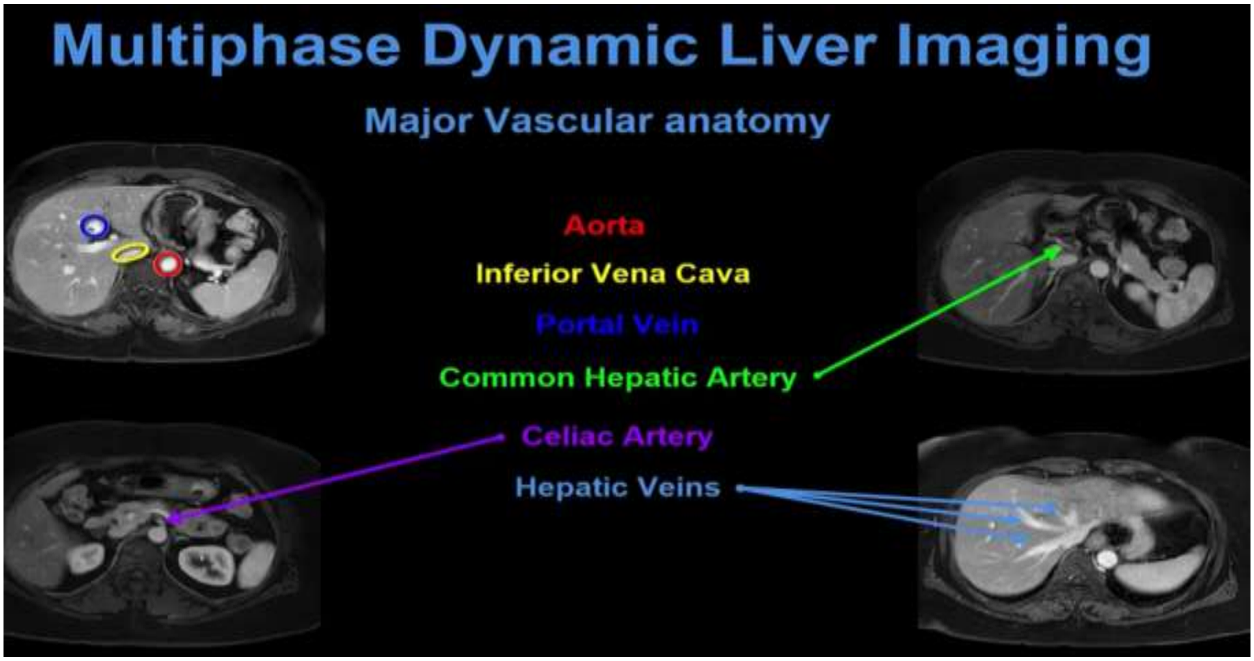
3. **Contrast**
   - **Contrast-Enhanced**: Standard for most abdominal evaluations (typically 80-100 mL of iodinated contrast medium).
   - **Oral Contrast**: Often used to delineate the GI tract.
4. **Reconstruction**
   - **Soft Tissue Window**: For evaluation of abdominal organs and structures.
   - **Bone Window**: For evaluation of bony structures.
   - **Reformats**: Axial, coronal, and sagittal planes.

LIVER CT (MULTI-PHASE)

Indications: Evaluation of liver lesions, tumors, cirrhosis, and other liver pathology.

1. **Patient Positioning**
   - Supine with arms above the head.
2. **Scan Parameters**
   - **Slice Thickness**: 1-2 mm.
   - **Mode**: Helical scanning.

   - **FOV**: Focused on the liver, typically 35-40 cm.
3. **Contrast**
   - **Multi-phase Imaging**: Non-contrast, arterial phase, portal venous phase, and delayed phase with 80-100 mL of iodinated contrast medium.
   - **Injection Rate**: 3-5 mL/sec.
4. **Reconstruction**
   - **Soft Tissue Window**: For detailed evaluation of liver parenchyma.
   - **Reformats**: Axial, coronal, and sagittal planes, with focus on different phases.



KIDNEYS CT (WITH CONTRAST)

Indications: Evaluation of renal masses, stones, infections, and vascular abnormalities.

1. **Patient Positioning**
   - Supine with arms above the head.
2. **Scan Parameters**
   - **Slice Thickness**: 1-2 mm.
   - **Mode**: Helical scanning.
   - **FOV**: From the diaphragm to the pelvis, typically 35-40 cm.

3. **Contrast**
   - **Contrast-Enhanced**: Standard for renal evaluations with 80-100 mL of iodinated contrast medium.
   - **Phases**: Corticomedullary, nephrographic, and excretory phases.
4. **Reconstruction**
   - **Soft Tissue Window**: For detailed evaluation of renal parenchyma and collecting system.
   - **Reformats**: Axial, coronal, and sagittal planes.

PANCREAS CT

Indications: Evaluation of pancreatic masses, pancreatitis, and cysts.

1. **Patient Positioning**
   - Supine with arms above the head.
2. **Scan Parameters**
   - **Slice Thickness**: 1-2 mm.
   - **Mode**: Helical scanning.
   - **FOV**: From the diaphragm to the pelvis, typically 35-40 cm.
3. **Contrast**
   - **Contrast-Enhanced**: Standard with 80-100 mL of iodinated contrast medium.
   - **Phases**: Arterial and portal venous phases for optimal pancreatic parenchyma and vascular evaluation.
4. **Reconstruction**
   - **Soft Tissue Window**: For detailed evaluation of pancreatic parenchyma and surrounding structures.
   - **Reformats**: Axial, coronal, and sagittal planes.

ADRENALS CT

Indications: Evaluation of adrenal masses, hyperplasia, and incidental findings.

1. **Patient Positioning**
   - Supine with arms above the head.
2. **Scan Parameters**
   - **Slice Thickness**: 1-2 mm.
   - **Mode**: Helical scanning.
   - **FOV**: From the diaphragm to the kidneys, typically 35-40 cm.
3. **Contrast**
   - **Non-Contrast**: Initial evaluation.
   - **Contrast-Enhanced**: Standard with 80-100 mL of iodinated contrast medium for further characterization.
4. **Reconstruction**
   - **Soft Tissue Window**: For detailed evaluation of adrenal glands.
   - **Reformats**: Axial, coronal, and sagittal planes.

GI TRACT CT

Indications: Evaluation of bowel obstruction, inflammatory bowel disease, tumors, and other GI pathology.

1. **Patient Positioning**
   - Supine with arms above the head.
2. **Scan Parameters**
   - **Slice Thickness**: 5 mm.
   - **Mode**: Helical scanning.
   - **FOV**: From the diaphragm to the pelvis, typically 35-40 cm.
3. **Contrast**
   - **Oral Contrast**: To delineate the GI tract.
   - **IV Contrast**: Standard with 80-100 mL of iodinated contrast medium for enhanced visualization.
4. **Reconstruction**
   - **Soft Tissue Window**: For evaluation of the GI tract and abdominal organs.

- **Reformats**: Axial, coronal, and sagittal planes.

ABDOMINAL TRAUMA CT

Indications: Evaluation of blunt or penetrating trauma, internal bleeding, and organ injury.

1. **Patient Positioning**
    - Supine with arms above the head if possible.
2. **Scan Parameters**
    - **Slice Thickness**: 2-3 mm.
    - **Mode**: Helical scanning for rapid acquisition.
    - **FOV**: From the diaphragm to the pelvis, typically 35-40 cm.
3. **Contrast**
    - **Contrast-Enhanced**: Standard with 80-100 mL of iodinated contrast medium.
    - **Phases**: Arterial and portal venous phases to identify active bleeding and organ injuries.
4. **Reconstruction**
    - **Soft Tissue Window**: For detailed evaluation of abdominal organs and vasculature.
    - **Bone Window**: For evaluation of fractures.
    - **Reformats**: Axial, coronal, and sagittal planes.

VASCULAR ABDOMEN CT (CTA)

Indications: Evaluation of aneurysms, vascular malformations, and arterial occlusions.

1. **Patient Positioning**
    - Supine with arms above the head.
2. **Scan Parameters**
    - **Slice Thickness**: 1-2 mm.
    - **Mode**: Helical scanning with fast acquisition.

- **FOV**: From the diaphragm to the pelvis, typically 35-40 cm.

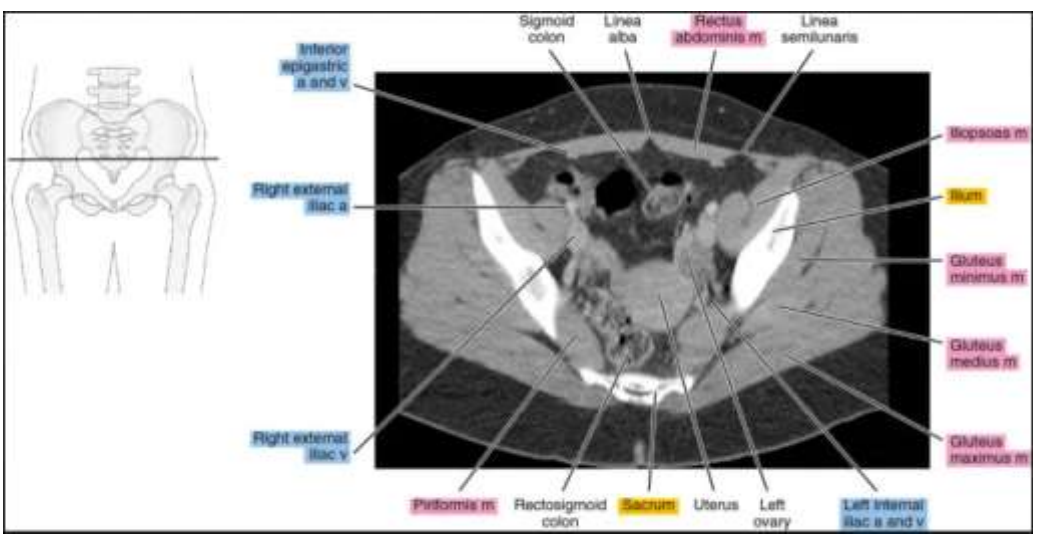
3. **Contrast**
   - **Contrast-Enhanced**: Rapid injection of 80-100 mL iodinated contrast medium using a power injector at 4-5 mL/sec, with timing to capture the arterial phase.
4. **Reconstruction**
   - **Arterial Phase Imaging**: For visualization of arteries and any vascular abnormalities.
   - **Reformats**: Axial, coronal, sagittal, and 3D reconstructions.

CT PROTOCOLS FOR PELVIC IMAGING

ROUTINE PELVIS CT

Indications: Evaluation of pelvic masses, infections, and general pelvic pathology.

1. **Patient Positioning**
   - Supine with arms above the head.
2. **Scan Parameters**
   - **Slice Thickness**: 5 mm.
   - **Mode**: Helical scanning.
   - **Field of View (FOV)**: From the iliac crests to the mid-femurs, typically 35-40 cm.



3. **Contrast**
   - **Contrast-Enhanced**: Standard with 80-100 mL of iodinated contrast

medium.
   - **Oral Contrast**: Often used to enhance visualization of the bowel.
4. **Reconstruction**
   - **Soft Tissue Window**: For detailed evaluation of pelvic organs and structures.
   - **Bone Window**: For evaluation of bony structures.
   - **Reformats**: Axial, coronal, and sagittal planes.

BLADDER CT

Indications: Evaluation of bladder tumors, stones, and other bladder pathologies.

1. **Patient Positioning**
   - Supine with arms above the head.
2. **Scan Parameters**
   - **Slice Thickness**: 1-3 mm.
   - **Mode**: Helical scanning.
   - **Field of View (FOV)**: Focused on the pelvis, typically 20-30 cm.
3. **Contrast**
   - **Contrast-Enhanced**: Standard with 80-100 mL of iodinated contrast medium to evaluate vascular and soft tissue detail.
4. **Reconstruction**
   - **Soft Tissue Window**: For evaluation of the bladder wall and surrounding structures.
   - **Reformats**: Axial, coronal, and sagittal planes.

PELVIC TRAUMA CT

Indications: Evaluation of blunt or penetrating trauma, fractures, and internal bleeding.

1. **Patient Positioning**
   - Supine with arms above the head if possible.
2. **Scan Parameters**
   - **Slice Thickness**: 2-3 mm.
   - **Mode**: Helical scanning for rapid acquisition.
   - **Field of View (FOV)**: From the iliac crests to the mid-femurs,

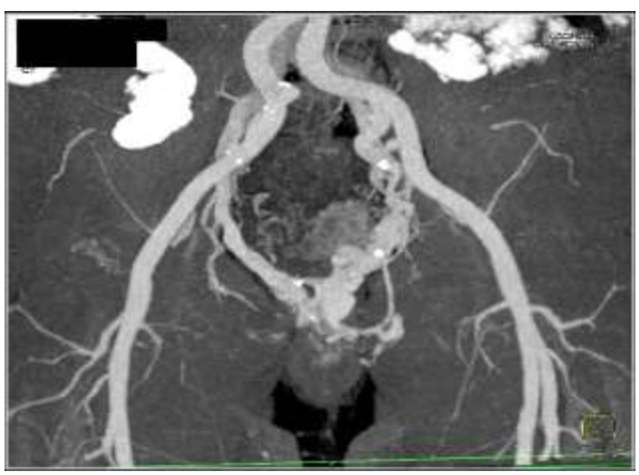
typically 35-40 cm.

3. **Contrast**
    - **Contrast-Enhanced**: Standard with 80-100 mL of iodinated contrast medium, particularly if internal bleeding or vascular injury is suspected.
4. **Reconstruction**
    - **Soft Tissue Window**: For evaluation of pelvic organs and soft tissues.
    - **Bone Window**: For detailed evaluation of fractures.
    - **Reformats**: Axial, coronal, and sagittal planes.

<u>VASCULAR PELVIS CT (CTA)</u>

Indications: Evaluation of vascular structures, aneurysms, or arterial occlusions.

1. **Patient Positioning**
    - Supine with arms above the head.
2. **Scan Parameters**
    - **Slice Thickness**: 1-2 mm.
    - **Mode**: Helical scanning with fast acquisition.
    - **Field of View (FOV)**: From the iliac crests to the mid-femurs, typically 35-40 cm.



3. **Contrast**
    - **Contrast-Enhanced**: Rapid injection of 80-100 mL iodinated contrast medium using a power injector at 4-5 mL/sec, with timing to capture the arterial phase.
4. **Reconstruction**

    - **Arterial Phase Imaging**: For detailed evaluation of vascular structures.
    - **Reformats**: Axial, coronal, sagittal, and 3D reconstructions for comprehensive vascular assessment.

COLORECTAL STUDIES CT

Indications: Evaluation of colorectal cancer, inflammatory bowel disease, and other colorectal pathologies.

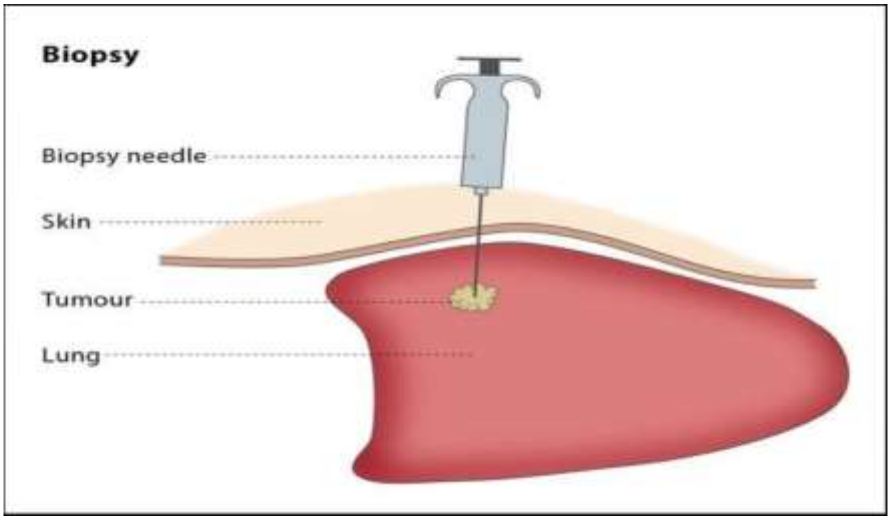
1. **Patient Positioning**
    - Supine with arms above the head.
2. **Scan Parameters**
    - **Slice Thickness**: 1-2 mm.
    - **Mode**: Helical scanning.
    - **Field of View (FOV)**: From the diaphragm to the pelvis, typically 35-40 cm.
3. **Contrast**
    - **Oral Contrast**: Often used to enhance visualization of the bowel.
    - **IV Contrast**: Standard with 80-100 mL of iodinated contrast medium to evaluate the vascular and soft tissue details.
4. **Reconstruction**
    - **Soft Tissue Window**: For detailed evaluation of the colon and surrounding structures.
    - **Reformats**: Axial, coronal, and sagittal planes.

SPECIAL PROCEDURES IN CT IMAGING: BIOPSIES AND DRAINAGE/ASPIRATIONS

BIOPSIES

Indications: To obtain tissue samples for diagnosis of tumors, infections, or other pathologies.

1. **Patient Preparation**
   - **Fasting**: Usually 4-6 hours prior to the procedure.
   - **Consent**: Obtain informed consent from the patient.
   - **Pre-Procedure Imaging**: CT imaging may be done to plan the biopsy.
2. **Procedure**
   - **Positioning**: Patient positioned according to the biopsy site (e.g., supine, prone).
   - **Scout Images**: Initial CT scout images to localize the biopsy site.
   - **Needle Insertion**:
     - **Technique**: Typically performed under CT guidance using a dedicated biopsy needle.
     - **Local Anesthesia**: Administered to the area of needle insertion.
   - **Sample Collection**: Needle is advanced to the target lesion, and tissue samples are collected.
   - **Post-Biopsy Imaging**: Often performed to confirm the needle's position and assess for complications.



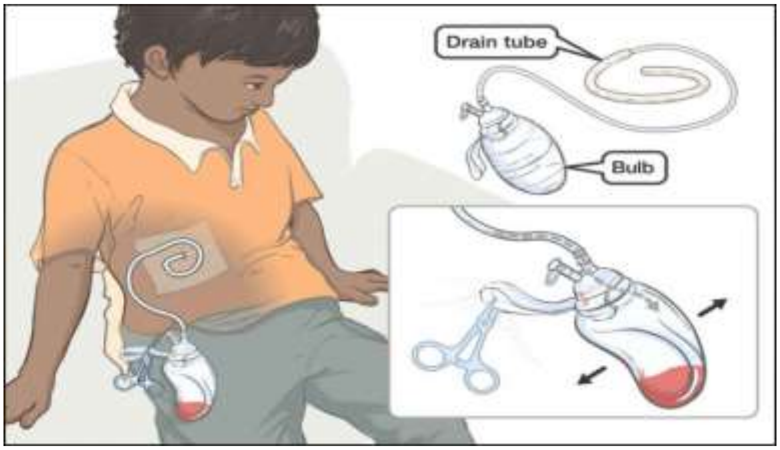
3. **Post-Procedure Care**
   - **Monitoring**: Monitor for complications such as bleeding or pneumothorax.
   - **Follow-Up**: Instructions for care at home and scheduling follow-up visits.
4. **Complications**
   - Hemorrhage, infection, and injury to adjacent structures.

DRAINAGE/ASPIRATIONS

Indications: To remove fluid or pus from abscesses, cysts, or effusions for diagnostic or therapeutic purposes.

1. **Patient Preparation**
   - **Fasting**: Usually 4-6 hours prior to the procedure.
   - **Consent**: Obtain informed consent from the patient.
   - **Pre-Procedure Imaging**: CT imaging is used to identify and plan for the drainage site.

2. **Procedure**
   - **Positioning**: Patient is positioned based on the location of the fluid collection.
   - **Scout Images**: Initial CT scout images to localize the fluid collection.
   - **Needle Insertion**:
     - **Technique**: Use a dedicated drainage or aspiration needle under CT guidance.
     - **Local Anesthesia**: Administered to the area of needle insertion.
   - **Fluid Removal**:
     - **Drainage**: Fluid is aspirated and sent for laboratory analysis if needed.
     - **Catheter Placement**: Sometimes, a catheter is left in place for continuous drainage.
   - **Post-Procedure Imaging**: Often performed to confirm complete drainage and assess for complications.



3. **Post-Procedure Care**
   - **Monitoring**: Watch for signs of infection, bleeding, or displacement

of the catheter.
  - **Follow-Up**: Instructions for catheter care (if applicable) and scheduling follow-up visits.

4. **Complications**
   - Infection, bleeding, injury to surrounding structures, and reaccumulation of fluid.

CT IMAGE DISPLAY AND POST-PROCESSING

1. GEOMETRIC MEASUREMENTS

Purpose: To quantify specific dimensions and distances within CT images, which is essential for evaluating various conditions and interventions.

- **Stent Graft Measurement**
  - **Technique**: Use specialized tools in CT imaging software to measure the dimensions of stent grafts.
  - **Steps**:
    - **Identify**: Locate the stent graft in the CT images.
    - **Select**: Use the measurement tool to define points at the ends and along the length of the stent graft.
    - **Measure**: Assess the diameter, length, and any deviations from the intended position.
    - **Evaluate**: Compare measurements with pre-procedure plans or standards to check for migration, expansion, or complications.
- **Distance Measurement**
  - **Technique**: Employ linear or curved measurement tools to quantify distances between anatomical points.
  - **Steps**:
    - **Identify**: Choose anatomical landmarks or regions of interest on the CT images.
    - **Measure**: Draw lines or curves between points using the software's measurement tools.
    - **Record**: Document measurements for clinical evaluation, such as tumor size, organ distances, or lesion spread.

2. REGION OF INTEREST (ROI)

Purpose: To focus on specific areas within CT images for detailed analysis or quantification.

- **ROI Definition**
  - **Technique**: Use tools to define and analyze specific areas of interest within the image.
  - **Steps**:
    - **Select**: Choose the ROI tool in the imaging software.
    - **Draw**: Outline the region using a freehand or predefined shape tool (e.g., circle, rectangle, or ellipse).
    - **Analyze**: Obtain measurements, attenuation values, or volume calculations within the defined ROI.
    - **Compare**: Assess changes over time or differences between regions.
- **Applications**:
  - **Quantification**: Measure lesion volumes, assess contrast enhancement, or analyze tissue characteristics.
  - **Evaluation**: Monitor disease progression or treatment response.

3. RETROSPECTIVE RECONSTRUCTION

Purpose: To reconstruct images from raw data for improved visualization or additional analysis.

- **Technique**: Utilize raw CT data to create new image reconstructions after the initial scan.
- **Steps**:
  - **Acquire Raw Data**: Ensure access to raw CT data (DICOM format) for reconstruction.
  - **Select Reconstruction Parameters**: Choose slice thickness, reconstruction algorithms (e.g., iterative reconstruction), and image filters (e.g., sharpness, smoothing).
  - **Reconstruct**: Generate new images or reformats in different planes or with enhanced detail.

- **Review**: Compare the reconstructed images with original images to evaluate improvements or additional details.
- **Applications**:
    - **Multiplanar Reconstructions**: Create coronal, sagittal, or oblique views from axial images.
    - **3D Reconstruction**: Generate three-dimensional images for surgical planning or anatomical visualization.
    - **Enhanced Visualization**: Improve contrast or detail for better diagnostic accuracy.

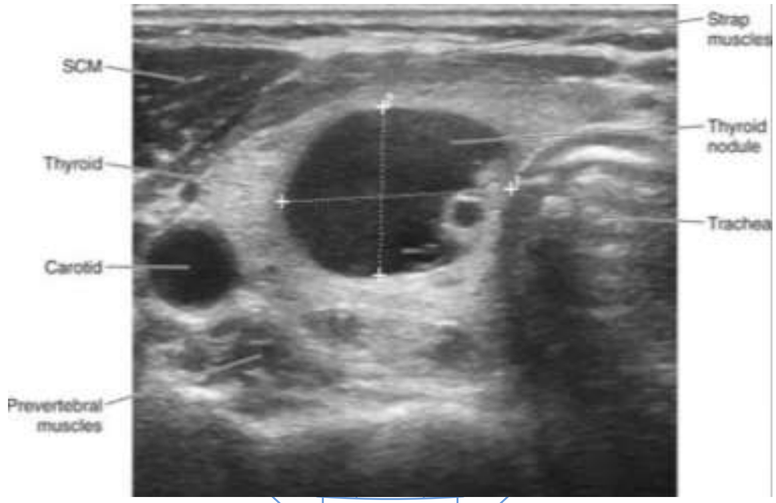
ULTRASONOGRAPHY PROTOCOL:

Ultrasound Protocols for Head & Neck Imaging

1. Soft Tissue Neck

Indications: Evaluation of neck masses, lymphadenopathy, thyroid abnormalities, and other soft tissue pathologies.

- **Patient Positioning**:
    - Supine with neck extended slightly (e.g., pillow under shoulders).
- **Transducer**:
    - **Type**: High-frequency linear transducer (7-15 MHz).
- **Scan Technique**:
    - **Longitudinal and Transverse Views**: Obtain images in both planes.
    - **Area Coverage**: From the mandible to the clavicles, including the carotid sheath and surrounding structures.
    - **Image Optimization**: Adjust gain, depth, and focus for optimal visualization of soft tissues.

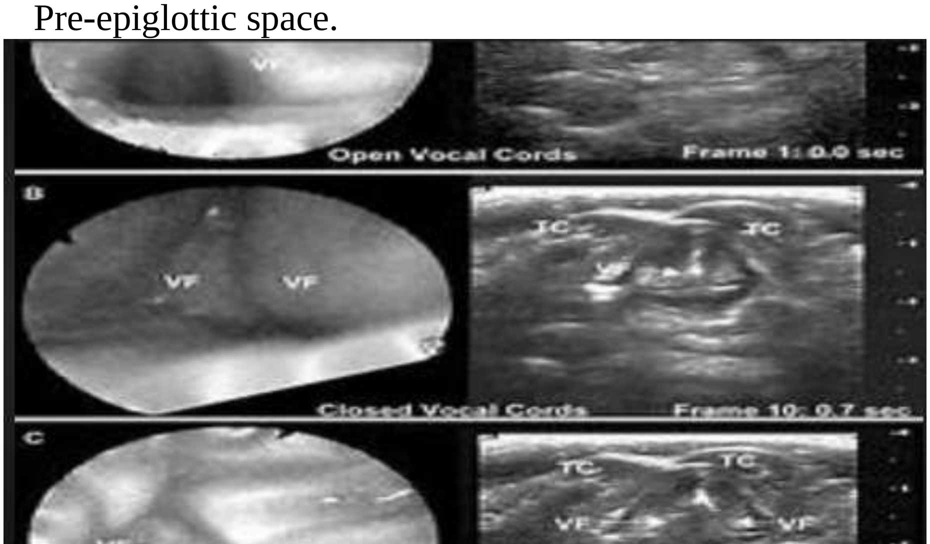


- **Key Areas**:
  - Thyroid gland (including lobes and isthmus).
  - Lymph nodes (size, shape, and echogenicity).
  - Salivary glands (parotid, submandibular, and sublingual).
  - Neck muscles (sternocleidomastoid, trapezius).

2. LARYNX AND VOCAL CORDS

Indications: Evaluation of laryngeal masses, vocal cord lesions, and laryngeal function.

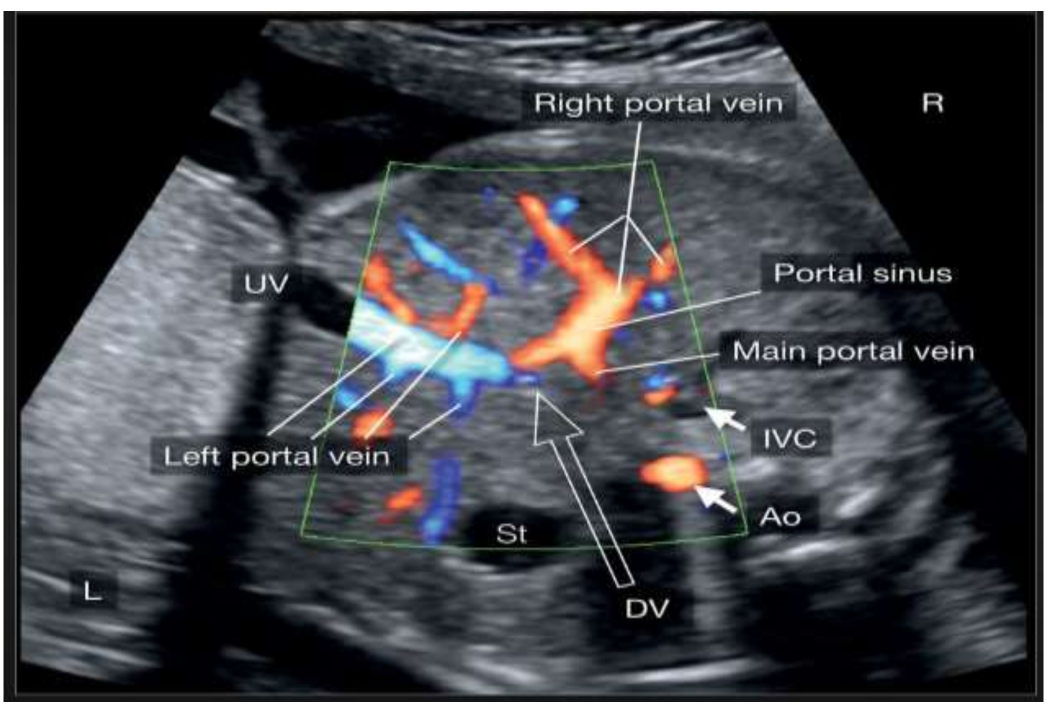
- **Patient Positioning**:
  - Supine with neck extended, or seated with neck slightly extended (depending on patient comfort).
- **Transducer**:
  - **Type**: High-frequency linear transducer (7-15 MHz) or curved array transducer for deeper penetration if needed.
- **Scan Technique**:
  - **Longitudinal and Transverse Views**: Obtain images of the larynx in both planes.
  - **Area Coverage**: From the hyoid bone to the trachea, including the vocal cords and surrounding structures.
  - **Image Optimization**: Adjust settings to highlight the vocal cords and other structures.
- **Key Areas**:
  - Vocal cords (anterior, middle, and posterior segments).
  - Laryngeal cartilages (thyroid, cricoid, and arytenoid).
  - Supraglottic and infraglottic regions.
  - Pre-epiglottic space.



3. ARTERIES AND VEINS

Indications: Assessment of blood flow, thrombosis, aneurysms, and other vascular abnormalities in the neck.

- **Patient Positioning**:
  - Supine with head slightly turned away from the side being examined.
- **Transducer**:
  - **Type**: High-frequency linear transducer (7-15 MHz) for arteries and veins.
- **Scan Technique**:
  - **Longitudinal and Transverse Views**: Obtain images of major arteries and veins in both planes.
  - **Color Doppler**: To assess blood flow and detect abnormalities like stenosis or thrombosis.
  - **Image Optimization**: Adjust Doppler settings (e.g., gain, scale, and wall filter) for optimal flow visualization.
- **Key Areas**:
  - Common carotid arteries (internal and external branches).
  - Internal jugular veins.
  - Vertebral arteries.
  - Subclavian arteries and veins.

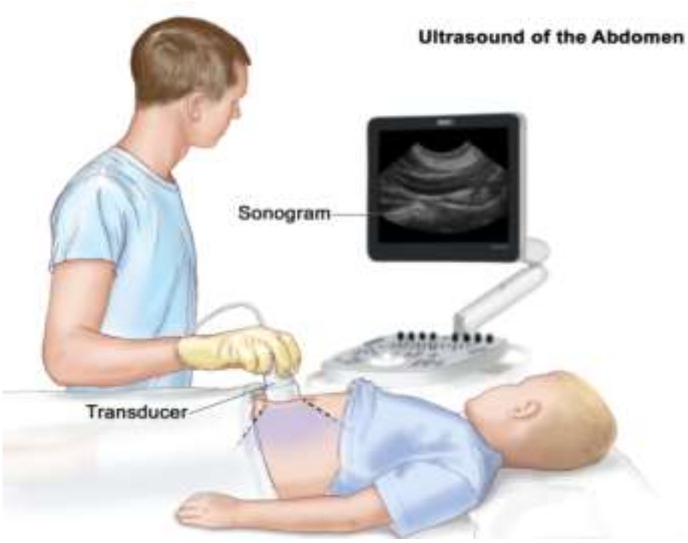


Ultrasound Protocols for Abdomen Imaging

1. Routine Abdomen

Indications: Evaluation of general abdominal pain, masses, and overall organ assessment.

- **Patient Positioning**:
  - Supine with arms at the sides or above the head.
- **Transducer**:
  - **Type**: Curved array transducer (2-5 MHz) for deeper penetration.
- **Scan Technique**:
  - **Longitudinal and Transverse Views**: Obtain images of the liver, spleen, kidneys, and other abdominal organs.
  - **Area Coverage**: From the diaphragm to the pelvis.
  - **Image Optimization**: Adjust gain, depth, and focus for each organ.
- **Key Areas**:
  - Liver (including lobes and hepatic veins).
  - Spleen.
  - Kidneys.
  - Ascitic fluid (if present).

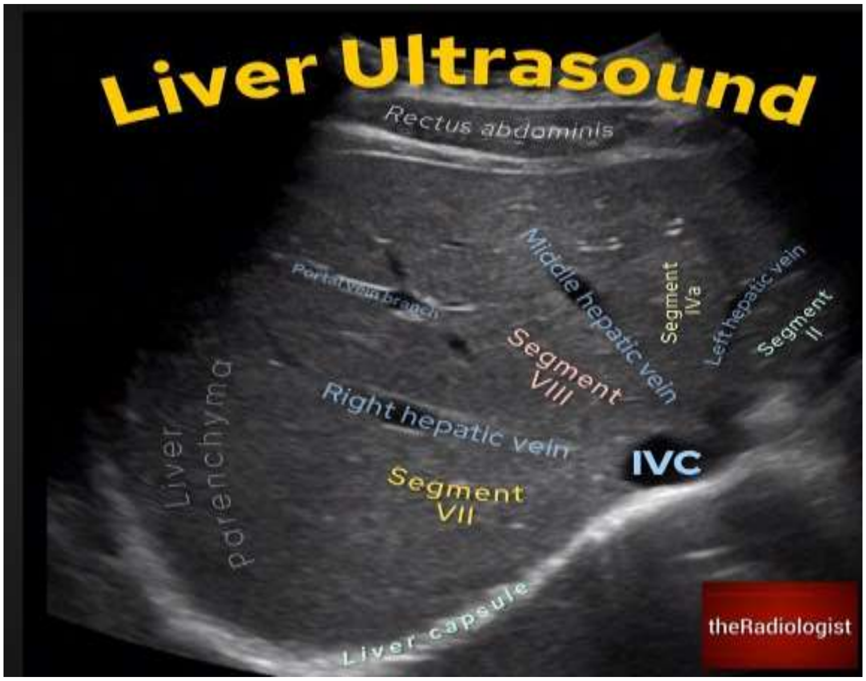


2. LIVER

Indications: Assessment of liver lesions, cirrhosis, and hepatomegaly.

- **Patient Positioning**:

  - Supine or left lateral decubitus position to better visualize the liver.
- **Transducer**:
  - **Type**: Curved array transducer (2-5 MHz) or high-frequency linear transducer (4-7 MHz) for detailed imaging.
- **Scan Technique**:
  - **Longitudinal and Transverse Views**: Obtain images of the liver in various planes.
  - **Image Optimization**: Adjust depth, gain, and focus to visualize liver parenchyma and vessels.
- **Key Areas**:
  - Liver lobes (right and left).
  - Hepatic veins and portal vein.
  - Lesions and liver texture.

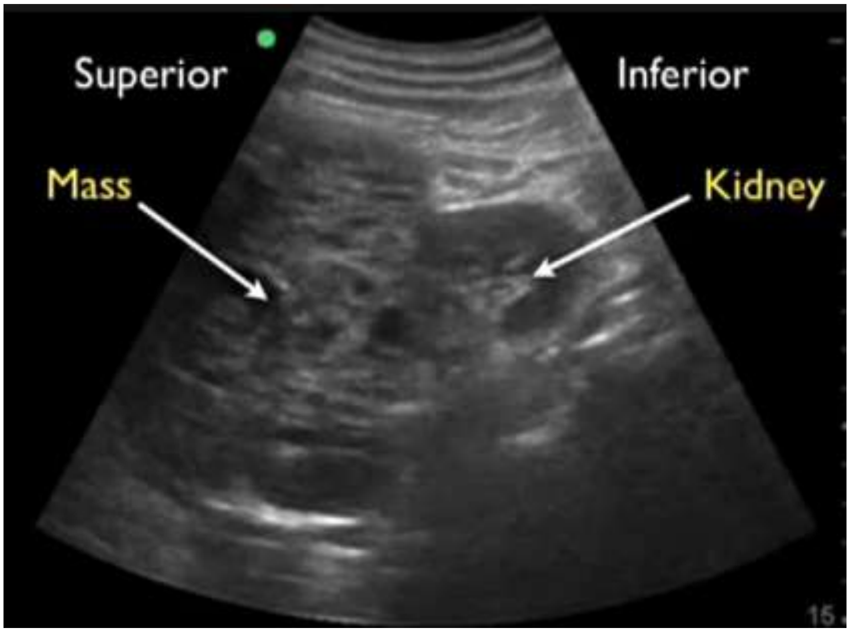


3. KIDNEYS

Indications: Evaluation of renal masses, stones, hydronephrosis, and cysts.

- **Patient Positioning**:
  - Supine or prone position for optimal visualization of both kidneys.
- **Transducer**:
  - **Type**: Curved array transducer (2-5 MHz).
- **Scan Technique**:
  - **Longitudinal and Transverse Views**: Obtain images of both

kidneys.
    - **Image Optimization**: Adjust depth, gain, and focus to visualize renal structures and pathology.
- **Key Areas**:
    - Renal cortex and medulla.
    - Renal pelvis and calyces.
    - Ureteric passage and any stones or masses.



4. PANCREAS

Indications: Assessment of pancreatic tumors, cysts, and pancreatitis.

- **Patient Positioning**:
    - Supine or left lateral decubitus to improve access.
- **Transducer**:
    - **Type**: Curved array transducer (2-5 MHz) or high-frequency linear transducer (4-7 MHz) for better detail.
- **Scan Technique**:
    - **Longitudinal and Transverse Views**: Obtain images of the pancreas.
    - **Image Optimization**: Adjust depth, gain, and focus for detailed visualization of pancreatic tissue and ductal structures.
- **Key Areas**:
    - Pancreatic head, body, and tail.
    - Pancreatic duct.
    - Surrounding structures like the duodenum and aorta.

5. ADRENALS

Indications: Evaluation of adrenal masses, hyperplasia, or other abnormalities.

- **Patient Positioning**:
  - Supine or left/right lateral decubitus, depending on the adrenal gland being examined.
- **Transducer**:
  - **Type**: Curved array transducer (2-5 MHz) or high-frequency linear transducer (4-7 MHz) if needed for detail.
- **Scan Technique**:
  - **Longitudinal and Transverse Views**: Obtain images of the adrenal glands.
  - **Image Optimization**: Adjust depth and gain for clear visualization.
- **Key Areas**:
  - Right and left adrenal glands.
  - Adrenal masses or lesions.
  - Surrounding structures (e.g., kidneys).

6. GI TRACT

Indications: Evaluation of bowel obstruction, tumors, or inflammatory bowel disease.

- **Patient Positioning**:
  - Supine or left lateral decubitus to access different parts of the GI tract.
- **Transducer**:
  - **Type**: Curved array transducer (2-5 MHz).
- **Scan Technique**:
  - **Longitudinal and Transverse Views**: Obtain images of the stomach, small intestine, and large intestine.
  - **Image Optimization**: Adjust settings for clear visualization of bowel wall layers and any fluid or masses.
- **Key Areas**:
  - Stomach, duodenum, jejunum, ileum, and colon.
  - Bowel wall thickness and echogenicity.
  - Presence of fluid, gas, or masses.

7. ABDOMINAL TRAUMA

Indications: Evaluation of abdominal injury, bleeding, or organ damage.

- **Patient Positioning**:
  - Supine or as tolerated based on the patient's condition.
- **Transducer**:
  - **Type**: Curved array transducer (2-5 MHz) for deep penetration.
- **Scan Technique**:
  - **Longitudinal and Transverse Views**: Assess organs for injury.
  - **Image Optimization**: Adjust depth and gain to detect fluid collections or organ damage.
- **Key Areas**:
  - Liver, spleen, kidneys, and bladder.
  - Presence of free fluid or hematomas.

8. ARTERIES & VEINS

Indications: Assessment of blood flow, thrombosis, and aneurysms in abdominal vessels.

- **Patient Positioning**:
  - Supine or slightly tilted based on the vessel being examined.
- **Transducer**:
  - **Type**: Curved array transducer (2-5 MHz) for arterial and venous imaging.
- **Scan Technique**:
  - **Longitudinal and Transverse Views**: Obtain images of major arteries and veins.
  - **Color Doppler**: Assess blood flow, detect thrombosis or aneurysms.
  - **Image Optimization**: Adjust Doppler settings for accurate flow visualization.
- **Key Areas**:
  - Abdominal aorta (including common, internal, and external iliac

arteries).
  - Inferior vena cava and major veins.
  - Blood flow and potential blockages.

ULTRASOUND PROTOCOLS FOR PELVIS IMAGING

1. ROUTINE PELVIS

Indications: General assessment of pelvic organs, including evaluation of masses, pain, and overall anatomy.

- **Patient Positioning**:
  - **Supine**: Preferred for better access and comfort.
- **Transducer**:
  - **Type**: Curved array transducer (2-5 MHz) or high-frequency linear transducer (4-7 MHz) for detailed imaging.
- **Scan Technique**:
  - **Longitudinal and Transverse Views**: Obtain images of the pelvic organs and structures.
  - **Area Coverage**: From the iliac crests to the perineum.
  - **Image Optimization**: Adjust depth, gain, and focus to highlight pelvic structures.
- **Key Areas**:
  - Bladder (including wall and contents).
  - Uterus and ovaries (in females).
  - Prostate (in males).
  - Pelvic muscles and connective tissues.

2. BLADDER

Indications: Evaluation of bladder masses, wall abnormalities, and urinary retention.

- **Patient Positioning**:
  - **Supine**: With the bladder in the center of the imaging field.
- **Transducer**:
  - **Type**: Curved array transducer (2-5 MHz) or high-frequency linear transducer (4-7 MHz) for better detail.
- **Scan Technique**:
  - **Longitudinal and Transverse Views**: Obtain images of the bladder in various planes.
  - **Image Optimization**: Adjust settings to visualize the bladder wall, lumen, and any abnormalities.
- **Key Areas**:
  - Bladder wall thickness and echogenicity.
  - Presence of masses, stones, or debris.
  - Post-void residual volume if necessary.

3. PELVIC TRAUMA

Indications: Assessment of trauma-related injuries, hemorrhage, or organ damage.

- **Patient Positioning**:
  - **Supine**: With slight adjustments based on patient comfort and injury location.
- **Transducer**:
  - **Type**: Curved array transducer (2-5 MHz) for deep penetration.
- **Scan Technique**:
  - **Longitudinal and Transverse Views**: Obtain images of affected areas.
  - **Image Optimization**: Adjust depth, gain, and focus to detect fluid collections, hematomas, and organ damage.
- **Key Areas**:
  - Bladder and surrounding structures.
  - Pelvic organs (uterus, ovaries, prostate).
  - Presence of free fluid or blood.
  - Pelvic bones and soft tissue injuries.

4. COLORECTAL STUDIES

Indications: Evaluation of colorectal masses, inflammatory conditions, and other pathologies.

- **Patient Positioning**:
  - **Supine** or **left lateral decubitus**: Depending on patient comfort and area of interest.
- **Transducer**:
  - **Type**: Curved array transducer (2-5 MHz) or high-frequency linear transducer (4-7 MHz) for detailed imaging.
- **Scan Technique**:
  - **Longitudinal and Transverse Views**: Obtain images of the rectum, colon, and surrounding structures.
  - **Image Optimization**: Adjust settings to highlight bowel wall layers and any abnormalities.
- **Key Areas**:
  - Rectum and anal canal.
  - Colon (including ascending, transverse, descending, and sigmoid).
  - Presence of masses, thickening of bowel wall, or fluid.

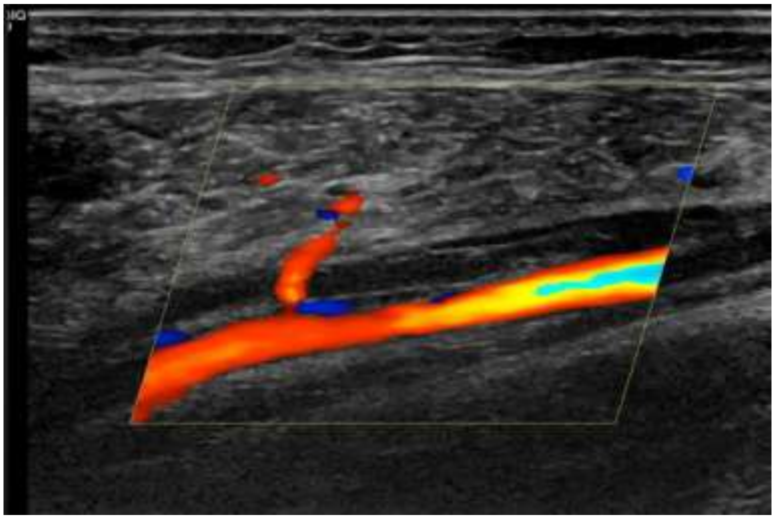
ULTRASOUND PROTOCOLS FOR UPPER AND LOWER LIMBS: ARTERIES AND VEINS

1. UPPER LIMB

ARTERIES

Indications: Evaluation of arterial patency, stenosis, aneurysms, and other vascular abnormalities.

- **Patient Positioning**:
  - **Supine or sitting**: Depending on patient comfort and the specific artery being examined.
- **Transducer**:
  - **Type**: High-frequency linear transducer (7-15 MHz) for detailed imaging of superficial vessels.
- **Scan Technique**:
  - **Longitudinal and Transverse Views**: Obtain images of major arteries.
  - **Color Doppler**: Assess blood flow and detect abnormalities like stenosis or thrombosis.
  - **Image Optimization**: Adjust Doppler settings for optimal flow visualization and vessel wall assessment.
- **Key Areas**:
  - **Brachial Artery**: From the shoulder to the elbow, including branches.
  - **Radial and Ulnar Arteries**: From the wrist to the forearm.
  - **Axillary Artery**: In the axilla region.



VEINS

Indications: Assessment of venous patency, thrombosis, and other vascular issues.

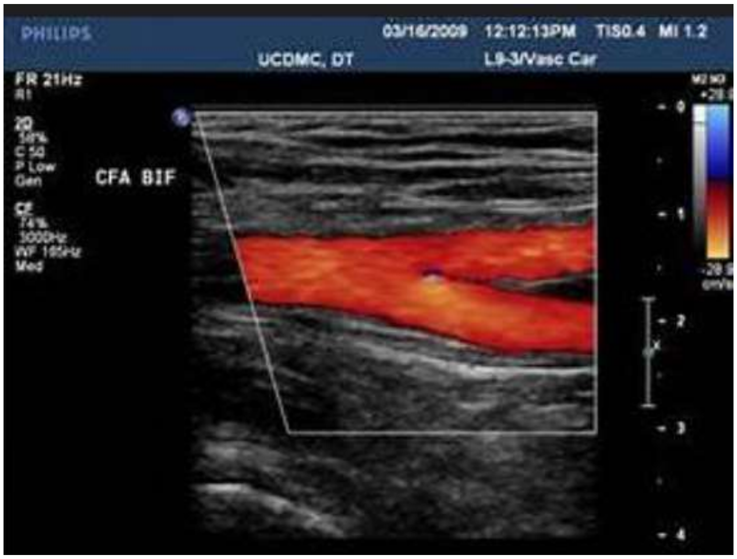
- **Patient Positioning**:
  - **Supine or sitting**: Depending on patient comfort and the specific vein being examined.
- **Transducer**:
  - **Type**: High-frequency linear transducer (7-15 MHz) for detailed imaging of superficial veins.
- **Scan Technique**:
  - **Longitudinal and Transverse Views**: Obtain images of major veins.
  - **Compression Technique**: Apply gentle pressure to assess for thrombosis (e.g., compressibility of veins).
  - **Color Doppler**: Assess blood flow and detect abnormalities.
- **Key Areas**:
  - **Brachial Vein**: From the shoulder to the elbow.
  - **Radial and Ulnar Veins**: From the wrist to the forearm.
  - **Axillary Vein**: In the axilla region.

2. LOWER LIMB

ARTERIES

Indications: Evaluation of arterial patency, stenosis, aneurysms, and peripheral artery disease.

- **Patient Positioning**:
  - **Supine or sitting**: Depending on patient comfort and the specific artery being examined.
- **Transducer**:
  - **Type**: High-frequency linear transducer (7-15 MHz) for detailed imaging of superficial vessels.
- **Scan Technique**:
  - **Longitudinal and Transverse Views**: Obtain images of major arteries.
  - **Color Doppler**: Assess blood flow and detect abnormalities like stenosis or thrombosis.
  - **Image Optimization**: Adjust Doppler settings for optimal flow visualization and vessel wall assessment.
- **Key Areas**:
  - **Femoral Artery**: From the groin to the knee.
  - **Popliteal Artery**: Behind the knee.
  - **Anterior and Posterior Tibial Arteries**: From the knee to the ankle.
  - **Dorsalis Pedis Artery**: On the dorsum of the foot.

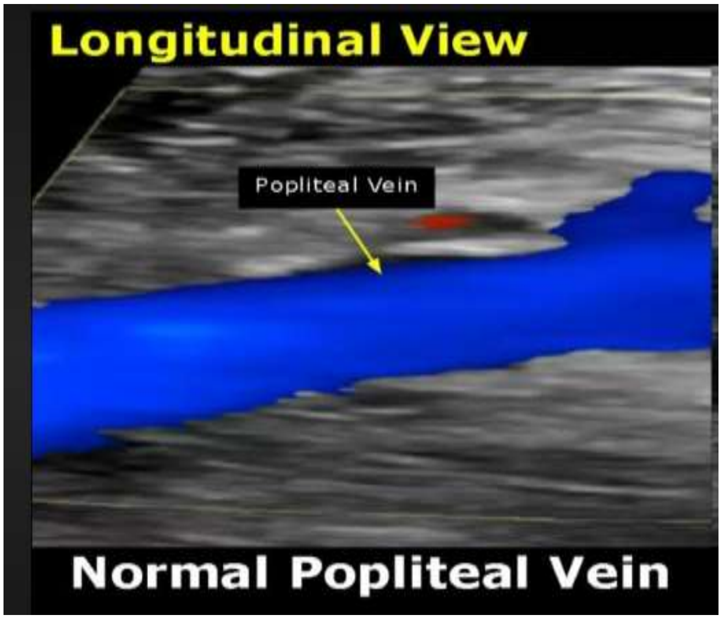


VEINS

Indications: Assessment of venous patency, thrombosis, and other venous conditions.

- **Patient Positioning**:
  - **Supine or sitting**: Depending on patient comfort and the specific vein being examined.

- **Transducer**:
  - **Type**: High-frequency linear transducer (7-15 MHz) for detailed imaging of superficial veins.
- **Scan Technique**:
  - **Longitudinal and Transverse Views**: Obtain images of major veins.
  - **Compression Technique**: Apply gentle pressure to assess for thrombosis (e.g., compressibility of veins).
  - **Color Doppler**: Assess blood flow and detect abnormalities.
- **Key Areas**:
  - **Femoral Vein**: From the groin to the knee.
  - **Popliteal Vein**: Behind the knee.
  - **Great Saphenous Vein**: Running along the inner side of the leg.
  - **Small Saphenous Vein**: Running along the outer side of the leg.



ULTRASOUND-GUIDED SPECIAL PROCEDURES

1. BIOPSIES

Indications: Obtaining tissue samples for histological analysis to diagnose conditions such as tumors, cysts, or infections.

- **Patient Positioning**:
  - **Varies**: Based on the target organ or lesion. Common positions include supine, prone, or lateral decubitus.

- **Transducer**:
  - **Type**: High-frequency linear transducer (7-15 MHz) for superficial lesions or a curved array transducer (2-5 MHz) for deeper lesions.

- **Procedure Steps**:

1. **Preparation**:
   - Clean the skin with an antiseptic solution.
   - Apply a sterile gel to the area of interest.
   - Local anesthesia may be administered to the biopsy site.
2. **Localization**:
   - **Real-Time Imaging**: Use ultrasound to visualize the lesion and guide the biopsy needle.
   - **Marking**: Identify and mark the exact location of the lesion on the skin surface.
3. **Needle Insertion**:
   - Insert the biopsy needle under real-time ultrasound guidance.
   - Confirm the needle's position within the lesion.
4. **Sample Collection**:
   - Obtain the tissue sample using the biopsy needle.
   - Ensure multiple samples are taken if necessary for accurate diagnosis.
5. **Post-Procedure**:
   - Apply pressure to the biopsy site to minimize bleeding.
   - Cover the area with a sterile dressing.
   - Monitor the patient for any immediate complications.

- **Key Areas**:
  - **Liver**: For liver lesions or masses.
  - **Breast**: For palpable or imaging-detected abnormalities.
  - **Thyroid**: For thyroid nodules or cysts.
  - **Kidney**: For renal masses or cysts.

2. DRAINAGE / ASPIRATIONS

Indications: Removal of fluid collections such as abscesses, cysts, or seromas.

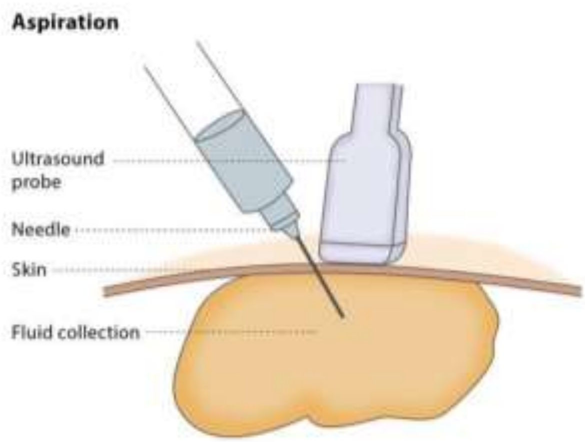
- **Patient Positioning**:
  - **Varies**: Based on the location of the fluid collection. Common positions include supine or prone.
- **Transducer**:
  - **Type**: High-frequency linear transducer (7-15 MHz) for superficial collections or a curved array transducer (2-5 MHz) for deeper collections.

- **Procedure Steps**:

1. **Preparation**:
   - Clean the skin with an antiseptic solution.
   - Apply a sterile gel to the area of interest.
   - Local anesthesia may be administered if necessary.
2. **Localization**:
   - **Real-Time Imaging**: Use ultrasound to visualize the fluid collection and guide the needle.
   - **Marking**: Identify and mark the exact entry point on the skin.
3. **Needle Insertion**:
   - Insert the drainage or aspiration needle under real-time ultrasound guidance.
   - Confirm the needle's position within the fluid collection.
4. **Fluid Extraction**:
   - Aspiration: Remove fluid using a syringe attached to the needle.
   - Drainage: Insert a catheter or drainage tube to allow continuous fluid drainage if needed.
5. **Post-Procedure**:
   - Apply pressure to the site to reduce bleeding.
   - Cover the area with a sterile dressing.
   - Monitor for signs of infection or other complications.

- **Key Areas**:
  - **Abdomen**: For ascitic fluid, abscesses, or cysts.
  - **Breast**: For cystic lesions or abscesses.
  - **Pelvis**: For ovarian cysts or abscesses.

- **Soft Tissues**: For localized infections or fluid collections.



DIGITAL RADIOGRAPHY TECHNIQUES

Computed Radiography (CR)

1. Overview

Computed Radiography (CR) is a digital imaging technique used in radiology to capture and analyze X-ray images. Unlike traditional film-based radiography, CR uses photostimulable phosphor (PSP) plates to capture and store X-ray images, which are then read and converted into digital images by a CR scanner.

2. Components

1. **Photostimulable Phosphor (PSP) Plates**:
   - **Composition**: Plates coated with phosphor materials that store the X-ray image.
   - **Function**: Absorb and store the X-ray energy as latent images.
2. **CR Reader/Scanner**:
   - **Function**: Scans the PSP plates using a laser to release the stored energy, which is then converted into a digital image.
   - **Types**: Can be standalone units or integrated into imaging systems.
3. **Workstation**:
   - **Function**: Where the digital images are processed, viewed, and analyzed.
   - **Software**: Includes image enhancement tools, measurement tools, and diagnostic features.

3. Workflow

1. **Image Acquisition**:
    - **Plate Placement**: The PSP plate is placed in the X-ray machine where it receives the X-ray exposure.
    - **X-ray Exposure**: X-rays pass through the patient and strike the PSP plate, creating a latent image.

2. **Image Processing**:
    - **Plate Retrieval**: The exposed PSP plate is removed from the X-ray machine and inserted into the CR reader.
    - **Laser Scanning**: The CR reader scans the plate with a laser to release the stored energy as visible light.
    - **Conversion to Digital Image**: The visible light is detected by a photomultiplier tube (PMT) and converted into a digital signal.

3. **Image Display and Analysis**:
    - **Image Processing**: The digital signal is processed to create a digital image.
    - **Viewing**: The image is displayed on a computer monitor where it can be analyzed using various software tools.

4. **Image Storage and Retrieval**:
    - **Digital Storage**: The digital image is stored in a PACS (Picture Archiving and Communication System) or other digital storage systems.
    - **Retrieval**: Images can be accessed, shared, and reviewed by radiologists and other healthcare professionals.

4. Advantages

1. **Digital Workflow**:
    - **Efficiency**: Faster image acquisition and processing compared to traditional film-based systems.
    - **Integration**: Easy integration with PACS and electronic health records (EHRs).
2. **Image Quality**:
    - **Enhancement**: Advanced image processing and enhancement capabilities improve diagnostic accuracy.
    - **Reprocessing**: Images can be reprocessed to adjust contrast and

brightness.

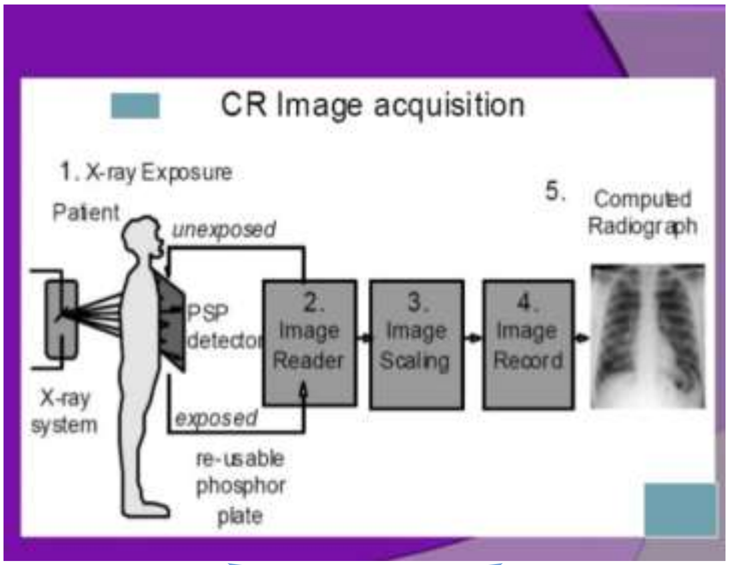
3. **Reduced Film Usage**:
    - **Environmentally Friendly**: Eliminates the need for chemical processing and physical film storage.
4. **Patient Safety**:
    - **Lower Dose**: Potential for reduced radiation dose compared to conventional film radiography.

5. Disadvantages

1. **Initial Cost**:
    - **Equipment Costs**: Higher initial investment for CR systems and digital infrastructure.
2. **Maintenance**:
    - **Equipment Maintenance**: Requires regular maintenance and calibration of CR readers and PSP plates.
3. **Image Artifacts**:
    - **Plate Handling**: Care is needed to prevent artifacts from dust, scratches, or improper handling of PSP plates.

6. Applications

1. **General Radiography**:
    - **Bone Imaging**: Fractures, joint abnormalities, and bone diseases.
    - **Chest Imaging**: Lung conditions, heart size, and mediastinal structures.
2. **Specialized Imaging**:
    - **Dental Radiography**: Intraoral and extraoral imaging.
    - **Orthopedic Imaging**: Detailed imaging of musculoskeletal structures.



DIGITAL RADIOGRAPHY (DR) DETAILS

1. Overview

Digital Radiography (DR) is a modern X-ray imaging technique that captures and processes X-ray images directly in digital form, eliminating the need for film and chemical processing. It uses digital detectors to convert X-ray energy into digital signals that can be immediately processed and viewed on computer screens.

2. Components

1. **Digital Detectors**:
    - **Types**:
        - **Flat Panel Detectors (FPDs)**: Consist of a layer of amorphous selenium or amorphous silicon coupled with a thin film transistor (TFT) array.
        - **Computed Radiography (CR) Detectors**: Use photostimulable phosphor plates (similar to CR but with direct digital conversion capabilities).
    - **Function**: Convert X-ray photons into electrical signals that are digitized for image processing.
2. **X-ray Machine**:
    - **Function**: Produces X-rays that pass through the patient and are detected by the digital detector.
3. **Image Processing System**:
    - **Software**: Includes algorithms for image enhancement, measurement, and analysis.
    - **Workstation**: Where digital images are reviewed, processed, and stored.

4. **Storage and Archiving**:
    - **PACS (Picture Archiving and Communication System)**: System used for storing, retrieving, and managing digital images.
    - **DICOM (Digital Imaging and Communications in Medicine)**: Standard format for storing and exchanging medical imaging data.

3. Workflow

1. **Image Acquisition**:
    - **X-ray Exposure**: The patient is positioned, and X-rays are directed at the area of interest.
    - **Detection**: The digital detector captures the X-ray photons and converts them into an electrical signal.
2. **Image Processing**:
    - **Digital Conversion**: The electrical signal is converted into a digital image.
    - **Enhancement**: Image processing software applies adjustments such as contrast, brightness, and noise reduction.
3. **Image Viewing**:
    - **Display**: The processed image is displayed on a computer monitor.
    - **Analysis**: Radiologists or technicians analyze the image using various software tools.
4. **Image Storage and Retrieval**:
    - **Storage**: The digital image is stored in a PACS for future reference and analysis.
    - **Retrieval**: Images can be accessed, shared, and reviewed as needed.

4. Advantages

1. **Immediate Image Availability**:
    - **Speed**: Instant access to images allows for quicker diagnosis and decision-making.
2. **Enhanced Image Quality**:
    - **Processing**: Advanced algorithms improve image quality, contrast, and resolution.
    - **Reprocessing**: Images can be adjusted after acquisition for better diagnostic clarity.
3. **Reduced Radiation Dose**:
    - **Efficiency**: DR systems can achieve high-quality images with lower radiation doses compared to traditional film-based systems.
4. **Improved Workflow**:
    - **Integration**: Seamless integration with PACS and electronic health

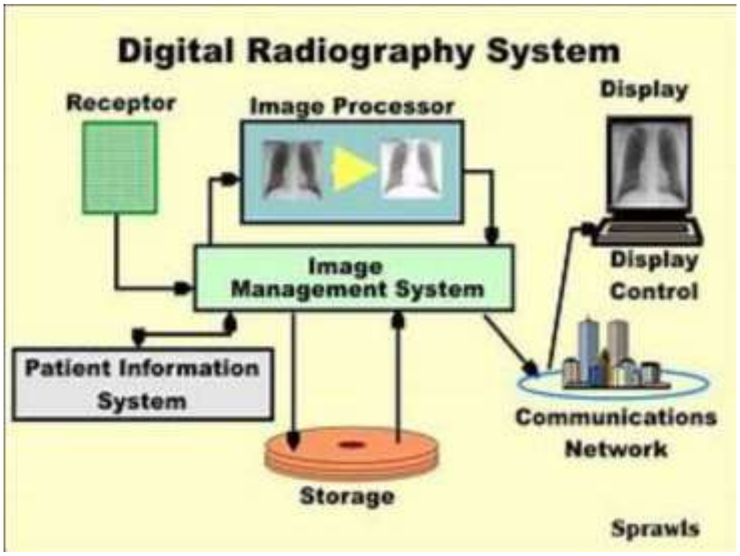
records (EHRs) facilitates efficient data management.
   - **Digital Storage**: Eliminates the need for physical storage and reduces handling errors.
5. **Environmental Benefits**:
   - **Less Waste**: No need for film, chemicals, or darkroom processing, reducing environmental impact.

5. Disadvantages

1. **High Initial Cost**:
   - **Equipment and Installation**: Higher upfront costs for DR systems and associated infrastructure.
2. **Technical Maintenance**:
   - **Maintenance**: Requires regular maintenance and calibration of digital detectors and software systems.
3. **Image Artifacts**:
   - **Detector Issues**: Potential for artifacts related to detector defects or improper calibration.

6. Applications

1. **General Radiography**:
   - **Bone Imaging**: Fractures, joint conditions, and bone diseases.
   - **Chest Imaging**: Lung conditions, heart evaluation, and mediastinal structures.
2. **Specialized Imaging**:
   - **Orthopedic Imaging**: Detailed assessment of musculoskeletal structures.
   - **Dental Radiography**: Intraoral and extraoral imaging for dental diagnostics.



PICTURE ARCHIVING AND COMMUNICATION SYSTEM (PACS) DETAILS

1. Overview

Picture Archiving and Communication System (PACS) is a medical imaging technology used for storing, retrieving, managing, and sharing digital medical images. PACS integrates imaging data from various modalities, facilitating efficient image management and distribution within healthcare settings.

2. Components

1. **Image Acquisition Systems**:
    - **Modalities**: Includes X-ray, CT, MRI, ultrasound, and other imaging modalities.
    - **Function**: Capture and produce digital images for storage and analysis.
2. **PACS Server**:
    - **Function**: Central repository for storing and managing medical images and associated data.
    - **Types**: Can be on-premises or cloud-based.
3. **Workstations**:
    - **Radiology Workstations**: Used by radiologists to view, analyze, and interpret images.
    - **Clinical Workstations**: Used by clinicians to access and review

images for patient management.

4. **Image Storage**:
    - **Storage Types**: Includes hard drives, network-attached storage (NAS), and cloud storage.
    - **Archiving**: Long-term storage of images for future reference and compliance.
5. **Communication Network**:
    - **Function**: Facilitates the transfer of images and data between modalities, PACS servers, and workstations.
    - **Protocols**: Uses DICOM (Digital Imaging and Communications in Medicine) standards for image exchange.
6. **DICOM Interface**:
    - **Function**: Ensures compatibility and standardization of medical images across different systems and devices.
    - **Standard**: Defines protocols for image formatting, transmission, and storage.

3. Workflow

1. **Image Acquisition**:
    - **Capture**: Medical images are captured by various imaging modalities and converted into digital format.
2. **Image Transfer**:
    - **Transmission**: Digital images are sent from the imaging modality to the PACS server using DICOM protocols.
3. **Image Storage**:
    - **Archiving**: Images are stored in the PACS server, categorized by patient, modality, and study.
4. **Image Retrieval**:
    - **Access**: Authorized users access images via PACS workstations or web-based interfaces.
    - **Query**: Users can search for images by patient ID, study date, modality, etc.
5. **Image Viewing and Analysis**:
    - **Display**: Images are viewed and analyzed using PACS workstations.
    - **Processing**: Advanced tools for image enhancement, measurement, and annotation are available.
6. **Image Sharing**:
    - **Distribution**: Images can be shared with other healthcare providers or institutions as needed.
7. **Reporting**:

- **Integration**: PACS can be integrated with electronic health records (EHR) systems to link images with patient records and reports.

4. Advantages

1. **Efficiency**:
    - **Immediate Access**: Provides instant access to images, improving diagnostic turnaround times.
    - **Reduced Film Handling**: Eliminates the need for physical film and processing, streamlining workflows.
2. **Integration**:
    - **EHR Integration**: Seamless integration with EHR systems for comprehensive patient records.
    - **Interoperability**: Compatible with various imaging modalities and systems.
3. **Storage and Retrieval**:
    - **Long-Term Storage**: Enables long-term storage of images with easy retrieval.
    - **Backup and Recovery**: Includes features for data backup and recovery.
4. **Collaboration**:
    - **Remote Access**: Allows for remote viewing and consultation, facilitating collaboration between healthcare providers.
5. **Image Enhancement**:
    - **Tools**: Provides advanced tools for image processing, analysis, and interpretation.

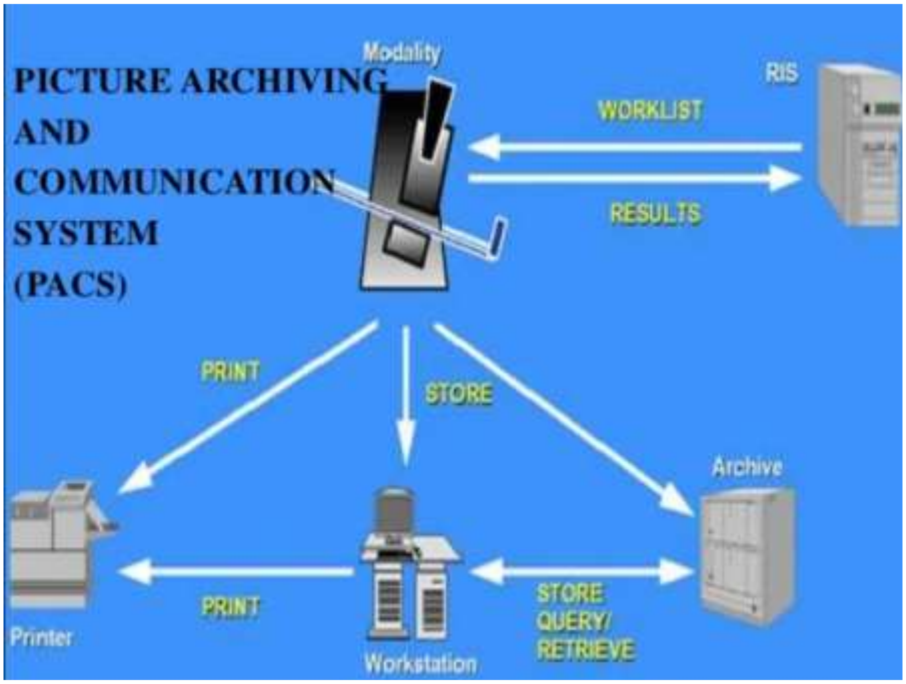
5. Disadvantages

1. **Cost**:
    - **Implementation**: High initial cost for system setup, including hardware, software, and infrastructure.
    - **Maintenance**: Ongoing costs for system maintenance, updates, and technical support.
2. **Data Security**:
    - **Privacy**: Requires robust security measures to protect patient data and comply with regulations (e.g., HIPAA).
3. **Complexity**:
    - **Training**: Requires training for users to effectively navigate and utilize the system.
    - **Technical Issues**: Potential for technical issues or system downtimes that may impact access to images.

4. **System Integration**:
    - **Compatibility**: Integration with existing systems and workflows may pose challenges.

6. Applications

1. **Radiology**:
    - **Diagnostic Imaging**: Central repository for X-ray, CT, MRI, and ultrasound images.
    - **Workflow Management**: Facilitates radiology workflow, including image interpretation and reporting.
2. **Oncology**:
    - **Tumor Monitoring**: Tracks and monitors tumors over time, aiding in treatment planning and evaluation.
3. **Orthopedics**:
    - **Bone Imaging**: Manages and analyzes images related to bone fractures, joint conditions, and surgical planning.
4. **Pediatrics**:
    - **Child-Specific Imaging**: Handles images for pediatric patients, including congenital and developmental conditions.



DIGITAL SUBTRACTION ANGIOGRAPHY (DSA) DETAILS

1. Overview

Digital Subtraction Angiography (DSA) is a specialized imaging technique used primarily to visualize blood vessels and blood flow by subtracting the background anatomy from the images. This method is particularly useful for detecting and evaluating vascular diseases and abnormalities.

2. Components

1. **X-ray System**:
   - **Function**: Produces X-rays that pass through the patient to capture images of the blood vessels.
   - **Types**: May include fixed or mobile units, often with a C-arm configuration.
2. **Digital Subtraction System**:
   - **Function**: Performs the image subtraction process to enhance visualization of blood vessels by removing non-vascular structures.
3. **Contrast Agent**:
   - **Type**: Iodine-based contrast medium is injected into the blood vessels to make them visible on the X-ray images.
   - **Administration**: Typically administered via a catheter.
4. **Workstation**:
   - **Function**: Where images are processed, analyzed, and reviewed.
   - **Software**: Includes tools for image manipulation, measurement, and interpretation.

3. Workflow

1. **Patient Preparation**:
   - **Assessment**: Review patient history and confirm indication for the procedure.
   - **Preparation**: Explain the procedure to the patient, and prepare the injection site (e.g., groin or arm) for catheter placement.
2. **Contrast Injection**:
   - **Catheterization**: Insert a catheter into the blood vessel, often using fluoroscopic guidance.
   - **Injection**: Inject the contrast agent into the vessel to opacify the blood vessels.
3. **Image Acquisition**:
   - **Initial Imaging**: Capture pre-contrast images to serve as the baseline or background.
   - **Contrast Imaging**: Capture post-contrast images to visualize the blood vessels.

4. **Image Subtraction**:

- **Subtraction Process**: Use digital subtraction techniques to remove the background anatomy from the post-contrast images, leaving only the blood vessels visible.
- **Enhancement**: Apply image enhancement algorithms to improve the clarity and detail of the vascular structures.

5. **Image Review and Analysis**:
    - **Assessment**: Review the images to identify and assess vascular conditions, such as stenosis, aneurysms, or arteriovenous malformations.
    - **Reporting**: Document findings and prepare a report for the referring physician.
6. **Post-Procedure Care**:
    - **Observation**: Monitor the patient for any immediate complications related to the procedure or contrast agent.
    - **Instructions**: Provide post-procedure instructions, including potential side effects of the contrast agent.

4. Advantages

1. **High-Resolution Vascular Imaging**:
    - **Detail**: Provides detailed images of blood vessels with high resolution, allowing for precise evaluation of vascular abnormalities.
2. **Dynamic Imaging**:
    - **Real-Time**: Enables real-time visualization of blood flow and vascular structures, facilitating dynamic assessment.
3. **Enhanced Detection**:
    - **Sensitivity**: Improves detection of small or subtle vascular abnormalities that may be missed with other imaging modalities.
4. **Minimal Background Interference**:
    - **Clarity**: Reduces background interference, providing a clearer view of the vascular structures.

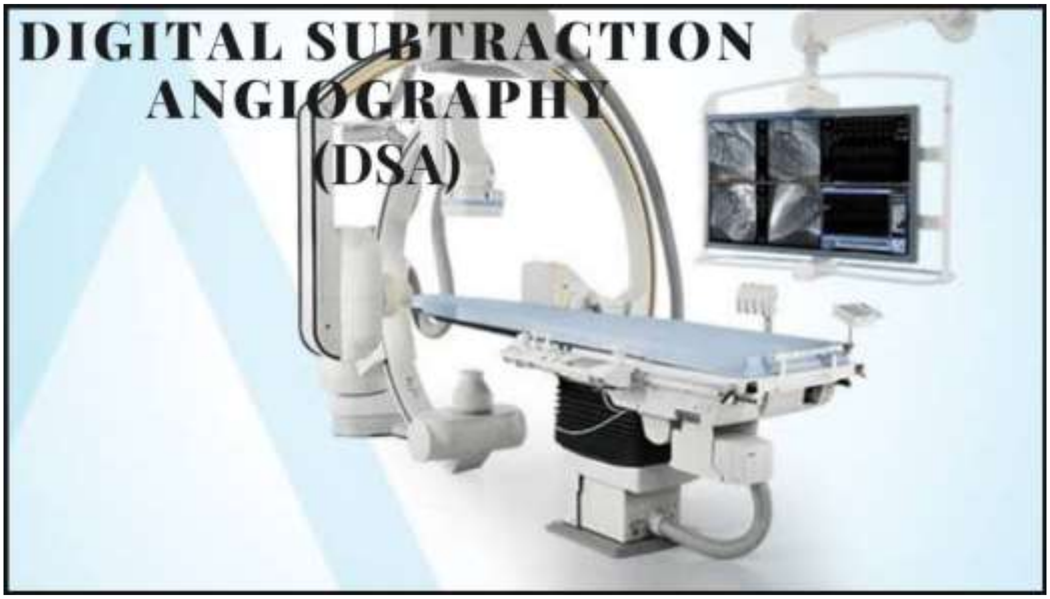
5. Disadvantages

1. **Radiation Exposure**:
    - **Dose**: Involves exposure to ionizing radiation, which requires careful dose management to minimize risk.
2. **Contrast Risks**:
    - **Allergy**: Potential for allergic reactions to the contrast agent.
    - **Renal Impact**: Risk of contrast-induced nephropathy, particularly in patients with pre-existing kidney conditions.
3. **Invasive Procedure**:

   - **Catheterization**: Requires catheter insertion, which carries risks of complications such as bleeding or infection.
4. **Cost and Equipment**:
   - **Expense**: High costs associated with the specialized equipment and contrast agents used in DSA.

6. Applications

1. **Neurovascular Imaging**:
   - **Cerebral Angiography**: Evaluates blood vessels in the brain for conditions such as aneurysms, stenosis, or arteriovenous malformations.
2. **Cardiovascular Imaging**:
   - **Coronary Angiography**: Assesses the coronary arteries for blockages or other abnormalities.
   - **Peripheral Angiography**: Evaluates blood vessels in the limbs for peripheral artery disease.
3. **Interventional Procedures**:
   - **Guidance**: Provides real-time imaging guidance for interventional procedures, such as stent placement or embolization.
4. **Oncological Imaging**:
   - **Tumor Vascularity**: Assesses the blood supply to tumors, aiding in diagnosis and treatment planning.



<u>MAMMOGRAPHY</u>

1. Overview

Mammography is an imaging technique used to examine the breast tissue using X-rays. It is primarily employed for the early detection and diagnosis of breast cancer and other breast abnormalities.

2. Types of Mammography

1. **Screening Mammography**:
   - **Purpose**: To detect breast cancer early in asymptomatic women.
   - **Frequency**: Typically recommended annually or biennially for women over the age of 40, depending on guidelines and individual risk factors.
2. **Diagnostic Mammography**:
   - **Purpose**: To investigate symptoms or abnormalities found during a screening mammogram or physical examination, such as lumps or changes in breast tissue.
   - **Features**: Includes additional views or specialized techniques to further evaluate areas of concern.
3. **Digital Mammography**:
   - **Technology**: Uses digital detectors to convert X-ray images into electronic signals, which are then processed and displayed on a computer monitor.
   - **Advantages**: Provides better image quality, allows for digital image manipulation, and is often more effective in detecting abnormalities in dense breast tissue.
4. **Tomosynthesis (3D Mammography)**:
   - **Technology**: Creates a three-dimensional image of the breast by taking multiple X-ray images from different angles and reconstructing them into a 3D view.
   - **Advantages**: Reduces overlapping tissue artifacts and improves the detection of small cancers and details.

3. Equipment

1. **Mammography Machine**:
   - **Components**: Includes an X-ray tube, compression plates, and a digital detector or film.
   - **Function**: Compresses the breast to spread out the tissue and capture clear X-ray images.
2. **Compression Plates**:
   - **Purpose**: Gently compress the breast to minimize movement, reduce tissue thickness, and improve image quality.
3. **Image Processing System**:

- **Software**: For viewing, analyzing, and interpreting mammographic images.

4. Procedure

1. **Preparation**:
    - **Instructions**: Patients should avoid using deodorants, powders, or lotions on the day of the exam as they can interfere with the images.
    - **Positioning**: The patient stands in front of the mammography machine and positions their breast on the compression plate.
2. **Image Acquisition**:
    - **Compression**: The breast is gently compressed between two plates to obtain clear and uniform images.
    - **Views**: Standard views include the cranio-caudal (CC) and medio-lateral oblique (MLO) projections. Additional views may be taken if needed.
3. **Image Review**:
    - **Processing**: The images are processed and analyzed on a computer workstation.
    - **Interpretation**: A radiologist reviews the images to identify any abnormalities or areas of concern.
4. **Post-Procedure**:
    - **Results**: Patients receive their results, usually within a few days to a week. Follow-up may be required for additional imaging or diagnostic procedures if abnormalities are detected.

5. Advantages

1. **Early Detection**:
    - **Screening**: Effective in detecting breast cancer before symptoms develop, which can lead to earlier treatment and improved outcomes.
2. **Non-Invasive**:
    - **Procedure**: Relatively simple and non-invasive compared to other diagnostic procedures.
3. **Image Quality**:
    - **Detail**: Provides high-resolution images of breast tissue, aiding in accurate diagnosis.
4. **Advancements**:
    - **Digital and 3D Mammography**: Offer improved diagnostic capabilities and reduce the need for follow-up imaging due to better clarity and fewer false positives.

6. Disadvantages

1. **Radiation Exposure**:
   - **Dose**: Involves exposure to low doses of ionizing radiation. However, the benefits of early detection generally outweigh the risks.
2. **Compression Discomfort**:
   - **Pain**: Some patients may experience discomfort or pain during the compression of the breast.
3. **False Positives/Negatives**:
   - **Accuracy**: There is a possibility of false positives (indicating an abnormality where there is none) and false negatives (missing an abnormality).
4. **Detection Limitations**:
   - **Dense Breast Tissue**: May be less effective in women with very dense breast tissue, which can obscure abnormalities.

7. Applications

1. **Breast Cancer Screening**:
   - **Detection**: Identifies early signs of breast cancer in asymptomatic women.
2. **Diagnostic Evaluation**:
   - **Investigation**: Assesses symptoms such as lumps, changes in breast shape, or discharge.
3. **Pre-Surgical Planning**:
   - **Assessment**: Evaluates the extent of breast cancer and helps in planning surgical or other treatments.
4. **Monitoring**:
   - **Follow-Up**: Monitors changes in breast tissue over time, particularly in women with a history of breast cancer or other risk factors.

DENTAL RADIOGRAPHY DETAILS

1. Overview

Dental Radiography involves using X-ray imaging techniques to visualize the teeth, jaw, and surrounding structures. It is essential for diagnosing dental conditions, planning treatments, and monitoring oral health.

2. Types of Dental Radiography

1. **Intraoral Radiography**:
    - **Purpose**: Provides detailed images of the teeth and surrounding bone structures.
    - **Types**:
        - **Periapical X-rays**: Capture the entire tooth from the crown to the root and surrounding bone.
        - **Bitewing X-rays**: Show the upper and lower teeth in one area of the mouth, focusing on the contact points between teeth.
        - **Occlusal X-rays**: Capture a larger area of the jaw or palate, often used to examine the development of teeth and detect abnormalities.

2. **Extraoral Radiography**:
    - **Purpose**: Provides broader views of the jaw, sinuses, and other structures outside the teeth.
    - **Types**:
        - **Panoramic X-rays**: Capture a comprehensive view of the entire mouth, including teeth, upper and lower jaws, and surrounding structures.
        - **Cephalometric X-rays**: Show the profile of the face and are used for orthodontic evaluations and treatment planning.
3. **Cone Beam Computed Tomography (CBCT)**:
    - **Purpose**: Provides three-dimensional images of the teeth, jaws, and facial structures.
    - **Advantages**: Offers detailed and precise information, especially useful for complex cases such as implant planning or evaluating jawbone structure.

3. Equipment

1. **Intraoral X-ray Machine**:
    - **Components**: Includes an X-ray tube, sensor or film holder, and

control panel.
  - **Function**: Captures images of individual teeth or specific areas within the mouth.
2. **Panoramic X-ray Machine**:
  - **Components**: Includes a rotating X-ray tube and a detector that moves around the patient's head.
  - **Function**: Provides a broad view of the entire oral cavity in one image.
3. **CBCT Scanner**:
  - **Components**: A cone-shaped X-ray beam and a detector that rotates around the patient's head.
  - **Function**: Produces detailed 3D images of the dental and skeletal structures.
4. **Digital Sensors**:
  - **Types**: Direct sensors that convert X-ray images into digital signals.
  - **Advantages**: Provide immediate image acquisition and allow for enhanced image processing.

4. Procedure

1. **Preparation**:
  - **Patient Positioning**: The patient is positioned correctly based on the type of radiograph being taken. For intraoral X-rays, a small film or sensor is placed in the mouth. For panoramic X-rays, the patient stands or sits with their head positioned in a specific way.
  - **Protection**: A lead apron may be used to protect the patient's body from unnecessary radiation.
2. **Image Acquisition**:
  - **Intraoral X-rays**: The X-ray machine is aimed at the sensor or film in the patient's mouth, and the X-ray is taken with the patient holding still.
  - **Panoramic X-rays**: The patient bites down on a bite block, and the X-ray machine rotates around the patient to capture a panoramic image.
  - **CBCT**: The patient remains still while the scanner takes multiple X-ray images from different angles to create a 3D model.
3. **Image Processing**:
  - **Digital Processing**: The images are processed on a computer workstation where they can be viewed, enhanced, and analyzed.
  - **Review**: The radiologist or dentist reviews the images to identify any issues or abnormalities.

4. **Post-Procedure**:
    - **Results**: The images are used to diagnose dental conditions and plan treatments.
    - **Patient Follow-Up**: Based on the findings, further dental procedures or treatments may be recommended.

5. Advantages

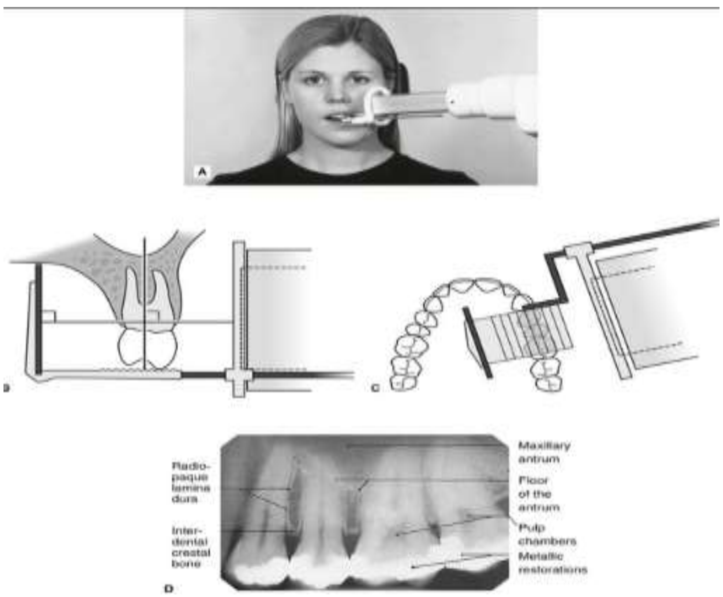
1. **Detailed Visualization**:
    - **Diagnosis**: Provides detailed images of the teeth, bone, and surrounding structures, aiding in accurate diagnosis and treatment planning.
2. **Early Detection**:
    - **Conditions**: Helps in the early detection of dental issues such as cavities, infections, bone loss, and impacted teeth.
3. **Non-Invasive**:
    - **Procedure**: Generally a quick and non-invasive procedure with minimal discomfort.
4. **Immediate Results**:
    - **Digital Imaging**: Digital sensors provide immediate results and allow for rapid image review and analysis.
5. **Treatment Planning**:
    - **Guidance**: Assists in planning dental treatments, such as orthodontics, implants, and extractions.

6. Disadvantages

1. **Radiation Exposure**:
    - **Dose**: Involves exposure to ionizing radiation, although the dose is generally low. Use of protective measures and modern equipment minimizes exposure.
2. **Image Artifacts**:
    - **Interference**: Artifacts or distortions in images can occur due to patient movement, improper positioning, or other factors.
3. **Cost**:
    - **Equipment**: Advanced imaging technologies like CBCT can be costly and may not be available in all dental practices.
4. **Limited Field**:
    - **Intraoral Limitations**: Intraoral X-rays provide limited views compared to panoramic or CBCT imaging.

7. Applications

1. **Cavity Detection**:
    - **Early Identification**: Detects cavities and decay that are not visible during a routine dental examination.
2. **Orthodontic Assessment**:
    - **Treatment Planning**: Helps in evaluating the alignment of teeth and planning orthodontic treatments.
3. **Implant Planning**:
    - **Precision**: Provides detailed images for the accurate placement of dental implants.
4. **Monitoring**:
    - **Progress Tracking**: Monitors the progression of dental conditions and the effectiveness of treatments.
5. **Emergency Situations**:
    - **Diagnosis**: Assists in diagnosing trauma or injuries to the teeth and jaw.



MACRO RADIOGRAPHY DETAILS

1. Overview

Macro Radiography is a specialized radiographic technique used to capture enlarged images of objects or anatomical structures. It is commonly employed in fields such as materials science, forensic analysis, and some medical applications to examine details that are not visible in standard radiographic images.

2. Purpose and Applications

1. **Materials Science**:
   - **Analysis**: Used to inspect the internal structure of materials, such as metal components or composite materials, for defects, cracks, or inclusions.
   - **Research**: Helps in understanding material properties and manufacturing processes.
2. **Forensic Science**:
   - **Evidence Examination**: Allows for detailed examination of forensic evidence, such as firearms, tools, or other objects, to identify marks, damages, or other features relevant to investigations.
3. **Medical Applications**:
   - **Detailed Imaging**: Employed to obtain enlarged images of small or detailed anatomical structures, such as bones or foreign bodies, when more conventional imaging techniques are insufficient.
4. **Industrial Quality Control**:
   - **Inspection**: Used in the quality control of manufactured parts to detect flaws or irregularities in products.

3. Equipment

1. **X-ray Machine**:
   - **Components**: Includes an X-ray tube, detector, and a system for adjusting the magnification.
   - **Function**: Captures high-resolution images with adjustable magnification to examine details.
2. **High-Resolution Film or Digital Detector**:
   - **Film**: Traditional X-ray film or radiographic plates with high resolution.
   - **Digital**: Digital detectors capable of capturing detailed images with high spatial resolution.
3. **Magnification Accessories**:
   - **Lenses or Collimators**: Special lenses or collimators may be used to increase the image size and focus on specific areas of interest.

4. Procedure

1. **Preparation**:
   - **Setup**: Position the object or anatomical structure of interest in the X-ray machine. Adjust the machine settings to accommodate the desired magnification level.
   - **Calibration**: Ensure the equipment is calibrated for accurate

magnification and resolution.

2. **Image Acquisition**:
    - **Exposure**: Take the X-ray image using the machine, adjusting the exposure parameters as needed for optimal image quality.
    - **Magnification**: Utilize the magnification features to capture the enlarged view of the object or structure.
3. **Image Processing**:
    - **Film Development**: For film-based systems, develop the film using standard radiographic processing techniques.
    - **Digital Processing**: For digital systems, process the image using specialized software to enhance detail and clarity.
4. **Analysis**:
    - **Review**: Examine the enlarged image for detailed analysis. Look for specific features, defects, or abnormalities.
    - **Reporting**: Document findings and prepare reports based on the analysis.

5. Advantages

1. **Enhanced Detail**:
    - **Resolution**: Provides high-resolution images with fine detail, allowing for close examination of small or intricate features.
2. **Versatility**:
    - **Applications**: Applicable in various fields, including materials science, forensic analysis, and medical imaging.
3. **Improved Inspection**:
    - **Defect Detection**: Facilitates the detection of small defects or features that may not be visible with standard radiographic techniques.
4. **Flexibility**:
    - **Customizable**: Allows for adjustments in magnification and focus to suit specific imaging needs.

6. Disadvantages

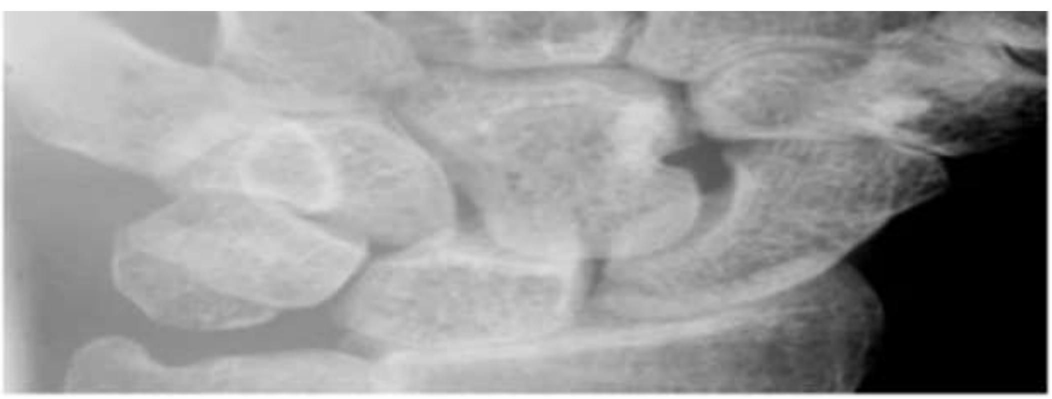
1. **Radiation Dose**:
    - **Exposure**: May involve higher radiation doses compared to standard radiographic techniques, requiring careful management.
2. **Cost**:
    - **Equipment**: Specialized equipment and high-resolution detectors can be costly and may not be available in all settings.
3. **Technical Complexity**:
    - **Setup**: Requires precise setup and calibration to achieve desired

magnification and resolution, which may involve technical expertise.

4. **Image Artifacts**:
   - **Distortions**: Magnification can introduce artifacts or distortions, which need to be managed to ensure accurate analysis.

7. Applications

1. **Material Defect Analysis**:
   - **Inspection**: Used to detect internal defects in materials such as welds, castings, and composites.
2. **Forensic Investigation**:
   - **Evidence Detail**: Enhances the examination of forensic evidence to identify markings, damages, or other critical features.
3. **Medical Diagnosis**:
   - **Small Structures**: Provides detailed views of small anatomical structures or foreign bodies for accurate diagnosis and treatment planning.
4. **Quality Control**:
   - **Manufacturing**: Ensures the quality and integrity of manufactured parts by detecting flaws or irregularities.



Macroradiograph of wrist with a magnification factor of 2

DIGITAL X-RAY TECHNIQUES FOR WHOLE BODY IMAGING

Digital X-ray techniques are widely used in medical imaging to obtain detailed images of the body. While full-body X-rays are less common due to practical and safety considerations, various digital X-ray methods are employed for specific parts of the body and can be combined for comprehensive assessment. Here’s a breakdown of digital X-ray techniques used for whole-body imaging:

1. Overview

Digital X-ray technology uses electronic sensors to capture images of internal body structures. These images are then processed digitally, allowing for high-resolution imaging and immediate review.

2. Types of Digital X-ray Techniques

1. **Digital Radiography (DR)**:
   - **Technology**: Uses digital detectors that convert X-rays directly into electronic signals. These detectors are placed inside the X-ray machine.
   - **Advantages**: Provides high image quality, immediate image availability, and the ability to adjust contrast and brightness digitally.
2. **Computed Radiography (CR)**:
   - **Technology**: Uses photostimulable phosphor plates to capture X-ray images. The plates are then scanned by a reader to produce digital images.
   - **Advantages**: Allows for a wider range of X-ray equipment to be converted to digital, though generally slower than DR.
3. **Tomosynthesis (Digital Breast Tomosynthesis, DBT)**:
   - **Technology**: Creates a series of thin, cross-sectional images of the breast by moving the X-ray tube in an arc around the patient.
   - **Applications**: Primarily used for breast imaging, but the technology principles can be adapted for other parts of the body.
4. **Fluoroscopy**:
   - **Technology**: Provides real-time moving images using a continuous X-ray beam and digital detectors.
   - **Applications**: Used for dynamic studies such as gastrointestinal tract examinations and guiding interventional procedures.

3. Whole-Body Imaging Techniques

1. **Digital Whole-Body Imaging**:
   - **Technology**: While full-body digital X-rays are not commonly performed due to high radiation doses, specialized equipment can capture large areas or multiple parts of the body sequentially.
   - **Applications**: Useful for certain types of trauma assessments or in cases where comprehensive imaging is required.
2. **Body CT Scanning**:
   - **Technology**: Utilizes computed tomography (CT) with digital detectors to capture cross-sectional images of the body, which can be combined to create a 3D representation.

   - **Advantages**: Provides detailed images of all body regions in a single scan, often used for comprehensive diagnostic evaluations.
3. **Positron Emission Tomography (PET)/CT**:
   - **Technology**: Combines CT scanning with PET imaging to provide both anatomical and functional information.
   - **Applications**: Often used for cancer diagnosis, staging, and monitoring treatment responses.

4. Workflow for Whole-Body Imaging

1. **Patient Preparation**:
   - **Instructions**: Provide the patient with instructions based on the type of imaging required. This may include fasting, avoiding certain medications, or specific positioning.
   - **Positioning**: Ensure proper positioning to capture the necessary areas of interest.
2. **Image Acquisition**:
   - **Setup**: Configure the X-ray machine or CT scanner for whole-body imaging. For digital X-rays, capture images of different body parts sequentially or use specialized equipment for broader coverage.
   - **Exposure**: Adjust exposure settings to minimize radiation dose while ensuring image quality.
3. **Image Processing**:
   - **Digital Enhancement**: Use digital processing tools to enhance image quality, adjust contrast, and optimize visualization of anatomical structures.
   - **Review**: Radiologists review the images to assess for any abnormalities or conditions.
4. **Post-Procedure**:
   - **Results**: Provide results and diagnostic information to the referring physician. Follow-up may be required for further imaging or treatment based on findings.

5. Advantages of Digital X-ray Techniques

1. **High Image Quality**:
   - **Detail**: Digital X-ray techniques provide high-resolution images with excellent detail.
2. **Immediate Availability**:
   - **Efficiency**: Images are available for review almost immediately after acquisition, facilitating faster diagnosis and treatment.
3. **Reduced Radiation Dose**:

- **Optimization**: Modern digital X-ray techniques often use lower radiation doses compared to traditional film-based systems.

4. **Digital Processing**:
    - **Flexibility**: Allows for adjustment of image contrast and brightness, improving diagnostic capabilities.

6. Disadvantages and Considerations

1. **Radiation Exposure**:
    - **Dose**: While digital X-rays often use lower doses, full-body imaging still involves significant radiation exposure. Careful dose management is essential.
2. **Equipment Cost**:
    - **Expense**: Digital X-ray systems and advanced imaging technologies can be costly to install and maintain.
3. **Limited Full-Body Applications**:
    - **Practicality**: Full-body digital X-rays are less commonly used compared to CT or PET/CT scans due to practical limitations and radiation concerns.

7. Applications of Whole-Body Imaging

1. **Trauma Assessment**:
    - **Emergency**: Used in emergency settings to quickly assess injuries and conditions across multiple body regions.
2. **Cancer Screening**:
    - **Diagnosis**: Employed for staging and monitoring cancer, especially in cases where comprehensive imaging is required.
3. **Pre-Operative Planning**:
    - **Surgical Planning**: Provides detailed anatomical information to plan complex surgical procedures.
4. **Comprehensive Diagnostics**:
    - **Evaluation**: Useful for detailed evaluation of systemic conditions or multiple simultaneous issues.

MAGNETIC RESONANCE IMAGING

MRI Brain

Common Indications For Mri Of The Brain

- Transient ischaemic attack (TIA), cerebrovascular attack (CVA)

- Infection, inflammation, meningitis, encephalitis, HIV, AIDS, TB
- Cognitive decline, neurodegenerative disorders, dementia
- Demyelinating disease, multiple sclerosis
- Loss of consciousness, seizures, epilepsy
- Brain tumour, metastases, abscess
- Cerebellar lesion, brainstem lesion
- Congenital abnormalities
- Post-operative follow-up
- Vascular pathologies
- Headaches
- Haemorrhage

Contraindications

- Any electrically, magnetically or mechanically activated implant (e.g. cardiac pacemaker, insulin pump biostimulator, neurostimulator, cochlear implant, and hearing aids)
- Intracranial aneurysm clips (unless made of titanium)
- Pregnancy (risk vs benefit ratio to be assessed)
- Ferromagnetic surgical clips or staples
- Metallic foreign body in the eye
- Metal shrapnel or bullet

Patient Preparation For Mri Brain

- A satisfactory written consent form must be taken from the patient before entering the scanner room
- Ask the patient to remove all metal objects including keys, coins, wallet, cards with magnetic strips, jewellery, hearing aid and hairpins
- If possible provide a chaperone for claustrophobic patients (e.g. relative or staff)
- Contrast injection risk and benefits must be explained to the patient before the scan
- Gadolinium should only be given to the patient if GFR is > 30
- Offer earplugs or headphones, possibly with music for extra comfort
- Explain the procedure to the patient
- Instruct the patient to keep still
- Note the hight and weight of the patient

Positioning For Mri Brain

- Head first supine
- Position the head in the head coil and immobilise with cushions

- Give cushions under the legs for extra comfort
- Now, connect the top portion of the head coil and secure it in place.
- Centre the laser beam localiser over the glabella

Sequences

- Localizer 3 plane
- T2 tse tra
- T2 flair tra
- T1 se cor
- T2 tse seg
- Resolve DWI 2trace tra
- Contrast enhancement
- T1 se cor post gd
- T1 se Tra post gd

MRI Orbits

Indications For Mri Orbits Scan

- Visual loss that is clinically compatible with an intracranial pre- or postchiasmal lesion
- Vascular lesions of the orbit (AV malformation , carotid-cavernous fistula, orbital varix)
- History of visual disturbances
- Optic nerve sheath meningioma
- Tumours or suspected tumours
- Thyroid ophtalmopathy
- Extraocular myopathy
- Optic nerve neuritis
- Optic nerve glioma
- Unilateral proptosis
- Orbital abscess
- Inflammation

Contraindications

- Any electrically, magnetically or mechanically activated implant (e.g. cardiac pacemaker, insulin pump biostimulator, neurostimulator, cochlear implant, and hearing aids)

- Intracranial aneurysm clips (unless made of titanium)
- Pregnancy (risk vs benefit ratio to be assessed)
- Ferromagnetic surgical clips or staples
- Metallic foreign body in the eye
- Metal shrapnel or bullet

Patient Preparation For Mri Orbits Scan

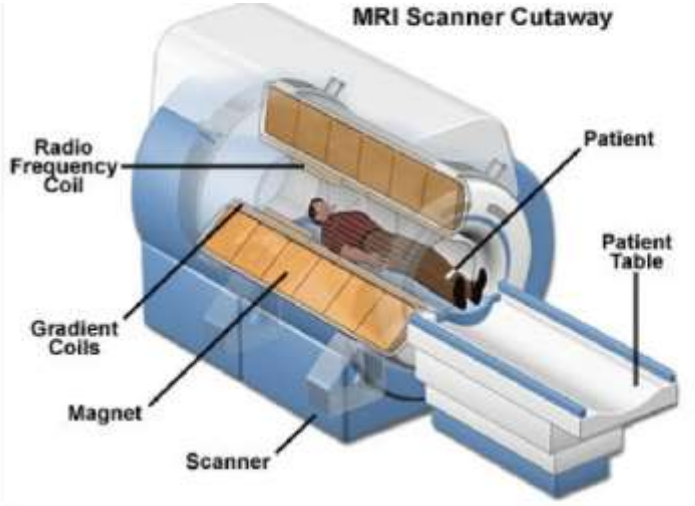
- A satisfactory written consent form must be taken from the patient before entering the scanner room (For paediatric patients this must be done by the parents)
- Ask the patient to remove all metal objects including keys, coins, wallet, cards with magnetic strips, jewellery, hearing aid and hairpins
- If possible provide a chaperone for claustrophobic patients (e.g. relative or staff)
- Contrast injection risk and benefits must be explained to the before the scan
- Gadolinium should only be given to the patient if GFR is > 30
- Offer earplugs or headphones, possibly with music for extra comfort
- Explain the procedure to the patient
- Instruct the patient to keep still
- Note the weight of the patient

Positioning For Mri Orbits Scan

- Head first supine
- Position the head in the head coil and immobilise with cushions
- Give cushions under the legs for extra comfort
- Centre the laser beam localiser over the glabella

Sequences

- localizer_3plane
- T2_tse_tra.
- T2_STIR_CORONAL
- T1_TSE_CORONAL
- T2_TSE_Sagittal_Oblique_RT
- T2_TSE_Sagittal_Oblique_LT
- T2_STIR_AXIAL
- Contrast enhancement stop
- T1 tse coronal Fat Sat post gd
- T1 Tse fat set post GD



PARANASAL SINUSES MRI

Indications For Paranasal Sinuses (Pns) Mri Scan

- For the evaluation of intracranial extension of sinonasal disease.
- For the evaluation of malignant tumors of the sinonasal tract
- For the evaluation of sinus extension of orbital cellulitis and abscess
- For the evaluation of brain abscess due to sinusitis
- Fibro-osseous lesions of sinuses
- Inverted papilloma
- Sinus infections
- Encephalocele
- Meningioma
- ENT tumour
- Keratocyst
- Mucocele

Contraindications Paranasal Sinuses (Pns) Mri Scan

- Any electrically, magnetically or mechanically activated implant (e.g. cardiac pacemaker, insulin pump biostimulator, neurostimulator, cochlear implant, and hearing aids)
- Intracranial aneurysm clips (unless made of titanium)
- Pregnancy (risk vs benefit ratio to be assessed)
- Ferromagnetic surgical clips or staples
- Metallic foreign body in the eye
- Metal shrapnel or bullet

Patient Preparation For Paranasal Sinuses Mri Scan

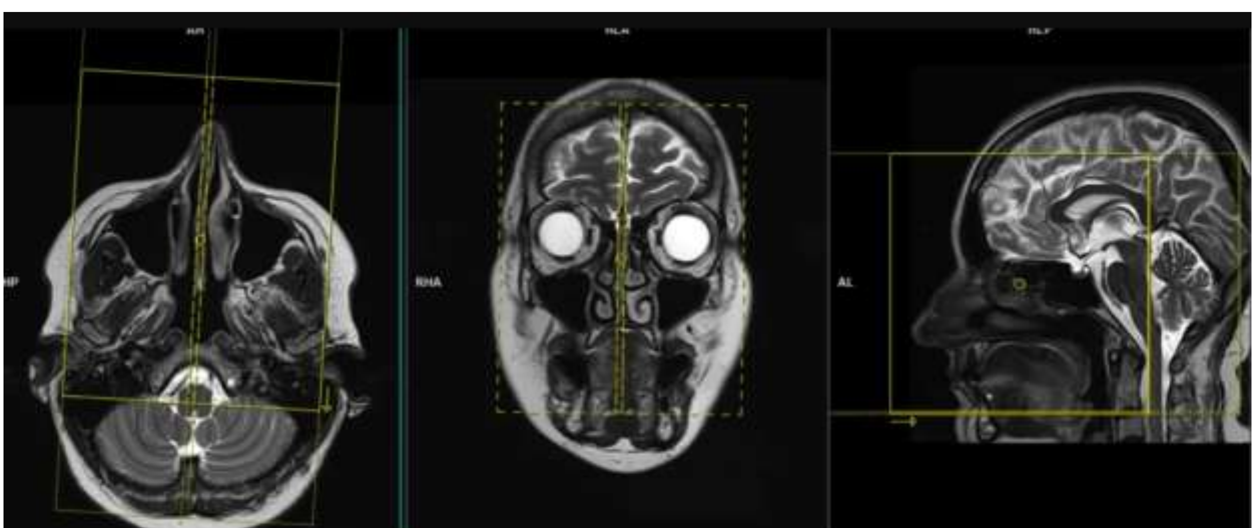
- A satisfactory written consent form must be taken from the patient before entering the scanner room
- Ask the patient to remove all metal objects including keys, coins, wallet, cards with magnetic strips, jewellery, hearing aid and hairpins
- If possible provide a chaperone for claustrophobic patients (e.g. relative or staff)
- Contrast injection risk and benefits must be explained to the patient before the scan
- Gadolinium should only be given to the patient if GFR is > 30
- Offer earplugs or headphones, possibly with music for extra comfort
- Explain the procedure to the patient
- Instruct the patient to keep still
- Note the weight of the patient

Positioning For Paranasal Sinuses Mri Scan

- Head first supine
- Position the head in the head coil and immobilise with cushions
- Give cushions under the legs for extra comfort
- Centre the laser beam localizer over the glabella

The Sequences

- Localize three plan.
- T2 tse Tra
- T2 STIR coronal 3MM SFOV
- T1 tse coronal 3MM SFOV
- T2 STIR axial 3MM SFOV
- Contrast enhancement.
- T1 fat sat coronal 3MM SFOv post GD
- T1 fat sat Axial 3MM SFOV post GD



MRI CERVICAL SPINE

Indications For Mri Cervical Spine

- Persistent neck pain or radiculopathy with 6-week course of conservative care and inadequate > response to treatment.
- Cancer or tumours of the spine (cancer of the spine, spinal cord, or meninges)
- Evaluation or monitoring of congenital malformations of the spinal cord
- Myelopathies, Multiple Sclerosis and other demyelinating disease
- Possible spinal cord injury and post-traumatic neurologic deficit
- Post-operative evaluation, with new neurologic findings
- Congenital or acquired spinal abnormalities in children
- Fracture evaluation for suspected or known fracture.
- Infectious or inflammatory processes
- Evaluation or monitoring of myelopathy
- Monitoring of previous spinal surgery
- Evaluation or monitoring of syrinx
- Spinal injury or trauma
- Spinal cord tumour
- Spinal TB

Contraindications

- Any electrically, magnetically or mechanically activated implant (e.g. cardiac pacemaker, insulin pump biostimulator, neurostimulator, cochlear implant, and hearing aids)
- Intracranial aneurysm clips (unless made of titanium)
- Pregnancy (risk vs benefit ratio to be assessed)
- Ferromagnetic surgical clips or staples
- Metallic foreign body in the eye
- Metal shrapnel or bullet

Patient Preparation For Mri Cervical Spine

- A satisfactory written consent form must be taken from the patient before entering the scanner room
- Ask the patient to remove all metal objects including keys, coins, wallet, cards with magnetic strips, jewellery, hearing aid and hairpins
- If possible provide a chaperone for claustrophobic patients (e.g. relative or staff)
- Contrast injection risk and benefits must be explained to the patient before the scan

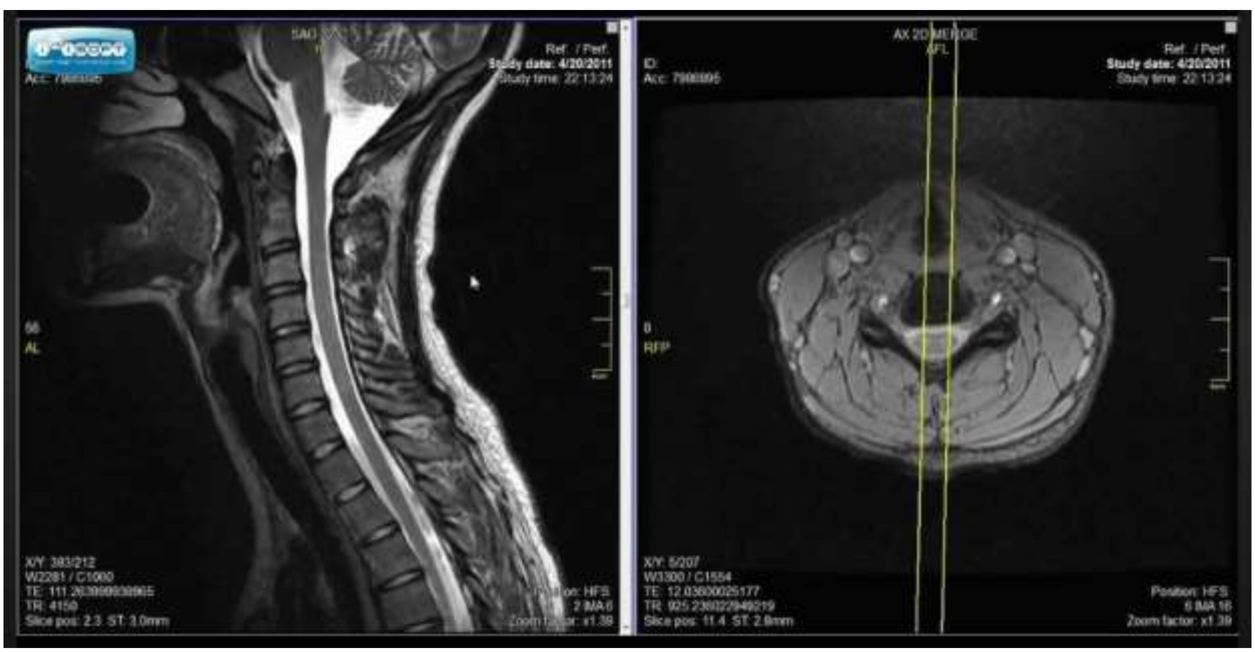
- Gadolinium should only be given to the patient if GFR is > 30
- Offer earplugs or headphones, possibly with music for extra comfort
- Explain the procedure to the patient
- Instruct the patient to keep still
- Note the weight of the patient

Positioning For Mri Cervical Spine

- Head first supine
- Position the head in the head and neck coil and immobilise with cushions
- Give cushions under the legs for extra comfort
- Centre the laser beam localiser over the mid neck (2.5cm below the chin in chin-down position)

The Sequences

- Localizer 3 plane
- T2 TSE SAGITTAL
- T1 TSE SAGITTAL
- T2 TSE STIR SAGITTAL
- T2 TSE AXIAL
- T1 TSE AXIAL
- T1 TSE SAGITTAL FAT SAT POST GD
- T1 TSE AXIAL FAT SAT POST GD
- T2 SPACE 3D SAGITTAL 0.7MM ISO



MRI THORACIC SPINE

Indications For Mri Thoracic Spine

- Localised upper back pain and radiculopathy with 6-week course of conservative care and inadequate response to treatment.
- Infectious or inflammatory processes (eg.Spinal Cord Abscess or Spinal Osteomyelitis)
- Myelopathies, Multiple Sclerosis and other demyelinating diseases
- Evaluation or monitoring of congenital malformations of the spinal cord
- Evaluation or monitoring of inflammation of the CNS or meninges
- Evaluation or monitoring of tumour of the CNS or meninges
- Evaluation or monitoring of demyelinating disease
- Nontraumatic vascular injuries of the spine
- Monitoring of previous spinal surgery
- Evaluation or monitoring of trauma
- Spinal Cord Tumour
- Spine TB

Contraindications

- Any electrically, magnetically or mechanically activated implant (e.g. cardiac pacemaker, insulin pump biostimulator, neurostimulator, cochlear implant, and hearing aids)
- Intracranial aneurysm clips (unless made of titanium)
- Pregnancy (risk vs benefit ratio to be assessed)
- Ferromagnetic surgical clips or staples
- Metallic foreign body in the eye
- Metal shrapnel or bullet

Patient Preparation For Mri Thoracic Spine

- A satisfactory written consent form must be taken from the patient before entering the scanner room
- Ask the patient to remove all metal object including keys, coins, wallet, any cards with magnetic strips, jewellery, hearing aid and hairpins
- Ask the patient to undress and change into a hospital gown
- Contrast injection risk and benefits must be explained to the patient before the scan
- Gadolinium should only be given to the patient if GFR is > 30
- If possible provide a chaperone for claustrophobic patients (e.g. relative or staff)

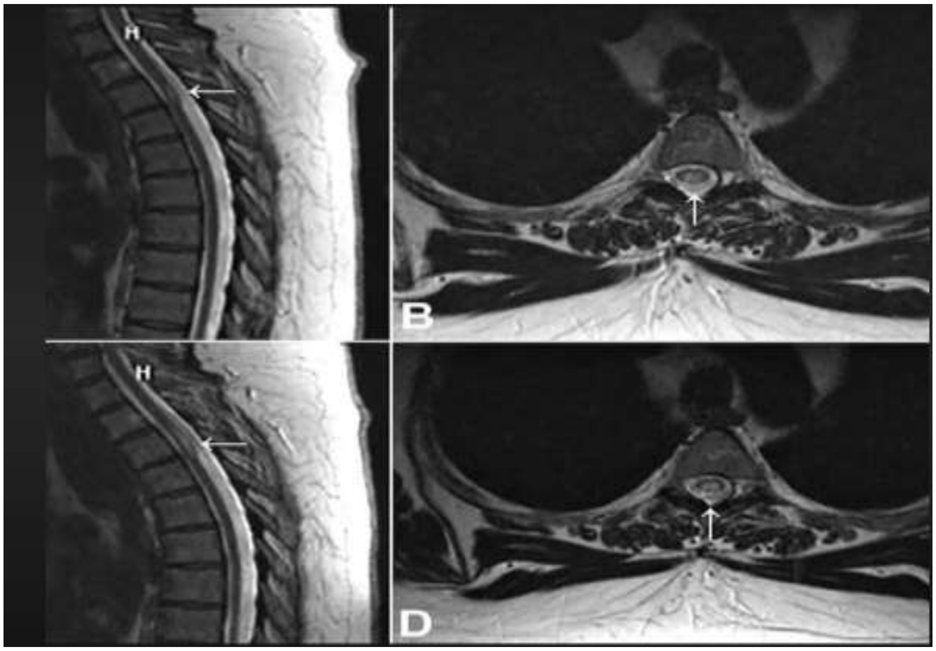
- Offer earplugs or headphones, possibly with music for extra comfort
- Explain the procedure to the patient
- Instruct the patient to keep still
- Note down the weight of the patient

Positioning For Mri Thoracic Spine

- Head first supine
- Position the patient in the spine and neck coils
- Give cushions under the legs for extra comfort
- Centre the laser beam localiser over the mid sternum (T4-T5 level)

The Sequences

- Localizer 3 plane
- T2 TSE SAGITTAL
- T1 TSE SAGITTAL
- T2 TSE STIR SAGITTAL
- T2 TSE AXIAL
- T1 TSE AXIAL
- CONTRAST ENHENCEMENT
- T1 TSE SAGITTAL FAT SAT POST GD
- T1 TSE AXIAL FAT SAT POST GD



LUMBAR SPINE MRI (PROTOCOLS AND PLANNING)

Indications For Lumbosacral Spine Mri

- Localized back pain and radiculopathy with 6-week course of conservative care and inadequate response to treatment.
- Infectious or inflammatory processes (eg.spinal cord Abscess or spinal osteomyelitis)
- Myelopathies, Multiple Sclerosis and other demyelinating diseases
- Possible spinal cord injury and post-traumatic neurologic deficit
- Cauda equina syndrome, (e.g. sudden bowel/bladder disturbance).
- Evaluation or monitoring of congenital malformations of the spinal cord
- Evaluation or monitoring of inflammation of the CNS or meninges
- Evaluation or monitoring of tumour of the CNS or meninges
- Investigation of any cause of spinal disease in pregnancy
- Evaluation or monitoring of spinal cord compression
- Evaluation or monitoring of demyelinating disease
- Non-traumatic vascular injuries of the spine
- Reduced power on physical examination
- Monitoring of previous spinal surgery
- Evaluation or monitoring of trauma
- Spinal cord tumour
- Spine TB

Contraindications

- Any electrically, magnetically or mechanically activated implant (e.g. cardiac pacemaker, insulin pump biostimulator, neurostimulator, cochlear implant, and hearing aids)
- Intracranial aneurysm clips (unless made of titanium)
- Pregnancy (risk vs benefit ratio to be assessed)
- Ferromagnetic surgical clips or staples
- Metallic foreign body in the eye
- Metal shrapnel or bullet

Patient Preparation For Lumbosacral Spine Mri

- A satisfactory written consent form must be taken from the patient before entering the scanner room
- Ask the patient to remove all metal object including keys, coins, wallet, any cards with magnetic strips, jewellery, hearing aid and hairpins
- Ask the patient to undress and change into a hospital gown

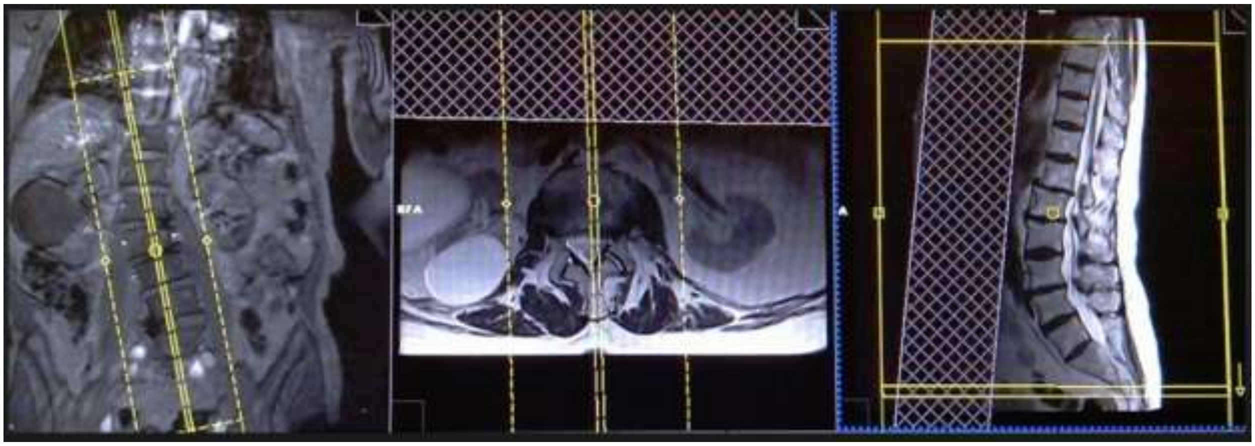
- Contrast injection risk and benefits must be explained to the patient before the scan
- Gadolinium should only be given to the patient if GFR is > 30
- If possible, provide a chaperone for claustrophobic patients (e.g. relative or staff)
- Offer earplugs or headphones, possibly with music for extra comfort
- Explain the procedure to the patient
- Instruct the patient to keep still
- Note the weight of the patient

Positioning For Lumbosacral Spine Mri

- Head first supine
- Position the paient in the spine coil and immobilise with cushions
- Give cushions under the legs for extra comfort
- Centre the laser beam localiser over the mid abdomen (4 inches above the iliac crest)

The Sequences

- LOCALIZER 3PLANE
- T2 TSE SAGGITAL
- T1 TSE SAGITTAL
- T2 TSE STIR SAGITTAL
- T2 TSE AXIAL
- T1 TSE AXIAL
- CONTRAST ENHENCEMENT
- T2 TSE SAGITTAL FAT SAT POST GD
- T1 TSE AXIAL FAT SAT POST GD



CHEST MRI

Indications For Chest Mri Scan

- Assess abnormal growths, including cancer of the lungs or other tissues where MRI offers a
  superior alternative to other imaging techniques eg. mediastinal node
- For assessment of chest wall tumours, such as sarcoma, osteochondroma, haemangioma, and metastatic tumours of the bone,
- To display lymph nodes and blood vessels, including vascular and lymphatic malformations of the chest
- For assessment of disorders of the bone marrow, such as anaemia and avascular necrosis of the bone
- For assessment of chest wall or diaphragmatic extension of intra thoracic masses
- For assessment of chest and chest wall infections
- Suspected superior sulcus tumour by chest x ray
- Lung cancer staging
- Trauma

Contraindications

- Any electrically, magnetically or mechanically activated implant (e.g. cardiac pacemaker, insulin pump biostimulator, neurostimulator, cochlear implant, and hearing aids)
- Intracranial aneurysm clips (unless made of titanium)
- Pregnancy (risk vs benefit ratio to be assessed)
- Ferromagnetic surgical clips or staples
- Metallic foreign body in the eye
- Metal shrapnel or bullet

Patient Preparation For Chest Mri Scan

- A satisfactory written consent form must be taken from the patient before entering the scanner room
- Ask the patient to remove all metal objects including keys, coins, wallet, cards with magnetic strips, jewellery, hearing aid and hairpins
- Ask the patient to undress and change into a hospital gown
- Instruct the patient to hold their breath for the breath hold scans and breathe gently for the gated scans (it is advisable to coach the patient two to three times before starting the scan)
- If possible provide a chaperone for claustrophobic patients (e.g. relative or

staff)

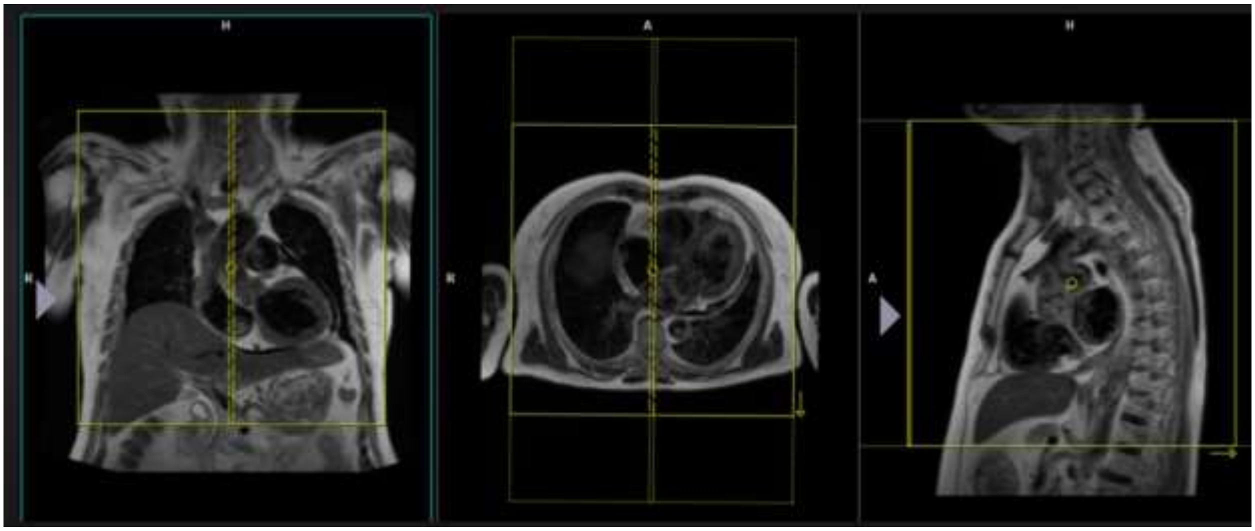
- Offer earplugs or headphones, possibly with music for extra comfort
- Explain the procedure to the patient
- Instruct the patient to keep still
- Note down the hight and weight of the patient

Positioning For Chest Mri Scan

- Position the patient in supine position with head pointing towards the magnet (head first supine)
- Position the patient in the spine,head and neck coil and place the neck and body coil over the neck and chest covering from the tip of the nose down to the lower intercostal border
- Securely tighten the body coil using straps to prevent respiratory artefacts
- Give cushions under the head and legs for extra comfort
- Centre the laser beam localiser over mid chest (i.e. over the nipples)

The Sequences

- LOCALIZER 3PLANE
- T1 VIBE FAT SAT CORONAL BREATH HOLD
- T2 TSE CORONAL BREATH HOLD
- T1 VIBE FAT SAT AXIAL BREATH HOLD
- T2 TSE AXIAL BREATH HOLD
- T2 TSE FAT SAT AXIAL BREATH HOLD
- T2 TSE SAGITTAL BREATH HOLD
- CONTRAST ENHENCEMENT
- T1 VIBE FAT SAT CORONAL BH POST GD
- T1 VIBE FAT SAT AXIAL BH POST GD



MRI BREAST

Indications For Breast Mri Scan

- Identified mass with indeterminate characteristics following mammography or sonography where patient wishes to avoid biopsy
- Staging for chest wall invasion or lymphadenopathy after cancer diagnosis
- Dense breasts with difficult to read mammogram based on visualisation
- Palpable mass with negative mammography/sonography
- Axillary node metastases with unknown primary
- Unexplained swollen breast or breast implant
- To check the response to neoadjuvant chemotherapy
- To check the extent of infiltrating lobular or ductal carcinoma
- To check residual disease post-lumpectomy
- Postoperative tissue reconstruction
- Dense breasts in the high risk patient
- For MR guided biopsy
- Surveillance of high-risk patients
- Contralateral breast screening
- Determine extent of disease
- Recurrence of breast cancer
- Lesion characterization

Contraindications For Breast Mri Scan

- Any electrically, magnetically or mechanically activated implant (e.g. cardiac pacemaker, insulin pump biostimulator, neurostimulator, cochlear implant, and hearing aids)
- Intracranial aneurysm clips (unless made of titanium)
- Pregnancy (risk vs benefit ratio to be assessed)
- Ferromagnetic surgical clips or staples
- Metallic foreign body in the eye
- Metal shrapnel or bullet

Patient Preparation For Breast Mri Scan

- A satisfactory written consent form must be taken from the patient before entering the scanner room
- Please ask the patient to change into a hospital gown that opens at the front. It is important to ensure that the gown is worn correctly as the patient will be lying face down with the gown open in order to position the breast in the coil.

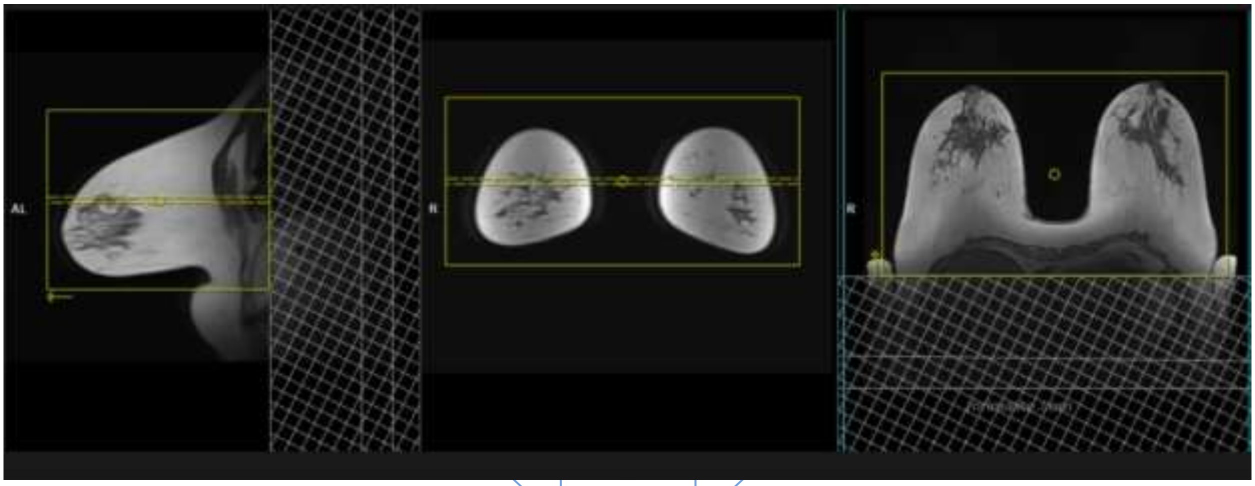
- Ask the patient to remove all metal objects including keys, coins, wallet, any cards with magnetic strips, jewellery, hearing aid and hairpins
- If possible offer a chaperone to accompany claustrophobic patients into the scanner room (e.g. relative or staff)
- An intravenous line must be placed with extension tubing extending out of the magnetic bore
- Contrast injection risk and benefits must be explained to the patient before the scan.
- Gadolinium should only be given to the patient if GFR is > 30
- Offer earplugs or headphones, possibly with music for extra comfort
- Properly explain the procedure to the patient
- Instruct the patient to keep still
- Note the weight of the patient

Positioning For Breast Mri Scan

- Head first prone
- Position the patient with breasts inside the breast coil and both arms by the sides of the body (be careful not to dislodge the intravenous line while positioning the patient)
- Give cushions under the legs and under the forehead for extra comfort
- Centre the laser beam localizer over the mid chest (T6-T7 level)

The Sequences

- LOCALIZER 3PLANE
- T2 STIR AXIAL
- T1 FLASH 3D AXIAL NON FAT SAT 1MM
- T2 TSE SAGITTAL RT
- T2 TSE SAGITTAL LT
- T1 FLASH 3D AXIAL FAT SAT 1MM DYNAMIC 1 PRE 5 POST
- T1 FLASH 3D CORONAL FAT SAT POST GD
- EPI DWI AXIAL B0 B500 B1000



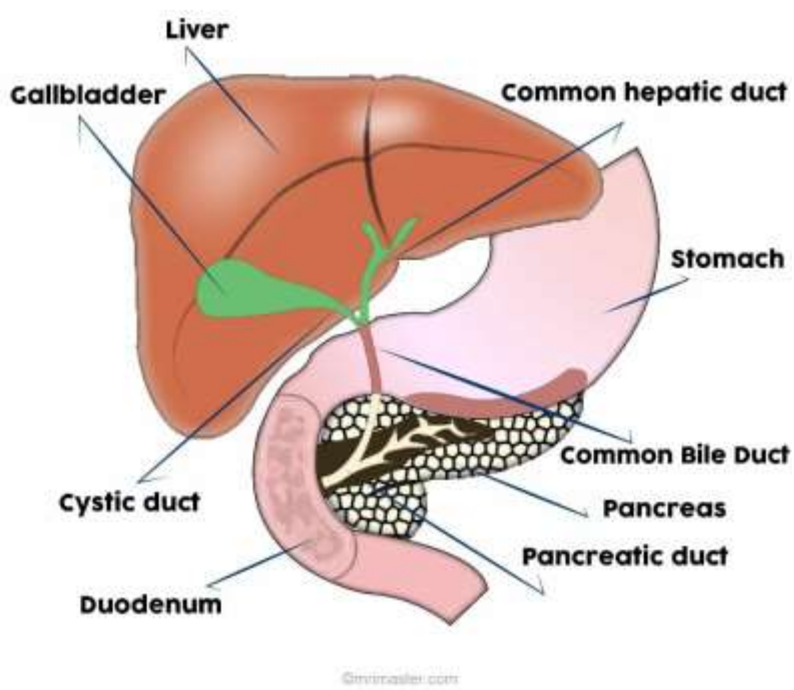
MAGNETIC RESONANCE CHOLANGIOPANCREATOGRAPHY (MRCP): PROTOCOL AND PLANNING

Anatomy Of Biliary System

The anatomy of the biliary system is of utmost importance in radiology as it plays a crucial role in the diagnosis and treatment of biliary disorders. The biliary system consists of various interconnected structures that facilitate the production, transportation, and storage of bile.

Starting with the liver, the intrahepatic bile ducts collect bile produced by hepatocytes. These ducts merge to form the right and left hepatic ducts, which exit the liver and join together to form the common hepatic duct. The common hepatic duct combines with the cystic duct from the gallbladder to form the common bile duct.

The common bile duct runs through the head of the pancreas and usually joins the main pancreatic duct, forming the hepatopancreatic ampulla (ampulla of Vater). The ampulla opens into the duodenum through the sphincter of Oddi, allowing the release of bile into the digestive system.



Indications For Magnetic Resonance Cholangiopancreatography

- Biliary obstruction (choledocholithiasis, benign and malignant strictures)
- Bile ducts, surgery or postsurgical biliary tract alterations

- Biliary cystadenoma and cystadenocarcinoma
- Congenital anomalies
- Pancreatic pseudocyst
- Chronic pancreatitis
- Acute cholecystitis
- Bile ducts, calculi
- Pancreatic cancer
- Pancreas divisum

Contraindications

- Any electrically, magnetically or mechanically activated implant (e.g. cardiac pacemaker, insulin pump biostimulator, neurostimulator, cochlear implant, and hearing aids)
- Intracranial aneurysm clips (unless made of titanium)
- Pregnancy (risk vs benefit ratio to be assessed)
- Ferromagnetic surgical clips or staples
- Metallic foreign body in the eye
- Metal shrapnel or bullet

Patient Preparation For Mrcp

- A satisfactory written consent form must be taken from the patient before entering the scanner room
- Ask the patient to remove all metal objects including keys, coins, wallet, cards with magnetic strips, jewellery, hearing aid and hairpins
- Ask the patient to undress and change into a hospital gown
- Instruct the patient to hold their breath for the breath hold scans and breathe gently for the gated scans. It is recommended to provide coaching to the patient two to three times before initiating the scan.
- Claustrophobic patients may be accompanied into the scanner room e.g. by staff member or relative with proper safety screening
- Patients should fast for 4 -6 hours before the exam (nothing to eat or drink)
- Offer headphones for communicating with the patient and ear protection
- Explain the procedure to the patient and answer questions
- Note down the weight of the patient

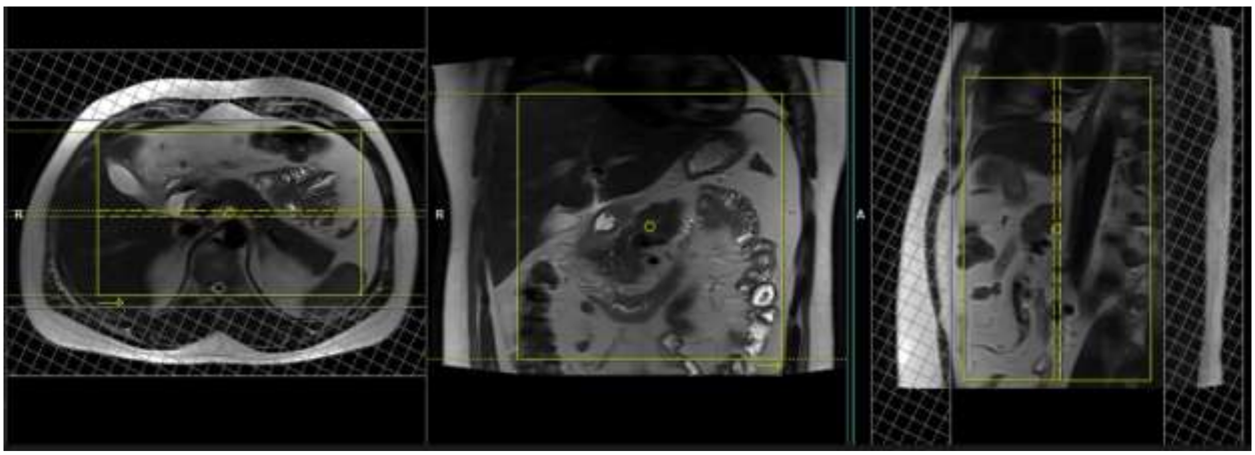
Positioning For MRCP

- Position the patient in supine position with head pointing towards the magnet (head first supine)
- Position the patient over the spine coil and place the body coil over the upper abdomen (nipple down to iliac crest)

- Securely tighten the body coil using straps to prevent respiratory artefacts
- Give a pillow under the head and cushions under the legs for extra comfort
- Centre the laser beam localizer over xiphoid process of sternum

The Sequences

- LOCALIZER 3PLANE
- T2 HASTE FAT SAT CORONAL
- T2 TRUFI AXIAL
- T2 HASTE FAT SAT AXIAL
- T1 HASTE 40MM CORONAL OBL
- T2 HASTE 40MM CORONAL OBL
- T2 TSE 3D CORONAL



MRI KIDNEY URETERS AND BLADDER (KUB) PROTOCOLS AND PLANNING

Indications For Mri Kidney Ureters And Bladder (Kub) Scan

- Detection of suspected stones where CT is contraindicated (post radiotherapy , children)
- For the evaluation of solid abdominal masses
- For the evaluation of malignancy
- For the evaluation of cyst
- Local staging of cancer
- Genitourinary tract TB
- Haematuria
- Trauma

Contraindications For Mri Kidney Ureters And Bladde Scan

- Any electrically, magnetically or mechanically activated implant (e.g. cardiac pacemaker, insulin pump biostimulator, neurostimulator, cochlear implant, and hearing aids)
- Intracranial aneurysm clips (unless made of titanium)
- Pregnancy (risk vs benefit ratio to be assessed)
- Ferromagnetic surgical clips or staples
- Metallic foreign body in the eye
- Metal shrapnel or bullet

Patient Preparation Mri Kidney Ureters And Bladder (Kub) Scan

- A satisfactory written consent form must be taken from the patient before entering the scanner room
- Ask the patient to remove all metal object including keys, coins, wallet, any cards with magnetic strips, jewellery, hearing aid and hairpins
- Ask the patient to undress and change into a hospital gown
- Claustrophobic patients may be accompanied into the scanner room e.g. by staff member or relative with proper safety screening
- Offer headphones for communicating with the patient and ear protection
- Explain the procedure to the patient and answer questions
- Note the weight of the patient
- Patient should be have a full balder

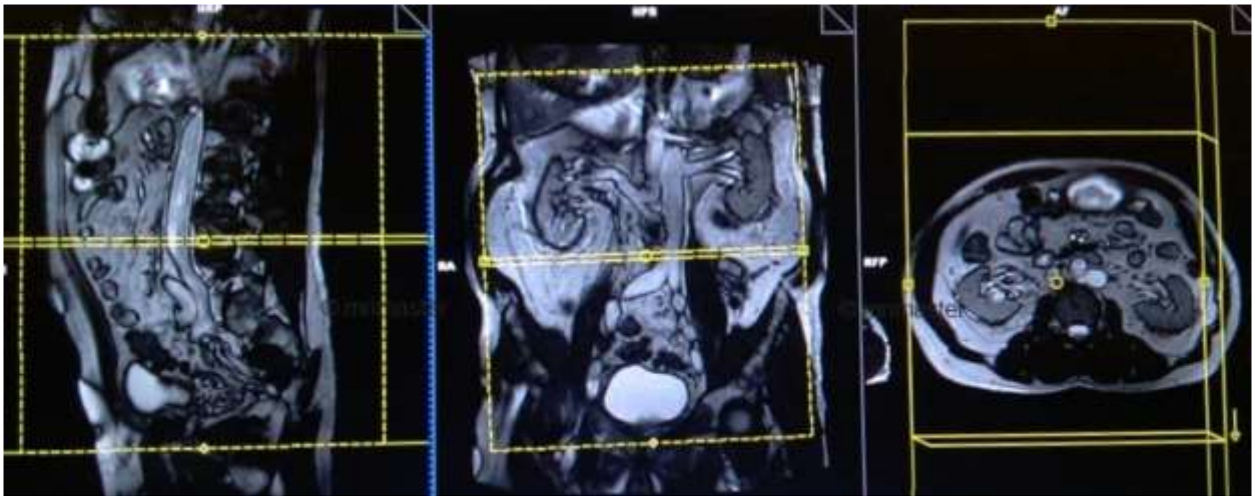
Positioning Mri Kidney Ureters And Bladder (Kub)

- Position the patient in supine position with head pointing towards the magnet (head first supine)
- Position the patient over the spine coil and place the body coils over abdomen and pelvis (nipple down to elbow three inches below symphysis pubis)
- Securely tighten the body coil using straps to prevent respiratory artefacts
- Give a pillow under the head and cushions under the legs for extra comfort
- Centre the laser beam localiser over the iliac crest
- Register the patient in the scanner as head first supine

The Sequences

- LOCALIZER 3PLANE
- T2 TRUFI AXIAL 4MM
- T2 TRUFI FAT SAT AXIAL 4MM
- T1 VIBE AXIAL 4MM
- T1 VIBE CORONAL 2MM
- T2 TRUFI FAT SAT CORONAL 3MM

- T2 TSE BH AXIAL 3MM SFOV
- T2 TSE HIGH RES AXIAL 3MM SFOV



MIDNAPORE CITY COLLEGE

Department of Paramedical and Allied Health Sciences

Bachelor of Radiology and Imaging Techniques

3rd Year

Paper Title: Computer Application and Medical Data Entry (Practical)

Paper Code: Paper –IV

Syllabus

A. Operation of personal computer.

B. Data storage, reporting, data presentation in computer

OPERATION OF PERSONAL COMPUTER.

Introduction :

A personal computer (PC) is a versatile, general-purpose computer designed for individual use. PCs are intended to be operated directly by an end user, rather than by a computer expert or technician. The capabilities of a personal computer have expanded greatly since their inception, allowing them to perform a wide range of tasks from word processing to complex calculations, graphic design, and internet browsing.

Components of a Personal Computer:-

A personal computer (PC) is made up of various components that work together to perform a wide range of tasks. Here's a detailed look at each of these components:

1. Central Processing Unit (CPU)

Function: The CPU, often referred to as the "brain" of the computer, performs calculations and executes instructions to carry out tasks. It processes data and controls the flow of information within the computer.

Key Features:

- **Clock Speed**: Measured in gigahertz (GHz), it indicates how many cycles per second the CPU can execute.
- **Cores**: Modern CPUs have multiple cores, allowing them to perform multiple tasks simultaneously.
- **Cache**: A small amount of high-speed memory within the CPU that stores frequently accessed data for quick retrieval.

Fig: CPU

2. Memory (RAM)

Function: Random Access Memory (RAM) is the computer's short-term memory. It temporarily stores data that the CPU needs while performing tasks, allowing for quick access and efficient processing.

Key Features:

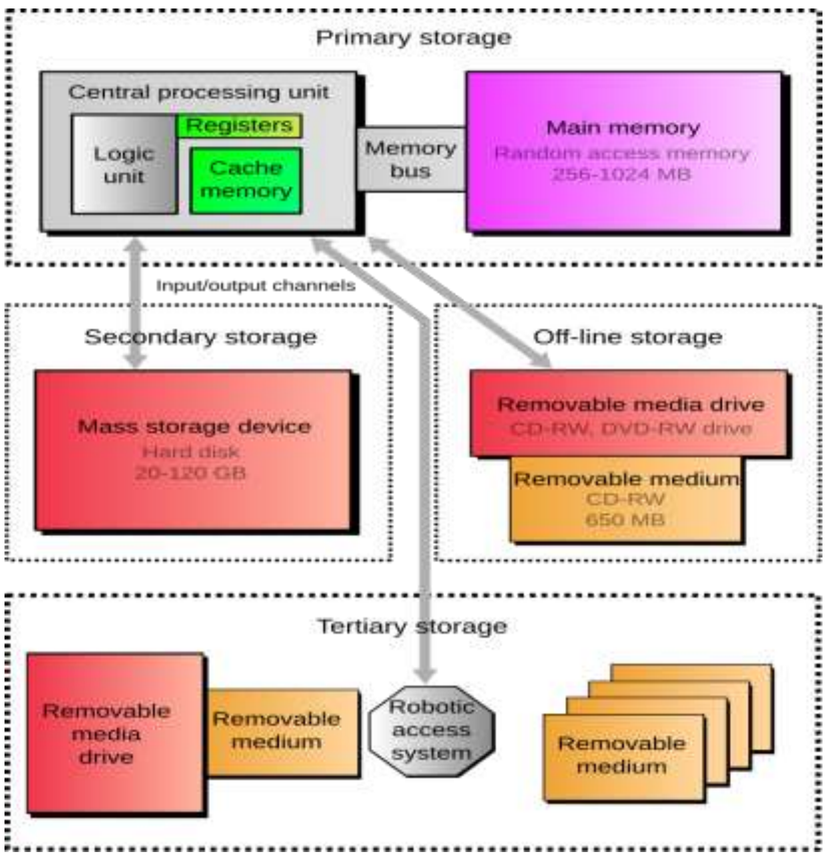
- **Capacity**: Measured in gigabytes (GB), more RAM allows a computer to handle more tasks simultaneously.
- **Speed**: Measured in megahertz (MHz) or gigahertz (GHz), higher speeds improve data transfer rates.

3. Storage

Function: Storage devices hold the computer's data, software, and operating system. Unlike RAM, storage retains information even when the computer is turned off.

Types:

- **Hard Disk Drive (HDD)**: Uses spinning disks to read/write data. Offers large capacity at a lower cost but slower speed compared to SSDs.
- **Solid State Drive (SSD)**: Uses flash memory to store data. Faster and more reliable than HDDs but generally more expensive.
- **Hybrid Drives (SSHD)**: Combine HDD and SSD technology to offer a balance of speed and capacity.



4. Motherboard

Function: The motherboard is the main circuit board that connects all components of the computer. It houses the CPU, RAM, and other essential components and provides connectors for peripherals.

Key Features:

- **Chipset**: Determines the compatibility and features of the motherboard, including support for CPUs, RAM, and expansion cards.
- **Slots and Ports**: Includes slots for RAM, expansion cards (e.g., graphics cards), and ports for USB, audio, and network connections.

Fig: Motherboard

5. Power Supply Unit (PSU)

Function: The PSU converts electrical power from an outlet into a usable form for the computer's components. It supplies power to the motherboard, CPU, and other internal components.

Key Features:

- **Wattage**: Indicates the total power output of the PSU. Higher wattage units can support more powerful and numerous components.
- **Efficiency Rating**: Certifications such as 80 Plus indicate how efficiently the

PSU converts power.

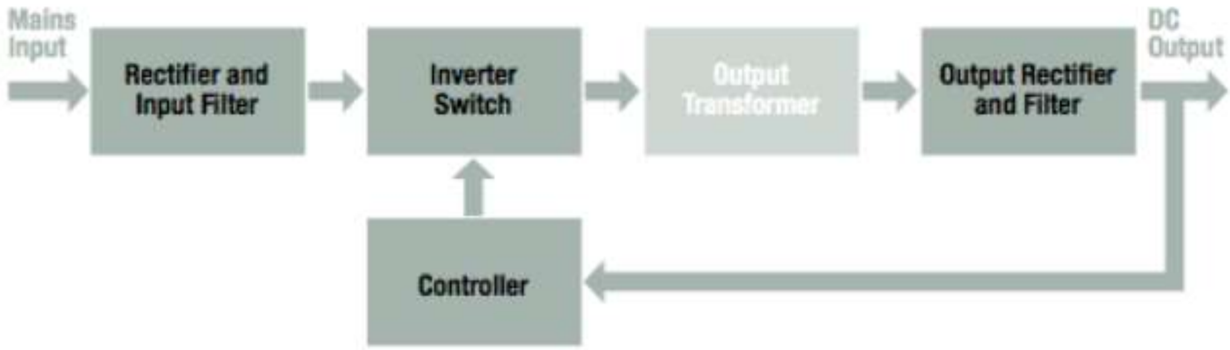


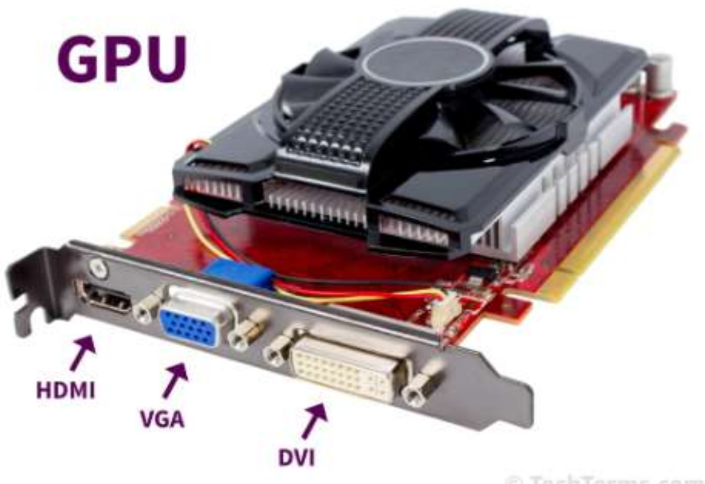
Fig: Block diagram of Power Supply Unit

6. Graphics Processing Unit (GPU)

Function: The GPU handles rendering images, video, and animations. It's crucial for tasks involving graphics, such as gaming, video editing, and 3D rendering.

Types:

- **Integrated GPU**: Built into the CPU, suitable for basic tasks and everyday use.
- **Dedicated GPU**: A separate component that offers significantly more power for demanding applications.



7. Input Devices

Function: Allow users to interact with the computer.

Common Input Devices:

- **Keyboard**: Used for typing text and commands.
- **Mouse**: Pointing device used for navigation and interaction with the computer's interface.
- **Other Devices**: Trackpads, touchscreens, stylus pens, etc.

Fig:- Mouse & Keyboard

8. Output Devices

Function: Display or output information from the computer.

Common Output Devices:

- **Monitor**: Displays visual output from the computer.
- **Printer**: Produces hard copies of documents and images.
- **Speakers**: Output sound generated by the computer.

9. Storage Devices

External: Used for additional storage or backups.

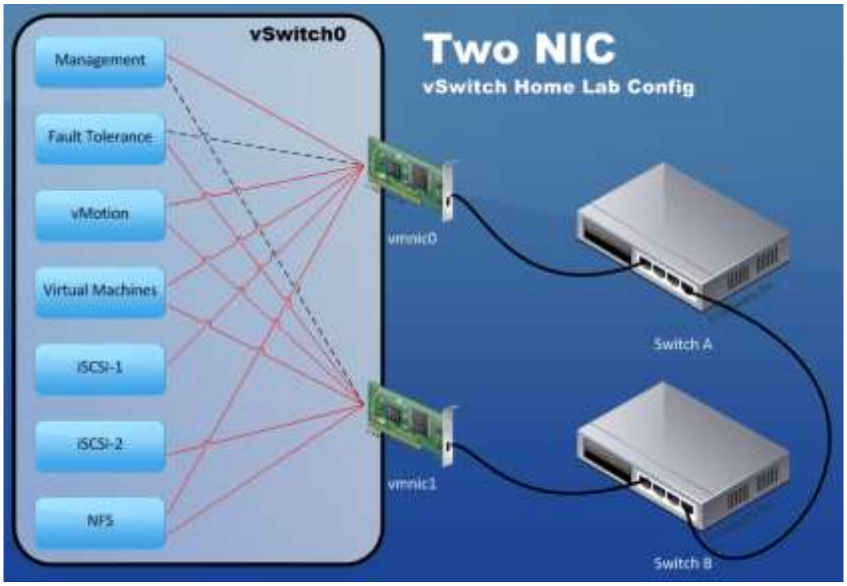
- **External HDDs/SSDs**: Provide portable storage solutions.
- **USB Flash Drives**: Small, portable storage devices.

10. Network Interface Card (NIC)

Function: Allows the computer to connect to a network (e.g., internet or local network).

Types:

- **Wired NIC**: Connects via Ethernet cables.
- **Wireless NIC**: Connects via Wi-Fi.



11. Cooling System

Function: Keeps the computer's components cool to prevent overheating.

Types:

- **Fans**: Common cooling method using air circulation.
- **Heatsinks**: Metal components that dissipate heat.
- **Liquid Cooling**: Uses liquid to transfer heat away from components, often used in high-performance systems.

12. Case (Chassis)

Function: The enclosure that houses all the internal components of the computer. It provides protection, organization, and cooling.

Key Features:

- **Form Factor**: Size and layout of the case, such as ATX, Micro-ATX, and Mini-ITX.
- **Cooling Support**: Availability of fan mounts, liquid cooling support, and airflow design.

In conclusion

a personal computer is a versatile and essential tool that integrates several critical components and systems to perform a wide range of tasks. Its core elements—the CPU, memory, storage, and motherboard—work together to process and manage data efficiently. Input and output devices facilitate user interaction, while the operating system and software applications provide a platform for diverse functionalities. The power supply ensures that all components receive the necessary energy, and the cooling system maintains optimal performance by managing heat.

Overall, the personal computer's ability to execute complex instructions, handle multiple tasks, and interact with various peripherals makes it an indispensable device in both personal and professional environments. Its design and operation are centered around optimizing performance, user experience, and adaptability to different needs and applications.

DATA STORAGE, REPORTING, DATA PRESENTATION IN COMPUTER

DATA STORAGE

1. Database Setup:

- **Relational Database (e.g., MySQL):**
    - **Installation:** Install MySQL server on a local machine or a remote server.
    - **Database Creation:** Use SQL commands to create a database and tables.
    - **Data Insertion:** Use SQL INSERT statements or ETL (Extract, Transform, Load) tools to import data from CSV files or other databases.

- **NoSQL Database (e.g., MongoDB):**
  - **Installation:** Install MongoDB server on a local machine or a remote server.
  - **Database Creation:** Use MongoDB shell or GUI tools (e.g., MongoDB Compass) to create databases and collections.
  - **Data Insertion:** Use JSON or BSON format for inserting data.

Example: Creating a MySQL Database and Table

sql Copy code

```sql
CREATE DATABASE SalesDB;
USE SalesDB;

CREATE TABLE Sales (
    ID INT AUTO_INCREMENT PRIMARY KEY,
    ProductName VARCHAR(100),
    Quantity INT,
    Price DECIMAL(10, 2),
    SaleDate DATE
);

INSERT INTO Sales (ProductName, Quantity, Price, SaleDate)
VALUES ('Product A', 10, 19.99, '2024-01-01');
```

2. Cloud Storage Setup:

- **Service Selection:** Choose a cloud storage provider (e.g., AWS S3, Google Cloud Storage, Microsoft Azure Blob Storage).
- **Bucket Creation:** Create a storage bucket in the cloud service.
- **File Upload:** Use the cloud provider's console, CLI, or APIs to upload files.

Example: Uploading a File to AWS S3

```bash
aws s3 cp myfile.csv s3://mybucket/myfile.csv
```

DATA REPORTING

1. BI Tool Setup (e.g., Tableau):

- **Installation:** Install Tableau Desktop on your computer.
- **Data Connection:** Connect Tableau to your data source (e.g., MySQL, Excel).
- **Report Creation:** Use Tableau's drag-and-drop interface to create charts, graphs, and dashboards.

Example: Creating a Simple Sales Report in Tableau

- **Connect to Data:** Connect to MySQL database SalesDB.
- **Data Preparation:** Select the Sales table.
- **Visual Creation:** Drag SaleDate to Columns and Quantity to Rows to create a time-series chart of sales.

2. Spreadsheet Software (e.g., Excel):

- **Data Import:** Import data from CSV, database, or other sources.
- **Report Creation:** Use pivot tables and charts to create summary reports.

Example: Creating a Pivot Table in Excel

- **Data Import:** Open the CSV file containing sales data.
- **Pivot Table Creation:** Select the data and insert a pivot table.
- **Field Arrangement:** Drag ProductName to Rows, Quantity to Values, and

SaleDate to Columns.

DATA PRESENTATION

1. Visualization Tools:

- **Chart Creation:**
    - **Bar Chart:** Use to compare quantities across categories.
    - **Line Chart:** Use to show trends over time.
    - **Pie Chart:** Use to show proportions of a whole.

Example: Creating a Bar Chart in Excel

- **Data Selection:** Select the data range.
- **Chart Insertion:** Go to Insert > Charts > Bar Chart.

2. Dashboard Creation (e.g., Power BI):

- **Data Connection:** Connect Power BI to your data source.
- **Visual Creation:** Use Power BI's visualizations to create interactive dashboards.

Example: Creating a Sales Dashboard in Power BI

- **Connect to Data:** Connect to the SalesDB database.
- **Visual Creation:** Add visualizations for total sales, sales by region, and sales trends.
- **Dashboard Sharing:** Publish the dashboard to Power BI Service for sharing with stakeholders.

3. Presentation Software (e.g., PowerPoint):

- **Slide Design:** Design slides to present key findings and insights.
- **Chart Insertion:** Insert charts and graphs from Excel or other visualization tools.

Example: Creating a Presentation in PowerPoint

- **Slide Creation:** Create a new presentation and add slides for each major finding.
- **Chart Insertion:** Copy and paste charts from Excel or Tableau into PowerPoint slides.
- **Narrative:** Add text and annotations to explain the data and insights.

Practical Workflow Example

Scenario: Quarterly Sales Analysis for a Retail Company

1. **Data Storage:**
    - Store sales data in a MySQL database called RetailSales.
    - Archive historical sales data in an AWS S3 bucket.

2. **Data Reporting:**
    - Use Tableau to connect to the RetailSales database.
    - Create a dynamic report showing quarterly sales by product category and region.

3. **Data Presentation:**
    - Design a Power BI dashboard with key metrics like total sales, top-selling products, and sales growth.
    - Create a PowerPoint presentation summarizing the quarterly sales performance and trends.
    - Present the findings to the executive team using the Power BI

dashboard for live interaction and the PowerPoint for structured presentation.

This workflow ensures that data is securely stored, accurately reported, and effectively presented to support decision-making.

APPLICATION OF MS-OFFICE IN PATHOLOGICAL LABORATORIES

Microsoft Excel

1. Data Management and Analysis:

Example: Tracking Patient Samples

- **Create a Worksheet:**
    - Open Excel and create a new worksheet.
    - Set up columns for Patient ID, Sample ID, Test Type, Date Received, and Results.
    - Enter sample data.

```excel
| Patient ID | Sample ID | Test Type | Date Received | Results
|------------|-----------|-----------|---------------|----------
| P001       | S001      | Blood     | 01/01/2024    | Normal
| P002       | S002      | Urine     | 01/02/2024    | Abnormal
```

Data Analysis:

- Use SUM, AVERAGE, and other functions to calculate statistics.
- Example: Calculate the average turnaround time for test results.

```excel
=AVERAGE(E2:E10)
```

2. Reporting:

Example: Generate a Test Report

- **Create a Template:**
  - Design a standard test report format with patient information, test details, and results.

```excel
| Report for Patient: | P001         |
|--------------------|-------------|
| Sample ID:         | S001         |
| Test Type:         | Blood        |
| Date Received:     | 01/01/2024   |
| Results:           | Normal       |
```

- **Automate Reports with Macros:**
  - Record a macro to automate report generation.
  - Go to Developer > Record Macro, perform the steps, and save the macro.

3. Quality Control:
Example: Create a QC Chart

- **Enter QC Data:**
    - Create a table with columns for Date, Control Sample, Test Value, and Control Limits.

```excel
| Date       | Control Sample | Test Value | Lower Limit | Upper
|------------|----------------|------------|-------------|-----
| 01/01/2024 | CS001          | 5.5        | 4.0         | 6.0
```

Insert a Control Chart:

- Highlight the data and insert a line chart.
- Add horizontal lines for lower and upper control limits.

Microsoft Word
1. Documentation:
Example: Write SOPs

- **Create a Template:**
    - Open Word and create a new document.
    - Define sections: Purpose, Scope, Procedure, Equipment, Safety, etc.

```word
# Standard Operating Procedure (SOP)
## Purpose
[Describe the purpose of the SOP]

## Scope
[Describe the scope of the SOP]

## Procedure
[Detailed steps of the procedure]
```

2. Communication:

Example: Prepare Patient Communication

- **Create a Result Letter Template:**
  - Design a letter format for test results with patient details and explanations.

```word
Dear [Patient Name],

Your recent test results are as follows:
[Insert test results]

Sincerely,
[Lab Name]
```

- **Use Mail Merge:**
  - Use the Mailings tab to merge patient data from Excel into the Word template.

Microsoft PowerPoint

1. Presentations:

Example: Create a Case Presentation

- **Create a Slide Deck:**
  - Open PowerPoint and create a new presentation.
  - Add slides for patient history, test results, images, and conclusions.

```ppt
Slide 1: Case Presentation: Patient P001
Slide 2: Patient History
Slide 3: Test Results and Analysis
Slide 4: Images and Findings
Slide 5: Conclusions and Recommendations
```

- **Include Visuals:**
  - Insert charts from Excel and images from lab tests.

2. Training:
Example: Develop Training Materials

- **Design Training Slides:**
  - Create slides with text, images, and videos on laboratory techniques.

```ppt
Slide 1: Training on New Diagnostic Equipment
Slide 2: Equipment Overview
Slide 3: Step-by-Step Usage
Slide 4: Safety Precautions
Slide 5: Hands-on Practice
```

Microsoft Access

1. Database Management:
Example: Manage Patient Records

- **Create a Database:**
    - Open Access and create a new database.
    - Set up tables for patients, samples, and test results.

```access
Table: Patients
Fields: PatientID, Name, DOB, Contact

Table: Samples
Fields: SampleID, PatientID, TestType, DateReceived

Table: TestResults
Fields: ResultID, SampleID, TestValue, DateTested
```

- **Create Forms:**
    - Design forms for easy data entry and retrieval.

2. Custom Applications:
Example: Develop a Lab Management System

- **Design the Interface:**
    - Use forms, queries, and reports to create a custom application.

```access
Form: Sample Tracking
Form: Test Result Entry
Report: Monthly Test Summary
```

Microsoft Outlook

1. Communication:

Example: Manage Appointments

- **Schedule Appointments:**
  - Use the calendar to set up patient appointments and staff meetings.

```outlook
Create a new appointment:
- Subject: Patient Appointment for Blood Test
- Location: Pathology Lab
- Time: 10:00 AM, 01/01/2024
```

- **Send Reminders:**
  - Set up automatic email reminders for appointments.

2. Task Management:

Example: Assign Lab Tasks

- **Create Task Lists:**
  - Use the task feature to assign and track tasks.

```outlook
Task: Perform QC Check
- Due Date: 01/01/2024
- Assigned To: Lab Technician
```

- **Set Reminders:**
  - Set reminders for critical tasks like equipment calibration.

Microsoft OneNote
1. Note-taking:
Example: Document Meeting Notes

- **Create a Notebook:**
  - Open OneNote and create a new notebook for lab meetings.
  - Add sections for different topics.

```onenote
Notebook: Lab Meetings
Section: Weekly Updates
Page: Meeting Notes 01/01/2024
```

- **Take Notes:**
  - Record meeting discussions, action items, and follow-ups.

2. Documentation:
Example: Maintain a Lab Journal

- **Create a Journal:**
  - Use OneNote to document experiments and observations

```onenote
Notebook: Lab Journal
Section: Experiment 001
Page: Observations and Results
```

- **Include Multimedia:**
  - Add images, data tables, and links to references.

These practical applications of MS Office enhance the efficiency, accuracy, and productivity of pathological laboratories, supporting various tasks from data management to reporting and communication.