

# **CHAPTER ONE**

## **Introduction**

## **1-1 Introduction**

Recent technologic advances have markedly enhanced the clinical applications of computed tomography (CT). While the benefits of CT exceed the harmful effects of radiation exposure in patients, increasing radiation doses to the population have raised a compelling case for reduction of radiation exposure from CT. Strategies for radiation dose reduction are difficult to devise, however, because of a lack of guidelines regarding CT examination and scanning techniques. Various methods and strategies based on individual patient attributes and CT technology have been explored for dose optimization. It is the purpose of this review article to outline basic principles of CT radiation exposure and emphasize the need for CT radiation dose optimization based on modification of scanning parameters and application of recent technologic innovations.

## **1-2 the problem**

Owing to the ongoing technologic boom during the past 10 years, there has been a corresponding notable increase in the number of computed tomographic (CT) examinations being performed around the world. The

Broadened use of CT in clinical practice has raised concerns about mounting radiation exposure, thus emphasizing the need for appropriate strategies to optimize and thereby, if possible, reduce radiation dose due to CT. In the present review, we will present data that document the magnitude of CT radiation exposure and discuss the important safety issues. Various technologic and patient-based strategies proposed by radiologists, physicists, and the CT industry for radiation dose optimization will be discussed.

### **1-3 General objectives**

Apply a technical protocol to reduce the CT reduction close in trauma cases by decreasing the mA (tube current) - The target reduction is 50% .

#### **1-3-1specific Objectives were to**

1. Evaluate the radiation safety practices in the general diagnostic radiology for the patients' group in Madinat Zayed Hospital. `
2. Discuss the radiation close in different CT exams.
3. Investigate the current radiology study protocols of the CT radiology Examinations and compare it the international guidelines and standards.
4. Investigate the radiation dose levels of the Toshiba 16 slice system at Madinat Zayed Hospital.
5. Carry CT scans on phantom in two phases.
6. Design standard exposure factor and guidelines that produce acceptable image quality with less exposure compared to the reference exposure.
7. Evaluate and analyze the result image in each stage of mA reduction.

#### **1-4 the rational and importance of the study:**

The study would be of great benefit to the patients undergoing CT exams in reducing effective dose received.

## **CHAPTER TWO**

### **LITERATURE REVIEW**

## **Embryology of neural system development:**

2.1 Neural development is one of the earliest systems to begin and the last to be completed after birth .This development generates the most complex structure within the embryo and the long time period of development in utero insult means during pregnancy may have consequences to development of the nervous system.

The early central nervous system begins a simple neural plate that folds to form a groove then tube open initially at each ends, failure of these opening to close contributes major class of neural abnormalities.

Within the neural tube stem cells generate the major classes of cells that make the majority of nervous system, neurons and glia .Both these classes of cells differentiate into many types generated with highly specialized function and shapes .This section covers the establishment of neural populations, the inductive influences of surrounding tissues and the sequential generation of neurons establishing the layered structure seen in the brain and spinal cord.

## 2.2

### **Human Early Neural Development.**

\*(About 18 postovulatory days) neural groove end folds are first seen.

\*The three main divisions of the brain, which are not cerebral vesicles, can be distinguished while the neural groove is still completely open.

\* Two days later neural folds begin to fuse near the junction between brain and spinal cord when neural crest cells are arising mainly from the neural ectoderm.

\* (About 24 days) the rostral or cephalic neuropore closes within a few hours closure is bidirectional, it takes place from the dorsal and terminal lips and may occur in several areas simultaneously, the two lips, however behave differently.

\* (About 26 days) the caudal neuropore take a day to close.

\* The level of the final closure is approximately at future somatic pair 31.corresponds to the level of sacral vertebra 2.

\*(4 week) the neural tube is normally completely closed.

### **2.3 Early Development Sequence.**

Epiblast. Ectoderm. Neural plate. Neural groove and neural crest.

Neural tube and neural crest.

Neural tube 3 week	Primary vesicles 4 week	Secondary vesicles 5 week	Adult structure adult
Neural plate Neural groove Neural tube brain	pros encephalon	Telencephalon	Cerebrum, basal ganglia, lat. ventricles Hippocampus, hypothalamus.
		Diencephalon	Epithalamas.3 ventricles.thalamas, subthalamas.
	mesencephalon	mesencephalon	Cerebral peduncle, cerebral aqueduct.tectum, pretectum.
	rhomb encephalon	Met encephalon	Pons, cerebellum.
		mesencephalon	Medulla oblongata.
Spinal cord			

## **2.4 Skull anatomy:**

The skull is the most modified part of the axial skeleton on .it rest on the upper and of the vertebral column and its bony structure is divided in to two parts the cranium and the face.

The cranium is formed by a number of flat irregular bones that provide a bony protection for the brain. It has a base upon which the brain rest and a vault that surround and cover it , the periosteal inside the skull bones consists of the outer layer of Dura matter immature skull the joints (suture) between the bones are immovable (fibrous joints), the bones have numerous perforations through which nerve blood and lymph vessels pass.

## **2.5 The bone of cranium:**

1. Frontal bone 2 .parietal bones .2. Temporal bones.
2. Occipital bone .1. Sphenoid bone.

## **3. Ethmoid bone.**

## **2.6 brain Anatomy.**

The brain constitutes about one fifth of the body weight and lie within the cranial cavity. The brain consists of three main parts:

1. Cerebrum or forebrain.
2. The brain stem, consist of :
  - i. Midbrain
  - ii. Pons varollii

Medulla oblongata

## **2.7 Cerebrum**



This is the largest part of the brain and it occupies the interior and the middle cranial fossae. It is divided by deep cleft the longitudinal cerebral fissure into right and left cerebral hemispheres, each containing one of the lateral ventricles.

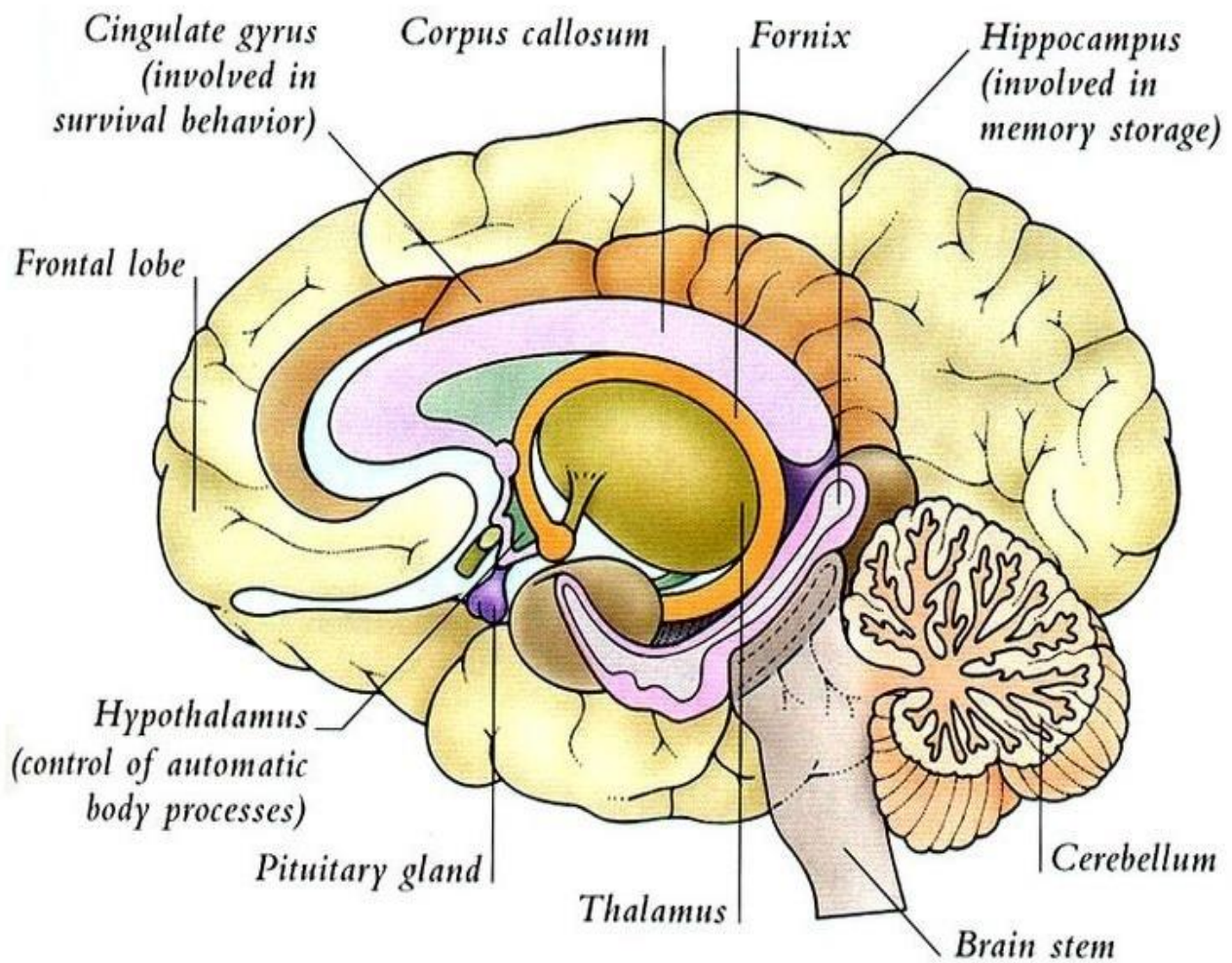
Deep within the brain the hemispheres are connected by a mass of white matter (nerve fibers) called the corpus callosum.

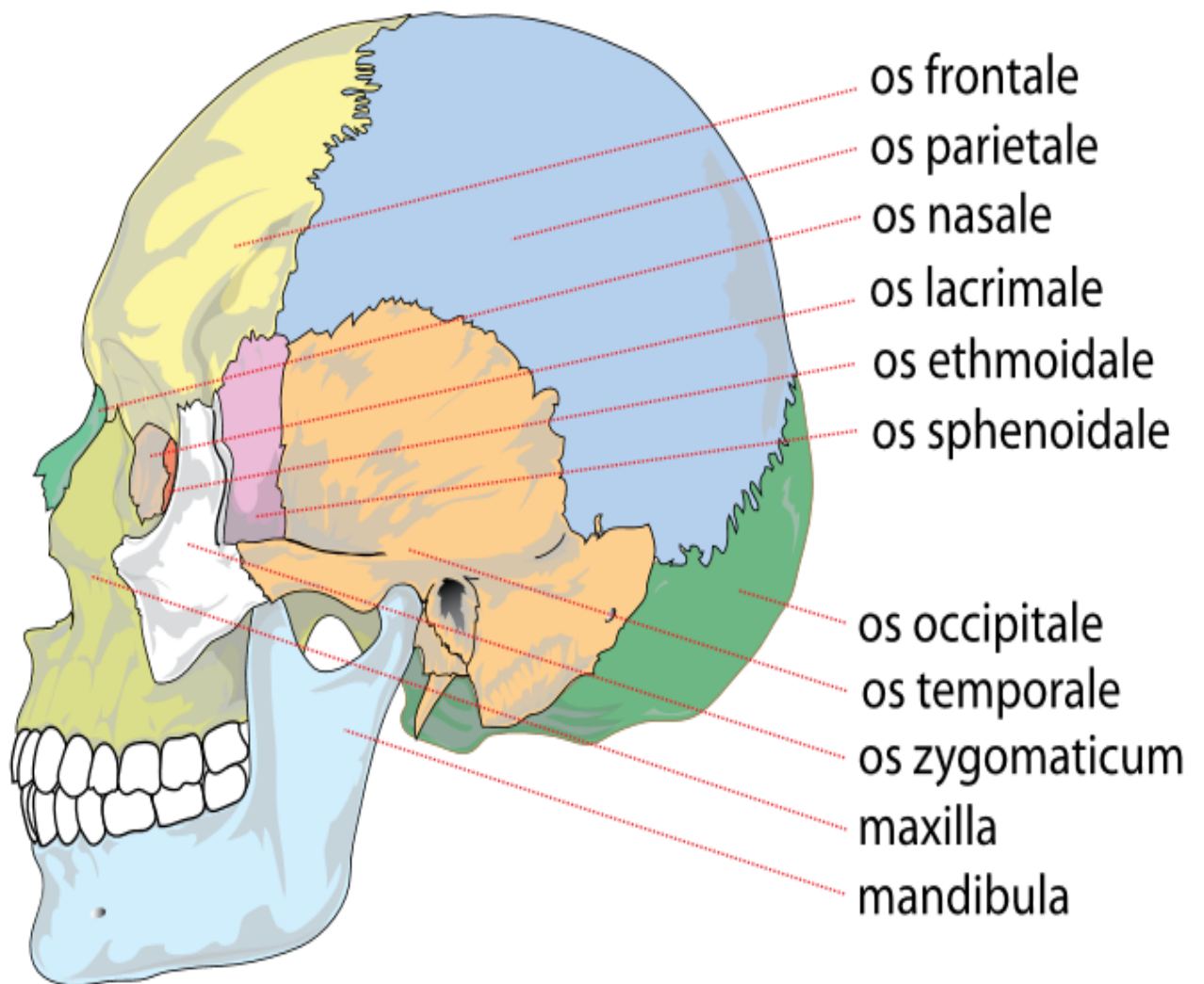
Cerebrum consists of four lobes: frontal, parietal, temporal and occipital lobe.

## **2.6: brain stem**

The midbrain is the area of the brain situated around the cerebral aqueduct.

FG 2.1 BRAIN SAGITAL PLANE





FG 2.2: SKULL BONES

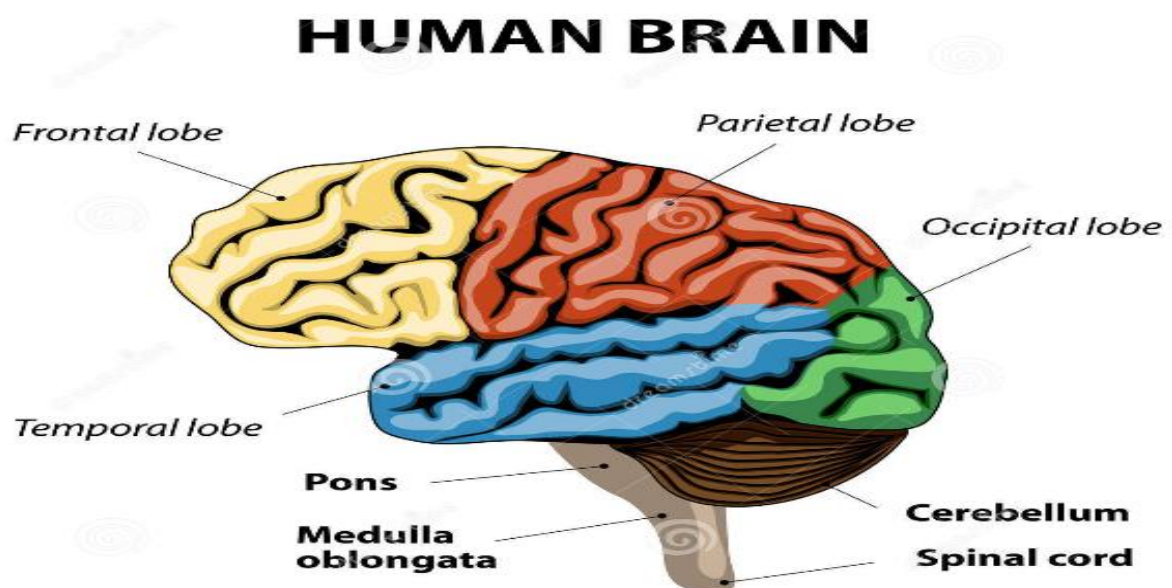
Between the cerebrum above and the bones varouli blow.

Consist of group of nerve call and nerve fiber which connect the cerebrum with the lower part of the brain and with the spinal card.

The pons varollii is situated in front of the cerebellum, below the midbrain and above the medulla oblongata .it consists of mainly of nerve fiber which from a bridge between the two hemispheres of the cerebellum, and of fiber passing between the higher levels of the brain and spinal cord. The medulla oblongata extends from the pons varollii above and it is continuous with the spinal cord below.

It is about 2.5 cm long and it lies just within the cranium above the foramen magnum.

**FG 2.3**



## **2.9 cerebellums:**

The cerebellum is situated behind the pons varollii and immediately below the posterior portion of the cerebrum occupying the posterior cranial fossa , it ovoid in shape and has two called the vermis,gray matter forms the surface of the cerebellum and the white matter lies deeply.

## **2.10 Hind brain:**

The pons situated on the anterior surface of the cerebellum below the mid brain and above the medulla oblongata, it composed mainly of nerves fiber which connect the two halves of the cerebellum..

## **2.11 Head injury:-**

One of the most common causes of disability and death.The injury can be mild as bump, bruise (contusion) or cut on the head of open wound. Fracture of skull bone or from bleeding and damage to brain.

- head injury is a board term that describes a vast array of injury that occur to the scalp ,skull brain and underlining tissues and blood vessels inside the head injury are also commonly referred to as brain injury , or traumatic brain injury (TBI) depending on the extend of head trauma

Primary and secondary injuries are described with head trauma and the presence of these injuries affects the outcome of these patients.

The primary injury occurs at the time of impact, either by a direct injury to the brain parenchyma or by an injury to the white matter tracts through acceleration –deceleration forces .direct injury to the brain parenchyma occurs as the brain is impacted on the bony protuberances of the calvarias or by penetration of the brain by bony fragments or foreign bod in

children the skull is easily deformed and impact on the brain at the time of the insult in a coup injury, as opposed to adults, in whom the brain is forced against the bony protuberances opposite to the point of impact resulting in a counter coup injury, intracranial hemorrhage may also result from shearing or laceration of vascular structures, Acceleration – deceleration forces cause shearing of the long white matter tracts leading to axonal displacement and secondary cell death.

- The secondary injury is represented by systemic and intracranial events that occur in response to the primary injury and further contribute to neuronal damage and cell death.

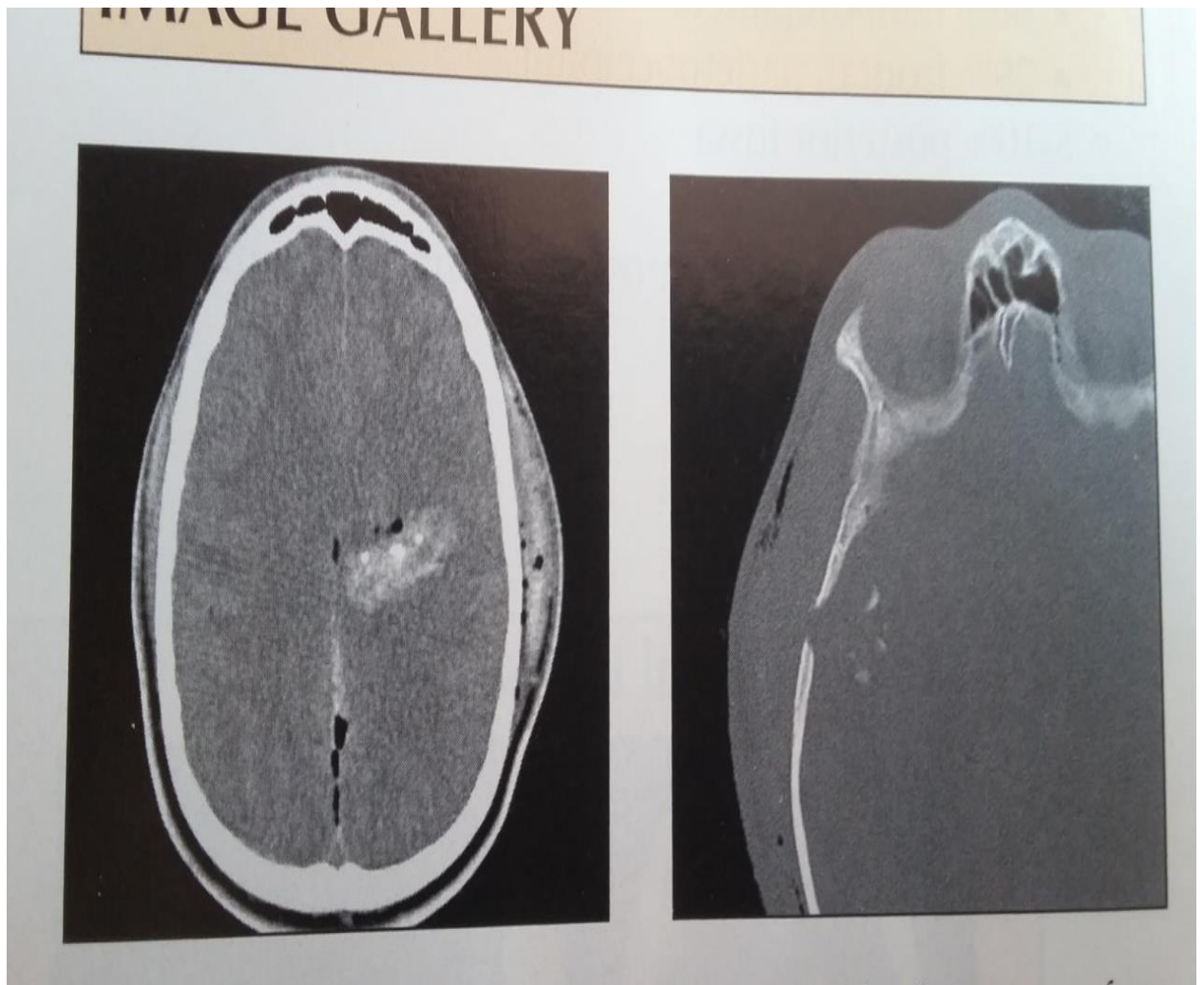
The systemic events are hypotension, hypoxia and hypercapnia and many occur as a direct result of primary injury in person with multi-trauma.

The intracranial events are a series of inflammatory changes and pathophysiologic perturbations that immediately after the adverse outcome of the head trauma patients. The inflammatory events are the result of cascade of biochemical changes triggered by the initial insult leading to microcirculatory disruption and neuronal disintegration. A series of factors such as free radicals, free iron and excitatory neurotransmitters are the result of these inflammatory events presence.

## **2.12 Skull fractures:**

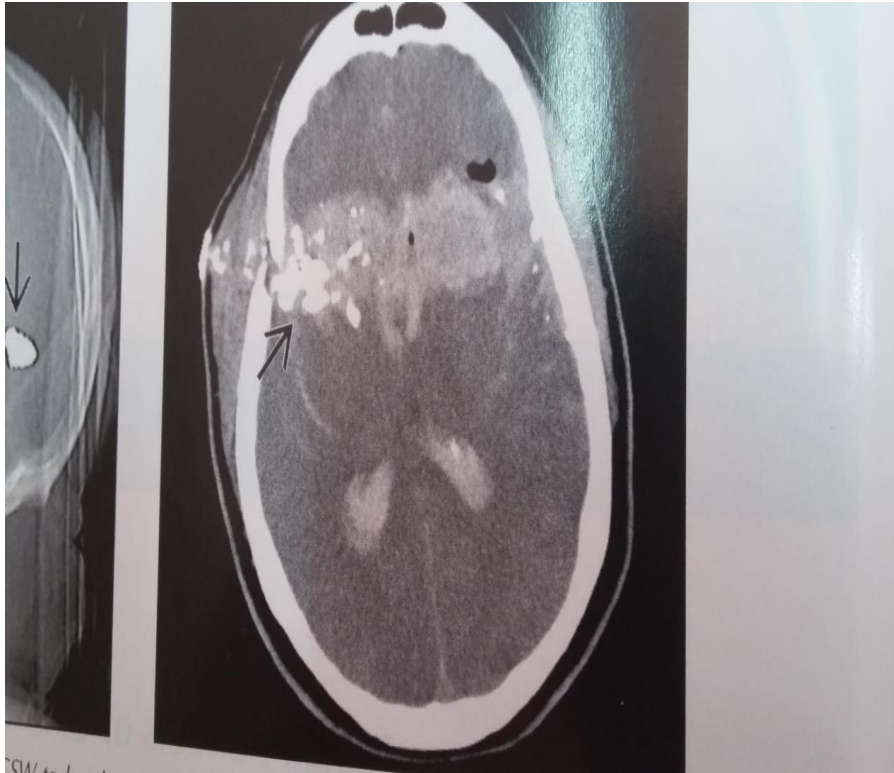
Skull fractures are break or discontinuity of bones. There are four major types of skull fractures.

## **2.13 Linear skull fracture:**



FG 2.4: SKULL FRACTURE AND BONE FRAGMENT

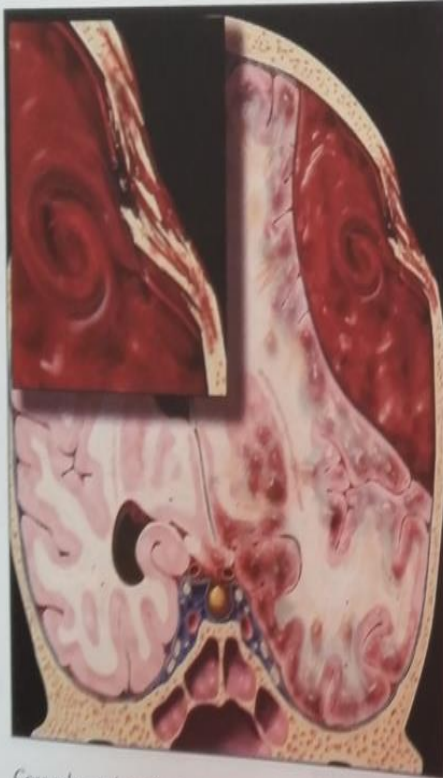




FG 2.5: SKULL FRACTURE AND INTRACRANIAL  
BLEEDING



## EPIDURAL HEMATOMA



Coronal graphic illustrates swirling acute hemorrhage from middle meningeal artery, lacerated by an overlying skull fracture. Epidural hematoma displaces dura inward as it expands.



Axial NECT shows a hyperdense, biconvex epidural hematoma with compression of brain. Note internal hypodense "swirl sign" (arrow) implying active bleeding with unretracted semiliquid clot.

### TERMINOLOGY

FG: 2.6 EPIDURAL HEAMATOMA

This is most common type of fracture, in linear fracture there is a break in these patient may be observed in the hospital in bride of time.

Usually resume normal activities in a few days no intervention are necessary.

#### **2.14 Depressed skull fractures:**

This type of fracture may be seen with or without a cut in the scalp, in this fracture part of the skull is actually sunken in due to trauma .may require surgical intervention depending on the severity of the fracture.

#### **2.15 Diastasis skull fractures:**

These are fractures that occur along the suture lines in the skull sutures are the sort of joints fused and not moving.

In these types of fracture the normal suture lines are widened, the fractures are often seen in new born and older indents.

#### **2.16 Basilar skull fracture:**

This is the most serious type of skull fracture ,involves a break in the bone at the base of the skull , patients with this types of fracture frequently have bruises around the ire yes ansada bruise behind their ear, they may also have clear fluid draining from nose and ears due to tear of some layer covering the brain . The patient needs special care.

## **2.17 Complication of the head injury:**

### **2.17 Intracranial hematoma (ICH)**

There are several type OF (ICH) or blood dots in or around the brain .the different types are classified by the brain different types are classified by their location in the brain these can range from riled head injure to quite serious and potentially life threatening injures .

## **2 .18 Deferent type of ICH:**

### **2.18 Epidural hematoma (EDH)**

Epidural hematoma occurs when a blood clot form underneath the skull, but on top of the durra, the rough covering that surrounds the brain.

They usually come from a tear in an artery that runs just under the skull called the middle minimal artery. Epidural hematoma is usually associated with a skull fracture.

### **2.19 Subdural hematoma (SDH):**

Subdural hematoma occur when a blood clot form subdural the skull and underneath the durra, but outside of the brain. the escape from a tear in there in that froth brain to the durra , or from a cut on the brain itself. But not always associated with a skull fracture.

### **2.20 Contusion:**

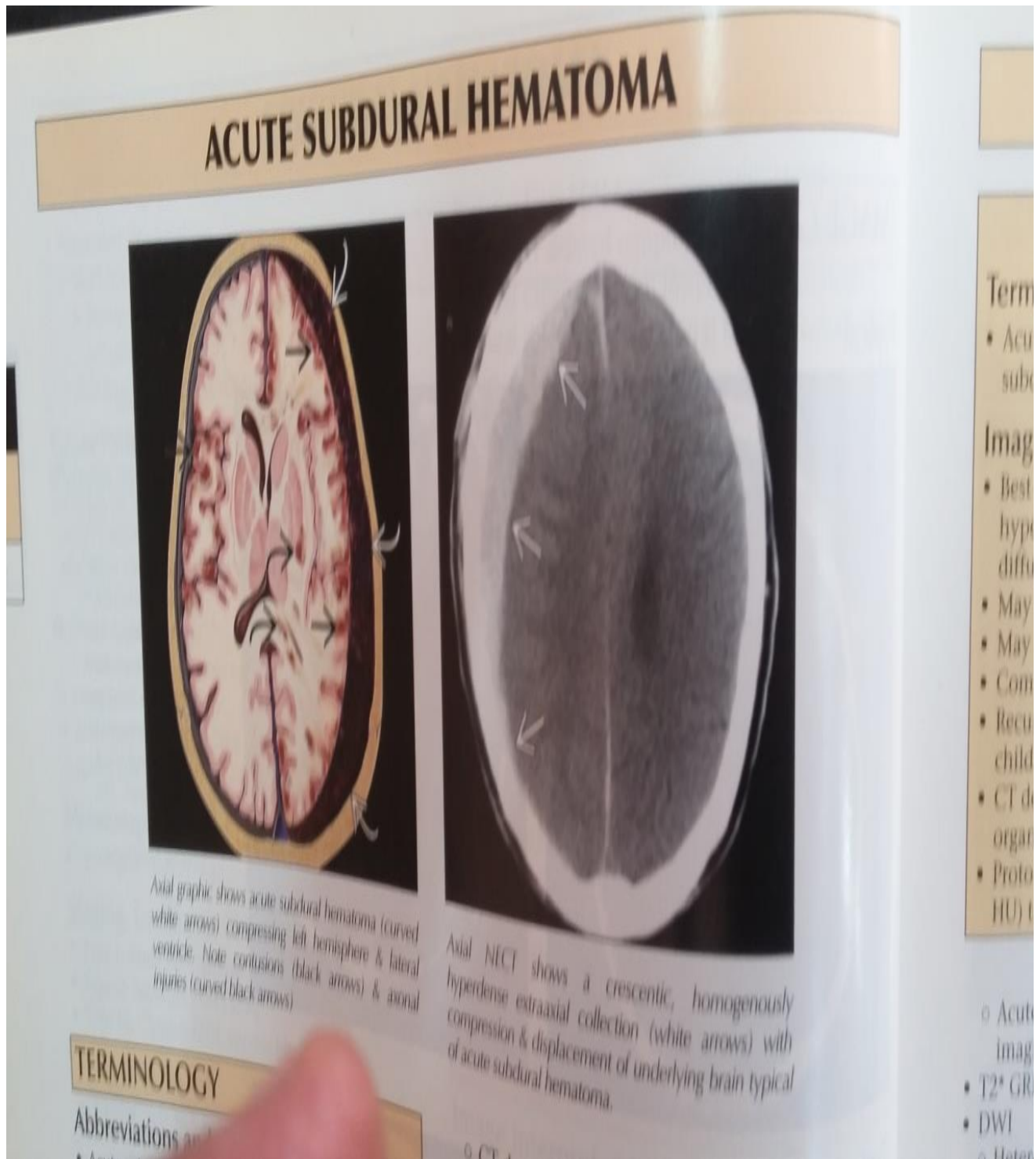
A contusion is bruises of the brain itself .contusion causes bleeding and a welling inside of the brain around the area where the head was struck .contusion may occur with skull fractures or other blood clot such as subdural or epidural hematoma.

### 2.21 Extra Dural hematoma: (EDH):

The temporal bones usually the thinnest part of the skull. Fracture at this it may tear the middle meningeal artery as it passes up ward within a groove between the inner skull table and the durra, Blow to the temporal bone may result in a tear of the temporal artery without a fracture. An arterial bleed from a middle meningeal artery accumulate forming a hematoma between the inner skull table and stripped durra, this called an EDH which acts as a space – occupying lesion .this accumulation can be immediate or delayed . EDH is easily over looked, as mild concussion is followed by a lucid interval before neurologic symptoms and coma develop many hours later. When the enlarging hematoma begins to exert pressure on the brain EDH is amenable to surgical decompression when diagnosed early.

### 2.22 Subdural hemorrhage:

SDH is more common than an EDH. SDH is especially common in the elderly children and individuals with alcoholism. SDH is not usually associated with skull fractures, SDH may occur after Sudan jarring or rotation of the head .a blow to the head or a fall trauma to the head may be trivial movement of the brain relative to the durra often associated with widened Cs F spaces causes' hear and tear of the small veins that bridge the gap between the Dura and the cortical surface of the brain. Blood from to vessel accumulates over several hours and usually tracks extensively as a thin film over the surface of the brain. A small self-limiting SDH may remain asymptomatic and be an incidental finding.



FG:2.7 ACUTE SUBDURAL HEAMATOMA

## 2:23 **CEREBRAL CIRCULATION:**

It is the movement of blood through the network of cerebral arteries and veins supplied the brain. The rate of the cerebral blood flow in the adult is typically 750 ml per minute representing 15% of the cardiac output. The arteries deliver oxygenated blood, glucose and other nutrients to the brain and the veins carry deoxygenated blood back to the heart removing carbon oxide, lactic acid, and other metabolic products since the brain is very vulnerable to compromises in its blood supply, the cerebral circulatory system has many safeguard including auto regulation of the blood vessels and the failure of these safeguard can result in a stroke. The amount of blood that the cerebral circulation carries is known as cerebral blood flow.

### 2:24 Blood supply:

Blood supply to the brain is normally divided into anterior and posterior segments relating to different arteries that supply brain the two main pairs arteries are the internal carotid arteries supply the anterior brain vertebral arteries supply the brain stem and posterior brain, the anterior and posterior cerebral circulations are interconnected via bilateral posterior communicating arteries, they are the part of the circle of Willis. Which provides back up to the brain in case of the supply artery is occluded.

The circle of Willis provides interconnections between the anterior and posterior cerebral circulations along the floor of the cerebral vault, providing blood to the tissues that would otherwise become ischemic.

### 2.25 Anterior cerebral circulation:

Is the blood supply to the anterior portion of the brain by internal carotid arteries. These large are the L&R branches of common carotid arteries in

The neck which enter the skull as opposed to the external carotid branches which supply the facial tissues, the internal carotid arteries branches into the anterior cerebral artery and continues to form the middle cerebral artery. Anterior communicating artery connect both anterior cerebral arteries within and along of the cerebral vault.

#### 2.26 posterior cerebral circulations:

Is the blood supply to the posterior portion of the brain including the occipital lobes, cerebellum and brain stem. It supply by the following arteries:

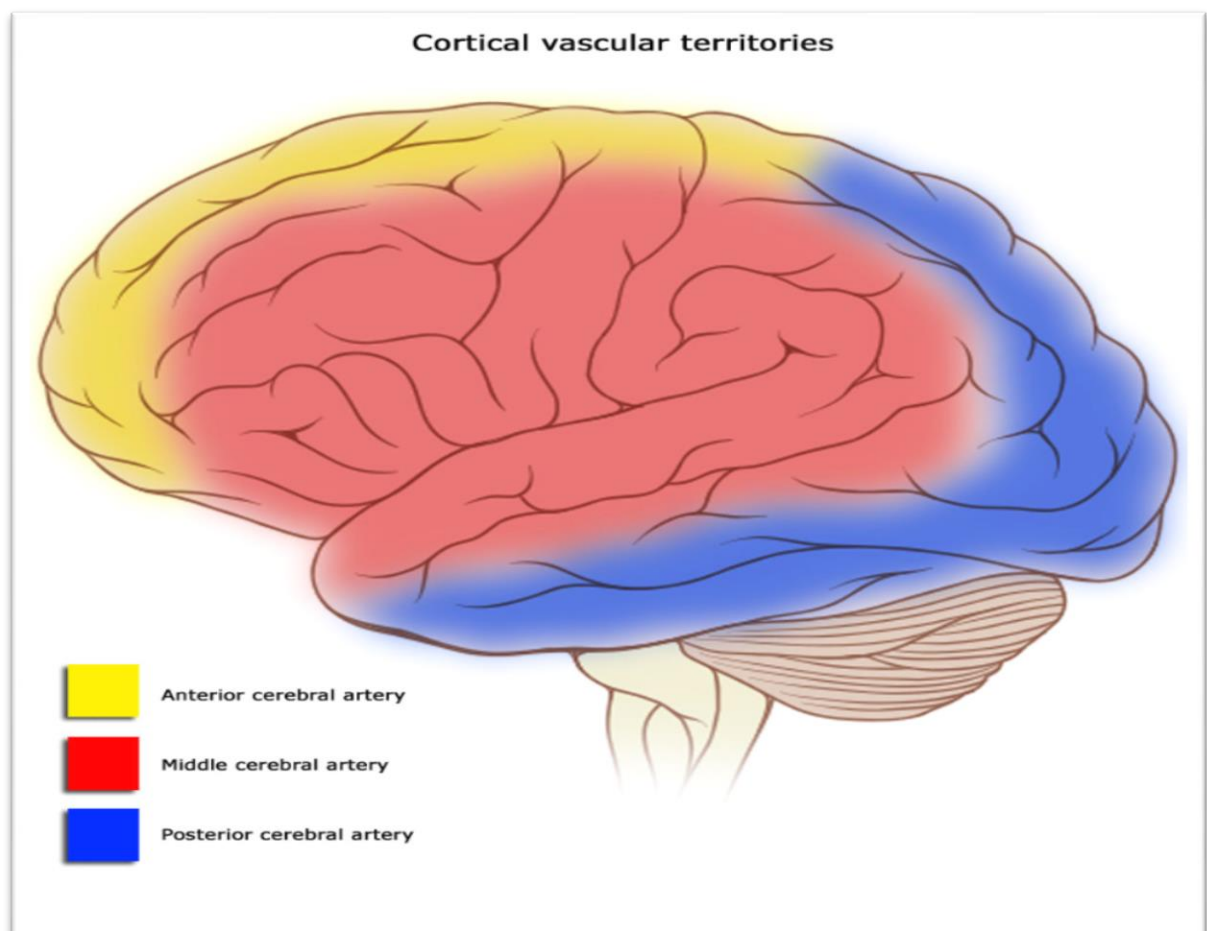
Vertebral arteries these smaller arteries branch from subclavian arteries which primary supply the shoulders, lateral chest and arms. Within the cranium the two vertebral arteries fuse into the basilar artery.

Basilar artery supplies the midbrain, cerebellum, and usually branches into the posterior cerebral arteries. Anterior inferior cerebellar arteries (AICA). Pontine branches, superior cerebral arteries (SCA), posterior cerebral arteries (PCA), posterior communicating artery the anterior and posterior circulations meet at the circle of Willis which rest at the top of the brain stem.

#### 2.27 VEOUS DRAINAGE:

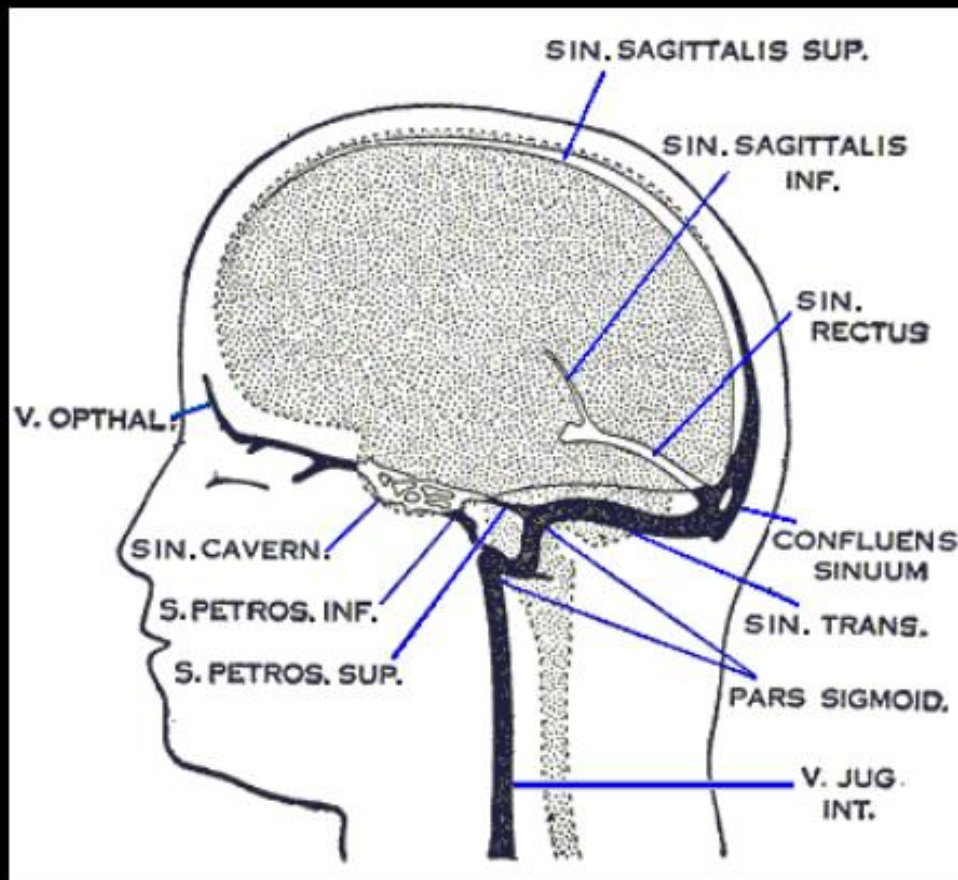
The venous drainage of cerebrum can be separated into two subdivisions superficial and deep. The superficial system is composed of dural venous sinuses which have wall composed of Dura mater as opposed to traditional vein. They are located on the surface of the cereblum. The most prominent these sinuses the superior sagittal sinus which flow in the sagittal plane under the midline of the cerebral vault, posteriorly and

inferiorly to confluence of sinuses, where the superficial drainage joins with the sinus that primarily drains the deep venous system. From here two transverse sinuses bifurcate and travel laterally and inferiorly in an s – shapes curve that form the sigmoid sinuses which go on to form the jugular veins in the neck the jugular veins parallel the upward course of the carotid arteries and drain blood into (SVA). The deep venous drainage is primarily composed of traditional veins inside the deep structure of the brain which join behind the midbrain to form Galen. This vein merges with inferior sagittal sinus to form the straight sinus which joins the superficial venous system mentioned above at the confluence sinuses.

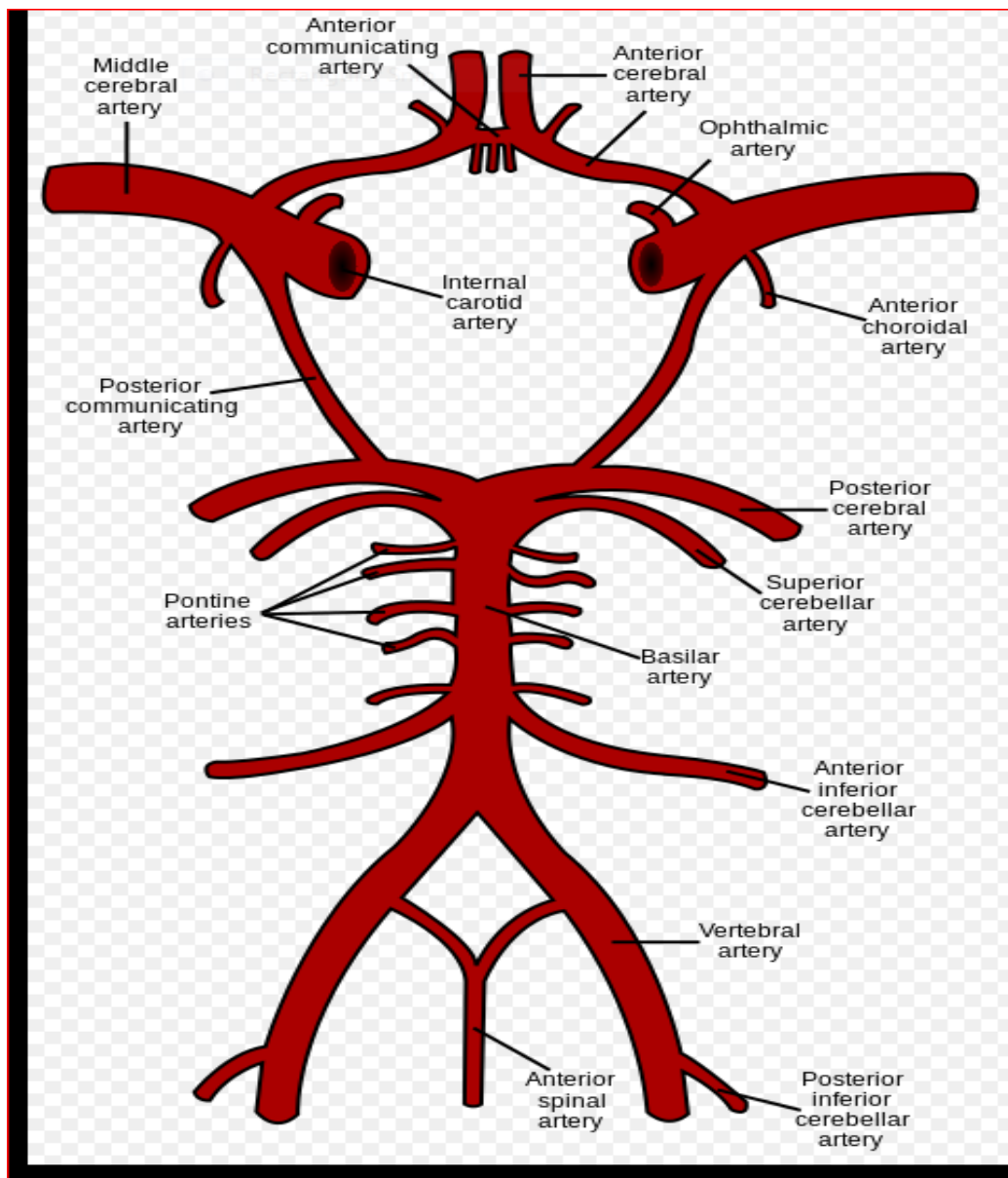


FG.2.8 cortical vascular territories.





FG.2.9 brain sinuses.



FG.2.10 Circle of WILLIS

## **2.28 Brain physiology:**

### **Cerebrum:**

The cerebrum is the largest of the brain, divided into 2 parts (halves) called left and right hemispheres and connected by a bridge of nerve fibers called the corpus callosum, the right hemisphere controls the left side of the body. The left hemisphere controls the right side of the body.

The outer surface of the cerebrum is called the cerebral cortex or gray matter it is the area of the brain where nerve cells make connections synapses that control brain activity the inner area of the cerebrum contains the insulated (myelinated) bodies of the nerve cells (axons) that relay information between the brain and spinal cord this inner area is called the white matter because the insulation around the axons gives it a whitish appearance. The cerebrum is further divided into 4 sections called lobes. These include the frontal, parietal, temporal and occipital.

### **Cerebellum:**

Is the next largest part of the brain. It is located under the cerebrum at the back of the brain, it is divided into 2 parts or hemispheres and has grey and white matter like the cerebrum. The cerebellum is responsible for movement, posture, balance, reflexes, complex actions, collecting sensory information from the body.

### **Brain stem:**

The brain stem is a bundle of nerve tissue at the base of the brain. It connects the cerebrum to the spinal cord and sends messages between different parts of the body at the brain. The brain stem has 3 areas midbrain, pons, and medulla oblongata. The brain stem controls breathing, body temperature, blood pressure, heart rate, hunger and thirst.

Cranial nerves emerge from the brain stem control facial sensation, eye movement, hearing, swallowing, taste and speech.

### **Cerebrospinal fluid (CSF):**

The (CSF) fluid is a clear watery liquid that surrounds and cushions and protects the brain and spinal cord. The CSF also carries nutrients from the blood and removes waste products from the brain. It circulates through

chambers called ventricles and over the surface of the brain and spinal cord the brain control the level of the CSF in the body.

Meninges:

The brain and spinal cord are covered and protected by 3 layers of tissue (membranes) called meninges

Dura matter:

Thickest outside.

Arachnoid layer: middle, thin.

Pia matter: inner, thin.

CSF flows in the space between the arachnoid and pia matter called subarachnoid space. The tentorium is a flap made of fold in the meninges it separates the cerebrum from the cerebellum.

The supratentorial area of the brain is the area above the tentorium it contains the cerebrum, lateral ventricles, third ventricle, and gland structure in the center of the brain.

The infratentorial area is located at the back of the brain below the tentorium it contains the cerebellum and brain stem this area is called the posterior fossa.

Corpus Callosum:

A bundle of nerve fibers between the 2 cerebral hemispheres it connects and allows communication between both hemispheres.

Thalamus:

Structure in the middle of the brain has 2 lobes it acts as a relay station for almost all information that come and go between the brain and the rest of the nervous system in the body.

Hypothalamus:

Is small structure in the middle of the brain below the thalamus it plays apart in controlling body temperature, hormones, secretions, blood pressure, emotions, appetite, and sleep pattern.

### Pituitary Gland:

Is small pea sized organ in the center of the brain it attached to the hypothalamus and secretes different hormones that affect other glands of the body endocrine system. It receives message from hypothalamus and release hormones that control the thyroid and adrenal glands as growth, physical, and sexual development.

### Ventricles:

They are fluid filled spaces (cavities) within the brain there are 4 ventricles.

2 lateral in the cerebral hemispheres. The third one is on the center of the brain surround by thalamus and hypothalamus. The fourth is at the back of the brain between the brain stem and cerebellum.

The ventricles are connected to each other by a series of tubes. The fluid in the ventricles is cerebrospinal fluid CSF flows through the ventricles around the brain in the space subarachnoid space and down the spinal cord.

### Pineal Gland:

Is a very small gland in the third ventricle of the brain it produces the hormone melatonin for sleeping, walking, and sexual development.

### Choroid Plexus:

Small organ in the ventricles that make CSF.

### Cranial Nerves:

There are 12 pairs of cranial nerves that perform specific function in the head and neck areas. The first pair starts in the cerebrum while the others 11pairs start in the brain stem. Cranial nerves are indicated by number Roman numeral or name.

### Cranial Nerves and Their function:

1-Olfactory: smell

11-Optic: vision and light detection by the pupil.

111-Oculomotor: eye movement upward down ward or inward, narrowing and widening of the pupil, lifting of the eyelid.

1V- Trochlear: eye movement down and inward.

V- Trigeminal: facial sensations, chewing.

V1- Abducens: outward eye movement.

V11- Facial: facial expression, closing of eyelid, taste in front part of the tongue.

11X- Acoustic: hearing, balance.

1X- Glossopharyngeal: swallowing, gag reflex, speech.

X- Vagus: swallowing, gag reflex, speech (vocal cord). Control of muscles in internal organs.

X1-Accessory: neck turning, shoulder shrugging.

X11- Hypoglossal: tongue movement.

### Blood Brain Barrier:

Is specialized system of blood vessels and enzymes that protect the brain from chemicals or toxins produced by bacteria. It helps maintain a constant environment for the brain.

The blood brain barrier is made up of very small blood vessels that are line within thin flat endothelial cells, they are packed tightly together so substances cannot pass out of the blood stream in to the brain the enzymes also restrict the types of substances that can be carried from blood in to the brain.

### Types of cells in the brain:

The brain made up of neurons and glial cells.

Neurons carry the signal that make the nervous system work they cannot replaced or repaired if they are damaged.

Glial cells:

Neuroglial cells these cells support, feed, and protect the neurons.

The different types of glial cells are:

- Astrocytes.
- Oligodendrocytes.
- Ependymal cells
- Microglial cells

## 2.29 Brain disease:

Brain disease comes in different form infection, trauma, stroke, seizures, and tumors are some of major categories of brain disease.

Infections disease:

Meningitis an inflammation of the lining around brain or spinal cord usually due to infection, neck stiffness, headache, fever, and confusion are common symptoms.

Encephalitis:

An inflammation of the brain tissues, usually due to viral infection, meningitis and encephalitis often occur together which is called meninges encephalitis.

Brain abscess:

A pocket of infection in the brain, usually caused by bacteria, antibiotic and surgical drainage of the area are often necessary.

Seizures:

A condition characterized by recurring seizures caused by abnormal and excessive electrical activity in the brain.

Trauma:

Concussion a brain injury that causes a temporary disturbance in brain functions, sometimes with unconscious and confusion, and may cause headache, along with concentration and memory problems.

Intracerebral hemorrhage:

Any bleeding inside the brain may occur after traumatic injury or stroke as a result of high blood pressure.

Tumor and Masses:

Increase pressure any abnormal tissue growth inside the brain whether malignant or benign usually cause problems by the pressure on the

On the normal brain.



#### Glioblastoma:

An aggressive cancerous brain tumor it progress rapidly and usually difficult to cure.

#### Hydrocephalus:

Increased amount of cerebrospinal fluid inside the skull because the fluid is not circulating properly.

#### Pseudo tumor cerebra:

Increase pressure inside the skull with no apparent cause, vision changes, headache, dizziness, and nausea are common symptoms.

#### Stroke:

Blood flow oxygen is suddenly interrupted to an area of the brain tissue which then may die. The body part controlled by the damaged brain area may no longer function properly.

#### Ischemic stroke:

A blood clot suddenly develops in an artery or is formed elsewhere in anterior artery and breaks off and lodges in the brain blood vessels blocking blood flow and cause stroke.

#### Hemorrhagic stroke:

Bleeding in the brain creates congestion and pressure on brain tissues impairing healthy blood flow and causing a stroke.

#### Transit ischemic attack (TIA):

A temporary interruption of blood flow and oxygen to a part of the brain symptoms are similar to those of stroke but they resolve completely usually within 24 hours without damage to the brain.

#### Brain aneurysm:

An artery in the brain develops a weak area that swell like a balloon. A brain aneurysm rupture cause stroke due to bleeding.

Subdural hematoma (SH):

Bleeding on surface of the brain may exert pressure on the brain causing neurological problems.

Epidural hematoma:

Bleeding between the skull and tough Dura lining the brain the bleeding is typically from artery usually shortly after head injury, initial mild symptoms can progress rapidly to unconsciousness and death if untreated. This is also referred to as an extradural hematoma.

Cerebral edema:

Swelling of the brain tissues which can be due to different causes.

Autoimmune conditions:

Vacuities an inflammation of blood vessels of the brain, confusion, seizures, headache and unconsciousness can result.

Multiple sclerosis (MS):

The immune system mistakenly attack and damage the body own nerves, muscle spam, fatigue, and weakness are symptoms, may occur in periodic attacks or be steadily progressive.

Neurodegenerative conditions:

Parkinson's disease nerve in internal area of the brain degenerate slowly causing problems with movement and coordination early signs are tremor of the hands, stiffness of the limbs and truck, slowness of movement and unstable posture.

Huntington's disease:

An inherited nerve disorder that causes degeneration of brain cells, dementia and difficulty controlling movements are symptoms, depression and irritability.

Picks disease:

Frontotemporal dementia over years large areas of the nerve at the front sides of the brain are destroyed due to buildup of abnormal protein. Personality changes, difficulty speech and loss of memory, intellectual ability are symptoms. Steadily progressive.

Amyotrophic lateral sclerosis:

Nerves controlling muscles function are steadily and rapidly destroyed, progress to paralysis and inability to breathe without mechanical assistance.

Dementia:

A decline in cognitive function due to death or malfunction of nerve cells in the brain, condition in which nerves in the brain degenerate as well as alcohol abuse and stroke can cause dementia.

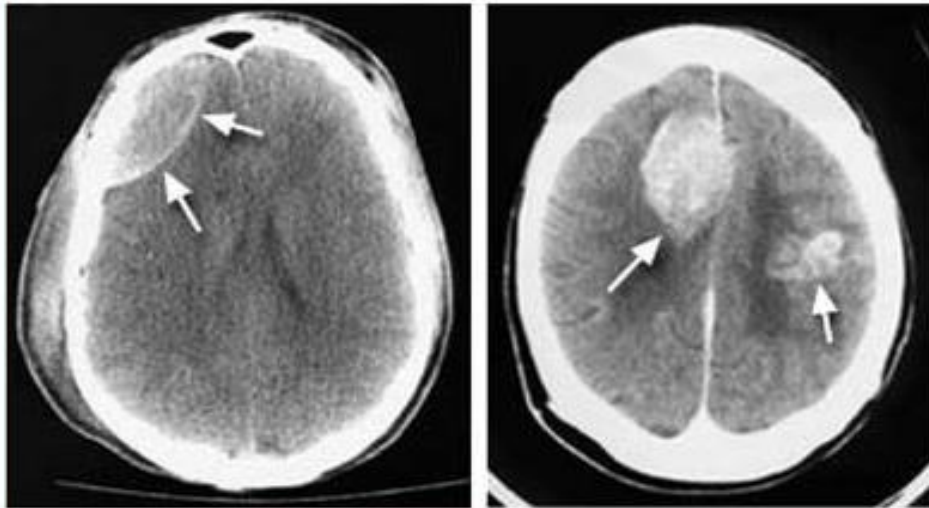
Alzheimer's disease:

For unclear reasons nerves in certain brain areas degenerate causing progressive loss of memory and mental function and change in behavior and personality. The buildup of abnormal tissue in brain areas.

Alzheimer's is the most common form of dementia.

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## CT scan images of the brain



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Left: Arrows indicate a collection of blood between the skull and the outer covering of the brain (epidural hematoma) that's compressing the frontal lobe. Right: Contrast material injected into a vein during this CT scan of the head highlights tumors in both sides of the brain.

FG.2.11 CT brain with and without contrast for comparison.

### **2.30 Head injuries diagnosis:**

The full extent of the problem may not completely understand immediately after injury but may be revealed with a comprehensive medical evaluation and diagnostic.

### **2.31 Diagnostic tests:**

1. EEG electroencephalogram.
2. CT scan.
3. MRI

### **2.32 Importance CT in head trauma:**

C.T is more advantage in the evaluation of the head trauma and can detect abnormality of soft tissues and bone in one scan and also so fast in golden hour for the traumatic patients.

So C.T scan is very important in emergency department.

### **2.33 Toshiba Aquilion 16**

The Toshiba Aquilion I6 is a third generation multi-slice helical CT scanner. Featuring a 60 kW generator, 7, 5 MHU tube and a fastest scanners on CFX data per rotation time of 0.5 seconds (0.4 seconds optional, standard on CFX cardiac version). In helical mode it is capable of acquiring 16 parallel rows of data per rotation. With collimations of  $16 \times 0.5$  mm,  $16 \times 1$  and  $16 \times 1$  mm. More detailed specifications are given in the next section of this report.

The Aquilion 16 is development of the Toshiba Aquilion Multi 4-slice system. The main hardware difference between the two is that the Aquilion 16 is capable of acquiring sixteen rows of data per rotation,



FG.2.12 CT AQUILLION 16 SLICE

Compared to the Aquilion four. There are also differences in the computer hardware used. And in the techniques for reconstructing images from helical data. Based upon the 3-dimensional Feld Kamp back-projection method.

### **2.34 Summary:**

The scanners close efficiency figure.  $Q_2$  is typical for head and body scanning when compared to the other sixteen-slice scanners In1PAC T has assessed Scanners with higher  $Q_2$  values will require lower patient Closes in order to produce images of a given image quality in terms of spatial resolution and image noise. The high contrast spatial solution of the scanner in both the x- y plane and along the z-axis. Is typical for a top range system.

The inter-slice variation of image noise and slice thickness is good a benefit of 16-slice scanning is an increase in geometric: efficiency is 37% in 4-slice mode and 69 % in 16- slice mode. For 2 nun slices the figures are 75% and 87% for 4- and 16 –slice modes respectively

When operating in axial mode the scanner is routinely limited to the acquisition of 4 simultaneous slices. This is to avoid the introduction of cone-beam artifacts.

The default helical reconstruction algorithm. Known as its TCOT. is based on a 3-dimensional Feldkamp back-projection method and is effective at suppressing cone-beam artifacts, as TCOT does not make use of complementary data projections, increased image noise is

Observed when compared to using the conventional Toshiba -4-slice reconstruction algorithm MUSCOT.

In addition a wind mill artifact correction is available 'when spiral scanning With either 16 x 1 or 16 x 2 mm collimation.

Impact. Assessment of low contrast detachability on the Catphan phantom showed that 0.3% contrast details of 6 mm diameter were visible in more than 50% of images at a surface dose of 25 m Gy.

### **2.35 Scanner specification**

#### **Scanner gantry:**

Generation	3rd
Aperture (cm)	72
Maximum scan field of view (cm)	50
Normal slice widths for axial scans (mm)	0.5, 1.0, 2, 3, 4, 6, 8

#### **Couch:**

Length and width (cm)	218.7×47 (188.7×47 short version)
Horizontal movement range (cm)	219 (189 short version)
Vertical movement range out of gantry (cm)	31-95.4
Maximum weight on couch (kg)	205

#### **Tube and generator:**

<b>Generator power rating (KW)</b>	<b>60</b>
Anode heat capacity (MHU)	7.5
Maximum anode cooling rate (KHU/ min)	1386
Guaranteed tube life (revolutions)	3000000



**Detection system:**

Number of elements along Z-axis 40

Effective length of each element at isocentre (mm)  $16 \times 0.5$ ,  $24 \times 1$

Total effective length of detector array at isocentre (mm) 32

Future option for more slices / rotation none currently

**System Start –up and calibration:**

Total start –up time (in routine use) 2 min. from fully off .0 from stand by.

Time to perform full set detector calibrations (mints) up to 20

**Scanning:**

Helical pitches (range and increment .quoted relative to x-ray beam width, known as pitch)

**Operators Console:**

Number of monitors at console 2 (acquisition /review and

Processing)

Control methods mouse, cursor, and keyboard

**Image storage:**

Total hard disk storage capacity supplied as standard (G bytes) 234

Archive options MOD

**Image Reconstruction:**

Time (s) from the start of data acquisition to the appearance of the 30<sup>th</sup> image of a series.

(i) Standard axial brain scan	20
(ii) Helical abdomen scan	20
Simultaneous scanning and reconstruction	Yes

### **3D Reconstruction:**

3D reconstruction software MIPS, MinIPs, SSD, MPR,  
3D Volume rendering, 3DVirtual Endoscopy (optional on console)

### **Additional Facilities:**

Independent Workstation	Standard
Contrast injector	Optional
Contrast media bolus tracking	Optional
Real time CT and fluoroscopy	Optional
CT Angiography	Standard
Prospective ECG –triggered cardiac software	standard
Dental	Optional

### **Image Transfer /Connectivity:**

DICOM service classes provided by CT console (SCP and SCU)

Speed of scanner /workstation connections to local area network  
(Mbits/s).

## 2.36

### TMH – TRAUMA BRAIN TOSHIBA AQUILION 16 PROTOCOL

**Indications: Non contrast: CVA, intracranial bleed, mental status change, trauma**

<b>Position/Landmark</b>	Head first or feet first-Supine 1cm superior to skull vertex				
<b>Topogram Direction</b>	Craniocaudal				
<b>Scan Type</b>	Axial				
<b>Respiratory Phase</b>	Any				
<b>KV / mA / Rotation time (sec)</b>	120kv 320mas 1sec				
<b>Detector width x Rows = Beam Collimation</b>	.5 mm x 16 = 8mm				
<b>Axial Set</b>	recon	body part	thickness/ spacing	kernel	recon destination
Slice Thickness/ Spacing	axial 1	brain	4.mm x 4.mm	FC30	pacs
Kernel	axial 2	skull	4.mm x 4.mm	FC64	pacs
Recon Destination					
<b>Scan Start / End Locations</b>	skull base skull vertex				
<b>DFOV</b>	25 cm decrease appropriately				
<b>Gantry Angle</b>	15 degrees cephalad to the OML				
<b>IV Contrast Volume / Type / Rate</b>					
<b>Scan Delay</b>					
<b>Archiving to MOD</b>	Only prospective recons will be archived to mod as done by the scanner				
<b>2D/3D Technique Used</b>					
<b>Comments:</b>					
<b>Note:</b>					
<b>Images required in PACS</b>	Scanogram , 4mm x 4mm axial brain, 4mm x 4mm axial skull				

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### **2.37 Reducing: reducing dose in body CT:**

**Objective:** the purpose of these articles.

Is to describe how to interpret radiation dose metric data available on body CT dose report and to explain the effects of key operator chosen CT parameters on patient radiation dose.

**Conclusion :** it apply dose reduction strategies in body Ct Radiologists must understand , the information contained in the CT dose report and know the effects of key CT technical parameters on patient reduction exposure.

**Radiologists:** should adhere to both the principle of ALARA as low as reasonably a checkable referring to be fit the objectives to achieve diagnostic – quality images.

#### **CT dose report:**

To understand and mark optimal use of dose reduction strategies in CT .radiologist should first be familiar with the concepts of exposure absorbed dose and effective dose.

The term exposure refers to the intensity of an x.-Ray beam. It is a measure of the ability of an x- ray beam to ionize air.

The absorbed radiation dose is the amount of energy absorbed per unit mass, measured in grays ( $1 \text{ Qi} = 1 \text{ J/kg}$ )

The effective dose is the uniform whole body dose that result in the same stochastic risk as the absorbed dose from any given no uniform exposure such as a CT examination.

Currently CT scan provides dose data for each examination in dose report as a D icon.

Image that can be easily stored in PACS, for future study. The most important in the dose report is the (CTDI<sub>vol</sub>) and the dose length product (DLP) – (CTDI) and (DLP) expressed in (MGY).

The DLP, expressed in. (MQyxc<sub>m</sub>), is the product of the CTDI<sub>vol</sub>(mag) and scan length (cm) . it represents the integrated dose over the length (cm) of the exposure and reflects the total amount of radiation incident on the patient . A change in DLP reflects changes to CT dose parameters and changes in scan length.

### **2.38 Body size: Adopted CT protocols:**

Body size -adopted CT protocols is a fundamental part of CT dose optimization because the minimal radiation dose required for diagnostic image quality would be varied even at the same diagnostic depending on body size and habitués. Then the optimal tube voltage and current should be determined for the adapted radiation dose, one of the common misconceptions is that lowering the tube voltage at the same tube current is a good strategy for low dose.

CT. actually a higher tube current should be used at a lower tube potential to compensate for the increased image noise.

### **Tube current modulation:**

The tube current modulation greatly contributes CT dose optimization by reducing the CT dose according to body size, shape and attenuation without degrading image quality . the tube current may be adjusted in the x – y plane ( angular modulation ) , the Z-axis or combination of both CT. dose reduction achieved by tube current modulation has been reported to be up to 28-50% in children and adults (25 -27%).

### **2.39 Optimal tube voltage:**

Optimal tube voltage should be determined for patient size and each type of CT examination to achieve an optimal tradeoff between contrast noise artifacts and scanning speed .contrast knowledge on CT physics and the diagnostic purposes of CT examination is mandatory for the task .the importance of optimal tube voltage has been recently emphasized for CT dose optimization in order to maximize the clinical benefits of CT examination at low radiation dose and in order to determine the most dose efficient tube voltage- Based on CT physics the iodine contrast image noise, and iodine contrast to noise ratio (CNR) show different behaviors at different tube voltage and different phantom size . Increasing iodine contrast at lower tube voltage that is decreasing for larger phantom and dramatic increase in noise level for a 40 – cm phantom.

Markedly increasing iodine CNR at lower tube voltage for a 10-cm phantom and minimally increasing iodine CNR at lower tube voltage for 40- cm phantom. In regard to the diagnostic task radiologist should determine the degree of importance of iodine CNR or image noise for particular type of CT. Examination .in general iodine CNR is

more important in contrast-enhanced examinations while image noise is more important in pre-contrast examination or in detecting low-contrast lesions, and is less important in detecting high-contrast lesions, image noise should be sufficiently low to increase contrast. This can be achieved not only by using an adaptive noise reduction filter or sliding-thin-slab averaging algorithm but also by simply using a higher tube voltage. A higher noise at lower tube voltage may affect the assessment of ground glass opacity in the lungs.

Higher tube voltage is also commonly used in an unenhanced brain CT requiring lower noise in assessing low-contrast intracranial structures. A general strategy for selecting optimal tube voltage at different body parts to get different contrast.

#### **2.40 Noise – Reducing image reconstruction Algorithms:**

The use of noise-reducing image reconstruction may have a potential to reduce the CT radiation dose. However, conventional noise-reduction filters decrease image noise but simultaneously decrease lesion contrast.

Using (IR) iterative reconstruction, a dose reduction of 40-50% can be achieved without degrading image quality. (IR) reconstruction algorithms are continuously improving, with most image quality and reconstruction speed.

We may anticipate that conventional filtered back projection will eventually be replaced by an iterative reconstruction algorithm and that high image quality will be achieved.



## **CHAPTER THREE**

**Material and method.**

### **3.1 Material and method.**

Location: emergency department in Madinat zayed hospital UAE united Arab Emirates.

Equipment: Toshiba CT Scanner 16 slice.

Tools: Adult phantom for head and body standard.

Objection: Apply technical protocol to reduce the CT radiation dose in trauma cases by decreasing the MA (tube current), the target reduction is 50%.

Method: performing scanning on adult phantom for trauma protocol for head.

Phase: Scan (1): reference scans 300 MA to be registered in exposure log shot and calculate the dose in msv.

Scan (2): reducing the MA to 200 MA and requested the dose received, and evaluate the image quality by technologist and radiologist.

Scan (3): reducing the MA to 100 MA and requested the dose received and evolution the image quality by technologist and radiologist.

Phase (2): (implement if phantom image is of acceptable quality).

1. Performing CT head trauma with default exposure parameters and registered the dose received.

(Reference scan) can be obtained from previous CT head trauma.

2. Performing CT head trauma with reduction of MA factor to 200 MA and registering the dose received .image to be evaluated by the technologist and radiologist.

3. Performing CT head trauma with reduction of MA factor to 100 MA and registering the dose received image also to be evaluated by the technologist and radiologist.
4. Applying the recommendation CT technologist and radiologist on the range of accepted quality image and delineate the reduction rate.

Samples: we apply new exposure factors for 26 patients with 100 MA 28 patients with 200 MA.

Total samples are 54 patients.

To get the effective dose the (DLP)(Dose length product) is to be multiplied by the K constant this K varies from one anatomical region to another and from children to adults.

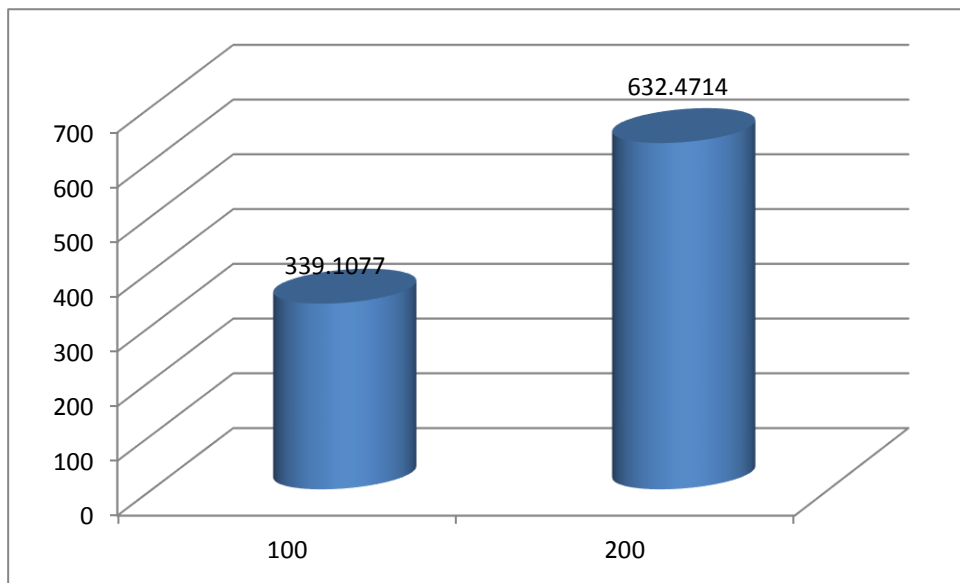
So the K constant for the adult brain is (0.0025).

## **CHAPTER FOUR**

### **RESULT**

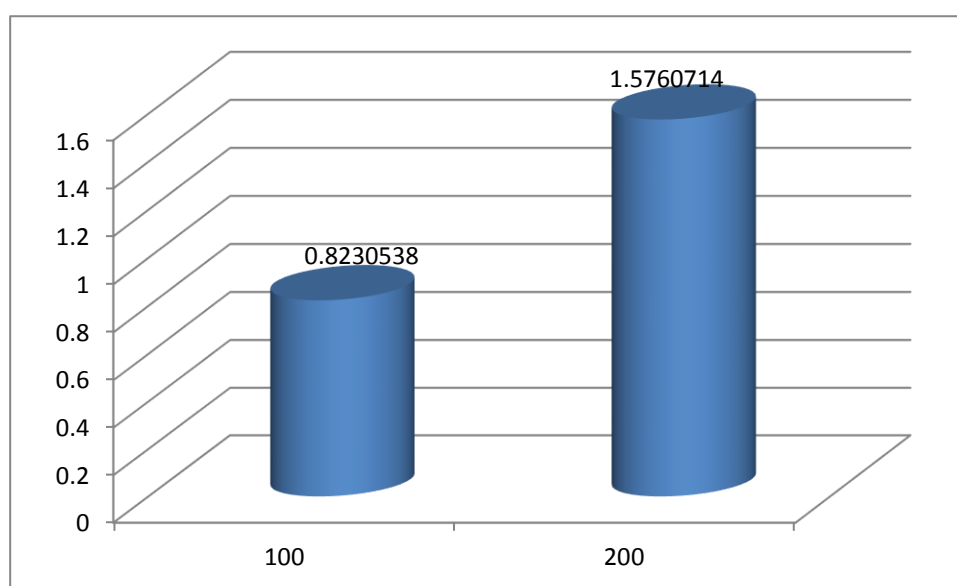
DLP

AM	Mean	N	Std. Deviation
100	339.1077	26	28.00958
200	632.4714	28	38.50818
Total	491.2222	54	151.71337



Effective Dose

AM	Mean	N	Std. Deviation
100	.823	26	.148
200	1.576	28	.0960
Total	1.213	54	.399



Performed scan for 54 cases 28cases with 200mA and 26cases It with100mA .The result was found clearly that the absorbed dose and the Effective dose they fall down to the half when using 200mA and it Fall more than that when we used 100mA as tube current.

## DLP

AM	N	Mean	Std. Deviation	T-Test	d-f	P- Value
100	26	339.1077	28.00958	-32.175	52	0.00*
200	28	632.4714	38.50818			

\*significant different at the 0.05 level.

## Effective Dose

AM	N	Mean	Std. Deviation	T-Test	d-f	P- Value
100	26	.82305	.1483190	-22.305	52	0.00
		38	5			
200	28	1.5760	.0960454			
		714	9			

\*significant different at the 0.05 level.

**One-Sample T-test DLP(AM100)**

N	Mean	Std. Deviation	T-Test	d-f	P- Value
26	339.10 77	28.00958	- 203.50 7	25	0.00*

\*significant different at the 0.05 level.

**One-Sample Effective Dose**

N	Mean	Std. Deviation	T-Test	d-f	P-Value
26	.8230538	.14831905	-96.843	25	0.00*

\*significant different at the 0.05 level.

**One-Sample T-test DLP(AM200)**

N	Mean	Std. Deviation	T-Test	d-f	P- Value
28	632.471 4	38.50818	- 203.50 7	25	0.00*

\*significant different at the 0.05 level.



**One-Sample Effective Dose(AM200)**

N	Mean	Std. Deviation	T- Test	d-f	P- Value
28	1.5760 714	.09604549	- 113.7 09	27	.000

\*significant different at the 0.05 level.

## **CHAPTER FIVE**

### **Discussion, Conclusion, and Recommendations**

## **Discussion, Conclusion, and Recommendations:**

### **5-1 Discussion**

Even though it is possible to perform a spiral C.T with lower radiation dose than slice – by- slice C.T, practice the patient ( scan volume , MAS, pitch slice with limit the scanned volume ,reduce MAS values use automatic exposure control by adapting the scanning parameters to the patient Cross section 10-15% reduction in dose documental without any loss of image quality.

When we analyzed the data collected from Madinat Zayed hospital .you can see the factor of tube current 200MA IS and still the image quality can be diagnosed by the radiologist and reported.

The main of the dose for 100 MA data is 0.823 msv and for the 200 MA is 1.576 msv and for the references dose 300 MA is 3.6 msv.

So when decrease tube current to 200 MA so get only 1.576msv which is the half of the normal exposure or radiation dose if reduce tube current to 100 MA we get only 1\4 quarter of the normal dose.

### **5-2 Conclusion:**

Reduction of MA factor in CT parameters will induce reduction in CT dose to the patient and this can be applied to all CT cases.

Remarks: CT trauma with reduced MA can be viewed and review the radiologist reports.

### **5-3 Recommendations:**

- I hope more study can be done in many items affect CT spiral and radiation dose reductions.
- Radiologist can read the noise image to safe patients from radiation.

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## Appendix

### Appendix (1) Data collection Sheet

patients	Tube current mA.	DPL.mG cm	Effective dose msv.
Reference	300	1457	3.64
1	200	657.6	1.64
2	200	641.5	1.60
3	200	602.7	1.50
4	200	654.2	1.58
5	200	600.1	1.50
6	200	681.9	1.70
7	200	665.4	1.66
8	200	651.3	1.62
9	200	659.5	1.64
10	200	589.9	1.47
11	200	657.2	1.64
12	200	601.3	1.50
13	200	598.7	1.49
14	200	641.6	1.60
15	200	674.3	1.69
16	200	597.8	1.49
17	200	613.4	1.53
18	200	618.9	1.54
19	200	639.4	1.59

20	200	587.5	1.71
21	200	599.8	1.49
22	200	630.9	1.57
23	200	635.4	1.58
24	200	661.2	1.65
25	200	633.8	1.58
26	200	664.3	1.66
27	200	559.7	1.40
28	200	609.9	1.52
29	100	328.8	0.822
31	100	300.0	0.750
31	100	319.7	0.799
32	100	301.3	0.753
33	100	315.4	0.788
34	100	299.9	0.749
35	100	300.8	0.752
36	100	302.5	0.756
37	100	329.7	0.844
38	100	318.9	0.797
39	100	321.8	0.804
40	100	291.9	0.729
41	100	313.0	0.782
42	100	311.8	0.779
43	100	331.7	0.829
44	100	321.5	0.803
45	100	308.7	0.771
46	100	319.8	0.799
47	100	312.4	0.781

48	100	330.2	0.825
49	100	321.9	0.804
50	100	312.7	0.781
51	100	307.3	0.768
52	100	320.2	0.800
53	100	299.9	0.749
54	100	337.5	0.843
55	100	329.7	0.824
56	100	307.8	0.769