Chapter one

1.1 Introduction

All human beings occupying this globe belong to the same species i.e., Homo sapiens, no two individuals are exactly alike in all their measurable traits; even genetically identical twins (monozygotic) differ in some respects. These traits tend to undergo changes in varying degrees from birth to death in health and disease and since skeletal development is influenced by a number of factors producing differences in skeletal proportions between different geographical areas, it is desirable to have some means of giving quantitative expression to variations which such traits exhibit. Anthropometry as a study is a technique of expressing quantitatively the different forms of the human body (Barreto and Mathog 1999). That human physical variability has been a subject of great interest for the scientists for very long time and anthropometry evolved as a standard scientific technique for measuring human body dimensions (Eickstedt 1927). Physical anthropology relies mainly on external measurements and descriptions of the human body and in particular upon the skeleton. Such measurements are useful in the analysis and classification of fossil remains as well as study of living population (Alex 1996). Hence facial anthropometry has become an important tool used in genetic counseling, reconstructive surgery and forensic investigation (Oladipo 2007; Krishan 2008; Olotu 2009).

Anthropometric characteristics have direct relationship with sex, shape and form of an individual and these factors are intimately linked with each other and are manifestation of the internal structure, tissue components which in turn and are influenced by environmental and genetic factors (Danborno et al 1997; Abbie 1950). Anthropometric data is believed to be objective and allow the cephalometric examiner to go beyond subjective assessments (Panero 1979; Radovic et al 2000). Anthropometry can be subdivided into somatometry, cephalometry and osteometry. Somatometry is a subdivision of anthropometry for measurement of different body dimensions while keeping soft tissue intact either in the living body or cadaver including head and face. It is also considered as a major tool in the study of human biological variability including morphological variations. Somatometry is useful in the study of age estimation from different body segments in a given set of individuals (Majekodunmi and Oluwole 2009; Heidari et al 2006). The importance of anthropology as a course using osteometry in the measurement of the skeleton and its parts cannot be over-emphasized. Anthropometry is being used more often in sexing the skeletal remains. Worldwide, various studies have been conducted on the determination of sex from variety of human bones including skull, pelvis, long bones, scapula, clavicle and the bones like metatarsals, metacarpals, phalanges, patella, vertebrae, ribs etc. and the most popular statistical model in sex determination has been developed (Reichs 1998). Today, anthropometry plays an important role in industrial design, ergonomics and architecture where statistical data about the distribution of body dimensions in the population are used to optimize products (Rajlakshmi et al

2001; Safikhani and Bordbar, 2007). Various method have been used in the past to indirectly analyse the craniofacial region .Cephalomitrec radiography first introduced by Broadbent (1931) has traditionally been used to study the morphology and patterns of growth of the craniofacial skeleton ,and developed standards for it . the large collection of normative data that have been developed allow clinicians to monitor an individual patient`s developments (Bambha1961; Enlow1968;Broadbent et al 1975) other methods of quantitative craniofacial analysis have been used to much more limited extend example of these include anthropometry (Farkas 1981) and cephalometric with multiplane and finite –element scaling analysis (Grayson et al 1983)each of these techniques is limited in its capacity to develop accurate normative standards for craniofacial complex although useful for surface analysis , anthropometry is influenced by overlying soft tissues and is therefore unreliable in the assessment of the skull other method based on cephalometric radiology (Bambha 1961) Where the number of anatomic land marks that can be identified accurately is limited , and the overlap of the structures on radiograph makes locating these landmarks difficult to compensate, derived landmarks peculiar to the cephalogram have been constructed , these ,however aren’t true biologic loci and may be of limited use to clinician the vast majority of available normative data which is obtained from lateral strictly two-dimensional projection ,oversimplifies the craniofacial form the radiographs used in such studies are usually indirectly interpreted from tracings, which can be another substantial source of error (Farkas and Munro 1987)

Computed tomography (CT) of the head is a common source for clinical and basic science research, , now an established key modality in diagnosis surgical planning, and follow - up of craniofacial anomalies (Dufresne and Richtsmeier 1995) This technology is further enhanced by computer software that allows three dimensional reconstructions of the (CT) slices, allowing life-like visualization of the skull and face for measuring purposes and there is no significant enlargement or distortion of the image, overlap of structures, or tracing error, and the number of anatomic landmarks is vast three – dimensional representation is possible this technique is particularly useful in the surgical reconstruction of the upper facial skeleton(Kim DO et al 2002), henceforth (CT) has provided new tools for medical investigation and has been widely used for pre and postoperative imaging when evaluating patients with craniofacial abnormalities.

During craniofacial growth and development each face obtains individual characteristics. Though the human face displays a wide variety of appearances, this variability stays within certain limits, so that the face is recognizable as typical human. Though these limits are not absolute, we do have feelings of awareness whether a face is normal. However, sometimes growth and development lead to such an aberrant result that it can be regarded as a deformity. The etiology of these deformities is not completely understood. As often occurs in history of life sciences, there has been some controversy whether genetic factors or environmental factors are responsible for growth and development. It seems plausible that both factors are involved in the regulation of craniofacial growth. It is postulated that growth of bone centres of chondral origin is predominantly controlled by genetic factors whereas growth of bone centres with a dismal background is controlled by local environmental factors (Van Limborgh 1972).

In ancient times, anthropometry was used in criminology where criminals were identified by measuring parts of their body. During the early 20th century, one of its primary uses became the attempted differentiation between differences in the races of man (Franciscus, 1991). So the study of anthropometric characteristics is of fundamental importance in solving problems related to identification. Craniometric features are included among these characteristics since they are closely connected to forensic dentistry and can be used to aid in identifying an individual from a skull found detached from its skeleton (Ono 1992). Facial anthropometry has become an important tool used in genetic counselling, reconstructive surgery and forensic investigation (Olotu 2009). The measurements of nose can help to reveal the course of evolution leading to the modern varieties of man(Last 1981) that mean the shape of the external nose is variable(Standring 2008) and is also useful in determination of race and sex of individual or group whose identity is unknown The shape of the nose is determined through the environmental factors, and climatic conditions (Last 1981) the narrower noses are favoured in cold and dry climate where as broader noses in warmer and moister one as a consequence of natural selection in human evolution (Oladipo et al 2009) So the nose is a distinctive feature of human physiognomy. Its shape, form, and contour have stimulated anatomists and anthropologists (Bhargava et al 1959). The craniofacial anthropometrics studies are so valuable for medicine, dentistry, plastic and reconstructive surgery, bioengineering and also for anthropologists and forensic facial reconstruction experts (Baral,2010, Mahdi2012) However, the dimensions of the human body are affected by ecological, biological, geographical, racial, age and sex factors (Imami1996, Hamill et al .1979).

On the basis of these factors, studies about intra- and interpopulation variations have long been an interest and have been conducted on the age, sex and racial groups (Imami1996,, Ghosh 2007,, Golalipour 2003). With population specific anthropometric studies, the most specific parameter/s for every population should be determined.

To the best of our knowledge; no local studies had been reported for Sudanese craniofacial measurement and nasal parameters .because extra information and knowledge of craniofacial measurements among Sudanese is important especially in craniofacial deformities and reconstructive surgery; so this study aim to establish anatomical reference value for craniofacial dimensions.

1.2 Problem of the study

The normal values of craniofacial measurements and nasal parameters are vital measurements in the evaluation and diagnosis of craniofacial deformities. Many populations have standard craniofacial measurements normative data have been generated. As far as the Sudanese ethnic group is our concerned, and to the best of our knowledge; no published craniofacial norms have been reported for in the open literature and no measurements or index were found for Sudanese population as it differ according to different Sudanese ethnic groups.

1.3 General Objective

To characterize craniofacial bones and nasal parameters for adult Sudanese population using computed tomography.

1.4 Specific objectives

- To define distinct craniofacial features in Sudanese.
- To compare the craniofacial measurements between males and females to determine the extent of sexual dimorphism.
- To measure the nasal bone length, width, height and nasal index.
- To classify the nasal index in male and female adults according to Sudanese ethnic group.
- To evaluate the relationship between craniofacial bones and nasal bone.
- To compare the Sudanese findings with other populations.

1.5Thesis out come

To make aims of the research above true the thesis falls in to five chapters, chapter one which is an introduction, deals with theoretical frame work of the study it presents the statement of the study problem, objectives, and thesis outcome. Chapter two deals with theoretical background of skull and craniofacial anatomy, physiology, pathology, and review of the instrumentation and techniques which include craniofacial assessment by clinical examination and CT investigations. Chapter three discus material and method. Chapter four presentation of the result, finally chapter five discussion, recommendations and conclusion as well as future work.

Chapter Two
Literature Review

2.1Anatomy

2.1.1The Head

The head is formed mainly by the skull with the brain and it's covering meninges enclosed in the cranial cavity. The special senses, the eye and the ear, lie within the skull bones or in the cavities bounded by them. The brain gives rise to 12 pairs of cranial nerves, which leave the brain and pass through foramina and fissures in the skull. All the cranial nerves are distributed to structures in the head and neck, except the 10th, which also supplies structures in the chest and abdomen (Helen 2010).

2.1.1.1Bones of the Skull

The skull is composed of several separate bones united at immobile joints called sutures. The connective tissue between the bones is called a sutural ligament. The mandible is an exception to this rule, for it is united to the skull by the mobile temporomandibular joint. The bones of the skull can be divided into those of the cranium and those of the face. The vault is the upper part of the cranium, and the base of the skull is the lowest part of the cranium. The skull bones are made up of external and internal tables of compact bone separated by a layer of spongy bone called the diploë . The internal table is thinner and more brittle than the external table. The bones are covered on the outer and inner surfaces with periosteum (Helen 2010).

The cranium consists of the following bones, two of which are paired:

Frontal bone forms the anterior part of the roof of the skull, the forehead and the upper part of the orbits or eye socket. Parietal bones two bones form the upper sides of the skull and the back of the roof of the skull .Occipital bone forms the back of the skull. Temporal bones two bones form the sides of the skull below the parietal bones and above and around the ears. Sphenoid bone Located in front of the temporal bone and serves as a bridge between the cranium and the facial bones.

Ethmoid bone forms part of the wall of the orbit, the roof of the nasal cavity and part of the nasal septum (Helen 2010).

2.1.1.2Facial bones

The facial bones consist of the following, two of which are single:

Zygomatic bones are two bones, the most prominent of the facial bones and form the Cheekbones.

Maxillae two bones largest bones of the face and they form the upper jaw and support the upper teeth. Nasal bones two bones. These small bones form the bridge of the nose.

Lacrimal bones two bones the smallest of the facial bones, located close to the medial part of the orbital cavity.

Vomer a single bone at the back of the nasal septum. Palatine bones two L-shaped bones which form the anterior part of the roof of the mouth.

Inferior conchae two Layers of bone located either side of the outer walls of the nasal cavities(Helen 2010).

Mandible one bone, the only moveable bone of the skull and forms the lower jaw and supports the lower teeth. The mandible is the largest and heaviest bone in the skull (Helen 2010).

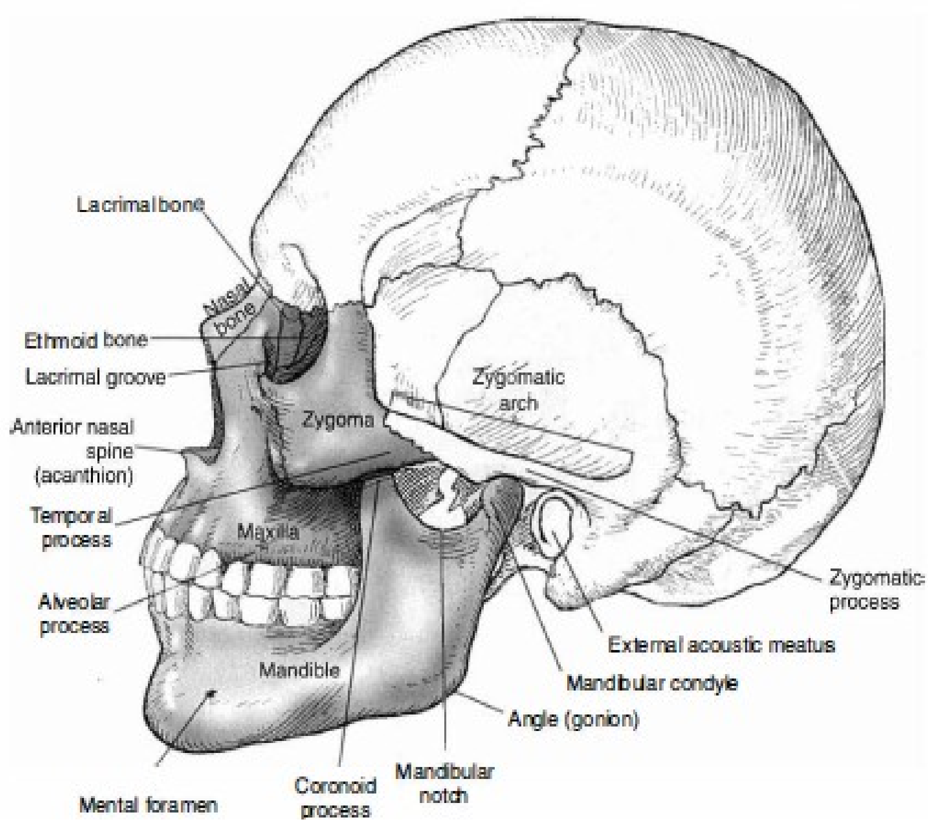

Fig (2.1) Sagittal view of facial bones (Lorrie Kelly 2007).

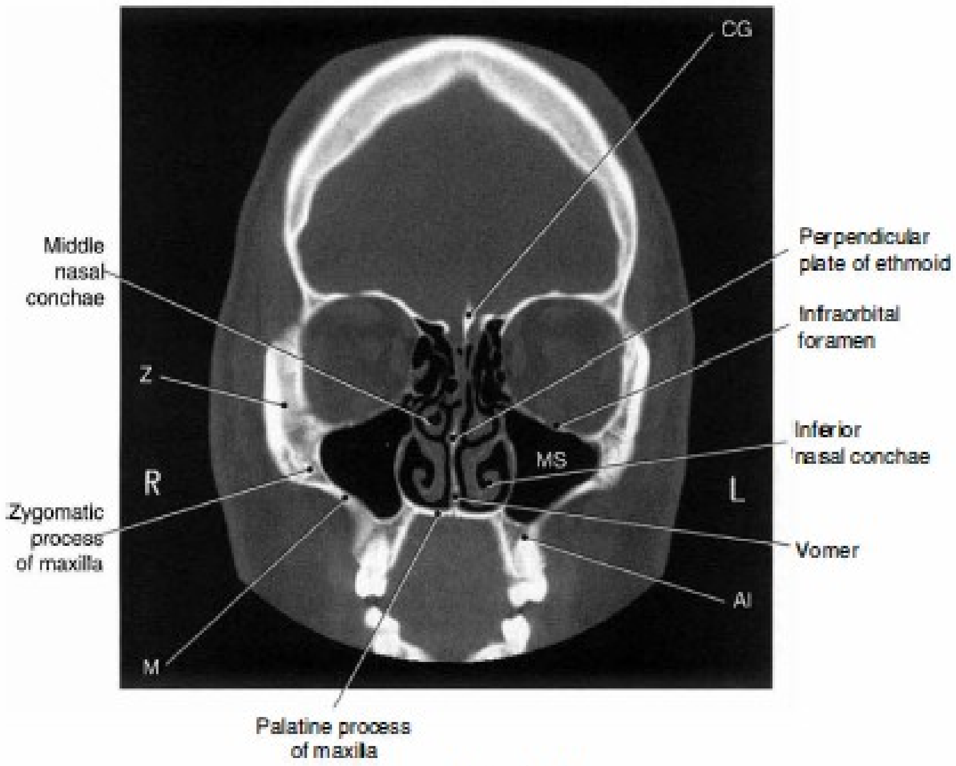

Fig (2.2) Coronal CT scan of maxillary and zygoma **(** Lorrie Kelly 2007)

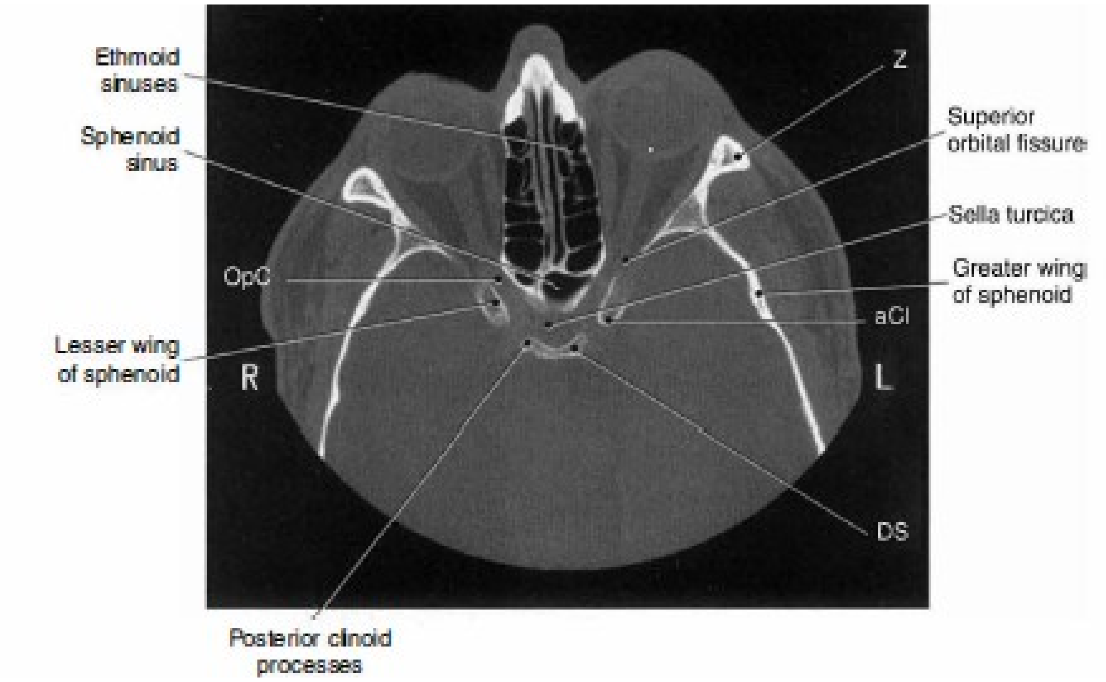

Fig (2.3) CT axial view of facial bones **(** Lorrie Kelly 2007)

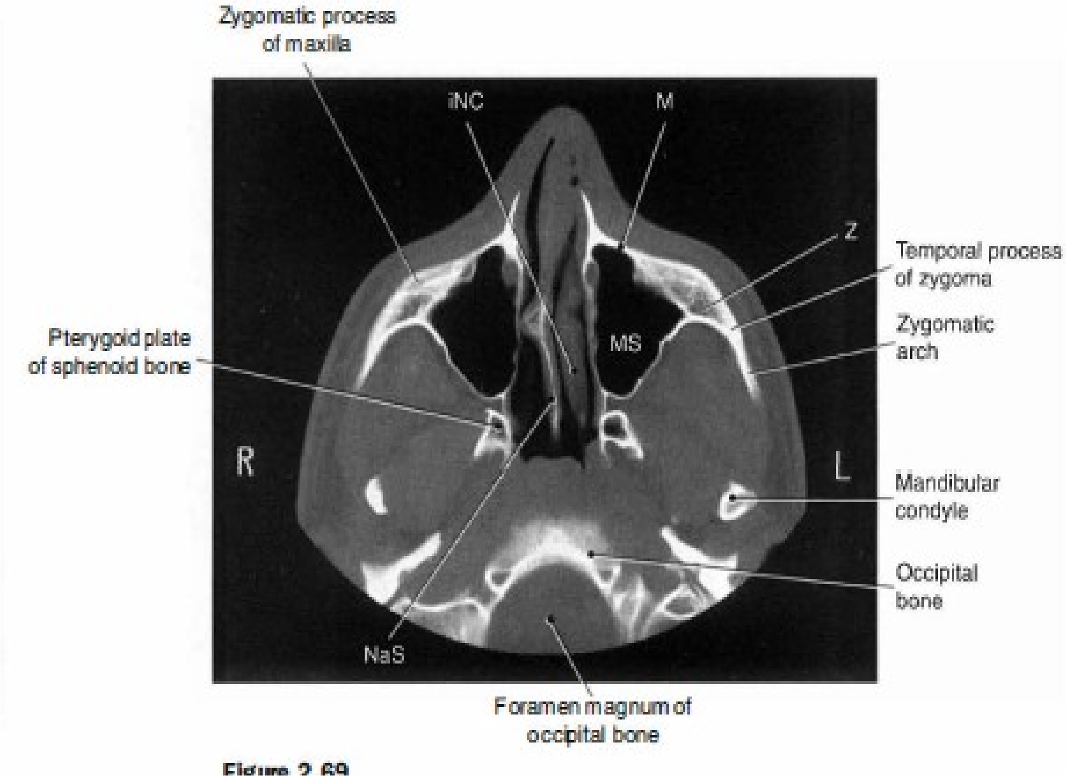

Fig (2.4) CT axial view of facial bones **(**Lorrie Kelly 2007)

2.1.1.3Anterior View of the Skull

The frontal bone, or forehead bone, curves downward to make the upper margins of the orbits. The superciliary arches can be seen on either side , and the supraorbital notch, or foramen, can be recognized. Medially, the frontal bone articulates with the frontal processes of the maxillae and with the nasal bones. Laterally, the frontal bone articulates with the zygomatic bone. The orbital margins are bounded by the frontal bone superiorly, the zygomatic bone laterally, the maxilla inferiorly, and the processes of the maxilla and frontal bone medially. Within the frontal bone, just above the orbital margins, are two hollow spaces lined with mucous membrane called the frontal air sinuses. These communicate with the nose and serve as voice resonators (Helen 2010).

The two nasal bones form the bridge of the nose. Their lower borders, with the maxillae, make the anterior nasal aperture. The nasal cavity is divided into two by the bony nasal septum, which is largely formed by the vomer. The superior and middle conchae are shelves of bone that project into the nasal cavity from the ethmoid on each side; the inferior conchae are separate bones. The two maxillae form the upper jaw, the anterior part of the hard palate, part of the lateral walls of the nasal cavities, and part of the floors of the orbital cavities. The two bones meet in the midline at the intermaxillary suture and form the lower margin of the nasal aperture. Below the orbit, the maxilla is perforated by the infraorbital foramen. The alveolar process projects downward and, together with the fellow of the opposite side, forms the alveolar arch, which carries the upper teeth. Within each maxilla is a large, pyramid-shaped cavity lined with mucous membrane called the maxillary sinus. This communicates with the nasal cavity and serves as a voice resonator (Helen 2010). The zygomatic bone forms the prominence of the cheek and part of the lateral wall and floor of the orbital cavity. Medially, it articulates with the maxilla and laterally it articulates with the zygomatic process of the temporal bone to form the zygomatic arch. The zygomatic bone is perforated by two foramina for the zygomaticofacial and zygomaticotemporal nerves. The mandible, or lower jaw, consists of a horizontal body and two vertical rami (Helen 2010).

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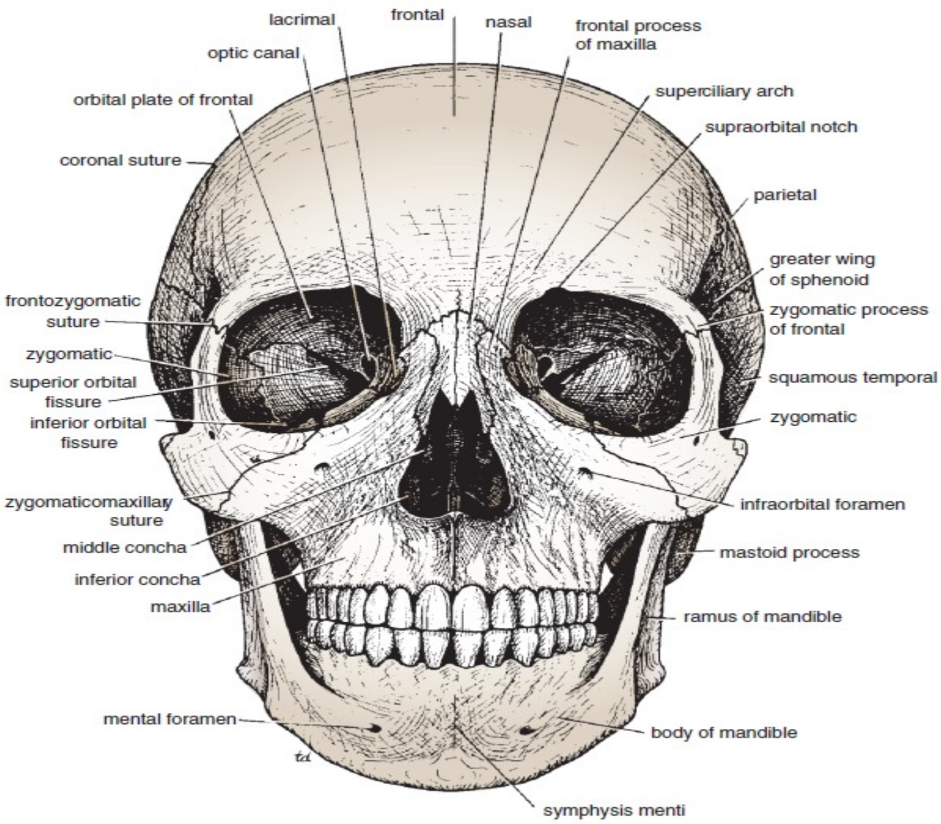


Fig (2.5) anterior view of the Skull (Richard S.Snell 2012).

The frontal bone forms the anterior part of the side of the skull and articulates with the parietal bone at the coronal suture. The parietal bones form the sides and roof of the cranium and articulate with each other in the midline at the sagittal suture. They articulate with the occipital bone behind, at the lambdoid suture. The skull is completed at the side by the squamous part of the occipital bone; parts of the temporal bone, namely, the squamous, tympanic, mastoid process, styloid process, and zygomatic process; and the greater wing of the sphenoid. The ramus and body of the mandible lie inferiorly (Helen 2010).

The thinnest part of the lateral wall of the skull is where the anteroinferior corner of the parietal bone articulates with the greater wing of the sphenoid; this point is referred to as the pterion. Clinically, the pterion is an important area because it overlies the anterior division of the middle meningeal artery and vein. Identify the superior and inferior temporal lines, which begin as a single line from the posterior margin of the zygomatic process of the frontal bone and diverge as they arch backward. The temporal fossa lies below the inferior temporal line. The infratemporal fossa lies below the infratemporal crest on the greater wing of the sphenoid. The pterygomaxillary fissure is a vertical fissure that lies within the fossa between the pterygoid process of the sphenoid bone and back of the maxilla. It leads medially into the pterygopalatine fossa. The inferior orbital fissure is a horizontal fissure between the greater wing of the sphenoid bone and the maxilla. It leads forward into the orbit. The pterygopalatine fossa is a small space behind and below the orbital cavity. It communicates laterally with the infratemporal fossa through the pterygomaxillary fissure, medially with the nasal cavity through the sphenopalatine foramen, superiorly with the skull through the foramen rotundum, and anteriorly with the orbit through the inferior orbital fissure (Helen 2010).

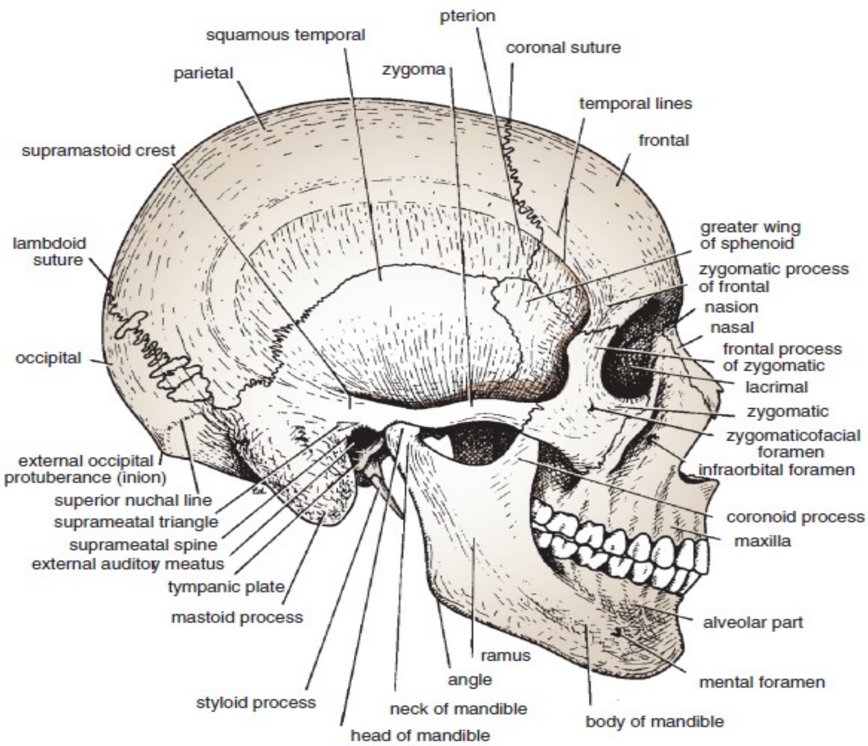


Fig (2.6) lateral view of the skull (Richard S.Snell 2012).

2.1.1.4Posterior View of the Skull

The posterior parts of the two parietal bones, with the intervening sagittal suture are seen above. Below, the parietal bones articulate with the squamous part of the occipital bone at the lambdoid suture. On each side the occipital bone articulates with the temporal bone. In the midline of the occipital bone is a roughened elevation called the external occipital protuberance, which gives attachment to muscles and the ligamentum nuchae. On either side of the protuberance the superior nuchal lines extend laterally toward the temporal bone (Helen 2010).

2.1.1.5Superior View of the Skull

Anteriorly, the frontal bone articulates with the two parietal bones at the coronal suture. Occasionally, the two halves of the frontal bone fail to fuse, leaving a midline metopic suture. Behind, the two parietal bones articulate in the midline at the sagittal suture. Inferior View of the Skull If the mandible is discarded, the anterior part of this aspect of the skull is seen to be formed by the hard palate.

The palatal processes of the maxillae and the horizontal plates of the palatine bones can be identified. In the midline anteriorly is the incisive fossa and foramen. Posterolaterally are the greater and lesser palatine foramina. Above the posterior edge of the hard palate are the choanae (posterior nasal apertures) (Helen 2010).These are separated from each other by the posterior margin of the vomer and are bounded laterally by the medial pterygoid plates of the sphenoid bone. The inferior end of the medial pterygoid plate is prolonged as a curved spike of bone, the pterygoid hamulus. Posterolateral to the lateral pterygoid plate, the greater wing of the sphenoid is pierced by the large foramen ovale and the small foramen spinosum. Posterolateral to the foramen spinosum is the spine of the sphenoid. Behind the spine of the sphenoid, in the interval between the greater wing of the sphenoid and the petrous part of the temporal bone, is a groove for the cartilaginous part of the auditory tube. The opening of the bony part of the tube can be identified. The mandibular fossa of the temporal bone and the articular tubercle form the upper articular surfaces for the temporomandibular joint. Separating the mandibular fossa from the tympanic plate posteriorly is the squamotympanic fissure, through the medial end of which the chorda tympani nerve exits from the tympanic cavity. The styloid process of the temporal bone projects downward and forward from its inferior aspect (Robert 1995). The opening of the carotid canal can be seen on the inferior surface of the petrous part of the temporal bone. The medial end of the petrous part of the temporal bone is irregular and, together with the basilar part of the occipital bone and the greater wing of the sphenoid, forms the foramen lacerum. During life, the foramen lacerum is closed with fibrous tissue, and only a few small vessels pass through this foramen from the cavity of the skull to the exterior. The tympanic plate, which forms part of the temporal bone, is C shaped on section and forms the bony part of the external auditory meatus. While examining this region, identify the suprameatal crest on the lateral surface of the squamous part of the temporal bone, the suprameatal triangle, and the suprameatal spine. In the interval between the styloid and mastoid processes, the stylomastoid foramen can be seen. Medial to the styloid process, the petrous part of the temporal bone has a deep notch, which, together with a shallower notch on the occipital bone, forms the jugular foramen. Behind the posterior apertures of the nose and in front of the foramen magnum are the sphenoid bone and the basilar part of the occipital bone(Robert 1995). The pharyngeal tubercle is a small prominence on the undersurface of the basilar part of the occipital bone in the midline. The occipital condyles should be identified; they articulate with the superior aspect of the lateral mass of the first cervical vertebra, the atlas. Superior to the occipital condyle is the hypoglossal canal for transmission of the hypoglossal nerve. Posterior to the foramen magnum in the midline is the external occipital protuberance. The superior nuchallines should be identified as they curve laterally on each side (Helen 2010).

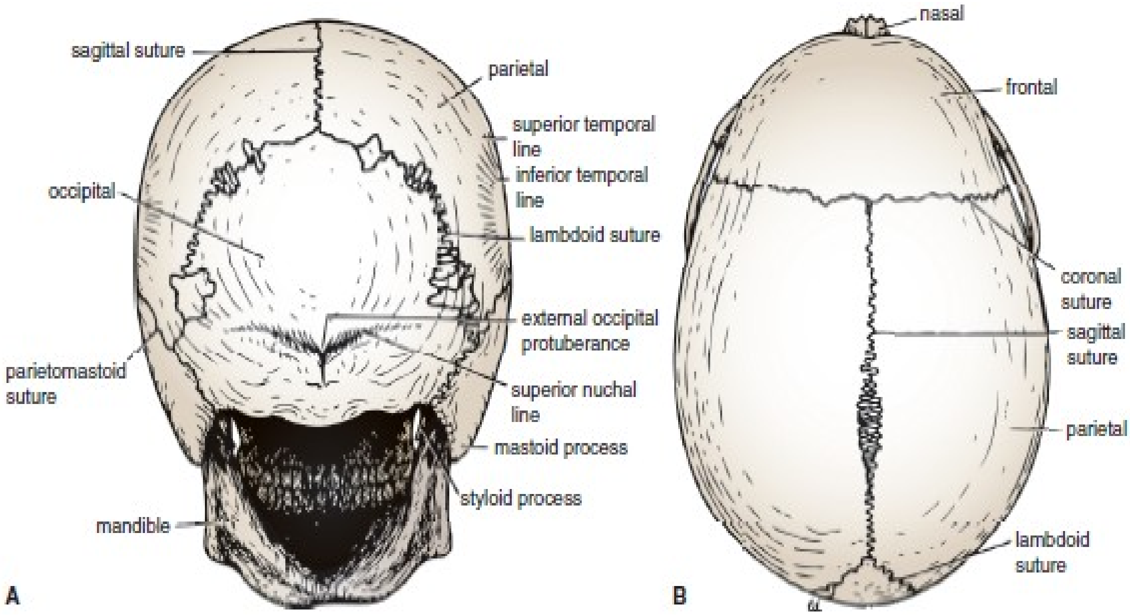


Fig (2.7) posterior (A) Superior (B) View of the Skull (Richard S.Snell 2012).

2.1.2Blood supply

2.1.2.1Facial arteries

Arises in the neck from the external carotid artery and appears along the inferior border of the mandible, anterior to the masseter (its pulse can be felt here); it then ascends deep to the facial musculature, coursing near the corner of the mouth and along the side of the nose toward the medial angle of the eye.

Its Branches (Robert 1995)

2-1-2-1-1 Inferior labial artery: arises inferior to the corner of the mouth and courses medially within the lower lip

2-1-2-1-2 Superior labial artery: arises superior to the corner of the mouth and courses medially within the upper lip

2-1-2-1-3 Lateral nasal artery: arises distal to the superior labial artery and courses forward on the side of the nose; distal to the lateral nasal artery, the facial artery is sometimes called the angular artery (Robert 1995)

2-1-2-2 Ophthalmic artery

2-1-2-2-1 Arises from the internal carotid artery within the cranial cavity and courses forward within the orbit; branches that emerge from the orbit to supply the face are noted below(Robert 1995)

2-1-2-2-2 Supraorbital artery: emerges from the supraorbital foramen and courses with the supraorbital nerve

2-1-2-2-3 Supratrochlear artery: emerges from the frontal notch and courses with the supratrochlear nerve

2-1-2-2-4 Dorsal nasal artery: emerges from the orbit with the infratrochlear nerve and anastomoses with the angular artery

2-1-2-2-5 Medial and lateral palpebral arteries: supply the medial and lateral parts of the eyelids, respectively (Robert 1995)

2-1-2-3 Maxillary artery

Arises from the external carotid artery posterior to the neck of the mandible and courses within the deep face; its branches to the face are

2-1-2-3-1Infraorbital artery: emerges from the infraorbital foramen and courses with the infraorbital nerve

2-1-2-3-2 Mental artery: emerges from the mental foramen and courses with the mental nerve

2-1-2-3-3 Buccal artery: emerges from the deep face and courses with the buccal nerve

2-1-2-3-4 Superficial temporal artery: arises from the external carotid artery posterior to the neck of the mandible and ascends anterior to the auricle with the auriculotemporal nerve; one of its branches, the transverse facial artery, courses anteriorly on the face, inferior to the zygomatic arch, with a zygomatic branch of the facial nerve(Robert 1995)

2-1-3 Facial veins

2-1-3-1Facial vien

Descends from the medial angle of the eye, lateral to the facial artery, and superficial to the facial musculature; its tributaries are noted below

2-1-3-2Superior ophthalmic vein: emerges from the orbit and drains into the facial vein near the medial angle of the eye; since it is valveless, it may also drain posteriorly through the orbit and into the cavernous sinus, a dural venous sinus within the cranial cavity (Robert 1995).

2-1-3-3 Deep facial vein: extends from the pterygoid venous plexus in the deep face to the facial vein near the corner of the mouth (Robert 1995).

2-1-3-4Superior and inferior labial veins: course with their corresponding arteries and drain into the facial vein superior and inferior to the corner of the mouth, respectively; above the superior labial vein, the facial vein is sometimes called the angular vein (Robert 1995)

2-1-4Scalp Vessels

2-1-4-1 Anterior artery: supraorbital artery—accompanies the supraorbital nerve (Robert 1995).

2-1-4-2 Lateral artery: superficial temporal artery—accompanies the auriculotemporal nerve and divides into an anterior and a posterior branch which supply the lateral part of the scalp (Robert 1995).

2-1-4-3 Posterior arteries: posterior auricular artery—arises from the external carotid artery posterior to the ramus of the mandible and ascends posterior to the auricle to supply the scalp posterior and superior to the auricle;

2-1-4-4 occipital artery—arises from the external carotid artery in the neck and ascends posteriorly across the back of the neck to course with the greater occipital nerve

2-1-4-5Veins: accompany their respective arteries (Robert 1995)

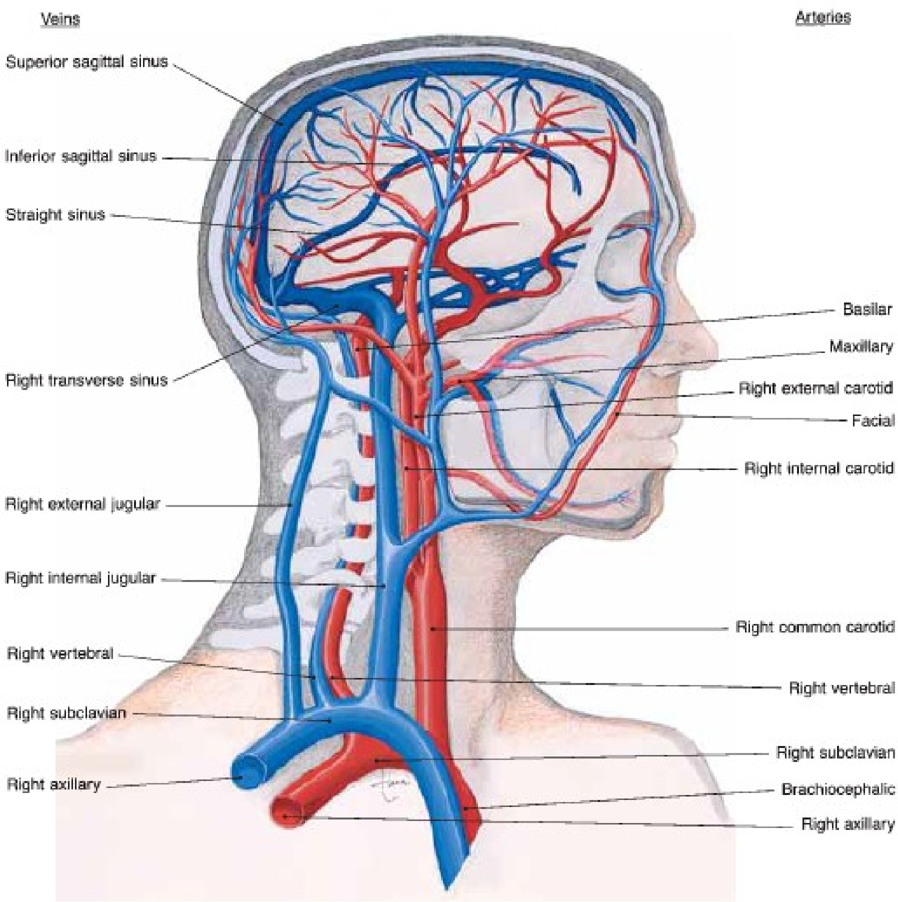


Fig (2-8) Arteries and veins of the head and neck shown in right lateral view
(Valerie &Tina Sanders 2007) .

2-2 Pathology

2-2-1Congenital deformities of fusion

Abnormalities of the complex fusion process are numerous and constitute one of the commonest groups of congenital deformities these anomalies are associated with other congenital conditions such as spina bifida, syndactyly (fusion of fingers or toes), etc. Indeed, it is good clinical practice to search a patient with any congenital defect for others. The following anomalies are associated with defects of fusion of the face (Harold 2006).

2-2-1-1Macrostoma and Microstoma

Are conditions were either too little or too great a closure of the stomodaeum. (Harold 2006).

2-2-1-2Cleft upper lip

(Or ‘hare lip’)—this is only very rarely like the upper lip of a hare, i.e. a median cleft, although this may occur as a failure of development of the philtrum from the frontonasal process. Much more commonly, the cleft is on one or both sides of the philtrum, occurring as failure of fusion of the maxillary and frontonasal processes. The cleft may be a small defect in the lip or may extend into the nostril, split the alveolus or even extend along the side of the nose as far as the orbit. There may be an associated cleft palate (Harold 2006).

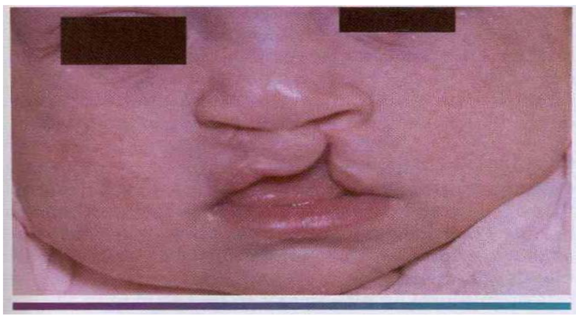


Fig (2-9) Cleft lip. Infant with bilateral cleft of the upper lip (Brad et al 2002).

2-2-1-3Cleft lower lip — occurs very rarely but may be associated with a cleft tongue and cleft mandible (Harold 2006).

2-2-1-4Cleft palate

It is a failure of fusion of the segments of the palate. The following stages may occur(Harold 2006).

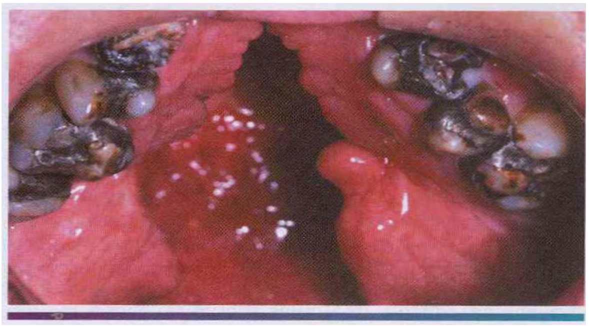


Fig (2-10) Cleft palate. Palatal defect resulting in communication with nasal cavity (Brad et al ,2002).

2-2-1-4-1 bifid uvula, of no clinical importance;

2-2-1-4-2 partial cleft, which may involve the soft palate only or the posterior part of the hard palate also (Harold 2006).

2-2-1-4-3 complete cleft, which may be unilateral, running the full length of the maxilla and then alongside one face of the premaxilla, or bilateral in which the palate is cleft with an anterior V separating the premaxilla completely (Harold 2006).

2-2-1-5Inclusion dermoids

May form along the lines of fusion of the face. The most common of these is the external angular dermoid at the lateral extremity of the upper eyebrow. Occasionally this dermoid extends through the skull to attach to the underlying dura (Harold 2006).

2-2-2Facial Fractures

The upper part of the skull is developed from membrane (whereas the remainder is developed from cartilage); therefore, this part of the skull in children is relatively flexible and can absorb considerable force without resulting in a fracture. Signs of fractures of the facial bones include deformity, ocular displacement, or abnormal movement accompanied by crepitation and malocclusion of the teeth. Anesthesia or paresthesia of the facial skin will follow fracture of bones through which branches of the trigeminal nerve pass to the skin. The muscles of the face are thin and weak and cause little displacement of the bone fragments. Once a fracture of the maxilla has been reduced, for example, prolonged fixation is not needed. However, in the case of the mandible, the strong muscles of mastication can create considerable displacement, requiring long periods of fixation. The most common facial fractures involve the nasal bones, followed by the zygomatic bone and then the mandible. To fracture the maxillary bones and the supraorbital ridges of the frontal bones, an enormous force is required (Richard S. Snell 2012).

2.2.2.1Nasal Fractures

Fractures of the nasal bones, because of the prominence of the nose, are the most common facial fractures. Because the bones are lined with mucoperiosteum, the fracture is considered open; the overlying skin may also be lacerated. Although most are simple fractures and are reduced under local anesthesia, some are associated with severe injuries to the nasal septum and require careful treatment under general anesthesia (Richard S. Snell 2012).

2.2.2.2Maxillofacial Fractures

Maxillofacial fractures usually occur as the result of massive facial trauma. There is extensive facial swelling, midface mobility of the underlying bone on palpation, malocclusion of the teeth with anterior open bite, and possibly leakage of cerebrospinal fluid (cerebrospinal rhinorrhea) secondary to fracture of the cribriform plate of the ethmoid bone. Double vision (diplopia) may be present, owing to orbital wall damage. Involvement of the infraorbital nerve with anesthesia or paresthesia of the skin of the cheek and upper gum may occur in fractures of the body of the maxilla. Nose bleeding may also occur in maxillary fractures. Blood enters the maxillary air sinus and then leaks into the nasal cavity (Richard S. Snell 2012)..

The sites of the fractures were classified by Le Fort as type I, II, or III.

Blowout Fractures of the Maxilla. A severe blow to the orbit (as from a baseball) may cause the contents of the orbital cavity to explode downward through the floor of the orbit into the maxillary sinus. Damage to the infraorbital nerve, resulting in altered sensation to the skin of the cheek, upper lip, and gum, may occur (Richard S. Snell2012).

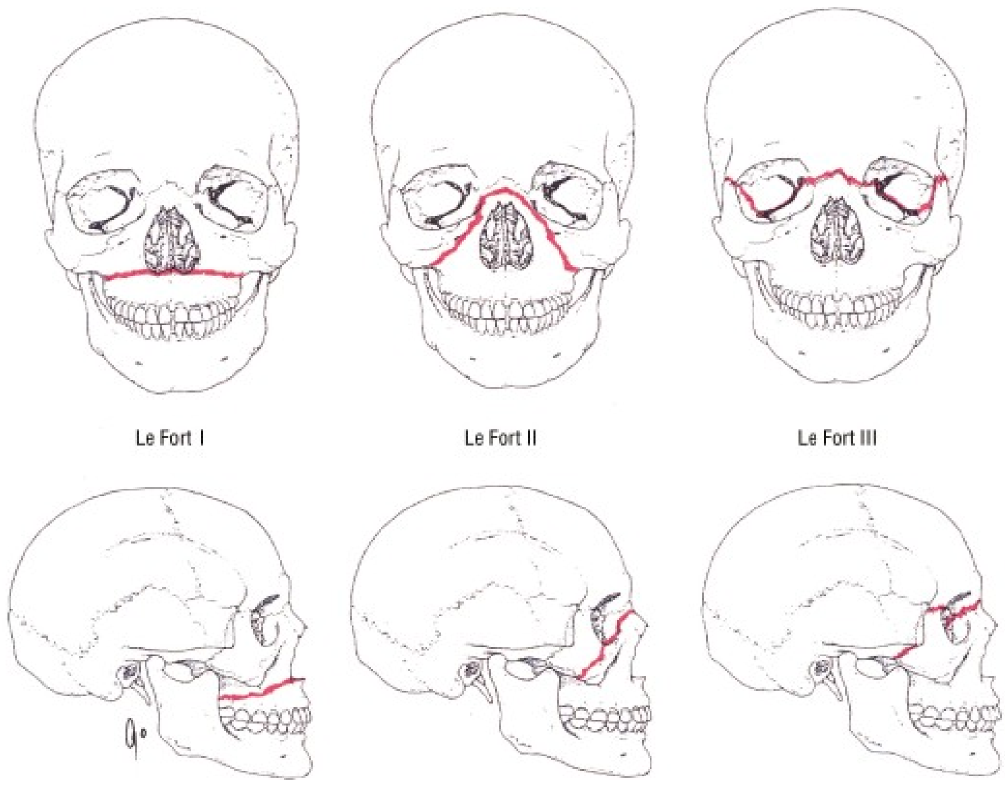


Fig (2-11) Le Fort classification of maxillofacial fractures. The line denotes the fracture line (Richard S.Snell 2012).

2.2.2.3Fractures of the Zygoma or Zygomatic Arch

The zygoma or zygomatic arch can be fractured by a blow to the side of the face. Although it can occur as an isolated fracture, as from a blow from a clenched fist, it may be associated with multiple other fractures of the face, as often seen in automobile accidents (Richard S.Snell 2012).

2.2.2.4 Fractures of the Mandible

The mandible is horseshoe shaped and forms part of a bony ring with the two temporomandibular joints and the base of the skull. Traumatic impact is transmitted around the ring, causing a single fracture or multiple fractures of the mandible, often far removed from the point of impact (Richard S.Snell 2012).

2.2.3 Paget's disease of bone (Osteitideformans)

Paget's disease of bone is a disease characterized by abnormal and anarchic resorption and deposition of bone, resulting in distortion and weakening of the affected bones. The cause of Paget's disease is unknown, but inflammatory, genetic and endocrine factors may be contributing agents.(Brad et al , 2002)

Fig (2.12) Paget's disease. Lateral skull film shows marked enlargement of the cranium with new bone formation above the outer table of the skull and a patchy, dense, "cotton wool" appearance.(Brad et al ,2002)

2.2.4 Hemihyperplasia (Hemihypertrophy)

Hemihypcrpla sia is a rare developmental anomaly characterized by asymmetric overgrowth of one or more body parts. Although the condition is known more commonly as hemihypertrophy. it actually represents a hyperplasia of the tissues rather than a hypertrophy. Hemihyperplasia can be an isola ted finding. but it also may be associated with a variety of malformation syndromes. Almost all casesof isolated hemihyperplasia are sporadic. A number of possible etiologic factors have been suggested. but the cause remains obscure. Various theories include vascular or lymphatic abnormalities. Central nervous system disturbances, endocrine dysfunctions. And aberrant twinning mechanisms. Occasionally chromosomal anomalies have been documented (Brad et al, 2002).

Fig (2-13) Hemihyperplasia. Enlargement of the right side of the face.

(Brad et al 2002)

2-3 Radiographic Imaging of craniofacial

2-3-1Cephalometry

Cephalometric radiography is a standardized and reproducible form of skull radiography used extensively in orthodontics to assess the relationships of the teeth to the jaws and the jaws to the rest of the facial skeleton. Standardization was essential for the development of cephalometry — the measurement and comparison of specific points, distances and lines within the facial skeleton, which is now an integral part of orthodontic assessment. The greatest value is probably obtained from these radiographs if they are traced or digitized and this is essential when they are being used for the monitoring of treatment progress (Eric Whaites ,2003).

2-3-2Virtual Cephalogram

In a 3-D environment, 3-D CT imaging is needed to volumetrically measure the patient's anatomy. However, for a cephalometric analysis, the availability of 2-D lateral and frontal cephalograms is beneficial to indicate landmarks accurately and repeatably in the 3-D scene. Therefore, the geometrical relationship between cephalogram and CT image volume is a prerequisite if one is to benefit from the combination of CT and virtual cephalograms (Gwen Swennen, 2006). To avoid extra radiation dose, and to achieve this geometric relationship, lateral and frontal cephalograms are computed from the CT data. In this way, an unlimited number of virtual X-ray images of the skull can be computed. To compute a virtual X-ray image, a bundle of parallel rays is cast through the CT volume. Each CT number is associated with an opacity value.When a ray travels through the CT volume, the CT numbers, modulated with the related opacity value, are accumulated, resulting in a final grey value. The grey values of the bundle of rays compose the virtual X-ray image. Again, the contrast of this projection image can be adjusted by modifying the window/level settings in a similar way as on a native CT slice (Gwen Swennen, 2006).

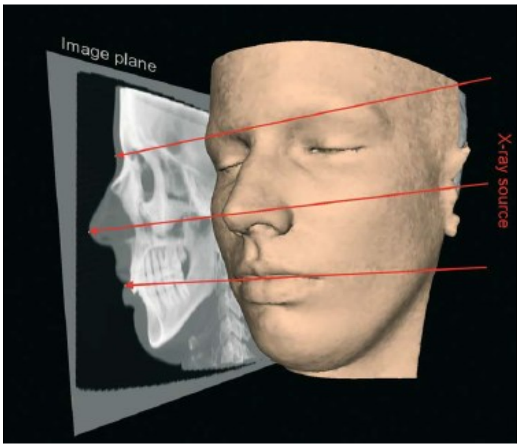
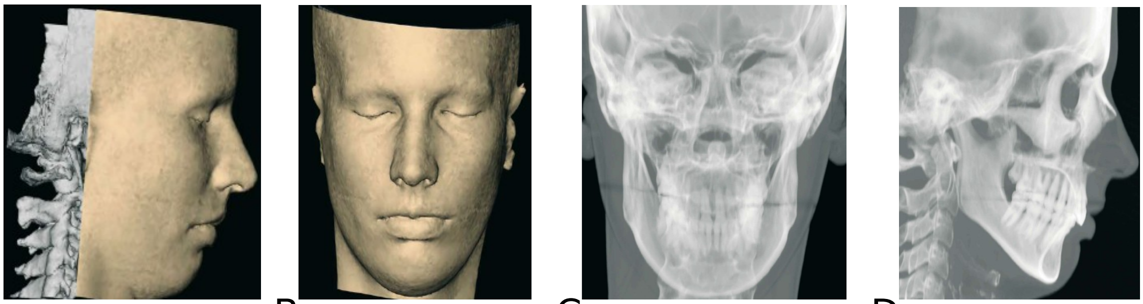


Fig (2.14)A virtual cephalogram is computed from the CT image volume
(Gwen Swennen, 2006).



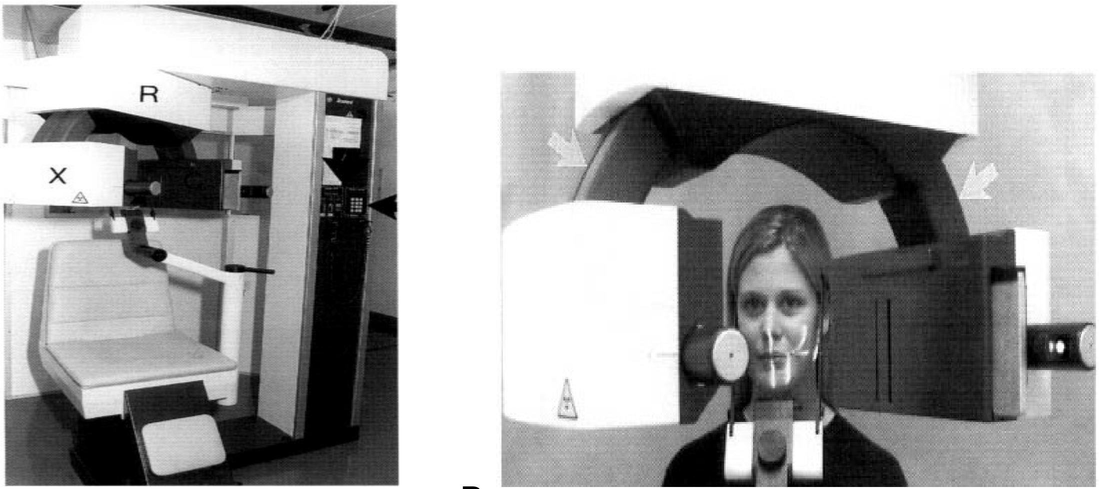
A B C D

Fig (2.15) virtual volumetric lateral view (A) virtual volumetric frontal view (B) Virtual X-ray film of the skull, frontal view (D) Virtual X-ray film of the skull, lateral view(Gwen Swennen, 2006).

2-3-3Tomography

Is a specialized technique for producing radiographs showing only a section or slice of a patient. A useful analogy is to regard the technique as dividing up the patient like a loaf of sliced bread. Each tomograph (or slice of bread) shows the tissues within that section sharply defined and in focus (Eric Whaites , 2003).

The section is thus referred to as the focal plane or focal trough. Structures outside the section (i.e. the rest of the loaf) are blurred and out of focus. By taking multiple slices, three-dimensional information about the whole patient can be obtained. Production of each conventional tomographic slice requires controlled, accurate movement of both the X-ray tubehead and the film during the exposure, thereby differing from all the techniques. Originally sections were obtained in either the sagittal or coronal planes, but modern equipment now allows tomography in other planes as well. Conventional tomography has essentially been superseded in medical radiography by the development of computed tomography (CT). It is however still important in dentistry, forming the basis of dental panoramic tomography and recently developed multi-functional dental and maxillo-facial tomographic machines (Eric Whaites , 2003)



A B

Fig (2.16) (A)multi-functional tomographic unit (B) Patient being positioned in the Scanora® unit; with light markers on the face to facilitate accurate positioning. The C-arm linking together the tube and cassatte
(Eric Whaites ,2003)

2-3-3Computed tomography (CT)

CT scanners use X-rays to produce sectional or slice images, as in conventional tomography, but the radiographic film is replaced by very sensitive crystal or gas detectors. The detectors measure the intensity of the X-ray beam emerging from the patient and convert this into digital data which are stored and can be manipulated by a computer. This numerical information is converted into a grey scale representing different tissue densities, thus allowing a visual image to be generated (Eric Whaites ,2003).

2-3-3-1Equipment and theory

The CT scanner is essentially a large square piece of equipment (the gantry) with a central circular hole. The patient lies down with the part of the body to be examined within this circular hole. The gantry houses the X-ray tube and the detectors. The mechanical geometry of scanners varies(Eric Whaites , 2003).

In so-called third-generation scanners, both the X-ray tube and the detector array revolve around the patient. In so-called fourth-generation scanners, there is a fixed circular array of detectors (as many as 1000) and only the X-ray tube rotates. Whatever the mechanical geometry, each set of detectors produces an attenuation or penetration profile of the slice of the body being examined. The patient is then moved further into the gantry and the next sequential adjacent slice is imaged. The patient is then moved again, and so on until the part of the body under investigation has been completed. This stop-start movement means the investigation takes several minutes to complete and the radiation dose to the patient is high (Eric Whaites 2003).As a result, spiral CT has been developed in recent years. Acquiring spiral CT data requires a continuously rotating X-ray tube and detector system in the case of third-generation scanners or, for fourth-generation systems, a continuously rotating X-ray tube. This movement is achieved by slip-ring technology. The patient is now advanced continuously into the gantry while the equipment rotates, in a spiral movement; around the patient. The investigation time has been shortened to only a few seconds with a radiation dose reduction of up to 75%. Whatever type of scanner is used, the level, plane and thicknesses (usually between 1.5mm and 6 mm) of the slices to be imaged are selected and the X-ray tube rotates around the patient, scanning the desired part of the body and producing the required number of slices. These are usually in the axial plane. The sequence of events in image generation can be summarized as follows: the tube rotates around the patient; the detectors produce the attenuation or penetration profile of the slice of the body being examined. The computer calculates the absorption at points on a grid or matrix formed by the intersection of all the generation profiles for that slice. Each point on the matrix is called a pixel and typical matrix sizes comprise either 512 x 512 or 1024 x 1024 pixels the smaller the individual pixel the greater the resolution of the final image. The area being imaged by each pixel has a definite volume, depending on the thickness of the tomographic slice, and is referred to as a voxel (Eric Whaites , 2003).

2.4 Background studies

Oladipo, G.S et al (2007a) .They studied Nasal indices among major ethnic groups in southern Nigeria. Aimed to measur nasal indices in subjects of Igbo, Yoruba and Ijaw ethnic groups. Selected 750 subjects each of Igbo and Yoruba with 175 subjects of Ijaw ethnic groups and measured nasal height (NH) and nasal breadth (NB). They calculated the nasal indices from the measurements. Their results showed that on the average, the Igbos had a mean nasal index of 94.1± 0.37, Yorubas 89.2±0.30 and the Ijaws 96.37±1.06. Thus the Ijaws had a significantly higher nasal index ($p<0.05$) than either the Igbos or Yorubas. Sexual dimorphism was also observed in all the ethnic groups studied with males having significantly higher ($p<0.05$) nasal index than the females. Found that the three ethnic groups still fall within the same nose type platyrrhine (short and broad nose) expected of an African population. Their result confirmed anthropological differences amongst the three Nigerian ethnic groups investigated

Oladipo et al (2010) they search in Anthropometric Study of Some Craniofacial Parameters: Head Circumference, Nasal Height, Nasal Width and Nasal Index of Adult Ijaws of Nigeria. Selected a sample of one thousand (1000) adults comprising 500 males and 500 females with age ranging from 18-65 years old. Their results showed that the Ijaw male and female had mean head circumference of 57.49 and 56.25 cm respectively, mean nasal height of 4.08 and 3.89 cm respectively, mean nasal width of 4.06 and 3.79 cm respectively and mean nasal indices of 99.83 and 97.79 respectively. The z-test analysis indicates a sexual dimorphism, with significantly higher values of all the parameters in males compared to the females ($p< 0.05$). They recommended to use their result from forensic anthropologists, craniofacial surgeons and medical practitioners and also aimed to serves as the basis for future studies on other Nigerian ethnic group

Oladipo, G. S et al (2011) reported Anthropometric study of some craniofacial parameters: head circumference, nasal height, nasal width and nasal index of adult Omoku indigenes of Nigeria. They studied a total of eight hundred (800) adults comprising 400 males and 400 females with age ranging from 18 years and above. All the subjects were drawn from Omoku ethnic group in Rivers State. They found that in results the omoku male and female had mean head circumference of 55.72cm and 54.89 cm respectively, mean nasal height of 4.66cm and 4.36cm respectively, mean nasal width of 4.01cm and 3.93cm respectively and mean nasal indices of 86.09 and 90.16 respectively. Found that the z-test analysis indicates a sexual dimorphism, with significantly higher values of all the parameters in males compared to the females.

Kaushal et al . (2012) they studied Somatometric Analysis of Nasal Morphology in the Endogamous groups of Punjab**.** They measured four nasal parameters for each selected individual and nasal index was calculated. They recorded Sexual dimorphism in all parameters except for nasal depth among Muslims. The parameters showed significant differences between three groups ($p<0.001$) and clearly showed the anthropometric variation for nasal parameters in three communities. And suggested that nasal parameters can play significant role in determining sex and ethnicity of characteristic pure races of national importance and the plastic surgeons can utilize this knowledge during rhinoplasty of an individual from a particular endogamous group.

Mekala D et al. (2015) were studied orbital dimensions and orbital index: a measurement study on south Indian dry skulls. They found that in total of 24 patients, male orbits, the range of height was observed as 3.3 – 4.2cm, whereas in case of female orbits it was 3.0 – 3.9cm. They observed the range of breadth as 3.7 – 4.9cm in male orbits, whereas in female orbits it was 3.5 – 5cm. By using orbital Height and Breadth, and calculated OI. Found that in male skulls, the range of OI was 70.2 – 97.7, whereas in case of female skulls, it was 66.6 – 97.7. Compared the mean values,and found the orbital height and breadth were to be higher in males than females. When compared the mean OI between male and female orbits, statistically there was no significant difference observed.

Gloria Staka et al (2012),They reported Anthropometric Study of Nasal Index of the Kosovo Albanian Population they aimed to determine the nasal index of the Kosovo Albanian population. Selected a sample of 204 subjects (101 males and 103 females) aged 18-25 years. They measured nasal height and nasal width using an electronic digital caliper, with accuracy of 0.01 mm (Boss, Hamburg – Germany). Found that the mean nasal height and nasal width in males were 55.26 ± 3.57 and 36.90 ± 2.67, while those in females were 36.90 ± 2.67 and 33.12 ± 2.22, respectively. Showed that the mean nasal height and width in male subjects was significantly higher than those in female subjects also Kosovo Albanian males and females had mean nasal index of 67.07 ± 6.67 and 63.87 ± 5.56, respectively. Their result according to distribution of the nose types showed leptorrhine to be 76.96 % and dominant type among Kosovo – Albanian population.

Ahsen Kaya et al (2014). They studied Sex estimation in 3D CTA-scan based on orbital measurements in Turkish population. Aimed to obtain and analyze data regarding the computed scans of orbital aperture measurements in Turkish population for sex estimation and for comparing with other populations. Used a total of 112 Three-Dimensional Angiography Computed Tomography scans of 52 female and 60 male subjects aged between 13 and 86 years were examined in terms of Orbital Width (OW) and Orbital Height (OH). Analyzed sexual dimorphism by using discriminate function models. Determined that both left and right OW and OH of males were significantly larger than females. While single variable used for sexual dimorphism, the most confidential variable was the left OW for males (71.7%) and the left OH for females (69.2%). When used, combined models , the left OW and OH model was the best one for both males (80.0%) and females (69.2%). Obtained data showed that orbital measurements could be used to create a new data collection for Turkish population. However, it was seen that these measurements are not reliable parameters for sex discrimination. It should be better, if they are combined with other methods for sex estimation.

Osvaldo et al (2012) studied Sexual Dimorphism in Brazilian Human Skull, aimed to verify the presence of sexual dimorphism in the Brazilian population by craniometric analysis; identified the most reliable measurements and proposed a discriminant function for sex determination. They selected sample was composed of 100 adult skulls, 50 male and 50 female, from Cuiabá city, Mato Grosso State, Brazil. Took Of all the measurements, only the difference between the bi-euryon distances and proved insignificant, while themost dimorphic measure was the bi-zygomatic diameter. A discriminant function was obtained by applying the bi-zygomatic and the basion-lambda measurements, with a confidence level of 72%. The authors concluded that most of the traits analyzed are sexually dimorphic and the discriminant function elaborated is reliable for sex determination in human identification for forensic purposes

Hyun Chul Jeong, Hee Bae Ahn (2015) made a Comparison of Orbital Anatomy in Korean and Caucasian Patients Using Computed Tomography ,and performed a cross-sectional, retrospective analysis of 44 CT scans of subjects (22 Koreans, 22Caucasians) with no appreciable orbital or globe disease. Obtained ten length measurements, and 3 angle measurements of various orbital aspects. Analysed that data to determine if changes in these parameters were associated with race.

In their result found that anterior medial interorbital length was 24.05 ± 2.00 mm in Korean and 21.96 ± 1.96 mm in Caucasian subjects. Anterior vertical orbital length was 34.19 ± 1.67 mm in Korean and 35.03 ± 1.18 mm in Caucasian subjects. The anterior medial interorbital length and anterior vertical orbital length ($p < 0.05$) were significantly different. Interorbital angle was 47.69o ± 1.49o in Korean and 46.15o ± 2.19o in Caucasian subjects; the difference was statistically significant ($p < 0.05$).

And they Compared their results with Caucasians, found that the orbit of Korean subjects has a narrower orbital opening and longer interorbital distance.

Guilherme Janson et al (2010). Studied Craniofacial characteristics of Caucasian and Afro-Caucasian Brazilian subjects with normal occlusion used sample comprised lateral cephalograms of untreated normal occlusion subjects, divided into 2 groups. Group 1 included 40 Caucasian subjects (20 of each sex), with a mean age of 13.02 years; group 2 included 40 Afro-Caucasian subjects (20 of each sex), with a mean age of 13.02 years. Groups 1 and 2 and males and females within each group were compared with t tests. They found that Afro-Caucasian subjects presented greater maxillary protrusion, smaller upper anterior face height and lower posterior face height, larger upper posterior face height, greater maxillary and mandibular dentoalveolar protrusion as well as soft tissue protrusion than Caucasian subjects. The Afro-Caucasian female subjects had less mandibular protrusion and smaller total posterior facial height and upper posterior facial height than males. Their conclusions was Brazilian Afro-Caucasian subjects have greater dentoalveolar and soft tissue protrusion than Brazilian Caucasian subjects, with slight sexual dimorphism in some variables.

Franklin D, Freedman L, Milne N.(2005) studied Sexual dimorphism and discriminant function sexing in indigenous South African crania. They found Univariate male/female ratios indicate significant sexual dimorphism in the pooled South African crania. After analysis of the pooled sample showed that facial width is the strongest discriminating morphometric variable; cranial length and basi-bregmatic height are the next most significant features. Eight measurements derived from the three-dimensional data were produced a series of discriminate functions for sex determination in the pooled sample, for which an accuracy of 77-80% was attained. Analysed the calvarias and face, separately, found that the sex of damaged material can be diagnosed with a reasonable degree of accuracy (75-76%).

S.G Obaje et al. (2015) did a Study of Cephalic Indices among Benue Ethnic Groups,Nigeria, found that the anthropometric characteristics of 425 apparently normal adults of ages 17-40 years of Igede and Idoma ethnic extractions of Benue State, Nigeria with no physical deformities of the face and head were randomly selected. They established satisfactorily characterizations between the two ethnic groups was clearly. They used 425 subjects for the study of which 158 were Igede and 267 were Idoma with mean age of 22.6 ± 0.45 and 23.0 ± 0.47 year, respectively. They measured anthropometric variables as head length, head width, bizygomatic distance, upper facial length, lower facial length, total facial length, nose width and skull height from which the cephalometric indices were calculated. Their results showed that there were statistically significant differences ($p<0.05$) in some of the measured variables between the Igede and Idoma tribes of Benue State. The results also showed a positive correlation between the head width and bizygomatic distance and other anthropometric variables which could be used to predict cephalic indices among the Igede and Idoma ethnic groups of Benue State, Nigeria. These results showed that the dominant head form among the Idoma and Igede Ethnic groups were mesocephalic respectively. Facial indices showed dominant hypereuryprosopic face type for both ethnic groups.

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Zavando et al (2009). They studied Sexual Dimorphism Determination from the Lineal Dimensions of Skulls. 226 skulls were analyzed measurements which carried out among the following reference points of the skull: right Eurion- left Eurion (Eu - Eu) Male140,86 Female 137.66 , Glabella- Opisthocranion (Gla – Op) Male 184.09 Female 178.81, Nasion – Prosthion (Na-Pr) Male 68.846 Female 64.492, Bizigomatic (Zi-Zi) Male 127.02 Female 119.67, and Nasion – Spinal (Na-ANS) Male 51.250 Female 47.613. calculated descriptive and inferential statistics (student’s t-test proved $p < 0.05$, analysis of discriminant function) for sex. Saw statistically significant differences in the following dimensions: Gla - Op, Na - Pro, Zi - Zi, and Na - ANS. Only for the distances Zi - Zi and Na-ANS, a discriminant function with a yield of 82% was identified for the correct classification for sex. And concluded that the lineal dimensions present a limited utility for sexual dimorphism in this sample

G. Staka, F. Dragidella& M. Disha (2012), did an Anthropometric Study of Nasal Index of the Kosovo Albanian Population and they determind an important athropometric parameter , classifyed the race and sex of the individual whose identity is unknown. They determined the nasal index of the Kosovo Albanian population. Selected sample comprised 204 subjects (101 males and 103 females) aged 18-25 years. And they measured Nasal height and nasal width using an electronic digital caliper, with accuracy of 0.01 mm (Boss, Hamburg – Germany).Their result showed that Kosovo Albanian males and females had mean nasal index of 67.07 ± 6.67 and 63.87 ± 5.56, respectively. And the distribution of the nose types showed leptorrhine to be 76.96 % and dominant type among Kosovo – Albanian population.

Ese Anibor et al (2011) did an Anthropometric study of the nasal parameters of the Isokos in Delta State of Nigeria, determined and compared the nasal parameters of male and female Isokos. The sample comprised two hundred and ten (210) males and two hundred (200) females of Isoko descent. The ages of the subjects ranged from 18-35years. Obtained nasal width and nasal height with the aid of a sliding caliper and calculated nasal indices as the ratio of nasal width and nasal height multiplied by 100. Subjected the data to statistical analysis used descriptive statistics and t-test. Found that males had mean nasal width, height and index of 4.22cm, 4.60cm and 92.35 respectively, while those of females were 3.87cm, 4.35cm and 89.51 respectively. The mean nasal index of the

Isoko males was significantly higher than that of the females (P<0.05). The Isoko ethnic group has a mean nasal index of 91.0. Their results had showed that the mean nasal index of the Isokos falls within the platyrrhine (broad nose) type.

Abdelmonem Awad Hegazy (2014) studied in anthropometric study of nasal index of egyptians a total of 290 subjects, 144males and 146 females, aged 1month– 65 years, when enrolled in the study, showed the existence of sexual dimorphism in nasal morphology, appearing after the age 20 years. Found that the mean nasal index in the investigated adults was 68.01; in males and females was 71.46 and 64.56, respectively. Concluded that the dominant nasal type in Egyptians was in-between mesorrhine “medium” and leptorrhine “narrow” nose.
Oluwayinka Paul et al (2015) researched An Anthropometric Study of some Basic Nasal Parameters .they selected sample comprised 302 subjects aged 17-45 years; 109 Okun subjects comprising of 57 males and 52 females, 107 Igala subjects comprising of 55 males and 52 females and 86 Ebira subjects comprising of 55 males and 31 females. Measured the nasal height and nasal width by using a sliding vernier calliper and calculated the nasal index. Showed their result that the mean nasal index for Okun males and females were 97.23±7.89 and 93.64±8.22 respectively; the mean nasal index for Igala males and females were 97.21±8.88 and 93.48±8.72 and the mean nasal index for Ebira males and females were 96.93±8.66 and 92.99±7.62 respectively. Noted Sexual dimorphism in the nasal

parameters of males and females in each ethnic group at P<0.05 but there was no significant difference in the nasal parameters between the ethnic groups considered at p<0.05. Okun, Igala and Ebira fall under the platyrrhine nose type.

Sharma et al (2014) Anthropometric Comparison of Nasal Parameters between Male and Female of Gwalior Region. Studied a random sample of males of 19 to 45 years age group was chosen for examination. Nasal length, nasal breadth, nasal height and nasal depth were measured with the help of Digital Vernier Caliper. calculated nasal index (NI) as NB/NH×100. They found a result comparable with other studies with mean NI ± SD of 80.59±9.122 in male which was significantly higher (p<0.05) than that of females who has NI ± SD of 77.29±8.472. Except for nasal depth, the other nasal parameter shows sexual dimorphism. They concluded that based on the mean NI, the predominant nose type is Mesorrhine in 63.73% of male and female (Hindu community) of Gwalior region.

Sanjai Sangvichien et al (2007) studied Sex Determination in Thai Skulls by Using Craniometry. Selected a sample of One hundred and one Thai skulls (66 males and 35 females) which ranged in age from 18 to 86 years. Found according to craniometry, the skull of a male is larger and higher than that of a female. Considering each individual measurement, although 26 of 30 measurements and 5 of 14 indices showed a statistically significant difference between males and females, they had some overlaps. To predict gender more accurately, developed a multiple logistic regression model based on 4 skull measurements (mm) i.e., nasion-basion length, maximum breadth of the cranium, facial length, and bizygomatic breadth of the face. Found that the probability of being males (P) is then ez/(1+ez). Then concluded that Jorgensenûs craniometry of the cranium and mandible can be used to determine gender among Thais

Sayee Rajangam, et al(2012). Measured the Orbital Dimensions, They found that the measurements of the orbit (height/ width/index) (Right: height 3.509 +/- 0.267, width 4.174 +/- 0.215, orbital index 73.55 +/- 12.89) (Left: height 3.37 +/- 0.257, width 4.082=/- 0.198, orbital index 75.273 +/- 11.132), were increased for the male. The right side measurements for the height and width were increased for both the sexes. Observed significance for the orbital index between the male and the female skulls for the right and the left orbits. Identified the application of the demarcation points, and identified the transverse diameters of the left and the right orbits 15 to 22 male skulls. Hence, the transverse diameters of the orbit could be considered as a parameter in sex determination of the skulls. Concluded that the observed differences in the orbital measurements may be because of the sample size or the methodology or also the cardinal features pertaining to the skulls.

Chapter Three
Materials and Methods

3-1Study design

Descriptive analytic cross sectional study

3-2 Study area

The study was carried out in Khartoum state, Sudan in CT radiology departments of Antalya Medical Centre, and Royal Care Hospital

3-3 Study duration

The study was conducted in a period from September2013 till March 2016 according to the patient's rate in the radiology department.

3-4 Study population sampling

Patients were selected randomly who were sending to do a C T investigation of facial bones and paranasal sinuses in radiology departments.

3-4-1Sample size

It was done on 110 patients

3-4-2Inclusion criteria

Normal data had taken from patients with condition that did not affect the normal craniofacial skeletal dimensions.

3-4-3Exclusion criteria

Any patient had craniofacial pathology which distorted normal craniofacial dimensions.

3-5 Method of data collection

Data collected by using observation during performing computerize tomography of paranasal sinusese and findings information recorded on data sheet.

3-6 Technique

Because of all patients of facial bones were abnormal the researcher collected data from patients were send to do paranasal sinuses CT examination. The technique used Supplementary techniques of axial imaging – using scanning factors and algorithms similar to the coronal protocol as mentioned by (Suzanne Henwood, 2008)**.** Where patient position Supine with head in head cushion on table top. Start position superior to frontal sinuses and the end position was inferior to maxillary palate Gantry angle parallel to infra-orbital meatal line.

3-7Equipment

Scans performed using spiral CT (Aquilon ,Toshiba Medical System Corp-Tokyo, Japan, helical mode 64 slice) and (General Electric ,helical mode 16 slice bright speed). Acquisition was obtained with a slice thickness of 2 mm, 1.25mm and FOV of

250mm, 240mm.Kvp of120,mA50 and 60 with images matrix size512X512 respectively.

3.8 Data analysis

All data obtained in the study were documented and analyzed using descriptive statistics, including mean ± standard deviation, were calculated. ANOVA (analysis of variance) test was applied, to test the significance of differences, p-value of less than 0.05 was considered to be statistically significant.

3.9 Method

Scans were obtained by two CT scanners. The original CT data were stored on a CD-ROM to allow full retrospective review of any data and image processing

3.9.1Computed tomography protocol

Patients were supine head was rest on the head holder no rotation and no tilting; all patients were positioned by laser light guiding for scanning in the orbitomeatal plane (baseline). Head position was maintained with restraints and confirmed with a scout film. A localizer radiograph was taken prior to the actual CT procedure.

3.9.2 Land marks determination

The images were taken on DICOM and then later land marks identified Anatomical landmarks modified from orthodontic craniometric (cephalometric) points were defined in the axial slice CT images as. The lower border of the midmandibular suture was defined as point Menton (M). The midpoint of the bilateral infraorbital margins was defined as point Orbitale (Or). The superior surface of the external auditory meatus was defined as point Porion (Po), and the most inferior and posterior points at the right and left angles of the mandible were defined as points Gonion (Go). Similarly, the pulp cavity of the upper and lower first molars (Fm), the crest of the alveolar ridge between the central incisors (In), the condyles (Co) of the temporomandibular joint, the anterior nasal spine (Ans), and the junction of the nasal and frontal bones in the midline (N)

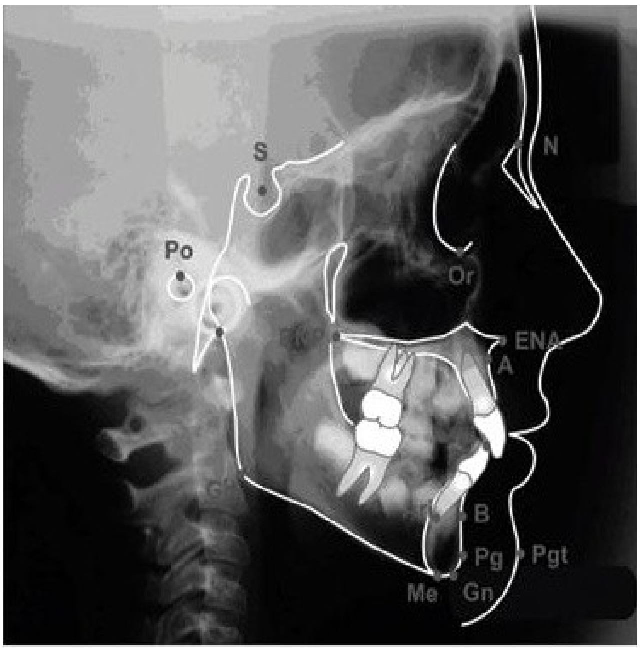

Fig (3.1) cephalometric land marks (Eric Whaites 2003).

3.9.3 Measurements identifications

A series of measurements in millimetres was obtained from stored images, all measurements performed by the same individual, were described in **Table (3.1)** each measurement was chosen for its ease of identification, reproducibility and clinical usefulness.

Table (3-1) shows the identification of measurement distances

	Dimension	meaning	Plane
1.	Zy-Zy	Bi zygomatic breadth (facial breadth)	Axial
2.	Zygomatic arch length (ZAL)	Distance between the antero lateral corner of the zygomatic buttress and the insertion of the Zygomatic arch in to the squamous part of the temporal bone	Axial
3.	Eu-Eu Bi-Euryon	Skull width (The two Eu points establish a line that represents the greatest width of the skull)	axiall
4.	(Op-G)	Distance between most anterior and posterior point of the skull Opisthocranion to glabila (Cephalic length)	Sagittal
5.	Or Hi	Orbital height	coronal
6.	Or Brd	Orbital breadth (maximum width of orbit measured from Dacryon)	coronal
7.	Orb-Orb	Bi orbital roof	coronal
8.	Mo-Mo	Anterior inter orbital	coron

		distance(anterior end of the medial orbital walls)	al
9.	Na H	Nasal height	sagittal
10.	Na w	Nasal width	Axial
11.	Na I	Nasal index (ratio of nasal length to nasal width)	

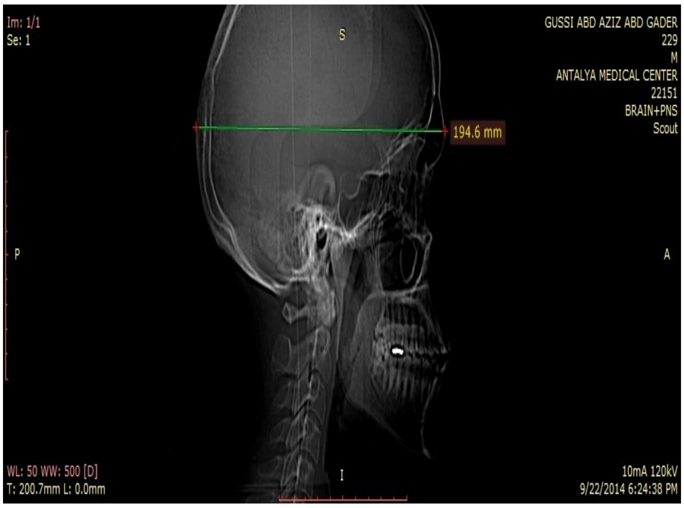

Fig (3-2) Cephalic length (Op-G)

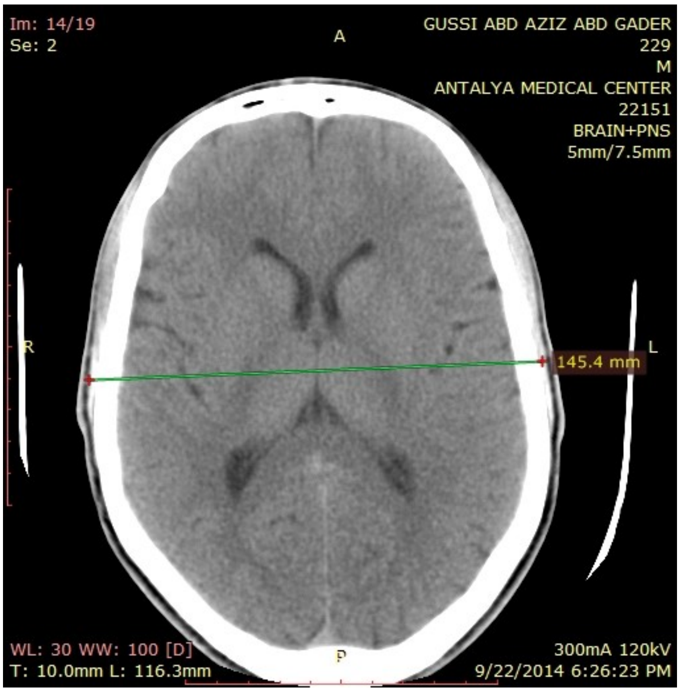

Fig (3-3) Cephalic width

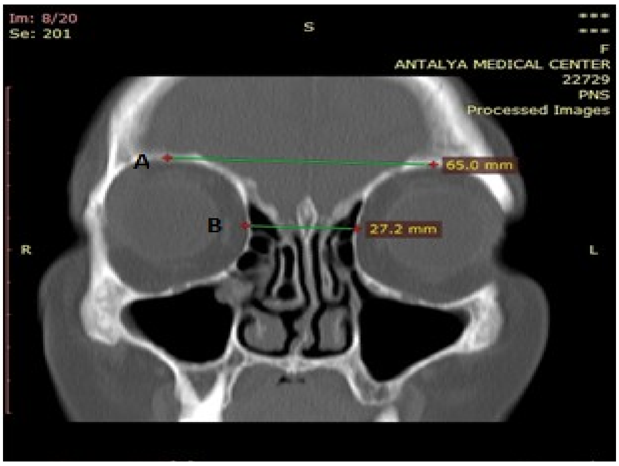

Fig (3-4)(A) Bi orbital roof (B) intra-orbital distance

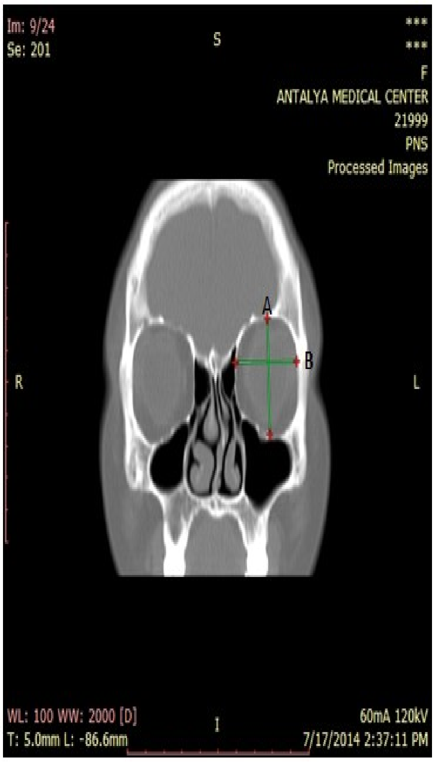

Fig (3-5) (A) orbital length (B) orbital width

Fig (3-6)(A) left zygomatic length (B)right zygomatic length

(c) bizygomatic distance

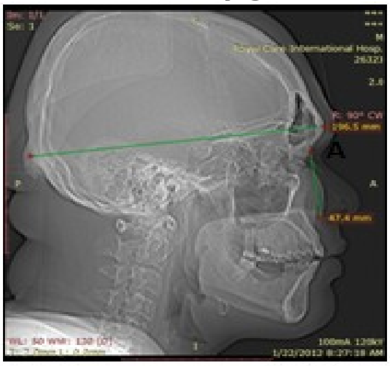

Fig (3-7)(A) Nasal height

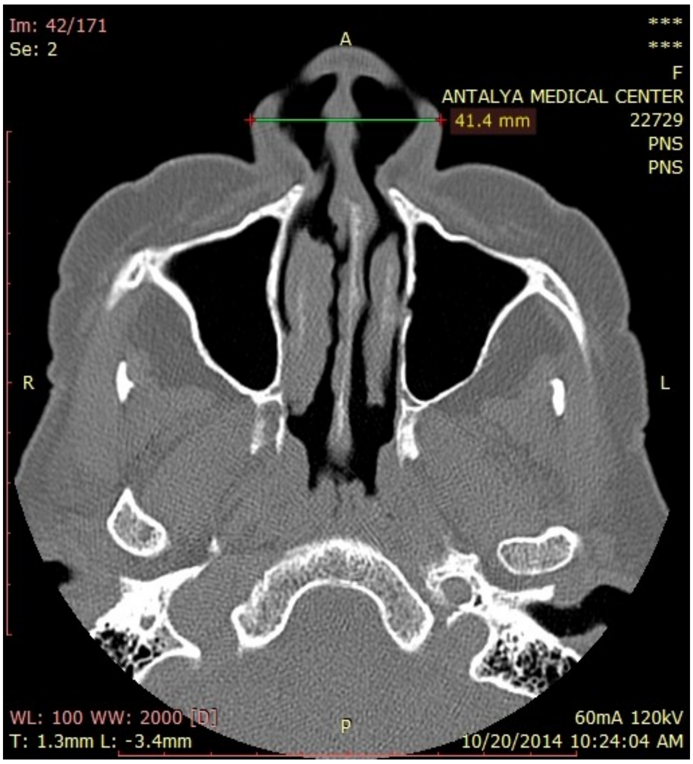

Fig (3-8) Nasal width

Chapter four
Result

Table (4.1) Shows distribution of gender according age

	Gender	N	Mean	Std. Deviation	Minimum	Maximum
Age	Male	34	40.80	16.39	14.00	73.00
	Female	76	38.90	12.35	14.00	75.00
	Total	110	39.50	13.68	14.00	75.00

(Fig 4.1) Shows distribution of gender in percentage

Table (4.2) Shows the descriptive statistics of the cranial width and cephalic length classified according to age.

	Age	N	Mean	Std. Deviation	Minimum	Maximum	P value
Eu -Eu	<25	16	123.57	6.80	107.04	132.69	
	26-30	16	125.02	10.51	109.95	156.60	
	31-35	12	124.56	7.52	114.89	137.33	
	36-40	19	123.45	7.14	108.35	142.95	
	41-45	14	120.93	6.24	110.98	136.29	
	46-50	10	125.89	15.81	115.43	168.32	.64
	51-55	7	129.17	7.23	115.43	136.65	
	>55	15	124.31	5.66	115.97	133.83	

	Total	109	124.21	8.49	107.04	168.32	
Op -G	<25	16	176.15	15.98	156.22	202.64	
	26-30	16	175.49	12.86	153.91	199.23	
	31-35	12	172.37	8.37	158.73	185.33	
	36-40	19	174.51	8.08	164.12	197.49	.82
	41-45	14	177.22	9.08	161.82	188.85	
	46-50	10	169.95	8.68	157.20	187.17	
	51-55	7	177.07	18.46	156.56	201.38	
	>55	16	175.79	9.38	156.28	196.82	
	Total	110	174.94	11.27	153.91	202.64	

Table (4.3) Shows the t-test and the Pearson correlation between the variables with the cranial width and cephalic length and age

		Eu -Eu	Op -G
Eu -Eu	Pearson Correlation	1	.19
	Sig. (2-tailed)		.06
	N	109	109
Op -G	Pearson Correlation	.18	1
	Sig. (2-tailed)	.06	
	N	109	110
age	Pearson Correlation	.07	-.01
	Sig. (2-tailed)	.49	.95
	N	109	110

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Table(4.4) Shows the descriptive statistics of the cranial width and cephalic length classified according to gender

Dimension	Gender	N	Mean	Std. Deviation	Minimum	Maximum	P value
Eu –Eu	Male	34	126.38	7.99	107.04	156.60	.07
	Female	75	123.22	8.58	108.35	168.32	
	Total	109	124.20	8.49	107.04	168.32	
Op –G	Male	34	181.32	10.59	167.79	202.64	.00
	Female	76	172.08	10.42	153.91	197.49	
	Total	110	174.94	11.27	153.91	202.64	

Table (4.5) Shows the descriptive statistics of the zygomatic variables (Bi zygomatic breadth and Zygomatic arch length (RT&LT) classified according to gender

Dimension	Gender	N	Mean	Std. Deviation	Minimum	Maximum	P value
Zy –Zy	Male	34	130.50	5.52	114.51	141.86	
	Female	76	123.51	4.40	112.69	136.11	.00
	Total	110	125.67	5.75	112.69	141.86	
Za L Rt	Male	34	55.33	5.01	45.48	64.97	
	Female	76	52.92	3.42	45.33	60.97	.00

		Total	110	53.66	4.11	45.33	64.97	
Za Lt	L	Male	34	55.10	4.74	44.45	64.87	
		Female	76	52.80	3.50	45.01	60.33	.00
		Total	110	53.51	4.05	44.45	64.87	

Table (4.6) shows the t-test and the Pearson correlation between the variables with the cranial width and cephalic length

		Cranial width	Cephalic length
Zy -Zy	Pearson Correlation	.30(**)	.26(**)
	Sig. (2-tailed)	.00	.01
	N	109	110
Za L Rt	Pearson Correlation	.04	.23(*)
	Sig. (2-tailed)	.66	.01
	N	109	110

Za L Lt	Pearson Correlation	.01	.13
	Sig. (2-tailed)	.90	.17
	N	109	110

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Table (4.7) Shows the descriptive statistics of the zygomatic variables (Bi zygomatic breadth and Zygomatic arch length) (RT&LT) classified according age.

	age	N	Mean	Std. Deviation	Minimum	Maximum	P value
Zy -Zy	<25	16	125.17	6.02	114.32	136.11	.84
	26-30	16	125.25	5.06	118.61	137.79	
	31-35	12	125.98	5.29	118.87	133.91	
	36-40	19	126.59	5.73	117.39	141.86	
	41-45	14	124.55	6.79	112.69	135.08	
	46-50	10	123.73	4.85	117.94	131.75	
	51-55	7	126.57	3.73	120.23	130.94	
	>55	16	127.09	7.14	113.71	141.86	
	Total	11	125.67	5.75	112.	141.8	

			0			69	6	
Za Rt	L	<25	16	53.24	4.79	46.72	61.84	.59
		26-30	16	53.72	4.57	45.33	60.97	
		31-35	12	52.91	3.85	45.33	60.24	
		36-40	19	52.43	2.88	49.08	61.09	
		41-45	14	54.26	4.26	46.50	59.98	
		46-50	10	53.29	3.38	47.71	58.80	
		51-55	7	54.81	1.83	53.21	58.83	
		>55	16	55.28	5.27	47.68	64.97	
		Total	110	53.66	4.11	45.33	64.97	
Za Lt	L	<25	16	53.04	4.18	46.88	60.45	.85
		26-30	16	53.94	4.41	44.45	59.54	
		31-35	12	52.81	3.19	46.67	58.17	
		36-40	19	52.74	3.28	46.01	61.49	
		41-45	14	53.45	3.78	46.00	60.33	
		46-50	10	53.28	4.10	45.29	58.80	
		51-55	7	54.96	2.41	50.95	57.13	
		>55	16	54.56	5.78	45.01	64.87	
		Total	110	53.51	4.05	44.45	64.87	

Table (4.8) Shows the descriptive statistics of the Orbital variables (orbital breadth, height, bi orbital roof and Anterior inter orbital distance) classified According gender

	gender	N	Mean	Std. Deviation	Minimum	Maximum	P value
Or Brd Rt	Male	34	34.96	1.77	30.38	37.54	
	Female	76	33.72	1.63	30.29	37.17	.00
	Total	110	34.10	1.77	30.29	37.54	
Or Brd Lt	Male	34	34.90	1.83	30.73	37.43	
	Female	76	33.69	1.79	30.08	38.89	.00
	Total	110	34.07	1.88	30.08	38.89	
Or Hi Rt	Male	34	38.71	2.59	31.44	44.38	
	Female	76	37.54	2.51	32.04	43.78	.027
	Total	110	37.90	2.58	31.44	44.38	
Or Hi Lt	Male	34	38.74	2.36	31.44	43.20	
	Female	76	37.47	2.45	32.46	43.50	.012
	Total	110	37.86	2.48	31.44	43.50	
Orb -Orb	Male	34	65.55	5.01	54.00	76.98	
	Female	76	63.75	5.42	50.53	78.18	.10
	Total	110	64.31	5.34	50.53	78.18	
Mo -Mo	Male	34	26.76	2.92	19.60	33.01	
	Female	76	25.88	2.76	20.80	32.37	.13
	Total	110	26.15	2.82	19.60	33.01	

Table(4.9) Shows the t-test and the Pearson correlation between the of the orbital breadth and height bi orbital roof and Anterior inter orbital distance with the cranial width and cephalic length

		Eu-Eu	G-Op
Or Brd Rt	Pearson Correlation	-.032	.039
	Sig. (2-tailed)	.740	.686
	N	109	110
Or Brd Lt	Pearson Correlation	.082	.141
	Sig. (2-tailed)	.396	.142
	N	109	110
Or Hi Rt	Pearson Correlation	.004	.140
	Sig. (2-tailed)	.968	.143
	N	109	110
Or Hi Lt	Pearson Correlation	.049	.142
	Sig. (2-tailed)	.613	.139
	N	109	110
Orb -Orb	Pearson Correlation	.183	.038
	Sig. (2-tailed)	.057	.695
	N	109	110
Mo -Mo	Pearson Correlation	.048	.164
	Sig. (2-tailed)	.617	.088
	N	109	110

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Table (4.10) Shows the descriptive statistics of the Orbital variables (orbital breadth, height, bi orbital roof and Anterior inter orbital distance classified according age.

	Age	N	Mean	Std. Deviation	Minimum	Maximum	P value
Or Brd Rt	<25	16	33.53	1.740	30.73	37.17	.38
	26-30	16	33.56	2.10	30.38	36.84	
	31-35	12	33.71	1.53	31.94	36.84	
	36-40	19	34.33	2.06	30.29	37.54	
	41-45	14	34.10	1.40	32.09	36.03	
	46-50	10	34.82	1.57	31.77	37.43	
	51-55	7	34.56	.76	33.76	35.98	
	>55	16	34.61	1.85	31.56	37.54	
	Total	110	34.10	1.77	30.29	37.54	
Or Brd Lt	<25	16	33.35	2.31	30.08	38.89	.47
	26-30	16	33.54	2.29	30.73	36.87	
	31-35	12	34.32	1.66	31.57	36.87	
	36-40	19	34.58	1.58	32.04	36.75	
	41-45	14	34.51	1.68	32.05	37.11	
	46-50	10	34.40	1.66	32.50	37.43	
	51-55	7	33.66	1.83	31.92	36.88	
	>55	16	34.07	1.72	30.96	36.29	
	Total	110	34.06	1.88	30.08	38.89	
Or Hi Rt	<25	16	38.45	2.81	32.04	43.78	.61
	26-30	16	37.84	2.42	34.05	42.28	
	31-35	12	37.48	1.94	35.45	41.19	
	36-40	19	37.29	2.08	32.98	40.44	
	41-45	14	37.88	2.96	32.42	43.46	
	46-50	10	37.01	2.94	31.44	42.43	
	51-55	7	38.43	3.41	34.63	44.38	
	>55	16	38.80	2.58	34.29	41.73	
	Total	110	37.90	2.58	31.44	44.38	
Or Hi Lt	<25	16	37.68	2.48	32.46	41.43	.57
	26-30	16	37.57	2.14	33.82	40.32	
	31-35	12	37.56	1.84	35.46	40.32	
	36-40	19	37.40	2.21	33.09	40.36	
	41-45	14	38.16	2.24	34.18	41.77	
	46-50	10	37.38	2.86	31.44	42.43	
	51-55	7	37.95	3.74	33.38	43.20	
	>55	16	39.11	2.90	34.77	43.50	
	Total	110	37.86	2.48	31.44	43.50	
Orb -Orb	<25	16	63.71	3.48	57.10	71.18	.10
	26-30	16	64.10	6.75	50.53	76.98	
	31-35	12	66.59	6.90	56.19	78.18	
	36-40	19	65.46	3.95	57.74	72.36	
	41-45	14	61.71	4.57	55.08	68.16	

	46-50	10	62.02	4.19	55.17	69.30	
	51-55	7	68.00	6.84	55.40	73.24	
	>55	16	64.11	5.11	55.31	74.38	
	Total	110	64.31	5.34	50.53	78.18	
Mo -Mo	<25	16	25.93	3.15	19.60	30.29	
	26-30	16	25.79	2.94	21.28	32.37	
	31-35	12	26.29	3.38	21.49	32.37	.08
	36-40	19	26.90	2.61	22.82	31.14	
	41-45	14	25.57	1.87	23.19	29.17	
	46-50	10	24.00	1.82	20.80	26.32	
	51-55	7	28.25	4.07	20.80	33.01	
	>55	16	26.69	2.10	23.11	30.80	
	Total	110	26.15	2.82	19.60	33.01	

Table (4.11) shows the descriptive statistics of the nasal bone height, width and index classified according to gender

	gender	N	Mean	Std. Deviation	Minimum	Maximum	P value
Na H	Male	34	43.30	3.41	36.89	51.90	
	Female	76	40.75	3.68	32.13	48.80	.00

	Total	110	41.53	3.78	32.13	51.90	
Na W	Male	34	42.83	4.17	34.09	53.82	
	Female	76	39.34	3.62	32.05	48.04	0.0
	Total	110	40.41	4.11	32.05	53.82	
Na Indix	Male	34	.991	.09	.84	1.27	
	Female	76	.97	.010	.72	1.29	0.06
	Total	110	.98	.09	.72	1.29	

Table (4.12) Shows the t-test and the Pearson correlation between the of the nasal bone height, width and index with the cranial width and cephalic length

		Eu-Eu	G-Op
Na H	Pearson Correlation	.07	.14
	Sig. (2-tailed)	.45	.15
	N	109	110
Na W	Pearson Correlation	.07	.22(*)
	Sig. (2-tailed)	.49	.02
	N	109	110
Na Indix	Pearson Correlation	.03	.11
	Sig. (2-tailed)	.80	.24
	N	109	110

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Table (4.13) Shows the descriptive statistics of the nasal bone height, width and index classified according to age.

		N	Mean	Std. Deviation	Minimum	Maximum	
Na H	<25	16	40.56	3.62	35.25	47.93	.81
	26-30	16	41.28	3.67	35.40	48.22	
	31-35	12	42.29	2.92	35.40	48.13	
	36-40	19	41.14	5.05	32.13	51.90	
	41-45	14	42.16	3.33	37.11	48.50	
	46-50	10	40.74	4.65	33.35	47.40	
	51-55	7	41.68	3.04	37.32	44.07	
	>55	16	42.54	3.22	36.63	48.80	
	Total	110	41.53	3.78	32.13	51.90	
Na W	<25	16	38.71	3.30	34.09	47.57	.39
	26-30	16	40.04	5.18	32.05	48.04	
	31-35	12	40.54	3.95	32.05	44.65	
	36-40	19	40.08	4.17	33.38	50.06	
	41-45	14	40.47	4.88	36.85	53.82	
	46-50	10	40.04	2.05	36.04	42.50	
	51-55	7	42.48	5.77	33.73	53.28	
	>55	16	42.07	2.83	36.03	46.76	
	Total	110	40.42	4.11	32.05	53.82	
Na Indix	<25	16	.96	.11	.84	1.29	.84
	26-30	16	.97	.091	.82	1.12	
	31-35	12	.9605	.08895	.72	1.07	

36-40	19	.9784	.06749	.89	1.19
41-45	14	.9619	.10462	.81	1.27
46-50	10	.9952	.13490	.86	1.25
51-55	7	1.0176	.09978	.90	1.21
>55	16	.9920	.07222	.87	1.13
Total	110	.9765	.09273	.72	1.29

Chapter Five

Discussion, Conclusion, and Recommendations

5.1 Discussion

The craniofacial anthropometrics studies are so valuable for medicine, dentistry, plastic and reconstructive surgery, bioengineering and also for anthropologists and forensic facial reconstruction experts (Baral,2010, Mahdi2012) However, the dimensions of the human body are affected by ecological, biological, geographical, racial, age and sex factors (Imami1996, Hamill et al .1979).

On the basis of these factors, studies about intra- and interpopulation variations have long been an interest and have been conducted on the age, sex and racial groups (Imami1996,, Ghosh 2007,, Golalipour 2003). With population specific anthropometric studies, the most specific parameter/s for every population should be determined. In accordance with this purpose, correlation between sex and two measurements of craniofacial were studied for Sudanese population.

In this study craniofacial dimension of normal Sudanese in different ages using computed tomography were measured. The study done over 110 subjects concerning normative Sudanese craniofacial measurement in (mm) using CT including both genders with mean age 40.88 and 38.90 Years for both males and females respectively (table 4.1) their ages were classified with an interval of 5 years. The mean of variables of cranial were bieurion (cranial width) in males and females measured 126.38mm and123.22 mm respectively (table4.4) , and glabila opsthrion (cranial length) measured 181.33mm in males and 172.08 mm in female(Table4.4).the study found that upper facial dimensions were Bi zygomatic breadth in male and female were measured 130.50mm and 123.51mm respectively, and Zygomatic arch length (RT&LT)in males55.33mm , 55.11mm respectively and in female were 52.92mm , 52.80mm respectively (Table4.5) In male orbits measurements, the mean of height was observed as 38.71mm and 38.74mm , right and left respectively, whereas in females orbits it was 37.54mm and37.47mm right and left respectively . The mean of breadth was observed right and left as 34.96mm and34.90mm respectively in male orbits, whereas in female orbits it was 33.72mm and 33.69mm right and left respectively. When the mean values were compared (Table 4-8), the orbital height and breadth were found to be higher in males than females.

Table (5-1) shows the comparison between the orbital measurements in the present study and some other populations

Author/ Year	population	Sample size	Orbit height	Orbit width	Mo-MO	Orbit index
Sanjai Sangvichien, et al 2007	Thahi	101	M33.44, F32.89		M 30 F 22	M83.50, F86.61
Sayee Rajangam et al 2012			Rt 35± 2.6 Lt33.7± 2.57	Rt41.7± 2.15 Lt 40=/- 1.9		Rt73.5 ± 12.89 Lt75.2 ± 11.132
Hyun chul2015	Korean	22		34.19±1.67	24.05±2.2	
Hyun chul2015	caucasion	22		35.03±1.18	21.96±1.96	
Mekala et al 2015		24	M33 F30.3	37-49 35-50		70.2-97.7
present study	Sudanese	110	M38.7 F37.5	34.9 33.7	26.15	Rt111.3 Lt111.4

The review of literature available for the orbitometry is less than the investigations for the craniometry. The parameters for the orbit, on its height, breadth diameters may be important in the investigation of the orbit especially, in the orbital floor (Lieberman and Carthy, 1999). In this study we presented the measurements of healthy normal orbital characteristics as seen on CT axial and coronal images (Table 4.8). Zygomatic and orbital measurements showed rapid growth of structures during the development but, instead of levelling off, the structures kept on growing until adulthood (Sayee, 2012). This study revealed that measurements of adult were achieved and classified according to age and was found to be higher at the age of 51-61 years. Cranial, zygomatic and orbital measurements showed similar attainment at this age with no significant difference detected at various age intervals (Tables 4.2, 4.5 and 4.10).

Regarding the gender ; for males, increased size differences compared to females were observed for left and right orbital measurements as well as the bi orbital roof and anterior inter orbital distance significantly at $p < 0.05$ this was presented in (Tables4.5 and 4.8). Correlation was studied between the cranial length and width with the orbits and zygomatic bone measurements which showed significant relation between the facial breadth (bi zygomatic breadth) and bi orbital roof with cranial breath for Sudanese (Table4.6). Studies showed that cranial breadth was strongly associated with facial breadth (Howells 1972; Brown 1973; Mizoguchi, 1992a). The present analyses of male data supported that males have greater cranial measurements (length and width) as seen in (Table 4.4). Significant associations between cranial breadth and bi zygomatic breadth (Table 4.6) can certainly be found in the total sample but separate correlations between genders were not considered regarding that issue in this study. If this is not due to the small size of the present male sample, the finding may suggest that some factors relating to sexual dimorphism, such as the difference in the degree of development of masticatory muscles as mentioned previously (Yuji, 2007) stablished the difference between males and females in the present results. The results of craniofacial measurements showed that cranial breadth and length were significantly associated with bi zygomatic breadth and bi orbital roof, however cranial length was significantly associated with right and left zygomatic arch length in addition, no associations were found regarding other variables. From this, it was inferred that cranial dimensions may be freely associated with facial structure. It was also found that, when a certain facial measurement was associated with one of the two cranial measurements, it was almost always cranial breadth, not cranial length. The study revealed that Sudanese measurements for the selected variables for orbits, zygomatic bone and cranial length and width; differ from what was mentioned in other studies mentioned in the literature (Yuji, 2007) The available literature on the gender and age determination and racial variation for the skulls is plenty; because they may be the reflected causes for the observed differences in the craniometry as well as for the orbitometry (Sayee, 2012). Racial/ Geographic variations: is the main cause of the difference between populations (Standring, 2005).That variation in craniometry internationally classified by cephalic indices using cephalometric parameters. Classified to long head called dolichocephalic is within a range of 70-74.9, moderate head called mesocephalic lies in a range 75-79.9, short head also called brachycephalic within 80-84.9 and very short head hyperbrachycephalic in the range of 85-89.9, respectively (Williams *et al*. 1995) Cephalic index (CI) was calculated by using the following formula,

CI = cranial height / cranial breadth x 100

Sudanese CI was 71.26 under category of dolichocephaly which was differ from African cephalic indices and unlike the data presented by Franklin (2005) and Zavando(2009) that which evinced by this study. That may be due to mixuer of races in Sudan and early migration from other populations.

Among modern human groups there was considerable variability in the characteristics of the orbit (Xing 2013) .The orbital index (OI), the proportion of the orbit height to its breadth multiplied by 100 determined by the shape of the face and varies with race, regions within the same race and periods in evolution (Munguti Jeremiah 2013).

Orbital index (OI) was calculated by using the following formula,

OI = orbital height / orbital breadth x 100

That classified the orbit to three main categories according to OI, megaseme

(Large) orbit ≥ 89 found in Yellow races, except the Esquimaux. Mesoseme (Intermediate) = 83-89 European were 87 and English in 88.4, and microseme small ≤ 83 in Black people(Mekala 2015). When the mean values compared (Table4.8), the orbital height and breadth were found to be higher in males than females. When the mean OI was compared between right and left orbits, statistically there was no significant difference observed. While the literature has been examined (Table 5.1)we found that Sudanese population had great orbital height rather than orbital width, according to that orbital index was higher than other population reviewed , that classified the Sudanese orbit as megaseme category (OI =111.3). The observed differences in the orbital measurements may be because of the sample size and also the basic features relevant to the skulls, subjective sex determination, age, racial and geological variations. The comprehensive set of measurements collected in this study provided detailed information on orbital geometry, as well as measurement of the cranium and zygomatic bone. This set of measurements can be used for the development of fixed element models of the orbit, zygomatic bone for computational modeling purposes. Although sample size was limited there was ability to obtain statistically significant relationships regarding the variables anthropometry with age. When normal variation in variables anthropometry is implemented in a standard reference model statistically significant variation in injury may result. Determining injury by quantifying anthropometric variation across individuals would be valuable in explanation of injuries. As a result; measurements of the orbita, zygomatic bone and cranium contain valuable practical knowledge about genders. With this method, in the future, in larger study groups, it would be possible to classify individuals to ethnic and gender groups. Also orbital measurement and index couldn’t be used as antherpometric variable.

Table (5-2) shows the comparison between the nasal index in the present study and some other populations

Author/ year	Population	Sampl e size	Nasal height	Nasal width	Nasal index

Niswander et al. (1967)	Brazilian Indians				72.3
Erika et al. (2006)	Latvians				70.9
Oladipo2007 Southern Nigeria	Igbos				94.1±0.37
	Yorubas				89.2±0.3
	Ijaws				96.37
Oladipo2010	Ijaws	1000	M 40.8 F 38.9	40.6 37.9	99.83 97.79
Oladipo2011	Omoku indigenoes	800	M 46.6 F 43.6	40.1 39.3	86.09 90.16
Gloria Staka et al 2012	Kosovo – Albanian	204	M55.26±3.5 F36.9±2.6	36.9±2.6 33.12±2.2	M67.07±6.6 F63.87± 5.5
Sharma et al 2014	Hindu of Gwalior region				M 80.59±9.1 F 77.29±8.4
Abdelmonem Awad Hegazy.2014	Egyptian	290			M 71.46 F 64.56
This study	Sudanese	110	M 43.29 F 40.74	M 42.82 F 39.33	M 99.12 F 96.98

Craniofacial anthropometry is important in the evaluation of facial trauma, defects, and identification of congenital malformation and diagnosis of different diseases (Oladipo et al., 2008a; Oladipo et al., 2008b; Oladipo et al., 2009a). Physical anthropology relies mainly on external measurements and descriptions of the human body and particularly of the skeleton. Nasal index is an ethnic sensitive anthropometric index, an important parameter used to classify race and sex of an unknown individual (Risely, 1969). and it has become a useful tool in Forensic Science (Xu B, 2011) analyzed by dividing the greatest width of nasal aperture by height of nasal skeleton multiplied by 100, the nasal indices are best classified into three types .The first one is Leptorrhine or (fine nose) with N.I. ≤ 69.9, and the Second is Mesorrhine or (medium nose) with N.I. ranging between 70 - 84.9 and the third is Platyrrhine or (broad nose) with N.I. ≥ 85.0 (Williams et al, 1995)

It is necessary to have local data of these parameters since these standards reflect the potentially different pattern of craniofacial growth resulting from racial, ethic, and sexual differences (Oladipo et al., 2009b). There are different racial groups including Asians, Blacks and Whites, their differences are based on physical characteristics (Montagu, 1960). On the other hand, there are critical genetic differences between different races. It is acknowledged that utilizing a standard for craniofacial structures is not appropriate when making diagnostic and treatment planning decisions for patients from diverse ethnic backgrounds. Craniofacial analyses studies were based mainly on people of European ancestry but most investigators have noted that there were significant differences between diverse ethnic groups. As a result, a large number of cephalometric references have been developed for different ethnic groups (Riolo et at., 1974; Broadbent et at., 1975; el-Batouti et at., 1994; Johannsdottir et at., 1999). The descriptive statistics of cephalic length and width and the nasal bone height, width and index classified according to age and according to gender were measured for 110 norm Sudanese subjects these were presented in (Tables 4-12,4-13). This study showed that the mean values in males were significantly larger than those of females ($p<0.05$).The result were in agreement with Franciscus and Long, (1991) and Oladipo et al.,(2010) who reported larger values for nasal height, nasal width and nasal index in males than females. Nasal index of Igbos (Oladipo et al., 2009a) was larger than that of Ijaws. It can be justified that the genetics and environmental factors are responsible for the variation in craniofacial dimension between and within populations (Cem et al., 2001; Kasai et al.,1993).

In the present study, the ages ranged from (≤25≥55) years. The choice of the study population was calculated since the age of 18 years, is the age of physical maturation and majority (Abigail, 2006), we divided adult’s subjects into six age groups, as shown in (tables 4-2 and 4-13) Zankl et al, (2002) reported that reference data for anthropometric characteristics of normal, healthy individuals should be provided in age ranges as wide as possible. The set of data offered by present study probably covers the largest age range with a considerable number of subjects in each gender and age group. The results of the present study indicated that adult males had higher values than adult females. The highest value nasal bone height, width and index classified were observed in the 51 to 60 years of age group. Similarly, the highest value for cranial width and cephalic length was observed in the 51-to-60 years of age group in Sudanese adults. The mean values of the variables computed in the present subjects were lesser in females than in males for all age groups. The observed differences between genders were statistically significant for both cranial length and cephalic width (p=0.051, 0.000) (Table 4-4) and for nasal bone height, width and index (P= 0.001, 0. 000&0.056) respectively

(Table 4-11). The results of this study agreed with many other studies that compare anthropometric characteristics of males and females. Most of such authors had concluded the presence of sexual dimorphism in their studied sample. Oladipo et al. (2007) on the facial measurements among major ethnic group in Nigeria where sexual dimorphism was observed in all the ethnic groups studied with males having significantly higher facial indices than females. In the present study, the cranial width and cephalic length were restricted to the dimensions and indices of Sudanese adults. The t-test and the Pearson correlation between the nasal bone height, width and index with the cranial width and cephalic length were obtained and presented in (table4-12), by comparing the measurements from previous study that mentioned in (Table 5-2) with that of the present study could reflect that the Sudanese population is belonging to African origin of the fore-mentioned ethnic groups and may be considered as a special ethnic group as the measurements were larger than the other groups. So according to classification of nose shape we found that Sudanese nose was Platyrrhine or (broad nose) with N.I. ≥ 85.0.

Given our present understanding of nasal physiological morpho-function, these results support and demonstrate an adaptive role for human nasal index variation. It has been suggested that the association of variability in the human nasal index for Sudanese may be due to climatic variation which is considered as an important element in Sudan. The study firmed general anthropometric form which can be established in addition to the race-specific growth criteria. To this end, we tested race/ethnic, age and gender effects on growth during the age's between ≤25≥55 years of four variables measured for the nasal region; the findings for all variables examined continued to show race effect when compared with other population. Thus, our results support gender and race-dependent anthropometric Sudanese growth form. Such an outcome is suggestive of universal applicability. This was consistent with the World Health Organization (2006) report on growth standards documenting growth to be remarkably similar during early childhood across human populations from diverse continental groups. Although we did not find age effects in this particular study, as our ages were between (≤25≥55) years old this does not imply that there are no specific individual age group differences.

The design of this study focused on age/gender anatomic differences in adults, this study assessed the effect of age/gender on development. However, it is possible that different sampling strategies and study designs with a larger proportion of racial/ethnic diversity may show significant race differences in growth trend. Thus, our findings and approach need to embrace a study design that includes all Sudanese ethnic groups, to assess race effects and determine whether the findings are generalizable.

5-2 Conclusion

Concluded that measurements of the orbital, zygomatic bone and cranium contain valuable practical knowledge about genders; since the anatomy of the face is interest to many radiological fields and determining the presence of abnormality and to help in surgical planning.

The present study was able to confirm the feasibility of advancing general anthropometric growth models by assessing racial/ethnic anatomic effects on growth within the construction of a purely anatomic framework, as well as to establish the nasal dimensions of adults in Central Sudan represented in Khartoum state.

It also established that as in other populations nasal parameters are sexually dimorphic among the Sudanese represented in Khartoum state and that male nasal dimensions are greater than those of females. And Sudanese had Platyrrhine nose, Megaseme orbit, and Dolichocephalic head.
Knowledge of mean nasal dimensions is important in evaluation of age, gender and racial differences, in clinical applications and in forensic application

Also images obtained with facial-CT can be used as a method for gender evaluation. From the findings of the present study of Sudanese adults, it can be fulfilled that the cranio-orbito-zygomatic structures displayed varying degrees of sexual dimorphism.
It was inferred that cranial dimensions may be freely associated with facial structure. It was also found that, when a certain facial measurement was associated with one of the two cranial

measurements, it was almost always cranial breadth, not cranial length The study concluded that the Sudanese population is belonging to African origin of the fore-mentioned ethnic groups and may be considered as a special ethnic group as the measurements were larger than the other groups. Also orbital measurement and index couldn’t be used as antherpometric variable.

Also the computed tomography is modality of choice in Anthropometry because it can visualize and facilitate the measurements of the internal structures.

5-3 Recommendations

1. Using the findings of this study for reconstructive surgery, forensic examinations in crime scenes and establishing racial differences.
2. Accentuating Sudanese orbital morphometric data in conceder when design the artificial ocular, and eye protective equipment.
3. Using large sample size and further researching in this topic to get ideal indices measurements.
4. The populations at centre of Sudan are mixture of races so more researching to differentiate between races and ethnicity is recommended.
5. Identifying more other land marks in future researches; so that using more cephalometric land marks in antherpometry will produce more effective result.
6. This study is therefore basic to forensic anthropologists, craniofacial surgeons and medical practitioners and also serves as the basis for future studies on other Sudanese ethnic groups.

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Sudan University of Science and Technology

College of graduate studies
Characterization of craniofacial bones and nasal parameters for Sudanese population using 3D CT
Collecting data sheet

Pt No (   )

Age						
Gender	M ( )	F ( )				
cranial	G-OP	Eu-Eu				
maxillary	Zy -Zy	Rt Zy L	Lt Zy L			
Orbital	Rt Or B	Lt Or B	Rt Or H	Lt Or H	Or-Or	Mo-Mo
Nasal	N H	NW	NI			

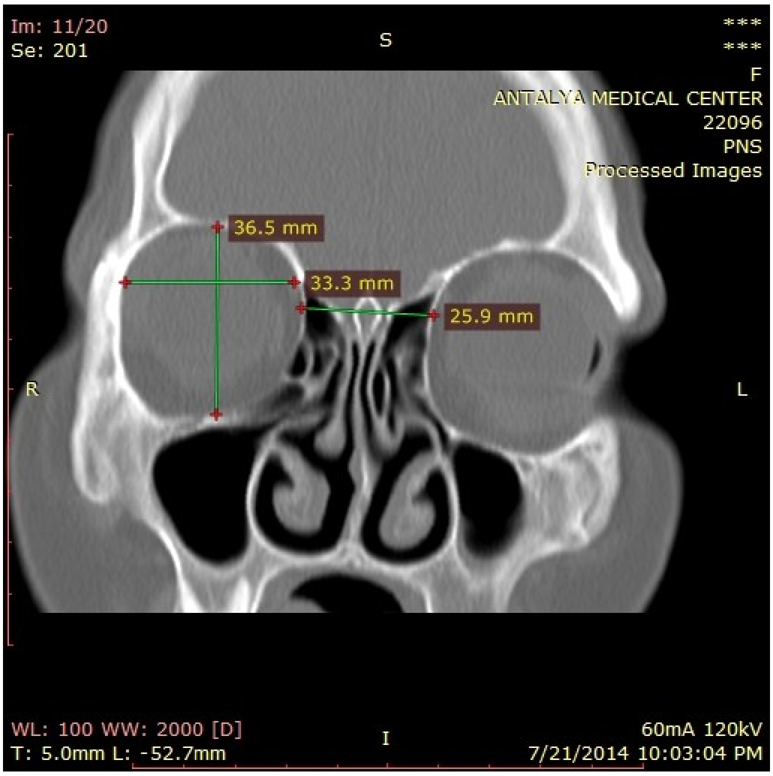

Image (1) female 48 years old with (Rt Or H &Rt Or W &Mo-Mo)measurement

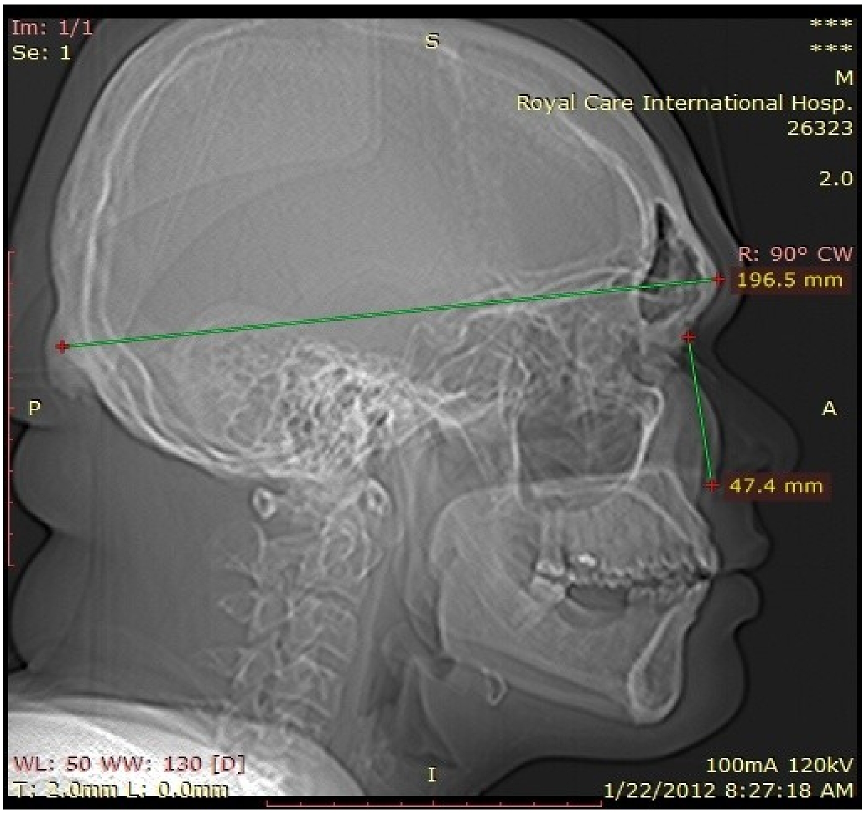

Image (2) 56years male with (G-Op)and (NH)

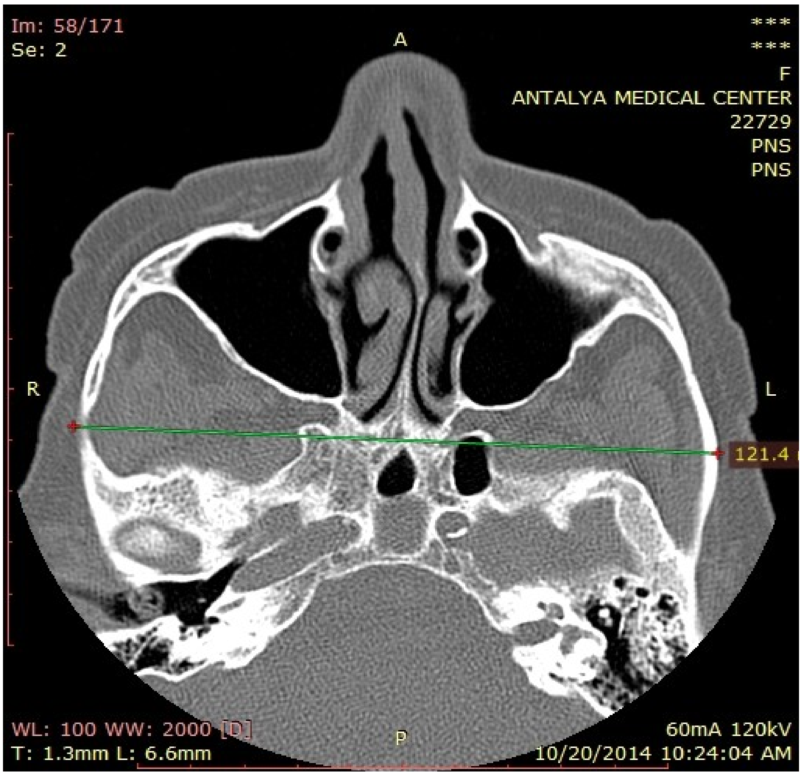

Image (4) 37years female with Zy-Zy

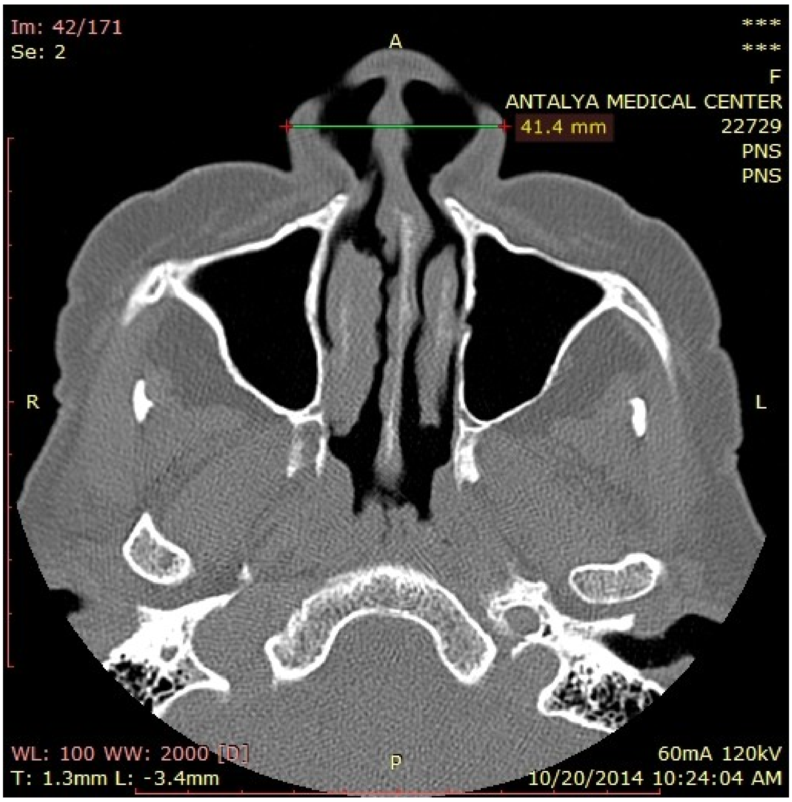

Image (5) 37 years female with NW

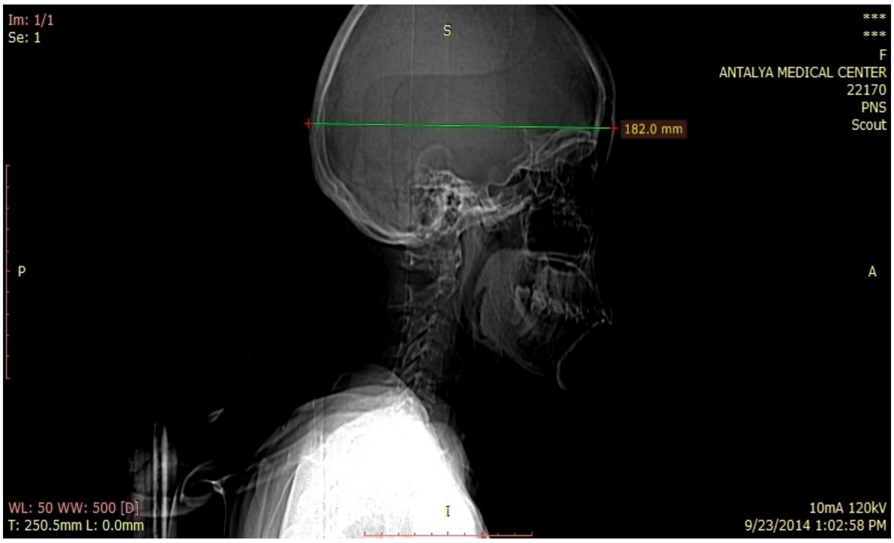

Image (6) 42years female with G- Op

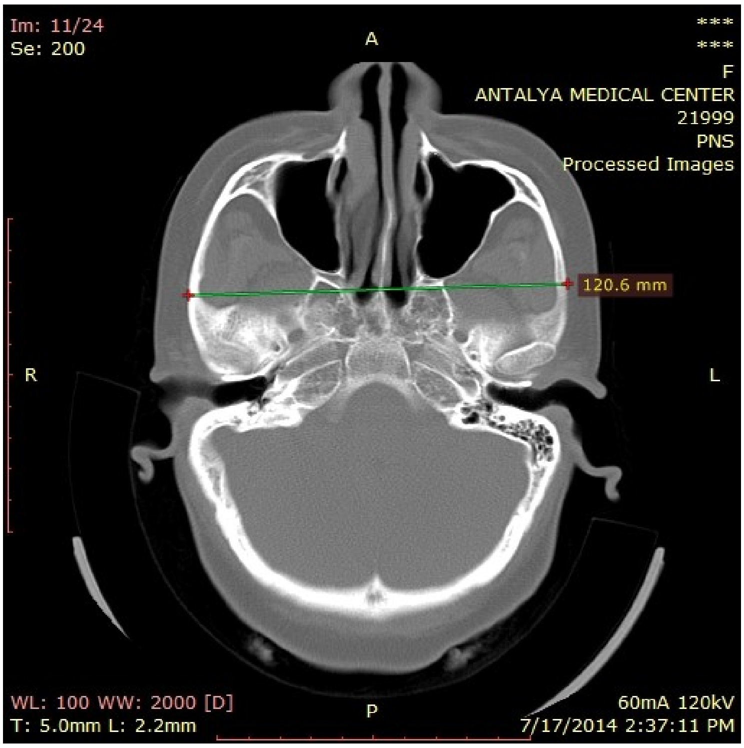

Image (7) 29 years female with bi-zygomatic breadth