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Original Research Article

Continuing Medical (Anatomy) Education Series: Imaging Techniques in Anatomy; Requisite Tools for Clinical Medicine

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Abstract: The normal anatomy of the human body is altered in sickness, diseases and physical trauma. The entire human body is covered by the skin and its appendages (hair and nail). For proper and effective management of the alteration(s) and its/their cause(s), it is essential to have image(s) that is/are precise and with high degree of accuracy. Here comes the relevance and contribution of imaging techniques. Anatomical imaging modalities such as ultrasonography, X-ray (plain and contrast-enhanced), computed tomography, magnetic resonance imaging and positron emission tomography. This article covers the basic operational principles, indications, images and limitations of each of these anatomical imaging techniques in a manner easily understood by undergraduate medical and dental students in advance of clinical training and practice.

Keywords: Anatomical Imaging, Ultrasonography, X-Ray, Computed Tomography, Magnetic Resonance Imaging, Positron Emission Tomography, Undergraduate Medical Education.

1. INTRODUCTION

The human body is covered by the skin and in certain areas by its appendages which are the hair and the nails. The consistency of the structures that lie internal to these vary from hard (bone), firm (muscles, tendons, cartilage, nerves) to soft (lung, stomach, intestine, vessels). When the normal anatomy is altered by diseases or trauma, these consistencies are likely to become altered. The surface may become coarse rather than being smooth, nodular or fluctuant (fluidly), tender rather than being painless, poorly defined edges instead of being well defined, altered resonance on percussion. Also, there may be additional sound on auscultation if it is the heart or reduced air entry if it is the lung. In order to institute an appropriate, effective and adequate treatment, there is need to make a diagnosis with high degree of accuracy. For patients that may need to undergo surgical procedures, precise location and localization of the pathology is paramount in order to optimize the cardiorespiratory status and body fluid dynamics of the patient during surgery. Also, this will reduce the chances of intraoperative (iatrogenic) injury.

For patients that require non-surgical (conservative) management, the response of the patient in terms of resolution or progression of the pathology is germane to the final outcome (prognosis).

All these aforementioned can only be achieved through visual images of high precision. This is where anatomical imaging techniques become relevant and essential. There are several modalities of anatomical imaging techniques and each is premised on the physicochemical properties of the tissue, structure, viscera and organs of the human body. Each of these techniques has unique and peculiar characteristics and features.

Subsequently, the underlying principles, indications, accuracy and limitations of each of the imaging techniques will be discussed.

Ultrasonography

The principle of ultrasonography is transmission of high intensity sound waves in order to generate an image. The transducer also known as probe is connected to the machine and it converts electrical current into high frequency sound waves that are transmitted to structures and organs underneath the area of application. The transducer produces sound waves with frequencies above the threshold of human hearing (greater than 20KHz). The waves are then reflected from the structures/organs back to the probe from where they are converted to electrical signals that are used to generate real time images and videos by the computer. These images or videos are displayed on the screen and can be saved or printed on paper to produce the scanogram. A non-irritant colourless gel is applied to the skin of the area that will be scanned this facilitates sound wave transmission from the transducer to the body.

The commonest region of the human body that is evaluated by ultrasound scanning (USS) is the abdomino-pelvic region. In obstetrics and gynaecology, it is used for progression of pregnancy in terms of foetal growth; foetal lie & presentation; gender of the foetus; position of the placenta and adequacy of the amniotic fluid. It is also used for diagnosis of fibroid which is the commonest benign tomour amongst female within the reproductive age bracket. It is also a very reliable means of assessing the dimensions of the liver, spleen, gall bladder, kidneys, urinary bladder, uterus and the ovaries. Also, presence of stones in the gall bladder, kidney, ureter and urinary bladder are readily discovered through abdominopelvic USS. It is also used to diagnose presence of fluid collection (cyst) within intraabdominal organs and abscess within the abdominopelvic cavity.

Ultrasonography is non-invasive, safe diagnostic procedure devoid of hazardous exposure.

Ultrasound machines are available in three types namely 2D,3D and 4D generating two- three- and four-dimensional images respectively. The 2D machine produces the standard gray scale images while the 3D machine scan tissue cross-sections from multiple angles to create detailed 3D images.

The 4D Ultrasound machine produces real-time, moving 3D images that are effective for identifying subtle anomalies [Probomedical 2026]. Another type is the portable and Handheld Laptop-sized or wireless devices used for point-of-care diagnostics especially in emergency medicine for rapid assessment.

Fig. 1: Ultrasound Scanning Machine

Courtesy: GE HEALTH CARE LOGIQ

Doppler Ultrasonography

A Doppler ultrasound is a safe, painless, non-invasive imaging technique utilizing sound waves to measure the speed and direction of blood flow through blood vessels.

It uses the Doppler effect that measures the sound waves reflected off moving red blood cells. These waves are then transmitted by the transducer to the computer to produce images.

Indications for Doppler ultrasound include deep vein thrombosis, carotid artery stenosis, coronary arterial disease, aneurysm, vascular thrombosis, embolism and peripheral arterial disease. It can also be used to monitor foetal blood circulation. It accurately assesses the status of the heart valves, cardiac chambers and blood flow through the four chambers of the heart.

Types include Colour Doppler which shows speed and direction of flow; Spectral Doppler (graphs flow) and Power Doppler which detects faint flow [Mayo Clinic 2026].

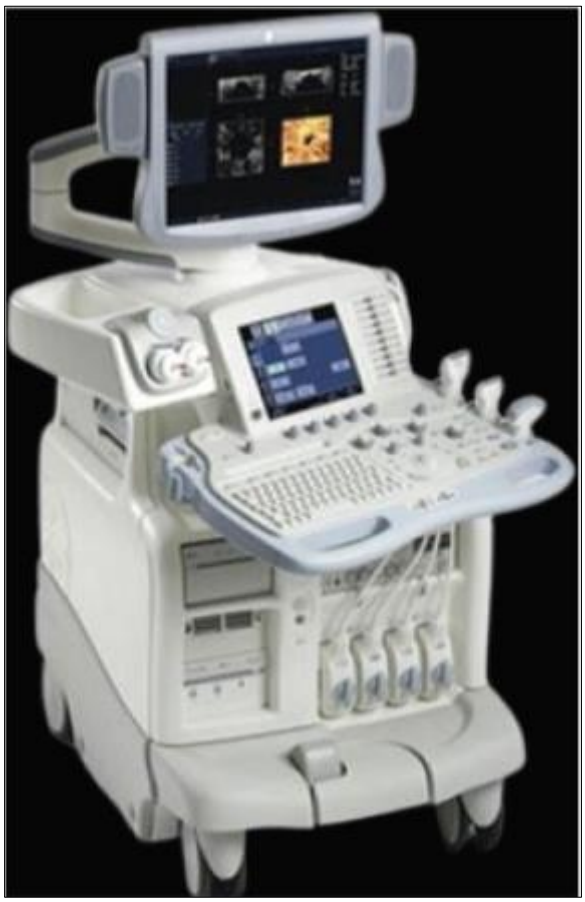

Fig. 2: Doppler Ultrasound Machine

Radiology

This is the largest group of anatomical imaging techniques. It consists of plain33 X-ray, contrast enhanced X-ray and Computed tomography (CT) Scan. The underlying principle is controlled exposure of the specific area of the body to non-lethal, permissible, low dose ionizing radiation for the purpose of producing digital images that can be printed on radiographic material known as photographic film.

X-rays are electromagnetic radiations like visible light but having higher energy with very variable penetrability of objects including the human body. The absorption of X-rays within the body is determined by the density of the structure and the atomic number of the element present in the structure. Thus, radiologically dense structures have high absorption and low penetrability and are referred to as being radio-lucent; while structures/organs with low absorption and high penetrability are said to be radio-opaque. Radiolucent structures such as bones and teeth appear white while radiopaque ones such as muscles, lungs, stomach, bowel loops are denoted by images that are in varying degrees of grey.

Plain radiograph of the limbs is very reliable in detecting fractures of bone, dislocation of joints such as shoulder, elbow, hip, knee and ankle. In patients with fracture, the progress of healing is assessed by repeated Xray for the status of callus and fracture line. Callus appears as lucent (whitish) and well circumscribed area that bridges the two ends of the fractured portion of a bone. Plain X-ray of the limb in a patient with osteomyelitis will show dead bone as grey area and abscess as lucent-greyish interphase. Plain radiograph will also display excellently areas of degenerative changes in the vertebral column, osteoporosis and bone tumours (both benign and malignant). Plain radiograph of the chest is very helpful in the detection of air-leak into the pleural cavity (pneumothorax); presence of fluid within the pleural cavity (pleural effusion); collection within the lung parenchymal (lung abscess); and areas of consolidation within the lungs (this may connote pneumonia, tuberculosis, cancer). For better appreciation of plain X-ray, radiographs of some parts of the body are shown in figures 3-8,12-15.

Contrast-Enhanced Xray

In this type of radiodiagnosis, a non-reactive and non-lethal substance is introduced into the specific area(s) of the body under investigation in order to outline the internal surface. By this, any surface irregularity inform of elevation or depression becomes visible, also any area of narrowing will be observed. An electronic monitor (screen) is connected to the Xray machine in order to track the flow of the agent. A summary of the Contrast-enhanced X-ray procedures are outlined in Table 1. Radiographs obtained from contrast-enhanced radiology are shown in figures 9-11; 16-24.

Table 1: Contrast Enhanced Xray Procedures- Types, sector and indications. ©rsajani2026

	Type	Contrast	Sector	Indications
1	Barium Swallow	Barium	Oesophagus	Intractable heartburns, Oesophageal stricture, Oesophageal cancer
2	Barium Meal	Barium	Stomach, Duodenum,	Gastritis, Gastric & duodenal ulcer, gastric tumour
3	Barium Enema	Barium	Anal canal, Rectum, Colon	Anal bleeding. Colorectal polyps, Colon diverticular disease, Colorectal cancers,
4	Intravenous urography. Hysterosalpingography	Urografin-a water soluble radioactive iodine containing contrast agent	Kidneys, ureters, urinary bladder; Uterus, uterine tubes.	Renal stones. Renal diseases, Bladder tumour, Narrowing of the urethra. Blockage of the uterine tube.
5	Intravenous angiography	Urografin	Arteries- arteriography Veins- venography.	Vascular abnormalities such as narrowing, occlusion and aneurysmal dilatation.

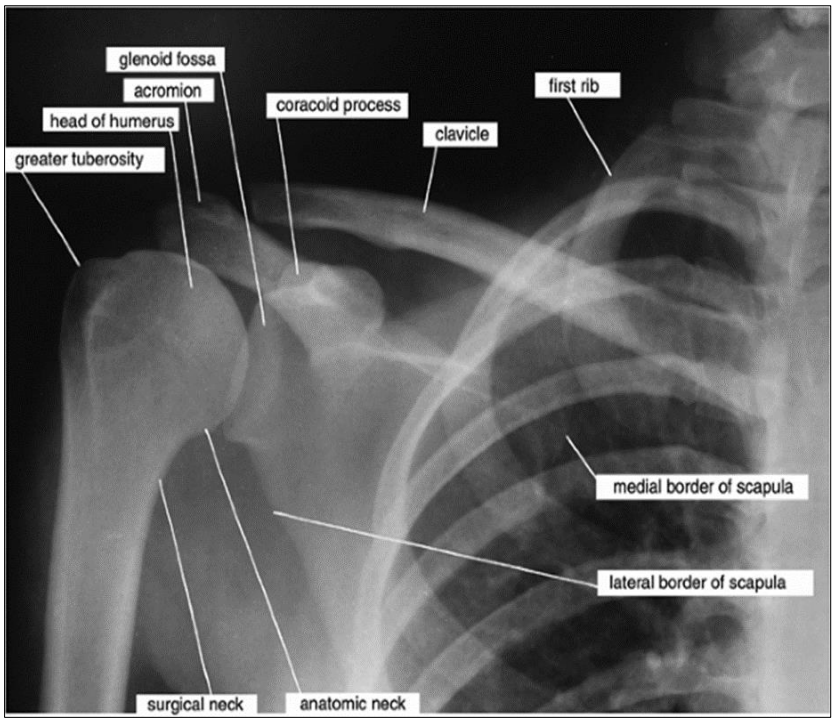

Fig. 3: Plain X-ray of the proximal Upper limb

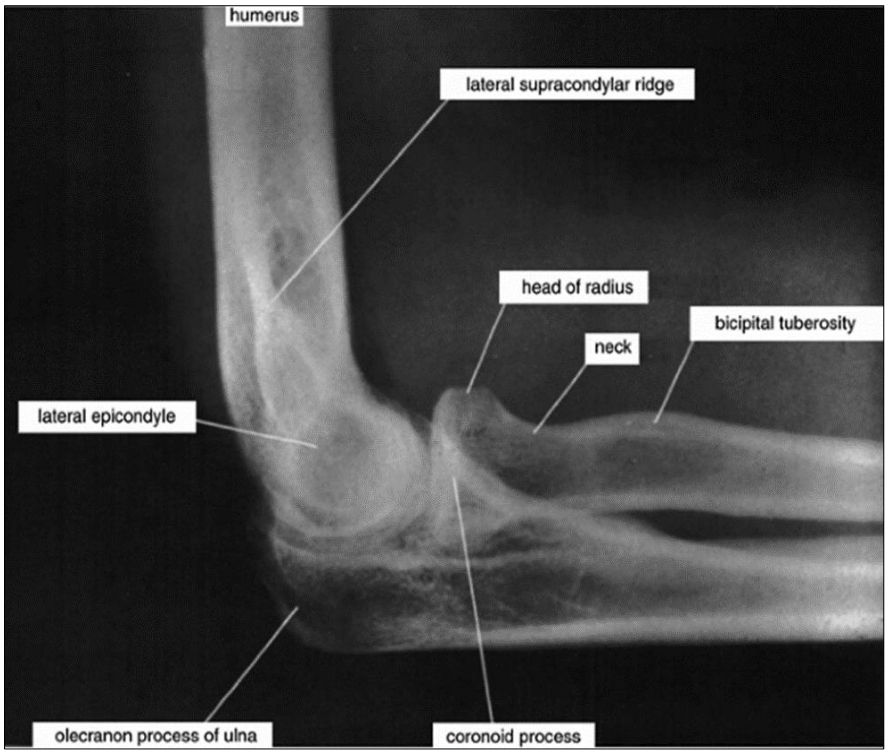

Fig. 4: lateral view of the Elbow joint.

Showing the Shoulder (Glenohumeral) Joint. ***Courtesy; Keith Moore& Arthur Dalley***

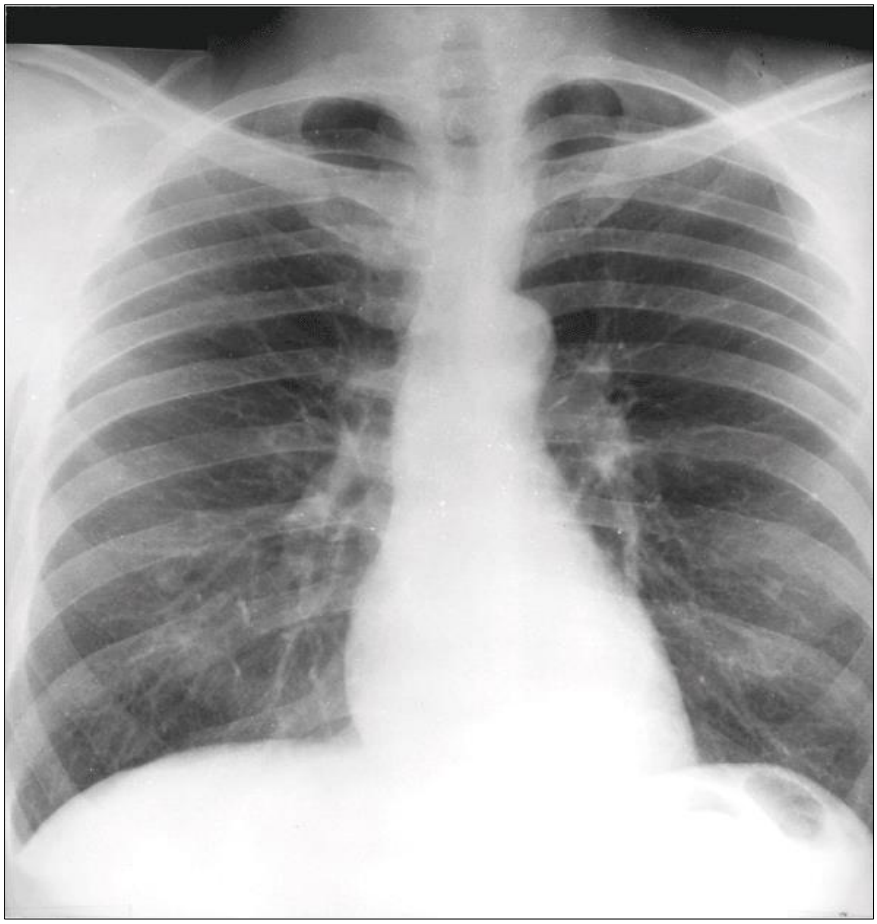

Fig. 5: Chest Xray (Posteroanterior view)

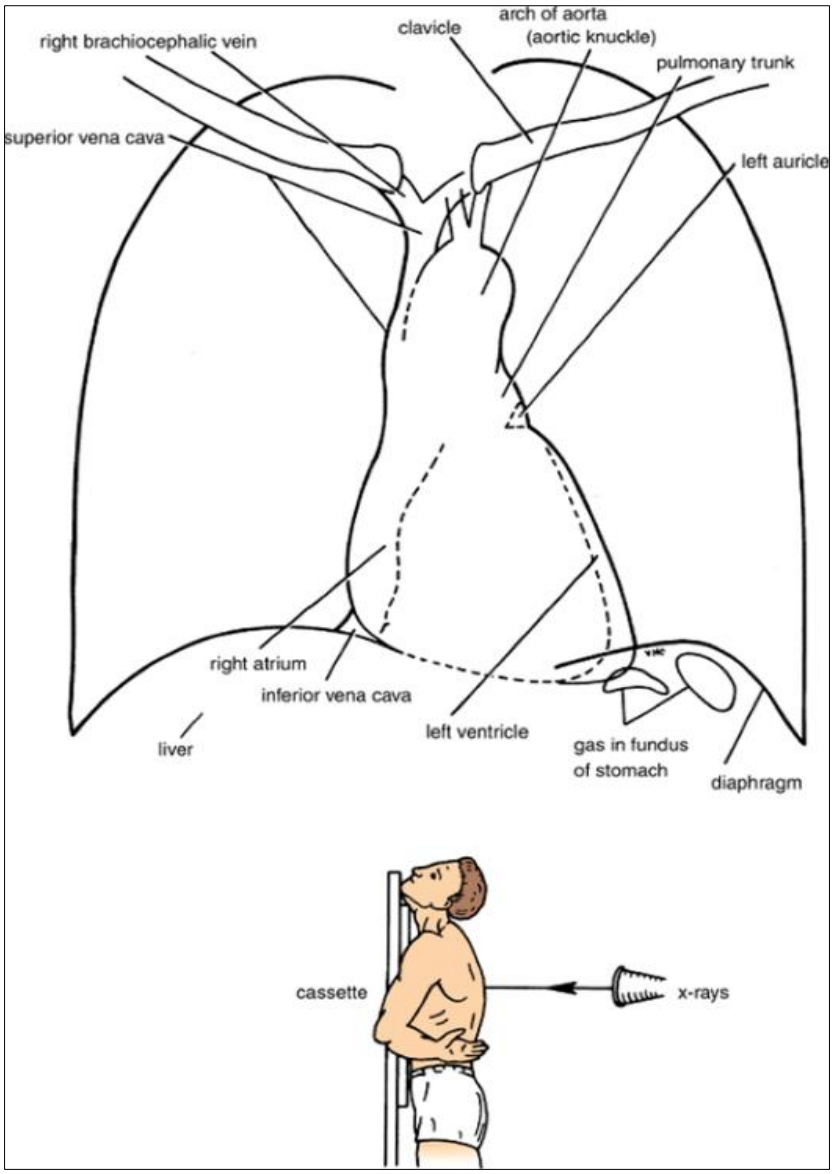

Fig. 6: Positioning of a patient for chest Xray (PA)

Courtesy*:* *Keith Moore& Arthur Dalley*

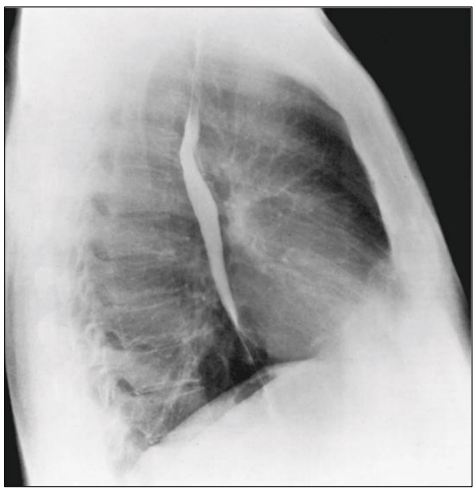

Fig. 7: Barium Swallow outlining the Oesophagus

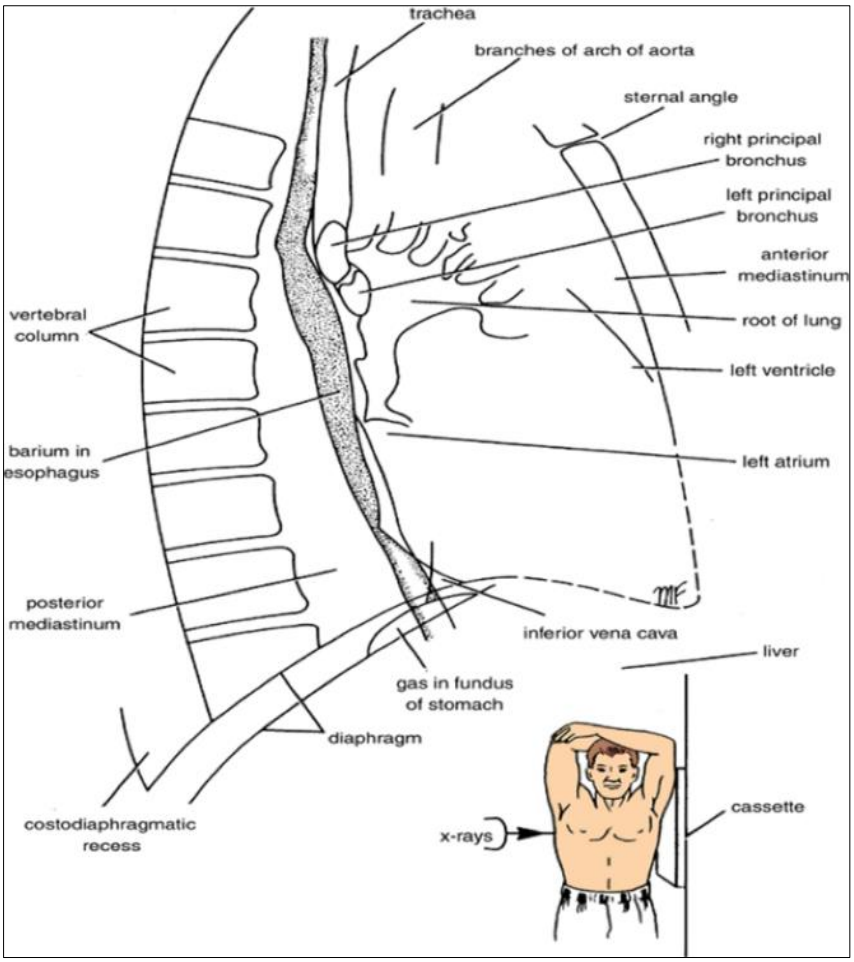

Fig. 8: Schematic diagram of Fig7

Courtesy*:* *Keith Moore& Arthur Dalley*

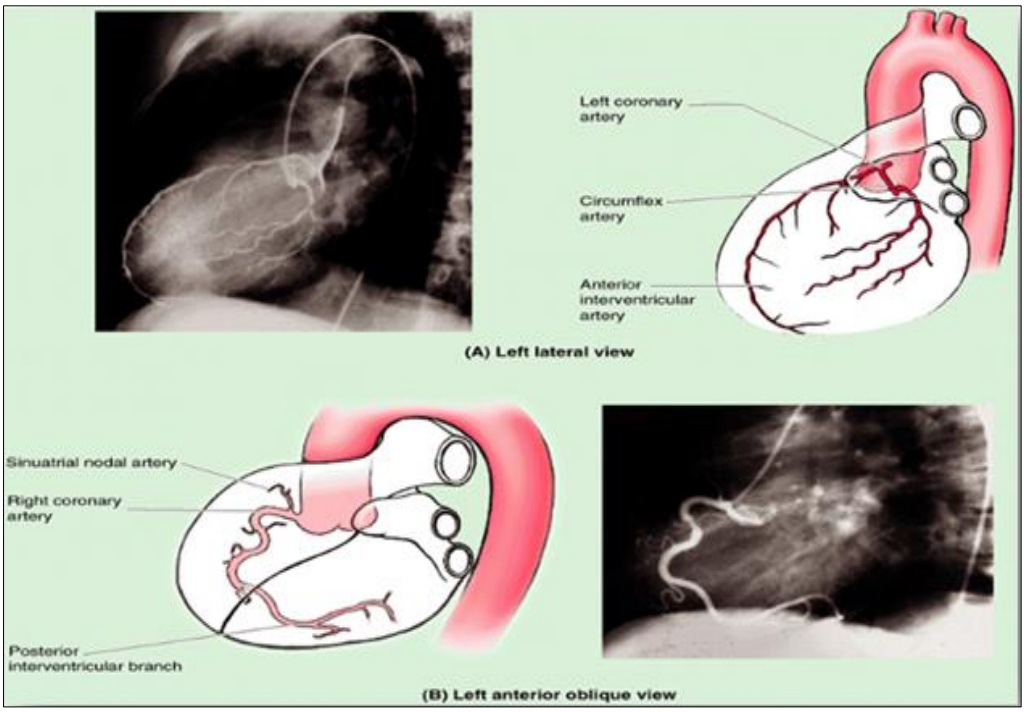

Fig. 9: Coronary Arteriography and illustrative diagrams. ***Courtesy; Keith Moore& Arthur Dalley***

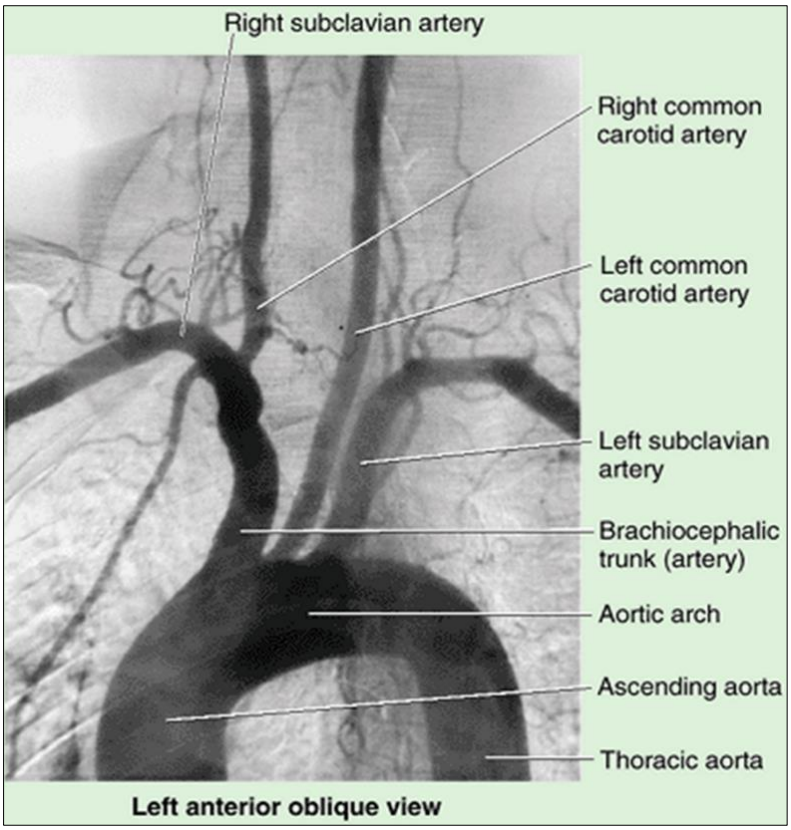

Fig. 10: Contrast-enhanced Xray- Aortic arch Angiogram showing braches of the Arch

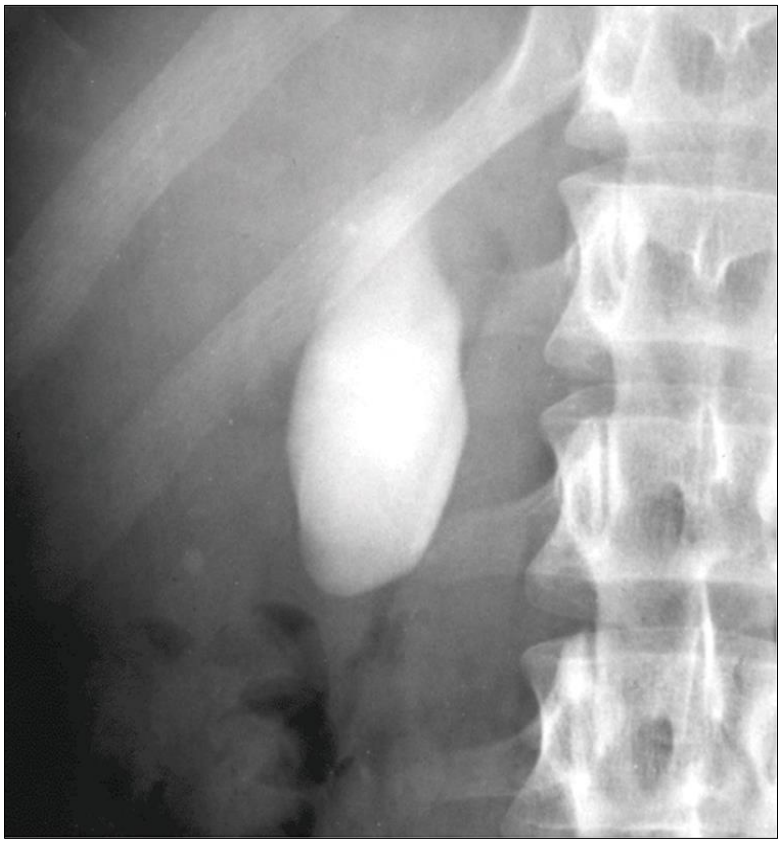

Fig. 11: Cholecystogram-outlining the Gall bladder

Courtesy; Keith Moore& Arthur Dalley

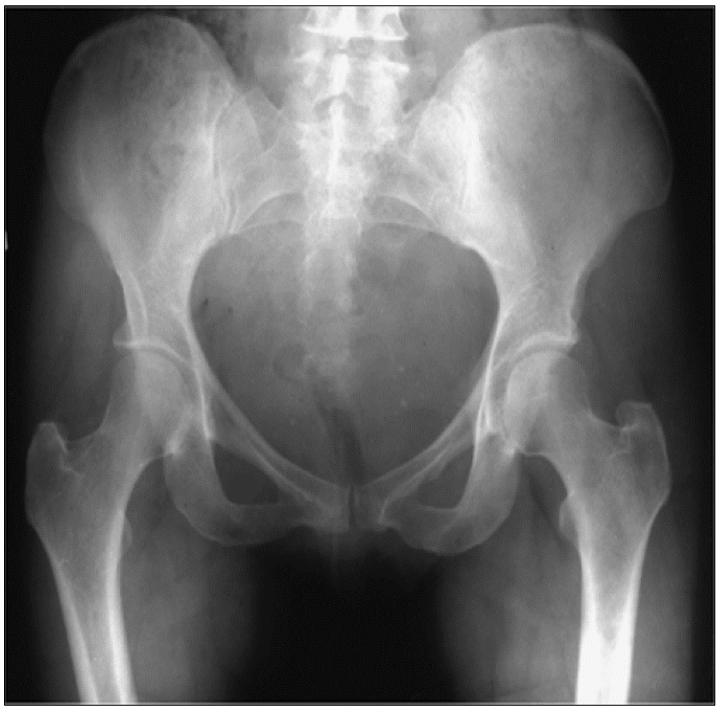

Fig. 12: Plain Xray of the Male Pelvis (AP view)

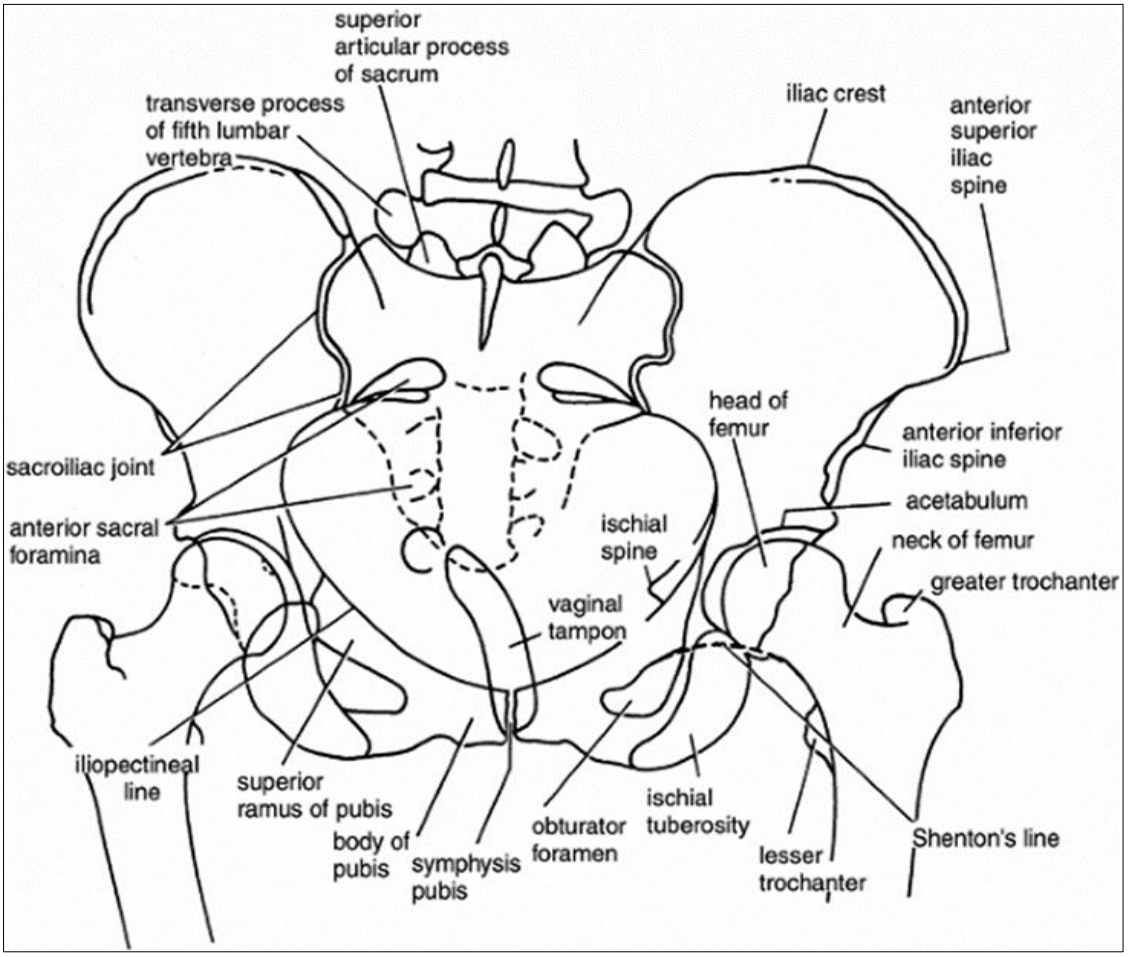

Fig. 13: Illustration of Fig 12

Courtesy: ***Keith Moore& Arthur Dalley***

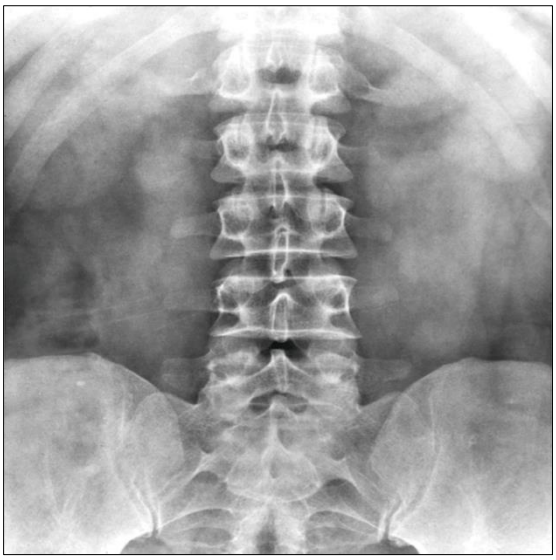

Fig. 14: Plain Xray of the Abdomen

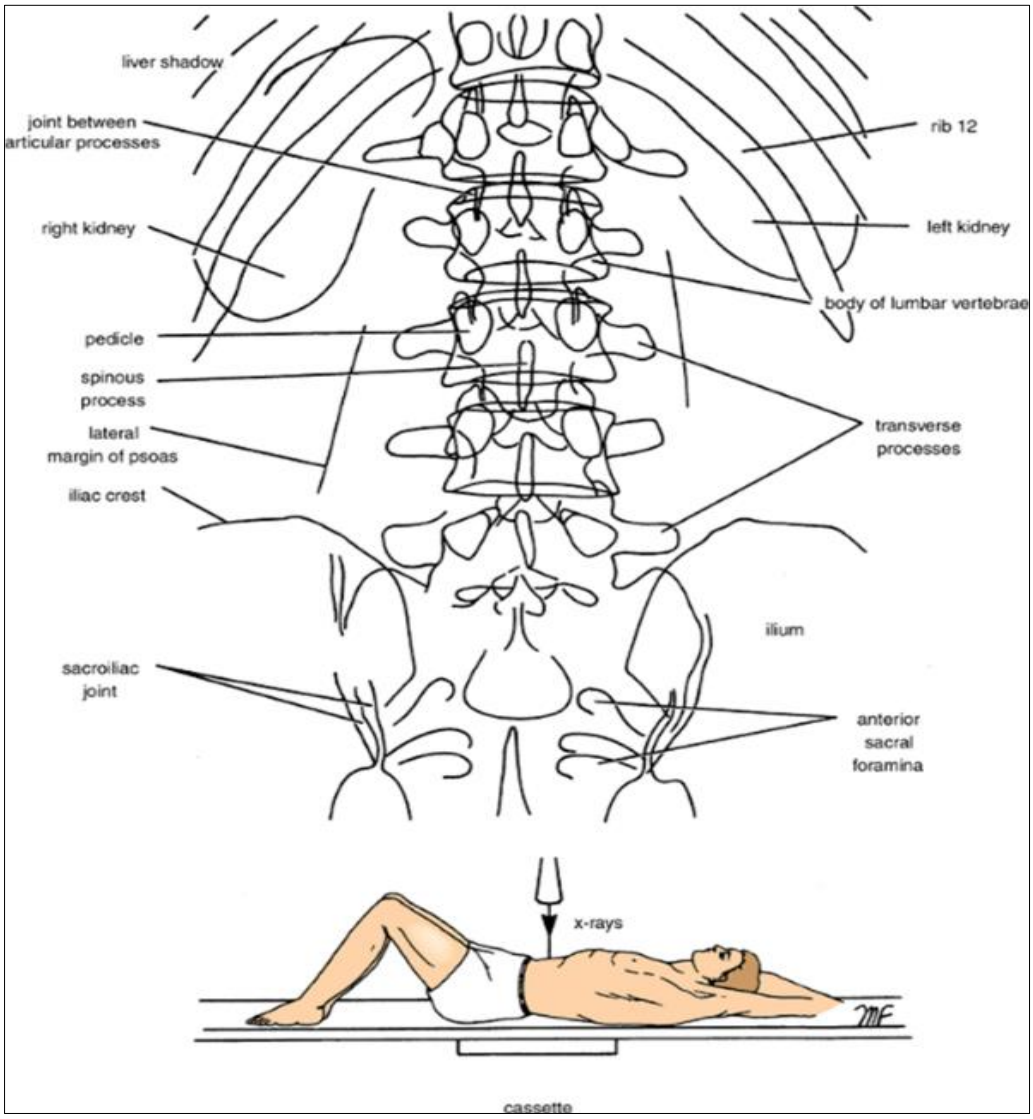

Fig. 15: Illustrative diagram of Fig 14

Courtesy*:* *Keith Moore& Arthur Dalley*

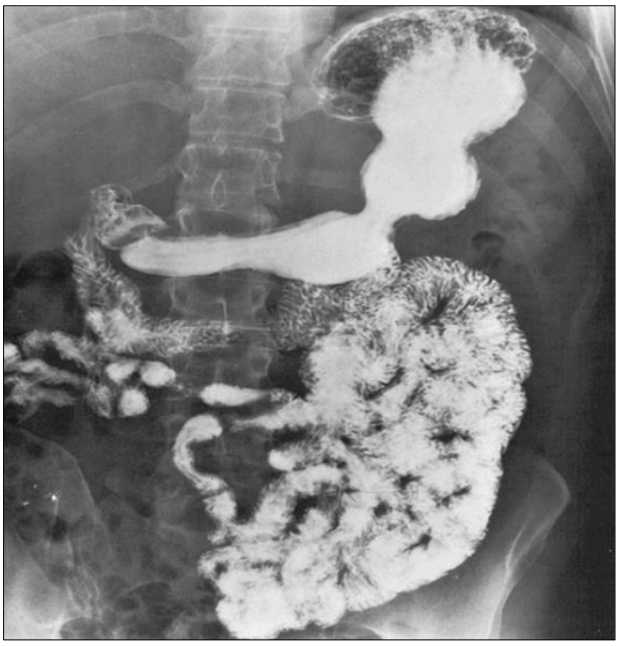

Fig. 16: Barium Meal. Note the stomach, duodenum & small intestine

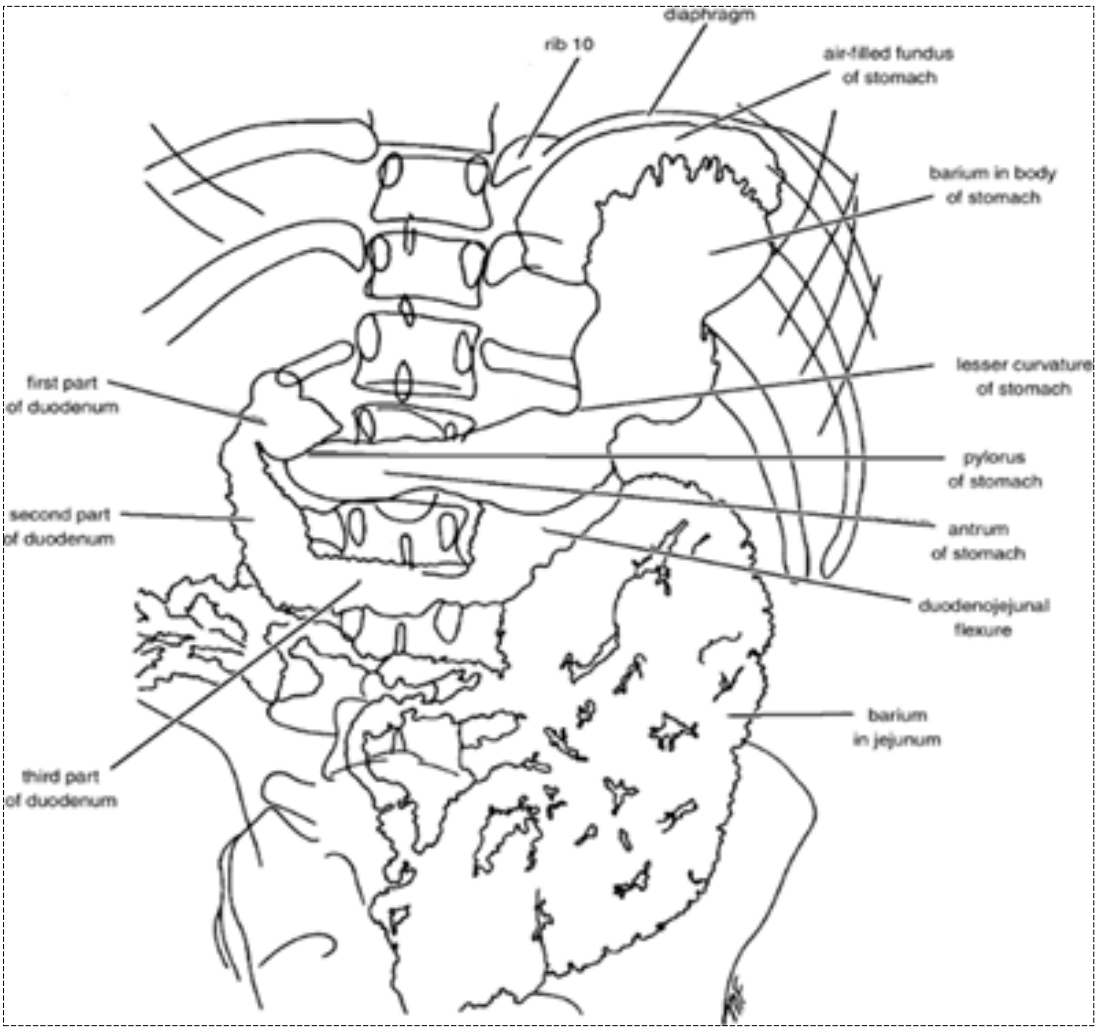

Fig. 17: Illustration of loops of the jejunum and ileum.

Courtesy: ***Keith Moore& Arthur Dalley***

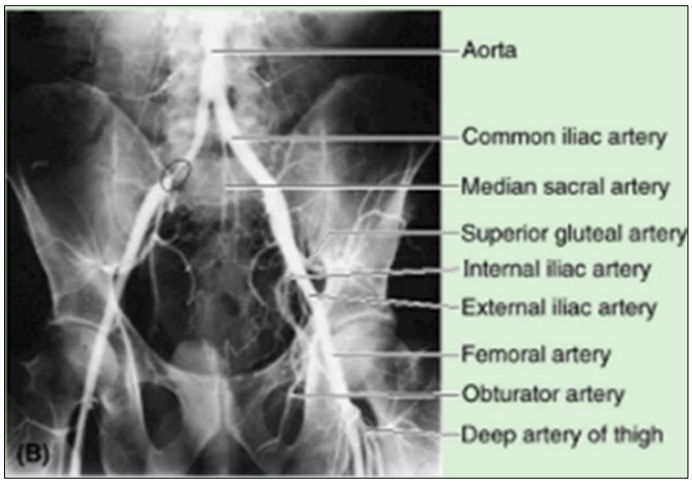

Fig. 18: Iliac Arteriogram-bifurcation of the abdominal aorta

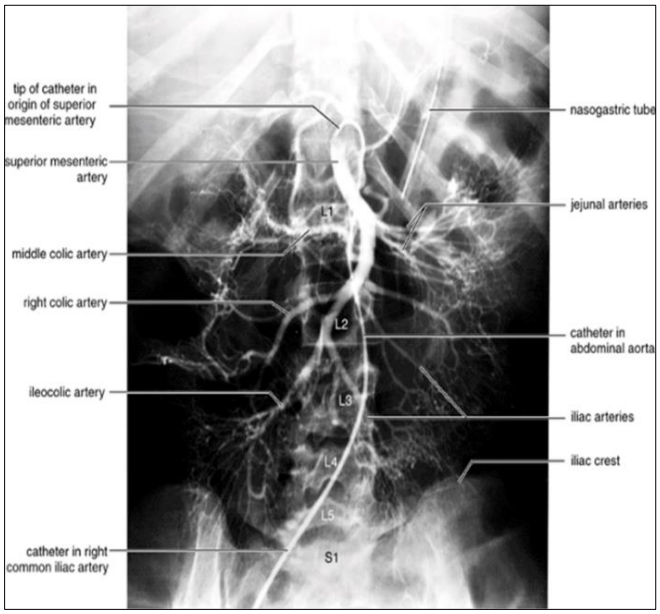

Fig. 19: Arteriogram of the Superior Mesenteric artery. ***Courtesy; Keith Moore& Arthur Dalley***

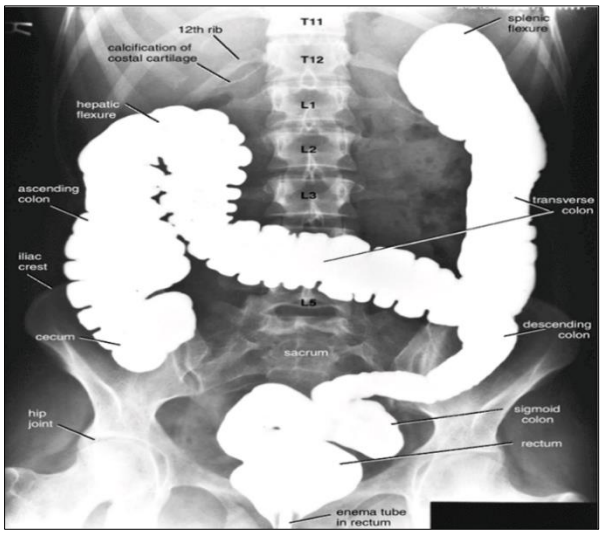

Fig. 20: Barium Enema showing the various segments of the large intestine
Courtesy; Keith Moore& Arthur Dalley

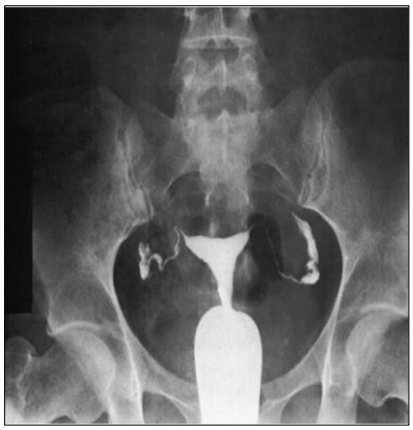

Fig. 21: Hysterosalpingogram. A contrast of the large bowel enhanced Xray of the female pelvis to outline female internal genitalia.

Courtesy: ***Keith Moore& Arthur Dalley***

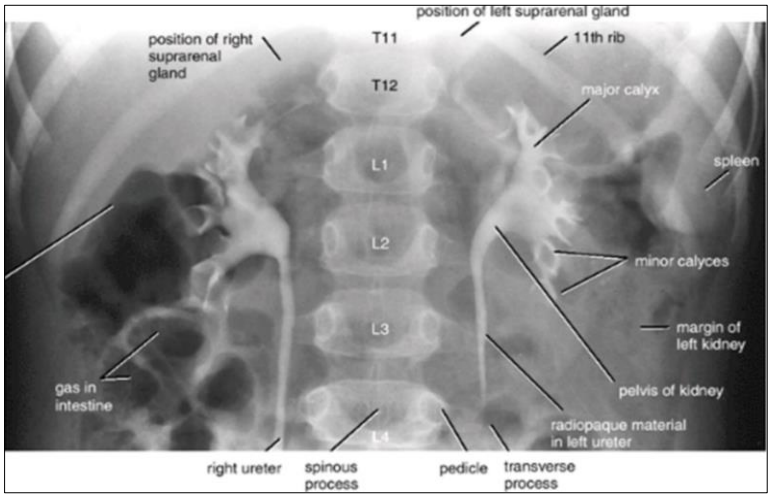

Fig. 22: Intravenous Pyelography. Note- the calyces (major & minor), pelvis and ureter.

Courtesy: *Keith Moore& Arthur Dalley*

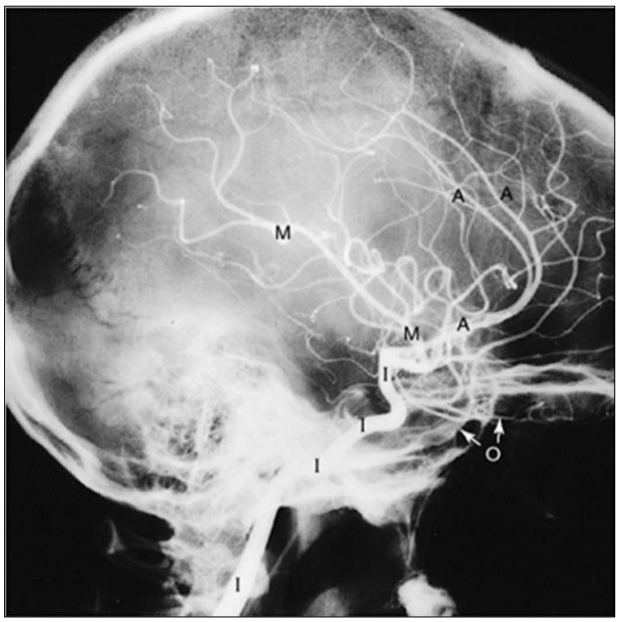

Fig. 23: Carotid arteriogram (lateral view)

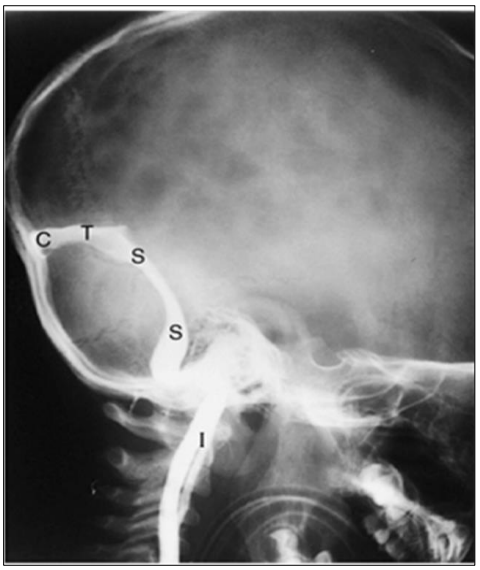

Fig. 24: Dura sinus venogram (Lateral view)

Courtesy: *Keith Moore& Arthur Dalley*

Legend: A-Anterior cerebral; **I**-Internal carotid; **M**-Middle cerebral; **O**-Ophthalmic artery. **C**- Confluence of sinuses; **I**-Internal jugular vein; **S**-sigmoid sinus; **T**-Transverse sinus

COMPUTED TOMOGRAPHY

Sir Godfrey Hounsfield, an electrical engineer, invented the first computed tomography (CT) scanner in 1972[Petrik *et al*., 2026]. About the same period, Allan McLeod Cormack, a physicist developed a similar system. Both Hounsfield and Cormack shared the Nobel Prize in Physiology or Medicine in 1979 [Nicholls *et al*., 2019; Hounsfied 1980; Raju 1979]. Ever since, CT has become an imaging modality widely used in medicine. Initially, CT was first available for head imaging only, but in 1976 a larger gantry was developed allowing whole-body scans [Hermena and Young 2026].

This imaging modality entails the passage of a narrow beam of Xray through and around the patient in order to generate signals that are subsequently processed by a computer to generate cross-sectional images or slices. These topographic slices are digitally sketched by the computer to form a 3-dimensional image of the body region under investigation. This cross-sectional imaging permits easier identification of basic structures and the extent of the lesion. Due to higher resolution over Xray machine, CT machine offers better visualization of bones, blood vessels and soft tissues thus providing more details.

In clinical practice, CT scan is frequently used for tumour staging and tracking progression of tumour, rapid assessment of injuries due to trauma including those of the head; and diagnosis of vascular lesions such as aneurysms, blockages and pulmonary emboli.

The CT machine has a mobile Xray source that rotates around a circular opening of a donut shaped structure called the gantry. The patient is positioned on a mobile bed that is in front of the gantry. During scanning, the bed is slowly moved through the gantry while the x-ray source rotates round the patient and emits radiation to the body of the patient. The digital xray detectors are directly opposite the source. The radiations leaving the body of the patient are transmitted to the computer that processes them to 2-dimensional image slices of the patient. The thickness of the slices ranges from 1-10 mm and is dependent on the grade of the Scanner. The image slices can be displayed individually or stacked together to generate 3-dimensional images of the region of the body being scanned. The 3D image gives a broader view.

In certain situations, for proper management of the patient, the exact localization and the extent of the lesion have to be precisely delineated. This delineation is achieved by instilling a radioiodine agent such as urografrin. Such procedure is called Contrast-enhanced computed tomography.

Image formation during CT scanning hinges on the resistance capability of the structures/tissues in the body to propagate the emitted radiations. Tissues that have low resistance to the propagation of the radiations appear faint while those that offer high resistance appear dark or greyish. Contrast enhancement is thus indicated in areas of low resistance for proper delineation and visualization of the lesion. This is very beneficial in intracranial collections such hematoma and

abscess. Pictures of the CT scanner and scans of some regions of the body are as below for better understanding (Figures 25-29).

Fig. 25: Computed Tomography Machine. ***Courtesy-Exceptional Emergency Center Texas, USA***

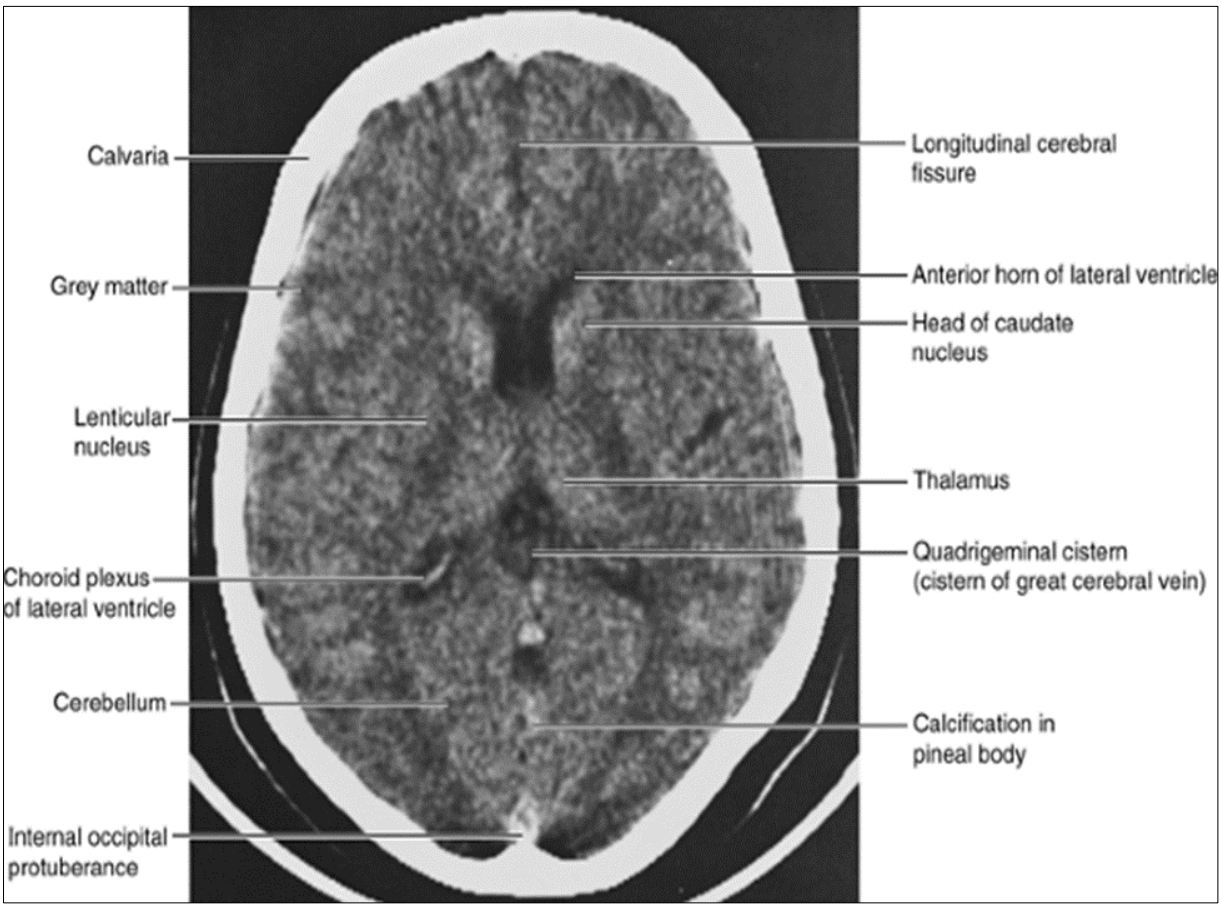

Fig. 26: Cranial CT showing a transverse slice of the brain. ***Courtesy; Keith Moore& Arthur Dalley***

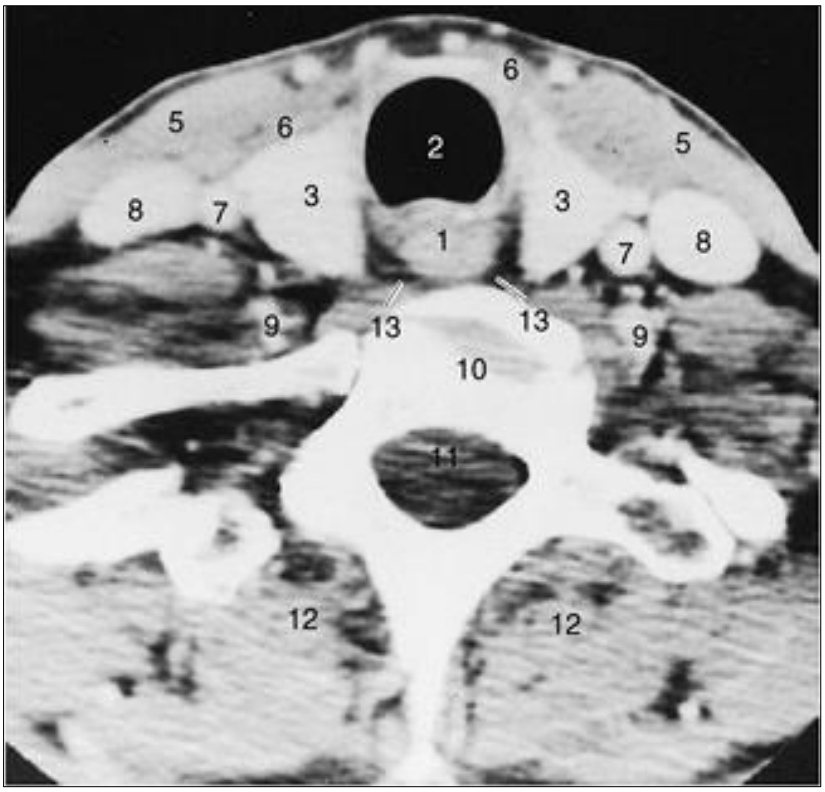

Fig. 27: Cervical CT at the level of the thyroid gland

Courtesy*: Keith Moore& Arthur Dalley*
Legend.**1**-Oesophagus,**2**-Trachea, **3**-Thyroid gland lobes,**4**-thyroid isthmus, **5**-SCM, **6**-sternohyoid muscles,**7**- common carotid artery, **8**- IJV, **9**- vertebral artery, **10**-vertebral body, **11**-spinal cord surrounded by cerebrospinal fluid in the subarachnoid space, **12**- deep muscles of the back, **13**- retropharyngeal space.

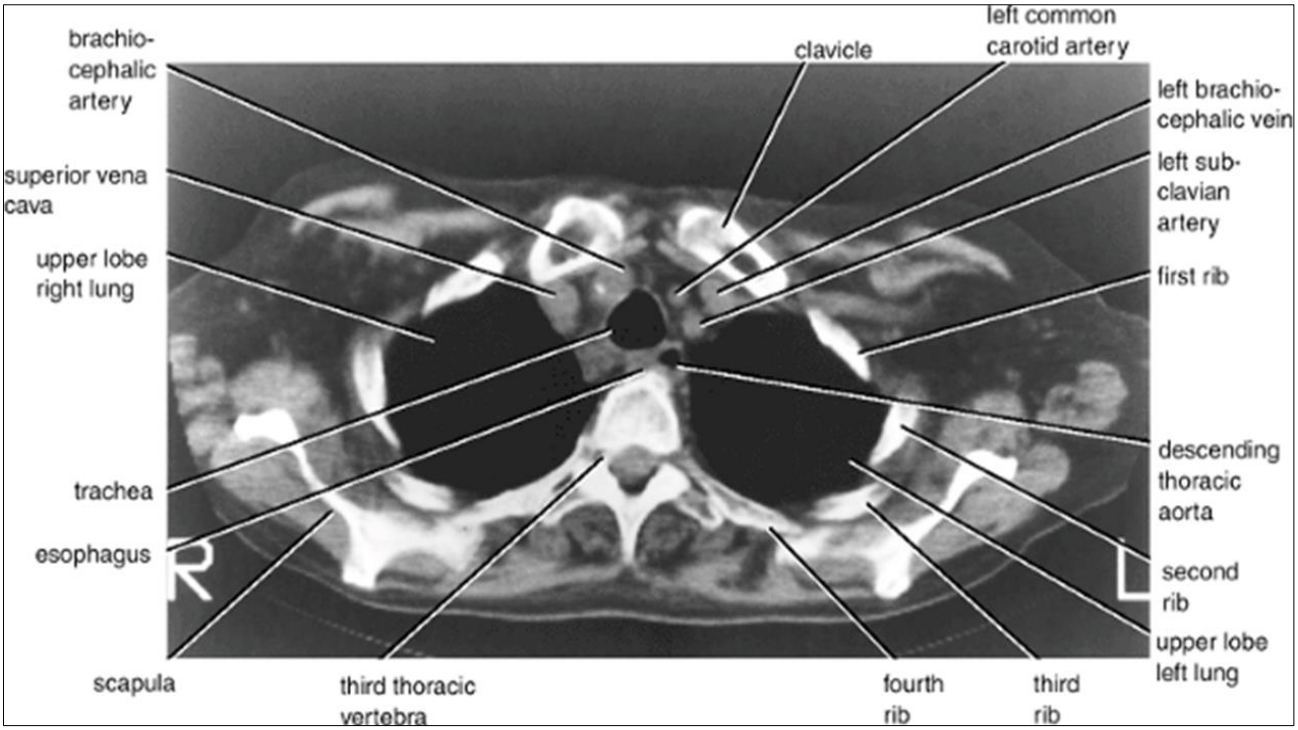

Fig. 28: CT scan of the thorax at the level of the third thoracic vertebra. ***Courtesy; Keith Moore& Arthur Dalley***

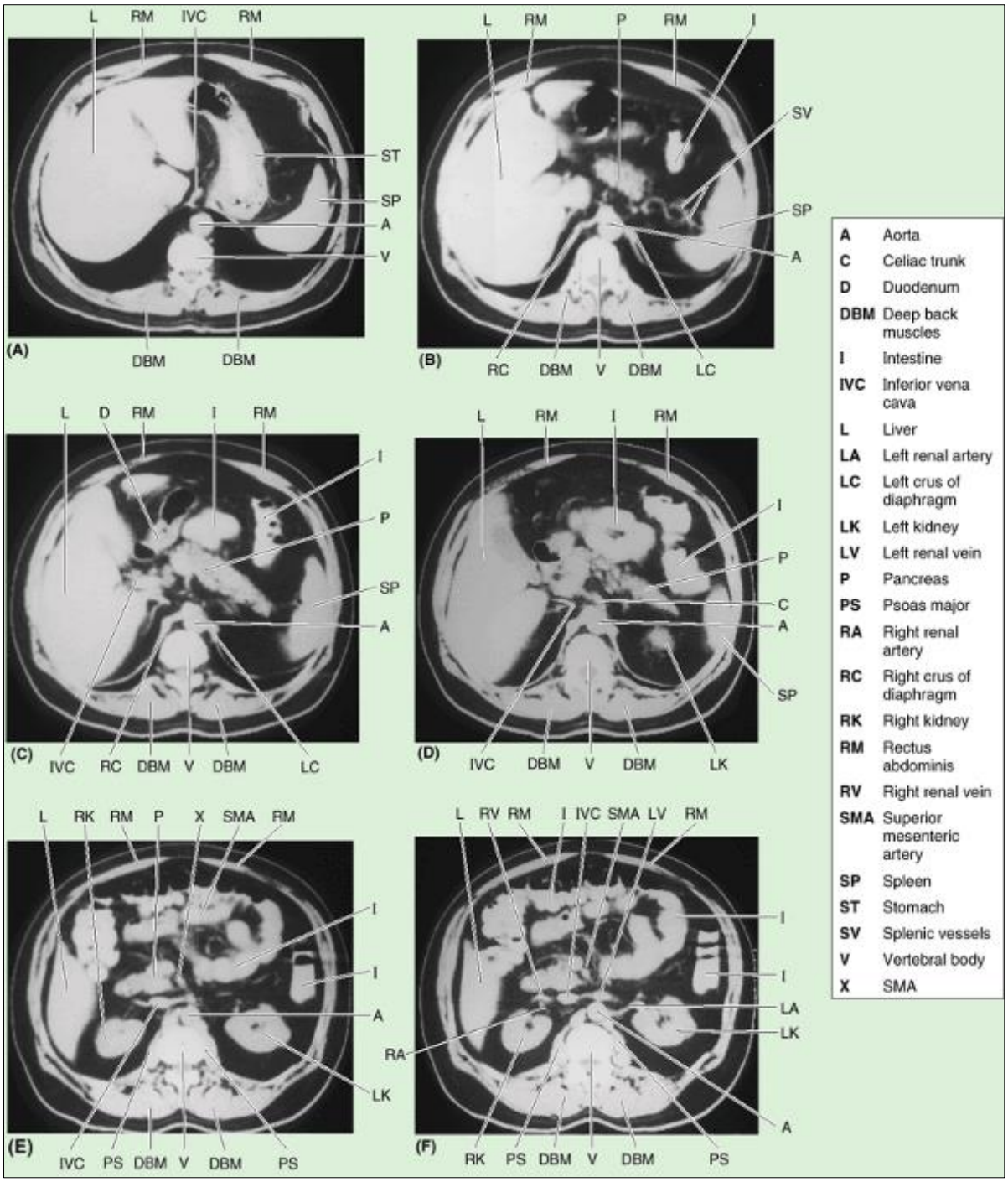

Figure 29: CT scans of abdomen at progressively lower levels showing viscera and blood vessels

(*Courtesy - Dr. Tom White, Radiology Department, The Health Sciences Center, University of Tennessee, Memphis, USA.)*

Courtesy: *Keith Moore& Arthur Dalley*

MAGNEIC RESONANCE IMAGING

The human body is at least 60% water in composition. Water (H_2O) is formed from two elements namely hydrogen and oxygen. The smallest indivisible part of an element is called an atom. An atom consists of proton (positive charge), electron (negative charge) and neutron (neutral). The magnetic resonance imaging (MRI) machine has powerful magnets that interact with protons of the body water to generate a strong magnetic field. With the pulsing of radiofrequency current through the patient, protons are stimulated to spin out of equilibrium and this causes straining against the pull of the magnetic field. On turning off the current, the MRI machine sensors detect the release of energy as the protons realign with the magnetic field and this results in the formation of a 3-D image. The time taken for proton realignment with the magnetic

field and the quantum of energy released depend on the chemistry of the molecules. The brightness of the image is determined by the speed at which the realignment takes place.

To obtain an MRI image, a patient is placed inside a large magnet and must remain very still during the imaging process in order not to blur the image. Contrast agents (often containing the element Gadolinium) may be given to a patient intravenously before or during the MRI to increase the speed at which protons realign with the magnetic field [National Institute 2026]. The Magnetic Resonance Imaging machine and films obtained from some parts of the body are shown in figures 30-35.

Fig. 30: Magnetic Resonance Imaging Machine

Courtesy*: SIEMENS Healthineers*

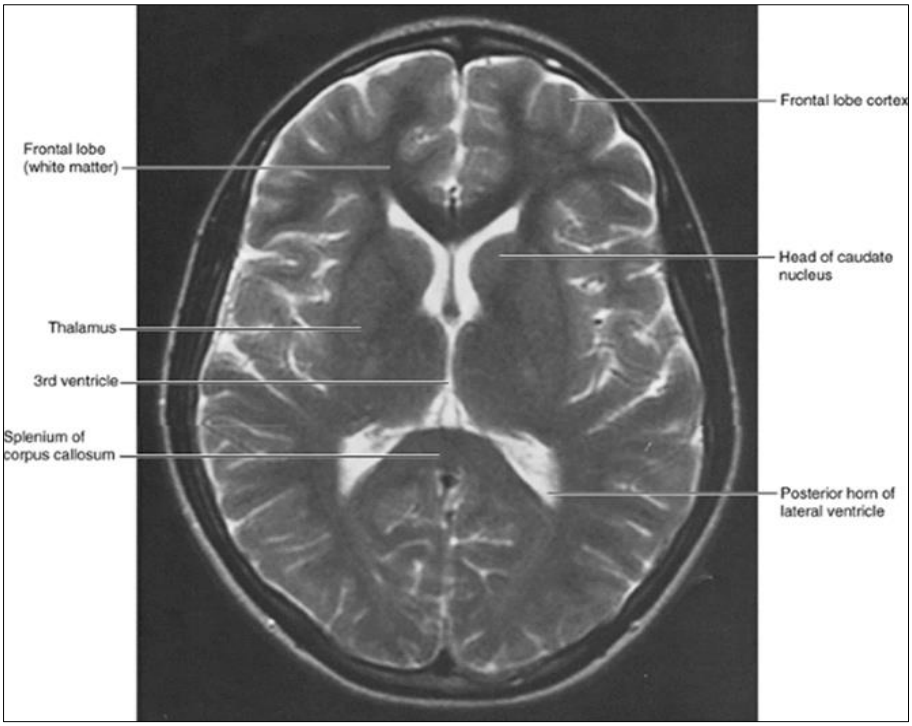

Fig. 31: Cranial MRI- *Courtesy; Keith Moore& Arthur Dalley*

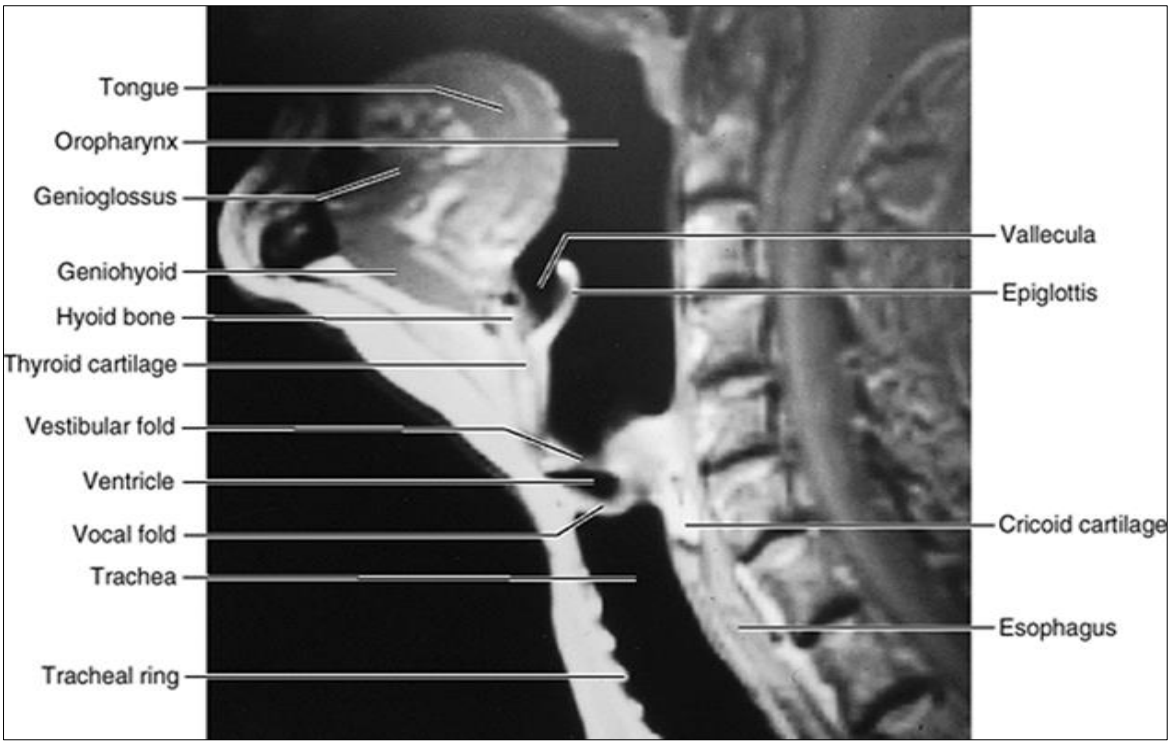

Fig. 32: MRI of the Neck- ***Courtesy; Keith Moore& Arthur Dalley***

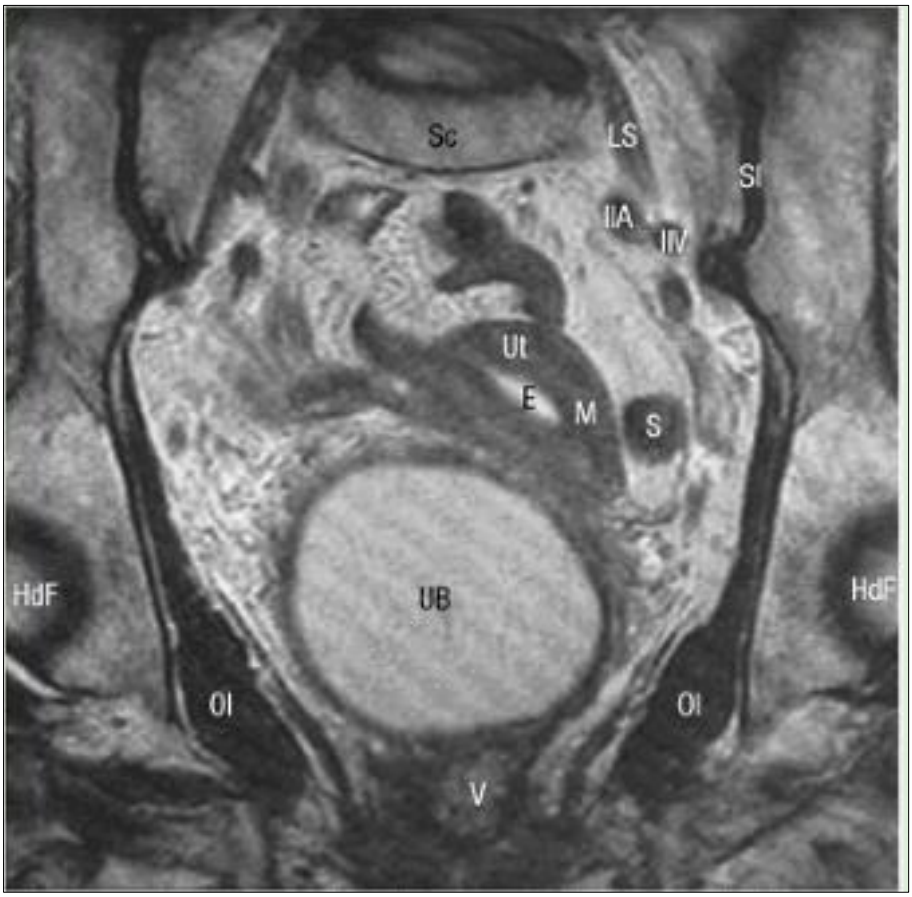

Fig. 33: MRI of the female Pelvis. ***Courtesy; Keith Moore& Arthur Dalley***

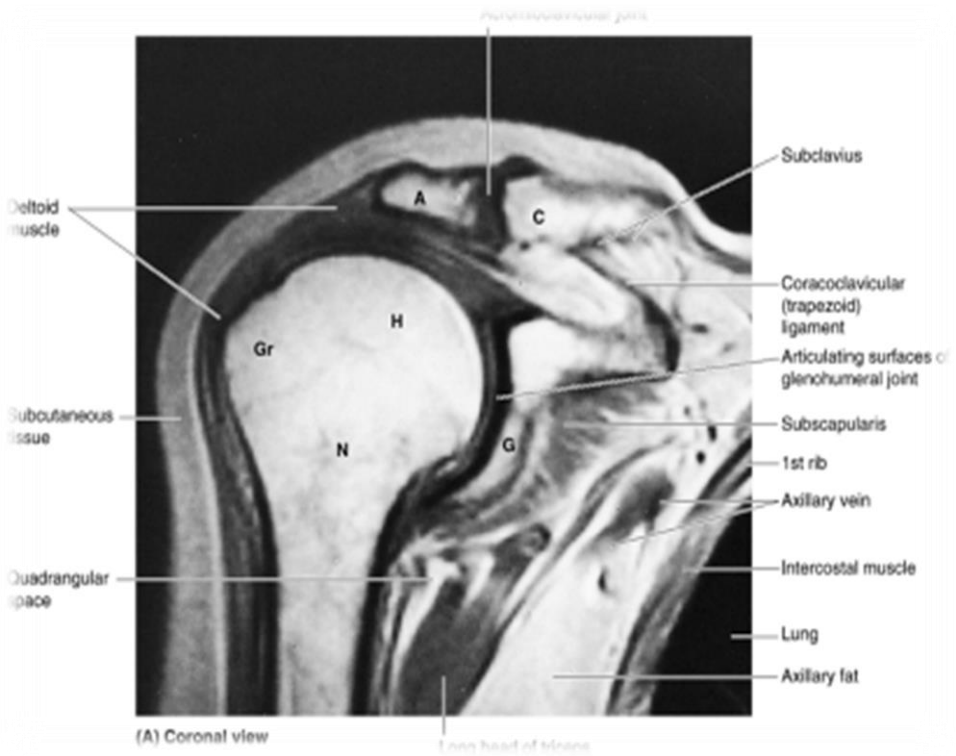

Fig. 34: MRI Left Shoulder (Coronal section)

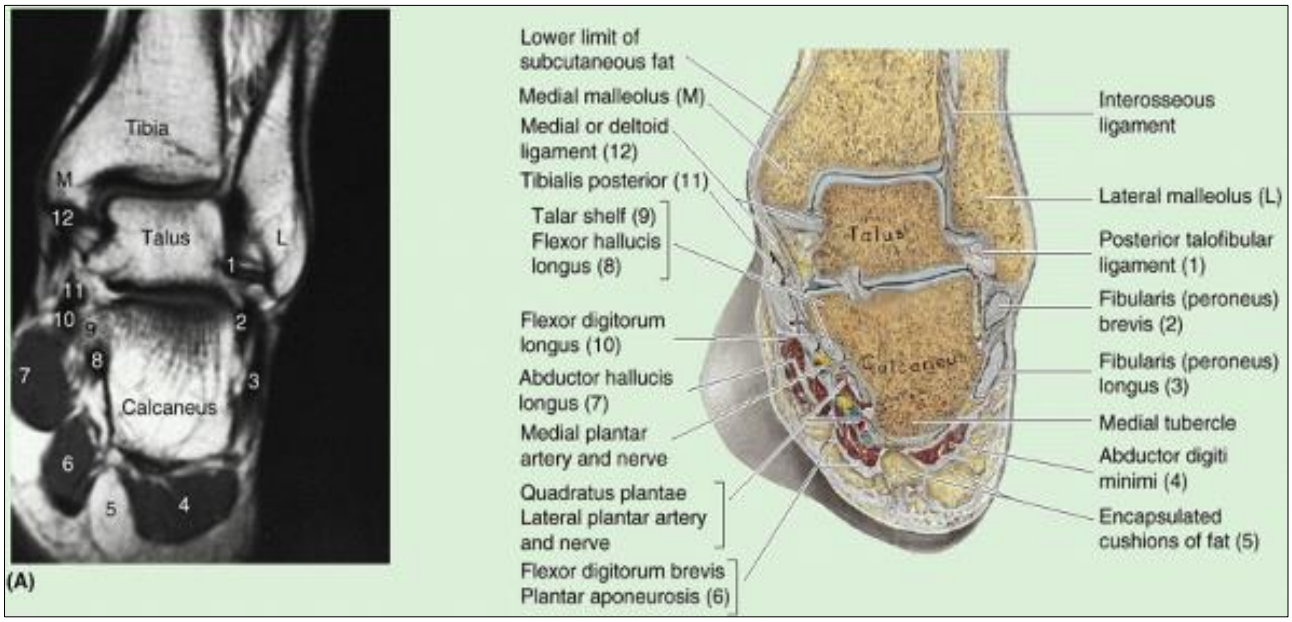

Fig. 35: MRI Right Ankle (Coronal section)

Courtesy; Keith Moore& Arthur Dalley

POSITRON EMISSION TOMOGRAPHY

This is a nuclear medicine procedure that measures metabolic activity of the cells in body tissues. It is a combination of nuclear medicine and biochemical analysis. A tiny amount of a substance called radionuclide or radioactive tracer is used during the procedure. Positron emission tomography (PET) procedures evaluate the metabolism of a particular organ or tissue obtaining information about the structure and functionality alongside the biochemical properties of the organ/tissue under investigation. In essence, PET may detect biochemical changes in an organ or tissue that can identify the onset of a disease process before anatomical changes related to the disease can be seen with other imaging modalities such as computed tomography (CT) or magnetic resonance imaging (MRI). Thus PET is used mostly in patients with brain and cardiac pathologies as well as malignancies. PET may be used in conjunction with CT or MRI to provide more

definitive pieces of information about cancerous growths and lesions that are necessary for the management planning that will be in the best interest of the patient. Newer technology combines PET and CT into one scanner, known as PET/CT. This combined scanner shows particular promise in the diagnosis and treatment of lung cancer, evaluating epilepsy, Alzheimer's disease and coronary artery disease.

As opposed to other nuclear medicine procedures, PET detects metabolism within body tissues, while other varieties detect the amount of a radioactive substance collected in body tissue in a certain location to examine the tissue's function.

Further increasing the availability of PET imaging is a technology called gamma camera systems (devices used to scan patients who have been injected with small amounts of radionuclides and currently in use with other nuclear medicine procedures). These systems have been adapted for use in PET scan procedures. The gamma camera system can complete a scan more quickly, and at less cost, than a traditional PET scan. [Hopkins Medicine 2026].

How Positron Emission Tomography works

PET works by using a scanning device (a machine with a large hole at its centre) to detect photons (subatomic particles) emitted by a radionuclide in the organ or tissue being examined.

The radionuclides used in PET scans are made by attaching a radioactive atom to chemical substances that are used naturally by the particular organ or tissue during its metabolic process. For example, in PET scans of the brain, a radioactive atom is attached to glucose to create a radionuclide called fluorodeoxyglucose (FDG), because the brain uses glucose for its metabolism. FDG is widely used in PET scanning.

Other substances may be used for PET scanning, depending on the purpose of the scan. If the blood flow and perfusion of an organ or tissue is of interest, the radionuclide may be a type of radioactive oxygen, carbon, nitrogen, or gallium.

The radionuclide is administered intravenously and about one hour prior to the commencement of scanning, This allows it to concentrate in the tissue/organ of interest. Next, the PET scanner slowly moves over the part of the body being examined. Positrons are emitted by the breakdown of the radionuclide. Gamma rays called annihilation photons are created when positrons collide with electrons near the decay event. The scanner then detects the annihilation photons, which arrive at the detectors in coincidence at 180 degrees apart from one another. A computer analyzes those gamma rays and uses the information to create an image map of the organ or tissue being studied. The amount of the radionuclide collected in the tissue affects how brightly the tissue appears on the image, and indicates the level of organ or tissue function.

Benefits of PET scan

Apart from being a diagnostic tool, PET offers other advantages that include-

- Preoperative localization of the tumour in the brain.
- Following head injury, it helps in detecting cerebral bleeding, hematoma, blood flow and oxygen perfusion of the brain.
- Spread (metastasis) of cancer cells to other parts of the body from the primary site.
- Evaluation of the efficacy and appropriateness of cancer therapy.
- Evaluation of myocardial perfusion in the course of trying to improve coronary circulation.
- Further evaluation of lung lesions or masses detected on chest x-ray or chest CT
- Assist in the management of lung cancer by staging lesions and following the progress of lesions after treatment
- Detection of tumour recurrence earlier than what X-ray, CT or MRI could offer.

The PET scanner is shown in figure36 while figures 37&38; and 39 respectively are PET images of the whole body and the prostate gland.

Fig. 36: PET scan machine Henry Westheim Photography / Alamy Stock Photo

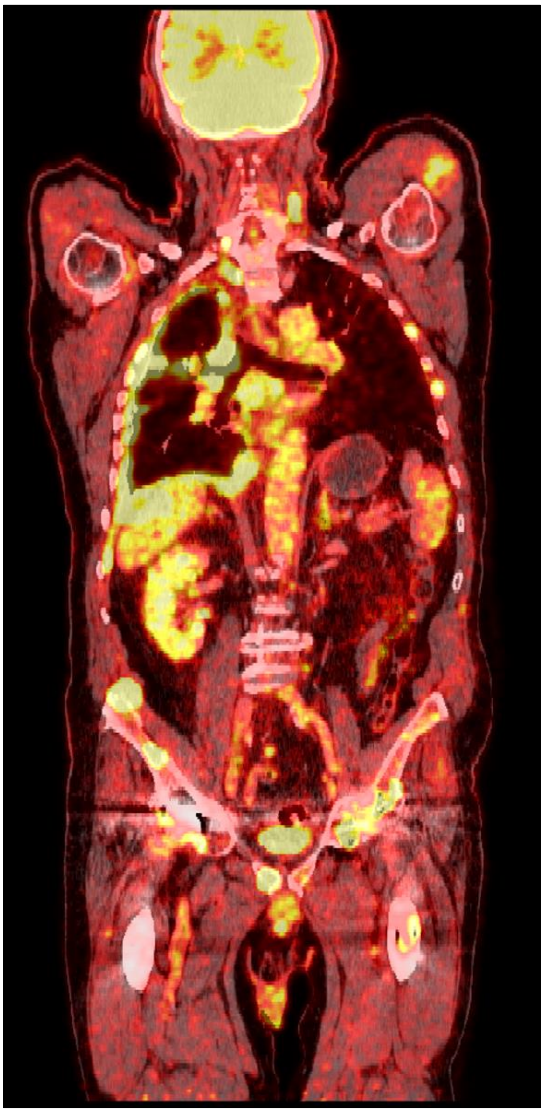

Fig. 37: Whole-body FGD-PET/CT Image fusion

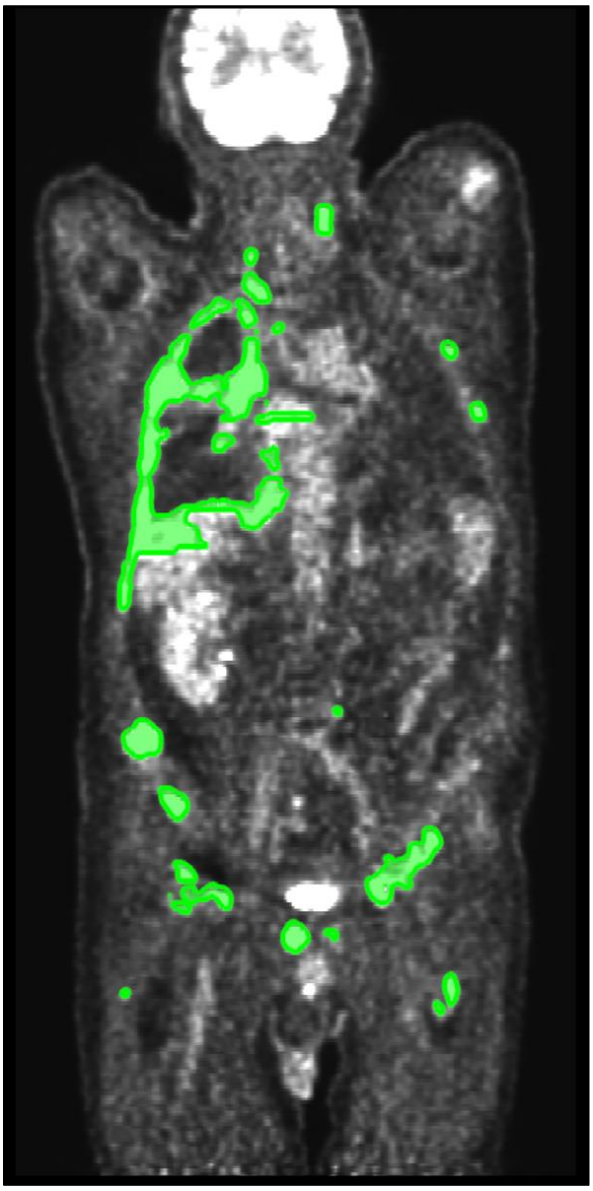

Fig. 38: Manual segmentation of FDG-avid malignant lesions

Courtesy- cancerimagingarchive.net

PET scans can be done on an outpatient basis. It is also possible that some hospital inpatients may undergo a PET examination for certain conditions.

Although each facility may have specific protocols in place, generally, a PET scan procedure follows this process:

1. The patient may be asked to remove any clothing, jewelry, or other objects that may interfere with the scan.
2. If asked to remove clothing, the patient will be given a gown to wear.
3. The patient will be asked to empty his or her bladder prior to the start of the procedure.
4. One or two venous access is secured for the administration of the radionuclide.
5. In some abdominal/pelvic scanning, there may be the need to catheterize the urinary bladder.
6. A scout scan may have to be performed before the administration of the radionuclide.
7. The radionuclide will be injected into the IV. The radionuclide will be allowed to concentrate in the organ or tissue for about 30 to 60 minutes. The patient will remain in the facility during this time. The patient will not be hazardous to other people, as the radionuclide emits less radiation than a standard X-ray.
8. After the radionuclide has been absorbed for the appropriate length of time, the scan will begin. The scanner will move slowly over the body part being studied.
9. Upon completion of the scanning, both the intravenous access and the urinary catheter will be removed.

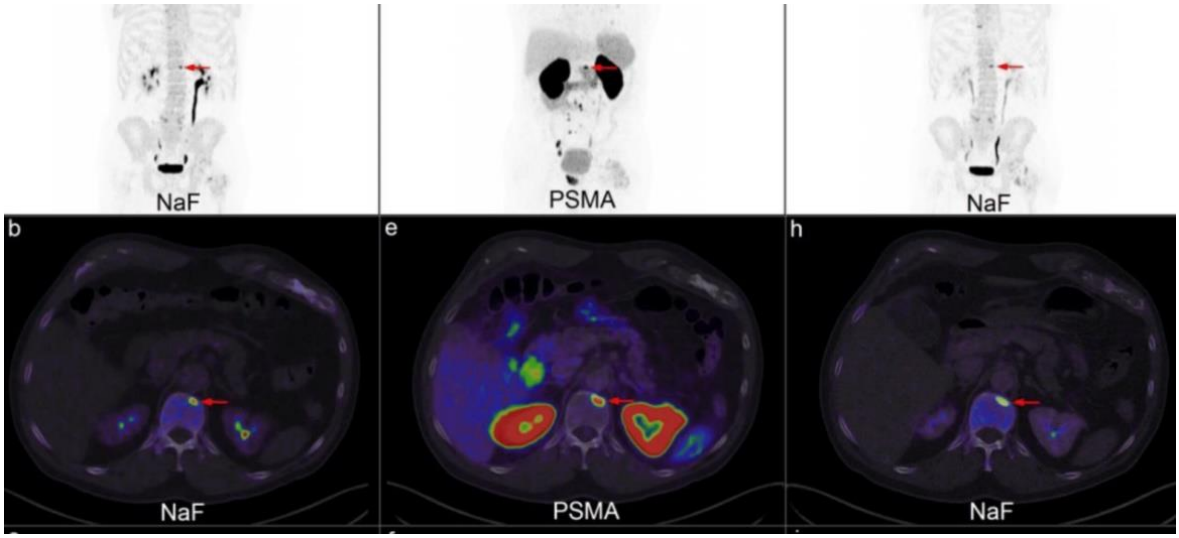

Fig. 39: PSMA PET scan of the Prostate (PSMA-Prostate- specific membrane antigen)

Courtesy-https://zwangerpesiri.com/services/molecular-imaging/psma/

DISCUSSION

Radiographic films are easier to relate with than Ultrasound picture which is entirely Sonographer (operator) dependent. It is easier to teach and learn anatomy with Xray films whether plain or contrast-enhanced than with USS pictures. The main advantage of USS over Xray is none exposure to ionizing radiation. This is however, not an issue when one considers the fact that the radiation dose is neither hazardous nor lethal. In most clinical scenarios, the indications for Xray are usually distinct from those of USS and rarely do they overlap. Although, magnetic resonance imaging (MRI) produces images with greater precision, details and resolution than CT and Xray and also it does not entail use of ionizing radiation its main drawback is cost and operational expertise. For soft tissues, MRI has an edge over CT and Xray while for bony structures, CT and Xray are more preferred to MRI.

Although, PET is a more superior diagnostic imaging modality than CT and MRI, the cost of the scanner (machine) as well as those of the radiopharmaceuticals (radionuclide and radioactive tracer) are limiting its availability especially in the West African sub-region. In Nigeria, CT Scanners are available in tertiary hospitals and some private medical facilities in Lagos, Abuja, Ibadan and Port Harcourt, these are still well below the need of the populace. This may be due to the very high prices of the machines. For the SIEMENS brands, a new 16–64 slice systems cost between $285,000 and $700,000, while high-end or 128+ slice models (e.g., Somatom Definition) can exceed $1–$2 million. Refurbished units generally cost between $90,000 and $650,000. [Google search]. These are just for the machine, by the time other costs such as logistics, consumables and housing facilities are factored, the overall cost becomes highly exorbitant and prohibitive. Fewer numbers of Magnetic Resonance Imaging Scanners are available in Nigeria. This is cost related as new Siemens 3.0T MRI machines typically cost between $1.6 million and $2.2 million, while used 3.0T models generally range from $900,000 to $1.4 million. Prices vary based on the specific series, field strength and software [Google search]. New Siemens PET-CT scan machines generally cost between $1.5 million and $2 million, with prices varying based on the specific model (such as the Biograph line) and detector technology. Refurbished or used Siemens PET-CT machines typically range from $200,000 to $700,000 depending on the slice count (e.g., 6, 16, 40, or 60-slice systems) [Google search].

In terms of complexity and sophistication, there is hierarchy amongst the various imaging techniques discussed so far. However, in clinical parlance rarely is comparison done in terms of accuracy, sensitivity, and specificity as the indications (be diagnostic, tumour staging, pre-operative planning or follow-up) for the imaging will determine the choice. Another major determinant of the imagining modality is the availability, functionality of the machine as well as the appropriate technical-know-how. In Nigeria, the National Health Insurance is still evolving with coverage of the populace and extent of medical expenses still very low thus most of the populace still pay for health services from their pockets thus affordability of the imaging types is a big issue.

CONCLUSION

Having presented a considerable number of anatomical imaging modalities viz a brief mention of each, underlying operational principles, their images, indications and limitations; there is need for a cautionary note to clinicians in the making i.e. medical and dental students, that these advanced technological machines should be seen and taken as

complements/supplements and never as alternatives to good/excellent clinical skill of history taking and physical examination collectively known as clerkship.

Irrespective of the level of sophistication and inbuilt artificial intelligence of the imagining machine, the decision as to what to do for the patient in the light of the images rest squarely and solely with the Physician who is a human being and not with the machine.

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