ADDIS ABABA UNIVERSITY, COLLEGE OF HEALTH SCIENCES, SCHOOL OF MEDICINE, DEPARTMENT OF ANATOMY

Anatomical Variations of Sphenoid Sinus: A Radiological Evaluation

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Anatomical Variations of Sphenoid Sinus: A Radiological Evaluation

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Declaration

This is to certify that the thesis prepared by Tizita Kinfe, entitled, ***"Anatomic Variations of Sphenoid Sinus: A Radiological Evaluation"*** and submitted in partial fulfillment of the requirements for degree of Masters of Science in Anatomy complies with the regulation of the University and meets the accepted standards with respect to originality and quality. This thesis has not been presented for degree any other University, and that all sources of materials used for the thesis have been fully acknowledged.

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LIST OF ABBREVIATIONS AND ACRONYMS

ACP……. Anterior clinoid process

CP……..Conchal pneumatization

CT……. Computed Tomography

ENT……Ear-Nose-Throat

ESS……Endoscopic Sinus Surgery

FESS……...Functional Endoscopic Sinus Surgery

GWS……...Greater wing of sphenoid bone

HNS……Head and Neck Surgery

ICA……... Internal Carotid Artery

MN……. Maxillary Nerve

MRI……Magnetic Resonance Imaging

ON……. Optic Nerve

ORL……Otorhinolaryngology

PNS……. Paranasal sinus

POP…… postsellar pneumatization

PRP……. Presellar pneumatization

SP…… Sellar pneumatization

SS…… Sphenoid Sinus

TASH……...Tikur Anbesa Specialized Hospital

VC……Vidian Canal

VN…….. .Vidian Nerve

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ABSTRACT

Background:- Sphenoid sinus is an important structure localized in the body of the sphenoid bone. The sphenoid bone composes of the body, the lesser and greater wings and the pterygoid plates. The sinus is formed in the body of the sphenoid bone between the anterior and middle cranial fossa and it is surrounded by more vital structures than any other sinus.

Aim:-This prospective observational study aims to determine and report the anatomical variations of sphenoid sinus by using CT scan examination.

Materials and Methods:-the retrospective observational study was conducted in the Department of Radiology, Tikur Anbesa Teaching Hospital and it considers 200 subjects from age group 18 up to 79 years. Descriptive analysis was used to determine the mean, frequency and proportion of variables describing variations. 95% Confidence Interval for the proportions was presented and Chi square test was used to calculate the p-value; and p-value < 0.05 is considered significant.

Result: - One hundred and seventeen (58.5%) were females with the mean age (±SD) 43 (±14.5) years. Conchal type of pneumatization was seen in 2%, presellar 25.5%, sellar 50% and 22.5%

postsellar pneumatization. Single complete septa is seen in 77.5%, single incomplete in 11.5%, double septa is found in 10% and no septa is found in 1% of the cases.

Conclusion:- Sellar type of pneumatization is the commonest type of pneumatization seen in the study population and single complete septa is commonest type of septum that separate the sinus in to right and left halves.

Keywords: - Sphenoid Sinus, Computed Tomography, Septum, Pneumatization, Dehiscence, Protrusion.

1. INTRODUCTION

1.1.Background

The paranasal sinuses (Pns) are air-filled and mucus membrane lined cavities situated in some bones of the skull. They help in producing resonance of sound and reduction of the weight of the skull. It includes frontal, ethmoidal, maxillary, sphenoid and mastoid sinuses. Out of these, sphenoid sinus (SS) has got clinical significance in this new era of minimal invasive surgery. Especially for neurosurgeons, when they discovered the trans-sphenoid approach for the pituitary surgeries and also for ear-nose-throat (ENT) surgeons for Functional Endoscopic Sinus Surgery (FESS); because of this the normal anatomical variations of the SS are important in surgeon's point of view.

SS is an important structure localized in the body of the sphenoid bone. The sphenoid bone composes of the body, the lesser and greater wings and the pterygoid plates. The sinus is formed in the body of the sphenoid bone between the anterior and middle cranial fossa and separated from critical surrounding structures like optic nerve and chiasm, cavernous sinus, pituitary gland and internal carotid artery by a thin bony lamella, the sphenoid sinus are surrounded by more vital structures than any other sinus. (Abbas et al., 2014) (Ahmed et al., 2013) (Eldan et al., 2012) (Pandey et al., 2014)

The SS is considered the most variable of the paranasal sinuses in terms of degree and type of pneumatization, number and position of inter-sinus septa, relation with the surrounding surgical risk elements: the II, III, IV, V, VI cranial nerves and vidian nerve, the internal carotid artery inside the cavernous sinus and the pituitary gland. (Lupascu et al., 2014)

1.2. Morphological features of the sphenoid sinus

1.2.1. Developmental appearance

The sphenoid bone originates from paraxial mesoderm and neural crest at about the 4thweek of gestation. The sphenoid sinus starts to develop in the 3rd or 4th month of prenatal life as bilateral invaginations of nasal mucosa into the cartilaginous cupolar recesses of the nasal cavity. The pneumatization of the sphenoid sinus after birth is negligible and it is filled with bone marrow.

During childhood, maturation of the bone from red to yellow marrow takes place in the anterior part of the sphenoid bone. (Ozdemir et al., 2014)

The skull base originates predominately from cartilaginous precursors with a small contribution from membranous bone. The sphenoid bone consists of the body, the lesser and greater wings and the pterygoid plates, all of them with different and complex ossification centers. The body of the sphenoid develops from the presphenoid and postsphenoid centers, with a contribution from the medial crus of the orbitosphenoid. The lesser wings develop from the orbitosphenoid and the greater wings from the larger alisphenoid. The pterygoid plates follow a complex development being formed by both intramembranous ossification (the lateral pterygoid plate) and endochondral ossification (the medial pterygoid plate from the lateral cartilage of the embryonic skull). Adjacent to the vomer, two paired ossification centers appear called bones of Bertin. They enclose the unossified rostrum of the basisphenoid. This will be the first site of sphenoid pneumatization. The relation of vascular and nervous structures such as the optic nerve, maxillary nerve, Vidian nerve and the internal carotid artery to the ossification centers of the sphenoid body explains their close relations to the sphenoid sinus. (Budu et al., 2013)

The development of Sphenoid sinus takes place in the body of sphenoid bone; SS growth starts between the third and fourth months of fetal development, as an invagination of the nasal mucosa into the posterior portion of the cartilaginous nasal capsule. Between birth and 3 years of age, the sphenoid is primarily a pit in the sphenoethmoid recess. Pneumatization of the sphenoid bone starts at age three, extends toward the sellaturcica by age seven, and reaches its final form in the mid-teens. The two sinuses generally develop asymmetrically, separated by the inter-sinus bony septum. (Afsoun et al., 2014) (David et al., 2001) (Ozdemir et al., 2014)

As compared to other paranasal sinuses, SS follows a different developmental pattern. A recess appears at birth which is present between the presphenoid body and the sphenoid concha. The development then begins posteriorly and inferiorly.

Throughout the second or third year of life, fusion of a part of sphenoid concha takes place with the presphenoid, thus forming the cavity for SS. As a result, the presphenoid recess becomes the sphenoethmoidal recess. Pneumatization occurs after this stage in the presphenoid and the basisphenoid of the sphenoid bone.

Although the definitive cavity forms at puberty, the actual sinus cavity starts becoming visible by the age of 8 to 10 years. On the posterior nasal wall, the origin of the sphenoid sinus can be clearly identified by the location of its ostium. (Afsoun et al., 2014) (Ahmed et al., 2013) (David et al., 2001) (Eggesbo et al., 2011) (Mubina et al., 2017)

1.2.2. Gross appearance

The sphenoid bone is unpaired bone of the neurocranium. It forms a componentof the floor of middle cranial fossa, the orbital apex and also a part of the lateral wall of skull. It resembles the shape of a butterfly with extended wings. Composed of the body, the lesser and greater wings and the pterygoid plates.

The sinus is formed in the body of the sphenoid bone located in the center of the cranial base. The anatomical relations of the sphenoid sinus are of utmost importance. It is bordered by the cavernous sinuses laterally, the ethmoidal air cells anteriorly, the clivus posteriorly, the pituitary fossa and planum sphenoidale superiorly, and the choana inferiorly. The sphenoid sinus is surrounded by more vital structures than any other sinus. (Abbas et al., 2014) (Ahmed et al., 2013) (Eldan et al., 2012) (Pandey et al., 2014)

The sphenoid sinus is related to sellaturcica superiorly causing sphenoid lesions which erodes the skull base and extends into the sella, and sellar lesions such as pituitary adenomas inferiorly into the sphenoid sinus. Inferiorly, sphenoid sinus is in close proximity to the nasopharynx, so sphenoid lesions can invade the nasopharynx and nasopharyngeal lesions can invade the sphenoid sinus. The cavernous sinuses and optic nerve are intimately related to the lateral wall, infections of the sinuses can spread to the cavernous sinus. The relationship of the sphenoid sinus is a prerequisite to safe and effective surgical treatment of lesions of the region and lack of orientation during dissection may cause surgical complications. (Raghunathan et al., 2016)

The sphenoid sinus is a highly variable anatomic structure because there are individual differences in the extent of sphenoid sinus pneumatization, varying number and position of septa, and the relationship with surrounding structures. (Friedman et al., 2011) (Gulgun et al., 2005)

The pneumatization pattern of the sphenoid sinus varies and can extend to the bones covering the carotid arteries and optic nerves that become thin or even absent, making these structures susceptible to iatrogenic injury. The optic nerve is least nourished and susceptible to injury due to surgical trauma or complications of the sinus disease. (Farah et al., 2014)

1.2.3 Microscopic appearance

All sinuses are lined by a respiratory pseudostratified epithelium, composed of four major types of cells: Ciliated columnar cells, Non ciliated columnar cells, Goblet type mucous cells and Basal cells

This mucosa is directly attached to bone and is referred to as mucoperiosteum. Although it is somewhat thinner, the mucoperiosteum of the sinuses is continuous with that of the nasal cavity through the various ostia of the sinuses. The ostium is a natural opening through which the sinus cavity drains into the airway. Sphenoid sinus drains directly in to the nasal cavity by sphenoethmoid recess. (Ahmed et al., 2013) (Eggesbo et al., 2011) (Zoukaa et al., 2007)

1.3. Classification of sphenoid sinus

I, Pneumatization

Sphenoid sinus is classified according to the extent of pneumatization (position of the sinus) in relation to the sella turcica and according to the extent of their posterior limits of the sinus as conchal, pre-sellar, sellar and post-sellar variety. (Afsoun et al., 2014) (Catalina et al., 2015) (Eldan et al., 2012) (Fasunla et al., 2012) (Raghunathan et al., 2016)

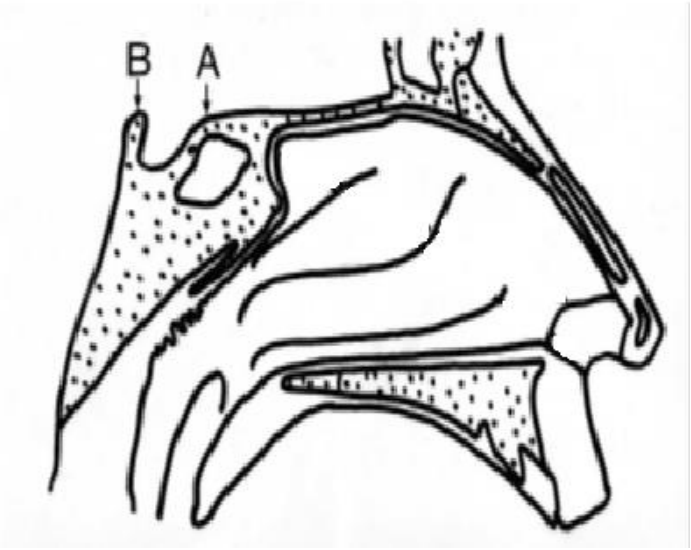


Figure 1:- A - Tuberculumsellae. B - Dorsum sellae. As modified from (Gulgun et al., 2005)

1. Conchal

Is described as pneumatization in which the posterior wall of the sinus lies anterior to the sella and the area below the sella is a solid block of bone without pneumatization. The sphenoid sinus is characterized by a very small sinus, separated from the sella turcica by a wall approximately 10 mm thick. (Fasunla et al., 2012)

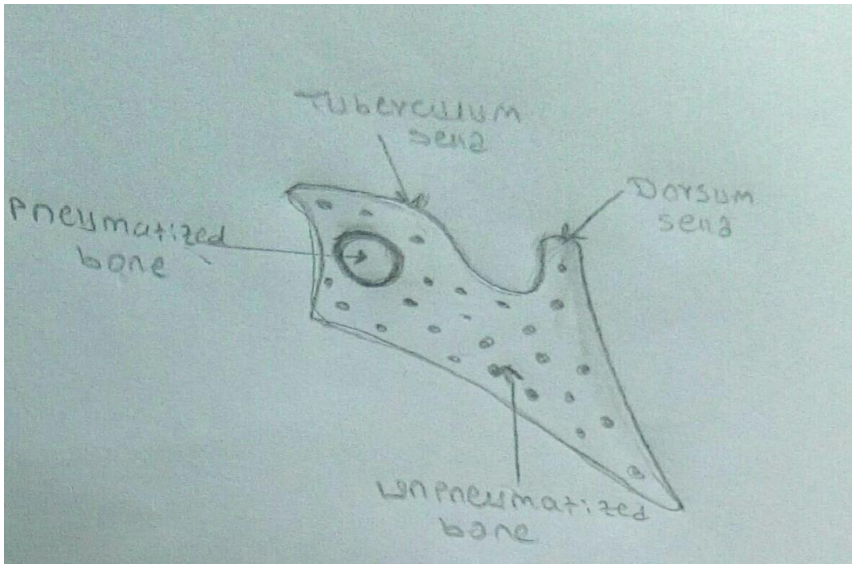


Figure 2: - Conchal types of Pneumatization of sphenoid sinus

2. **Presellar**

The sphenoid is pneumatized to the level of the frontal plane of the sella and not beyond. Pneumatization extends only as far posteriorly as the tuberculum sellae in the pre-sellar type and the posterior limit of the sinus extends into the anterior portion of the sella. Presellar (posterior wall of sphenoid sinus is in front of the anterior wall of the sella)

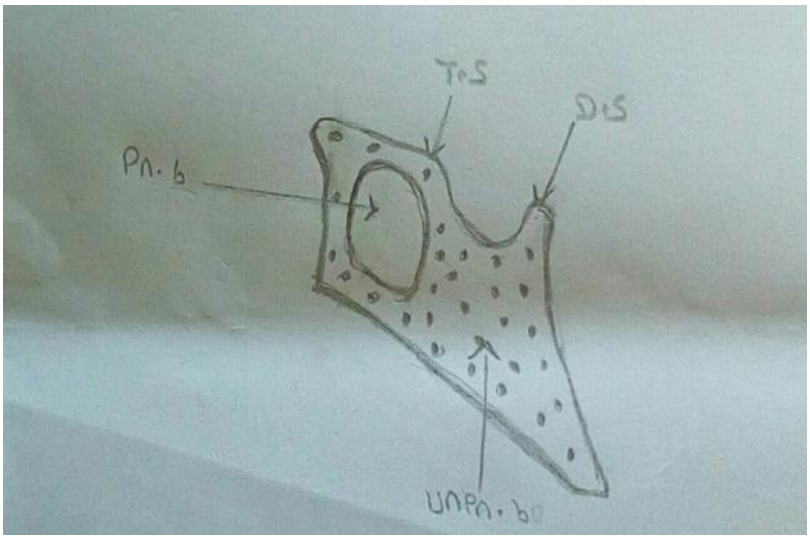


Figure 3:- Presellar types of Pneumatization of sphenoid sinus.(T.s:- tuberculum selle, D.s:- dorsum selle, Pn.b:- pneumatized bone, Unpn.b:- unpneumatized bone)

3. **Sellar**

The most common type of pneumatization where extends into the body of the sphenoid beyond the floor of sella and reaches clivus and a sellar floor bulges into a well-developed sinus, pneumatization extending beyond the tuberculum sellae. (Posterior wall of sphenoid sinus is behind anterior wall of sella)

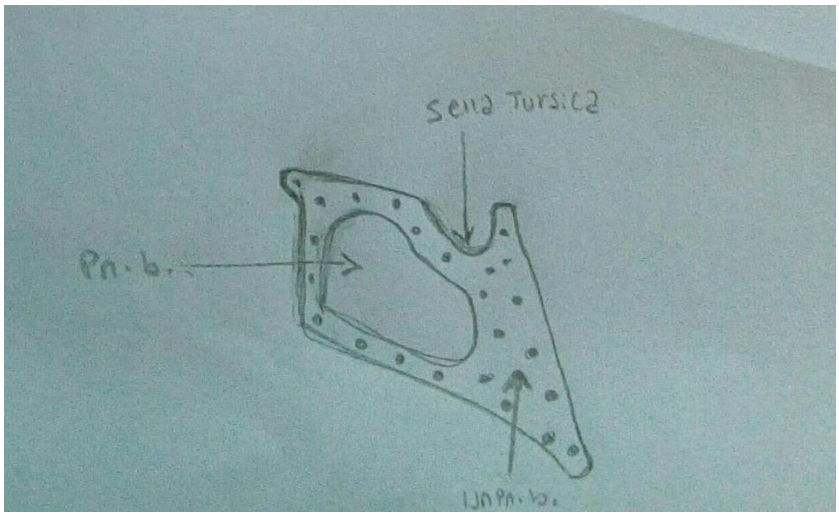


Figure 4: -Sellar types of Pneumatization of sphenoid sinus. (Pn.b:- pneumatized bone, Unpn.b:- unpneumatized bone)

1. Post sellar

Pneumatization extending up to the posterior border encroaching clivus.

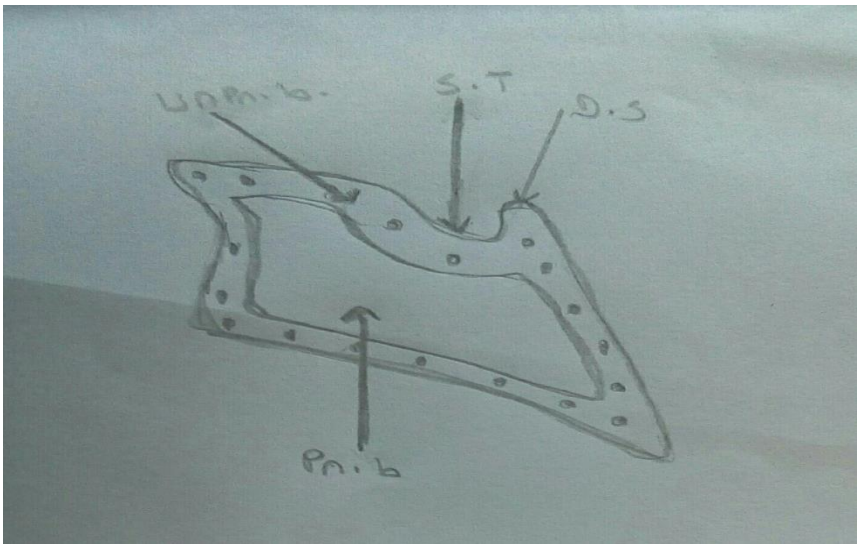


Figure 5: -Postsellar types of Pneumatization of sphenoid sinus. (S.T:- sella turcica, D.s:- dorsum selle, Pn.b:- pneumatized bone, Unpn.b:- unpneumatized bone)

II. Septum

Sphenoid sinus is asymmetrically divided in several compartments by one or more than one septum.

The septal bones are classified in to 5types: single complete septum, single incomplete septum, double septum (two complete septa or one complete and one incomplete) and sphenoid sinuses without septum. (Eldan et al., 2012)

III. Sphenoid sinus relation with the surrounding neurovascular structures

Sphenoid sinus can show various prominences, the important being the carotid canal and the optic canal: the internal carotid artery is the most medial structure in the cavernous sinus, and rests against the lateral surface of the sphenoid bone. Its prominence within the sphenoid varies from a focal bulge to a serpigenous elevation marking the full course of the intracavernous portion of the carotid artery from posteroinferior to posterosuperior. In some cases, even without advanced sinus disease, dehiscence in the bony margin can be present, and this should be particularly looked for on the CT scan.

The relationship of ICA to the sphenoid sinus is classified as either protrusion into the sphenoid sinus or presence of bone dehiscence. Protrusion of the ICA into the sphenoid sinus was defined as the presence of more than half the circumference of the ICA into the sphenoid sinus cavity with or without defects in their bony margins. Bone dehiscence was defined as the absence of visible bone density separating the sinus from the course of the ICA. (Fasunla et al., 2012)

The optic canal is found in the posterosuperior angle horizontally crossing the carotid canal from lateral to medial. The infraoptic recess lies between the optic nerve superiorly and the carotid canal inferiorly, and can sometimes pneumatize the anterior clinoid process below the level of the carotid canal: The second branch of the trigeminal nerve superiorly through the foramen roduntum and the vidian nerve in the pterygoid canal inferiorly.

Vidian canal is a short bony tunnel seen close to the floor of sphenoid sinus. This canal transmits the vidian nerve and a vidian vessel from the foramen lacerum to the pterygopalatine fossa.The vidian nerve is formed by post synaptic parasympathetic fibers and presynaptic sympathetic fibers. This is also known as the “Nerve of pterygoid canal”.

Vidian nerve is formed by Greater petrosal nerve (preganglionic parasympathetic fibers), deep petrosal nerve (post ganglionic sympathetic fibers) and ascending sphenoidal branch from otic ganglion

In some cases, these nerves are easily identified on a coronal CT scan defining the superior and the inferior borders of the entry into the so-called lateral recess in an extensively pneumatized sphenoid sinus.

The relationship of ON to the sphenoid sinus is classified as either protrusion into the sphenoid sinus or presence of bone dehiscence. (Fasunla et al., 2012)

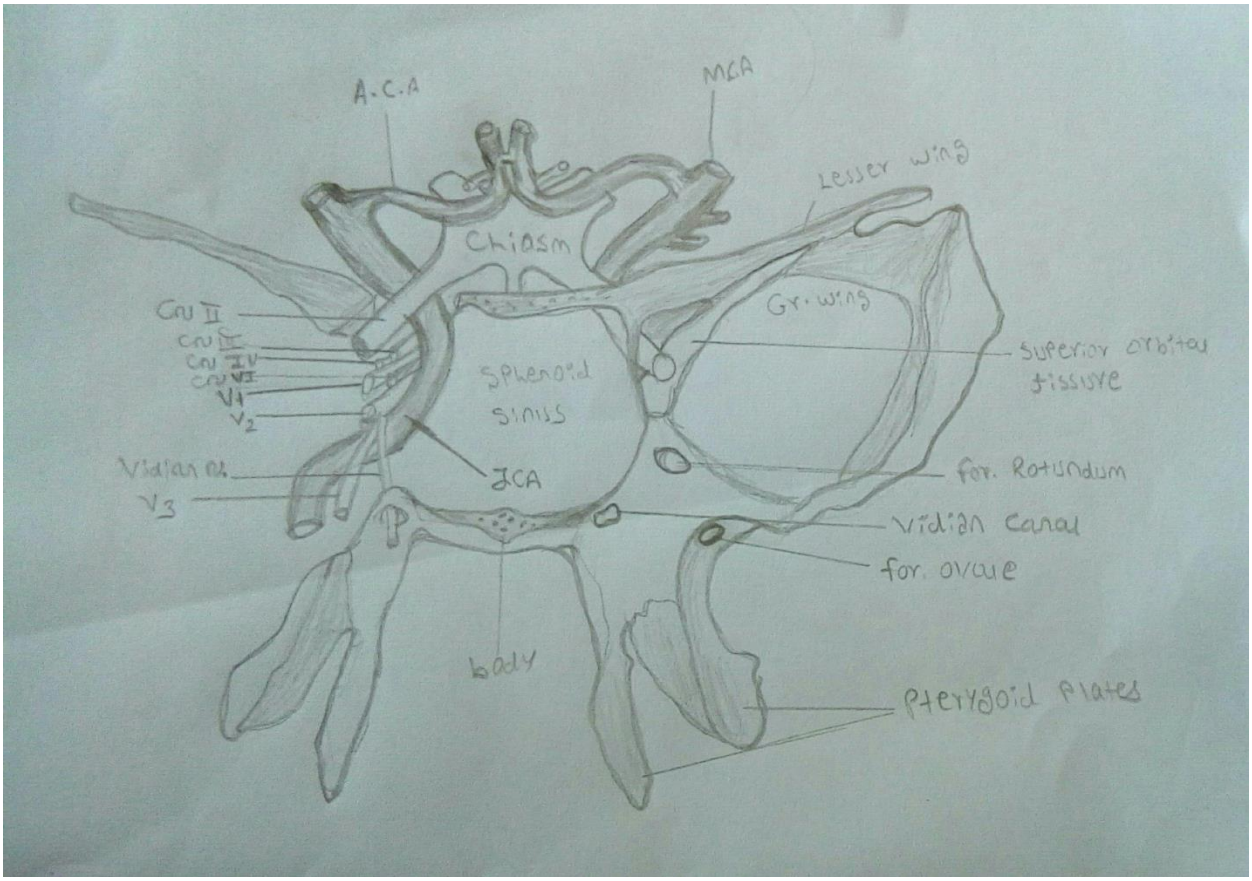


Figure 6:- Relation of sphenoid sinus with the surrounding neurovascular structures (ICA: - Internal Carotid Artery, ACA: - Anterior Cerebral Artery, MCA: - Middle Cerebral Artery)

The other variation seen is on the presence or absence of onodi cells. These cells are Posterior ethmoid cells that extend posterior, lateral and always superior to sphenoid sinus lying medial to the optic nerve, First described by Adolf Onodi in 1903**.** Extensive pneumatization can expose the circumference of optic nerve, which is surrounded by air spaces, mainly the inferior half. Onodi cells are also known as sphenoethmoid cells and are important to the surgeon in FESS.

Onodi cell is assessed by comparing both coronal and sagittal views carefully. They pneumatized superolateral to the sphenoid sinus: hence surgical clearance should be in the inferomedial direction, due to optic nerve and internal carotid relations. (Kamal et al., 2017)

Knowledge about anatomical variations of sphenoid sinus and also its relationship with surrounding structures as internal carotid artery, optic nerve, pituitary gland will shorten sphenoid sinus surgery and also prevent morbid or mortal complications. Determination of anatomical variations of this region will be the key point in the understanding of the steps of tumor invasion or spread of inflammatory process. Besides it will guide the management of the relevant pathologies.

1.4. Diagnostic modalities (radiology)

Many radiological techniques have been used for the visualization of sinuses. Conventional imaging technique (x-ray) has a historical value and nowadays it is replaced by CT and MRI. (Riza et al., 2014)

CT is the gold standard imaging modality. It plays a fundamental role in the diagnosis of anatomical variations as well as of sinonasal diseases for a better guidance in the decision making about clinical, therapeutic and surgical approaches. Spiral CT provides axial, coronal and sagittal images that facilitate good appreciation of the size and relationship of the paranasal sinuses. It is currently the gold standard (imaging modality of choice) for evaluating paranasal sinuses and adjacent structures.

CT of the paranasal sinuses reveals a spectrum of findings associated with the normal pneumatization process, both inside the sinus cavities and in the adjacent marrow spaces. Clear understanding of sinonasal anatomy and anatomic variants provides a better surgical approach in such narrow and vital areas. It is possible to detect the bony variations and mucosal abnormalities of paranasal sinuses with CT scan, which clearly visualize the anatomical variations and it is more sensitive than MRI in demonstrating bone tissue invasions. The disadvantage of CT is its ionizing radiation but is also more cost-effective and practical than MRI. (Abbas et al., 2014) (Farah et al., 2014)

Sphenoid sinus' most reliable landmark is the ostium which lies approximately 1cm superior to the posterior-inferior end of superior turbinate and approximately 1.5cm superior to the choana. CT scan evaluation focuses on pneumatization and the relation to both internal carotid artery and optic nerve. (Farah et al., 2014)

1.5. Statement of the problem

Para nasal sinuses lesions are common and affect a wide range of population with a variety of etiologies; it includes a wide spectrum ranging from inflammation to neoplasm. Paranasal sinus disease is a significant health problem affecting a large number of populations. Each year, nearly 31 million people in the USA are diagnosed with sinusitis. (Cochrane et al., 2009); In India almost 15% of the population is suffering from chronic sinusitis. (Pandey et al., 2014)

Sphenoid sinus diseases are difficult to diagnose and treat, because initial symptoms are vague and difficult to recognize. The sphenoid sinus has often been neglected because of its isolated location and difficult access. Furthermore, the rarity of sphenoidal involvement can be explained by the nonspecific symptoms, the inaccessibility to the sinus through the otorhinolaryngological physical examination, and the low number of diagnoses prior to the advent of more sophisticated technology, such as computed tomography (CT) and magnetic resonance imaging (MRI). (Ozdemir et al., 2014) (Socher et al., 2015)

The isolated involvement of the sphenoid sinus in most cases has an inflammatory origin, and a neoplastic origin is rare The clinical presentation involves headache (mainly retro-orbital),which may be associated with purulent rhinorrhea, retropharyngeal drip, nasal obstruction, abnormal vision, nerve deficits, and consequential damage of other inflammatory or neoplastic processes installed. Delayed diagnosis and treatment can result in serious complications. (Socher et al., 2015)

There is ORL-HNS and neurosurgery specialty training in our college and trans-sphenoidal surgery is one of the surgeries performed by neurosurgeons in our country. Understanding the anatomy, anatomic variations, and relation with adjacent vital structures is crucial for both the surgeons and radiologists.

1.6. Significance of the study

Higher number of anatomical variations of sphenoid sinus can lead to increased risk in terms of injury of important neurovascular and glandular structures. Extensive hyper pneumatization of sphenoid sinus with consecutive pneumatization of ethmoid sinus can lead to injury of the optic nerve. Protrusion of internal carotid artery into the lumen of the sinuses can also lead to its injury during endoscopic surgical procedures, especially in cases of variation in positions, numbers and insertions within the sinus septum.

Knowledge about anatomical variations of sphenoid sinus and also its relationship with surrounding structures as internal carotid artery, optic nerve, pituitary gland will shorten sphenoid sinus surgery and also prevent morbid or mortal complications. Determination of anatomical variations of this region will be the key point in the understanding of the steps of tumor invasion or spread of inflammatory process. Besides it will guide the surgical management of the relevant pathologies. (Farah et al., 2014)

Understanding and visualization of these relationships, and possibly present variations in this area is the key to successful surgical approach to these elements as well as appropriate functional endoscopic procedures. To perform high quality and safe functional endoscopic sinus surgery for the removal of pathological tissue changes, preoperative preparation and adequate diagnosis (primarily CT and MRI) is essential. (Aggarwal et al., 2012)

Sphenoid sinuses (SS) have got the importance because of trans-sphenoid approach for the pituitary surgeries and skull base surgeries. Therefore, awareness of anatomical variation of sphenoid sinus has a significant role in surgical access of pituitary fossa and also can anticipate the difficulties in surgery. (Catalina et al., 2015)

2. LITERATURE REVIEW

Sphenoid sinus anatomy is variable from individual to individual and so is the incidence of the anatomical variations. Different studies around the globe demonstrate different percentages for the anatomic variations. Those differences are expressed in terms of extent of pneumatization, septal bone found within the sinus and relation of the sinus with the surrounding neurovascular structure. These variations were not well studied specially in our content "Africa".

Pneumatization

The degree of pneumatization of the sphenoid sinus may vary considerably. The sphenoid sinus has been described as being conchal, presellar, sellar or postsellar.

A study done in Buzau, Romania, Sphenoidal pneumatization types have shown the sellar form as the most frequent, in 41/50 cases (prevalence of 82%), followed by the presellar type in 22/50 cases (prevalence of44%), the conchal type in 7/50 cases (prevalence of 14%), the last being the postsellar type (1 case, prevalence of 2%). (Ebrahim et al., 2016)

A study done in Celal Bayar University, Faculty of Medicine, Manisa and Turkey; One hundred and eighty midsagittal magnetic resonance images, 48 bones and 29 hemi-sectioned cadaveric heads were analyzed and four different types of sphenoid sinus pneumatization were observed. Conchal type sphenoid sinus was observed in 3 (1.7%), Pre-sellar type was observed in 15 (8.4%), Sellar type was found in 87 (48.3%), post-sellar type in 75 (41.7%). (Gulgun et al., 2005)

A study done in Karnataka, India, showed that there were 2 cases with conchal pneumatization, 29 cases with pre-sellar pneumatization, 47 cases with sellar pneumatization, and 72 cases with post-sellar pneumatization. It was observed that pneumatization of greater wing of sphenoid sinus (GWS) in 40 cases, pterygoid process (PP) in 39 cases and anterior clinoid process (ACP) in 34 cases. (Catalina et al., 2015)

A study done in Tehran, Iran, with evaluation of CT scans of 64 sphenoid sinuses reviewed patients, revealed that the degree of pneumatization were 34 cases with sellar type (59.4%), 14 patients with presellar type (15.6%), and 16 cases with conchal type (25%). (Fasunla et al., 2012).

Septal bone

A study done in Celal Bayar University Faculty of Medicine, Manisa and Turkey; One hundred and eighty midsagittal magnetic resonance images, 48 bones and 29 hemi-sectioned cadaveric heads were analyzed and Sphenoid sinus septation was investigated in bony specimens. A single major septum was observed in 22 (46%) specimens, 14 (64%) of these being off the midline. The incidence of accessory septae within the sinus was 52% (25 specimens). (Gulgun et al., 2005)

In a study done in Mardin Government Hospital, Mardin, Turkey Retrospective analysis of spiral computed tomography scanning of paranasal sinuses of 218 patients; a total of 5 types of septal variations were detected. A single complete septum (n=132; 60.5%), a single incomplete septum (n=66; 30.2%), double septum (complete + incomplete, n=6; 2.7%), two complete septa (n=9; 4.1%), and sphenoid sinuses without septum (n=5; 2.2%) were identified. Sixty-four percent of single septum was located in midline, while other types were found immediately right or left side of the midline. (Eldan et al., 2012)

A study done in Karnataka, India, Inter Sinus Septa (ISS) was noticed in the midline in 36 individuals (24%) and deviated from midline in 113 individuals (75%). Accessory septae were noticed in 76 sinuses (51%). (Catalina et al., 2015)

A study done in Tehran, Iran, The evaluation of CT scans of among 64 sphenoid sinuses reviewed patients; absence of septum is not observed. A single inter sphenoid septum observed in 18 of cases (28.1%), and 46 of cases had more than one intersphenoid septum (71.9%). (Fasunla et al., 2012)

In a study done in University of Sarajevo, Bosnia and Herzegovina, A retrospective study was done on 200 patients with an age range of 20 to 74 years (males, 48.6 ± 14.7 yrs.; females, 49.9±17.9 yrs.). By analysis of CT images of patients 2 (1%) had no septum within the sphenoid sinus. Other respondents (98%) possessed inter-sphenoid septum. Only one septum (single septum) is found 70 patients (68%) men. From the 103 men with the existence of one or more septa had not been placed in the median line, at its posterior point, but Para medially, on the left or right side. Of the 87 analyzed images of men, the right-set intersphenoid septum had 56 (64.4%), and left-set 31 (35.6%). From the 103 male patients who had verified existence of intersphenoid septum, 20 of them (19.4%) had one more septa (accessory septa), a total of two in

one sphenoid sinus. Of the 20 people who had registered the existence of accessory septum, in 13 cases, accessory septum was located to the right of the main septum, and in 7 cases left of it. Presence of 3 septa (1 main and 2 accessory) in male patients was found in 8 (7.8%) patients. In 5 cases one septum was located to the right and left of main intersphenoid septum, in 2 cases each additional septum was to the right from the main one, and in one case left from the main septum. The existence of sphenoid sinuses with 4 septa (1 main and 3 accessory) was registered in 5 (4.8%) male patients. The pattern was as follows: in 3 cases - 2 right, 1 left from the main septum, in 1 case-2 left, 1 right of the main septum, and in 1 case all 3 accessory septa were located to the right of the main septum. Based on analysis of CT scans of male patients they come to the conclusion of existence more than 1 sphenoid septum in the sinus in 33 cases (32%). (Aggarwal et al., 2012)

A study done in Kerala, India single inter sphenoid septum was observed in 83.3% of the images studied. Out of that, only in 11.4% showed the septum is in the midline, while the rest exhibited deviation of septum either to the right or the left side. The right deviation of inter sphenoid septum was observed to be dominant with 33.9% incidence while the left deviated septum was seen in 21.9% images. A horizontal septum in the sphenoid sinus was noted in a single image accounting for 0.8%. Para median or lateral septum was noted in 14.5% images. Multiple septum and/or accessory septum were seen in16.7%. Absence of inter sphenoid septum was observed in 0.8% of images studied. (Ebrahim et al., 2016)

A study done in Nigeria, absence of sphenoidal septum was found in 3(2.7%) cases in this study. presence of sphenoidal septum on the right side of the midline was encountered in 29 (26.4%), while that of the left side occurred in 48 (43.6%) cases. The sphenoidal septum was situated in the midline in 20(18.2%) cases while the presence of double sphenoidal septum was documented in only 5 (4.5%) cases. The attachment of the septum to the bony wall of the ICA occurred in 5 (4.5%) cases. (Ahmed et al., 2013)

Relation of the sinus with the surrounding neurovascular structure

A study done in Tehran, Iran, 1 Onodi cell was found. There are significant correlations between the presence of the onodi cell and optic nerve protrusion (80.1 %), optic nerve dehiscence (36.3

%), internal carotid artery protrusion (59 %), and internal carotid artery dehiscence (20.8 %) ($p<0.01$).The other surgically significant point is that the sphenoid sinus is located medially and inferiorly to the onodi cell. Consequently, attempts to use instrumentation to locate the sphenoid sinus directly behind the onodi cell may result in serious damage to the optic nerve or carotid artery. (Fasunla et al., 2012)

A study done in Karnataka, India out of 150 study participants; Onodi cell was noticed in 17 sinuses. Protrusion of ICA was found in 27 sinuses. The p-value was highly significant for the association between pneumatization of sphenoid sinus and protrusion and dehiscence of ICA in the sinus. (Catalina et al., 2015)

In a study done in Mardin Government Hospital, Mardin, Turkey, a total of 219 images were analyzed and protrusions of optic nerve and internal carotid artery were detected in 39 (17.8%) and 61 (27.9%) cases, respectively (Eldan et al., 2012)

As it has been on the above literatures there is variation in terms of gross appearance in sphenoid sinus. In pneumatization type most literatures shows that sellar type of pneumatization is the commonest type of pneumatization followed by presellar and postsellar types. The least being conchal type. Single inter-sphenoidal septum is the most frequent type of septal bone seen in majority of literatures. As for CT scan, it being the imaging modality of choice, most authors use less than three millimeter coronal plane cuts and axial plane cuts for a clearer, exact diagnosis. This study assesses the variations seen in sphenoid sinus in Addis Ababa Ethiopia.

3. OBJECTIVE OF THE STUDY

3.1. General Objective

- To assess anatomical variations of Sphenoid sinus among patients undergoing CT scan evaluation for PNS at Tikur Anbesa Hospital, Addis Ababa, Ethiopia.

3.2. Specific objective

- To determine the prevalence of septal bone variations of Sphenoid sinus in patients undergoing CT scan evaluation for PNS at Tikur Anbesa Hospital, Addis Ababa, Ethiopia.
- To determine the prevalence of pneumatization types of Sphenoid sinus in patients undergoing CT scan evaluation for PNS at Tikur Anbesa Hospital, Addis Ababa, Ethiopia.
- To indicate relations of sphenoid sinus with optic nerve, internal carotid artery, vidian canal and foramen rodtundum among patients undergoing CT scan evaluation for PNS at Tikur Anbesa Hospital, Addis Ababa, Ethiopia.

4. MATERIALS AND METHODS

4.1. Study Design

Institution-based retrospective observational study method

4.2. Study Population

All adult patients who have undergone CT scan imaging of "PNS" in the Radiology Department of Tikur Anbesa Hospital were considered.

4.3. Study Area

The study was conducted at Tikur Anbessa Teaching Hospital.

4.4. Study Period

This study identified CT image of patients from May 2018 G.C-May 2017 G.C

4.5. Sample Size

The sample size (n) of the patient's images will be determined by using

$$n = \frac{Z\,(\alpha/2)^2 * P\,(1-P)}{d^2}$$

n=is the sample size

z= 95% confidence level (1.96)

d^2=the margin of sampling error (5%)

P=is the estimate of the prevalence rate (0. 5)

Where; n = sample size, z= 1.96, p= 0.5, d= 0.05, CI= 95% & ȁ= 5%

$n = (1.96)^2 \times 0.5\,(1-0.5)/\,(0.05)^2 = 384.16 \approx \underline{384}$

By using reduction formula

nf = n/(1+n/N), N = 450 (estimated target population in the study period)

So, nf= 384/(1+384/450)

= <u>207</u>

Seven of the data's were incomplete (didn't contain full information) so 7 of them are excluded and a total sample of **200** were used.

4.6. Inclusion and exclusion criteria

Inclusion Criteria:

1. Patients > 16 years of age
2. Images that are done or can be reconstructed in axial, coronal and sagittal planes.
3. Images of high resolution quality and which didn't show any artifact were included

Exclusion Criteria:

1) Images having a slice thickness >3mm , didn't show the sinus area clearly
2) Patients with history of prior sinus or sphenoid surgery, facial trauma, obscured Sphenoid sinus pathology
3) Images with the presence of metallic artifacts and impaired sinus visualization were excluded from this study.

4.7. Sampling Technique

Simple random sampling technique was employed to select the radiological images.to apply this method first I take my sampling frame to be 450; total image taken through the year and they are numbered in the database (workstation) and the sample size is 200. The 1st radiologist was assigned to see two images out of the first five images so he picks two images by lottery method and the 2nd radiologist interpreted two images from the second five images by doing so we go through all the data's and pick the sample.

4.8. Variables

4.8.1 Dependent variable

- Inter-sphenoid septum
  - ✓ Complete or incomplete
  - ✓ Midline or paramedially (deviated to right or left)
  - ✓ existence (Accessory septa, multiple septum, transverse septa or no septum)
- types of Pneumatization

- ✓ Choncal, Presellar, Sellar, Postsellar, Anterior Clenoid Process, Pterigoid Plate, Greater Wing of Sphenoid

- lateral wall of the sphenoid sinus
  - ✓ Internal carotid artery (Normal, Protrude or dehisce)
  - ✓ Optic nerve (Normal, Protrude or dehisce)
  - ✓ Videan nerve (Normal, Protrude or dehisce)

4.8.2. Independent variables

- Sociodemographic variables:
  - ✓ Age
  - ✓ Sex

- Anatomy related variables:
  - ✓ Dimension of sinus (Increased/decreased)
  - ✓ Bone density (Normal, changed /deformed)
  - ✓ Sinus opacity (Partial or complete)
  - ✓ Mucosal thickening (>3mm or <3mm)

4.9. Data collection technique

This is a prospective observational study that was conducted at the Department of Radiology in Black Lion Teaching Hospital comprising of 200 patients' computed tomography scan images of paranasal sinuses. The machine that was used to take the images was Philips 128 slice MDCT scanner and GE machine, 130 kV, 120 mAs. CT scans were taken in axial plane and then 1.25 millimeter slices reconfigured into coronal and sagittal planes. Patients were placed in supine position with their chin hyper extended and scan plane angled such that it was as perpendicular to the hard palate. Scanning was completed from the anterior frontal sinus to the sphenoid sinus. Axial scans were performed from the maxillary sinus floor to the level of the frontal sinus roof, in a plane parallel with the hard palate. Images were reviewed on the console with varying window levels and widths. The sphenoid sinuses were reviewed in both axial and coronal planes, and the total number of septa were counted (single, double and absent) and compared in both planes. The images were viewed by" Radiant Viewer" computer software**.**

After the data's (CT scan images) were selected they were interpreted by one senior radiologist and five radiology residents for the detailed anatomic variation.

4.10. Data quality assurance

Half day training was given for the data collectors and supervisor. During data collection, close supervision and follow up was made. The collected data was cross checked for its completeness, clarity and consistency.

4.11. Data Analysis

A quantitative data was entered using Excel spreadsheet, cleaned and analyzed using SPSS version 20. Descriptive analysis was used to determine the mean, frequency and proportion of variables describing variations. 95% Confidence Interval for the proportions was presented and Chi square test was used to calculate the p-value; and p-value < 0.05 is considered significant. Results were presented as table and graphs together with brief descriptions.

4.12. Ethical Considerations

Permission to conduct this study was obtained from Department Research Ethics Review Committee (DRERC) of department of anatomy AAU, CHS. Informed consent from patients in this study wasn't required since it was conducted from secondary data (recorded images) and confidentiality was maintained by avoiding patient's name.

4.13. Operational definitions

Complete septa: - if the septal bone has anterior and posterior attachment with the wall of the sinus.

Incomplete septa: - if the septal bone has anterior or posterior attachment with the wall of the sinus.

Protrusion: - the presence of more than half the circumference of the vessel/nerve into the sphenoid sinus cavity with or without defects in their bony margins.

Dehiscence: - the absence of visible bone density separates the sinus from the course of the vessel/nerve.

High-resolution CT (HRCT):- is a scanning protocol in which thin sections (1.25 mm) are acquired and reconstructed using a sharp algorithm.

5. RESULT

There were a total of 200 participants included in the study. This includes 117 females (58.5%) and 83 males (41.5%). The mean age of participants was 43 years with standard deviation of 14.5 years. The median age was 43 and 42 years for males and females respectively as shown in table-1.

Table 1: Age distribution of study patients (n=200)

	MEDIAN AGE	MINIMUM	MAXIMUM
ENTIRE GROUP	43 Years	18 Years	79 Years
MALE	43 Years	18 Years	74 Years
FEMALE	42 Years	18 Years	79 Years

The present study result showed that from the total participants 50% of sphenoid sinus were Sellar Pneumatization, 25.5% were Presellar, 22.5% were Postsellar and 2% were Conchal Pneumatization as shown in figure 4.

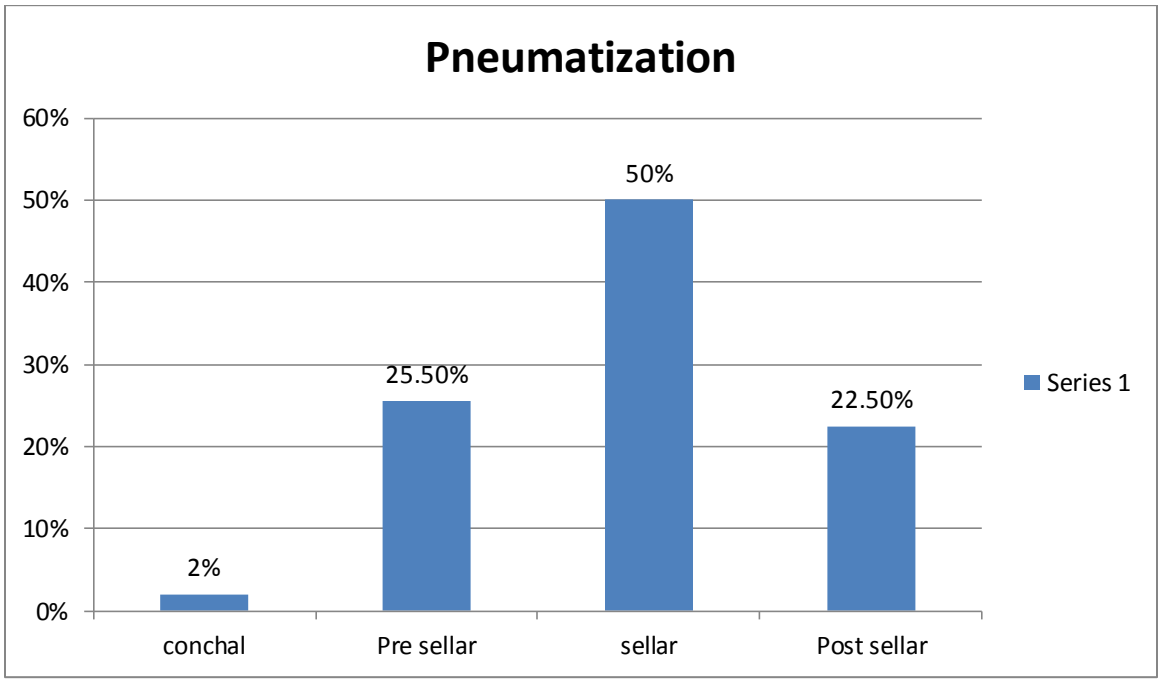
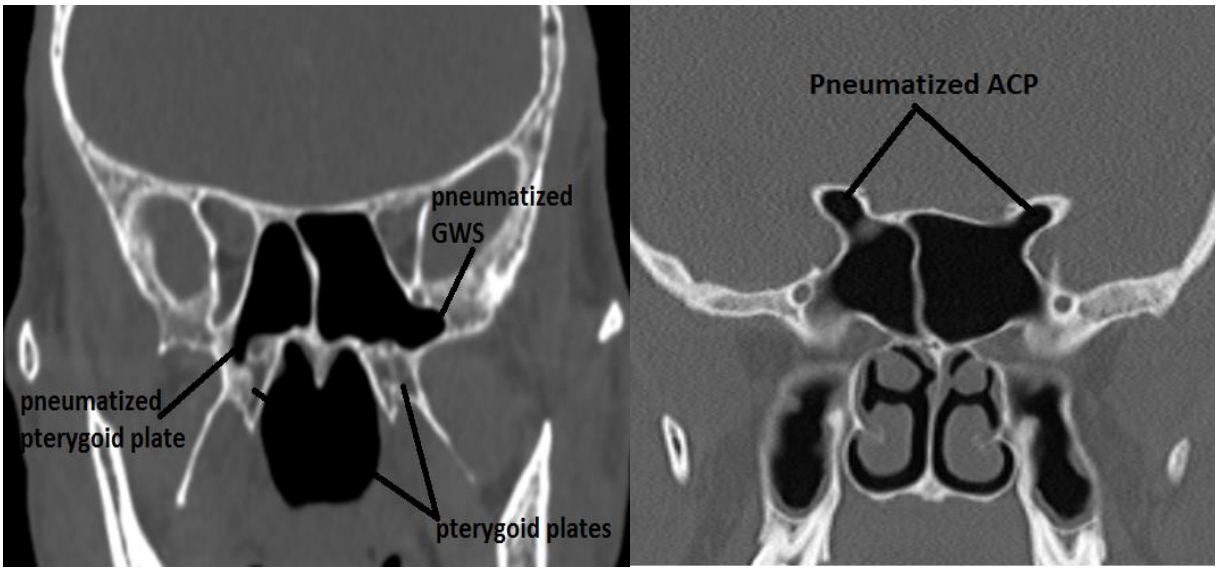


Figure 7:- Sphenoid sinus pneumatization

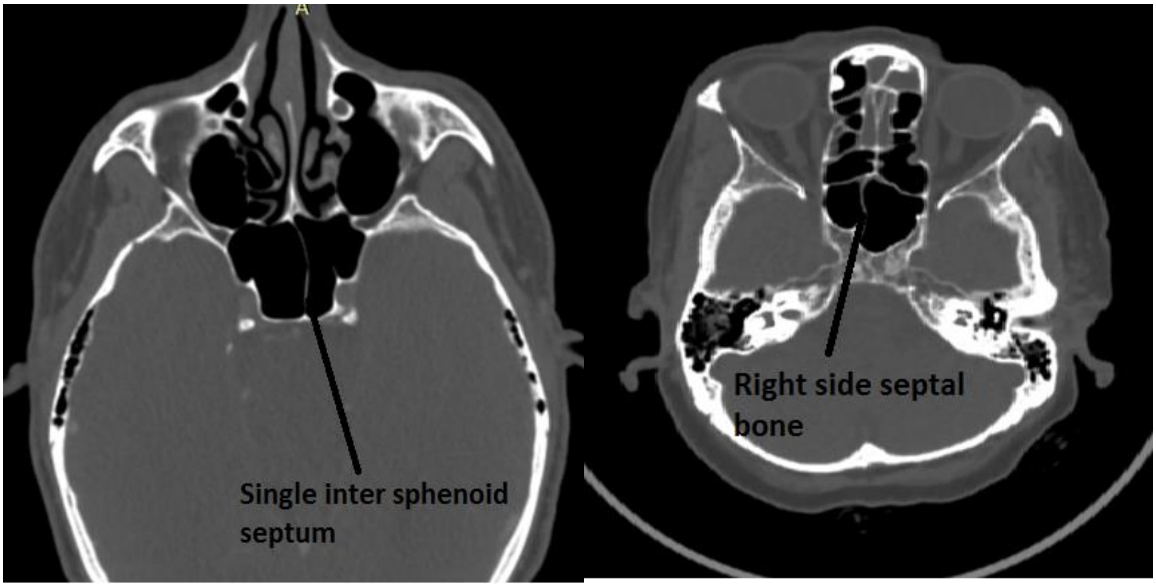
Also this study shows that Pneumatization of ACP 18%, PP 15%, GWS 16.5%.



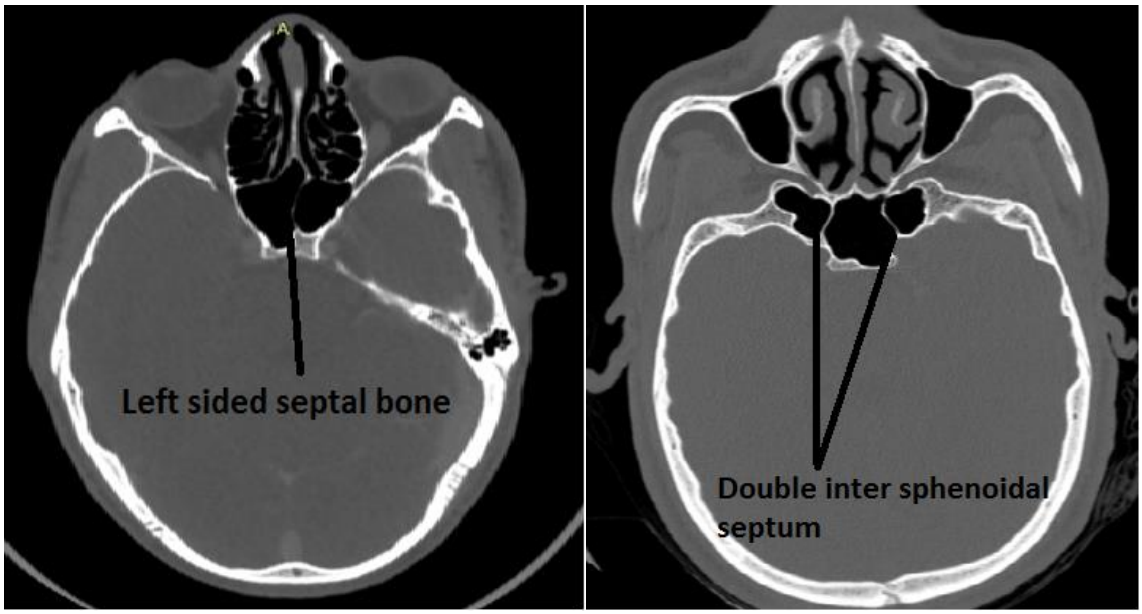
A **B**

Figure 8:- Coronal CT image (A) showing pneumatization of Pterygoid Plate on the left side and Greater Wing of Sphenoid on the right side; (B) showing Pneumatization of Anterior Clenoid Process

The present finding showed that single sphenoid sinus septal bone was seen 89% (77.5% complete and 11.5% incomplete), 10% double septum (all are complete) and 1% no septum as shown in figure 6.



A B



C D

Figure 9:- Axial CT A, Midline oriented septal bone B, Left side oriented septal bone C, Right sided septal bone D, Double inter-sphenoidal septum

As seen from the above figure in single complete septal bone participants 38% was midline oriented, 36.5% right sided and 3% left sided. The result also showed that 9.5% and 0.5% of double complete septal bone were right sided and midline oriented respectively.

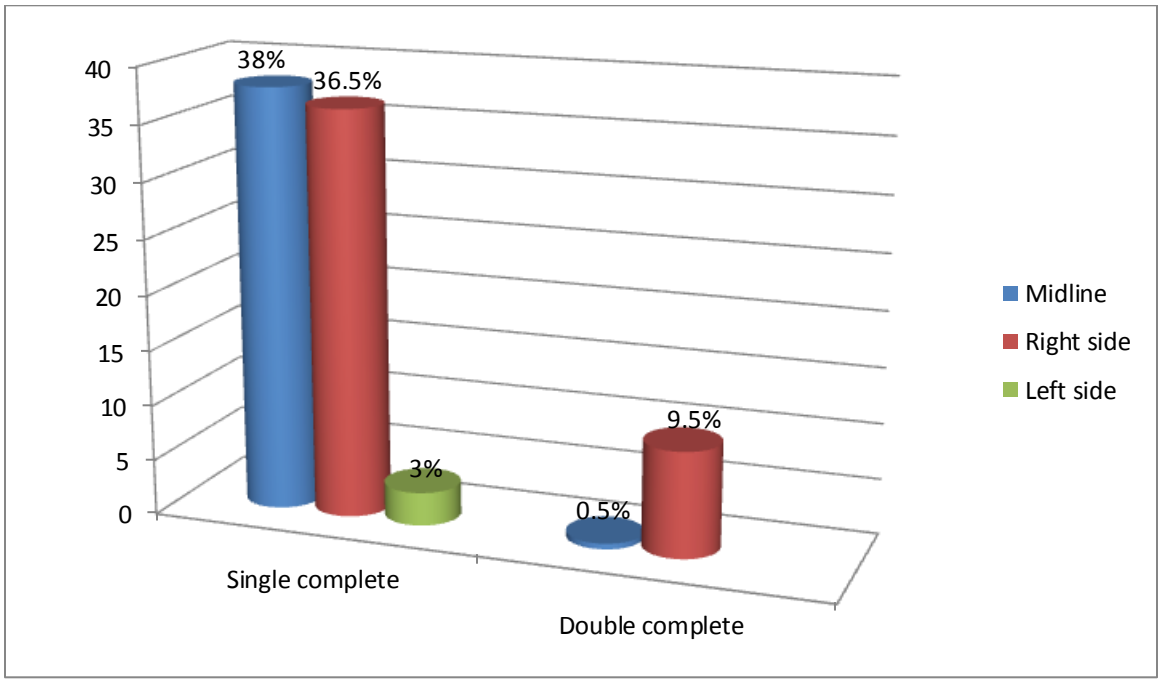


Figure 10:- sphenoid sinus septum in midline, right side and left side orientation

The relationship of internal carotid artery, Optic Nerve and foramen rodtundum to sphenoid sinus

1. **Internal Carotid Artery**

Protrusion of the ICA into the sphenoid sinus was identified on the CT images of 37 (18.5%) patients: The right side alone was involved in 12 (32.4%) patients; the left alone in 9 (24.3%) patients and bilateral involvement was found in 16 (43.2%) patients.

The dehiscence of the bony sphenoidal wall of the internal carotid artery occurred in 24 (12%) patients; the right side alone was involved in 7 (29.17%) cases, left side alone in 10 (41.7%) cases and bilateral involvement was seen in 7 (29.17%) case.

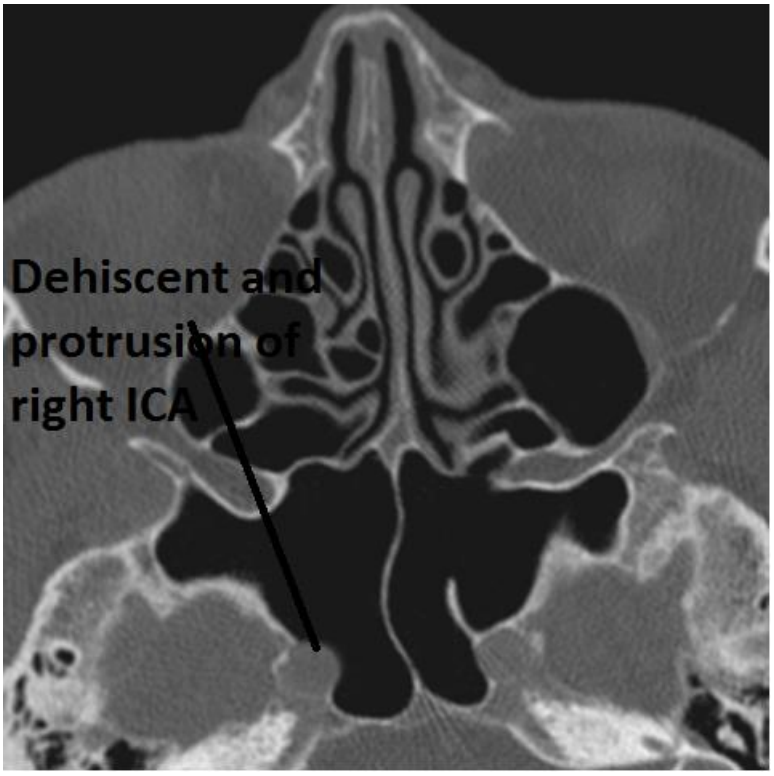


Figure 11:- Axial CT image showing Dehiscent and protrusion of right ICA

2. **Optic Nerve**

Nineteen (9.5%) cases have ON protruding into the sphenoidal sinus: right sided in 1 (5.26%) cases, left side in 10 (52.63%) cases and bilateral involvement in 8 (42.1%) cases. However,

dehiscence occurred in 31(15.5%) patients: right sided in 12 (38.7%) cases, left side in 9 (29%) cases and bilateral involvement in 10 (32.5%) cases.

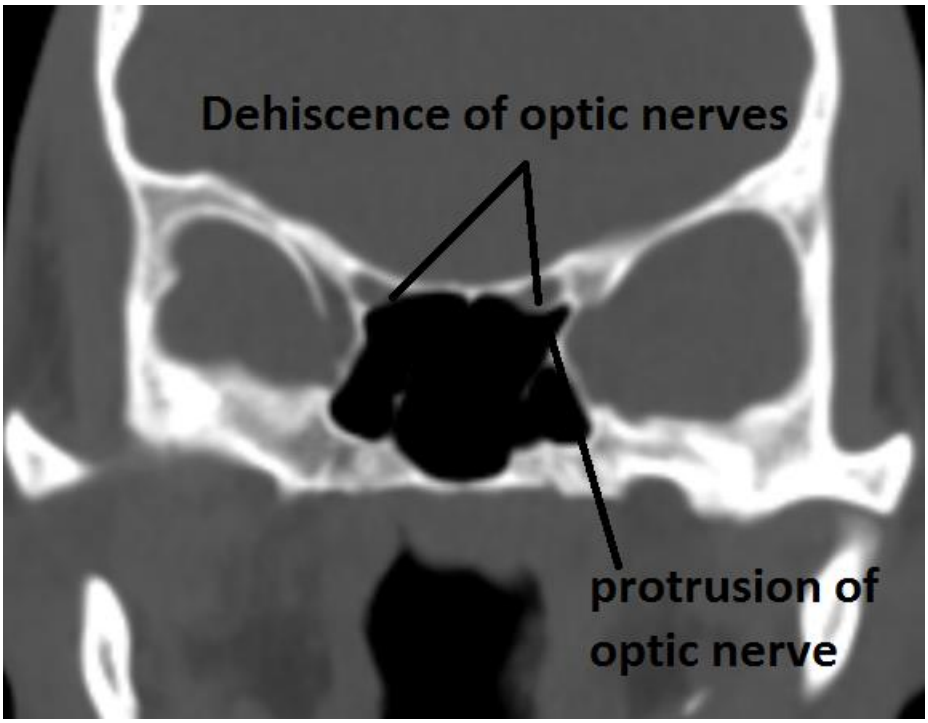


Figure 12:-Coronal CT image showing Dehiscence of optic nerves on both sides with protrusion in the right side

3. Foramen rodtundum

From the total participant 25(12.5%) cases have V2 protrusion into the sphenoid sinus: The right side alone was involved in 7(28%) patients; the left alone in 8(32%) patients and bilateral involvement was involved in 10(40%) patients. However, dehiscence occurred in 25(12.5%) patients: right sided in 4(16%) cases, left side in 11(44%) cases and bilateral involvement in 10 (40%) cases.

Table 2:-summary of relationship of internal carotid artery, optic Nerve and foramen rodtundum to sphenoid sinus

		Sides			
Structures		Right side	Left side	Bilateral	Total
ICA	Protrusion	12 (32.4%)	9 (24.3%)	16 (43.2%)	37 (18.5%)
	Dehiscence	7 (29.17%)	10 (41.7%)	7 (29.17%)	24 (12%)

ON	Protrusion	1 (5.26%)	10 (52.63%)	8 (42.1%)	19 (9.5%)
	Dehiscence	12 (38.7%)	9 (29%)	10 (32.25%)	31 (15.5%)
V2	Protrusion	7 (28%)	8 (32%)	10 (40%)	25 (12.5%)
	Dehiscence	4 (16%)	11 (44%)	10 (40%)	25 (12.5%)

The p-value was calculated to find out the association between protrusion of ON and the pneumatization of anterior clinoid process (ACP), dehiscence of ON and the pneumatization of anterior clinoid process (ACP) and protrusion of vidian nerve (VN) and pneumatization of PP

Table 3:-Chi-Square Tests

Table 3		
(df=1)	**Pearson Chi-square - $\chi 2$**	**p** **95% confidence interval**
pterigoid plate * vidian canal dehiscence	7.864[a]	0.049
protrusion of ON* pneumatization of ACP	.584[a]	.747
dehiscence of ON* pneumatization of ACP	7.945 [a]	0.046

6. DISCUSSION

Sphenoid sinus is one of the PNS subject to remarkable anatomical variations. Sellar pneumatization is the commonest type of pneumatization seen followed by presellar, postsellar 60%, 25.5%, 22.5%: respectively and the least type is being conchal (2 %)

The incidence of the sellar type of pneumatization in literature is found in 52-69% of cases, the presellar type in 10-38%, the conchal type in1-3% and postsellar type 2-42%; in our study the sellar type was as well, most frequently found, in 50% (100 cases); 24 cases on the right, 48 cases on the left and 12 cases it is found bilaterally, in our study male to female ratio is almost similar (61.5%:59.8%); of the cases, above the percentage found in the studies of 52.9% (Gulgun et al., 2005) and 59.4% (Afsoun et al., 2014) but lower than in the studies of 69% (Lupascu et al., 2014). The conchal type was the least frequent (2% of the cases), in other studies this type of pneumatization is seen 1.8% (3 cases out 170 samples) (Senja et al., 2013), 1.9% (Gulgun et al., 2005) , 3% (Lupascu et al., 2014). This type of pneumatization has an increased surgical risk in trans-sphenoidal surgery because of the amount of bone that needs to be drilled, even when guided by neuro-navigation, this type of pneumatization must be contra indication for trans-sphenoidal approach to the pituitary gland (Baldea et al., 2012). Presellar pneumatization is seen 25.5% (51 cases); 33 cases were on the left side, 12 cases on the right and 6 cases bilaterally; above the percentage found in the studies of 9% (Gulgun et al., 2005) this variations are due to too low sample size selection by the study and is consistent with the study 28% (Lupascu et al., 2014)

Extensions of pneumatization in to ACP 18%, of PP 15%, GWS 16.5%; pneumatization of ACP is seen in literatures from 10% - 33%. In a study done in New Jersey, USA ACP pneumatization is found in 20% of the population and was more prevalent in men than women, 27% versus 15.6% (Senja et al., 2013). It was seen in 16 (14.5%) cases in a study done in Oyo-State, Nigeria (Fasunla et al., 2012) and Pneumatization in to ACP 18%; is associated with optic nerve dehiscence in 81% of the cases due to its location having a p value 0.046. In a study done in Constanta, Romania, 33% of the cases were found extensive Pneumatization of the pterygoid process this finding is higher than my finding; 15% this might be due to race and in 8% of the cases there were lateral extensions of Pneumatization in the greater wing sphenoid.

Pneumatization of pterygoid plate is followed by dehisence of vidian canal in 72% of the cases and they are associated by having a p value of 0.049.

Sphenoid sinus septal bone variations are the other anatomical variation seen in the sinus, in present study; Single septum is seen in 89% of our study 77.5% were complete while 11.5% were incomplete, Double septum is seen 10% and absence of septa is seen in 1%. Single complete septum was the most frequent finding (77.5 %); among this majority were oriented in the midline (38%) followed by right side orientation (36.5%), left side orientation was the least frequent (3%); this type of septation is more frequent in females than males (87%:68%) ; when we see other studies: - single septum was found 83.3% in a study done Kerala, India (Priya et al., 2016), in another study which is done in *Mardin, Turkey* A single complete septum is found in 60.5%; a single incomplete septum 30.2%:- totally single septum is seen in 90.7% of the case; as we see it here our results are consistent with the findings that are found in Kerala, India and *Mardin, Turkey.*

Absence of septa in the present study is found in 2 cases (1%); in other papers sphenoidal septum was absent in 3(2.7%) cases In the study done in *Oyo-State, Nigeria* (Fasunla et al., 2012)in other study done in *Mardin, Turkey,* sphenoid sinuses without septum is found 2.2% (n=5) (Riza et al., 2014) absent septa is a rare finding and the results are consistent with other findings.

Regarding variations of adjacent vital Neuro-Vascular structures; In present study Protrusion of the ICA into the sphenoid sinus was identified in 37 cases (18.5%) and dehiscence of the bony sphenoidal wall of the internal carotid artery seen in 24 cases (12%); 19 cases (9.5%) have ON protruding into the sphenoidal sinus and ON dehiscence identified in 31cases (15.5%) In a study done in Mardin Government Hospital, Mardin, Turkey, protrusions of internal carotid artery and optic nerve were detected in 61 (27.9%) and 39 (17.8%) cases, respectively, which is higher than our finding. (Eldan et al., 2012), this might be due to race and also enviromental (developmental) factor.

7. STRENGTH AND LIMITATION OF THE STUDY

7.1. Strengths

The strengths of the study:

1) As to my knowledge, there was no research done on the radiological evaluation of sphenoid sinus anatomic variations. Therefore, this study offers local statistics on sphenoid sinus anatomy and its variants. It serves as a baseline research for anyone who wishes to carry further studies on sphenoid sinus.
2) This research contains multiple variables as compared to other papers.

7.2. Limitations

The limitations of the study were

1) This study is done on a total sample size of 200, due to time and cost limitation.

8. CONCLUSION

The anatomy of the sphenoid sinus is variable. The great amount of anatomic variation is attributed to the extent of sphenoid sinus pneumatization, varying number and position of septae, and followed by the relationship with the surrounding NV structures. Sellar type of pneumatization is the most frequent type of pneumatization visible using CT scan as seen in TASH followed by Presellar and Postsellar. Besides, single complete septum is commonest type of septation expected as anatomic variant of the sphenoid sinus among the study population.

9. RECOMMENDATION

Based on the results of the study, the following recommendations are forwarded

- ✓ Anatomists to give good knowledge about the anatomical variations of sphenoid sinus to their students as it contributes to a better understanding of the possible spread of any tumor or any inflammatory process in the sphenoid sinus and surrounding structures.
- ✓ A radiologist to include these variations in their report since it influences the choice and approach of therapeutic procedures.
- ✓ Further studies should be done including more institutions with large sample sizes
- ✓ Further studies using cadavers is recommended

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ANNEX

I. Data collecting tool

IDENTIFIER

Thank you for being a volunteer to participate in the study that focuses on **Anatomic Variations of Sphenoid Sinus: A Radiological Evaluation**. Now I will ask you few questions about the radiological evaluation of sphenoid sinus.

Section-1:-Demographic data

- Hospital Card No. _____C:\Users\Administrator\Downloads\Telegram Desktop
- Age. _____
- Sex. _____

Section-2:- CT-scans Technique

1) Slice thickness- < 3 mm
    - Specify thickness_____
2) Bone window
    - Plane- **(circle the plane used)**
        A. Sagittal
        B. Coronal
        C. Axial
3) Soft tissue window to check for any pathology affecting the sinus

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Section-3:- CT scans findings

I. Sphenoid Sinus type of pneumatization

1. Conchal
    a) Yes
    b) No

- **IF YES,** distance between posterior wall of the sinus and anterior plane of the sella is_____
- Side of pneumatization
    A. Right
    B. Left
    C. Bilateral

2. **Presellar**- the posterior limit of the sinus extends into the anterior plane of the sella
    A. Yes B. No
    - Side of pneumatization
        A. Right
        B. Left
        C. Bilateral
3. Sellar pneumatization **extending** beyond the tuberculumsellae up to the clivus (posterior plane of the sella)
    A. Yes B. No
    - **IF YES,** in which side?
        A. Right
        B. Left
        C. Bilateral
4. **Post-Sellar**- Pneumatization encroaching the clivus
    A. Yes
    B. No
    - Side of pneumatization
        A. Right
        B. Left
        C. Bilateral

5. Other pneumatization

A. Anterior clenoid process

- If yes 1) Right 2) Left 3) Both

B. Pterigoid plate

- If yes 1) Right 2) Left 3) Both

C. Greator wing of sphenoid

- If yes 1) Right 2) Left 3) Both

II. Sphenoid sinus Septum type

1) Single complete
   - Posterior attachment
     a) Midline
     b) Right side of the midline
     c) Left side of the midline
2) Single incomplete
3) Double septum (Complete & incomplete)
   - Posterior attachment of complete septa
     a) Midline
     b) Right side of the midline
     c) Left side of the midline
   - Position of Incomplete septa in relation to the complete septa
     a) Right Side b) Left side
4) Double septum (Incomplete)
5) Two complete septa
   A. One septa mid line C. Both right side
   B. Right & Left D. Both left side
6) More than two septa
   A. Yes B. No
   - If yes Specify number and completeness _____Septa
   - If there is complete septum specify number and position

   ___Complete & ___Incomplete

   a) __Incomplete septa to the right of the main septum

b) ___incomplete septa to the left of the main septum

c) ___Right and ___left of the main septum

7) No septum

III. Internal Carotid Artery

1) Dehiscence

A. Yes B. No

- **IF YES,** in which side?
  a) Right side
  b) Left side
  c) Both

2) Protrusion

A. Yes B. No

- **IF YES,** in which side?
  a) Right side
  b) Left side
  c) Both

IV. Optic nerve

1) Dehiscence

A. Yes B. No

- **IF YES,** in which side?
  a) Right side c) Both
  b) Left side
  d)

2) Protrusion

A. Yes B. No

- **IF YES,** in which side**?**
  a) Right side c) Both
  b) Left side

V. Foramen Rodtundum/V2

1) Dehiscence

A. Yes B. No

- **IF YES,** in which side?
    a) Right side
    b) Left side
    c) Both

2) Protrusion

A. Yes B. No

- **IF YES,** in which side?
    a) Right side
    b) Left side
    c) Both

VI. **Onodi cell**

A. Yes B. No

- **IF YES,** in which side?
    a) right side of the sphenoid
    b) Left side
    c) superior
    d) Inferior

VII. Vedian canal

1) Dehiscence

A, Yes B, No

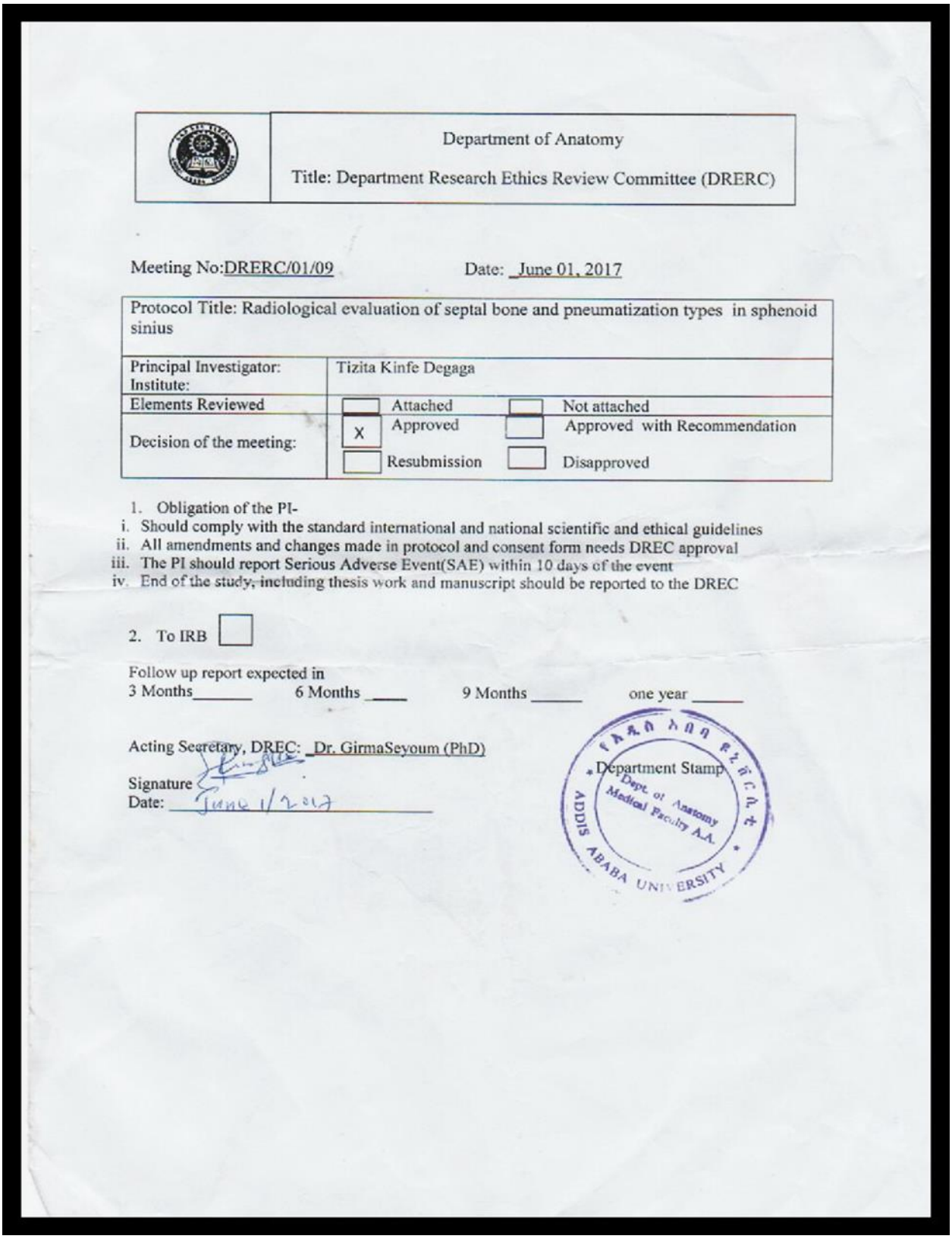
- **IF YES,** in which side?
    A) Right side
    B) Left side
    C) Both

2) Protrusion

A) Yes
B) No

- **IF YES,** in which side?
    A) Right side
    B) Left side

II, Ethical Clearance



Department of Anatomy

Title: Department Research Ethics Review Committee (DRERC)

Meeting No:DRERC/01/09 Date: June 01, 2017

Protocol Title: Radiological evaluation of septal bone and pneumatization types in sphenoid sinius				
Principal Investigator: Institute:	Tizita Kinfe Degaga			
Elements Reviewed	☐	Attached	☐	Not attached
Decision of the meeting:	X	Approved	☐	Approved with Recommendation
	☐	Resubmission	☐	Disapproved

1. Obligation of the PI-
   i. Should comply with the standard international and national scientific and ethical guidelines
   ii. All amendments and changes made in protocol and consent form needs DREC approval
   iii. The PI should report Serious Adverse Event(SAE) within 10 days of the event
   iv. End of the study, including thesis work and manuscript should be reported to the DREC

2. To IRB ☐

Follow up report expected in
3 Months_____ 6 Months ____ 9 Months _____ one year _____

Acting Secretary, DREC: Dr. GirmaSeyoum (PhD)

Signature

Date: June 1/2017

Department Stamp

Dept. of Anatomy Medical Faculty A.A.

ADDIS ABABA UNIVERSITY