Chapter One

Introduction

1.1 INTRODUCTION:

Orbits have been used in race and gender prediction of individuals for more than century. (Weaver et al 2010)

Understanding human anatomy, proportion, mechanical functions and racial variations concerning the ocular anatomy are of vital importance when treating or clinically evaluating patients. Anthropometry helps to understand anatomic structures and forms the technique of expressing quantitatively the form of the human body and skeleton. Anthropometric studies are an integral part of craniofacial surgery. (Ukohau 2011)

Difference amongst species provide important point of view to the forensic anthropometry in the process of individualization. Human skull and cranium are anthropometric tools of utmost importance in forensic research and in analyzing ethnic and racial relations. In 1875, Paul Broca found the orbital index by measuring orbital height and orbital width in order to evaluate the orbital size and shape as quantity. The orbital shape and size show differences in different races, ethnic groups and genders. (Pantaik 2001)

Patnaik et al (2001) calculated the orbital index and define 3 orbital categories:

1/ Megaseme (large): the orbital index is 89 or over.

2/ Mesoseme (medium): the orbital index range between 89 and 83.

3/ Microseme (small): the orbital index 83 or less.

Furthermore, in the last years, development of 3D-CT has been used in the measurement of the orbit. Weiss et al stated that computed tomography (CT) is best way to evaluate the orbital cavity because of the complex anatomy of the ocular and ethmoid region. Three dimensional (3D) CT is perfect method to obtain an objective result. (Weiss el at 1987)

1.2 Problem of the study:

To measure the diameter of the orbit in normal population and to defied the effect of age on this diameter and to detect if there is relation between the orbit diameter and head diameter in Sudanese population.

1.3 Objectives of the Study:

1.3.1General objective:

To characterize the orbit in Sudanese people using computed tomography.

1.3.2 Specific objectives:

- To measure the diameter of orbit
- To measure orbital dimension in both gender and age.
- To correlate the dimension of orbit of normal subject with head dimension and age and gander to define index of Sudanese.

1.4 Significance of the study:

This study will detect the orbital index in Sudanese population.

1.5 Overview of the study:

This study consisted of five chapters, chapter one an introduction which includes:

Problem of study also contain general, specific objectives and significant of the study. Chapter two includes back ground and literature review about role of CT images to measurement orbital diameter. Chapter three describe the methodology will be use in this study. Chapter four include result of presentation of finding of study, finally chapter five include discussion, conclusion and recommendation.

Chapter two

Literature review

2.1 ANATOMY:

The skull or bony skeleton of the head rest on superior end of the vertebral column and it divided into two main sets of bones: (Bontrager 2001)

1/ cranium 8 bones: 1 Frontal, 2 parietal, 2 temporal, 1 occipital, 1 ethmoid, 1 sphenoid.

2/ facial 14 bones: 2 maxilla, 2 zygomatic bones ,2 lacrimal bones ,2 nasal bones ,2 inferior nasal conchea ,2 palatine bones ,1 mandible, 1 vomer (Bontrager 2001).

2.1.1 Orbital bony:

The bony orbits are cone-shaped recesses that contain the globes, extraocular muscles, blood vessels, nerves, adipose and connective tissue, and most of the lacrimal apparatus. The junction of frontal, sphenoid and ethmoid bones of the cranium and lacrimal, maxillary, palatine, and zygomatic bones of the face form the orbit. (Lorrie L.Kelley 2007)

Each orbit present a roof ,floor, medial wall, lateral wall and an apex .the roof of the orbit is composed of the orbital plate of the frontal bone and most of the lesser wing of the sphenoid bone. On the anterolateral surface of the roof is the lacrimal fossa in which lies the lacrimal gland. The medial wall is exceedingly thin and is formed by a portion of the frontal process of the maxilla the lacrimal bone, ethmoid bone, and body of the sphenoid bone. On the anterior surface of the medial wall is the lacrimal groove for the lacrimal sac. The lacrimal groove is contained within the lacrimal bone and communicates below with the inferior meatus of nasal cavity through the nasolcrimal canal. The floor of the orbit, which is also the roof of the maxillary sinus, is made up of the maxilla, zygoma and the palatine bone. The lateral wall is the thickest wall and is formed by the greater wing of the sphenoid bone and the zygoma. The posterior portion of the orbit or the apex is basically formed by the optic canal (optic foramen) and the superior orbital fissure. The optic canal and the superior and inferior orbital fissures allow various structures to enter and exit the orbit and establish communication between the orbit and middle cranial fossa. The optic canal form an angle of about 37 degree with the sagittal plane of the head it is bounded medially by the body of sphenoid bone, superiorly by the lesser wing of the sphenoid, and inferiorly and laterally by the inferior root (optic strut) of the lesser wing of the sphenoid bone. Coursing through the optic canal are the ophthalmic artery and optic nerve. The superior orbital fissure is a triangular opening located between the greater and lesser wings of sphenoid bone that allows for the cranial nerves, oculomotor (lll),trochear (lV), ophthalmic branch of trigeminal (V), and abducens(Vl) to course as well as the ophthalmic veins. At the orbital apex, the inferior and lateral walls of the orbit are separated by the inferior orbital fissure through which the maxillary branch of the trigeminal nerve (V) courses. The medial lip of the inferior orbital fissure is notched by the infraorbital groove, which passes forward in the orbital floor to become the infraorbital canal that opens on the anterior surface of the maxilla as the infraorbital foramen. (Lorrie L.Kelley 2007)

2.1.2 SOFT TISSUE STRUCTURES :

GLOBE: the globe of the eye has irregular, spherical shape and sits in the socket of the bony orbit. The globe is divided into anterior and posterior compartment.

The anterior compartment is small cavity located anterior to the lens. It contains the cornea and it iris and is filled with aqueous humor that helps maintain intraorbital pressuer.

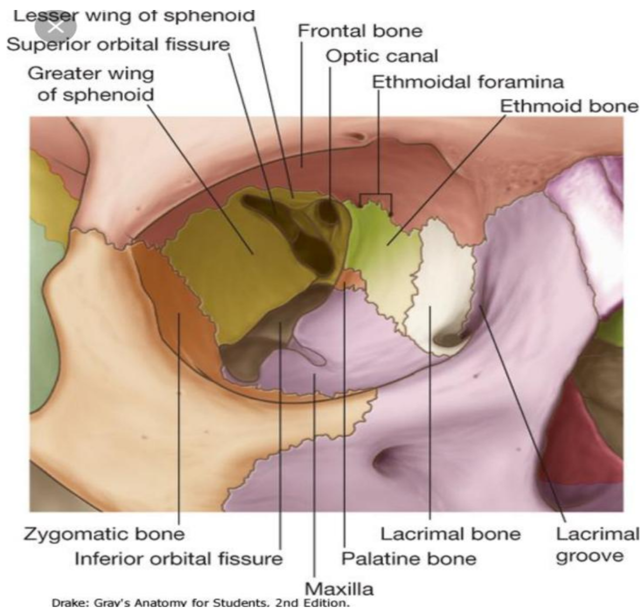
The large posterior compartmen is located behind the lens and is surrounded by the retina. The retina consist of layers of tissue that include the photoreceptors responsible for vision. The posterior chamber contains a jelly like substance called the vitreous humor that helps maintain the shape of the eyeball .located in the superolateral portion of the orbit is the lacrimal gland, which produces tears. (Lorrie L.Kelley 2007)

2.1.3 MUSCLES OF THE EYE:

Six major muscles work together to control the movment of the eye. The rectus muscle group consist of four muscles that arise from a common tendinous ring that surrounds the optic nerve and is located at the medial portion of the superior orbital fissure. The superior, inferior, medial and lateral rectus muscle act as abduct and adduct the eyeball. Two obliqe muscles, superior and inferior, abduct and rotate the eyeball. The superior oblique lies below and anterior to the inferior rectus muscle. (Lorrie L.Kelley 2007)

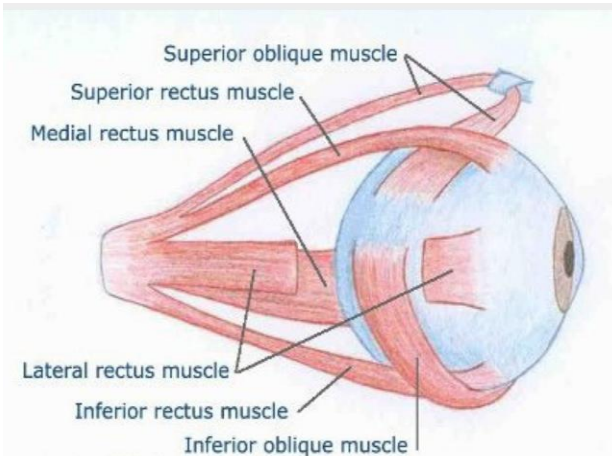
2.1.4 OPTIC NERVE AND BLOOD SUPPLY:

The optic nerve is the nerve of sight. It commences at the posterior surface of the globe and courses posteromedially to exit the orbit through the optic canal and entirely surrounded by dura mater from the meninges of the brain. The ophthalmic artery courses adjacent to the optic nerves as they exit through the optin canal. The superior ophthalmic vein is easily recognized as it originates from the medial orbit and courses below the superior rectus muscle, retroorbital fat surrounds the muscular and vascular structuers within the orbit, which allows for better visualization of the structures in cross-sectional imaging. (Lorrie L.Kelley 2007)



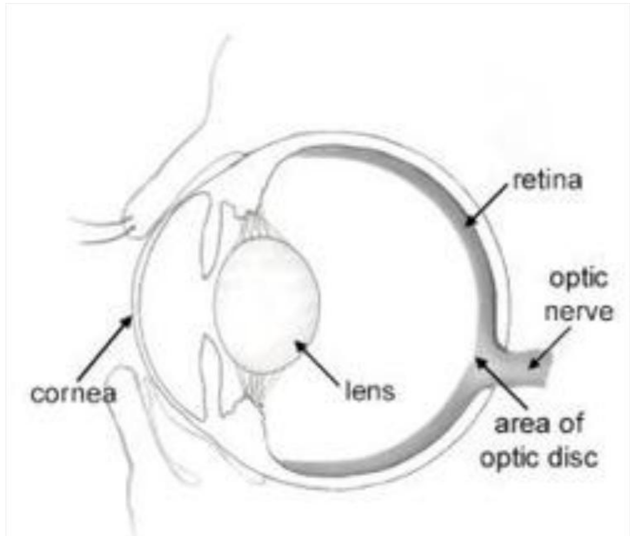
Figuer 2.1 compination of orbital bony

(www.forbestvision.com)



Figuer 2.2 muscle of orbit

(www.forbestvision.com)



Figuer 2.3 structer of globel.

(www.forbestvision.com)

2.2 PHISOLOGY:

The walls of the orbits (floor,roof,medial,lateral walls) protect the eyes from any injury and provide the points of attachment to the extra-ocular muscles,which allow the accurate position of the visual axis and determine the spatial relationship between the two eye,which is considered to be essential for both the binocular vision and the conjuate movment of the eyes.(Standring 2008)

2.3 PATHOLOGY:-

2.3.1 ORBITAL FRACTUER: is traumatic injury to the bone of the eye socket.these injuries are usually the result of the blunt force trauma to the eye.(www.templehalth.org)

There are three main types of orbital fractuers that can occur:

2.3.1.1 Direct orbital floor fracture:

if an orbital rim fractuer extend into nearby parts of the socket floor, both the rim and the socket floor are fractured.about 85% of these injuries happen by accident during contact sports , at work, in car crashes or while doing home repair projects. About 15% are caused by violent assaults.men suffer from traumatic eye injuries about four times more often than women.(www.reviewofophthalmology.com)

2.3.1.2 Indirect orbital floor fractuer :

this occurs when the boney rim of the eye remains intact, but the paper thin floor of the eye socket cracks or ruptures. This can cause a small hole in the floor of the socket that can trap parts of the eye muscles and surrounding structurs. The injured eye may not move normally in its socket, which can cause double vision. Most indirect fractures are caused by an impact to the front of the eye from something bigger than the eye opening such as a baseball. .(www.reviewofophthalmology.com)

2.3.1.3 Orbital rim fracture:

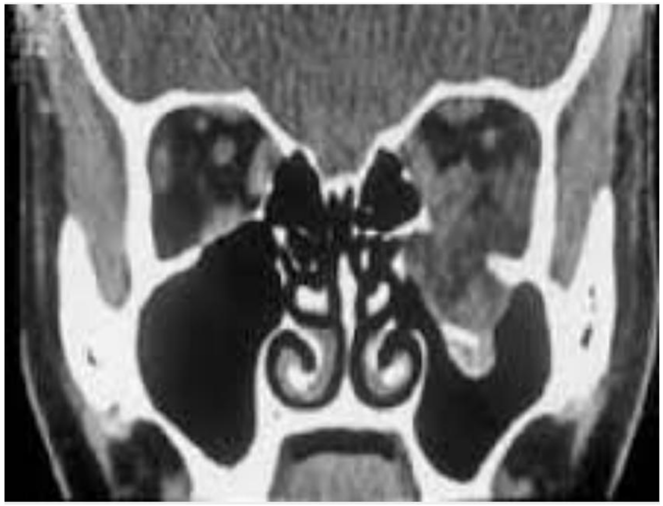
these are caused by a direct impact to the face most commonly by an automobile dashboard or steering wheel during a car crash. Because a great deal of force is requierd to cause these fractuer, they often occur with extensive injuries to other facial bones and some times injuries to the brain. Even if the damage is limited to the eye area , there may be additional injuries to the eye it self such as the optic nerve, the eye muscle , the nerve that provied sensation in the forhead and cheek, the sinusesaround the eye and the tear duct. .(www.reviewofophthalmology.com)

2.3.2 There are two types of orbital rim fractures:

A. A zygomatic fractuer: involves the lower edge of the eye rim, which is part of the cheekbone.

B. A frontal bone fractuer or frontal sinus fracture: involves the upper edge of the rim, which is part of the forehead frontal bone.

(www.reviewofophthalmology.com)

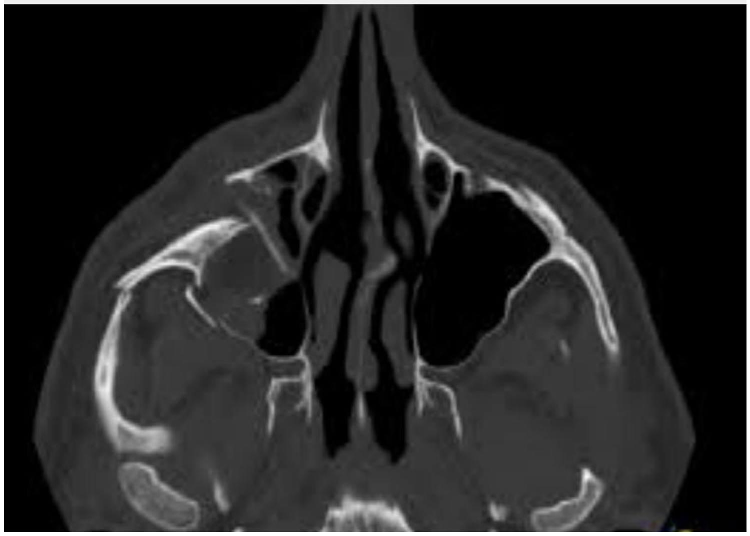


Figuer 2.4 cronal CT for indirect orbital fracter.

(www.europeanmedical)

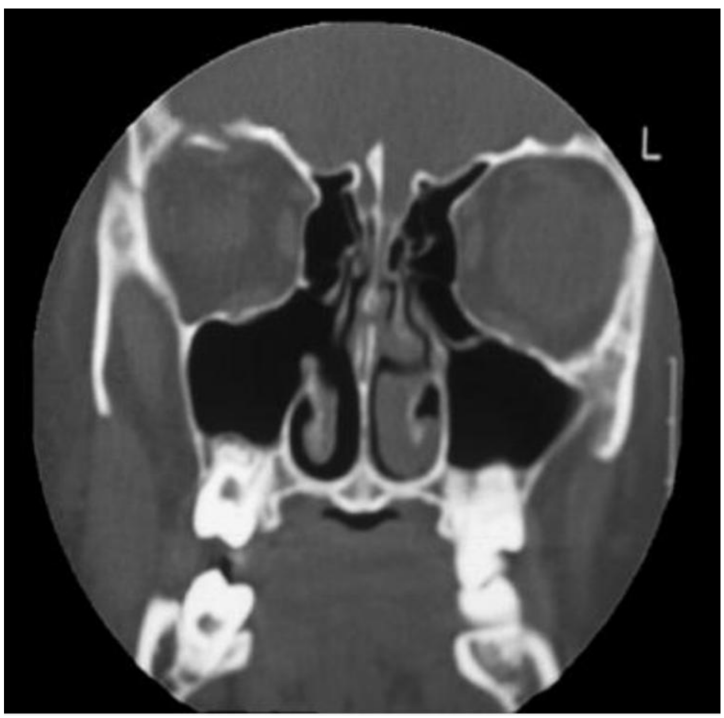
Figuer 2.5 coronal CT for direct orbital fractuer

(www.learningradiology.com)



Figuer 2.6 axial CT for orbital rim fractuer (zygomatic fractuer).

(www.aofoundation.org)



Figuer 2.7 cronal CT for orbital rim fractuer(frontal fractuer).

(www.medscape.com)

2.4 Previous studies:

Folia Morphol,2013 their study investigate the anthropometric variation in the normal Turkish population using three-dimensional computed tomography (3D-CT) images and to define the effect of age and gender on orbital anthropometry.

The widths and height of the orbits were as follows : mean right orbital width 45.3 ± 2.3 mm and mean height 38.2 ± 2.7 mm , mean left orbital width 45 ± 2.4 mm and mean height 38.2 ± 2.7 mm. when right and left orbital widths and hights were statistically analysed, it was found that right orbital width was statistically higher and significant than the left orbit($p < 0.0001$). there was no statistically significant difference between right and left orbital heights($p > 0.05$). the orbital index on the right side is 84.5 ± 6.2 and on the left side 85.2 ± 6.7 . when right and left orbital indexes were compared, right orbital index was found to be statistically lower and significant than the left side ($p = 0.005$). when right and left orbital indexes were comparatively evaluated between gender groups, no statistically significant difference was found ($p > 0.05$).

The average biorbital width was 97.8± 4.4 mm, and the introrbital width was 12.7 ± 2.1mm. when they evaluated the relation of age with right and left orbital width, length,orbital index and bi/interorbital width,they had found no statistically significant relation ($p> 0.05$).

Study done by Gopala krishna,2015 to evaluate the significant variation and correlation in the dimensions of pairs of orbital base.this study don in Indian population on dry skull. Orbital index was calculated from 128 pateints. Paired t test with p-values < 0.05 was considered significant. Bilaterally significant difference was found in vertical vertical diameter($p= 0.001$) and in orbital index ($p = 0.011$), but no significant difference was observed in horizental diameter ($p = 0.23$). the corelation between the vertical diameters ($r = 0.96$), horizental diameter ($r=0.95$) and orbital index(r = 0.776). the strength of relationship between the pair of orbits was up to 92.16% in vertical diameter 90.16% in horizental diameters and 60.22% in orbital index. The mean orbital index in present study was 80.69 ± 2.19 (right) and 81.16 ± 2.02 (left).

Table 2.1 compersion of research on different populations.

researcher	**population**	**Orbital index**	**Type**	**Vertical diameter**	**Horizental diameter**
Present study	Indian	80.69±2.19(R) 81.16±2.02(L)	Microseme	32.75±2.21 33.05±1.9	40.62±3.06 40.75±2.69
Ebeye O.A (2013)	Nigerian	78.57±0.6(R) 83.46±3.5(L)	Microseme	30.01±3.22 31.92±3.07	42.24±2.64 40.82±3.29
Fathy A (2014)	Egyption	84.13±3.76(R) 82.88±3.31(L)	Mesoseme	35.83±1.23 35.27±1.35	43.62±1.13 42.6±0.96

Study don dy Sayee Rajangam et al 2012, to measuer the diameter of the orbit. Right orbital hight 3.509+/-0.267 ,width 4.174+/-0,215 ,orbital index 73.55+/-12.89). left orbital hight3.37+/-0.257,width 4.082+/- 0.198, orbital index 75.273+/-11.132), where increase for male.the right side measuerment for height and width were increased for both gender and the right orbital index for the femal skulls. Significance was observed for orbital index between male and female skulls for the right and the left orbits anf the orbital index of the female skull between its right and left orbits.the application of the demarcation points have identified that the transvers diameters of the the left and right orbits identified 15 to 22 male skulls. Hence the transvers diameters of the orbit could be considered as a parameter in sex determination of the skulls. The observed differences in the orbital masuerment may be because of the sample size and the methodology and also the cardinal featuers pertaining to the skull.

Chapter three

Materials and methods

The methodology section of this thesis described the design of the study, the setting where it took place, the sampling design that was used, and the instruents that were involved in data collection, and also the procedures that were followed for data collection. The statistic that were used for data analysis and a description of the way in which data were analyzed are also discussed.

3.1Materials:

3.1.1Study sample:

Total samples of 50 patient in the study, their ages between (10-79) years old. both gender were include 25 were males and 25 were females.All patient with normal boney orbital.

3.1.2 Area and duration of the study:

The study had been carried out during the period from November 2015 up to January 2016 in ALmodares Medical Center in Khartoum.

3.1.3 Machines used:

CT scanner used GE high speed dual sensation with KVP 120.

3.2 Method of scanning:

CT scan was done from mandible to the frontal sinuses. The technical factors that were used in this study were 120 Kv , 100mAs ,5-10 mm slice thickness.

3.3 Methods of measuerment:

There were 4 measuers taken from orbital boney and measuer the transvers diameter of head (T).

- Orbital width : lateral curved distance between the dacryon (the point where frontal, lacrimal and maxillary bones intersect and the medial margin of the orbit is formed)and ectoconchion (the point of intersection of the anterior surface of the lateral limit of orbita, the lines divided the orbit along it axis into 2 parts).

- Orbital hight : distant between superior and inferior orbital margine, it is prependicular to it width and similarly divides the orbita into 2 parts.

- Orbital index = orbital hight / orbital width * 100

- Biorbital width : distance between left and right ectoconchion.

- Interorbital width : distance between right and left daryon.

- Transvers head diameter : distance between two parietal bones.

3.4 Data analyzes:

The mean and SD were presented after applying analyses using Excel programmed.

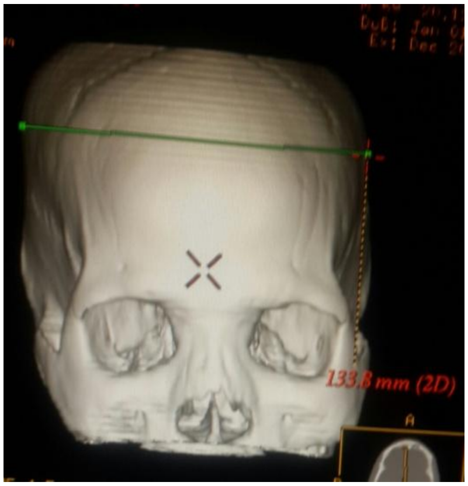


Figure 3.1 show the measurement of transverse head diameter

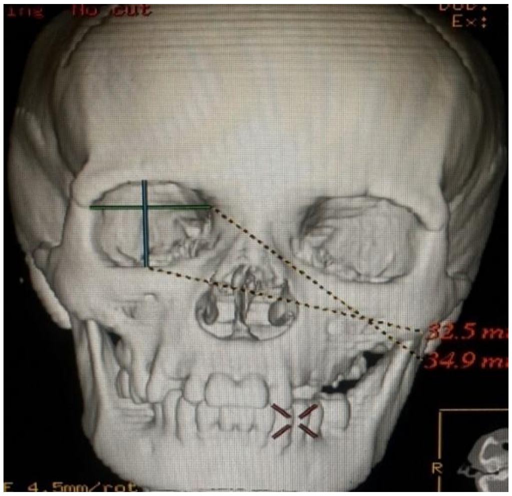


Figure 3.2 show the measurement of orbital height and orbital width

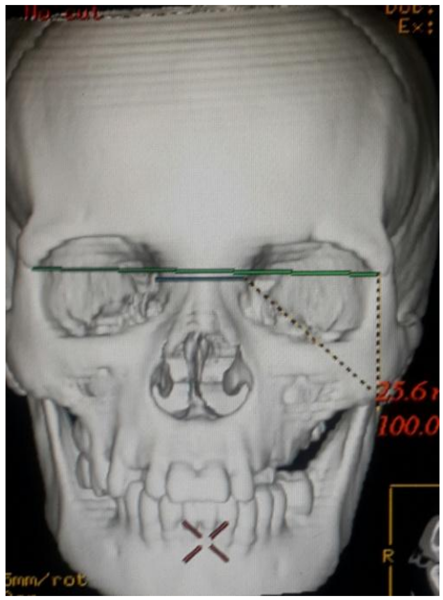


Figure 3.3 show the measurement of biorbital and intraorbital

Chapter Four

Results

Computerized Tomography scanning was performed in the Radiology Unit of the ALmodares Medical Center in Khartoum.

The data was collected from 50 normal CT scans for facial bones. Twenty five were males and twenty five were females. Age, orbital height, width and index were recorded. Measurement of the variables were made and classified according to age and gender

The mean and SD were presented after applying analyses using Excel programmers. Detailed results are shown in the tables and figures below.

Table 4.1 Gender Distribution

Gender	
Male	**Female**
25	25

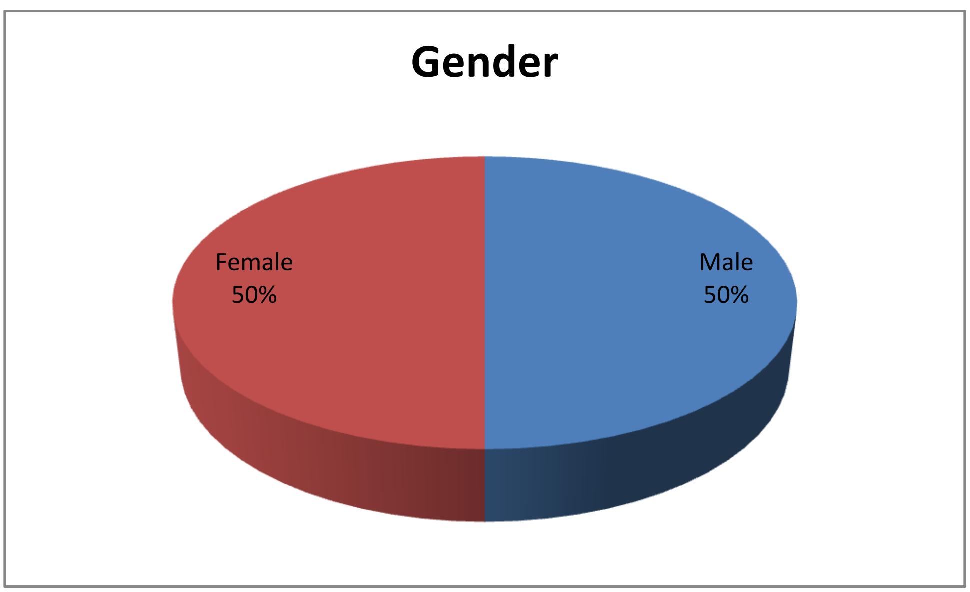


Figure 4.1 Gender Distribution

Table 4.2 Variables, mean (mm) and standard deviation

	Orbital width	Orbital height	Orbital index	Bi orbital width	Inter orbital width	Transverse head diameter
Mean	37.022	33.682	91.01	95.918	24.444	133.098
STDV	±1.681	±2.074	±4.258	±3.844	±3.275	±4.155

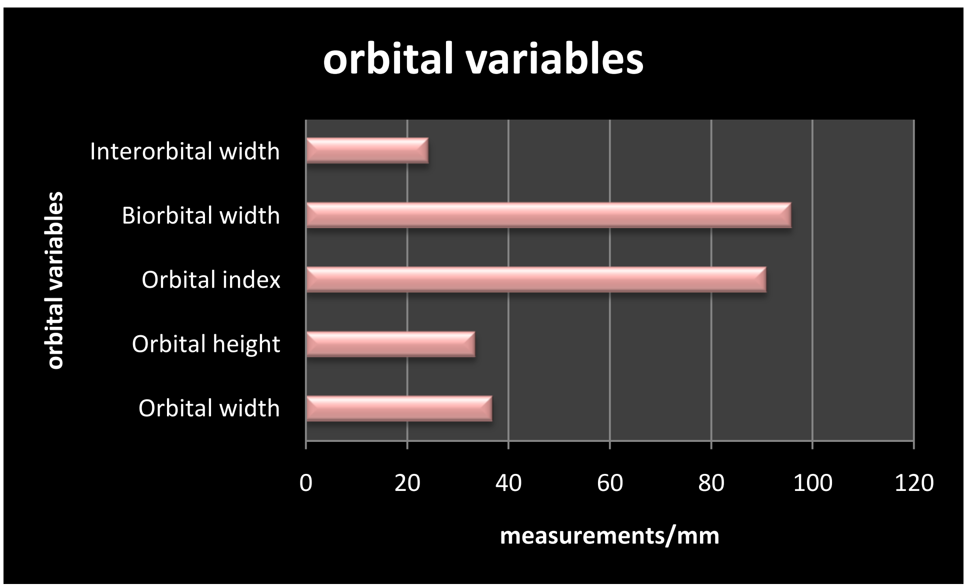


Figure 4.2 Variables measurements (mm)

Table 4.3 Classification of mean orbital Index according to age class

Age class	Mean orbital index
<10-19	89.5±4.173
20-29	91.483±3.728
30-39	91.085±6.076
40-49	90.47143±4.064
50-59	91.08571±3.044
60-69	91.36364±2.990
70-79	90.88±4.293
MEAN AGE/YEARS=47.1±16.957	

Table 4.4 Classification of mean orbital Index according to gender

Gender	Mean orbital index
Male	90.17692±4.259
Female	91.9125±4.162
Total Sample	91.01±4.258

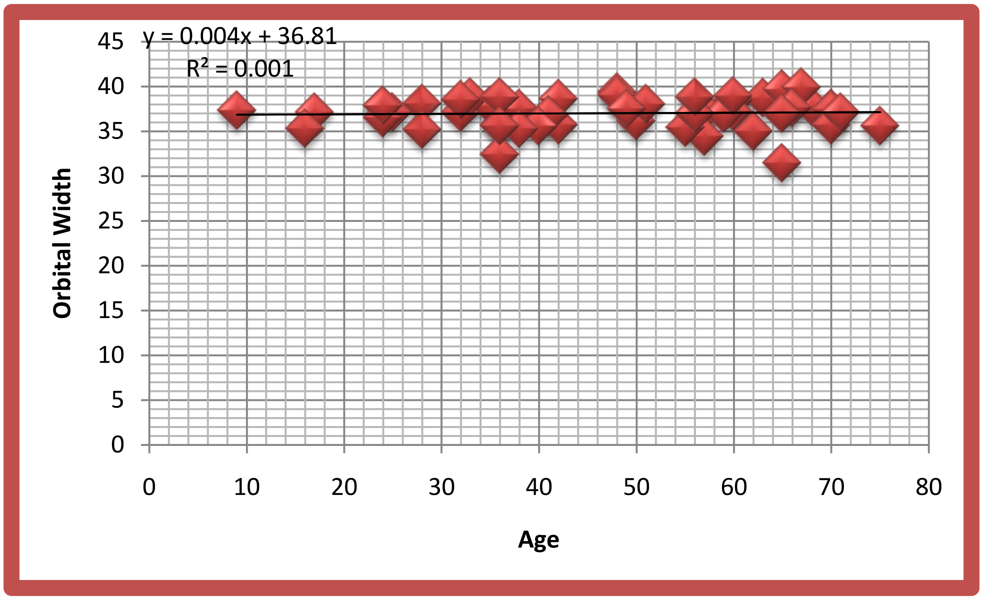


Figure 4.3 A scatter plot Diagramed shows a linear relationship between age and orbital width .As the age increases the width increased by 0.004 starting from 36.81mm

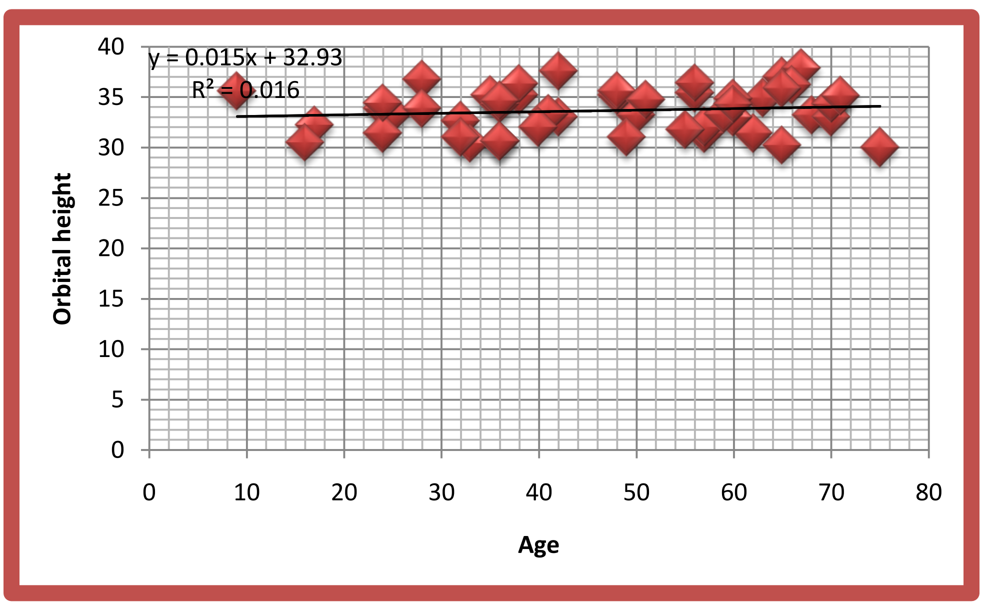


Figure 4.4 A scatter polt diagram show linear relationship between orbital height and age. As age increased the height increased by 0.015 from 32.93 mm.

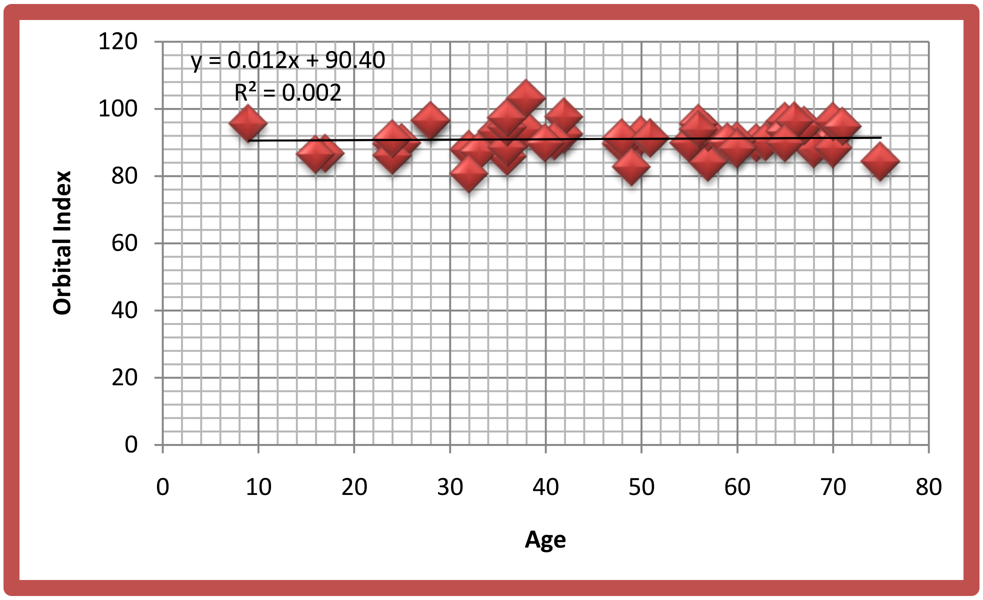


Figure 4.5 A scatter polt diagram show linear relationship between orbital index and age. As age increased the orbital index increased by 0.012 from 90.40mm.

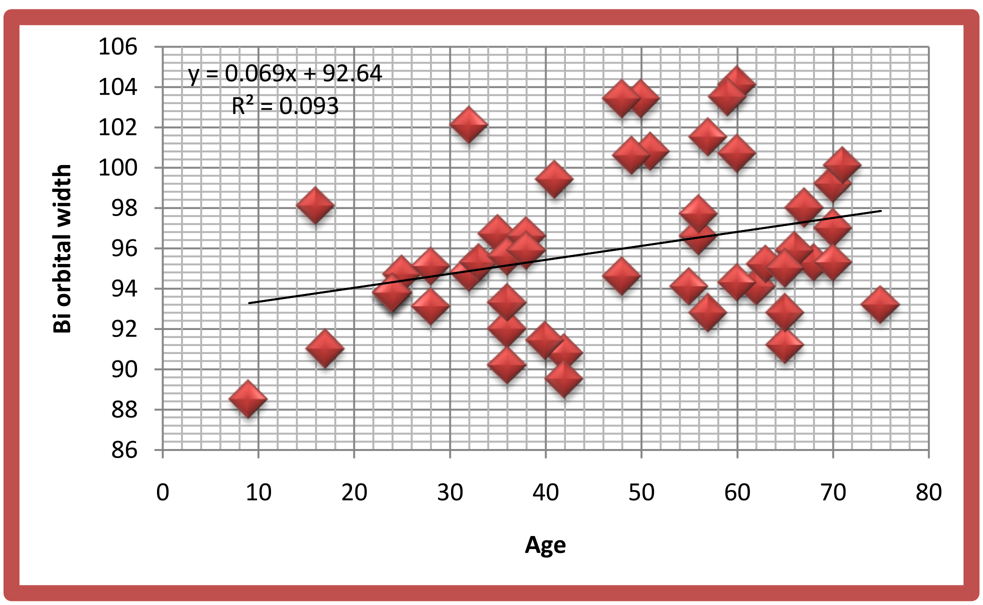


Figure 4.6 A scatter polt diagram show relation between biorbital width and age. As age increased the biorbital width increased by 0.068 from 92.64mm.

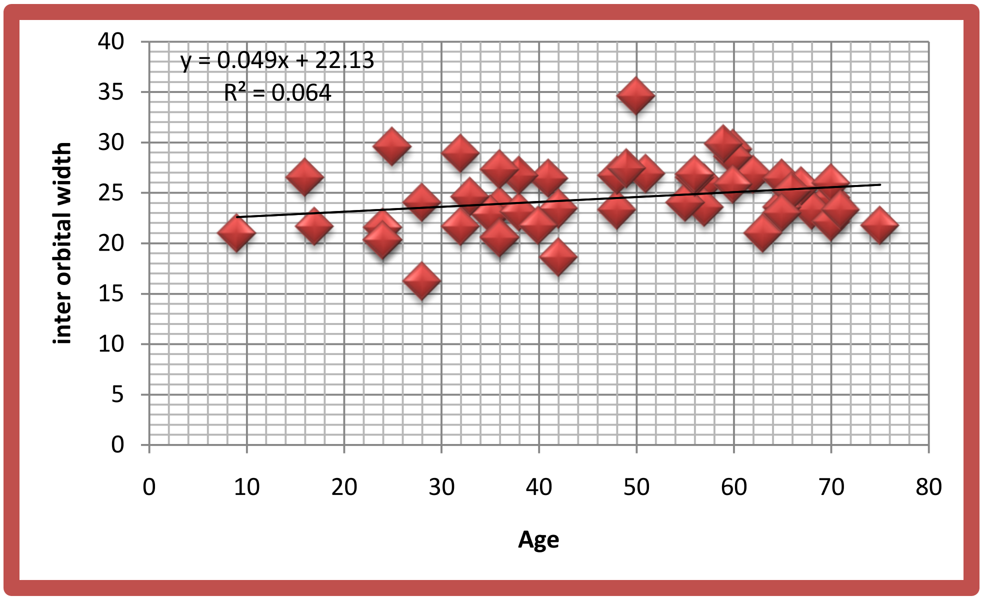


Figure 4.7 A scatter polt diagram show relationship between interorbital width and age. As age increased the interorbital increased by 0.049 from 22.13mm.

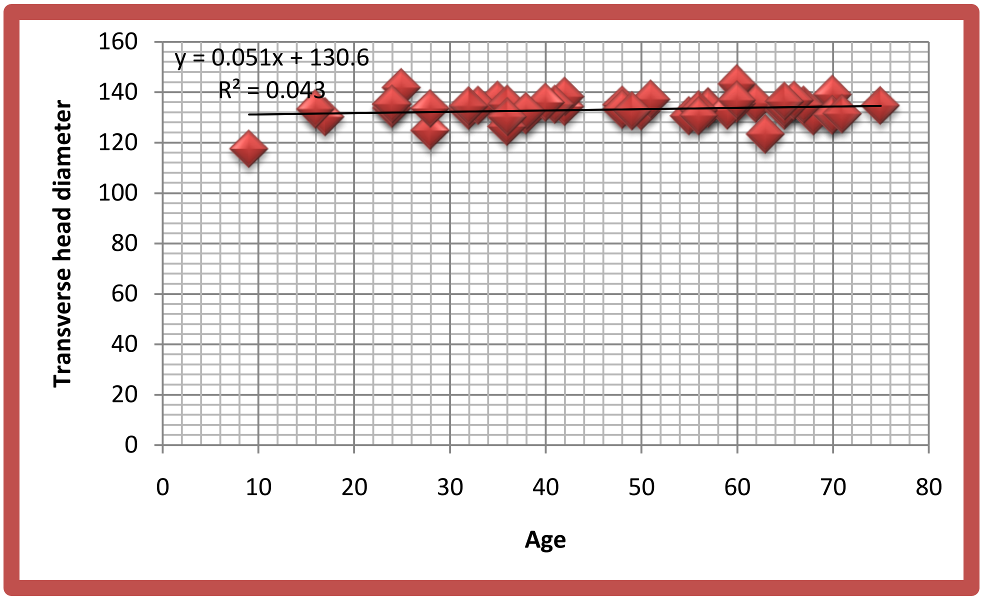


Figure 4.8 A scatter polt diagram show relation between transverse head diameter and age. As age increased the transverse head diameter increased by 0.051 from 130.6mm.

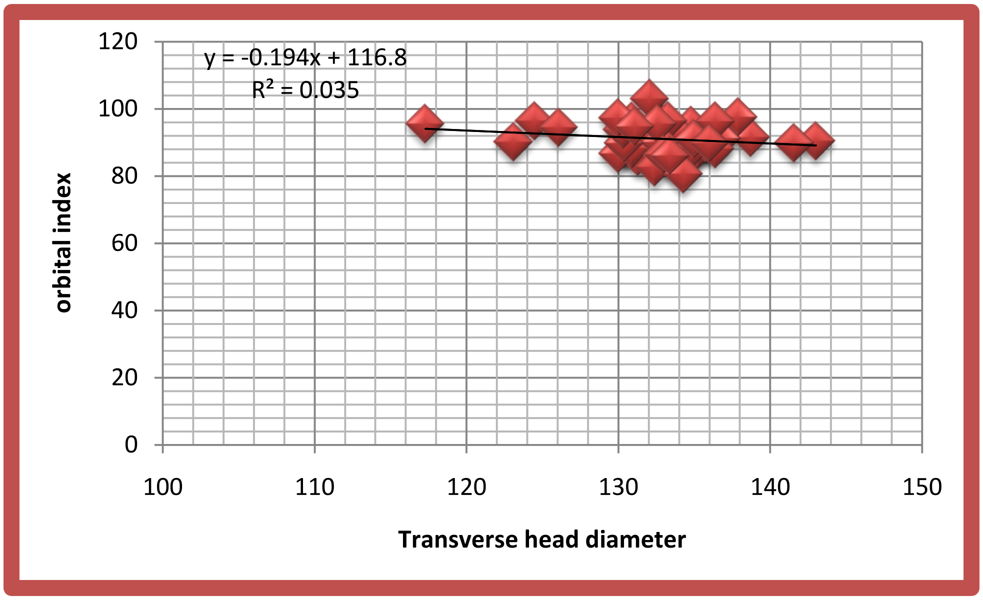


Figure 4.9 A scatter polt diagram relationship between orbital index and transverse head diameter. As transverse head diameter increased the orbital index decreased by 0.194 from 116.8 mm.

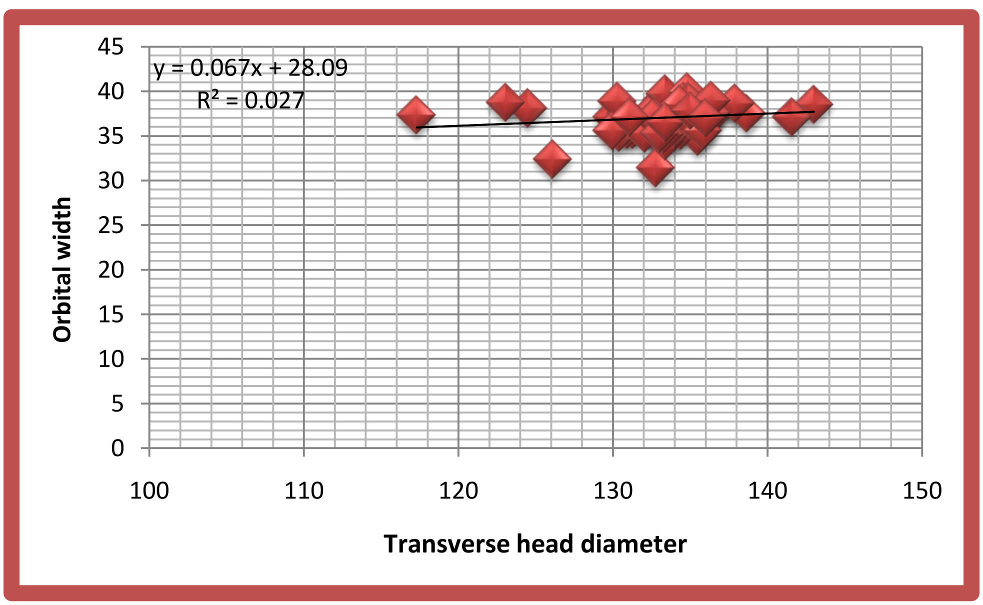


Figure 4.10 A scatter polt diagram show relation between orbital width and transverse head diameter .As transverse head diameter increased orbital width increased by 0.067 from 28.09 mm.

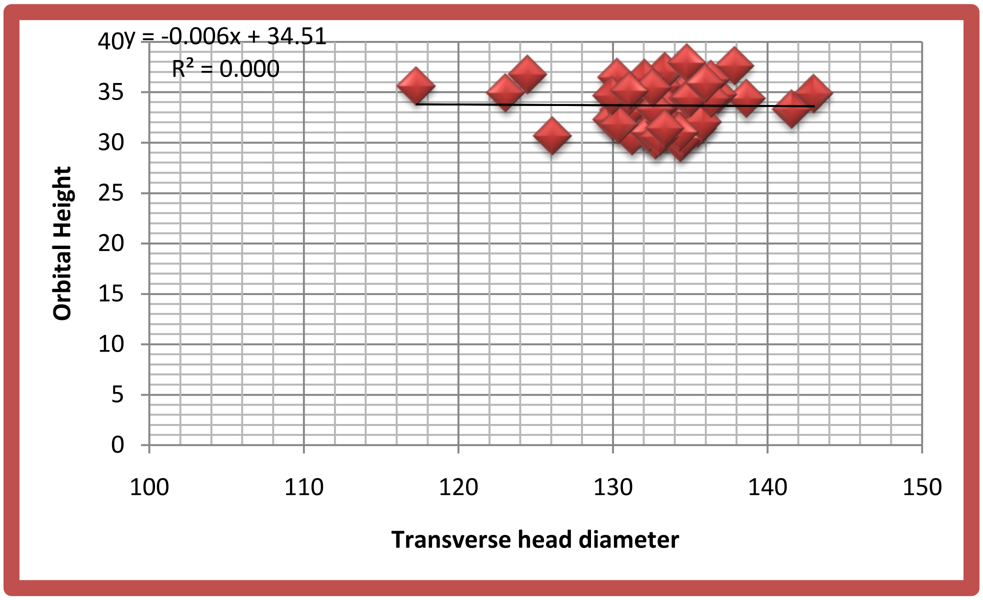


Figure 4.11 A scatter polt diagram show relationship between transverse head diameter and orbital height and. As transverse head diameter increased orbital height increased by 0.006 starting from 34.51mm.

Chapter five

Discussion, conclusion and recommendation

5.1Discussion:

This study is attempting to establish normal diameter of orbit in Sudanese patients and to study the effect of age and gender on this diameters.

This study was performed on 50 patients. The data collected for age (10-79) years old. The result showed orbital diameters were correlated age, gender and transverse diameter of skull (T).

The study showed the mean of orbital width (37.022) mm, orbital height (33.682) mm, orbital index (91.01) mm, biorbital width (95.918) mm, interorbital width (24.444) mm, transverse head diameter (133.098) mm.

The study showed the mean of orbital index (89.5±4.173) mm at age between (10-19) years old, (91.483±3.728) mm at age between (20-29) years, (91.085±6.076) mm at age between (30-39) years, (90.4713±4.064) mm at age between (40-49) years, (91.08571±3.044) mm at age between (50-59) years, (91.36364±2.990) mm at age between (60-69) years, (90.88±4.293) at age between (70-79) years.

The study showed the mean orbital index (90.12) mm for males and (91.9) mm for females.

This measurement compared with previous study done by Folia Morphol el 2013, in Turkish population by CT found the mean right orbital width 45.3±2.3 mm, mean height 38.2±2.7 mm, mean right orbital index 84.5±6.2 mm (mesoseme), mean biorbital width 97.8±4.4 mm and mean interorbital width 12.7±2.1 mm, which was higher than our study except in orbital index and in interorbital width which was higher in our study. Another study done by Gopala Krishna 2015 in Indian population done on dry skull found right orbital index 80.69±2.19 mm (microseme) which was lower than our study. Another study done by Ebeye O.A et al 2013 in Nigerian population found right orbital 78.57±0.6 mm (mesoseme) which was lower than our study. Another study done by Fathy A et al 2014 in Egyptian population found right orbital index 84.13±3.76 mm (mesoseme) which was lower than our study.

There were linear relationships between orbital height, orbital width, orbital index, biorbital width, interorbital width and transverse diameter of head with age show in figures (4.1 – 4.6).

There were linear relationships between orbital height, orbital width and orbital index with transverse diameter of head show in figures (4.7 – 4.11).

There were inverses relationship between orbital index and transverse head diameter show in figure (4.9).

The limitation of our study was orbital height, orbital width and orbital index was taken from one orbit (right orbit).

5.2 Conclusion:

The study calculate the diameter of orbit in Sudanese patients by CT facial bone the mean of orbital width 37.022 mm, orbital height 33.682 mm, biorbital width 95.918 mm, introrbital width 24.444 mm, transverse head diameter 133.098, orbital index in male 90.12 mm, in female 91.9 mm.

Linear relationship between ages, orbital height, orbital width, biorbital width, introrbital width. Inverses relationship between transverse head diameter and orbital index.

The diameter of orbit can increased due to age, but after 70 years old the diameter start to decrease due to bone shrinking.

Orbital index higher in females than males. The orbital index higher in Sudanese than other previous studies.

5.3 Recommendations:

Further study in evaluation of orbital diameter with larger sample of Sudanese population for more accurate results is needed.

References:

- Connie M and Lorrie L (2007), cranium and facial bone , Sectional Anatomy for Imaging Professionals, 2th ed , Mosby, Inc, an affiliate of Elsevier Inc , pp72-82.
- Ebeye O.A, Otikpo O,(2013) Orbital index in Nigeria. IOSR Journal of Dental and Medical Sciences 8:51-53.
- Fathy A, Mandour D, (2014) Morphometric analysis of the orbit in adult Egyptian skull and its surgical relevance.6:293-295
- Husmann PR,Sammson DR (2011) in the eye beholder, sex and race estimation using human orbital aperture, J forensic Sci 56: 1421-1429.
- Kenneth L.Bontrager , skull and cranial bones, facial bones, Textbook of Radiographic Positioning and Related Anatomy , 5th ed , Mosby, Inc, pp 354-355 ,380-381.
- Pantanaik VVG ,Sanju B ,Rajan RK (2001) Anatomy of bony orbits-some applied aspect. J Anatom Society India 50:59-67.
- Ukoha U, Egwu OA ,Okafor IJ, Ogugua PC,Onwudinijo O, Udemezue O (2011) Orbital dimensions of adult male Nigerians, Int J boil Med Res, 2:688-690
- Standring S, Grays Anatomy, The anatomical Basis of Clinical Practise ,40 th ed .Spain ,Churchill Livingstone – Elsevier 2008 419-421.
- Weaver AA, Loftis Loftis KL, Tan JC, Duma SM, Stitzel JD (2010) CT- based 3D measurement of orbit/eye anthropometry. Investigative Ophthalmol Visual Science
- Weiss RA, Haik BG, Saint-Louis LA, Ellsworth RM (1978) Advance diagnostic imaging techniques in ophthalmology. Ad Ophthalmic Plastic Reconstruct Surg , 6:207-263.

Appendix

NO	AGE	GENDER	ORBITAL WIDTH	ORBITAL HEIGHT	ORBITAL INDEX	BIORBITAL WIDTH	INTRORBITAL WIDTH	TRANSVERSE DIAMETER OF HEAD