

Chapter ONE

:Introduction 1.1

Sella turcica is an important structure in radiographic analysis of the neurocranial and craniofacial complex. Several landmarks within the cranium have been determined to act as reference points when tracing cephalometric radiographs. These landmarks are used to measure positions of structures (such as the maxilla or mandible) in relation to the cranium (Alkofide EA. 2007).

Sella turcica is a saddle-shaped structure located in the middle fossa on the intracranial surface of the body of sphenoid bone. The centre of sella turcica is routinely used as a cephalometric landmark to act as a reference point for evaluating spatial position of both jaws as they relate to the cranial base. A deviation from normal size and shape of sella turcica can be an indication of a pathological condition of the gland.⁵ A larger size may be indication of pituitary tumor over producing hormones such as ACTH, Prolactin and Growth hormones, a small size can lead to decreased pituitary function causing symptoms such as short stature, retarded skeletal maturation and growth.

The aim of the study to measure the size and shape of sella turcica in adult Sudanese population, The study was conducted at Almodares Hospital in Khartoum, The data collected of 50 patients (25 male, 25 female), adult (18-60) with normal sella turcica, The data of this study collected only from the midsagittal plane.

The study has come out with certain results including: No significant difference in shape of the sella turcica could be found between males and females. There was a significant difference in the size of sella turcica in older and younger age groups in all three-dimensions, and size was larger in older subjects. There was significant difference in depth of sella turcica between males and females. Shape of sella turcica was normal in 64.7% of the subjects.

1.2 problem of the study:

There is no previous measurement of normal sella turcica size and shape among the Sudanese population to the best of the researcher's knowledge

1.3 Importance of the study:

This study is going to give information about the normal size and shape of sella turcica among adult Sudanese.

This information could assist the doctors to distinguish normal from abnormal sella turcica.

1.4 Study Objectives:

1.4.1 General objective

To measure the size and shape of sella turcica in adult Sudanese population.

1.4.2 Specific objectives:

To measure the normal size and shape of sella turcica in adult Sudanese population.

To investigate the effect of age and gender on sella turcica size.

To compare between the sella turcica size in males and females.

1.4 Study out lines:

The study will be contained in five chapters as fallow:

Chapter one: Introduction, Importance of the study, study objective

Chapter two: literature review.

Chapter three: materials and methodology.

Chapter four: results

Chapter five: discussion, conclusions and recommendations as well as references and appendices.

Chapter Two

Literature review

:Theoretical Background 2.1

:2.1.1Anatomy of sella turcica

It is a saddle-like bony formation on the upper surface of the body of sphenoid bone. The anterior border of the sella turcica is represented by the tuberculum sellae and the posterior border by the dorsum sellae. The pituitary gland is surrounded by the sella turcica, whereas two anterior and posterior clinoid processes project over the pituitary fossa. The anterior clinoid processes are formed by the medial and anterior projections of the lesser wing of the sphenoid bone and posterior clinoid process by the endings of dorsum sellae. Any abnormality or pathology in the gland could manifest from an altered shape of sella turcica, to a disturbance in the regulation of secretion of glandular hormones, prolactin, growth hormones, thyroid stimulating hormone, follicular stimulating hormone, and so on.) Alkofide EA.2007)The anatomy of sella turcica has been described as variable. Sella turcica was divided in to three segments, consisting of an anterior wall, a floor, and a posterior wall. Morphologically, there are three basic types, Oval, round, and flat of which the first two types are more common.

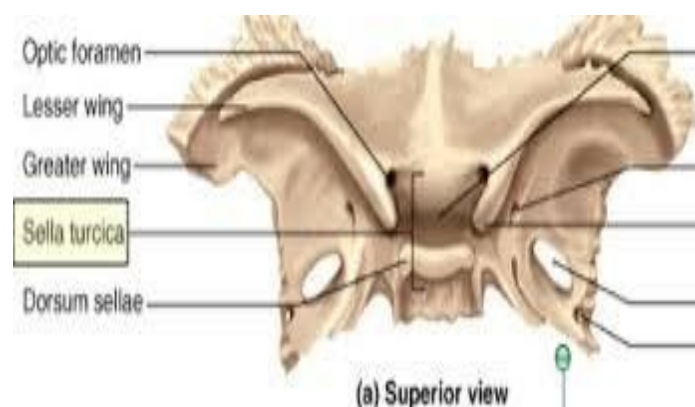


FIG (2.1): Superior view of sella turcica

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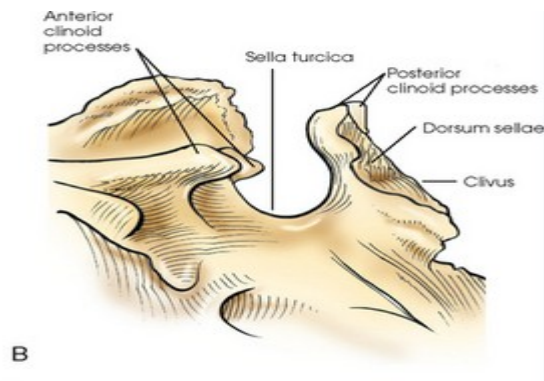


FIG (2.2): lateral view of sella turcica

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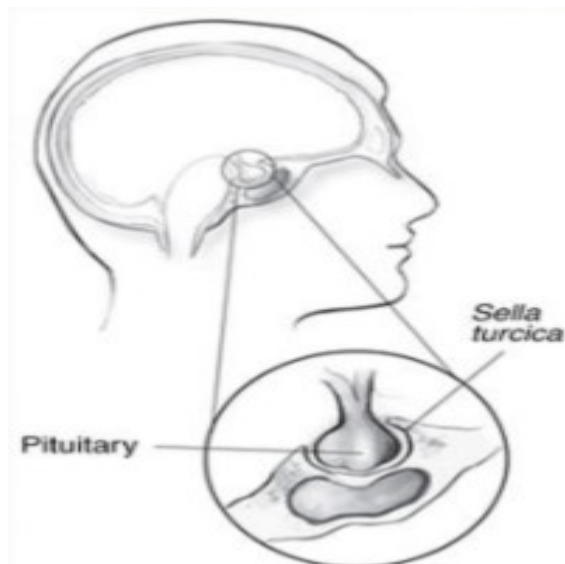


FIG (2.3)Sella turcica and pituitary gland

Mancall,elliott L, Brock, David G(2011)

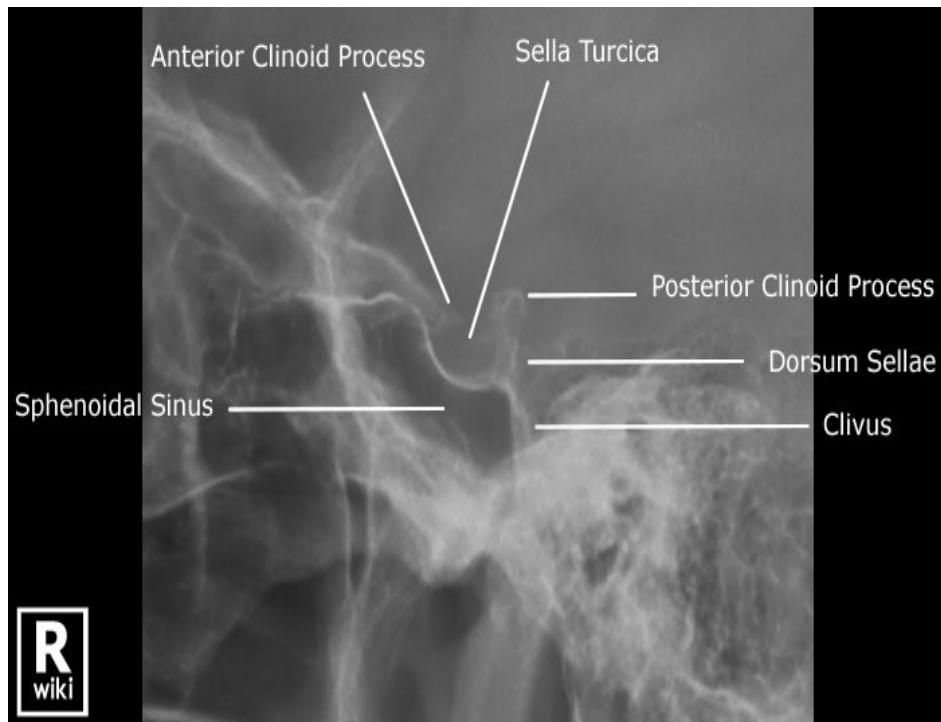


FIG (2.4).Lateral x-Ray view of sella turcica

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2.1.2 physiology of Sella Turcica:

The sella turcica is forms a bony seat and protected of the pituitary gland. (Melmed S, Kleinberg D, Ho ken2011).

2.1.3 Embryology:

The prenatal and postnatal formation of pituitary gland and sella turcica are complex processes. These two important structures are located in the boundary region, separating tissues of different origin and development. Origin of the pituitary gland is a result of interaction between oral ectoderm which gives rise to anterior pituitary and neural ectoderm gives rise to posterior pituitary. The pituitary fossa differentiates directly from the hypophyseal cartilage which in turn is derived from the cranial neural crest cells of the early chondrocranium(Miletich I, Sharpe PT. 2004).

During embryological development, sella turcica area is the key point for the migration of the neural crest cells to the fronto nasal and maxillary developmental fields. Formation and development of the anterior part of the pituitary gland, sella turcica, and teeth share in common, the involvement of neural crest cells, and dental epithelial progenitor cells differentiate through sequential and reciprocal interaction with neural crest-derived mesenchyme. (Kjaer I, Fischer-Hansen B. 2005)Posterior part of the pituitary gland develops

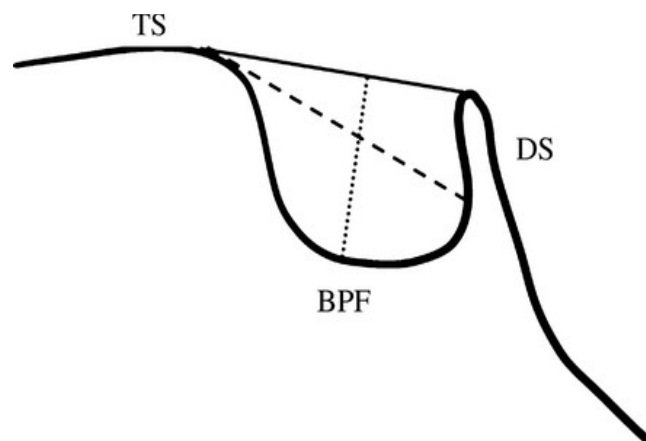
from the paraxial mesoderm which is closely related to notochordal induction(Kjaer I, Fischer-Hansen B.1995)

2.1.4The Postnatal Development of Sella Turcica:

The changes that take place in the size and shape of sella turcica during growth have been well-documented in the literature. Deposition of bone on the anterior part of the interior surface of the sella turcica ceased at an early age, where as resorption on the distal part of the sella floor and on the posterior wall continued for a longer period of time. Deposition of bone was seen on the tuberculum sellae and resorption at the posterior boundary of sella turcica up to 16-18 years of age. The sella point is displaced backward and downward during growth and development (Bjork A, Skieller V.1983).

2.1.5 Size of Sella Turcica:

The linear dimensions of sella turcica were measured according to the methods given by silverman and kisling ([Silverman \(1957\)](#)). All reference lines used in the current study were located in the midsagittal plane. The length of sella turcica was measured as the distance from the tuberculum sella to the tip of the dorsum sellae. The depth of the sella turcica was measured as a perpendicular from the line above to the deepest point on the floor. A line was also drawn from the tuberculum sella to the furthest point on the posterior inner wall of the fossa. This was considered as the antero-posterior diameter of sella turcica.



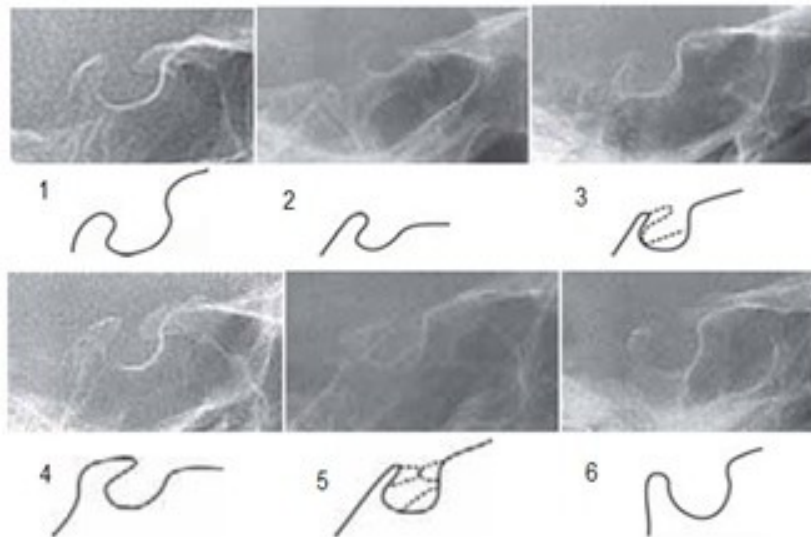
FIG(2.5) Normal sella turcica morphology and reference lines used for measuring sella size: TS, tuberculum sella; DS, dorsum sella; BPF, base of the pituitary fossa; black line, length of sella; dashed line, diameter of sella; dotted line, depth of sella.

<https://d10jvhkkgg1xqh.cloudfront.net/content/eortho/29/5/449/F1.large.jpg>

2.1.6 Shape of Sella Turcica:

Morphological appearance of sella turcica is established in early embryonic structure. The shape of sella turcica was classified into circular, oval, and flattened or saucer-shaped and majority of the subjects had either a circular or oval shaped sella. Other classifications were based on the contours of the sella floor, the angles formed by the contours of anterior and posterior clinoid processes and tuberculum sella and the fusion of both clinoid processes as sella turcica bridge (Choi WJ, Hwang EH, Lee SE. 2001) categorized the shape of sella turcica into six main types:

1. Normal sella turcica
2. Oblique anterior wall
3. Double contoured sella
4. Irregularity (notching) in the posterior part of the sella
5. Pyramidal shape of the dorsum sellae
6. Bridge sella turcica



FIG(2.6) Different morphological type of the sella turcica (Alkofide EA2007)

2.1.7 Pathology of sella turcica:

There are many disorders of sella turcica but we handle only two of them:

2.1.7.1 Rathke Cleft Cyst:

One of the most extraordinary advances pioneered at the Skull Base Institute is the minimally invasive, fully endoscopic approach to the skull base. Sellar and suprasellar lesions such as Rathke's cyst and other skull base disorders are routinely removed through this approach.

Rathke's cyst, or Rathke cleft cyst (RCC), is a benign epithelium-lined cyst, that arises primarily within the sella turcica and is thought to originate from remnants

of the Rathke's pouch (Rathke's pouch is the primordium of the anterior and intermediate lobes of the pituitary gland).

The cyst is lined with a single layer of epithelium and has a thin and transparent capsule. The fluid within the cyst is usually yellowish in color but can also be clear, grayish or bluish, it may be thick or gelatinous, but it also can be watery, serous, or similar to motor oil in consistency (Osborn AG. Osborn's 2013).

2.1.7.1.1 Causes Rathke's cyst:

Is congenital in origin, although its pathogenesis is by no means clear; it is generally believed that the cells of origin are the remnants of Rathke's pouch. The adenohypophysis (the anterior glandular part of the pituitary gland) is also driven embryologically from the anterior wall of Rathke's pouch and so RCCs have a similar lineage to that of a pituitary adenoma (Osborn AG. Osborn's 2013).

2.1.7.1.2 Symptoms RCCs:

1. Enlarge
- 2 .headache
3. Impairment
4. Endocrine disorders.

2.1.7.1.3 Treatment:

Surgery is the best form of treatment. Radical or total resection of the cyst is seldom indicated because doing so can damage the pituitary gland. Rather, the surgeon will remove a small portion of the membrane surrounding the cyst and then drain its content.

After the entire cyst has been removed, the surgeon will clean the cavity and seal it.

Type of surgery for RCCs:

Microsurgery and endoscopic surgery

Microsurgery uses a powerful operating microscope to help surgeon distinguish between tiny structures in and around the pituitary gland.

Endoscopic surgery uses small tube and a tiny camera to help surgeon remove tumor in small pieces

2.1.7.1.4 Diagnosis of RCCs:

1. MRI
2. Hormone testing

3.CT

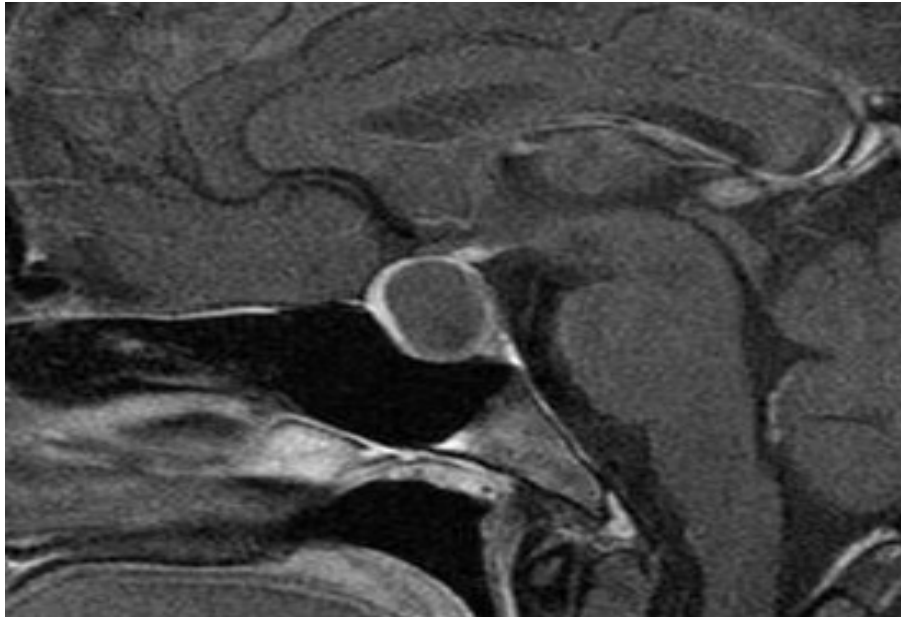


Fig (2.7) MRI Rathke Cleft Cyst
(Atlas SW **2008**)

2.1.7.2 Empty sella syndrome:

Empty sella syndrome is a rare disorder characterized by enlargement or malformation of a structure in the head known as the sella turcica.

The empty sella syndrome, the malformed sella turcica is often either partially or completely filled with cerebrospinal fluid. As a result, the pituitary gland is often compressed and flattened so that the sella turcica appears empty (Osborn AG. Osborn's2013).

2.1.7.2.1 Signs & symptoms:

The most common symptom potentially associated with empty sella syndrome is:

1. chronic headaches.
2. high blood pressure (hypertension).
3. leakage of cerebrospinal fluid from the nose (cerebrospinal rhinorrhea),
4. swelling of the optic disc due to increased cranial pressure
5. abnormalities affecting vision such as loss of clarity of vision.

2.1.7.2.2 Treatment:

For primary empty sella syndrome:

There is no treatment if pituitary function is normal

Medication such as bromocriptine, which lowers prolactin levels, may be prescribed if prolactin levels are high and interfering with the function of the ovaries or testes (Melmed et al., Kleinberg et al., 2011).

For secondary empty sella syndrome:

Treatment involves replacing the hormones that are lacking.

2.1.7.2.3 Diagnoses:

1. MRI
2. CT

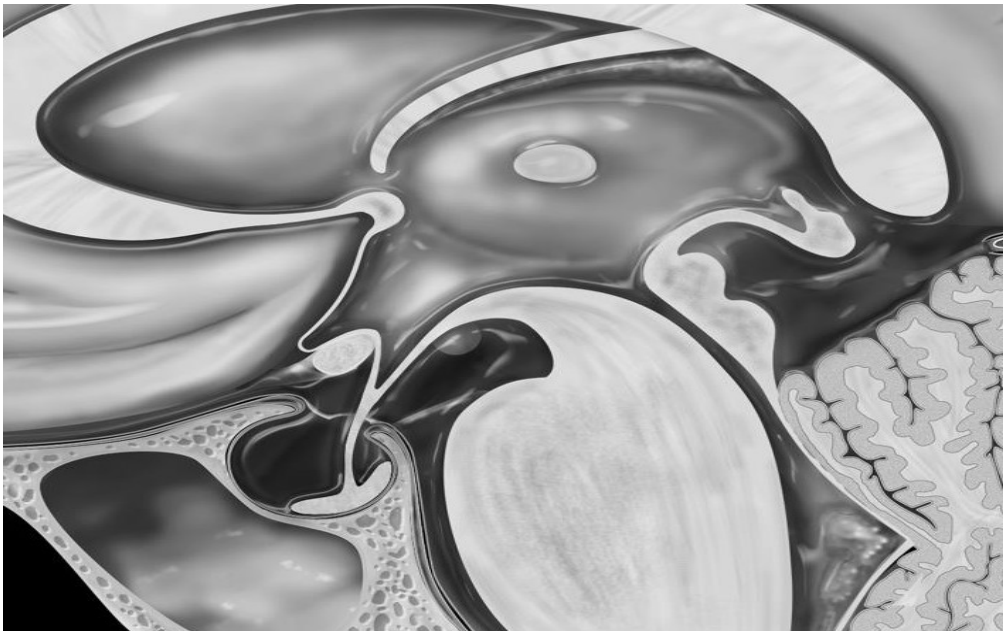


FIG (2.8) Empty sella syndrome

2.2 previous studies:

Ahsan Mahmood Shah (2011) The shape and size of the sella turcica in-skeletal class I, class II, class III in patients presenting at Islamic international dental hospital, Islamabad

The average length, depth and diameter of the sella turcica is shown for both male and female. The mean length of sella turcica in males and females varied by only 0.01mm being 11.3 mm in females and 11.4 mm in females. Similarly comparison of the mean diameter between both genders the mean value varied by only 0.02 mm being 12.0 mm in females and 12.8 mm in males. On comparison of mean depth between the male and female the values were equal i.e. in both genders the mean was 9.9 mm. The morphology of sella turcica appeared normal shape in the majority of patients presenting at Islamic International Dental Hospital (66 per cent).

Sathyanarayana HP, Kailasam V, ChitharanjanAB .2013 The size and-morphology of sella turcica in different skeletal patterns among south Indian population

The average length, depth and diameter of the sella turcica is shown for both male and female. The mean length of sella turcica in males and females varied by only 0.5mm being 8.9mm in females and 9.4mm in females. Similarly comparison of the mean diameter between both genders the mean value varied by only 0.3 mm being 10.9mm in females and 11.2mm in males. Similarly .comparison of the mean depth between both genders there is not differences

- Osunwoke EA, Mokwe CR, Amah- Tariah FS. 2014 Radiologic measurements of the sella turcica in an adult Nigerian population

The results obtained showed the Mean \pm SD of the length and depth of the sella turcica as $13.59 \pm 1.59\text{mm}$ and $8.94 \pm 1.99\text{mm}$ respectively. For males, the Mean \pm SD of the sella turcica length was found to be $13.61 \pm 1.64\text{mm}$ and depth was found to be $8.97 \pm 2.11\text{mm}$, for that of females, the Mean \pm SD of the sella turcica length was found to be $12.85 \pm 1.50\text{mm}$ and depth was found to be $9.87 \pm 1.75\text{mm}$ respectively. These results showed big differences between the above mentioned and this study

Chapter Three

Materials and methodology

3.1. Materials:

3.1.1.study sample

A sample of 50 patients (25 male, 25female),adult (18-60) with normal sella turcica were selected for the study.

3.1.2Machines used:

High speed dual CT scan, GE 120Kv, 100MAS was used.

3.1.3 Area of the study:

This research was done in ALmodares Hospital in Khartoum.

3.1.4 duration of the study:

The study was carried out during the period from April 2016 up to June 2016.

3.1.5 patient position:

PT supine in the table, head first, breath hold normal.

3.1.6Protocol of sella turcica:

Scouts: AP and lateral

Scan type: Axial

Scan plane: Transverse

Start location: Just below sella floor

End location: Through dorsum sellae

IV contrast: none

Reference angle: Angle gantry parallel to infraorbital meatal line

Slice thickness: 2-3 mm

3.2 Methodology:

3.2.1. method of data collection:

Text books, data sheet, previous studies and internet

3.2.2.method of data analysis:

In this research SPSS and EXCEL programs was used to find the relationship between sella turcica size in males and females.

3.2.3 Method of scanning:

CT scan was done from mandible to the apex of the skull. The technical factors that were used in this study were 120Kv, 100mAs, 2-10mm slice thickness.

3.2.4 Methods of measurement:

Data were collected only from the midsagittal plane, and three distances were measured:

The length of sella turcica was measured as the distance from the tuberculum .1
sella to the tip of the dorsum sellae

The depth of the sella turcica was measured perpendicularly from the line .2
.above to the deepest point on the floor

a line from the tuberculum sella to the furthest point on the posterior inner wall.3
of the fossa was drawn. This was considered as the antero-posterior diameter of
sella turcica

Normal sella turcica morphology and reference lines used for measuring sella -
:size

.(tuberculum sella (TS), dorsum sella (DS), base of the pituitary fossa(BPF

Sella turcica is a saddle-shaped structure located in the middle fossa on the intracranial surface of the body of sphenoid bone.

Chapter Four

Results

4. Results

Intracranial surface of the body of sphenoid bone. Computerized Tomography scanning was performed in the Radiology Unit of the ALmodares Hospital in Khartoum.

The data was collected from 50 normal CT scans for the sella turcica. Twenty five were males and twenty five were females. Length, depth, diameter and shape 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 and SPSS 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) Liner Measurements of Sella Turcica Size in Both Genders

Std. Deviation	Mean	N	gender	
2.13	11.5	25	Female	Length
2.17	12.6	25	Male	
11.7	10.7	26	Female	Depth
1.11	7.62	25	Male	
2.05	12.2	25	Female	Diameter
2.28	12.6	25	Male	

Table (4.3): Linear dimensions of sella turcica (in mm) according to age group

	age	N	Mean	Std deviation
Length (DS)	18-30	13	11.2	1.2
	31-45	15	11.3	1.5
	46-60	22	12.5	1.7

Depth(BPF)	18-30	13	7.6	1.1
	31-45	15	8	1.2
	46-60	22	10.7	12.5
Diameter(TS)	18-30	13	12.1	1.4
	31-45	15	12.5	2.2
	46-60	22	12.6	2.4

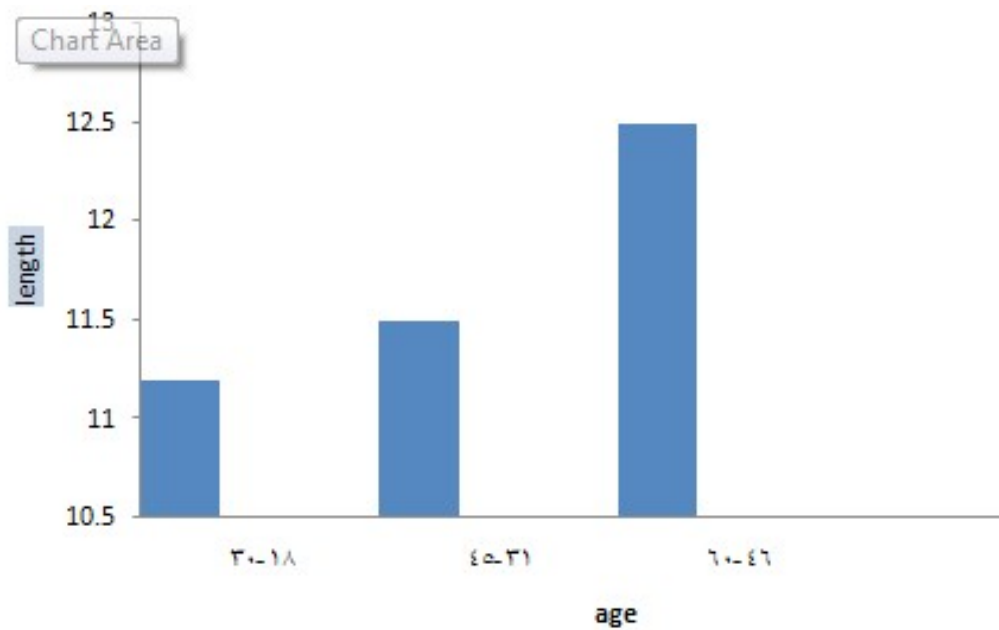


FIG (4.2) chart diagram show different in length between younger and older age, measurements (mm)

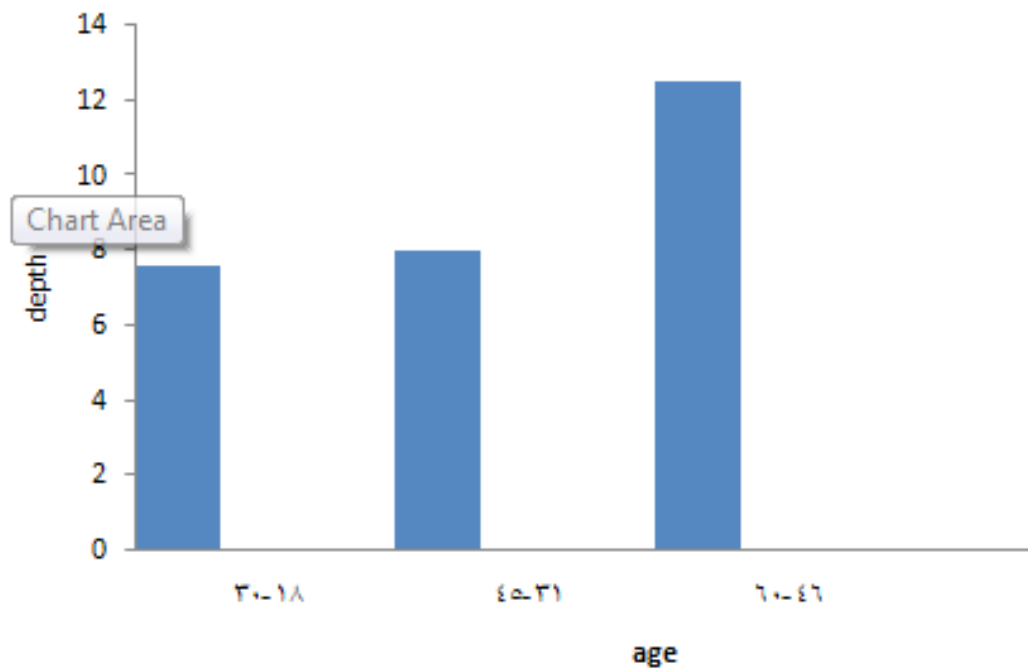


FIG (4.3) chart diagram show different in depth between younger and older age, measurements (mm)

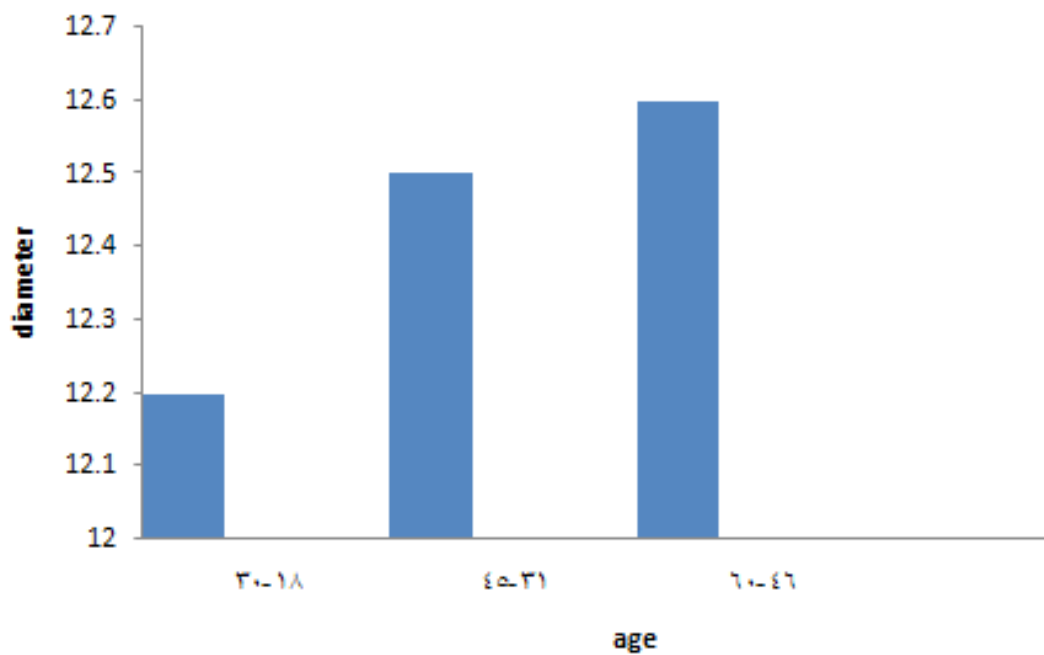


FIG (4.4) chart diagram show different in diameter between younger and older age, measurements (mm)

Table (4.4): Frequency of Morphological shape in patients:

Shape	Frequency	Percentage
1. normal sella turcica	32	64.7
2. oblique anterior wall	5	9.8
3. double contoured sella	2	3.9
4. irregularity (notching) in the posterior part of the sella	3	5.9
5. pyramidal shape of the dorsum sellae	1	2.0
6. sella turcica bridge	7	13.7
Total	50	100

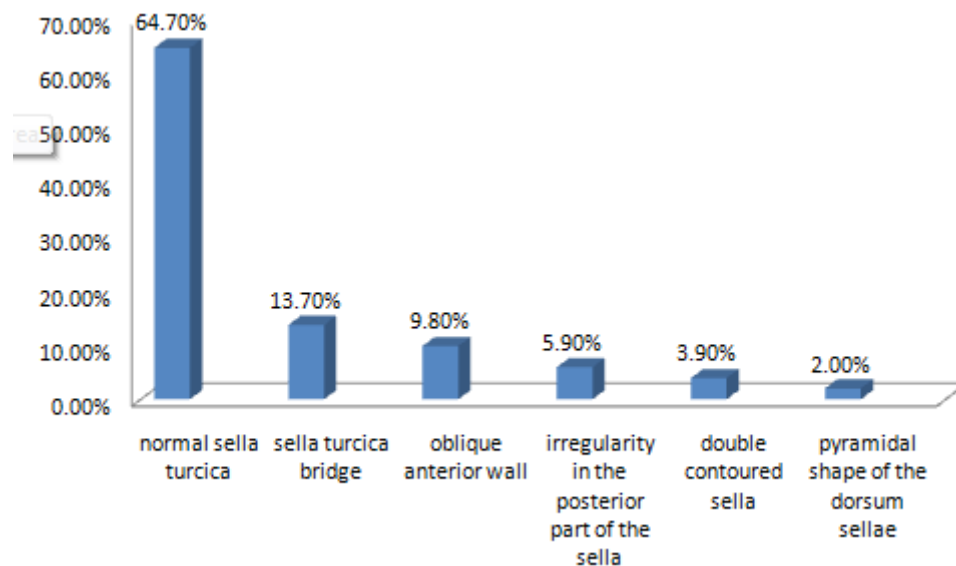


FIG (4.5) Chart diagram show percentage of the shape in patients.

Chapter Five

5.1 Discussion:

This study attempting to establish normal shape and size in adult Sudanese patient and to study the effect of age and gender on these variables and compared between male and female in size of sella turcica.

This study was done in ALmodares Hospital in Khartoum. The study was carried out during the period from April 2016 up to June 2016.

This study sample included 50 patients (25males and 25females), with ages ranged between (18-60) years (see table (1)).

5.1.1 Size of Sella Turcica:

The linear measurement of sella turcica in the midsagittal plane in both genders was presented in Table (2).

The average length, depth and diameter of the sella turcica were shown for both male and female. The mean length of sella turcica in males and females varied by only 1.1mm; being 11.5 mm in females and 12.6 mm in males. Comparison between the mean diameter in both genders showed that the mean value varied by only 0.04 mm; being 12.2 mm in females and 12.6 mm in males. On comparison of mean depth between the male and female, the value varied by only 3.1mm; being 10.7mm in females and 7.62 in males (see Table 2).

There was significant difference in depth of sella turcica between male and female there is large in female.

The size of sella turcica was larger in older age group than younger age group (see FIG (5)).

The linear diminutions and the average length, depth and diameter for males and females were shown on Table (3). When the average were compared between

older and younger age group the mean length of sella turcica in younger group was 11.2 but in older age was 12.5 (see FIG(2)), the depth in younger age was 7.6 and in older age was 10.7 (see FIG(3)), the diameter in younger age was 12.1 and in older age group was 12.6 (see FIG(4)).

5.1.2 Shape of the Sella Turcica:

The morphology of sella turcica appeared normal in the majority of patient referred to Almodares Hospital in Khartoum (64.7%) (see Table (3)). The morphological variation was found to be 35.3% of the subjects: an irregular dorsum sella was found in 5.9 %. A pyramidal shape was present in 2.0%, double contour sella was found in 3.9%, an oblique anterior wall was found in 9.8% while sella turcica bridge was found in 13.7% of the patients (see FIG(5)).

The previous studies on the same subject were shown as follows:

-Ahsan Mahmood Shah (2011) the shape and size of the sella turcica in skeletal class I, class II, class III in patients presenting at Islamic international dental hospital, Islamabad

The average length, depth and diameter of the sella turcica is shown for both male and female. The mean length of sella turcica in males and females varied by only 0.01 mm being 11.3 mm in females and 11.4 mm in males. Similarly comparison of the mean diameter between both genders the mean value varied by only 0.02 mm being 12.0 mm in females and 12.8 mm in males. On comparison of mean depth between the male and female the values were equal i.e. in both genders the mean was 9.9 mm. The morphology of sella turcica appeared normal shape in the majority of patients presenting at Islamic International Dental Hospital (66 per cent). These results were almost equal to the results of this study, but there are differences in the depth of sella turcica in females (lower than the values obtained in this research). Ahsan's study showed that the depth values were bigger in males, whereas the values in this study were lower than his values. As for the shape, this study values showed that the normal sella turcica constituted 64.7% of the total sample (see study results).

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The average length, depth and diameter of the sella turcica is shown for both male and female. The mean length of sella turcica in males and females varied

by only 0.5mm being 8.9mm in females and 9.4mm in females. Similarly comparison of the mean diameter between both genders the mean value varied by only 0.3 mm being 10.9mm in females and 11.2mm in males. Similarly .comparison of the mean depth between both genders there is not differences

The size of sella turcica was larger in older age group than the younger age group.

The shape of sella turcica appeared normal in majority of the subjects (61%). The morphological variation was found to be 39% of the subjects: an irregular dorsum sella was found in 15 %. A pyramidal shape was present in 5.5%, double contour sella was found in 5.5%, an oblique anterior wall was found in 8% while sella turcica bridge was not found in the patients. When these results are compared to the results of this study, some differences were noted as follows:

The size of the sella turcica: The average length, depth and diameter value of the sella turcica is smaller than the values of this study. The lower table shows the shape of sella turcica values in both studies.

Table(5.1)The shape of the sella turcica in both studies

Type of shape	Sathyanarayana HP, Kailasam V, ChitharanjanAB	Hadeel Alsiddig Osman
Normal sella turcica	61%	64.7%
an irregular dorsum sella	15%	5.9%
A pyramidal shape	5.5%	2.0%
double contour sella	5.5%	3.9%
oblique anterior wall	8%	9.8%
bridge sella turcica	Not found	13.7%

- Osunwoke EA, Mokwe CR, Amah-Tariah FS. 2014 radiologic measurements of the sella turcica in an adult Nigerian population

The results obtained showed the Mean \pm SD of the length and depth of the sella turcica as 13.59 ± 1.59 mm and 8.94 ± 1.99 mm respectively. For males, the Mean \pm SD of the sella turcica length was found to be 13.61 ± 1.64 mm and depth was found to be 8.97 ± 2.11 mm, for that of females, the Mean \pm SD of the sella turcica length was found to be 12.85 ± 1.50 mm and depth was found to be 9.87 ± 1.75 mm respectively. These results showed big differences between the above mentioned and this study (see study results).

5.2 Recommendations

- The results of the present study of sella shape and size may be used as reference guide for future studies about sella turcica morphology.
- Conducting a more deep study which includes greater sample on this issue is highly recommended.
- Conducting the same study using both CT and conventional X-ray examinations may give more reliable results.

5.3 Conclusion

This study was conducted at ALmodares Hopspital in Khartoum, during the period from April 2016 up to June2016. The main objective of the study was to measure the size and shape of sella turcica in adult Sudanese population who were referred to that hospital. The study has come out with certain results including: No significant difference in shape of the sella turcica could be found between males and females. There was a significant difference in the size of sella turcica in older and younger age groups in all three-dimensions, and size was larger in older subjects. There was significant difference in depth of sella turcica between male and female. Shape of sella turcica was normal in 64.7% of the subject. The morphological variation was found to be 35.3% of the subjects. The study also proposed some recommendations for future studies.

5.4 References:

- Ahsan Mahmood Shah (2011) The shape and size of the sella turcica in skeletal class I, class II, class III in patients presenting at Islamic international dental hospital, Islamabad. Pakistan Oral & Dental Journal
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5.5 Appendix

Sudan University of Science and Technology

College of Graduate Studies

Thesis Submitted in Partial Fulfillment of the Award of M.Sc Degree in
Diagnostic Radiology

Determination of Normal Size and Shape of Sella Turcica in Adult Sudanese
Population using Computed Tomography

Table (5.1) Data collecting sheet:

NO	Age	Gender	Length(DS)	Depth(BPF	Diameter(TS)	Shape
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DS: Dorsum Sella

BPF: Base of the Pituitary Fossa

TS: Tuberculum Sella



FIG (5.1) shows the method of measurement of length, depth, diameter of sella turcica used by the researcher)