بسم الله الرحمن الرحيم

Sudan University of Science and Technology

College Of Graduate Studies

A Study of Complication of Head Injuries using Computerized Tomography scan

دراسة مضاعفات إصابات الرأس باستخدام الاشعة المقطعية المحوسبة

A Thesis Submitted For Partial Fulfillment for the Requirement of (M.Sc) Degree in Medical Diagnostic Ultrasound

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الآية

قال الله تعالى:

(سَنُرِيهِمْ آيَاتِنَا فِي الْآفَاقِ وَفِي أَنفُسِهِمْ حَتَّى يَتَبَيَّنَ لَهُمْ أَنَّهُ الْحَقُّ)

صدق الله العظيم

فصلت الآية(53)

Dedication

To my mother,

Sisters

My husband and my daughter.

Acknowledgment

I would like to thank everyone who helps me in way or another to make this work appear to light especial thanks to my supervisor

Dr. Ikhlas Abd Eleziz Hassan Mohammed

Abstract

The study was conducted in Military hospital (medical corps) in the ER hospital and Aliaa hospital in Omdurman city in 2018 with population sample of 70 patients. The data collected from Radiology Department of those hospitals by using a CT machine (TOSHIBA aqilion 64) and these datd collected according to data sheet involved and analysis by SPSS.

The study focused on the complications of the head injuries by using CT due to increase of cars traffic movement and high way roads; the RTA increased and traumatic brain injuries increased which had high risk of death among population so it need accurate evaluation and the CT is the best accurate modalities to determined head injuries (both bony and soft tissue injuries).

A descriptive study designed to study the role of CT scan in detection of complications in patient with head injuries and to correlate these CT findings to age and gender. The study main findings that fractures were most common abnormality of patients with head injuries 51.4%. And Road traffic accident (RTA) is the main cause of head injuries54.3%. And males have high ratio to head injuries compare with females74.3%to 25.7% and the most common group affected were (18-30).

Finally, the study concluded that the CT is the best accurate modalities to determine head injuries (both bony and soft tissue injuries) and most of the head injuries were caused by RTA. The study concluded that there was relation between complications of head injury and age.

The study recommended that educational programs exist to lower the number of crashes, a new technique must exist in cars that prevent head trauma to the people inside the cars which were (air bags) should be found in Sudan or as safety criteria of traffic policy, the government hospitals (especially in far states) should be provided by CT scanning machines and more researches should be done using large sample of patients for further assessment.

المستخلص

أجريت هذه الدراسة في المستشفى العسكري (السلاح الطبي) تحديدا في مستشفى الطوارئ والإصابات و أيضا مستشفى عليا التخصصي في امدرمان 2018 باستخدام جهاز (توشيبا 64). وعدد المرضى تحت الدراسة 70 مريض وقد تم اخذ البيانات وفق ورقة جمع البيانات من أقسام أشعة المستشفيات المذكورة.

الدراسه ركزت على مضاعفات اصابة الرأس باستخدام الاشعه المقطعية لازدياد السيارات وحركة المرور مما ادى الى زيادة الحوادث المرورية وبالتالي زيادة اصابات الراس ولذلك تحتاج الى تقييم دقيق و سريع وتعتبر الاشعه المقطعيه افضل خيار لذلك لقدرتها في الكشف عن الاصابات في العظم والانسجه في وقت قصير.

هدفت الدراسة إلى وصف دور الأشعة المقطعية في الكشف عن المضاعفات التي تحدث للمرضى الذين لديهم إصابات رأس وربطها بالعمر والجنس.

تم تحليل البيانات باستخدام برنامج الحزمة الاحصائية للعلوم الاجتماعية(SPSS).

وتمثلت النتيجة الرئيسية في أن الكسور هي اكبر المضاعفات التي تحدث للمرضى الذين لديهم إصابات رأس51.4%. وان حوادث الطرق هي اكبر المسببات إصابات الرأس54.3%. وان الرجال أكثر عرضه لإصابات الرأس مقارنة بالنساء74.3% للرجال و25.7% للنساء وان الفئة العمرية الاكثر عرضه لهذه المضاعفات ما بين (18−30) سنه.

خلصت الدراسة بان الاشعه المقطعيه تعتبر أفضل الخيارات في تحديد اصابة الرأس لقدرتها في الكشف عن الاصابات في العظم و الانسجة.

توصي الدراسة بانشاء برامج تعليمية توعوية لخفض حوادث السير وايضا وضع تقنية الاكياس الهوائية في السيارات كجزء اساسي من معايير السلامه, وامداد المستشفيات الحكومية باجهزة الاشعة المقطعية كجزء من الكشف المبكر عن مضاعفات اصابات الرأس, واخيرا المزيد من البحوث المستقبلية باستخدام مجموعات كبيرة تحت الدراسة.

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List of Abbreviations

CSF	Cerebro Spinal Fluid
CT	Computed Tomography
GCS	Glasgow Coma Score
ICP	Intra Cranial Pressure
Iv	Intravenous
LOC	loss of Consciousness
MRI	Magnetic Resonance Imaging
RTA	Road Traffic Accident
SPSS	Statistical Package of Social Sciences
TBI	Traumatic Brain Injury

Chapter one

Introduction

1-1 Introduction

Computed tomography (CT) is a vital top in the assessment of patients with a serious head injury and revolutions management when it was introduced. (hptt://www.nlm.nih.medlineplus/ency/artcle/000713htm, 12-2011)

It remain the investigation of choice, even following the advent of magnetic resonance imaging (MRI) due to both easy monitoring of injured patients and the petter of demonstration of fresh bleeding and bony injury , and it can performed without intravenous contrast media administration. (hptt://www.nlm.nih.medlineplus/ency/artcle/000713htm, 12-2011)

The brain is the bulb of the central nervous system and control the body functions and processes, it weight about three pounds and surrounds by protective bone called skull or cranium, and it has a texture of gelatin and is held together by three layers of membrane called pia, dura, and arachnoid matter, between pia and arachnoid matter is subarachnoid space through which a network of arteries and veins carry blood from and to the heart, injury to those blood vessels caused hematomas. (hptt://www.nlm.nih. medlineplus/ency/artcle/000713htm, 12-2011).

This injury it can affect brain tissue or other part of the head such as scalp and skull, it may be open or closed. The main cause of these traumatic head injuries it may be traffic or sport accident falls assault. The incidence of the head trauma injuries increased in the last decade due to transportation and car accident. (hptt://www.nlm.nih.medlineplus/ency/artcle/000713htm, 12-2011).

Most patients with traumatic head injuries 75%-80% have a mild head injury and are divided equally between moderate and severe categories. (hptt://www.nlm.nih.medlineplus/ency/artcle/000713htm, 12-2011).

1-2 Problem of the study:

With increase cars, traffic movement and high way roads; the RTA increased and traumatic brain injuries increased which have high risk of death among population so it is need accurate evaluation and the CT is the best accurate modalities to determine head injuries (both bony and soft tissue injuries), The limitations of routine skull x-ray in detection and characterization of traumatic brain injury and difficulties of MRI to monitoring injured patients and demonstrating fresh bleeding and bony injury.

1-3 Research Objectives:

1-3-1 General objective:

The main objective of this study is to study complication of head injuries by using CT.

1-3-2 Specific objectives:

a- To detect the complications of head injuries.

b- To correlate types of head injuries with complication occurs.

c- To assess correlation between age and complications.

1-4 overview of the stud:

- **Chapter one:** Introduction and objectives.
- **Chapter two:** Literature review, anatomy and physiology of the brain, head trauma, computed tomography (CT).
- **Chapter three:** Materials and methods.
- **Chapter four:** Results presentation.
- **Chapter five:** Discussion, Conclusion and Recommendations as well as References used in this research.

Chapter Two

Literature Review and Previous Studies

2-1 Anatomy and physiology of the brain:

The brain is composed of the cerebrum, cerebellum, and brainstem

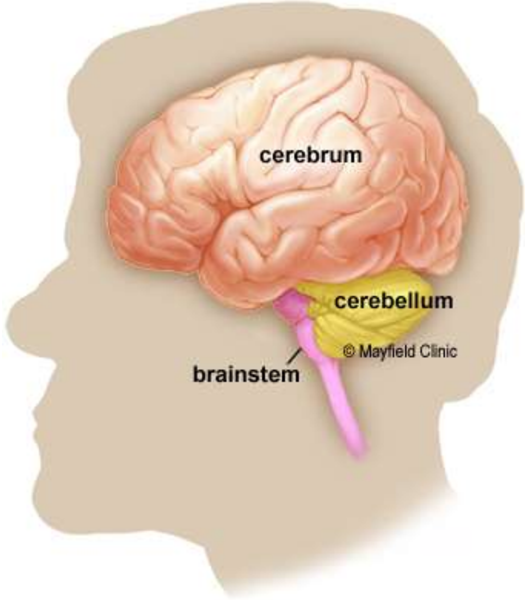

Fig (2. 1)show the three main parts of the brain: the cerebrum, cerebellum and brainstem. http://www.springer.com/978-1-4419-9996-2

2-1-i-Cerebrum:

Is the largest part of the brain and is composed of right and left hemispheres. It performs higher functions like interpreting touch, vision and hearing, as well as speech, reasoning, emotions, learning, and fine control of movement.

The cerebrum is divided into two halves: the right and left hemispheres .They are joined by a bundle of fibers called the corpus callosum that transmits messages from one side to the other. Each hemisphere controls the opposite side of the body. If a stroke occurs on the right side of the brain, the left arm or leg may be weak or paralyzed.

Not all functions of the hemispheres are shared. In general, the left hemisphere controls speech, comprehension, arithmetic, and writing. The right hemisphere controls creativity, spatial ability, artistic, and musical skills. The left hemisphere is dominant in hand use and language in about 92% of people.

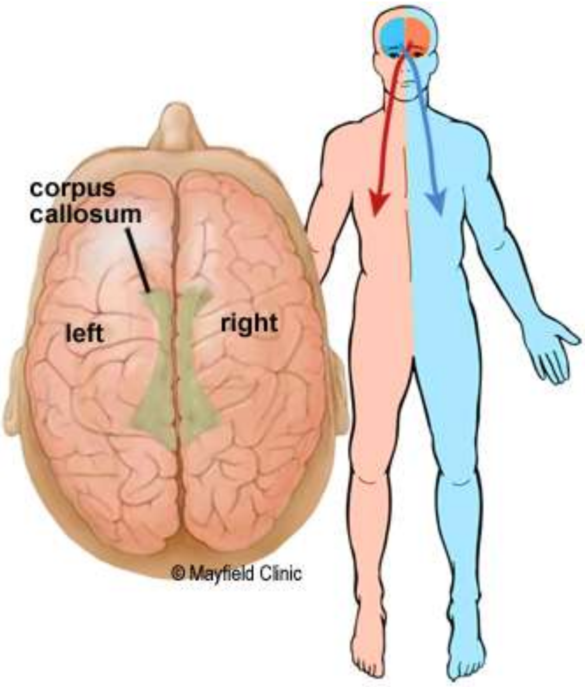

Fig (2. 2) Show the division of the cerebrum into left and right hemispheres. The two sides are connected by the nerve fibers corpus callosum. http://www.springer.com/978-1-4419-9996-2

2-1-ii- Cerebellum:

Is located under the cerebrum. Its function is to coordinate muscle movements, maintain posture, and balance.

2-1-iii- Brainstem:

Acts as a relay center connecting the cerebrum and cerebellum to the spinal cord. It performs many automatic functions such as breathing, heart rate, body temperature, wake and sleep cycles, digestion, sneezing, coughing, vomiting, and swallowing.

2-1-2 Lobes of the brain:

The cerebral hemispheres have distinct fissures, which divide the brain into lobes. Each hemisphere has 4 lobes: frontal, temporal, parietal and occipital.

Each lobe may be divided, once again, into areas that serve very specific functions. It's important to understand that each lobe of the brain does not function alone. There are very complex relationships between the lobes of the brain and between the right and left hemispheres.

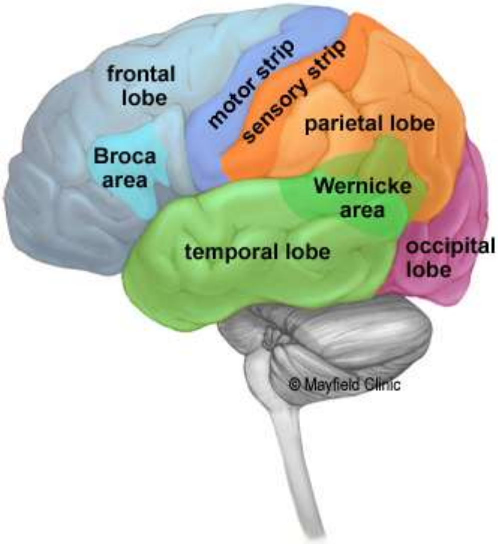

Fig (2. 3) Show the cerebrum division into four lobes: frontal, parietal, occipital and temporal. http://www.springer.com/978-1-4419-9996-2

2-1-2-a Frontal lobe:

- Personality, behavior, emotions
- Judgment, planning, problem solving
- Speech: speaking and writing (Broca's area)
- Body movement (motor strip)
- Intelligence, concentration, self awareness

2-1-2-b Parietal lobe:

- Interprets language, words
- Sense of touch, pain, temperature (sensory strip)
- Interprets signals from vision, hearing, motor, sensory and memory
- Spatial and visual perception

2-1-2-c Occipital lobe:

Interprets vision (color, light, movement)

2-1-2-d Temporal lobe:

- Understanding language (Wernicke's area)

- Memory
- Hearing
- Sequencing and organization

2-1-3 Cortex:

The surface of the cerebrum is called the cortex. It has a folded appearance with hills and valleys. The cortex contains 16 billion neurons (the cerebellum has 70 billion = 86 billion total) that are arranged in specific layers. The nerve cell bodies color the cortex grey-brown giving it its name – gray matter. Beneath the cortex are long nerve fibers (axons) that connect brain areas to each other — called white matter.

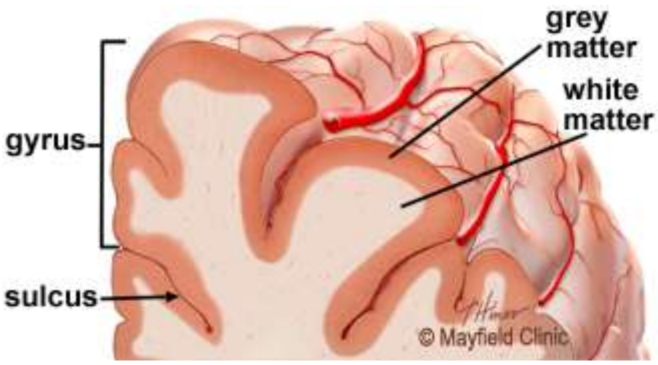

Fig (2. 4) Show The cortex contains neurons (grey matter), which are interconnected to other brain areas by axons (white matter). The cortex has a folded appearance. A fold is called a gyrus and the valley between is a sulcus. http://www.springer.com/978-1-4419-9996-2

The folding of the cortex increases the brain's surface area allowing more neurons to fit inside the skull and enabling higher functions. Each fold is called a gyrus, and each groove between folds is called a sulcus. There are names for the folds and grooves that help define specific brain regions.

2-1-4 Deep structures:

Pathways called white matter tracts connect areas of the cortex to each other. Messages can travel from one gyrus to another, from one lobe to another, from one side of the brain to the other, and to structures deep in the brain

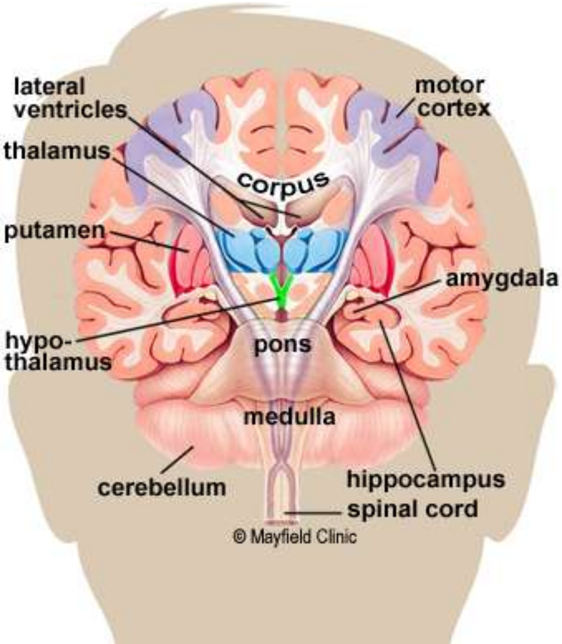

Fig (2. 5) Show Coronal cross-section showing the basal ganglia.

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A. Hypothalamus:

Is located in the floor of the third ventricle and is the master control of the autonomic system. It plays a role in controlling behaviors such as hunger, thirst, sleep, and sexual response. It also regulates body temperature, blood pressure, emotions, and secretion of hormones.

B. Pituitary gland:

Lies in a small pocket of bone at the skull base called the sella turcica. The pituitary gland is connected to the hypothalamus of the brain by the pituitary stalk. Known as the "master gland," it controls other endocrine glands in the body. It secretes hormones that control sexual development, promote bone and muscle growth, and respond to stress.

C. Pineal gland:

Is located behind the third ventricle. It helps regulate the body's internal clock and circadian rhythms by secreting melatonin. It has some role in sexual development.

D. Thalamus:

Serves as a relay station for almost all information that comes and goes to the cortex. It plays a role in pain sensation, attention, alertness and memory.

E. Basal ganglia:

Includes the caudate, putamen and globus pallidus. These nuclei work with the cerebellum to coordinate fine motions, such as fingertip movements.

F. Limbic system:

Is the center of our emotions, learning, and memory. Included in this system are the cingulate gyri, hypothalamus, amygdala (emotional reactions) and hippocampus (memory).

Memory:

Memory is a complex process that includes three phases: encoding (deciding what information is important), storing, and recalling. Different areas of the brain are involved in different types of memory.The brain has to pay attention and rehearse in order for an event to move from short-term to long-term memory – called encoding.

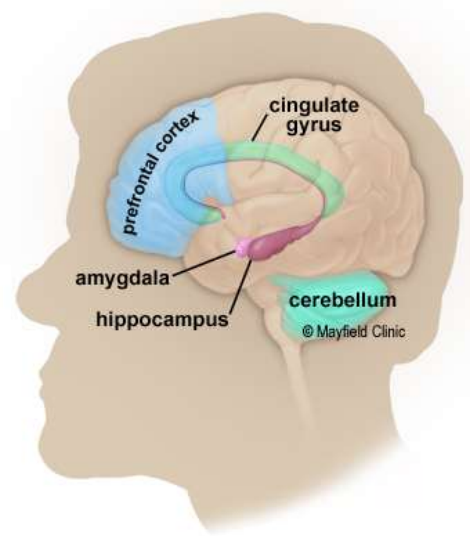

Fig (2. 6) Structures of the limbic system involved in memory formation. The prefrontal cortex holds recent events briefly in short-term memory. The hippocampus is responsible for encoding long-term memory. http://www.springer.com/978-1-4419-9996-2

i. -Short-term memory: also called working memory, occurs in the prefrontal cortex. It stores information for about one minute and its capacity is limited to about 7 items. For example, it enables to dial a phone number someone just told you. It also intervenes during reading, to memorize the sentence you have just read, so that the next one makes sense.

ii. -Long-term memory: is processed in the hippocampus of the temporal lobe and is activated when you want to memorize something for a longer time. This memory has unlimited content and duration capacity. It contains personal memories as well as facts and figures.

iii. -Skill memory: is processed in the cerebellum, which relays information to the basal ganglia. It stores automatic learned memories like tying a shoe, playing an instrument, or riding a bike.

2-1-5 Ventricles and cerebrospinal fluid:

The brain has hollow fluid-filled cavities called ventricles. Inside the ventricles is a ribbon-like structure called the choroid plexus that makes clear colorless cerebrospinal fluid (CSF). CSF flows within and around the brain and spinal cord to help cushion it from injury. This circulating fluid is constantly being absorbed and replenished.

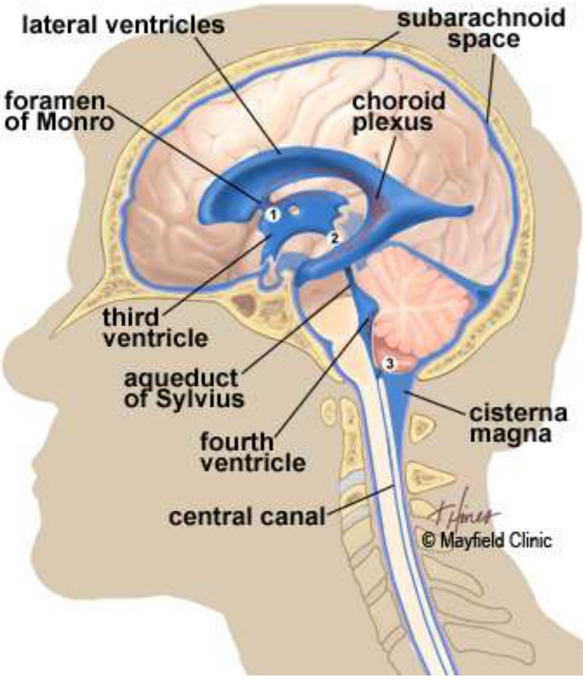

Fig (2. 7) Show CSF produced inside the ventricles deep within the brain. CSF fluid circulates inside the brain and spinal cord and then outside to the subarachnoid space. Common sites of obstruction: foramen of Monro, aqueduct of Sylvius, and obex. http://www.springer.com/978-1-4419-9996-2

There are two ventricles deep within the cerebral hemispheres called the lateral ventricles. They both connect with the third ventricle through a separate opening called the foramen of Monro. The third ventricle connects with the fourth ventricle through a long narrow tube called the aqueduct of Sylvius. From the fourth ventricle, CSF flows into the subarachnoid space where it bathes and cushions the brain. CSF is recycled (or absorbed) by special structures in the superior sagittal sinus called arachnoid villi.

A balance is maintained between the amount of CSF that is absorbed and the amount that is produced. A disruption or blockage in the system can cause a buildup of CSF, which can cause enlargement of the ventricles (hydrocephalus) or cause a collection of fluid in the spinal cord (syringomyelia).

2-1-6 Bones of the skull:

The cranium (skull) is the skeletal structure of the head that supports the face and protects the brain. It is subdivided into the facial bones and the brain case, or cranial vault. The facial bones underlie the facial structures, form the nasal cavity, enclose the eyeballs, and support the teeth of the upper and lower jaws. The rounded brain case surrounds and protects the brain and houses the middle and inner ear structures.

In the adult, the skull consists of 22 individual bones, 21 of which are immobile and united into a single unit. The 22nd bone is the mandible (lower jaw), which is the only moveable bone of the skull.

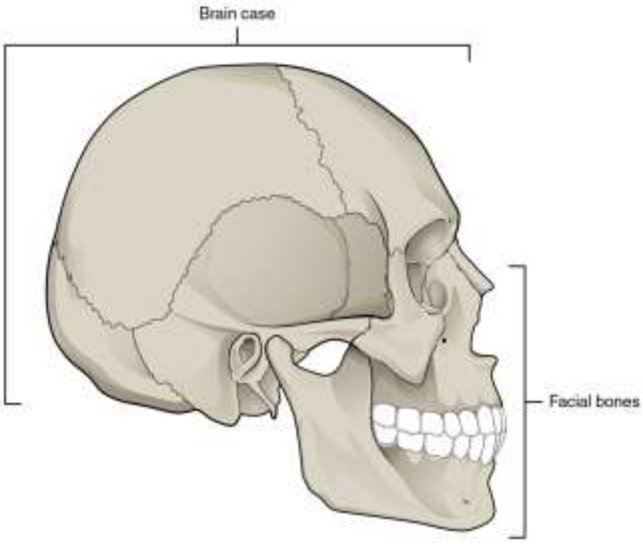

Fig (2. 8) Parts of the Skull.

The skull consists of the rounded brain case that houses the brain and the facial bones that form the upper and lower jaws, nose, orbits, and other facial structures.

Watch this video to view a rotating and exploded skull, with color-coded bones.

Watch this video to view a rotating and exploded skull, with color-coded bones. Which bone (yellow) is centrally located and joins with most of the other bones of the skull.

2-1-6-i Anterior view of skull:

The anterior skull consists of the facial bones and provides the bony support for the eyes and structures of the face. This view of the skull is dominated by the openings of the orbits and the nasal cavity. Also seen are the upper and lower jaws, with their respective teeth.

The orbit is the bony socket that houses the eyeball and muscles that move the eyeball or open the upper eyelid. The upper margin of the anterior orbit is the supraorbital margin. Located near the midpoint of the supraorbital margin is a small opening called the supraorbital foramen. This provides for passage of a sensory nerve to the skin of the forehead. Below the orbit is the infraorbital foramen, which is the point of emergence for a sensory nerve that supplies the anterior face below the orbit.

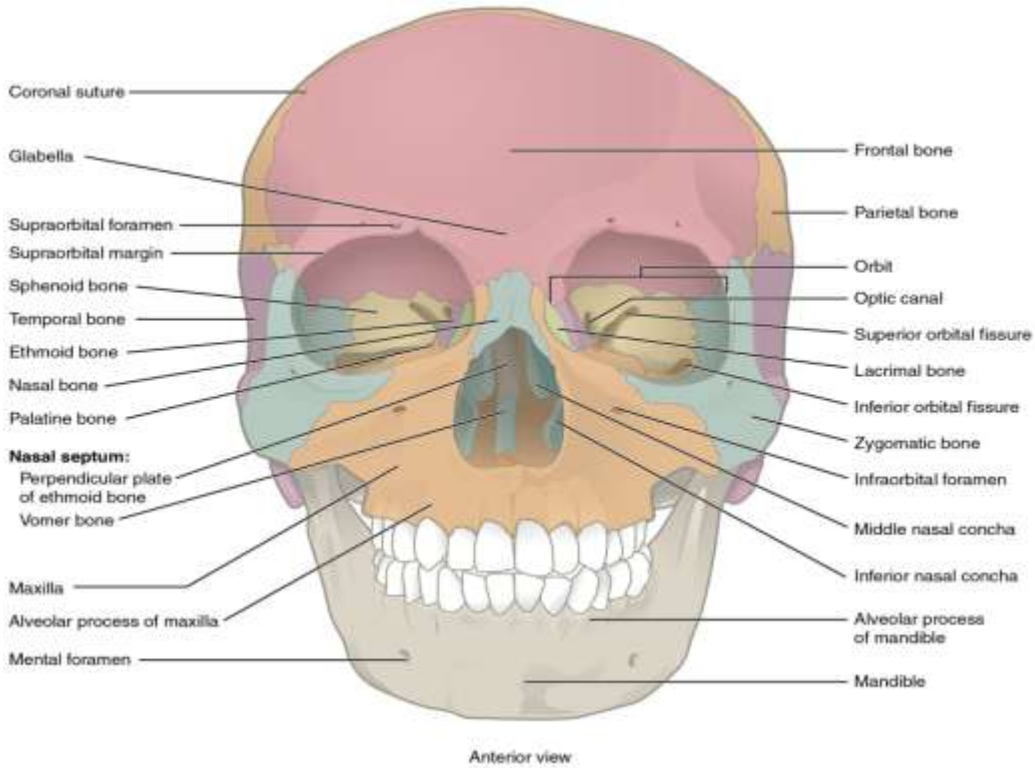

Fig (2. 9) Anterior View of Skull.

An anterior view of the skull shows the bones that form the forehead, orbits (eye sockets), nasal cavity, nasal septum, and upper and lower jaws.

Inside the nasal area of the skull, the nasal cavity is divided into halves by the nasal septum. The upper portion of the nasal septum is formed by the perpendicular plate of the ethmoid bone and the lower portion is the vomer bone. Each side of the nasal cavity is triangular in shape, with a broad inferior space that narrows superiorly. When looking into the nasal cavity from the front of the skull, two bony plates are seen projecting from each lateral wall. The larger of these is the inferior nasal concha, an independent bone of the skull. Located just above the inferior concha is the middle nasal concha, which is part of the ethmoid bone. A third bony plate, also part of the ethmoid bone, is the superior nasal concha. It is much smaller and out of sight, above the middle concha. The superior nasal concha is located just lateral to the perpendicular plate, in the upper nasal cavity.

2-1-6-ii Lateral view of skull:

A view of the lateral skull is dominated by the large, rounded brain case above and the upper and lower jaws with their teeth below. Separating these areas is the bridge of bone called the zygomatic arch. The zygomatic arch is the bony arch on the side of skull that spans from the area of the cheek to just above the ear canal. It is formed by the junction of two bony processes: a short anterior component, the temporal process of the zygomatic bone (the cheekbone) and a longer posterior portion, the zygomatic process of the temporal bone, extending forward from the temporal bone. Thus the temporal process (anteriorly) and the zygomatic process (posteriorly) join together, like the two ends of a drawbridge, to form the zygomatic arch. One of the major muscles that pulls the mandible upward during biting and chewing arises from the zygomatic arch.

On the lateral side of the brain case, above the level of the zygomatic arch, is a shallow space called the temporal fossa. Below the level of the zygomatic arch and deep to the vertical portion of the mandible is another space called the infratemporal fossa. Both the temporal fossa and infratemporal fossa contain muscles that act on the mandible during chewing.

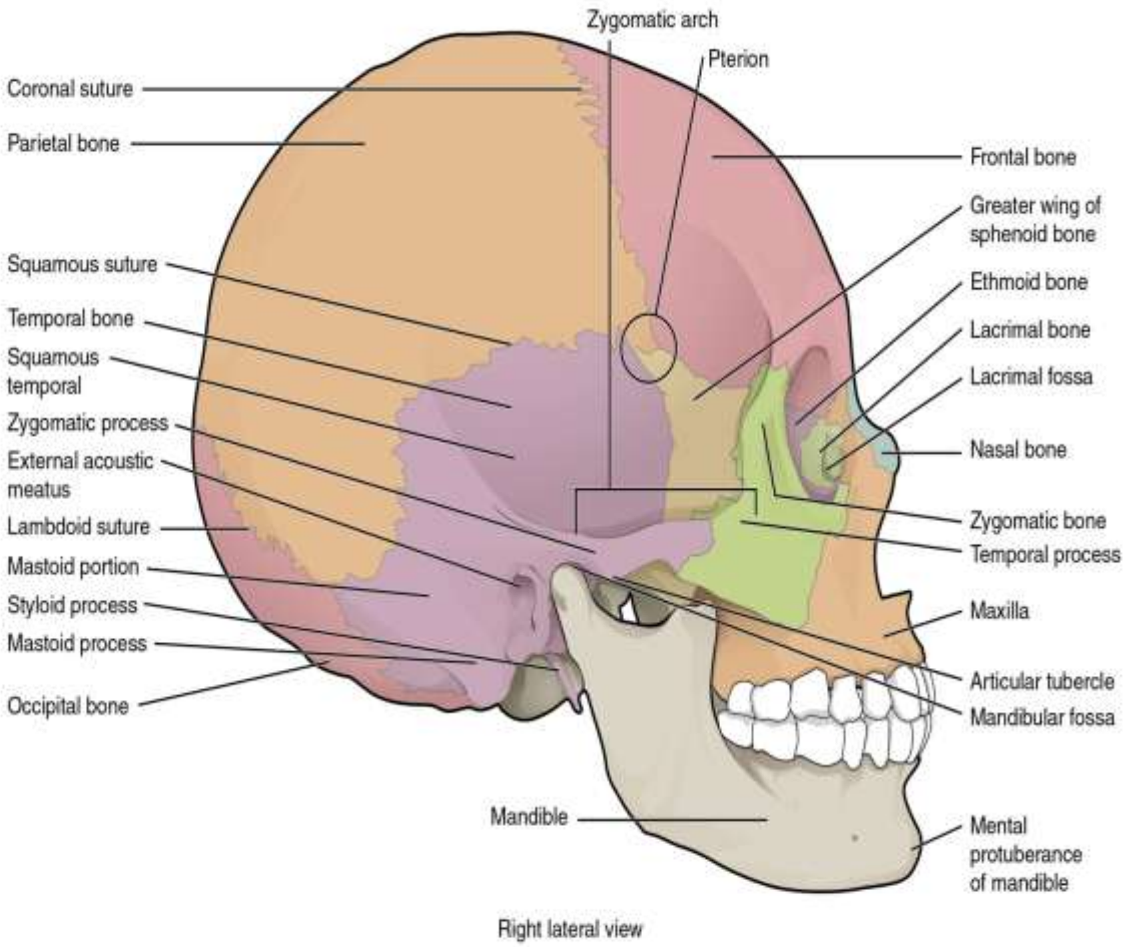

Fig (2. 10) Lateral View of Skull.

The lateral skull shows the large rounded brain case, zygomatic arch, and the upper and lower jaws. The zygomatic arch is formed jointly by the zygomatic process of the temporal bone and the temporal process of the zygomatic bone. The shallow space above the zygomatic arch is the temporal fossa. The space inferior to the zygomatic arch and deep to the posterior mandible is the infratemporal fossa.

2-1-6-iii bones of the brain case:

The brain case contains and protects the brain. The interior space that is almost completely occupied by the brain is called the cranial cavity. This cavity is bounded superiorly by the rounded top of the skull, which is called the calvaria (skullcap), and the lateral and posterior sides of the skull. The bones that form the top and sides of the brain case are usually referred to as the “flat” bones of the skull.

The floor of the brain case is referred to as the base of the skull. This is a complex area that varies in depth and has numerous openings for the passage of cranial nerves, blood vessels, and the spinal cord. Inside the skull, the base is subdivided into three large spaces, called the anterior cranial fossa, middle cranial fossa, and posterior cranial fossa (fossa = “trench or ditch”) (Figure 4). From anterior to posterior, the fossae increase in depth. The shape and depth of each fossa corresponds to the shape and size of the brain region that each houses. The boundaries and openings of the cranial fossae (singular = fossa) will be described in a later section.

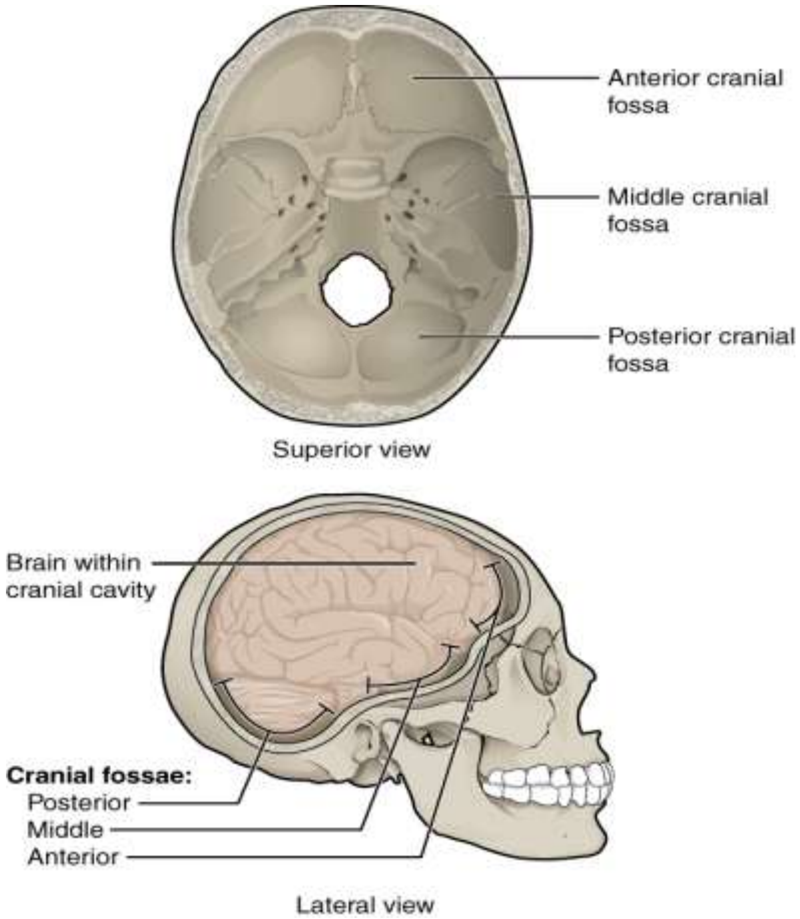

Fig (2. 11) Cranial Fossae.

The bones of the brain case surround and protect the brain, which occupies the cranial cavity. The base of the brain case, which forms the floor of cranial cavity, is subdivided into the shallow anterior cranial fossa, the middle cranial fossa, and the deep posterior cranial fossa.

The brain case consists of eight bones. These include the paired parietal and temporal bones, plus the unpaired frontal, occipital, sphenoid, and ethmoid bones.

A-PARIETAL BONE:

The parietal bone forms most of the upper lateral side of the skull. These are paired bones, with the right and left parietal bones joining together at the top of the skull. Each parietal bone is also bounded anteriorly by the frontal bone, inferiorly by the temporal bone, and posteriorly by the occipital bone.

B-TEMPORAL BONE:

The temporal bone forms the lower lateral side of the skull. Common wisdom has it that the temporal bone (temporal = "time") is so named because this area of the head (the temple) is where hair typically first turns gray, indicating the passage of time.

The temporal bone is subdivided into several regions. The flattened, upper portion is the squamous portion of the temporal bone. Below this area and projecting anteriorly is the zygomatic process of the temporal bone, which forms the posterior portion of the zygomatic arch. Posteriorly is the mastoid portion of the temporal bone. Projecting inferiorly from this region is a large prominence, the mastoid process, which serves as a muscle attachment site. The mastoid process can easily be felt on the side of the head just behind your earlobe. On the interior of the skull, the petrous portion of each temporal bone forms the prominent, diagonally oriented petrous ridge in the floor of the cranial cavity. Located inside each petrous ridge are small cavities that house the structures of the middle and inner ears.

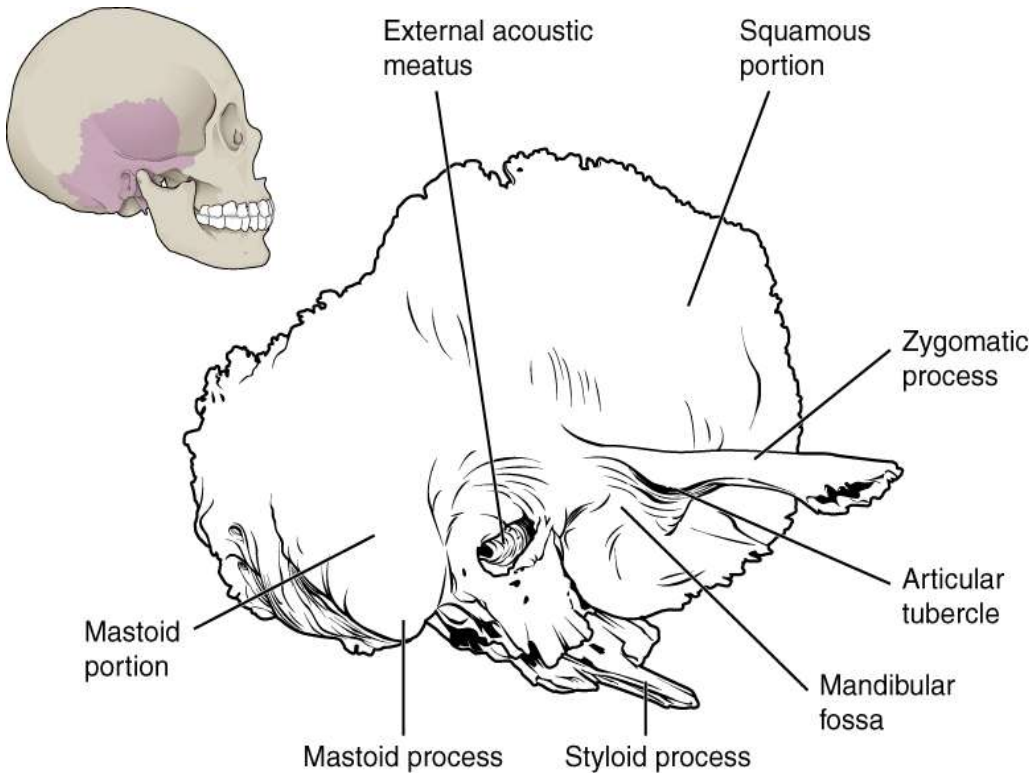

Fig (2. 12) Temporal Bone.

A lateral view of the isolated temporal bone shows the squamous, mastoid, and zygomatic portions of the temporal bone.

Important landmarks of the temporal bone, as shown in Figure 6, include the following:

I. **External acoustic meatus** (ear canal)—this is the large opening on the lateral side of the skull that is associated with the ear.

II. **Internal acoustic meatus**—this opening is located inside the cranial cavity, on the medial side of the petrous ridge. It connects to the middle and inner ear cavities of the temporal bone.

III. **Mandibular fossa**—this is the deep, oval-shaped depression located on the external base of the skull, just in front of the external acoustic meatus. The mandible (lower jaw) joins with the skull at this site as part of the temporomandibular joint, which allows for movements of the mandible during opening and closing of the mouth.

IV. **Articular tubercle**—the smooth ridge located immediately anterior to the mandibular fossa. Both the articular tubercle and mandibular fossa contribute to the temporomandibular joint, the joint that provides for movements between the temporal bone of the skull and the mandible.

V. **Styloid process**—Posterior to the mandibular fossa on the external base of the skull is an elongated, downward bony projection called the styloid process, so named because of its resemblance to a stylus (a pen or writing tool). This structure serves as an attachment site for several small muscles and for a ligament that supports the hyoid bone of the neck.

VI. **Stylomastoid foramen**—this small opening is located between the styloid process and mastoid process. This is the point of exit for the cranial nerve that supplies the facial muscles.

VII. **Carotid canal**—the carotid canal is a zig-zag shaped tunnel that provides passage through the base of the skull for one of the major arteries that supplies the brain. Its entrance is located on the outside base of the skull, anteromedial to the styloid process. The canal then runs anteromedially within the bony base of the skull, and then turns upward to its exit in the floor of the middle cranial cavity, above the foramen lacerum.

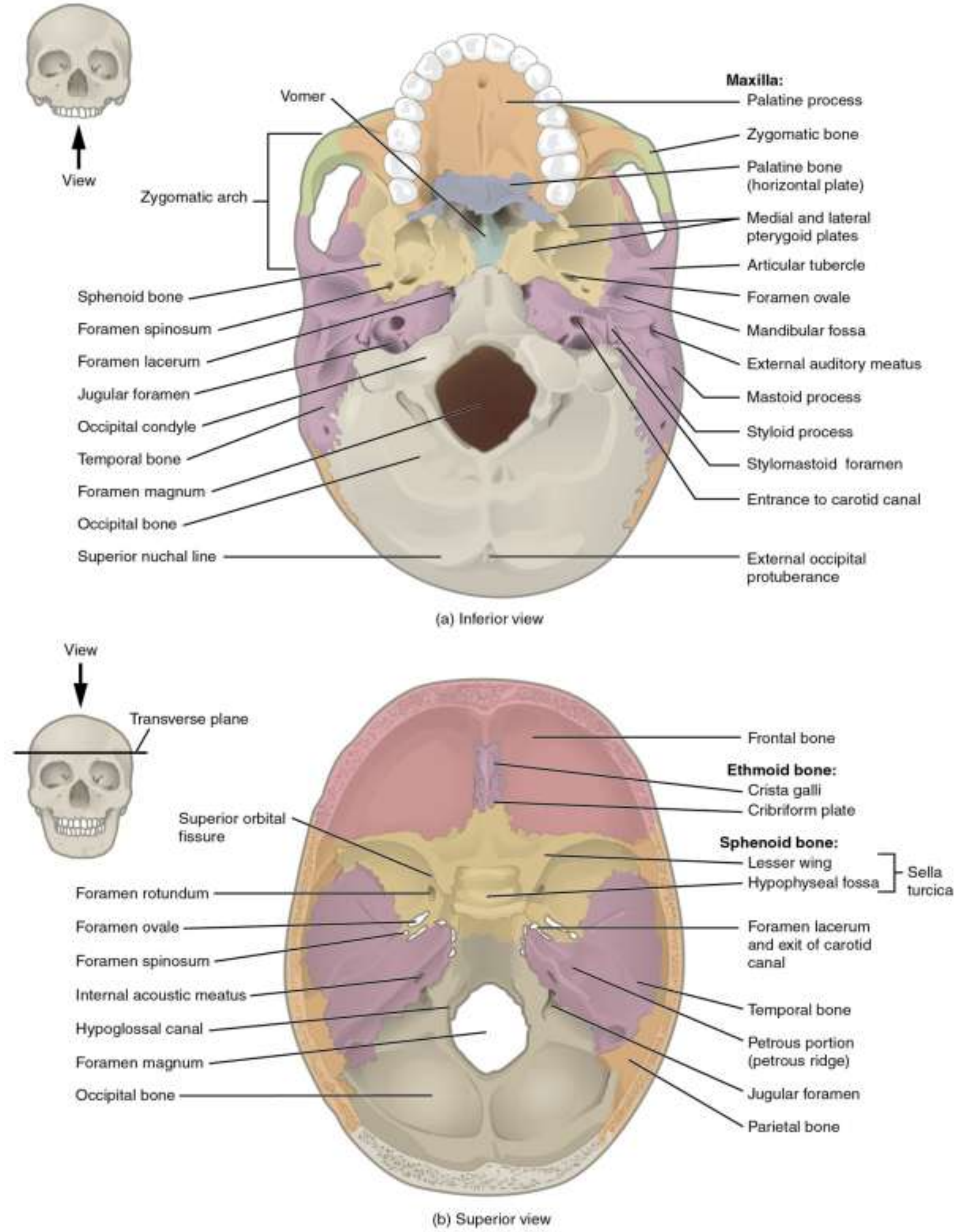

Fig (2. 13) External and Internal Views of Base of Skull. (a) The hard palate is formed anteriorly by the palatine processes of the maxilla bones and posteriorly by the horizontal plate of the palatine bones. (b) The complex floor of the cranial cavity is formed by the frontal, ethmoid, sphenoid, temporal, and occipital bones. The lesser wing of the sphenoid bone separates the anterior and middle cranial fossae. The petrous ridge (petrous portion of temporal bone) separates the middle and posterior cranial fossae.

C- FRONTAL BONE:

The frontal bone is the single bone that forms the forehead. At its anterior midline, between the eyebrows, there is a slight depression called the glabella. The frontal bone also forms the supraorbital margin of the orbit. Near the middle of this margin, is the supraorbital foramen, the opening that provides passage for a sensory nerve to the forehead. The frontal bone is thickened just above each supraorbital margin, forming rounded brow ridges. These are located just behind your eyebrows and vary in size among individuals, although they are generally larger in males. Inside the cranial cavity, the frontal bone extends posteriorly. This flattened region forms both the roof of the orbit below and the floor of the anterior cranial cavity.

D-OCCIPITAL BONE:

The occipital bone is the single bone that forms the posterior skull and posterior base of the cranial cavity (Figure 7; see also Figure 6). On its outside surface, at the posterior midline, is a small protrusion called the external occipital protuberance, which serves as an attachment site for a ligament of the posterior neck. Lateral to either side of this bump is a superior nuchal line (nuchal = “nape” or “posterior neck”). The nuchal lines represent the most superior point at which muscles of the neck attach to the skull, with only the scalp covering the skull above these lines. On the base of the skull, the occipital bone contains the large opening of the foramen magnum, which allows for passage of the spinal cord as it exits the skull. On either side of the foramen magnum is an oval-shaped occipital condyle. These condyles form joints with the first cervical vertebra and thus support the skull on top of the vertebral column.

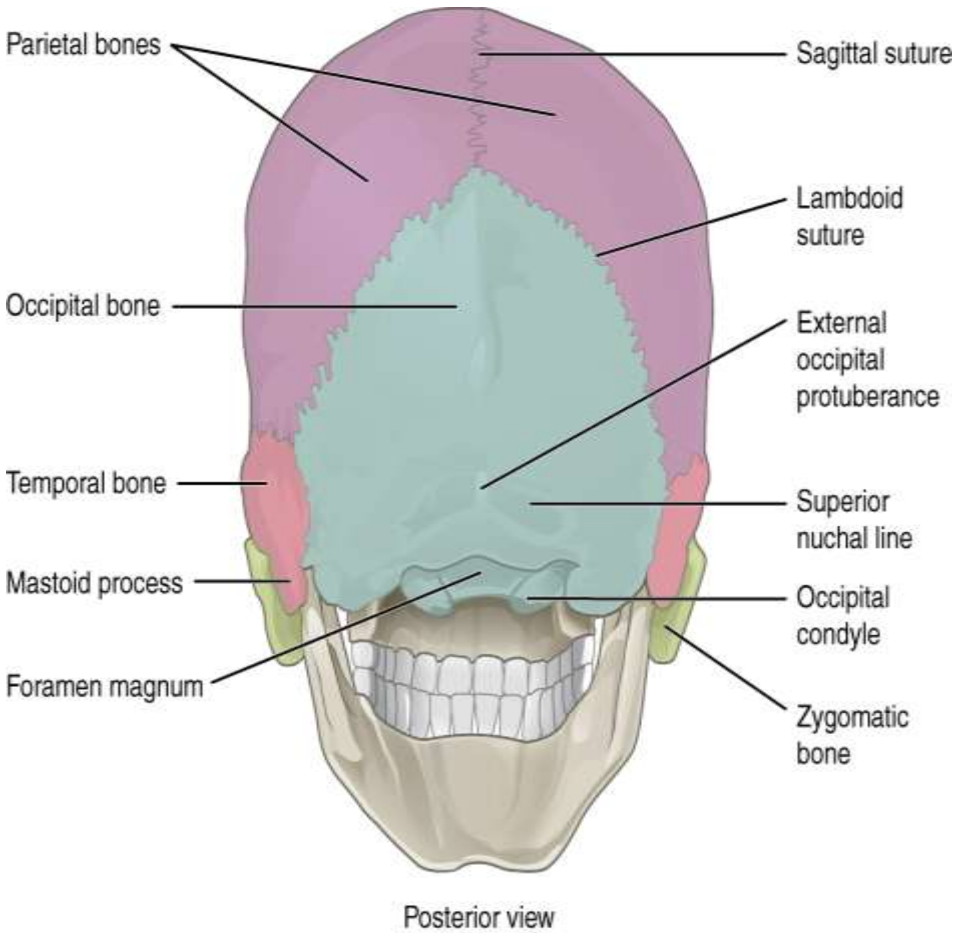

Fig (2. 14) Posterior View of Skull. This view of the posterior skull shows attachment sites for muscles and joints that support the skull.

E-SPHENOID BONE:

The sphenoid bone is a single, complex bone of the central skull. It serves as a “keystone” bone, because it joins with almost every other bone of the skull. The sphenoid forms much of the base of the central skull and also extends laterally to contribute to the sides of the skull. Inside the cranial cavity, the right and left lesser wings of the sphenoid bone, which resemble the wings of a flying bird, form the lip of a prominent ridge that marks the boundary between the anterior and middle cranial fossae. The sella turcica (“Turkish saddle”) is located at the midline of the middle cranial fossa. This bony region of the sphenoid bone is named for its resemblance to the horse saddles used by the Ottoman Turks, with a high back and a tall front. The rounded depression in the floor of the sella turcica is the hypophyseal (pituitary) fossa, which houses the pea-sized pituitary (hypophyseal) gland. The greater wings of the sphenoid bone extend laterally to either side away from the sella turcica, where they form the anterior floor of the middle cranial fossa. The greater wing is best seen on the outside of the lateral skull, where it forms a rectangular area immediately anterior to the squamous portion of the temporal bone.

On the inferior aspect of the skull, each half of the sphenoid bone forms two thin, vertically oriented bony plates. These are the medial pterygoid plate and lateral pterygoid plate (pterygoid = "wing-shaped"). The right and left medial pterygoid plates form the posterior, lateral walls of the nasal cavity. The somewhat larger lateral pterygoid plates serve as attachment sites for chewing muscles that fill the infratemporal space and act on the mandible.

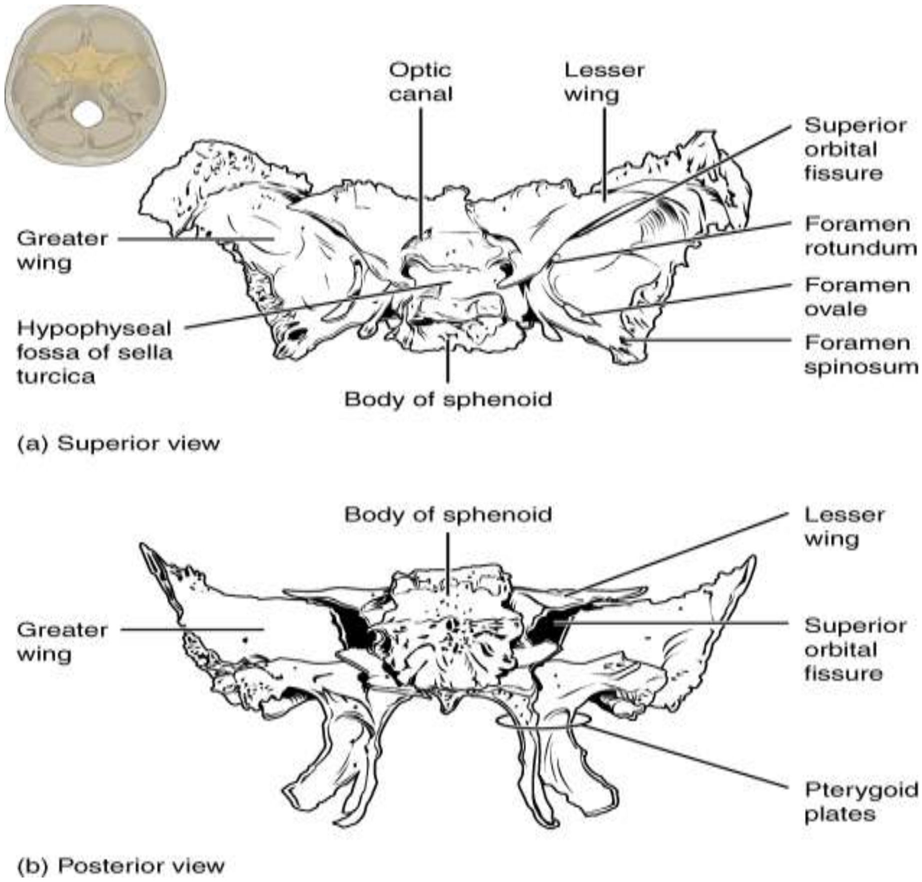

Fig (2. 15) Sphenoid Bone. Shown in isolation in (a) superior and (b) posterior views, the sphenoid bone is a single midline bone that forms the anterior walls and floor of the middle cranial fossa. It has a pair of lesser wings and a pair of greater wings. The sella turcica surrounds the hypophyseal fossa. Projecting downward are the medial and lateral pterygoid plates. The sphenoid has multiple openings for the passage of nerves and blood vessels, including the optic canal, superior orbital fissure, foramen rotundum, foramen ovale, and foramen spinosum.

F-ETHMOID BONE:

The ethmoid bone is a single, midline bone that forms the roof and lateral walls of the upper nasal cavity, the upper portion of the nasal septum, and contributes to the medial wall of the orbit.On the interior of the skull, the ethmoid also forms a portion of the floor of the anterior cranial cavity.

Within the nasal cavity, the perpendicular plate of the ethmoid bone forms the upper portion of the nasal septum. The ethmoid bone also forms the lateral walls of the upper nasal cavity. Extending from each lateral wall are the superior nasal concha and middle nasal concha, which are thin, curved projections that extend into the nasal cavity.

In the cranial cavity, the ethmoid bone forms a small area at the midline in the floor of the anterior cranial fossa. This region also forms the narrow roof of the underlying nasal cavity. This portion of the ethmoid bone consists of two parts, the crista galli and cribriform plates. The crista galli (“rooster’s comb or crest”) is a small upward bony projection located at the midline. It functions as an anterior attachment point for one of the covering layers of the brain. To either side of the crista galli is the cribriform plate (cribrum = “sieve”), a small, flattened area with numerous small openings termed olfactory foramina. Small nerve branches from the olfactory areas of the nasal cavity pass through these openings to enter the brain.

The lateral portions of the ethmoid bone are located between the orbit and upper nasal cavity, and thus form the lateral nasal cavity wall and a portion of the medial orbit wall. Located inside this portion of the ethmoid bone are several small, air-filled spaces that are part of the paranasal sinus system of the skull.

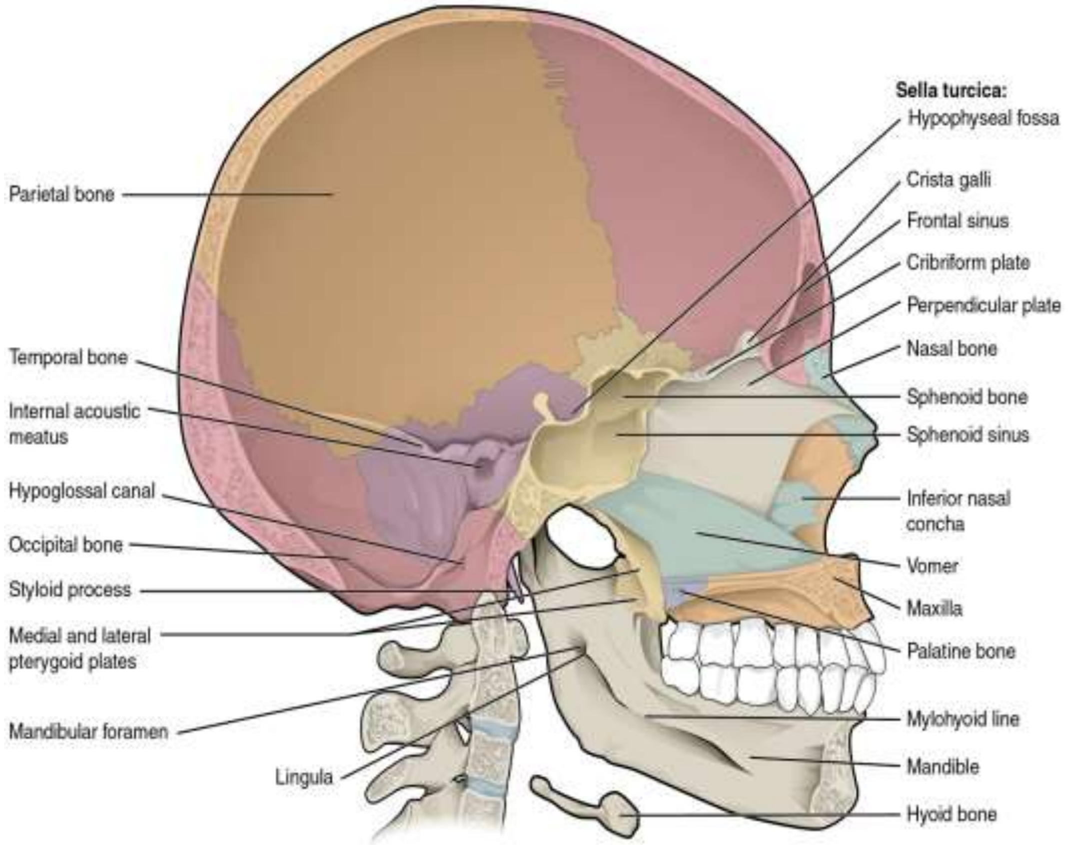

Fig (2. 16) Sagittal Section of Skull. This midline view of the sagittally sectioned skull shows the nasal septum.

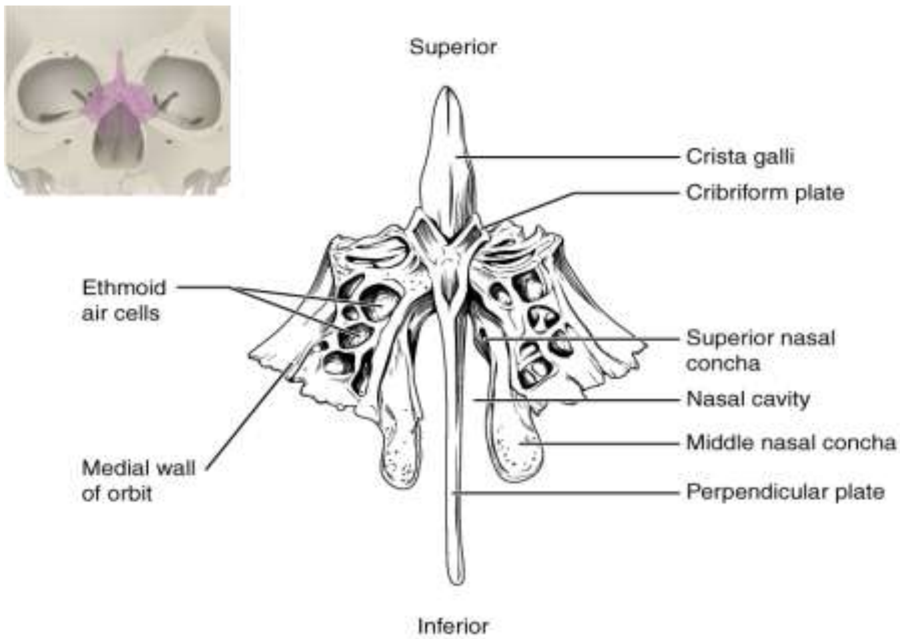

Fig (2. 17) Ethmoid Bone.

The unpaired ethmoid bone is located at the midline within the central skull. It has an upward projection, the crista galli, and a downward projection, the perpendicular plate, which forms the upper nasal septum. The cribriform plates form both the roof of the nasal cavity and a portion of the anterior cranial fossa floor. The lateral sides of the ethmoid bone form the lateral walls of the upper nasal cavity, part of the medial orbit wall, and give rise to the superior and middle nasal conchae. The ethmoid bone also contains the ethmoid air cells.

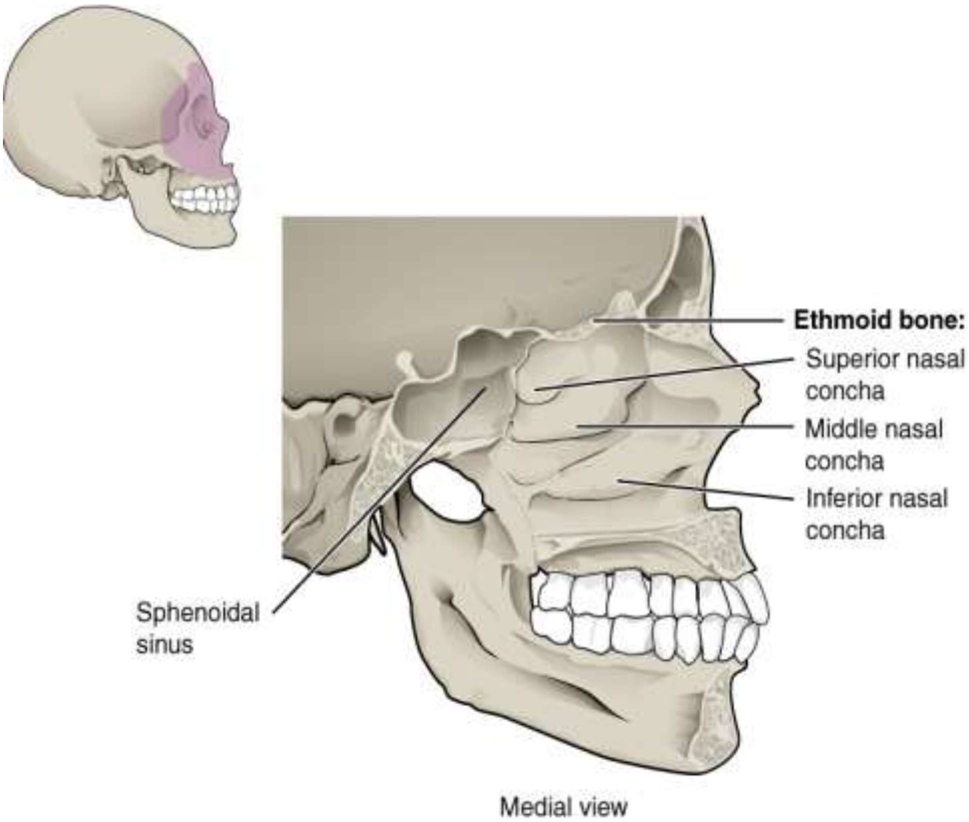

Fig (2. 18) Lateral Wall of Nasal Cavity.

The three nasal conchae are curved bones that project from the lateral walls of the nasal cavity. The superior nasal concha and middle nasal concha are parts of the ethmoid bone. The inferior nasal concha is an independent bone of the skull.

2-1-7 Sutures of the Skull

A suture is an immobile joint between adjacent bones of the skull. The narrow gap between the bones is filled with dense, fibrous connective tissue that unites the bones. The long sutures located between the bones of the brain case are not straight, but instead follow irregular, tightly twisting paths. These twisting lines serve to tightly interlock the adjacent bones, thus adding strength to the skull for brain protection.

The two suture lines seen on the top of the skull are the coronal and sagittal sutures. The coronal suture runs from side to side across the skull, within the coronal plane of section (see Figure 3). It joins the frontal bone to the right and left parietal bones. The sagittal suture extends posteriorly from the coronal suture, running along the midline at the top of the skull in the sagittal plane of section (see Figure 7). It unites the right and left parietal bones. On the posterior skull, the sagittal suture terminates by joining the lambdoid suture. The lambdoid suture extends downward and laterally to either side away from its junction with the sagittal suture. The lambdoid suture joins the occipital bone to the right and left parietal and temporal bones. This suture is named for its upside-down "V" shape, which resembles the capital letter version of the Greek letter lambda (Λ). The squamous suture is located on the lateral skull. It unites the squamous portion of the temporal bone with the parietal bone. At the intersection of four bones is the pterion, a small, capital-H-shaped suture line region that unites the frontal bone, parietal bone, squamous portion of the temporal bone, and greater wing of the sphenoid bone. It is the weakest part of the skull. The pterion is located approximately two finger widths above the zygomatic arch and a thumb's width posterior to the upward portion of the zygomatic bone.

2-1-7-1 Facial Bones of the Skull:

The facial bones of the skull form the upper and lower jaws, the nose, nasal cavity and nasal septum, and the orbit. The facial bones include 14 bones, with six paired bones and two unpaired bones. The paired bones are the maxilla, palatine, zygomatic, nasal, lacrimal, and inferior nasal conchae bones. The unpaired bones are the vomer and mandible bones. Although classified with the brain-case bones, the ethmoid bone also contributes to the nasal septum and the walls of the nasal cavity and orbit.

2-1-7-2 Maxillary Bone:

The maxillary bone, often referred to simply as the maxilla (plural = maxillae), is one of a pair that together form the upper jaw, much of the hard palate, the medial floor of the orbit, and the lateral base of the nose. The curved, inferior margin of the maxillary bone that forms the upper jaw and contains the upper teeth is the alveolar process of the maxilla. Each tooth is anchored into a deep socket called an alveolus. On the anterior maxilla, just below the orbit, is the infraorbital foramen. This is the point of exit for a sensory nerve that supplies the nose, upper lip, and anterior cheek. On the inferior skull, the palatine process from each maxillary bone can be seen joining together at the midline to form the anterior three-quarters of the hard palate. The hard palate is the bony plate that forms the roof of the mouth and floor of the nasal cavity, separating the oral and nasal cavities.

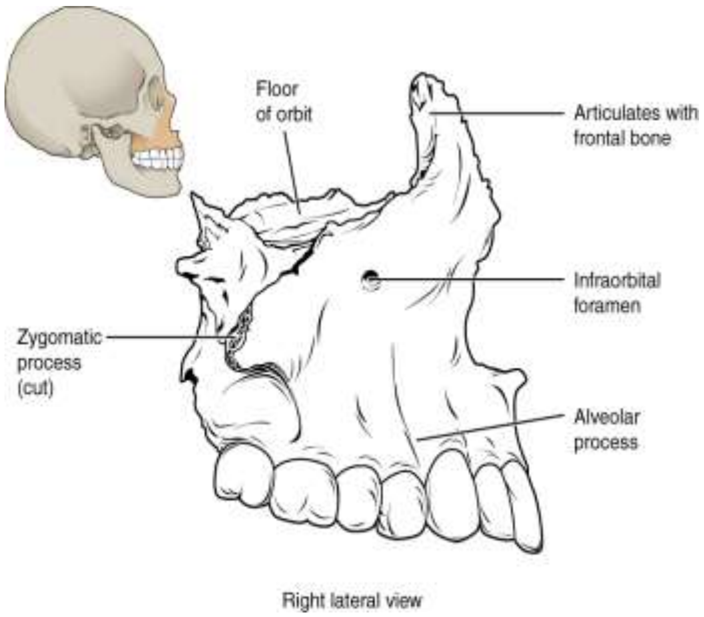

Fig (2. 19) Maxillary Bone. The maxillary bone forms the upper jaw and supports the upper teeth. Each maxilla also forms the lateral floor of each orbit and the majority of the hard palate.

2-1-7-3 Palatine Bone:

The palatine bone is one of a pair of irregularly shaped bones that contribute small areas to the lateral walls of the nasal cavity and the medial wall of each orbit. The largest region of each of the palatine bone is the horizontal plate. The plates from the right and left palatine bones join together at the midline to form the posterior quarter of the hard palate. Thus, the palatine bones are best seen in an inferior view of the skull and hard palate.

2-1-7-4 Zygomatic Bone:

The zygomatic bone is also known as the cheekbone. Each of the paired zygomatic bones forms much of the lateral wall of the orbit and the lateral-inferior margins of the anterior orbital opening. The short temporal process of the zygomatic bone projects posteriorly, where it forms the anterior portion of the zygomatic arch.

2-1-7-5 Nasal Bone:

The nasal bone is one of two small bones that articulate (join) with each other to form the bony base (bridge) of the nose. They also support the cartilages that form the lateral walls of the nose. These are bones that are damaged when the nose is broken.

2-1-7-6 Lacrimal Bone:

Each lacrimal bone is a small, rectangular bone that forms the anterior, medial wall of the orbit. The anterior portion of the lacrimal bone forms a shallow depression called the lacrimal fossa, and extending inferiorly from this is the nasolacrimal canal. The lacrimal fluid (tears of the eye), which serves to maintain the moist surface of the eye, drains at the medial corner of the eye into the nasolacrimal canal. This duct then extends downward to open into the nasal cavity, behind the inferior nasal concha. In the nasal cavity, the lacrimal fluid normally drains posteriorly, but with an increased flow of tears due to crying or eye irritation, some fluid will also drain anteriorly, thus causing a runny nose.

2-1-7-7 Inferior Nasal Conchae:

The right and left inferior nasal conchae form a curved bony plate that projects into the nasal cavity space from the lower lateral. The inferior concha is the largest of the nasal conchae and can easily be seen when looking into the anterior opening of the nasal cavity.

2-1-7-8 Vomer Bone:

The unpaired vomer bone, often referred to simply as the vomer, is triangular-shaped and forms the posterior-inferior part of the nasal septum. The vomer is best seen when looking from behind into the posterior openings of the nasal cavity. In this view, the vomer is seen to form the entire height of the nasal septum. A much smaller portion of the vomer can also be seen when looking into the anterior opening of the nasal cavity.

2-1-7-9 Mandible:

The mandible forms the lower jaw and is the only moveable bone of the skull. At the time of birth, the mandible consists of paired right and left bones, but these fuse together during the first year to form the single U-shaped mandible of the adult skull. Each side of the mandible consists of a horizontal body and posteriorly, a vertically oriented ramus of the mandible (ramus = “branch”). The outside margin of the mandible, where the body and ramus come together is called the angle of the mandible.

The ramus on each side of the mandible has two upward-going bony projections. The more anterior projection is the flattened coronoid process of the mandible, which provides attachment for one of the biting muscles. The posterior projection is the condylar process of the mandible, which is topped by the oval-shaped condyle. The condyle of the mandible articulates (joins) with the mandibular fossa and articular tubercle of the temporal bone. Together these articulations form the temporomandibular joint, which allows for opening and closing of the mouth. The broad U-shaped curve located between the coronoid and condylar processes is the mandibular notch.

Important landmarks for the mandible include the following:

A. **Alveolar process of the mandible**—this is the upper border of the mandibular body and serves to anchor the lower teeth.
B. **Mental protuberance**—the forward projection from the inferior margin of the anterior mandible that forms the chin (mental = “chin”).
C. **Mental foramen**—the opening located on each side of the anterior-lateral mandible, which is the exit site for a sensory nerve that supplies the chin.
D. **Mylohyoid line**—this bony ridge extends along the inner aspect of the mandibular body. The muscle that forms the floor of the oral cavity attaches to the mylohyoid lines on both sides of the mandible.
E. **Mandibular foramen**—this opening is located on the medial side of the ramus of the mandible. The opening leads into a tunnel that runs down the length of the mandibular body. The sensory nerve and blood vessels that supply the lower teeth enter the mandibular foramen and then follow this tunnel. Thus, to numb the lower teeth prior to dental work, the dentist must inject anesthesia into the lateral wall of the oral cavity at a point prior to where this sensory nerve enters the mandibular foramen.
F. **Lingula**—this small flap of bone is named for its shape (lingula = “little tongue”). It is located immediately next to the mandibular foramen, on the medial side of the ramus. A ligament that anchors the mandible during opening and closing of the mouth extends down from the base of the skull and attaches to the lingula.

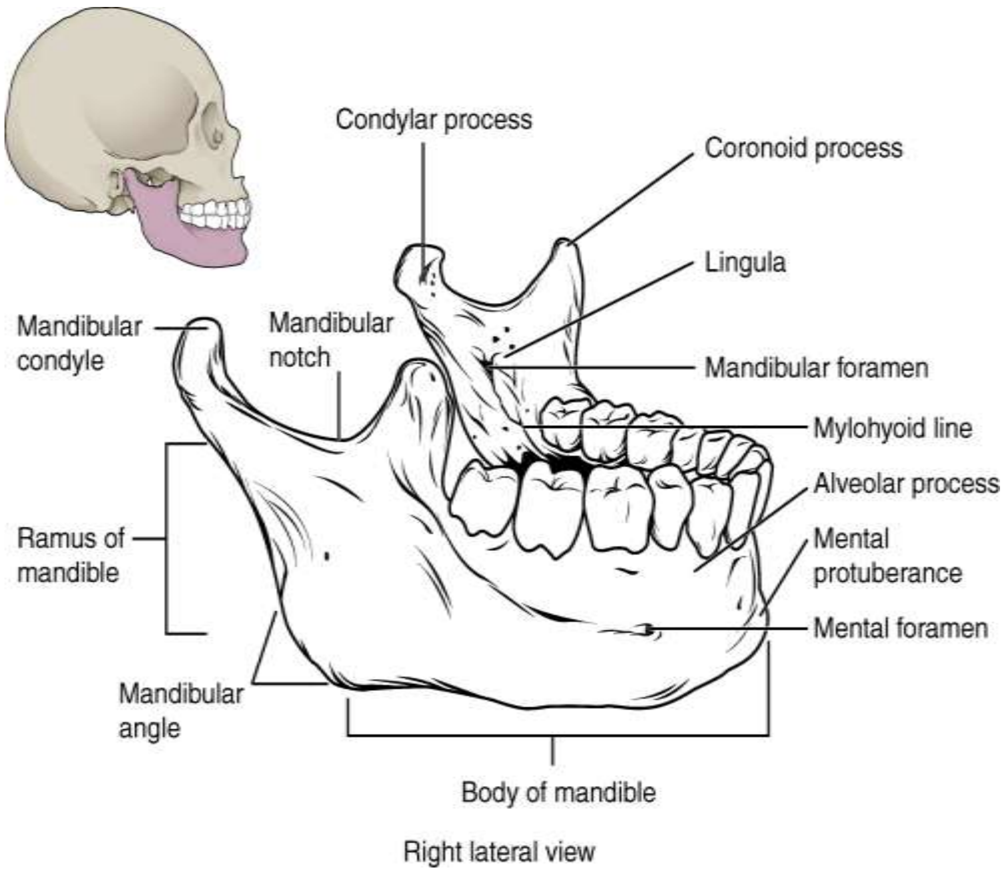

Fig (2. 20) Isolated Mandible. The mandible is the only moveable bone of the skull.

2-1-7-10 The Orbit:

The orbit is the bony socket that houses the eyeball and contains the muscles that move the eyeball or open the upper eyelid. Each orbit is cone-shaped, with a narrow posterior region that widens toward the large anterior opening. To help protect the eye, the bony margins of the anterior opening are thickened and somewhat constricted. The medial walls of the two orbits are parallel to each other but each lateral wall diverges away from the midline at a 45° angle. This divergence provides greater lateral peripheral vision.

The walls of each orbit include contributions from seven skull bones. The frontal bone forms the roof and the zygomatic bone forms the lateral wall and lateral floor. The medial floor is primarily formed by the maxilla, with a small contribution from the palatine bone. The ethmoid bone and lacrimal bone make up much of the medial wall and the sphenoid bone forms the posterior orbit.

At the posterior apex of the orbit is the opening of the optic canal, which allows for passage of the optic nerve from the retina to the brain. Lateral to this is the elongated and irregularly shaped superior orbital fissure, which provides passage for the artery that supplies the eyeball, sensory nerves, and the nerves that supply the muscles involved in eye movements.

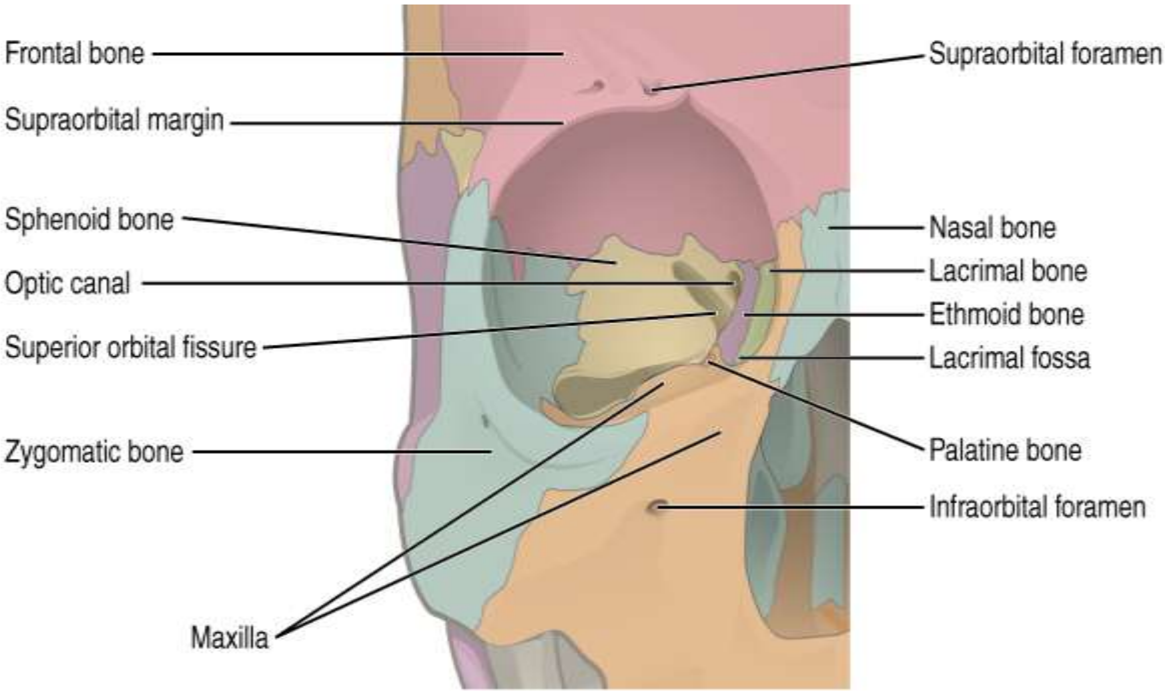

Fig (2. 21) Bones of the Orbit. Seven skull bones contribute to the walls of the orbit. Opening into the posterior orbit from the cranial cavity are the optic canal and superior orbital fissure.

2-1-7-11 The Nasal Septum and Nasal Conchae:

The nasal septum consists of both bone and cartilage components. The upper portion of the septum is formed by the perpendicular plate of the ethmoid bone. The lower and posterior parts of the septum are formed by the triangular-shaped vomer bone. In an anterior view of the skull, the perpendicular plate of the ethmoid bone is easily seen inside the nasal opening as the upper nasal septum, but only a small portion of the vomer is seen as the inferior septum. A better view of the vomer bone is seen when looking into the posterior nasal cavity with an inferior view of the skull, where the vomer forms the full height of the nasal septum. The anterior nasal septum is formed by the septal cartilage, a flexible plate that fills in the gap between the perpendicular plate of the ethmoid and vomer bones. This cartilage also extends outward into the nose where it separates the right and left nostrils. The septal cartilage is not found in the dry skull.

Attached to the lateral wall on each side of the nasal cavity are the superior, middle, and inferior nasal conchae (singular = concha), which are named for their positions. These are bony plates that curve downward as they project into the space of the nasal cavity. They serve to swirl the incoming air, which helps to warm and moisturize it before the air moves into the delicate air sacs of the lungs. This also allows mucus, secreted by the tissue lining the nasal cavity, to trap incoming dust, pollen, bacteria, and viruses. The largest of the conchae is the inferior nasal concha, which is an independent bone of the skull. The middle concha and the superior conchae, which is the smallest, are both formed by the ethmoid bone. When looking into the anterior nasal opening of the skull, only the inferior and middle conchae can be seen. The small superior nasal concha is well hidden above and behind the middle concha.

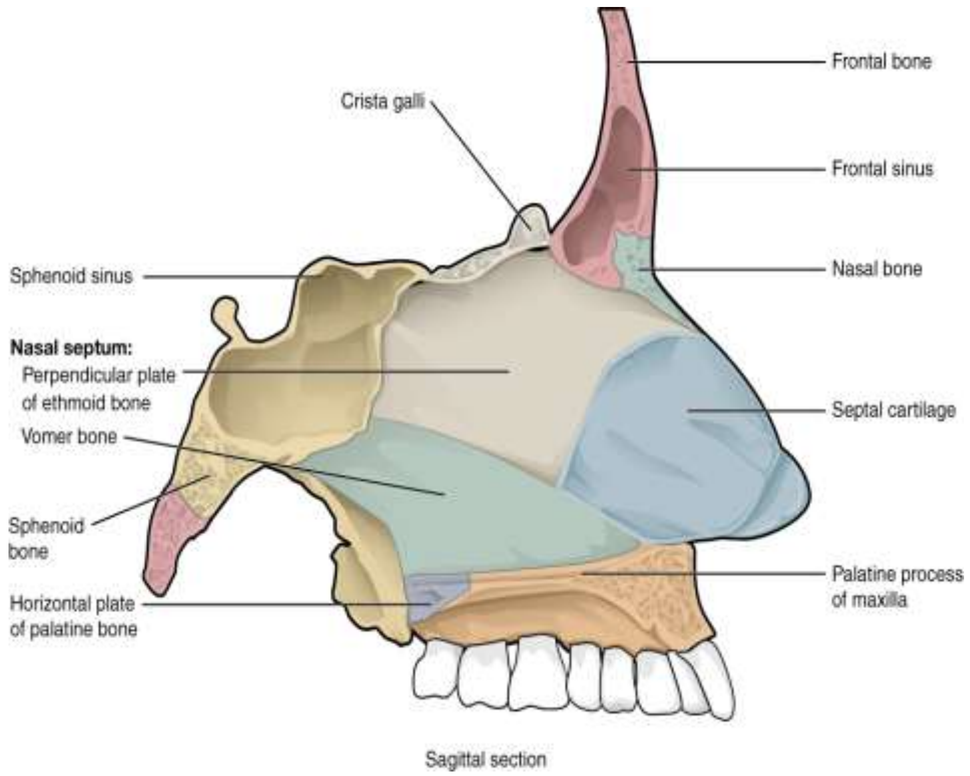

Fig (2. 22) Nasal Septum. The nasal septum is formed by the perpendicular plate of the ethmoid bone and the vomer bone. The septal cartilage fills the gap between these bones and extends into the nose.

2-1-8 CRANIAL FOSSAE:

Inside the skull, the floor of the cranial cavity is subdivided into three cranial fossae (spaces), which increase in depth from anterior to posterior. Since the brain occupies these areas, the shape of each conforms to the shape of the brain regions that it contains. Each cranial fossa has anterior and posterior boundaries and is divided at the midline into right and left areas by a significant bony structure or opening.

2-1-8-1 ANTERIOR CRANIAL FOSSA:

The anterior cranial fossa is the most anterior and the shallowest of the three cranial fossae. It overlies the orbits and contains the frontal lobes of the brain. Anteriorly, the anterior fossa is bounded by the frontal bone, which also forms the majority of the floor for this space. The lesser wings of the sphenoid bone form the prominent ledge that marks the boundary between the anterior and middle cranial fossae. Located in the floor of the anterior cranial fossa at the midline is a portion of the ethmoid bone, consisting of the upward projecting crista galli and to either side of this, the cribriform plates.

2-1-8-2 MIDDLE CRANIAL FOSSA:

The middle cranial fossa is deeper and situated posterior to the anterior fossa. It extends from the lesser wings of the sphenoid bone anteriorly, to the petrous ridges (petrous portion of the temporal bones) posteriorly. The large, diagonally positioned petrous ridges give the middle cranial fossa a butterfly shape, making it narrow at the midline and broad laterally. The temporal lobes of the brain occupy this fossa. The middle cranial fossa is divided at the midline by the upward bony prominence of the sella turcica, a part of the sphenoid bone. The middle cranial fossa has several openings for the passage of blood vessels and cranial nerves.

Openings in the middle cranial fossa are as follows:

- **Optic canal**—This opening is located at the anterior lateral corner of the sella turcica. It provides for passage of the optic nerve into the orbit.
- **Superior orbital fissure**—This large, irregular opening into the posterior orbit is located on the anterior wall of the middle cranial fossa, lateral to the optic canal and under the projecting margin of the lesser wing of the sphenoid bone. Nerves to the eyeball and associated muscles, and sensory nerves to the forehead pass through this opening.
- **Foramen rotundum**—This rounded opening (rotundum = "round") is located in the floor of the middle cranial fossa, just inferior to the superior orbital fissure. It is the exit point for a major sensory nerve that supplies the cheek, nose, and upper teeth.
- **Foramen ovale of the middle cranial fossa**—This large, oval-shaped opening in the floor of the middle cranial fossa provides passage for a major sensory nerve to the lateral head, cheek, chin, and lower teeth.

- **Foramen spinosum**—This small opening, located posterior-lateral to the foramen ovale, is the entry point for an important artery that supplies the covering layers surrounding the brain. The branching pattern of this artery forms readily visible grooves on the internal surface of the skull and these grooves can be traced back to their origin at the foramen spinosum.
- **Carotid canal**—This is the zig-zag passageway through which a major artery to the brain enters the skull. The entrance to the carotid canal is located on the inferior aspect of the skull, anteromedial to the styloid process. From here, the canal runs anteromedially within the bony base of the skull. Just above the foramen lacerum, the carotid canal opens into the middle cranial cavity, near the posterior-lateral base of the sella turcica.
- **Foramen lacerum**—This irregular opening is located in the base of the skull, immediately inferior to the exit of the carotid canal. This opening is an artifact of the dry skull, because in life it is completely filled with cartilage. All the openings of the skull that provide for passage of nerves or blood vessels have smooth margins; the word lacerum ("ragged" or "torn") tells us that this opening has ragged edges and thus nothing passes through it.

2-1-8-3 Posterior Cranial Fossa

The posterior cranial fossa is the most posterior and deepest portion of the cranial cavity. It contains the cerebellum of the brain. The posterior fossa is bounded anteriorly by the petrous ridges, while the occipital bone forms the floor and posterior wall. It is divided at the midline by the large foramen magnum ("great aperture"), the opening that provides for passage of the spinal cord.

Located on the medial wall of the petrous ridge in the posterior cranial fossa is the internal acoustic meatus (see Figure 9). This opening provides for passage of the nerve from the hearing and equilibrium organs of the inner ear, and the nerve that supplies the muscles of the face. Located at the anterior-lateral margin of the foramen magnum is the hypoglossal canal. These emerge on the inferior aspect of the skull at the base of the occipital condyle and provide passage for an important nerve to the tongue.

Immediately inferior to the internal acoustic meatus is the large, irregularly shaped jugular foramen. Several cranial nerves from the brain exit the skull via this opening. It is also the exit point through the base of the skull for all the venous return blood leaving the brain. The venous structures that carry blood inside the skull form large, curved grooves on the inner walls of the posterior cranial fossa, which terminate at each jugular foramen.

2-1-9 Paranasal Sinuses:

The paranasal sinuses are hollow, air-filled spaces located within certain bones of the skull. All of the sinuses communicate with the nasal cavity (paranasal = “next to nasal cavity”) and are lined with nasal mucosa. They serve to reduce bone mass and thus lighten the skull, and they also add resonance to the voice. This second feature is most obvious when you have a cold or sinus congestion. These produce swelling of the mucosa and excess mucus production, which can obstruct the narrow passageways between the sinuses and the nasal cavity, causing your voice to sound different to yourself and others. This blockage can also allow the sinuses to fill with fluid, with the resulting pressure producing pain and discomfort.

The paranasal sinuses are named for the skull bone that each occupies. The frontal sinus is located just above the eyebrows, within the frontal bone. This irregular space may be divided at the midline into bilateral spaces, or these may be fused into a single sinus space. The frontal sinus is the most anterior of the paranasal sinuses. The largest sinus is the maxillary sinus. These are paired and located within the right and left maxillary bones, where they occupy the area just below the orbits. The maxillary sinuses are most commonly involved during sinus infections. Because their connection to the nasal cavity is located high on their medial wall, they are difficult to drain. The sphenoid sinus is a single, midline sinus. It is located within the body of the sphenoid bone, just anterior and inferior to the sella turcica, thus making it the most posterior of the paranasal sinuses. The lateral aspects of the ethmoid bone contain multiple small spaces separated by very thin bony walls. Each of these spaces is called an ethmoid air cell. These are located on both sides of the ethmoid bone, between the upper nasal cavity and medial orbit, just behind the superior nasal conchae.

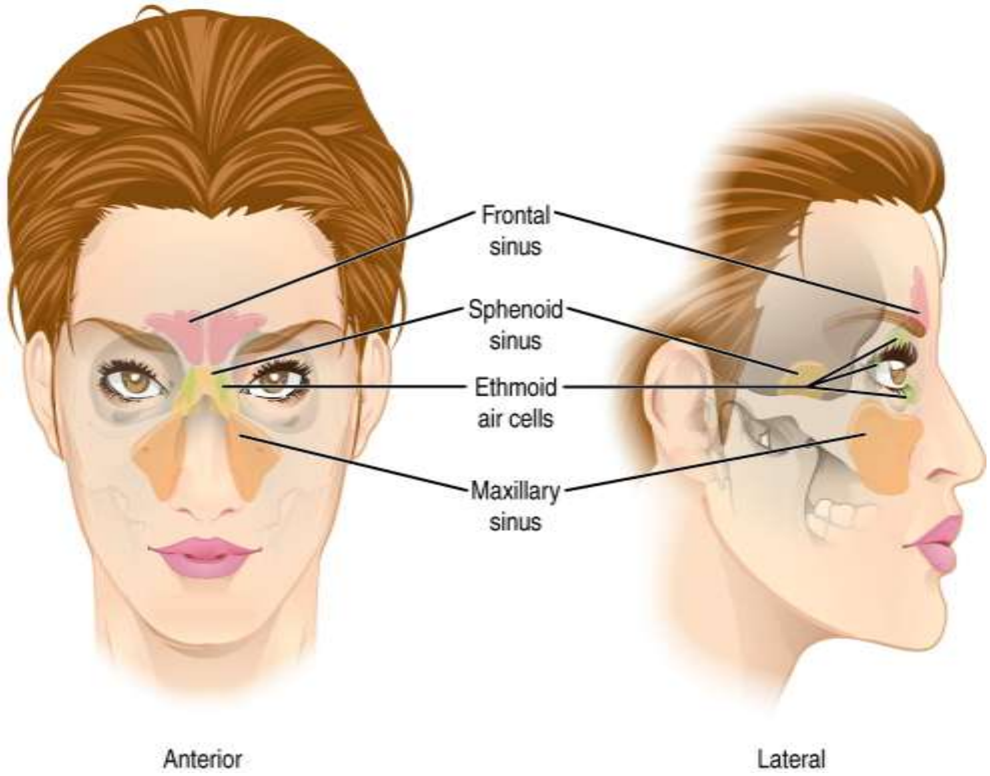

Fig (2. 23) Paranasal Sinuses.

The paranasal sinuses are hollow, air-filled spaces named for the skull bone that each occupies. The most anterior is the frontal sinus, located in the frontal bone above the eyebrows. The largest are the maxillary sinuses, located in the right and left maxillary bones below the orbits. The most posterior is the sphenoid sinus, located in the body of the sphenoid bone, under the sella turcica. The ethmoid air cells are multiple small spaces located in the right and left sides of the ethmoid bone, between the medial wall of the orbit and lateral wall of the upper nasal cavity.

2-1-10 Cranial nerves:

The brain communicates with the body through the spinal cord and twelve pairs of cranial nerves. Ten of the twelve pairs of cranial nerves that control hearing, eye movement, facial sensations, taste, swallowing and movement of the face, neck, shoulder and tongue muscles originate in the brainstem. The cranial nerves for smell and vision originate in the cerebrum.

The Roman numeral, name, and main function of the twelve cranial nerves:

Table

Table (2. 1) Show the cranial nerves. http://www.springer.com/978-1-4419-9996-2

Number	Name	Function
I	Olfactory	Smell
II	Optic	Sight
III	Oculomotor	moves eye, pupil
IV	Trochlear	moves eye
V	Trigeminal	face sensation
VI	Abducens	moves eye
VII	Facial	moves face, salivate
VIII	vestibulocochlear	hearing, balance
IX	glossopharyngeal	taste, swallow
X	Vagus	heart rate, digestion
XI	Accessory	moves head
XII	hypoglossal	moves tongue

2-1-11 Meninges :

The brain and spinal cord are covered and protected by three layers of tissue called meninges. From the outermost layer inward they are: the dura mater, arachnoid mater, and pia mater.

1-Dura mater:

Is a strong, thick membrane that closely lines the inside of the skull; its two layers, the periosteal and meningeal dura, are fused and separate only to form venous sinuses. The dura creates little folds or compartments. There are two special dural folds, the falx and the tentorium. The falx separates the right and left hemispheres of the brain and the tentorium separates the cerebrum from the cerebellum.

2-Arachnoid mater:

Is a thin, web-like membrane that covers the entire brain. The arachnoid is made of elastic tissue. The space between the dura and arachnoid membranes is called the subdural space.

3-Pia mater:

Hugs the surface of the brain following its folds and grooves. The pia mater has many blood vessels that reach deep into the brain. The space between the arachnoid and pia is called the subarachnoid space. It is here where the cerebrospinal fluid bathes and cushions the brain.

2-1-12 Blood supply :

Blood is carried to the brain by two paired arteries, the internal carotid arteries and the vertebral arteries. The internal carotid arteries supply most of the cerebrum. The common carotid artery courses up the neck and divides into the internal and external carotid arteries. The brain's anterior circulation is fed by the internal carotid arteries (ICA) and the posterior circulation is fed by the vertebral arteries (VA). The two systems connect at the Circle of Willis (green circle).

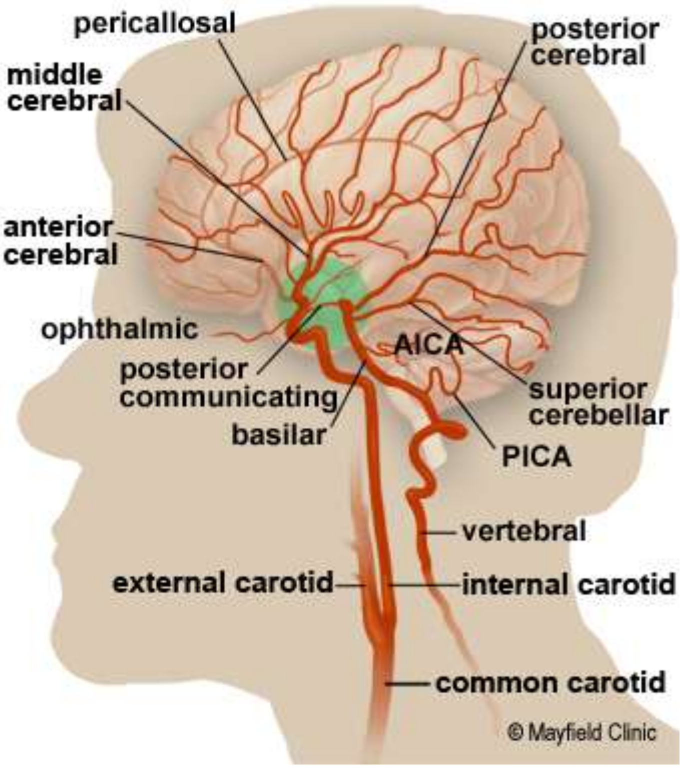

Fig (2. 24) Show blood supply of the brain.

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The vertebral arteries supply the cerebellum, brainstem, and the underside of the cerebrum. After passing through the skull, the right and left vertebral arteries join together to form the basilar artery. The basilar artery and the internal carotid arteries “communicate” with each other at the base of the brain called the Circle of Willis. The communication between the internal carotid and vertebral-basilar systems is an important safety feature of the brain. If one of the major vessels becomes blocked, it is possible for collateral blood flow to come across the Circle of Willis and prevent brain damage.

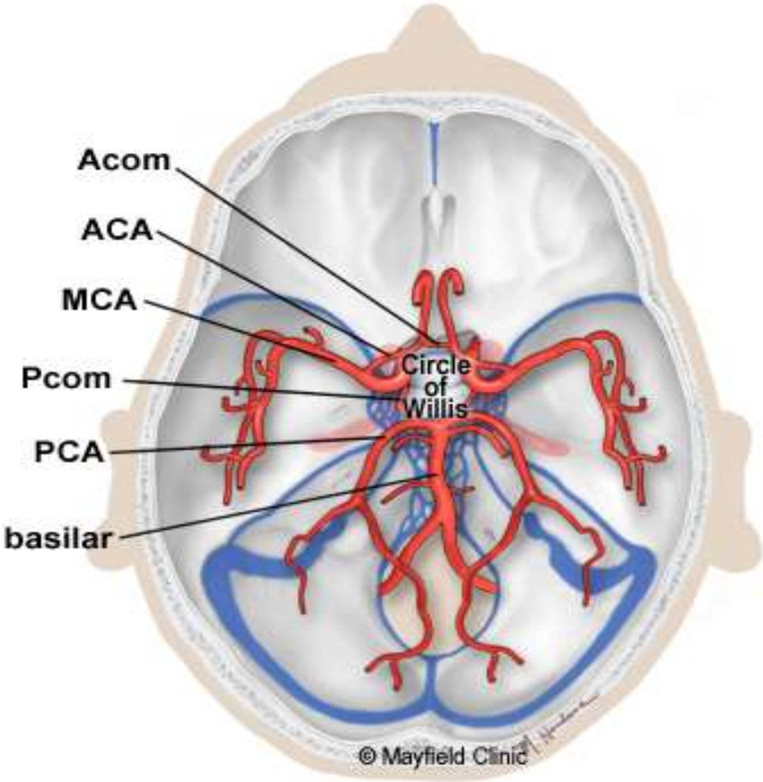


Fig (2. 25) Show the Circle of Willis. The internal carotid and vertebral-basilar systems are joined by the anterior communicating (Acom) and posterior communicating (Pcom) arteries. http://www.springer.com/978-1-4419-9996-2

The venous circulation of the brain is very different from that of the rest of the body. Usually arteries and veins run together as they supply and drain specific areas of the body. So one would think there would be a pair of vertebral veins and internal carotid veins. However, this is not the case in the brain. The major vein collectors are integrated into the dura to form venous sinuses — not to be confused with the air sinuses in the face and nasal region. The venous sinuses collect the blood from the brain and pass it to the internal jugular veins. The superior and inferior sagittal sinuses drain the cerebrum, the cavernous sinuses drains the anterior skull base. All sinuses eventually drain to the sigmoid sinuses, which exit the skull and form the jugular veins. These two jugular veins are essentially the only drainage of the brain.

2-1-12 Skull fractures:

Head accommodates one of the most vital parts of the body, the brain. Although it is well protected in a bony cranial cage, it still remains one of the most vulnerable parts of the body.

Head injury, a common term that is actually cranio-cerebral damage, has been recognized since ages. In medico-legal practice blunt head injuries are most frequently caused by traffic accident, fall from height, assault, train accident etc. The manner of death in cases of craniocerebral trauma may be accidental, homicidal or suicidal. Accidental deaths are by far the most common and road traffic accidents are the main component, followed by falls from height and railway accidents. Of all regional injuries, those of the head and neck are the most common and important in forensic practice.

After trauma, lesions such as skull fractures and cerebral injuries may develop. A fracture can be defined as an abnormal break in the continuity of a structure such as a bone produced by stress and strain". Out of all fractures, skull fractures draw attention of doctors as vital structure like brain lies inside the skull.

1- Linear fracture:

These are straight or curved fracture lines, often of considerable length. About 70% of skull fractures are linear. They either radiate out from a depressed zone, or arise under or at a distance from the impact area, from bulging deformation.

Also known as "Fissured fractures"; these are linear cracks without any displacement of the fragments and may involve whole thickness of the bone or one or the other table only. They are notoriously difficult to be detected and may not be demonstrable by X-rays; can be visualized with the help of a cranial Computed Tomography (CT) scan. These fractures are presumed as a one-dimensional injury.

A fissured fracture which involves only one table of the skull is referred to as a crack fracture.

2-Depressed fracture:

This occurs due to forceful localized impact causing multiple linear fractures radiating from the site of impact with depression of the site of impact where the bone breaks into pieces.

Rarely, only the inner table may get fractured and the outer remaining intact and vice versa may also be true. A violent blow with full striking area in operation, such as with a hammer, may detach almost the same diameter of the bone, which is driven inwards, thus often producing a pattern consistent with the offending object. This is why these fractures are also called "**Fractures a la Signature**" or

"**Signature fractures**". This type of fracture may also occur in case of primary impact by a vehicle. In such case, from the size and shape of the fracture, part of the vehicle striking the head can be known.

Impacts with axe or chopper etc, may leave characteristic lesions in the bone, whether skull or elsewhere. The shape of the fracture produced by such weapons may, to some degree, reveal the direction from which the blow was struck.

This is particularly true when a chopping instrument is used. The undermined edge of the fracture defect is the direction in which the lateral force vector is exerted and the slanted edge is the side of force transmission.

3-Comminuted fracture:

The term "comminution" refers to fracture division of a bone into several fragments. This results when a considerable force is applied over a relatively small area. Weapon with small striking surface like hammer are often the causative object. Comminution can also be a complication of fissured fractures.

Comminution fractures can be with or without depression of the affected area. The former is called Depressed Comminuted Fracture, while the latter is referred to as Non-depressed Comminuted Fracture.

When there is no displacement of the comminuted fragments, the area looks like

Spider's web or Mosaic, with fissured fractures radiating for varying distances along line of dissipation of the forces.

4-Diastatic fracture:

Diastatic factures are those in which the fracture line involves separation of one or more cranial sutures. These are most often seen in children and are commonly associated with epidural haemorrhage. It may occur alone but often is associated with other fractures. It is usually seen in the sagittal suture. They are particularly common in traffic accidents.

5-Ring fracture:

These occur in the posterior fossa around the foramen magnum and are most often caused by a fall from a height onto the feet. If the kinetic energy of the fall is not absorbed by fractures of the legs, pelvis or spine, the impact is transmitted up the cervical spine. This may be rammed into the skull, carrying a circle of occipital bone with it.

This is also known as the Foramen Fracture.

6-Hinge fracture:

This is a fracture of base of the skull where the fracture line runs from side to side across the middle cranial cavities separating the base into two halves, anterior and posterior.

It is also known as the Motorcyclist's fracture.

7-Basilar fracture:

Basilar skull fractures are linear fractures that occur in the floor of the cranial vault (skull base), which require more force to cause than other areas of the neurocranium. Thus they are rare, occurring as the only fracture in only 4% of severe head injury patients.

2-1-13 Traumatic Brain injury:

Traumatic brain injury is defined as damage to the brain resulting from external mechanical force, such as rapid acceleration or deceleration impact, blast waves, or penetration by a projectile, leading to temporary or permanent impairment of brain function.

Traumatic brain injury (TBI) has a dramatic impact on the health of the nation: it accounts for 15–20% of deaths in people aged 5–35 yr old, and is responsible for 1% of all adult deaths. TBI is a major cause of death and disability worldwide, especially in children and young adults. Males sustain traumatic brain injuries more frequently than do females. The overall mortality in severe TBI, defined as a post-resuscitation Glasgow Coma Score (GCS) ≤8, is 23%. In addition to the high mortality, approximately 60% of survivors have significant ongoing deficits including cognitive competency, major activity, and leisure and recreation. This has a severe financial, emotional, and social impact on survivors left with lifelong disability and on their families. It is well established that the major determinant of outcome from TBI is the severity of the primary injury, which is irreversible. However, secondary injury, primarily cerebral ischaemia, occurring in the post-injury phase, may be due to intracranial hypertension, systemic hypotension, hypoxia, hyperpyrexia, hypocapnia and hypoglycaemia, all of which have been shown to independently worsen survival after TBI.

2-1-13- I- Causes of TBI:

Falls, vehicle accidents, and violence. The most common causes of TBI include violence, transportation accidents, construction, and sports. Motor bikes are major causes, increasing in significance in developing countries as other causes reduce.

In children aged two to four, falls are the most common cause of TBI, while in older children traffic accidents compete with falls for this position.TBI is the third most common injury to result from child abuse. Abuse causes 19% of cases of pediatric brain trauma, and the death rate is higher among these cases. Domestic violence is another cause of TBI, as are work-related and industrial accidents. Firearms and blast injuries from explosions are other causes of TBI, which is the leading cause of death and disability in war zones. According to Representative Bill Pascrell (Democrat, NJ), TBI is "the signature injury of the wars in Iraq and Afghanistan."

2-1-13- ii Mechanism of injury:

The type, direction, intensity, and duration of forces all contribute to the characteristics and severity TBI. Forces that may contribute to TBI include angular, rotational, shear, and translational forces.

Even in the absence of an impact, significant acceleration or deceleration of the head can cause TBI; however in most cases a combination of impact and acceleration is probably to blame. Forces involving the head striking or being struck by something, termed *contact* or *impact loading*, are the cause of most focal injuries, and movement of the brain within the skull, termed *noncontact* or *inertial loading*, usually causes diffuse injuries. The violent shaking of an infant that causes shaken baby syndrome commonly manifests as diffuse injury. In impact loading, the force sends shock waves through the skull and brain, resulting in tissue damage. Shock waves caused by penetrating injuries can also destroy tissue along the path of a projectile, compounding the damage caused by the missile itself.

Damage may occur directly under the site of impact, or it may occur on the side opposite the impact (coup and contrecoup injury, respectively).When a moving object impacts the stationary head, coup injuries are typical, while contrecoup injuries are usually produced when the moving head strikes a stationary object

2-1-13-iii Pathophysiology:

One type of focal injury, cerebral laceration, occurs when the tissue is cut or torn. Such tearing is common in orbito frontal cortex in particular, because of bony protrusions on the interior skull ridge above the eyes. In a similar injury, cerebral contusion (bruising of brain tissue), blood is mixed among tissue. In contrast, intracranial hemorrhage involves bleeding that is not mixed with tissue.

Hematomas, also focal lesions, are collections of blood in or around the brain that can result from hemorrhage. Intra cerebral hemorrhage, with bleeding in the brain tissue itself, is an intra-axial lesion. Extra-axial lesions include epidural hematoma, subdural hematoma, subarachnoid hemorrhage, and intra -ventricular hemorrhage. Epidural hematoma involves bleeding into the area between the skull and the dura mater, the outermost of the three membranes surrounding the brain. In subdural hematoma, bleeding occurs between the dura and the arachnoid mater. Subarachnoid hemorrhage involves bleeding into the space between the arachnoid membrane and the pia mater. Intraventricular hemorrhage occurs when there is bleeding in the ventricles.

2-1-13-iv Signs and Symptoms (Clinical features):

Symptoms are dependent on the type of TBI (diffuse or focal) and the part of the brain that is affected. Unconsciousness tends to last longer for people with injuries on the left side of the brain than for those with injuries on the right. Symptoms are also dependent on the injury's severity. With mild TBI, the patient may remain conscious or may lose consciousness for a few seconds or minutes. Other symptoms of mild TBI include headache, vomiting, nausea, lack of motor coordination, dizziness, difficulty balancing, lightheadedness, blurred vision or tired eyes, ringing in the ears, bad taste in the mouth, fatigue or lethargy, and changes in sleep patterns. Cognitive and emotional symptoms include behavioral or mood changes, confusion, and trouble with memory, concentration, attention, or thinking. Mild TBI symptoms may also be present in moderate and severe injuries.

A person with a moderate or severe TBI may have a headache that does not go away, repeated vomiting or nausea, convulsions, an inability to awaken, dilation of one or both pupils, slurred speech, aphasia (word-finding difficulties), dysarthria (muscle weakness that causes disordered speech), weakness or numbness in the limbs, loss of coordination, confusion, restlessness, or agitation. Common long-term symptoms of moderate to severe TBI are changes in appropriate social behavior, deficits in social judgment, and cognitive changes, especially problems with sustained attention, processing speed, and executive functioning. Alexithymia, a deficiency in identifying, understanding, processing, and describing emotions occurs in 60.9% of individuals with TBI. Cognitive and social deficits have long-term consequences for the daily lives of people with moderate to severe TBI, but can be improved with appropriate rehabilitation.

When the pressure within the skull (intracranial pressure, abbreviated ICP) rises too high, it can be deadly. Signs of increased ICP include decreasing level of consciousness, paralysis or weakness on one side of the body, and a blown pupil, one that fails to constrict in response to light or is slow to do so. Cushing's triad, a slow heart rate with high blood pressure and respiratory depression is a classic manifestation of significantly raised ICP. Anisocoria, unequal pupil size, is another sign of serious TBI. Abnormal posturing, a characteristic positioning of the limbs caused by severe diffuse injury or high ICP, is an ominous sign.

Small children with moderate to severe TBI may have some of these symptoms but have difficulty communicating them. Other signs seen in young children include persistent crying, inability to be consoled, listlessness, refusal to nurse or eat, and irritability.

2-1-13-v Classification of TBI:

TBI is usually classified based on severity, anatomical features of the injury, and the mechanism (the causative forces).

A-Severity of TBI by using Glasgow coma scale, PTA and LOC:

Classification systems for determining the severity of TBI may use duration of PTA alone or with other factors such as Glasgow Coma Scale (GCS) score and duration of loss of consciousness (LOC) to divide TBI into categories of mild, moderate, and severe.

B-Mechanism-related classification divides TBI into:

Closed injury: A closed (also called non penetrating, or blunt) injury occurs when the brain is not exposed. ii. Penetrating head injury: A penetrating, or open, head injury occurs when an object pierces the skull and breaches the dura mater, the outermost membrane surrounding the brain.

C-Classification of TBI by its pathological (Anatomical) features:

Lesions can be extra-axial, (occurring within the skull but outside of the brain) or intra-axial (occurring within the brain tissue). Damage from TBI can be focal or diffuse, confined to specific areas or distributed in a more general manner, respectively. However, it is common for both types of injury to exist in a given case.

2-1-14 Computed tomography (CT):

2-1-14-1 CT Scanning of the Body:

Computed tomography, more commonly known as a CT or CAT scan, is a diagnostic medical test that,like traditional x-rays, produces multiple images or pictures of the inside of the body.

The cross-sectional images generated during a CT scan can be reformatted in multiple planes, and can even generate three-dimensional images. These images can be viewed on a computer monitor, printed on film or by a 3D printer, or transferred to a CD or DVD.

CT images of internal organs, bones, soft tissue and blood vessels provide greater detail than traditional x-rays, particularly of soft tissues and blood vessels.

Using specialized equipment and expertise to create and interpret CT scans of the body, radiologists can more easily diagnose problems such as cancer, cardiovascular disease, infectious disease, appendicitis, trauma and musculoskeletal disorders.

2-1-14-2 The CT equipments:

The CT scanner is typically a large, box-like machine with a hole, or short tunnel, in the center. Pt will lie on a narrow examination table that slides into and out of this tunnel. Rotating around pt, the x-ray tube and electronic x-ray detectors are located opposite each other in a ring, called a gantry.

The computer workstation that processes the imaging information is located in a separate control room, where the technologist operates the scanner and monitors the examination in direct visual contact and usually with the ability to hear and talk to the pt with the use of a speaker and microphone.

2-1-14-3 The procedure of CT:

In many ways CT scanning works very much like other x-ray examinations. Different body parts absorb the x-rays in varying degrees. It is this crucial difference in absorption that allows the body parts to be distinguished from one another on an x-ray film or CT electronic image.

In a conventional x-ray exam, a small amount of radiation is aimed at and passes through the part of the body being examined, recording an image on a special electronic image recording plate.

Bones appear white on the x-ray; soft tissue, such as organs like the heart or liver, shows up in shades of gray, and air appears black.

With CT scanning, numerous x-ray beams and a set of electronic x-ray detectors rotate around pt, measuring the amount of radiation being absorbed throughout your body. Sometimes, the examination table will move during the scan, so that the x-ray beam follows a spiral path. A special computer program processes this large volume of data to create two-dimensional cross-sectional images of the body, which are then displayed on a monitor. CT imaging is sometimes compared to looking into a loaf of bread by cutting the loaf into thin slices. When the image slices are reassembled by computer software, the result is a very detailed multidimensional view of the body's interior.

Refinements in detector technology allow nearly all CT scanners to obtain multiple slices in a single rotation. These scanners, called multislice CT or multidetector CT, allow thinner slices to be obtained in a shorter period of time, resulting in more detail and additional view capabilities.

Modern CT scanners are so fast that they can scan through large sections of the body in just a few seconds, and even faster in small children. Such speed is beneficial for all patients but especially children, the elderly and critically ill, all of whom may have difficulty in remaining still, even for the brief time necessary to obtain images.

For children, the CT scanner technique will be adjusted to their size and the area of interest to reduce the radiation dose.

For some CT exams, a contrast material is used to enhance visibility in the area of the body being studied.

2-1-14-4 The procedure of the exam:

The technologist begins by positioning pt on the CT examination table, usually lying flat on his back.

Straps and pillows may be used to help you maintain the correct position and to help pt remain still

-During the exam:

Many scanners are fast enough that children can be scanned without sedation. In special cases, sedation may be needed for children who cannot hold still. Motion will cause blurring of the images and degrade the quality of the examination the same way that it affects photographs.

If contrast material is used, depending on the type of exam, it will be swallowed, injected through an intravenous line (IV) or, rarely, administered by enema.

Next, the table will move quickly through the scanner to determine the correct starting position for the scans. Then, the table will move slowly through the machine as the actual CT scanning is performed.

Depending on the type of CT scan, the machine may make several passes.

Pt may be asked to hold his breath during the scanning. Any motion, whether breathing or body movements, can lead to artifacts on the images. This loss of image quality can resemble the blurring seen on a photograph taken of a moving object.

When the examination is completed, pt will be asked to wait until the technologist verifies that the images are of high enough quality for accurate interpretation.

The CT examination is usually completed within 30 minutes. The portion requiring intravenous contrast injection usually lasts only 10 to 30 seconds.

2-1-14-5The benefits vs. risks:

-Benefits:

CT scanning is painless, noninvasive and accurate.

A major advantage of CT is its ability to image bone, soft tissue and blood vessels all at the same time.

Unlike conventional x-rays, CT scanning provides very detailed images of many types of tissue as well as the lungs, bones, and blood vessels.

CT examinations are fast and simple; in emergency cases, they can reveal internal injuries and bleeding quickly enough to help save lives.

CT has been shown to be a cost-effective imaging tool for a wide range of clinical problems.

CT is less sensitive to patient movement.

CT can be performed if the pt has an implanted medical device of any kind.

CT imaging provides real-time imaging, making it a good tool for guiding minimally invasive procedures such as needle biopsies and needle aspirations of many areas of the body, particularly the lungs, abdomen, pelvis and bones.

A diagnosis determined by CT scanning may eliminate the need for exploratory surgery and surgical biopsy.

No radiation remains in a patient's body after a CT examination.

X-rays used in CT scans should have no immediate side effects.

-Risks:

There is no conclusive evidence that radiation at small amounts delivered by a CT scan causes cancer.

Large population studies have shown a slight increase in cancer from much larger amounts of radiation, such as from radiation therapy. Thus, there is always concern that this risk may also apply to the lower amounts of radiation delivered by a CT exam.

The effective radiation dose for this procedure varies.

Women should always inform their physician and x-ray or CT technologist if there is any possibility that they are pregnant.

CT scanning is, in general, not recommended for pregnant women unless medically necessary because of potential risk to the fetus in the womb.

Manufacturers of intravenous contrast indicate mothers should not breastfeed their babies for 24-48.

2-2 Pervious Study

Ghada Mohammed (2012) studied of head injuries by using CT-scan, in this study 51 Pt involved. 71% male and 29% female with variable ages which are grouped into 8 groups. The main findings; 24 were positive and 27 were negative with percent 47.1% and 52.9%. The most common cause of trauma is RTA with percent of 70.6%, and the most type of lesion occurs is hemorrhage both intra and extra axial hemorrhage with same percent 41.7%, 41.7%; and site of fracture is the most common in facial bone with percent 50.1% than the other site.

Nasr Mohammed (2008) studied CT findings of head injuries, 100 patients were selected randomly ; those with clinical diagnosis of head trauma, and their CT reports were collected to evaluate them. The study was carried out in four diagnostic CTcenters in Khartoum state; in a period extended from May 2008 to August 2008. The results of the study explain that; male have incidence of head trauma, about 67% of the full group; and the female about 33%. RTA is the main cause of head injury about 46% of full group.

Fares Ghassan Hafez (2017) studied head trauma using CT scan in 50 patient visit CT centers with head trauma. The study founded that males have more head injuries than females (40:10) of population of study. And the road traffic accident was the main cause of head trauma 74%, hit by stick18% and falling down 8%. Fracture +hemorrhage was the most common head injury abnormality 66% (fracture 20% and hemorrhage 14%). This study showed that was the RTA the most cause of head trauma. The most common affected group were (16-30 years) which was 44% ; (1-15 years 20%); (31-45 years which was 18%) ; (61-75 years which was 10 %) ; (46-60 years which was 6%); more than 75 years was 2% .

Debbie McGauran (Monday, August 10th).Traumatic brain injury (or TBI) occurs as the result of a traumatic event, which injures the brain. This can be a result of a penetrating injury or a closed injury. Brain damage can occur along the path where an object—such as a bullet or shrapnel—enters the brain. TBI can also occur as a result of sudden acceleration/deceleration of the structures of the brain within the cranium, for example if a hockey player receives a slap shot to the head or as the result of a fall.

National Center for Injury Prevention and Control, Division of Unintentional Injury Prevention(January 12, 2015).Traumatic brain injury (TBI) is the leading cause of death and disability in children and young adults in the United States. TBI is also a major concern for elderly individuals, with a high rate of death and hospitalization due to falls among people age 75 and older. Depending on the severity of injury, TBI can have a lasting impact on quality of life for survivors of all ages – impairing thinking, decision making and reasoning, concentration, memory, movement, and/or sensation (e.g., vision or hearing), and causing emotional problems (personality changes, impulsivity, anxiety, and depression) and epilepsy.

Chapter Three

Materials and Methods

Chapter Three

Materials and Methods

The study was collected from emergency department of military hospital (radiology department) and Alia hospital.

3-1 Materials:

3-1-1 Study population:

Study includes 70 traumatic patients visiting the emergency department with different ages. Exclusion criteria patients whom have non traumatic brain traumas and normal patients.

3-1-2 Machine used:

The machine used is A CT machine (TOSHIBA aquilion 64 ct scanner model TSx-101A).

3-2 Methods:

3-2-1 CT Brain Protocol Used:

All patients under CT study with the following parameters KVP (120-140) MA (150-300), with time (.75-1.5) second.

A-Slice thickness: thin slice at the base of skull (2-4) ml, thick slice above to the base (5-10) ml.

B-Breath hold: none.

C-I.V Contrast: none.

Patient position: supine head first, arms along the side of the body and head immobilized in the head holder.

D-Scout: lateral.

Start location and end: from foramen magnum to vertex.

E-Slice plane: Axial.

F-Image Interpretation:

All images done studies in soft tissue and bone window for diagnosis.

3-2-2 Data collection:

Data collected according to data collection sheet involved.

3-2-3 Data analysis:

Statistical Package of Social Sciences (SPSS) program.

3-2-4 Ethical consideration:

Explain the procedure to the patient.

Ask the patient if she pregnant and a wear her about the risks.

Chapter Four

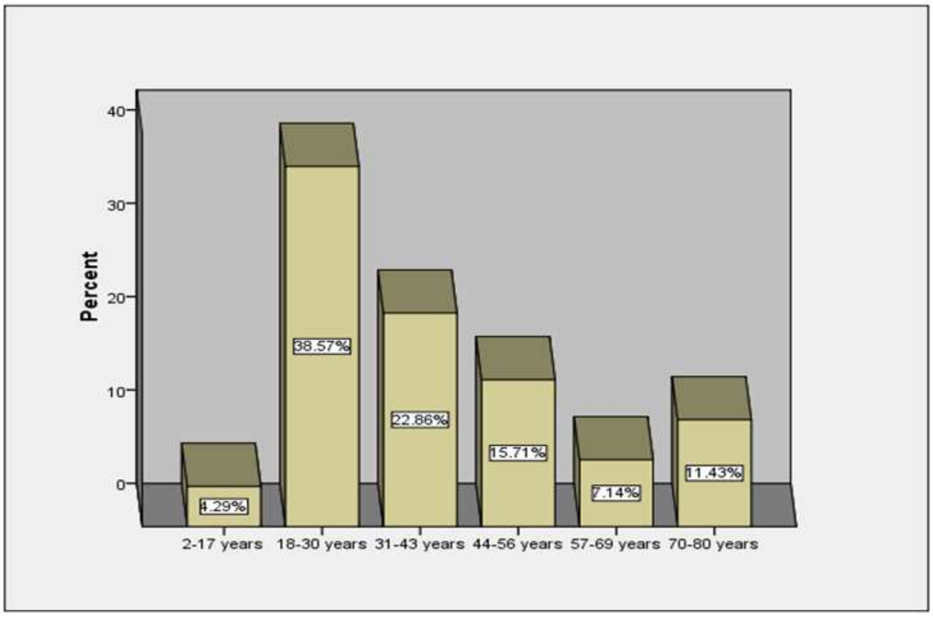
Results

Chapter four

The Results

Table (4. 1) frequency distribution of age

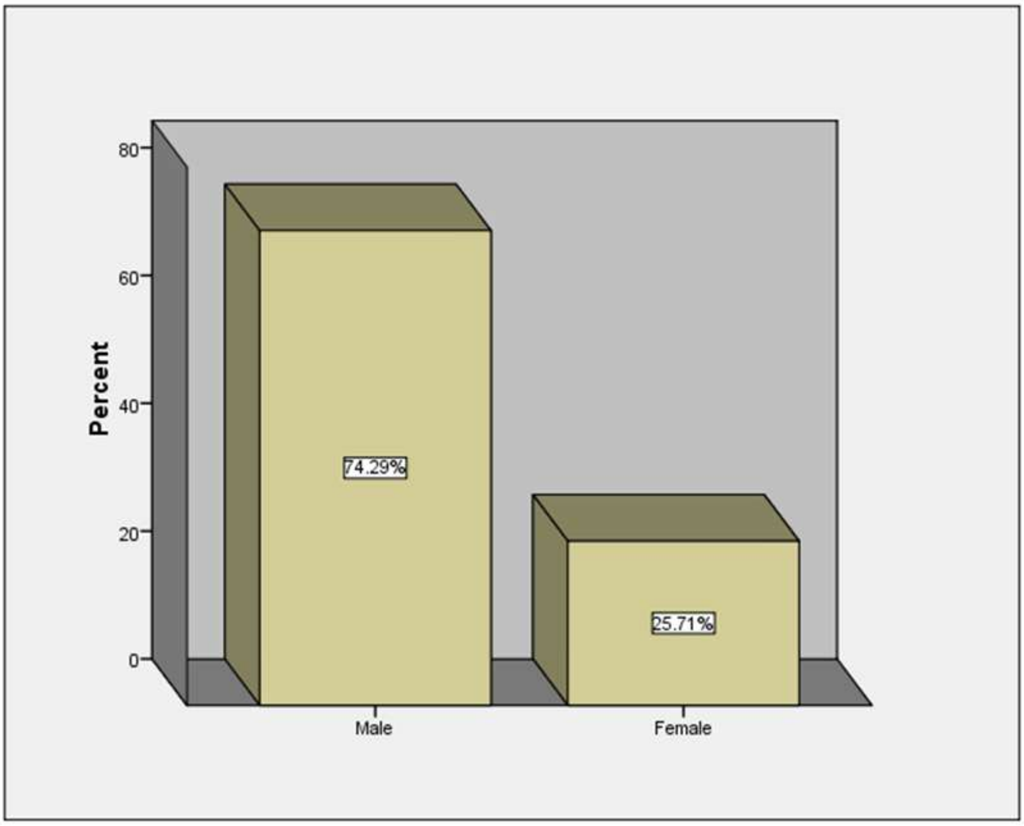
Age	Frequency	Percent	Valid Percent	Cumulative Percent
2-17 years	3	4.3	4.3	4.3
18-30 years	27	38.6	38.6	42.9
31-43 years	16	22.9	22.9	65.7
44-56 years	11	15.7	15.7	81.4
57-69 years	5	7.1	7.1	88.6
70-80years	8	11.4	11.4	100
Total	70	100	100	
Minimum=2,maximum =80, mean=38.33, St. Deviation = 18.375 years				



Fig(4. 1) frequency distribution of age

Table (4. 2) frequency distribution of gender:

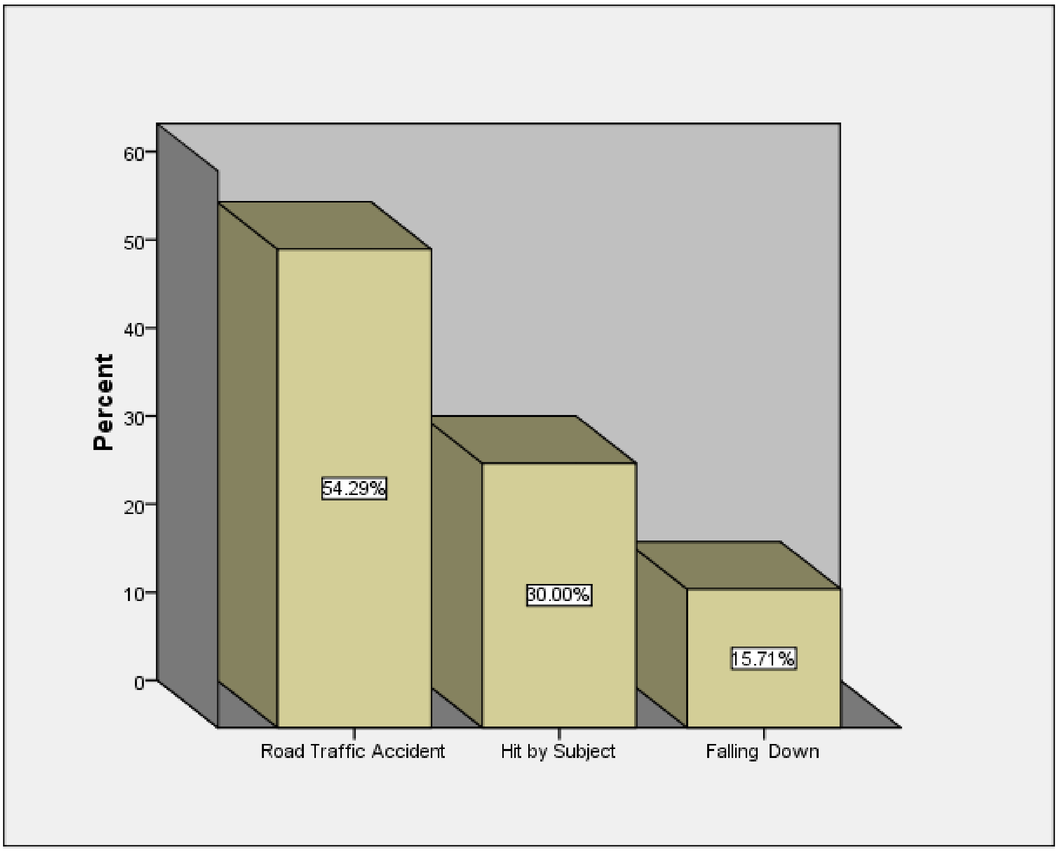
Sex	Frequency	Percent	Valid Percent	Cumulative Percent
Male	52	74.3	74.3	74.3
Female	18	25.7	25.7	100
Total	70	100	100	



Fig(4. 2) frequency distribution of gender

Table (4. 3) frequency distribution of cause of trauma

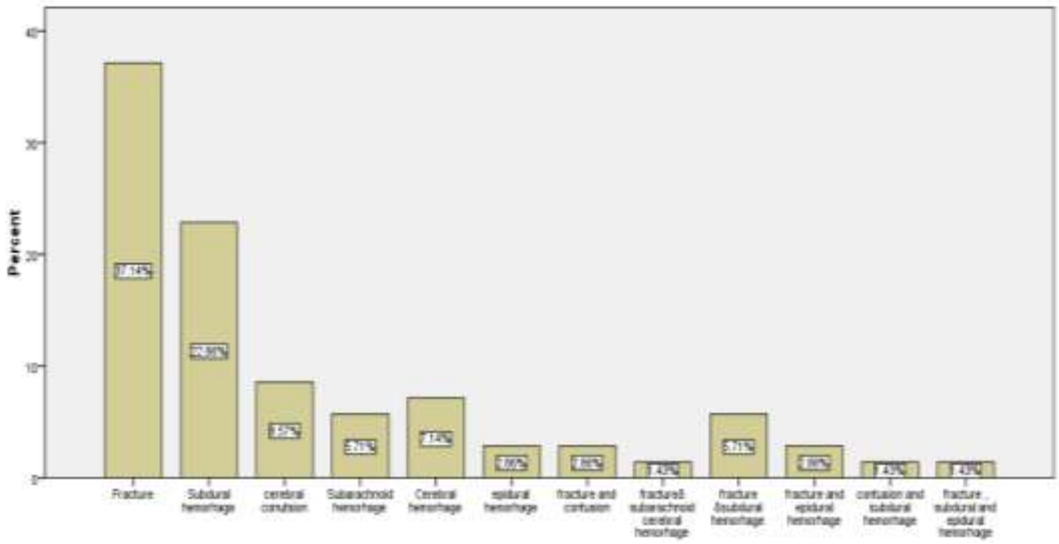
Cause of trauma	Frequency	Percent	Valid Percent	Cumulative Percent
Road Traffic Accident	38	54.3	54.3	54.3
Hit by Subject	21	30	30	84.3
Falling Down	11	15.7	15.7	100
Total	70	100	100	



Fig(4. 3) frequency distribution of cause of trauma

Table (4. 4) frequency distribution of complications which occurs as results of head injury:

CT Finding	Frequency	Percent	Valid Percent	Cumulative Percent
Fracture	26	37.1	37.1	37.1
Subdural hemorrhage	16	22.9	22.9	60
cerebral contusion	6	8.6	8.6	68.6
Subarachnoid hemorrhage	4	5.7	5.7	74.3
Cerebral hemorrhage	5	7.1	7.1	81.4
epidural hemorrhage	2	2.9	2.9	84.3
fracture and contusion	2	2.9	2.9	87.1
fracture& subarachnoid cerebral hemorrhage	1	1.4	1.4	88.6
fracture &subdural hemorrhage	4	5.7	5.7	94.3
fracture and epidural hemorrhage	2	2.9	2.9	97.1
contusion and subdural hemorrhage	1	1.4	1.4	98.6
fracture ,subdural and epidural hemorrhage	1	1.4	1.4	100
Total	70	100	100	



Fig(4. 4) frequency distribution of complications which occurs as results of head injury

Table (4. 5) frequency distribution of presence of fracture

Fracture	Frequency	Percent	Valid Percent	Cumulative Percent
YES	36	51.4	51.4	51.4
NO	34	48.6	48.6	100
Total	70	100	100	

Table (4. 6) frequency distribution of presence of contusion

Contusion	Frequency	Percent	Valid Percent	Cumulative Percent
YES	11	15.7	15.7	15.7
NO	59	84.3	84.3	100
Total	70	100	100	

Table (4. 7) frequency distribution of intra- axial hemorrhage

Intra –axial hemorrhage	Frequency	Percent	Valid Percent	Cumulative Percent
cerebral hemorrhage	5	7.1	50.0	50.0
subarachnoid hemorrhage	4	5.7	40.0	90.0
subarachnoid and cerebral hemorrhage	1	1.4	10.0	100.0
Total	10	14.3	100.0	
No	60	85.7		
Total	70	100.0		

Table (4. 8) frequency distribution of extra- axial hemorrhage

Extra –axial hemorrhage	Frequency	Percent	Valid Percent	Cumulative Percent
subdural	20	28.6	80	80
epidural	4	5.7	16	96
subdural and epidural	1	1.4	4	100
Total	25	35.7	100	
No	45	64.3		
	70	100		

Table (4. 9) frequency distribution of presence of midline shift

Midline shift	Frequency	Percent	Valid Percent	Cumulative Percent
YES	5	7.1	7.1	7.1
NO	65	92.9	92.9	100.0
Total	70	100.0	100.0	

Table (4. 10) cross tabulation complications and age

Finding	Age						Total
	2-17 years	18-30 years	31-43 years	44-56 years	57-69 years	70-82 years	
Fracture	2	14	8	2	0	0	26
Subdural hemorrhage	0	3	2	3	2	6	16
cerebral contusion	0	3	1	2	0	0	6
Subarachnoid hemorrhage	1	0	1	0	1	1	4
Cerebral hemorrhage	0	1	0	2	1	1	5
epidural hemorrhage	0	1	1	0	0	0	2
fracture and contusion	0	1	1	0	0	0	2
fracture& subarachnoid cerebral hemorrhage	0	1	0	0	0	0	1
fracture &subdural hemorrhage	0	2	0	1	1	0	4
fracture and epidural hemorrhage	0	0	1	1	0	0	2
contusion and subdural hemorrhage	0	0	1	0	0	0	1
fracture ,subdural and epidural hemorrhage	0	1	0	0	0	0	1
Total	3	27	16	11	5	8	70
$p>0.05$							

Table (4. 11) cross tabulation complications and sex

CT finding Sex	Male	Female	Total
Fracture	21	5	26
Subdural hemorrhage	8	8	16
cerebral contusion	6	0	6
Subarachnoid hemorrhage	3	1	4
Cerebral hemorrhage	3	2	5
epidural hemorrhage	2	0	2
fracture and contusion	2	0	2
fracture& subarachnoid cerebral hemorrhage	1	0	1
fracture &subdural hemorrhage	3	1	4
fracture and epidural hemorrhage	2	0	2
contusion and subdural hemorrhage	1	0	1
fracture ,subdural and epidural hemorrhage	0	1	1
Total	52	18	70
$p>0.05$			

Table (4. 12) cross tabulation complications and cause of trauma

	midline shift		Total
	YES	NO	
Fracture	0	26	26
Subdural hemorrhage	4	12	16
cerebral contusion	0	6	6
Subarachnoid hemorrhage	0	4	4
Cerebral hemorrhage	0	5	5
epidural hemorrhage	0	2	2
fracture and contusion	0	2	2
fracture& subarachnoid cerebral hemorrhage	0	1	1
fracture &subdural hemorrhage	1	3	4
fracture and epidural hemorrhage	0	2	2
contusion and subdural hemorrhage	0	1	1
fracture ,subdural and epidural hemorrhage	0	1	1
Total	5	65	70
$p>0.05$			

Table (4. 13) cross tabulation finding and midline shift

CT finding	type of trauma		Total	
	Road Traffic Accident	Hit by Subject	Falling Down	
Fracture	19	5	2	26
Subdural hemorrhage	3	6	7	16
cerebral contusion	3	3	0	6
Subarachnoid hemorrhage	2	1	1	4
Cerebral hemorrhage	3	1	1	5
epidural hemorrhage	1	1	0	2
fracture and contusion	2	0	0	2
fracture& subarachnoid cerebral hemorrhage	1	0	0	1
fracture &subdural hemorrhage	3	1	0	4
fracture and epidural hemorrhage	0	2	0	2
contusion and subdural hemorrhage	1	0	0	1
fracture ,subdural and epidural hemorrhage	0	1	0	1
Total	38	21	11	70
P >0.05				

Chapter five

Discussion, Conclusion and Recommendation

5-1 Discussion:

52 of them were males and 18 patients were females with percentage 74.3% and 25.7%from the total sample. This result was similar to the most previous studies (Ghada Mohammed 2012) (Nasr Mohammed 2008) (Debbie McGauran (2010) as shown in table (4-2).

According to age as it shown in table(4-1) found that the most common group affected were (18-30 year) which was % (2-17year) which was 4.3%, (31-43year) which was22.9%, (44-56year) which was15.7%, (57-69year) which was7.1%, (70-80years) which was11.4% this result similar to the study of (Fares Ghassan Hafez (2017)).

Road traffic accident (RTA) is the main cause of head injuries54.3%, then hit by subject (H.B.S) 30%, and then falling down 15.7% as shown in table (4-3). This result similar to the studies of (Fares Ghassan Hafez (2017), (Ghada Mohammed 2012) (Nasr Mohammed 2008) (Debbie McGauran (Monday, August 10th).

Presence of fracture in 36 patients of population sample with pecentage51.4% as in table (4-5).

Cerebral contusion appears in 11 patients of population sample with percentage 15.7% as in table 4-6.

Intra-axial hemorrhage include: Cerebral hemorrhage founded in 5 pt (7.1%), subarachnoid hemorrhage in4 pt (5.7%), and then both of them in1 pt (1.4%) as in table 4-7.

Extra-axial hemorrhage include: subdural hemorrhage founded in 20 pt (28.6%), epidural hemorrhage in 4 pt (5.7%), and then both of them in 1 pt (1.4%) as in table 4-8.

Fractures was the most common type trauma 37.1%, then subdural hemorrage22.9%, then cerebral contusion 8.6%, then cerebral hemorrhage 7.1%, then all of subarachnoid and (fracture&subdural hemorrhage) 5.7%, then all of epidural hemorrhage, (fracture&contusion)and (fracture&

epidural hemorrhage) 2.9%, then all of (fracture, subarachnoid & cerebral hemorrhage), (contusion & subdural hemorrhage) & (fracture, subdural& epidural hemorrhage) have same percentage 1.4% as shown in table(4-4).this result doesn’t agree with studies of (Fares Ghassan Hafez (2017).

Midline shift occurred in 5 pt with percentage7.1% as shown in table (4-7).

According to complication of head injury: fractures founded in 21 pt males compare with 5 pt females, subdural hemorrhage in 8 pt males and 8 pt females, cerebral contusion in 6 pt males and 0 pt female, subarachnoid hemorrhage in 3 pt males and 1 pt female, cerebral hemorrhage in 3 males and 2 females, epidural hemorrhage in 2 pt males and 0 pt female,(fracture &contusion) in 2 pt males and 0 pt female, (fracture& subarachnoid& cerebral hemorrhage) in 1pt male and 0 pt female, (fracture& subdural hemorrhage) in 3 pt males and 1 female, (fracture & epidural hemorrhage) in 2 pt males and 0 female, (contusion & subdural hemorrhage) in 1 pt male and 0 female, (fracture & subdural &epidural hemorrhage) in 0 male and1 female.

5-2 Conclusion:

The study concluded that: CT is the first choice compared with the other modality due to many advantages; it has such as need short time for procedure and accurately identifies the brain injuries (bony and soft tissue injuries).

The study founded that CT can determine the site, type and complications of head injuries.

The study concludes that most of the head injuries were caused by RTA.

The fractures most common injuries followed by hemorrhage then both of them.

The study concludes that there is relation between types of trauma and complications of head injury.

The study concludes that there is relation between complications of head injury and age.

The study founded that males have high ratio to head injuries compare with females.

The study concludes that most of the head injuries were occurred in range of age 18-30 years.

5-3 Recommendations:

1-The RTA is the major cause of TBI, so that their prevention or reduce of causes can reduce of RTA, and it can reduce by use seat belt, child safety seats and motorcycle helmets.

2-Educational programs exist to lower the number of crashes.

3-Patient with head injuries should be directed to do CT scan examination immediately after first aids to the patient.

4-A new technique exists in cars that prevent head trauma to the people inside the cars which were (air bags) should be found in Sudan or as safety criteria of traffic policy.

5-The governmental hospitals (espially in far states) should be provided by CTscanning machines.

6-The facilities for treatment of the patients should be available in all emergencies departments.

7-More researches should be done using a large sample of patients for further assessment.

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Appendix

Appendix(I)

بسم الله الرحمن الرحيم
جامعة السودان للعلوم والتكنولوجيا

Data Collection Sheet

Patient's No.	Age	Sex	Type of treatment	CT findings						
				Fracture	Cerebral contusion	Intra axial hemorrhage		Extra axial hemorrhage		Mid line shift
						Cerebral h	Subarachnoid h	Subdural h	Epidural h	
1.										
2.										
3.										
4.										
5.										
6.										
7.										
8.										
9.										
10.										
11.										
12.										
13.										
14.										
15.										
16.										

Appendix(II)

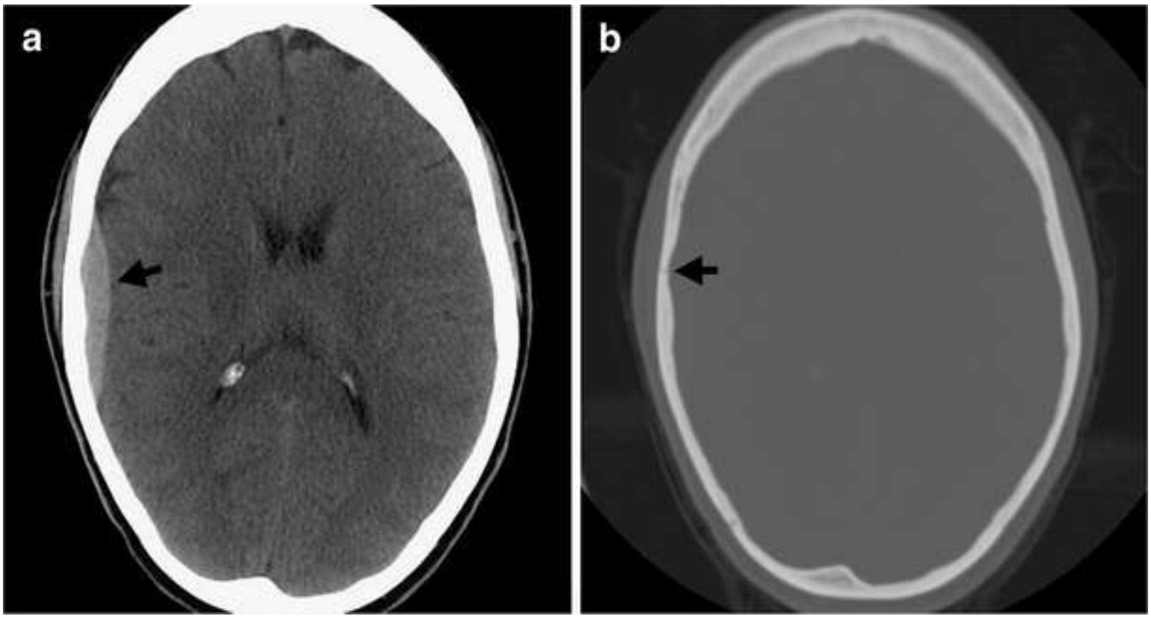

FIG. 1

(a) Axial noncontrast CT in brain windows shows a lentiform, high attenuation collection (arrow) adjacent to the right temporal lobe, consistent with an EDH caused by injury to a branch of the middle meningeal artery. (b) The skull fracture that is almost invariably seen with an EDH is best appreciated on bone windows (arrow). CT = computed tomography; EDH = epidural hematoma. (www.strich.lue.edu).

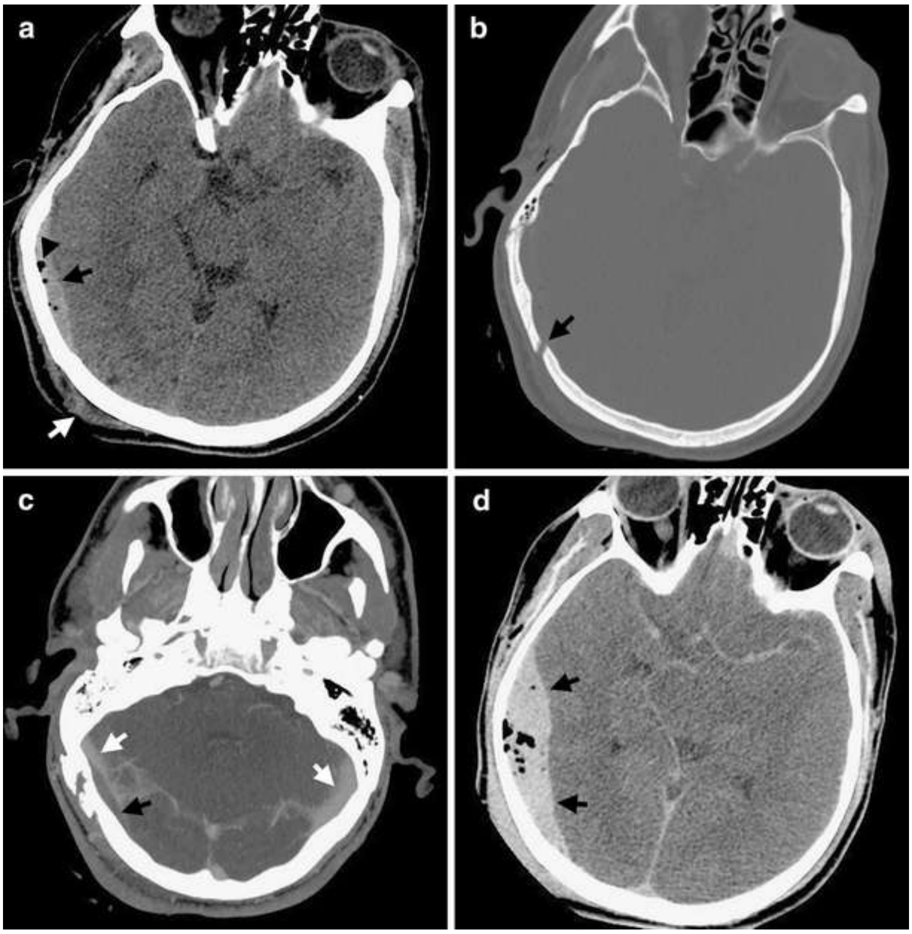

FIG. 2

(a) This patient sustained a blow to the back of his right occiput (coup site), as indicated by scalp soft tissue swelling (white arrow). Underlying the coup site is a lentiform EDH (black arrow). Several foci of pneumocephalus are noted (arrowhead) that indicate an associated skull fracture. (b) The displaced skull fracture (black arrow) is best seen on bone windows. (c) Contrast-enhanced CT venogram was obtained as the fracture line extended over the expected location of the right transverse sinus. The opacified transverse sinuses (white arrows) are patent, but the right transverse sinus is compressed and displaced from the inner table of the skull by the EDH (black arrow) caused by injury to the transverse sinus. Note that EDHs form superficial to the periosteal dural layer vesting the outer margin of the venous sinus, thereby possibly displacing the venous sinus away from the calvarium. (d) Follow-up CT 3 h after presentation shows substantial enlargement of the EDH (black arrows), which is less commonly seen with venous EDHs as compared to arterial EDHs. This was subsequently surgically evacuated. (www.strich.lue.edu).

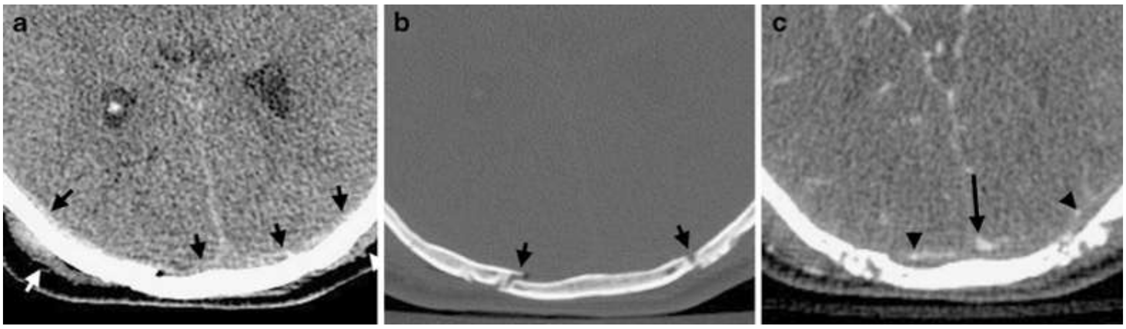

FIG. 3

EDH crossing midline. (a) Underlying the coup site, as indicated by soft tissue swelling (white arrows), is a subtle, relatively thin extra-axial hematoma (black arrows). Note that this hematoma extends across the midline, which distinguishes an EDH from an SDH. (b) The associated calvarial fractures (black arrows) at the coup site are readily appreciated on bone windows. (c) The superior sagittal sinus (long arrow) is displaced from the inner table of the skull by the EDH, as are small cortical vessels (arrowheads). SDH = Subdural hematoma. (www.strich.lue.edu).

Figure (4): CT image show A- Rt frontal chronic subdural hematoma (arrows) seen as an area of low density with crescent inner margin. B- Lt Frontal subdural hematoma increased. (www.strich.lue.edu).

Figure (5): Axial CT scan of spontaneous intra cranial hemorrhage. (www.radiopaedia.org).

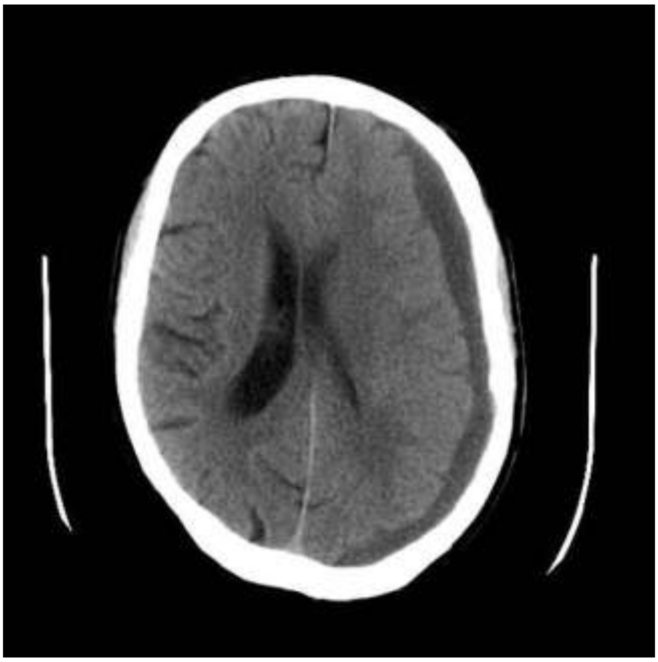

Figure (6): Axial non-contrast chronic subdural hematoma, Lt cerebral convexity subdural .H, chronic as it is low density. (www.radiopaedia.org).

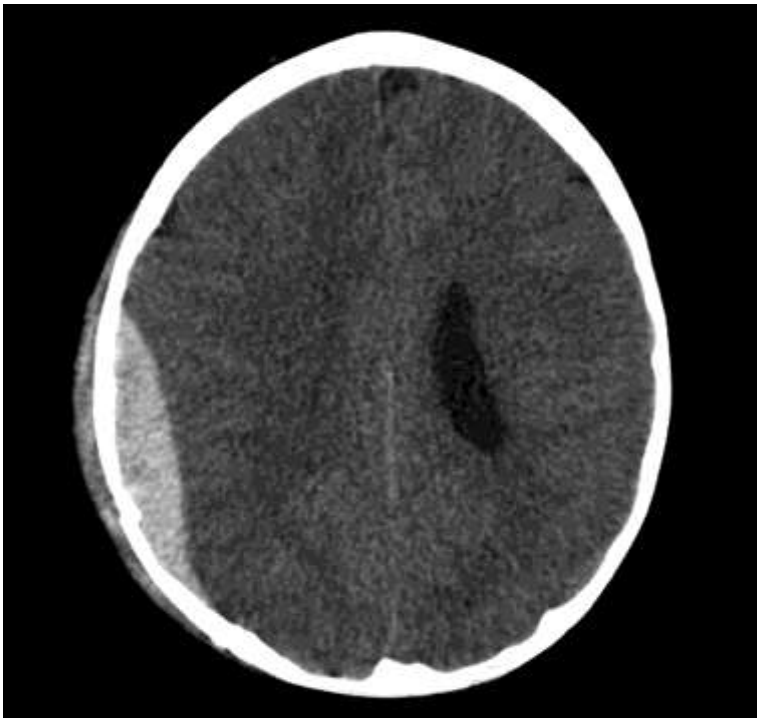

Figure (7): Axial non- contrast CT image show epidural hematoma, 6 years old boy fell and fracture his skull with a resultant EDH. (www.radiopaedia.org).

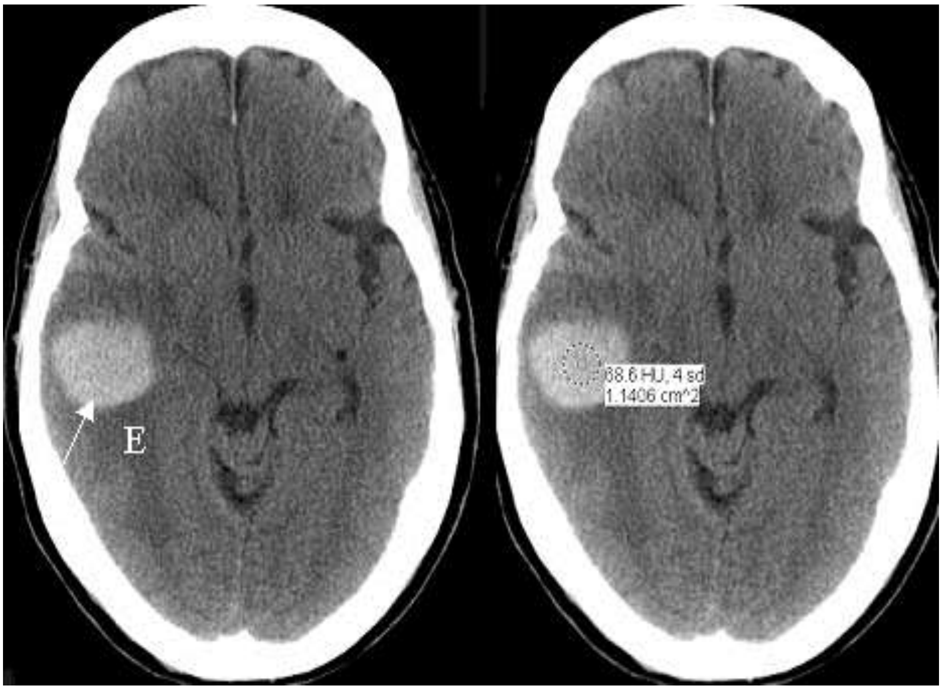

Figure (8): CT scan show acute intracerebral hemorrhage within the Rt temporal lobe (arrow) with surrounding edma (E). (www.radiopaedia.org).

Figure (9): CT scan show subarachnoid hemorrhage/ subdural hemorrhage, (arrow heads) points to subarachnoid in the sulci and subarachnoid space, (black arrow) points to subdural. H, (white arrow) points to shift midline. (www.radiopaedia.org).

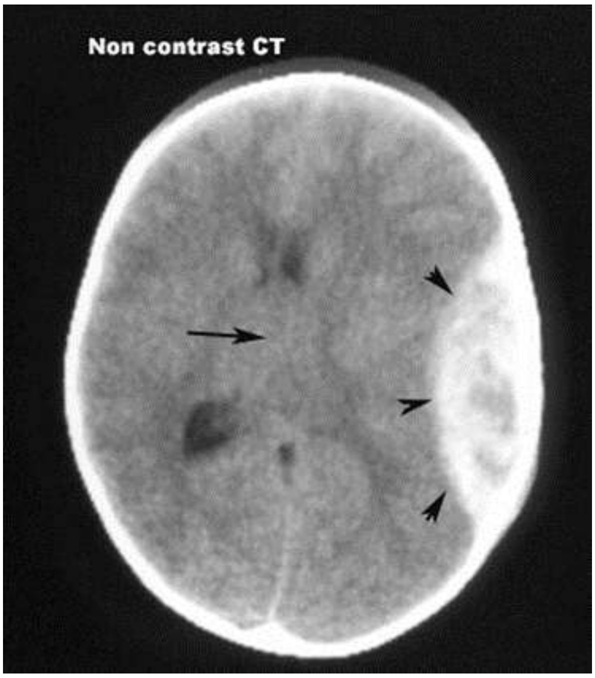

Figure (10): CT image show epidural hematoma, (arrow heads) points to the epidural. H which is a collection of blood between the skull and the Dura matter, (arrow) points to shift of the midline to the Rt. (www.radiopaedia.org).