"ANATOMICAL VARIATIONS OF SPHENOID SINUS AND RELATED STRUCTURES ON COMPUTED TOMOGRAPHY"

By

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Dissertation submitted to the

BLDEUNIVERSITY, BIJAPUR, KARNATAKA

In partial fulfilment of the requirements for the degree of

DOCTOR OF MEDICINE

IN

RADIO DIAGNOSIS

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ACKNOWLEDGEMENT

With regard to the dissertation titled "**ANATOMICAL VARIATIONS OF SPHENOID SINUS AND RELATED STRUCTURES ON COMPUTED TOMOGRAPHY"** I consider it a privilege to express a few words of gratitude and respect to all those who guided and inspired me in completing the dissertation.

I take this opportunity to express my profound sense of gratitude and indebtedness to my guide **Dr.B.R.DHAMANGAONKAR M.D.** Professor, Department of Radio Diagnosis, Shri B M Patil Medical College, Bijapur, who has been the source of propelling force, complete guidance and inspiration for this dissertation / research work. He has guided me by his constant encouragement and valuable suggestions to carry out and complete this dissertation.

I express my sincere gratitude to **DR. R C PATTANSHETTI M.D.**, Professor and Head, Department of Radio Diagnosis, BLDEU'S Shri B. M. Patil Medical College, Bijapur, who always stood by my side to encourage me in my study and research and for his motivation, enthusiasm, and immense knowledge. His guidance helped me in all the times of research and writing of this dissertation.

My heartfelt thanks to **Dr. M M PATIL** DMRD, Senior Resident, Shri B M Patil Medical College, Bijapur, for his constant support and encouragement.

My sincere thanks are due to **Dr. M S BIRADAR M.D.** Principal, Shri B M Patil Medical College, Bijapur, for his support and encouragement.

I want to thank all the department staff **Dr.Rudresh Hiremath, Dr.Pradeep Sonwalkar, Dr.Shivanand Patil, Dr. Praveen M. Mundaganur, Dr. Vishal N S, Dr.Ajey Bhagwat, Dr.Shriganesh Patil, Dr.Sanket Shah and Dr.Avinash** for their help, support and advice.

I thank my Co-PG **Dr.Narendra,** my juniors **Dr.Vinod, Dr.Chaitra and Dr.Sachin** PG's in Department of Radio Diagnosis, and my sub-juniors **Dr.Shivendra, Dr.Sheetal, Dr.Uday** and **Dr.Puneeth,** PG's in Department of Radio Diagnosis who rendered immense help and support during my postgraduate course. I thank them from my heart.

My sincere thanks to **Mr. M B PATIL, Minister for Major and Medium Irrigation, Government of Karnataka and Chairman BLDE Association** for his support throughout my course of post graduation.

I am thankful to all the Technical and non-teaching Staff of the Department of Radio Diagnosis, Shri. B M Patil Medical College, Bijapur for their co-operation.

I thank Mrs. Vijaya Soraganvi of Community Medicine Department for her valuable help in statistical analysis of data.

I sincerely acknowledge the support and kindness shown towards me by all the staff of Central Library, Shri B.M. Patil Medical College, Bijapur, at all times.

I would like to thank my **parents Shri. S Purushothama** and **Smt. M V Vedhavathi** for their constant encouragement, love, sacrifice and support in all the endeavours of my life and work.

I am grateful to Mr.Kalyan, Preeti net center who have helped in the editing, printing and binding of this thesis work.

Last but not the least, I would like to acknowledge all the participants for providing with necessary data and forming the backbone of this study, without whom this study would not have been possible.

I thank **GOD**, for all his blessings.

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LIST OFABBREVIATIONS

ACP	-	Anterior Clinoid Process
CT	-	Computed Tomography
FESS	-	Functional Endoscopic Sinus Surgery
GWS	-	Greater Wing of Sphenoid
ICA	-	Internal Carotid Artery
MN	-	Maxillary Nerve
MRI	-	Magnetic Resonance Imaging
ON	-	Optic Nerve
PNS	-	Paranasal Sinus
PP	-	Pterygoid Process
USG	-	Ultrasonography
VN	-	Vidian Nerve

ABSTRACT

Background:

Coronal computed tomographic study has become the most requested and precise imaging technique to demonstrate paranasal sinuses. The advantage of coronal sections is that it shows progressively deeper structures as encountered by the surgeon during functional endoscopic sinus surgery.

Out of all the paranasal sinuses sphenoid sinus is the most inaccessible sinus to the surgeons. The trans-sphenoid route is considered the standard approach for surgery of pituitary adenomas. Knowing the details of the anatomy of the sphenoid sinus and the extent of pneumatisation can guide the surgeon through difficult corners of the approach.

Aims and Objectives:

To demonstrate the anatomical variations of sphenoid sinus and related structures on computed tomography to help in the transsphenoidal and functional endoscopic sinus surgery and reduce complications due to it.

Materials and Methods:

Patients above 16 years of age who are referred to the Radiodiagnosis Department of B.L.D.E.U's ShriB.M.Patil Medical College Hospital and Research Centre with complaints of headache and sinusitis are included in this study.

Patients younger than 12 years are excluded from the study. Patients with prior surgery, sinonasal tumors, severe cervical arthropathy and head & neck injuries are excluded from the study.

Patients will undergo coronal sections on CT scan. Contiguous 03 mm sections with 1.5mm reconstructions will be obtained through the paranasal sinuses.

Results:

Vidian nerve protrusion was the most common variation (83%) followed by pneumatized pterygoid process (71%), anterior clinoid process (36%) and greater wing of sphenoid(10%).

Internal carotid artery protrusion into the sphenoid was noted in 22% and dehiscence in 4%. Protrusion of optic nerve in this study was seen in 39% and dehiscence of optic nerve in 8%. Maxillary nerve protrusion was noted in 37% and dehiscence of nerve in 8%. Vidian nerve dehiscence was noted in 41%.

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INTRODUCTION

The sphenoid sinus is deeply seated in the skull and is the most inaccessible paranasal sinus. It is surrounded by vital structures, such as the internal carotid artery, optic nerve and cavernous sinus[1].

It emerges in the fourth month as evagination from posterior nasal capsule into the sphenoid bone. Sinus will obtain the adult configuration by the age of 10 to 12 years[2].

The degree of pneumatization of sphenoid sinus varies & depending on that the sinus is classified as non pneumatized, presellar and sellar[2]. As result of extensive pneumatization of sphenoid sinus vital structures like internal carotid artery, optic nerve, vidian nerve and maxillary nerve can be protruded into the sinus with or without bony walls[2].

Coronal computed tomographic study has become the most requested and precise imaging technique to demonstrate paranasal sinuses[3]. The advantage of coronal sections is that it shows progressively deeper structures as encountered by the surgeon during functional endoscopic sinus surgery[4].

Out of all the paranasal sinuses sphenoid sinus is the most inaccessible sinus to the surgeons[5]. The trans-sphenoid route is considered the standard approach for surgery of pituitary adenomas. Knowing the details of the anatomy of the sphenoid sinus and the extent of pneumatisation can guide the surgeon through difficult corners of the approach[6].

The endoscopic transnasal approach to sphenoid sinus is a technique, which has established itself in the recent years and demands a thorough knowledge of the surgical anatomy and a huge amount of anatomical variations involving the sphenoid sinus[7].

In our study we intend to evaluate the anatomical variations of sphenoid sinus and its effect on the adjacent neurovascular structures.

AIMS AND OBJECTIVES

To demonstrate the anatomical variations of sphenoid sinus and related structures on computed tomography to help in the transsphenoidal and functional endoscopic sinus surgery and reduce complications due to it.

HISTORIC PERSPECTIVE

Sinonasal inflammatory disease is a frequently encountered health problem. Traditionally, plain films were the modality of choice in evaluation of sinus pathology. Clinical and radiographic emphasis was directed primarily to the maxillary and frontal sinuses. In recent years, it has become evident that sinusitis is primarily a clinical diagnosis. The role of imaging is to document the extent of disease, to answer questions regarding ambiguous cases, and to provide an accurate display of the anatomy of the sinonasal system.

Imaging now provides the surgeon with a detailed "road map" for guiding the functional endoscopic sinus surgery procedure. CT was invented in 1972 by British engineer Sir Godfrey Hounsfield of EMI laboratories, England and by South African born physicist Allan Cormack of Tufts University, Massachusetts. Hounsfield and Cormack were later awarded the Nobel Peace Prize for their contributions to medicine and science. Today, computed tomography (CT) is the modality of choice for the imaging evaluation of the morphology in this area.

Although most patients with sinonasal inflammatory disease are initially treated medically, the disease often does not resolve. Patients with persistent disease usually require surgical intervention, and the surgical treatment of refractory inflammatory sinus disease has undergone revolutionary changes in the last 10 to 20 years. These advances are due to an improved understanding of the mucociliary clearance pathways in the nasal cavity and paranasal sinuses, improved endoscopes that afford direct access to nasal cavity and ethmoid sinus drainage portals, and the availability display of the regional anatomy and anatomical variations.

Functional endoscopic sinus surgery (FESS) was first described independently by both Messseklinger in the German literature and Wigand Steiner, and Jaumann in the English literature in 1978. FESS was introduced in the United States in 1984 by Kennedy et al. and subsequent evolution of the technique has occurred through innovations in both the surgical and radiologic fields.

REVIEW OF LITERATURE

Between May 2006 and May 2007 a prospective study comprising of 300 paranasal computerized tomography scans of Libyan patients attending Al-Jalla Trauma Hospital, Benghazi, Libya was done[1].

In all the patients, the existence of the following variants were investigated: pneumatization of pterygoid process (PP), anterior clinoid process (ACP), and greater wing of sphenoid (GWS, i.e. floor of middle cranial fossa), protrusion of internal carotid artery (ICA), optic nerve (ON), maxillary nerve (MN) , and vidian nerve (VN) , and dehiscence of the walls of internal carotid artery, optic nerve , maxillary nerve , and vidian nerve.

The anatomical variations of the sphenoid sinus in Libyan population were remarkably common. Prevalence of protrusion and dehiscence of the internal carotid artery and optic nerve were high. The internal carotid artery and optic nerve may not be well protected and thus could be damaged during endoscopic sphenoid surgery. Protrusion of the vidian canal into the sinus cavity was strongly associated with pneumatization of the pterygoid process, on the same side. Coronal CT screening should be used in the pre-surgical evaluation of patients under consideration of endoscopic sphenoid sinus surgery to minimize perioperative neural and vascular injury.

In 2012 a retrospective study comprising of both the coronal and axial CT images of the paranasal sinuses were reviewed in black African population[52].

CT images of the paranasal sinuses and brain of 110 patients were reviewed, which were obtained for head and neck diseases other than malignancies, nasal polyps and craniofacial trauma.

All scans were evaluated on both soft tissue and bone windows for the identification of protrusion of optic nerve (ON) and internal carotid artery (ICA) into the sphenoid sinus, pneumatisation of the anterior clinoid process (ACP) and position of the sphenoid septum.

Anatomic variations in relationship of sphenoid sinus to ON and ICA are seen on CT examinations in black Africans population. The endoscopic head and neck surgeons managing black Africans should be aware of these varied relationships and ensure a detailed pre-operative review of the CT scans to avoid the potential risks of blindness, uncontrollable haemorrhage and death that may attend anatomically uninformed sphenoidal surgeries[52].

In 2004 a study on 64 cadaveric specimens was conducted. This study described computer-generated anatomic symmetry plane as a framework for the quantitative description of sphenoid sinus anatomy[8].

The aim of this study was to

(a) determine relationships and distances between a midline sphenoid reference point called the central sphenoid point and lateral sphenoid wall structures and

(b) assess the incidence of anterior clinoid process pneumatisation and pterygoid recess pneumatization.

A total of 128 slides in 64 cadaveric specimens were available for review. The incidences of anterior clinoid process pneumatisation and pterygoid pneumatization were 23.4 and 37.5%. The mean distances from the central sphenoid point to the left optic canal midpoint, the left anterior clinoid process entrance point, and the left pterygoid recess lateral wall were 17.2, 15.6, and 27.6 mm, respectively. The corresponding distances from the central sphenoid point on the right side were 17.3, 15.8, and 28.0 mm, respectively. Measurements from the maxillary spine to the optic canal midpoint, anterior clinoid process entrance point, and pterygoid recess lateral wall on each side were performed also. The approaches described in this study describe critical sphenoid anatomic relationships; such information will facilitate a wide variety of sphenoid procedures. This approach provides both quantitative and qualitative understanding of sphenoid osteology and may be coupled with intraoperative surgical navigation to reduce the risks of sphenoid surgery.

In 2005 a study of sphenoid sinus anatomy in relation to endoscopic surgery was done[7]. From the study, the following points of surgical significance may be concluded:

Pneumatization of the sphenoid sinus is highly variable and may be a helpful guide in deciding the surgical approach to the hypophysis.

Patterns of septation in the sphenoid sinus are highly variable making it an unreliable guide to the midline. Moreover, the septae may be attached to the bony bulges over the optic nerve or the internal carotid artery, which has to be taken into account if the septae are scheduled to be perforated.

The surgeon must always remember that the optic canal and internal carotid artery may not be well protected in the area of sphenoid and are liable to injury.

The superior turbinate is a reliable and consistent anatomic marker for localization of the sphenoid sinus, especially, in revision surgeries where middle turbinate has been already removed.

The study suggests strong possibilities of racial variations in terms of relationship of the internal carotid artery and optic nerve to the sphenoid sinus, in the Indian population.

ANATOMY OF SPHENOID SINUS

EMBRYOLOGICAL DEVELOPMENT[9]

The development of the sphenoid sinus is unique because of two factors:

(1) It is the only sinus that does not arise as an out pouching from the lateral nasal wall and

(2) There is no primary pneumatization, but rather a constriction of the developing presphenoid recess followed by secondary pneumatization.

During the third month of fetal development the nasal mucosa invaginates into the posterior portion of the cartilaginous nasal capsule. This primordium is only a small presphenoid recess within the posterior end of the cartilaginous nasal capsule.

By the end of the third and early fourth fetal months the postero-superior portion of the recess is separated incompletely from the nasal cavity by the development of a nasal mucosal fold, inferiorly based, curving upward and anterior to the body of the presphenoid.

As the nasal capsule undergoes chondrification, a cartilaginous concha forms within this fold, developing cartilaginous concavities, which, by the fifth fetal month, enclose the presphenoid recess. This site of initial sinus rudiment and of initial constriction is preserved in adulthood as the location of the sinus ostium. The wall surrounding this cartilage is ossified in the later months of fetal development.

At birth the sphenoid sinus is no more than an encircled recess, located between the sphenoid concha and the presphenoid body.

After birth, the sphenoid sinus primordium grows inferiorly and posteriorly. In the second and third years the intervening cartilage is resorbed, and part of the sphenoid concha fuses to the presphenoid body; the resulting cavity clearly becomes the sphenoid sinus.

The presphenoid recess becomes the sphenoethmoid recess. Following this fusion, pneumatization of the sphenoid occurs with expansion into the presphenoid and, later, the basisphenoid parts of sphenoid bone, with the sphenoid concha remaining as the anterior sinus wall.

By the age of 8 to 10 years a real sinus cavity may be observed, although the definitive form of the sinus is attained at puberty.

The origin of the sphenoid sinus from the posterior nasal cavity is always identified by the sinus ostium (the location where the sphenoid recess retained its continuity with the nasal cavity), which is located high on the anterior sinus wall, just a few millimeters below the sphenoethmoid recess.

ANATOMY[9]

The sphenoid sinus is generally a set of paired, asymmetric cavities lying within the sphenoid bone.

This bone is one of the most complex bones in the human body, forming the main part of the central skull base, a portion of the lateral skull, most of the apical component of the orbit, and the posterior wall of the nasopharynx.

It is attached to the basiocciput, the petrous, and the squamous portions of the temporal bone.

The sphenoid bone is the largest single bone in the skull base and is composed of a body that gives rise to the structures the sella turcica, the lesser wings (superiorly), the greater wings, the pterygoid plates (inferiorly), and the upper part of the clivus.

The sphenoid bone resembles a butterfly and contributes to the floor of the middle cranial fossa. The body of the “butterfly” is formed by the body of the sphenoid bone, and the wings are represented by the greater wings of the sphenoid bone.

The remainder of the floor of the middle cranial fossa is formed by the petrous and squamous parts of the temporal bone. The sphenoid sinus is located inside the body of the sphenoid bone. It has six sides toward the endocranial cavity and two sides toward the nasal cavity and nasopharynx.

The *superior wall or roof* of the sphenoid sinus is very thin and contributes to the anterior and middle floors of the base of the skull. It lies in direct contact, from front to back, with the olfactory nerves, the optic chiasm and the hypophysis.

The roof of the sphenoid sinus is in continuity with the roof of the ethmoid sinus, and this provides a useful landmark for surgical dissection. The bony walls of each lateral side are also very thin and composed of two areas: the orbital area in front and the cranial area behind.

Depending on the degree of pneumatization of the sphenoid sinus, it is possible to see, immediately adjacent to the lateral walls of the sphenoid bone, several very important structures: the internal carotid artery, the optic nerve and, more posteriorly, the cavernous sinus and its contents[53-56].

The *posterior wall* of the sphenoid bone forms the floor of the sella turcica, which is also known as the hypophyseal or pituitary fossa.

It is composed of three parts:

a) An olive-shaped swelling called the tuberculum sellae,

b) A saddle-like depression called the hypophysial fossa, and

c) Posteriorly the dorsum sellae.

The *anterior wall* of the sphenoid bone faces the upper region of the nasal cavity and is connected to the perpendicular plate of the ethmoid and vomer in the midline and to the lateral masses of the ethmoid bone on each side[9].

Between these attachments remains a free vertical surface above each nasal cavity on either side of the nasal septum. The anterior wall can be displaced by well developed Onodi cells of the posterior ethmoid sinus.

In this situation, the optic nerve is surrounded by the Onodi cells. It is on this vertical surface that the sphenoethmoid recess is located above the choana and between the superior or supreme turbinates and the septum.

The *inferior wall or floor* of the sphenoid bone forms the dome of the choanae (posterior nares) and the nasopharynx. The junction of the anterior and inferior walls makes an obtuse, rounded angle called the choanal arch, which demarcates the border between the nasal cavity in front and the nasopharynx behind.

The choana is limited laterally by the medial plate of the pterygoid process, medially by the posterior border of the septum, superiorly by the body of the sphenoid and by the posterior edge of the vomer, and inferiorly by the horizontal plate of the palatine bone (which also represents the posterior limit of the floor of the nasal cavity).

The bony plate of this choanal arch is relatively thick, reinforced by the ala of the pterygoid plate and vomer. The nasopalatine artery runs along this arch toward the septum.

The lesser wing of the sphenoid bone forms the posterior lip of the anterior cranial fossa, part of the orbital wall that includes the optic canal and the anterior clinoid processes.

The lesser wing is connected to the frontal bone along the posterior border of the anterior cranial fossa and to the cribriform plate of the ethmoid bone in the midline. It contributes to the posterior, apical area of the orbit, which includes the optic canal and the superior orbital fissure.

The anterior clinoid process extends from the posterior border of the lesser wing laterally to the optic canal. This is a very important anatomical landmark for identifying the location of the optic chiasm[9].

The greater wing constitutes the largest portion of the sphenoid bone extending from the body of the sphenoid laterally to form part of the floor of the middle cranial fossa.

More anteriorly, the greater wing forms the posterior wall of the orbit, including the inferior lip of the superior orbital fissure.

Posteriorly, the greater wing creates the lateral side of the carotid canal.

Projecting off the inferior and most posterior portion of the greater wing is the spine of the sphenoid bone, an important landmark for identification of the foramina spinosum from which pass the middle meningeal vessels and the recurrent meningeal branch of the mandibular division of the trigeminal nerve.

The greater wing of the sphenoid bone has two more foramina:

1. The foramen rotundum (which is crossed by the maxillary branch of the trigeminal nerve)
2. The foramen ovale (which transmits an accessory meningeal artery and the mandibular division of the trigeminal nerve).

The medial and lateral pterygoid plates extend inferiorly from the body of the sphenoid and are attached to the posterior wall of the maxillary sinus on the medial surface[9].

The medial pterygoid plate also forms the lateral wall of the nasopharynx superior to the Eustachian tube. Between the base of the pterygoid plate and the vertical segment of the palatine bone is an opening called the sphenopalatine foramen (although not a true foramen), located 10 to 12 mm above the posterior end of the middle turbinate and in front of the choanae.

This foramen transmits the sphenopalatine artery and the posterosuperior nasal branches of the maxillary nerve.

The clivus is the inferior projection of the body of the sphenoid and forms the posterior wall of the nasopharynx and part of the anterior wall of the foramen magnum.

The sphenoid sinus is formed by two generally asymmetric cavities in the body of the sphenoid bone. Asymmetry is caused by displacement of the median septum of the sphenoid sinus, which can take on a vertical, transverse, or oblique disposition. It may be in the midline, be S-shaped or C-shaped, be complete or incomplete, or even have an accessory septum[9].

In some cases, the sphenoid bone can have three seemingly identical cavities.

This anatomical variation combined with the degree of pneumatization and extension of the sphenoid sinus to other adjacent bony structures gives this sinus great variability in shape, size, and wall thickness even from one side to the other.

The average adult sphenoid sinus measures 20 mm x 23 mm x 17 mm, being smallest in the anteroposterior dimension. The size of the sphenoid sinus depends on the degree of intramural and extramural pneumatization.

The intramural extension of the sinus is observed in the greater wings, lesser wings, and pterygoid plates of the sphenoid bone, whereas the extramural expansion is seen in the maxillary and ethmoid bones. Depending on the degree of pneumatization, the sphenoid sinus can be described as condral, presellar, or sellar[9].

When the pneumatization of the sphenoid sinus is well developed, the surrounding vessels and nerves are in contact with the lateral wall of the sinus and are seen in the sinus cavity as ridges. The internal carotid artery and the optic nerve are the two important anatomical structures seen on the lateral wall of the sphenoid sinus.

Normally, a thin layer of bone covers these structures. However, in some individuals this bone may become very thin or completely disappear.

The internal carotid artery ascends from the carotid canal and courses vertically to cross posterior and lateral to the optic nerve. The optic nerve passes through the orbital apex transversely across the lateral wall of the sinus. Usually there is a depression in the lateral wall of the sinus called the optic recess just anterior and inferior to where the carotid artery and the optic nerve cross.

This is a very important landmark identifying the sinus cell as the sphenoid sinus and indicating the position of the carotid artery and optic nerve. In addition, the bulging of the maxillary nerve may be seen on the lateral wall of the sinus. The canal for the vidian nerve may bulge on the floor of the sphenoid sinus[9].

Thus, the carotid artery, optic nerve, ophthalmic or maxillary divisions of the trigeminal nerve, or the vidian nerve may be found immediately under the mucosa of the sphenoid sinus, without a bony covering. For this reason, any dissection should be carefully performed on the lateral wall of the sinus, taking into consideration the anatomical variation of the bony structures of the ethmoid and sphenoid bones and also from the internal carotid artery.

The cavernous sinus lies inferior to the location where the carotid artery and optic nerve cross on the lateral wall of the sphenoid sinus. This structure is usually separated from the sinus by a thick wall of bone.

Minor incomplete septations of the sphenoid sinus are also common.

Removal of any sphenoid septations should be undertaken with great care, as the septations and the intersinus septum are sometimes attached off midline near or on the bony canal of the optic nerve and/or the internal carotid artery[9].

The ostium of the sphenoid sinus is usually located in the sphenoethmoid recess, medial to the superior or supreme turbinates and close to the nasal septum. It is a few millimeters below the cribriform plate, ~1 cm above the choana, and 5 mm lateral to the nasal septum. The shape of the sphenoid sinus ostium varies widely. It may be elliptical, oval, or round, with 2 to 3 mm in diameter.

There may be two or more ostia on one side. The shape of the sinus is determined by the varying degrees of pneumatization that take place in the secondary pneumatization.

The sphenoid sinus may pneumatise beyond the confines of the sphenoid body to the greater or lesser wings, the medial and lateral pterygoid plates, the palatine and basioccipital bones, or the ethmoid bone. The lateral expansion brings the sphenoid into contact with the second and third divisions of the trigeminal nerve as well as the nerve of the pterygoid canal (vidian nerve).

The sphenoid sinus may be classified according to its degree of pneumatization:

1. Conchal or fetal-type sinus with minimal extension, which is relatively rare(2%);
2. Presellar or juvenile-type sinus, expanding posteriorly to the anterior sellar wall, which occurs in~10 to 24% of the adult population; and
3. Sellar or adult-type sinus, extending below the sella or farther, which may be found in as many as 86% of all adults[9].

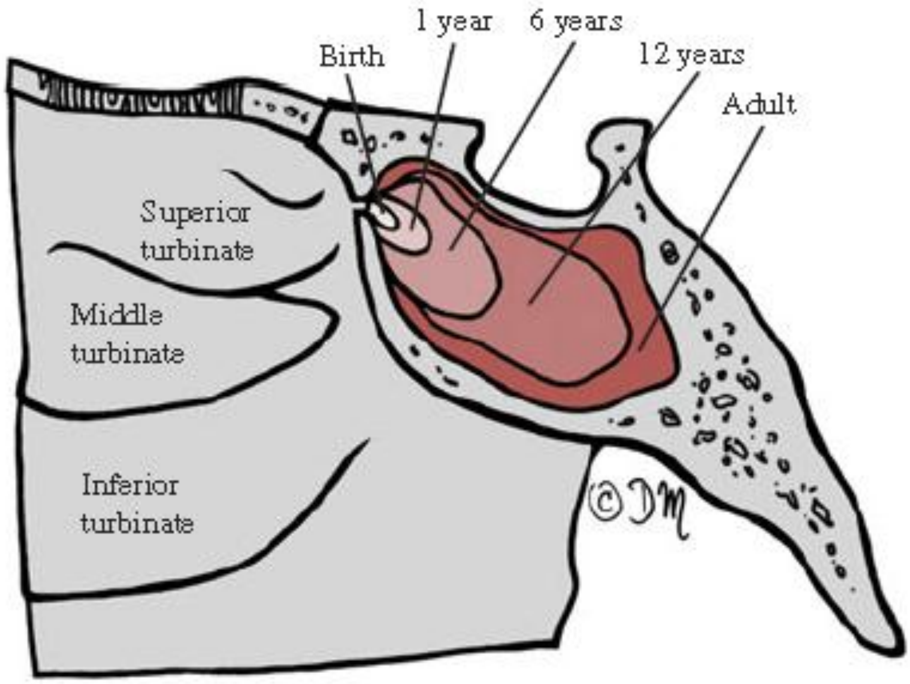


FIGURE 1: Developmental pattern of the sphenoid sinus.

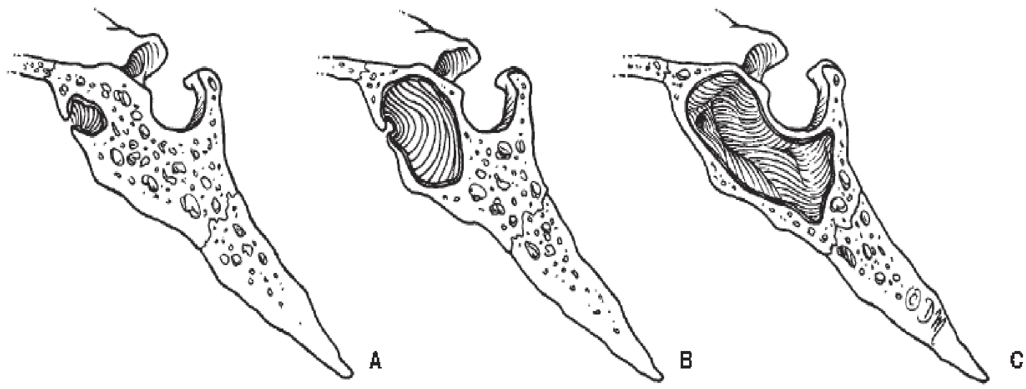


FIGURE 2 : Anatomical variations of the sphenoid sinus pneumatization.

A. Conchal or fetal type

B. Presellar or juvenile

C. Sellar or adult type

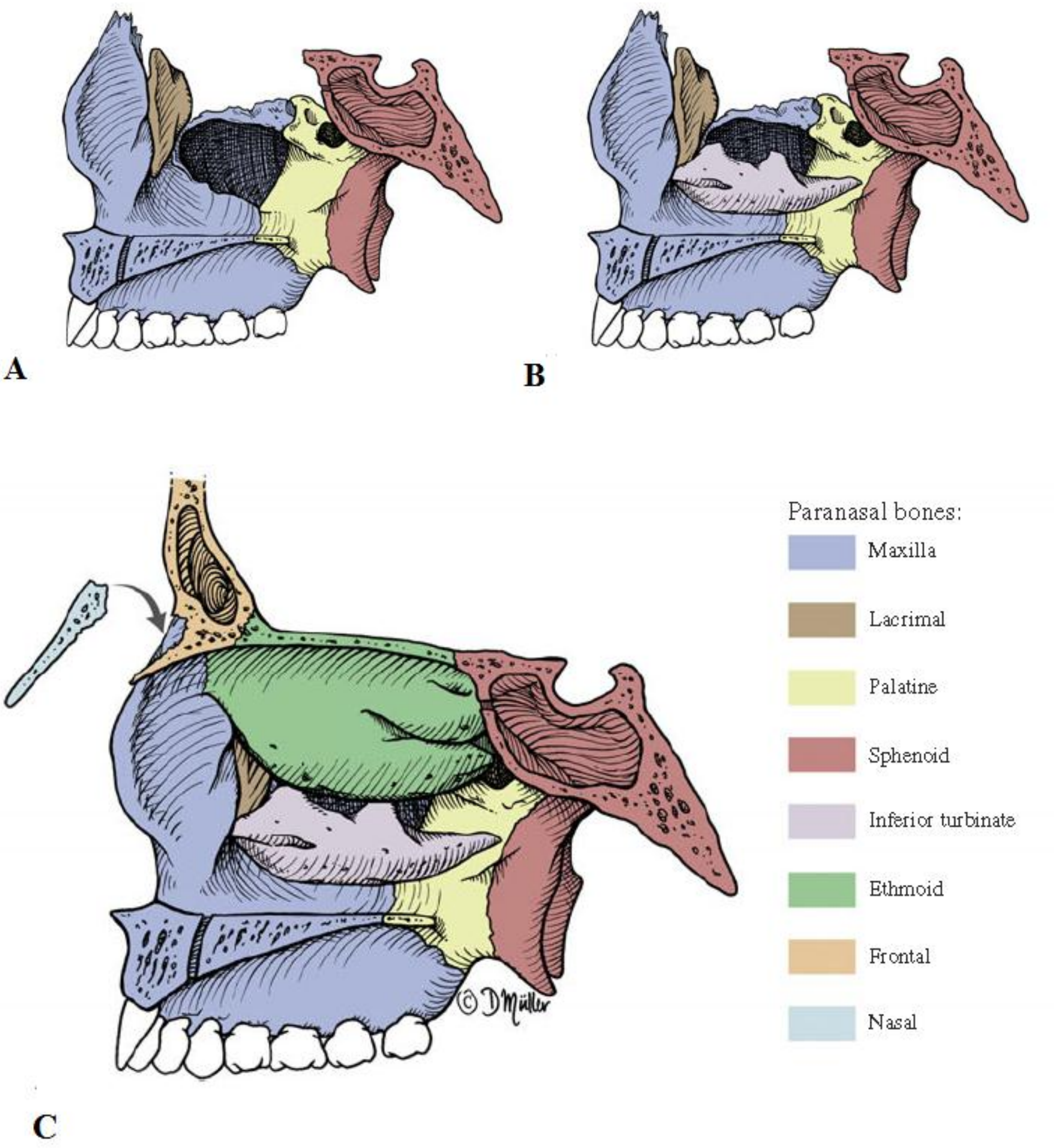


FIGURE 3: Osteology of the right lateral nasal wall.

A) Articulation of the maxilla with the sphenoid bone.

B) Articulation of the maxilla with the inferior turbinate.

C) Articulation of the maxilla with the ethmoid labyrinth and nasal bone.

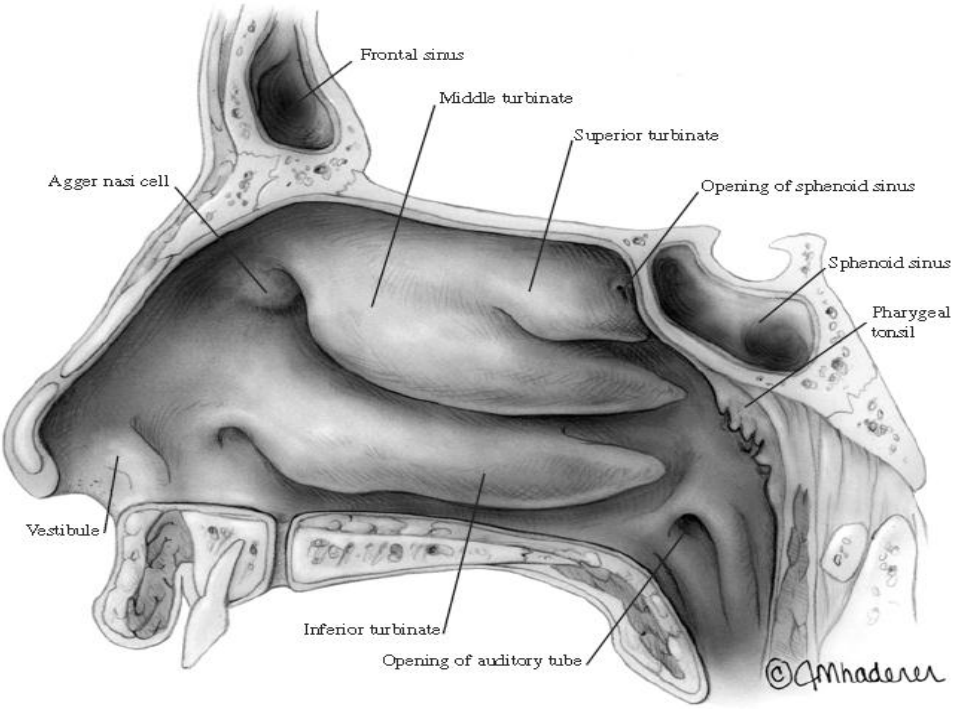


FIGURE 4: Lateral nasal wall anatomy

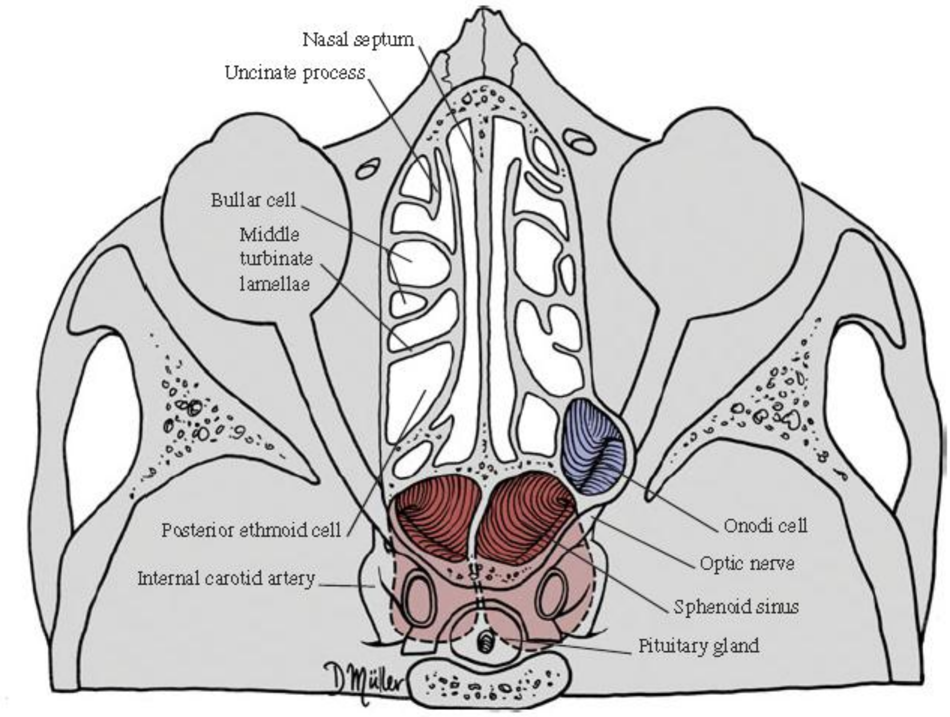


FIGURE 5:

Sagittal section showing sphenoid sinus relationship with the optic nerve, internal carotid artery, and a posterior ethmoid cell (Onodi cell or sphenoethmoid cell).

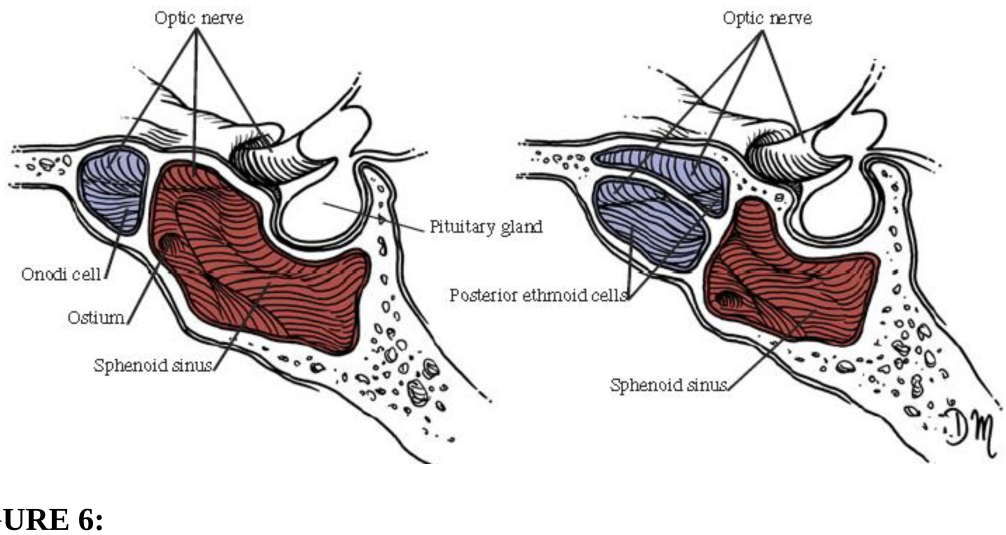


FIGURE 6:

Anatomical variations of the posterior ethmoid cells and their relationship with the sphenoid sinus and the optic nerve.

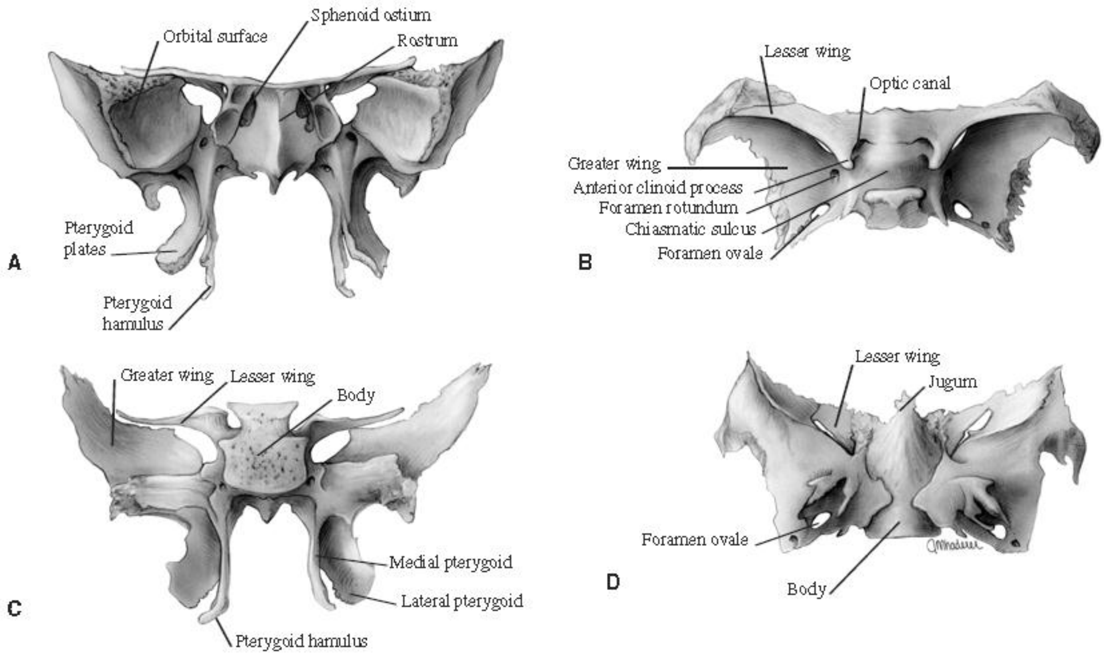


FIGURE 7: Bony anatomy of the sphenoid bone

A) Anterior view

B) Superior view

C) Posterior view

D) Inferior view

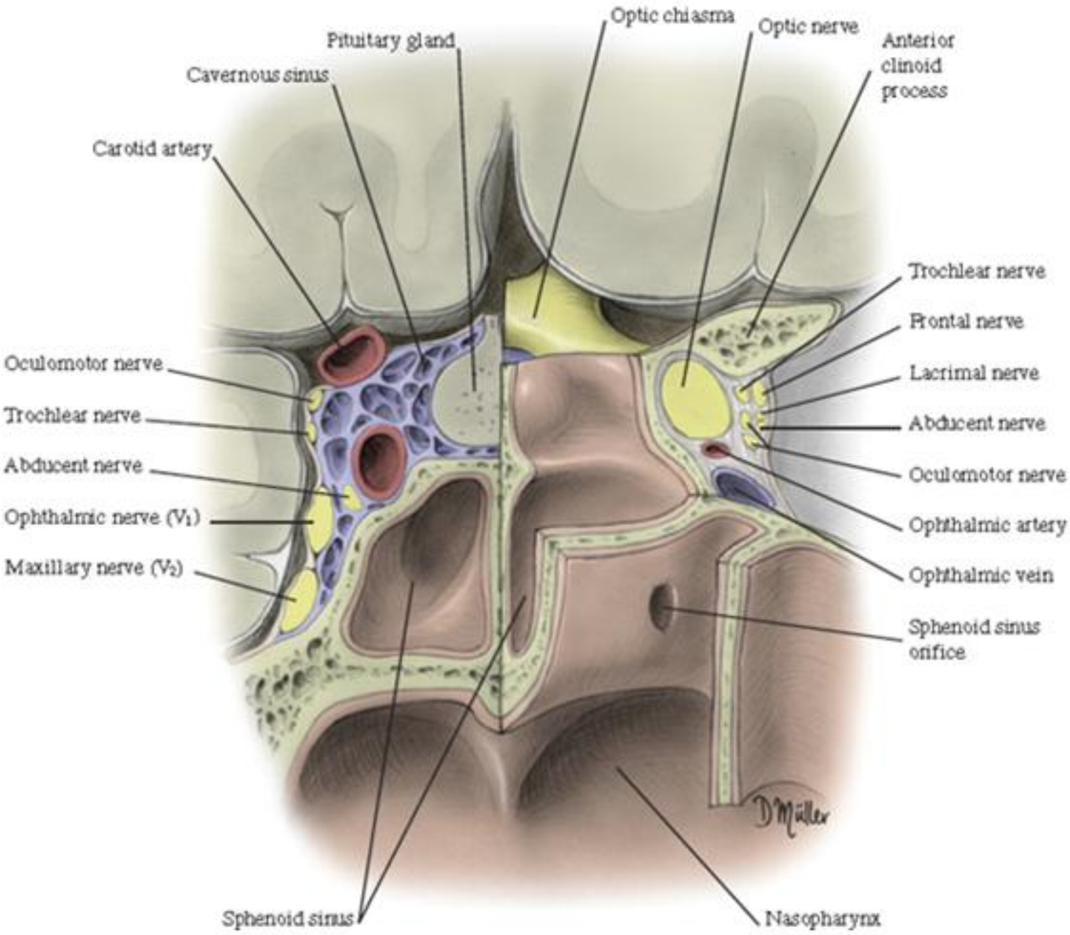


FIGURE 8: Coronal section at various levels illustrating the relationship with surrounding vascular and neural structures.

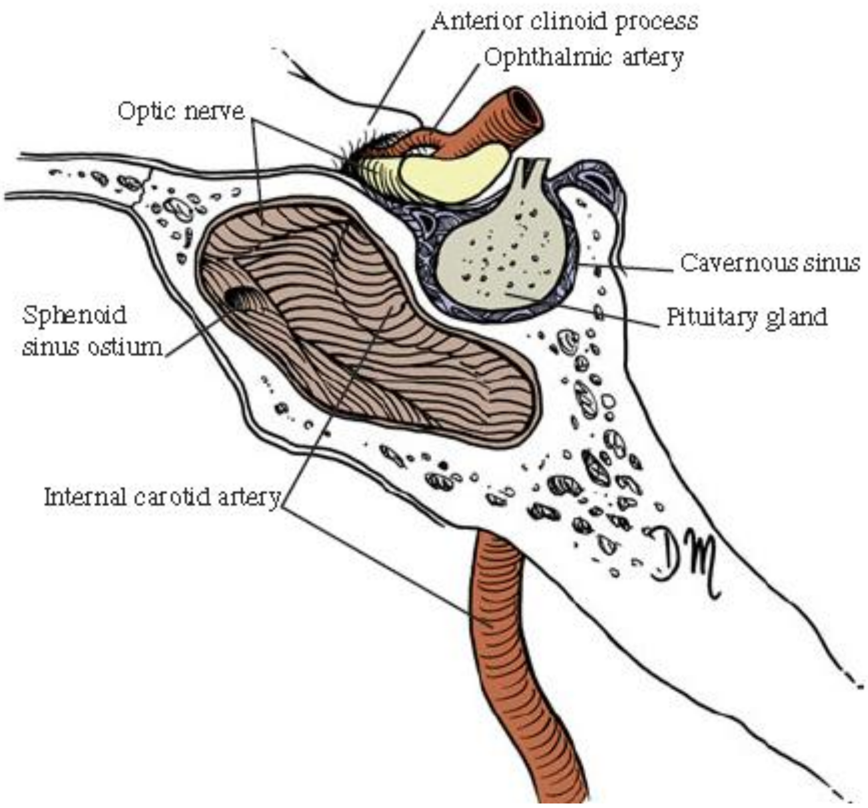


FIGURE 9: Sagittal section showing the adjacent courses of the internal carotid artery and the optic nerve.

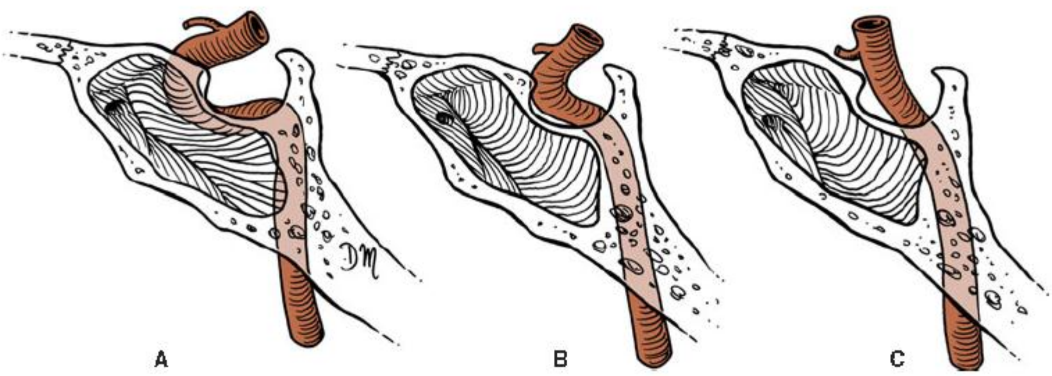


FIGURE 10: Anatomical variations in the course of the internal carotid artery in relation to the sphenoid sinus.

A) Exposed within the sphenoid sinus

B) Covered by thin bone with minimal protection

C) Extensive bony coverage and protection

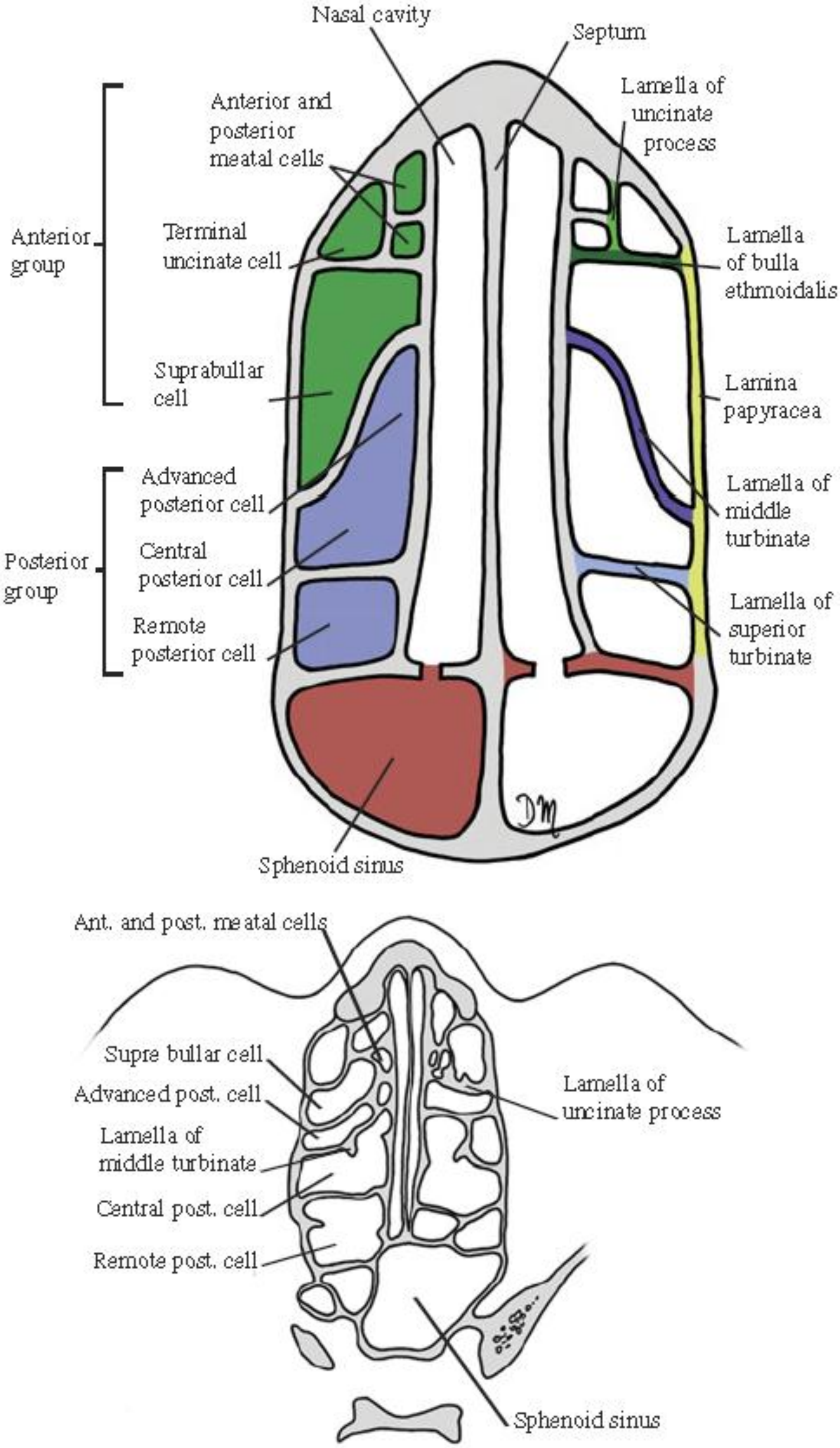


FIGURE 11: Basic cellular structure of the sinuses

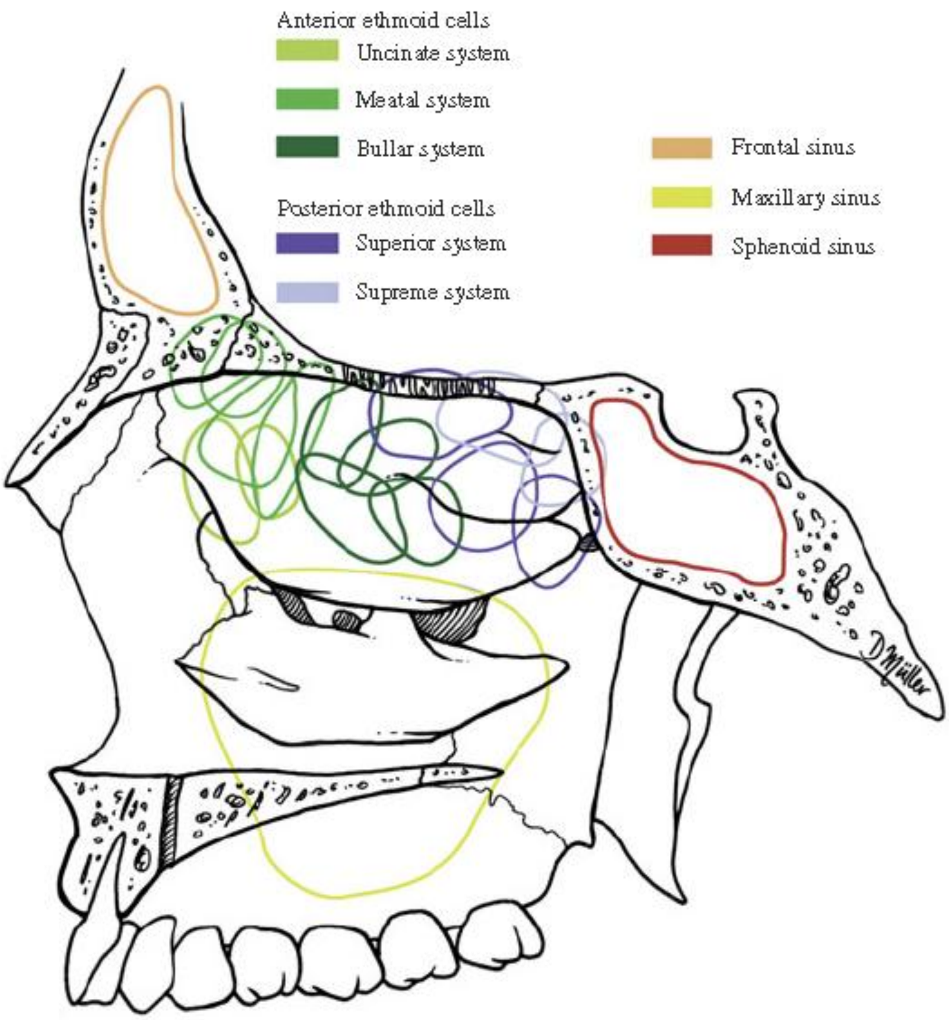


Figure 12: Lateral view of sinuses

PHYSIOLOGY OF MUCOCILIARY CLEARANCE

The movement of this mucous blanket is referred to as mucociliary clearance. Inflammatory sinus disease results primarily from interference of mucociliary clearance due to compromise of the drainage portals (ostiomeatal channels) of the individual sinus cavities.

The mucosa of the paranasal sinuses and nasal fossae is made up of a ciliated cuboidal epithelium that secretes mucus. The cilia are in constant motion and act in concert to propel the mucus in each sinus toward the sinus ostium and then, once in the nasal fossae, back toward the pharynx. The pattern of flow is specific for each sinus and persisits even if alternative openings are surgically created in the sinus.

In the maxillary sinus, mucous flow is directed centripetally toward the primary ostium. The mucus is then transported through the infundibulum to the hiatus semilunaris, once it passes into the middle meatus and ultimately into the nasophayrnx.

In the frontal sinus, the mucous flows into the primary ostium down the frontal recess and then into the middle meatus, where it joins the flow from the ipsilateral maxillary sinus.

The posterior ethmoid and sphenoid sinuses clear their mucus into the sphenoethmoidal recess. The flow then enters the superior meatus and subsequently the nasopharynx.

ANATOMICAL VARIATIONS

In each case existence of following variants will be looked for: pneumatization of pterygoid process, anterior clinoid process and greater wing of sphenoid, protrusion of internal carotid artery, optic nerve, maxillary and vidian nerve and dehiscence of walls of internal carotid artery, optic nerve, maxillary and vidian nerves.

Dehiscence is defined as absence of visible bone density separating the sinus from the course of concerned structures. Protrusion of internal carotid artery and optic nerve will be determined by finding any degree of protrusion of the structures into the sinus cavity. Presence of air density around the vidian nerve and maxillary nerve in at least one coronal section is accepted as protrusion of vidian nerve and maxillary nerve. Pterygoid process pneumatization is recognized if it extends beyond horizontal plane crossing vidian canal. Greater wing sphenoid pneumatization is considered when it extends beyond vertical pane crossing the maxillary canal.

The optic nerve, carotid arteries, and vidian nerve develop prior to the paranasal sinuses, and are responsible for the congenital variations in the walls of the sphenoid sinus. Delano, et al., categorized the various relationships between the optic nerve and posterior paranasal sinuses into four groups,[9] as follows:

- Type I: The most common type, it occurs in 76% of patients. Here, the nerve courses immediately adjacent to the sphenoid sinus, without indentation of the wall or contact with the posterior ethmoid air cell.
- Type II: The nerve courses adjacent to the sphenoid sinus, causing an indentation of the sinus wall, but without contact with the posterior ethmoid air cell.
- Type III: The nerve courses through the sphenoid sinus with at least 50% of the nerve being surrounded by air.

- Type IV: The nerve course lies immediately adjacent to the sphenoid and posterior ethmoid sinus

The relationship of ICA to the sphenoid sinus was 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.

Anterior clinoid process pneumatisation is associated with type II and type III optic nerve and predisposes this nerve to injury during FESS.

MATERIAL & METHODS

SOURCE OF DATA:

This study will be carried out in the Department of Radio Diagnosis, B.L.D.E.U's Shri B.M. Patil Medical College Hospital and Research Centre, Bijapur on patients above 16 years of age who are referred to the Radio Diagnosis Department with complaints of headache and sinusitis.

METHOD OF COLLECTION OF DATA:

Methodology:

Patients will undergo both coronal and axial sections. For coronal images the patients will be positioned prone with head hyperextended and scanner gantry angled perpendicular to the hard palate. Contiguous 03 mm sections with 1.5mm reconstructions will be obtained through the paranasal sinuses.

The exposure settings are 120 kVp and 80 to 160 mAs with a scan time of 5 to 7 seconds, window width of 1500 to 2000HU.

In each case existence of following variants will be looked for: pneumatization of pterygoid process, anterior clinoid process and greater wing of sphenoid, protrusion of internal carotid artery, optic nerve, maxillary and vidian nerve and dehiscence of walls of internal carotid artery, optic nerve, maxillary and vidian nerves.

INCLUSION CRITERIA:

Patients above 16 years of age who are referred to the Radio Diagnosis Department of B.L.D.E.U's Shri B.M. Patil Medical College Hospital and Research Centre with complaints of headache and sinusitis are included in this study.

EXCLUSION CRITERIA:

Patients younger than 12 years are excluded from the study.

Patients with prior surgery, sinonasal tumors, severe cervical arthropathy and head & neck injuries are excluded from the study.

STATISTICAL ANALYSIS:

Duration of study: November 2011 to April 2013.

All the subjects during this period, who will fulfil the inclusion criteria, will be included in the study.

From September 2009 to September 2011, 116 computed tomographic scan of paranasal sinuses were done in the Radio Diagnosis Department of B.L.D.E.U's Shri B.M. Patil Medical College Hospital and Research Centre.

So a minimum of 100 cases will be included in the study.

At the end of the study all the data will be compiled and analysed statistically using:

- Diagrammatic representation
- Mean +/- Standard deviation.

RESEARCH HYPOTHESIS:

A comprehensive knowledge of the variable regional anatomy of the sphenoid sinus will undoubtedly reduce the surgical complications associated with transsphenoidal and functional endoscopic sinus surgery.

ETHICAL CLEARANCE:

Ethical clearance was obtained from the institution.

PHILIPS - Brilliance(6 slice MDCT)

PHILIPS - Brilliance (6 slice MDCT)

IMAGING MODALITIES FOR SPHENOD SINUS

CT SCAN:

CT scan is currently the modality of choice in the evaluation of the sphenoid sinuses and adjacent structures.

Its ability to optimally display bone, soft tissue, and air provides an accurate depiction of both the anatomy and the anatomical variants in and around the sphenoid sinuses.

In contrast to standard radiographs, CT clearly shows the fine bony anatomy of the sphenoid sinuses and adjacent structures.

Sphenoid sinuses are best visualised in the coronal plane, it is the primary imaging orientation for evaluation of the sinonasal tract. This can be accompanied by direct coronal scanning or by reformatting data acquired in the axial plane into coronal plane images.

Coronal study optimally is performed with the patient in the prone position. In patients who cannot tolerate prone positioning the hanging head technique can sometimes be utilized.

When direct coronal study becomes difficult due to patient's positioning , spiral scanning or thin section, contiguous axial CT images with coronal reconstructions are performed.

The introduction of spiral CT and multidetector CT scanners has allowed even more refined reconstruction in planes other the primary scan plane.

MAGNETIC RESONANCE IMAGING:

Although magnetic resonance imaging provides better visualization of soft tissue than CT, its disadvantage is its inability to display optimally the cortical bone-air interface, because both cortical bone and air have signal voids, at times MR imaging is unable to discern the intricate anatomic relationships of the sinuses and their drainage portals.

PLAIN RADIOGRAPHY:

The standard plain film view for sphenoid sinus is Waters view but with mouth opened. The superimposition of structures precludes the accurate evaluation of the anatomy of sphenoid sinus and the surrounding structures with which the modern surgeon needs to be familiar.

ULTRASOUND:

Ultrasound is not of much value in the evaluation of the anatomical variants of sphenoid sinuses.

OBSERVATION AND RESULTS

Table No 1 :

Sex :

	No of patients
Male	71
Female	56

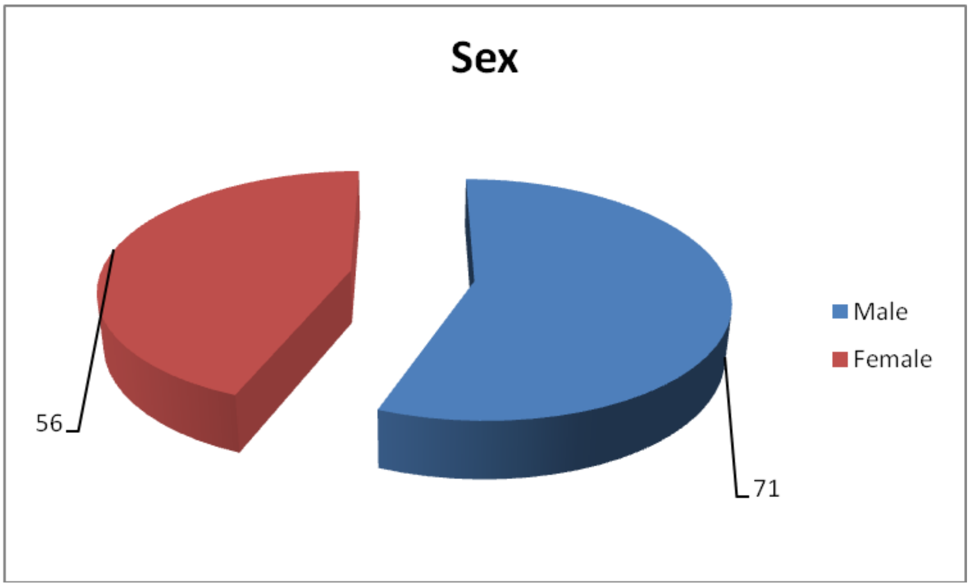
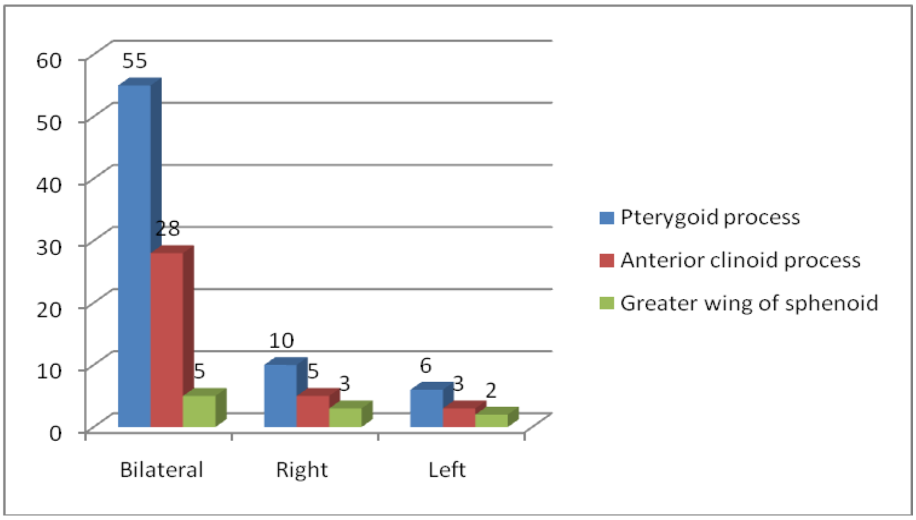


Table No. 2

PNEUMATIZATION

Pneumatization	Bilateral	Right	Left	Total(%)
Pterygoid process	55	10	6	71 %
Anterior clinoid process	28	5	3	36 %
Greater wing of sphenoid	5	3	2	10 %



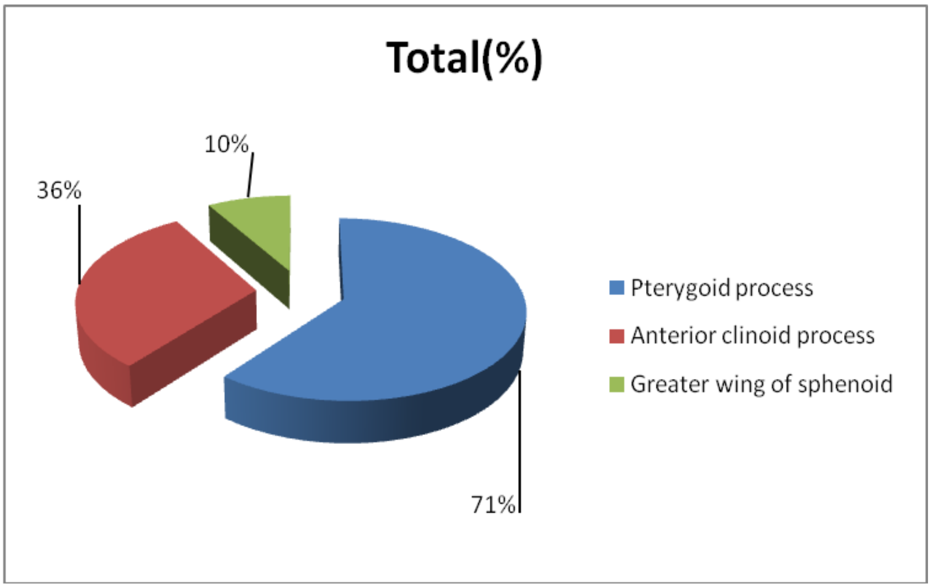
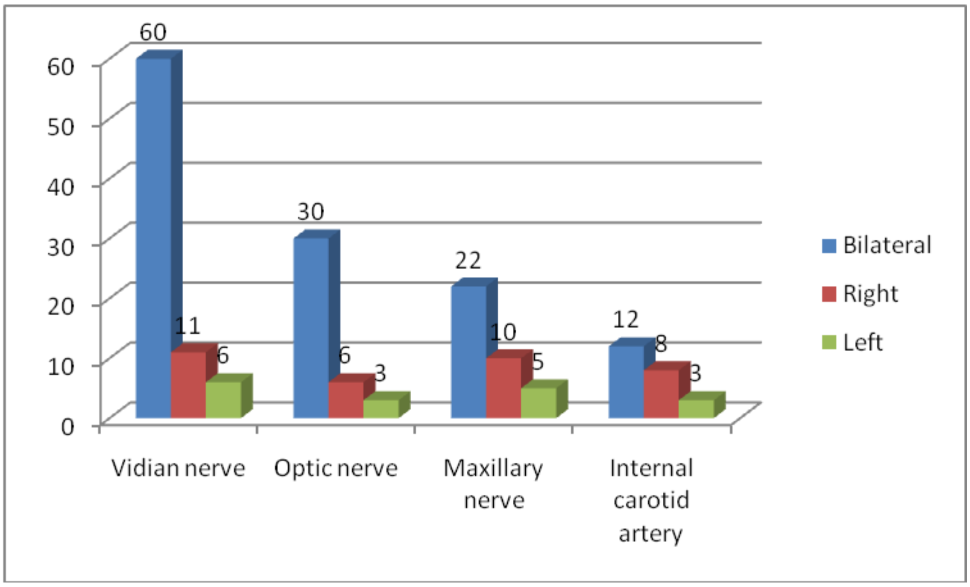


Table No. 3

PROTRUSION	Bilateral	Right	Left	Total(%)
Vidian nerve	60	11	6	83 %
Optic nerve	30	6	3	39 %
Maxillary nerve	22	10	5	37 %
Internal carotid artery	12	8	3	23 %



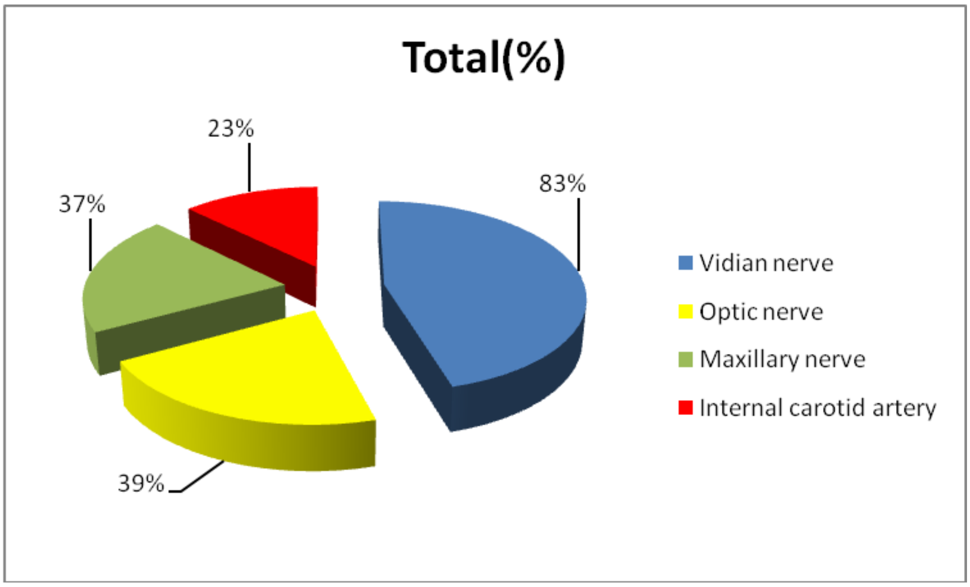
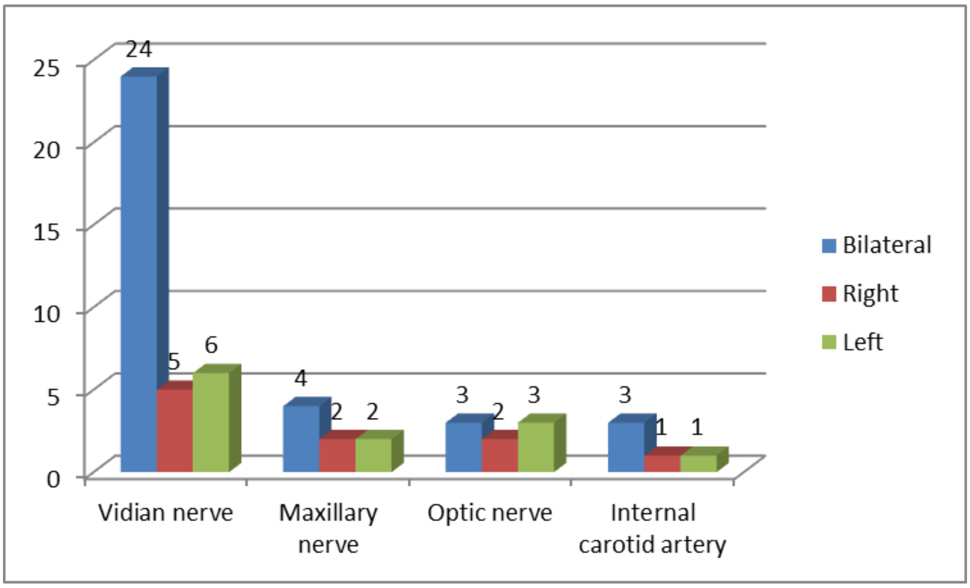
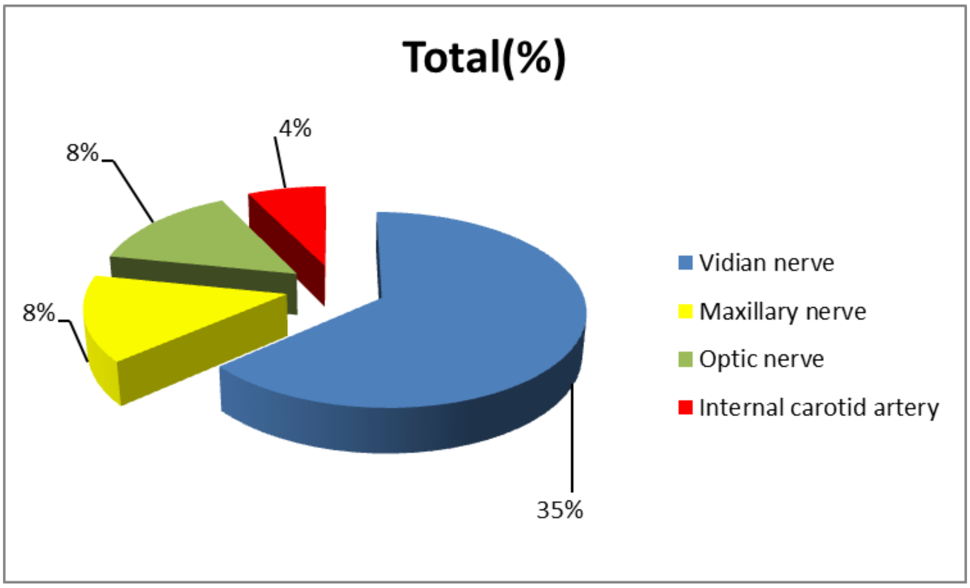


Table No. 4

DEHISCENCE	Bilateral	Right	Left	Total(%)
Vidian nerve	24	5	6	35 %
Maxillary nerve	4	2	2	8 %
Optic nerve	3	2	3	8 %
Internal carotid artery	3	1	1	4 %





CT APPEARANCE OF SPHENOID SINUS VARIATIONS

Pneumatization of the pterygoid process:

- Pterygoid process pneumatization is recognized if it extends beyond a horizontal plane crossing the vidian canal.
- Pterygoid process pneumatization, when present is an important pathway for access to the central skull base, as for extended transnasal endoscopic approaches which may reach the pterygoid process through the medial part of the posterior maxillary wall.

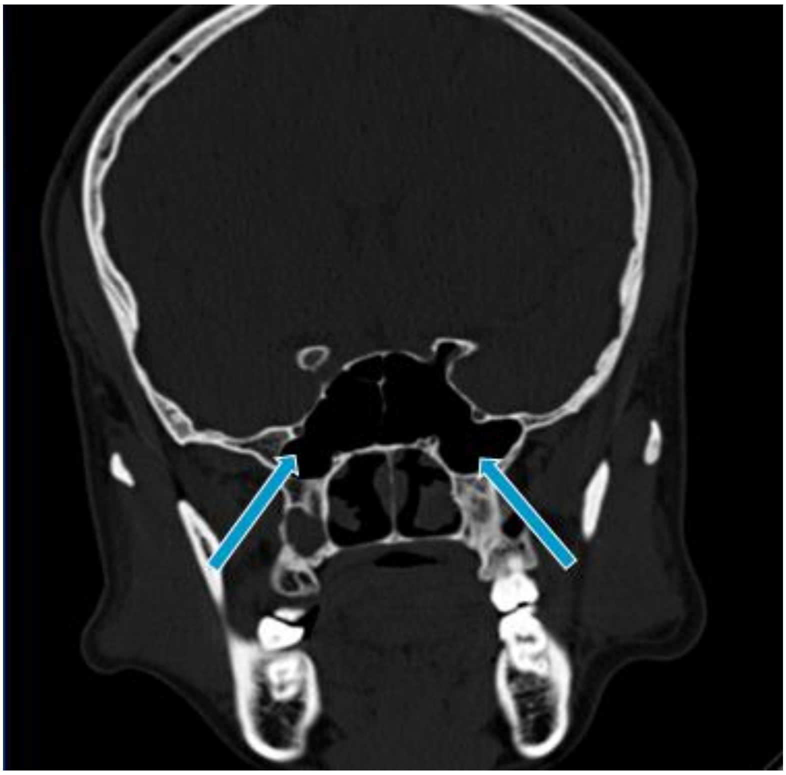


FIGURE 13: CT coronal section of sphenoid sinus showing pneumatization of bilateral pterygoid processes.

Pneumatization of the anterior clinoid process:

The anterior clinoidectomy has become an essential approach to enter cavernous sinus, to expose paraclinoid and upper basilar artery lesions, and to resect clinoidal meningiomas and giant pituitary adenomas[11].

Pneumatization of anterior clinoid process forms the opticocarotid recess, i.e. the small space on the lateral wall of the sphenoid sinus, between the optic canal, superiorly, and the carotid prominence, inferiorly. The opticocarotid recess is supposed to concur with ipsilateral optic nerve and/or internal carotid artery protrusion into the sphenoid sinus.

The frequency of rhinorrhoea after anterior clinoidectomy has been reported to be from 2.7 to 7.0 % which increases when there is pneumatized anterior clinoid process.

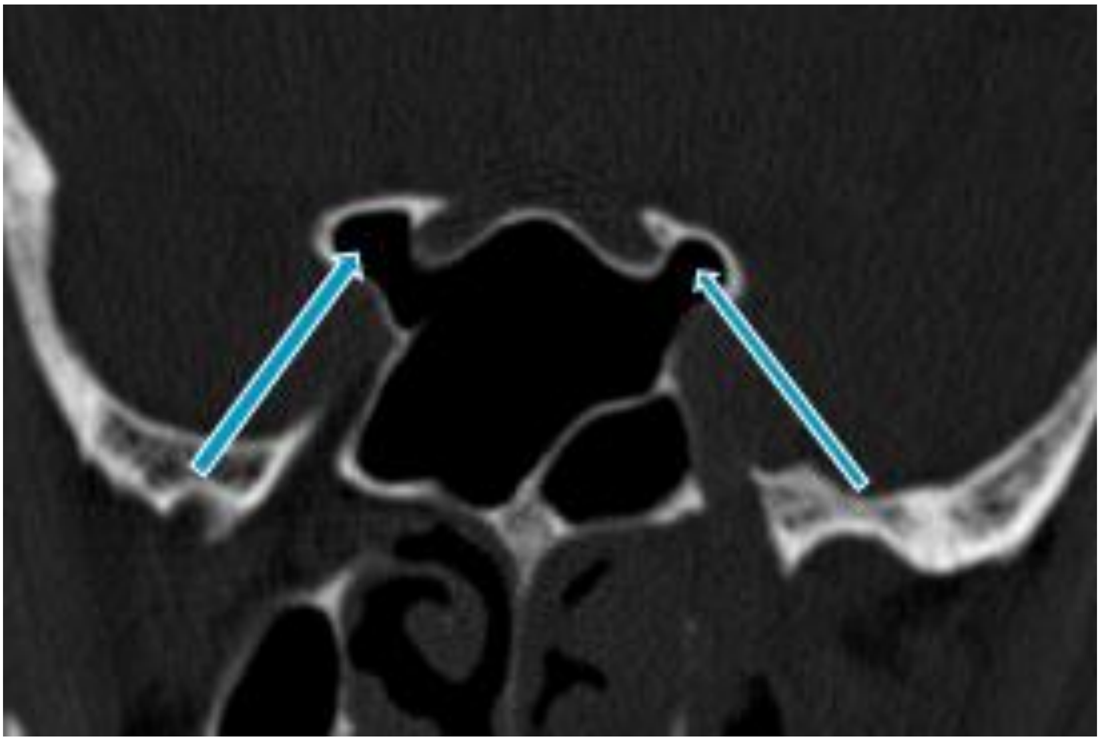


FIGURE 14: CT coronal section of sphenoid sinus showing pneumatization of both anterior clinoid processes.

Pneumatization of greater wing of sphenoid:

Pneumatization of grater wing of sphenoid is considered when extension goes beyond vertical line crossing foramen rotundum.

Pneumatization of floor of the middle cranial fossa in the presence of arachnoid granulations form ‘pit holes’, enlargement of these pits has been casually implicated in the development of non traumatic cerebrospinal leak.

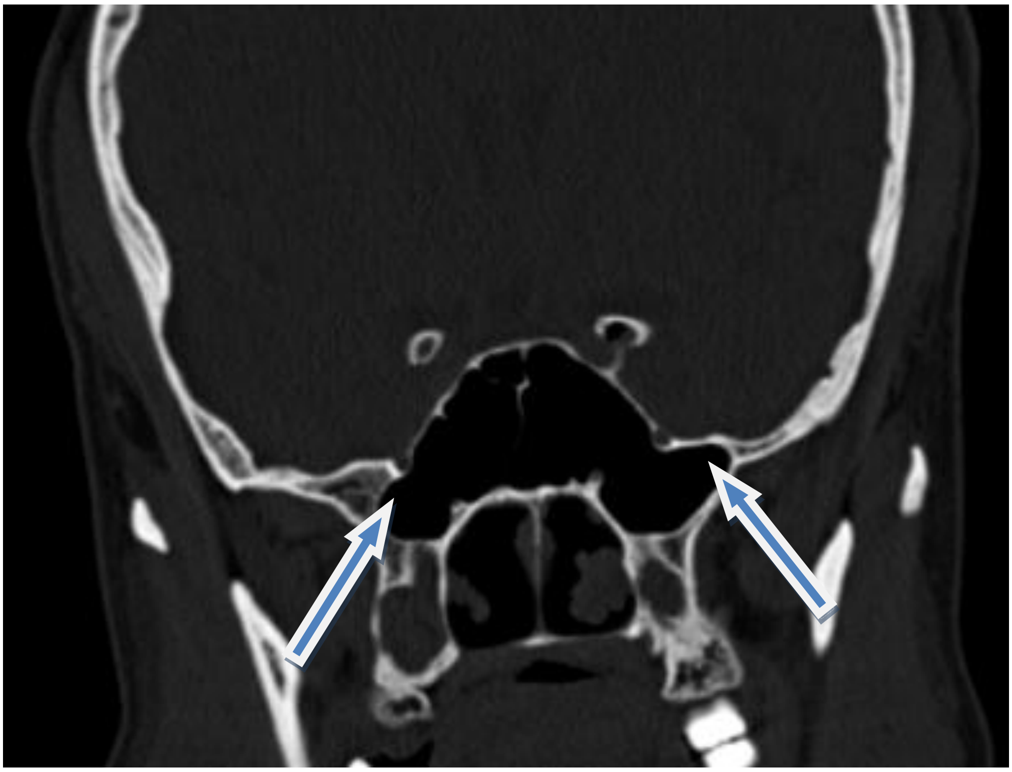


FIGURE 15: CT coronal section of sphenoid sinus showing pneumatization of greater wing of sphenoid.

Internal Carotid Artery :

In our present study, presence of the circumference into the sinus cavity, at any degree, was enough to define protrusion.

If the surgeon is unaware of dehiscence or protrusion of the artery fatal hemorrhage may happen. Sphenoid sinus infection may also make a dehiscent or protruded internal carotid artery vulnerable to damage.

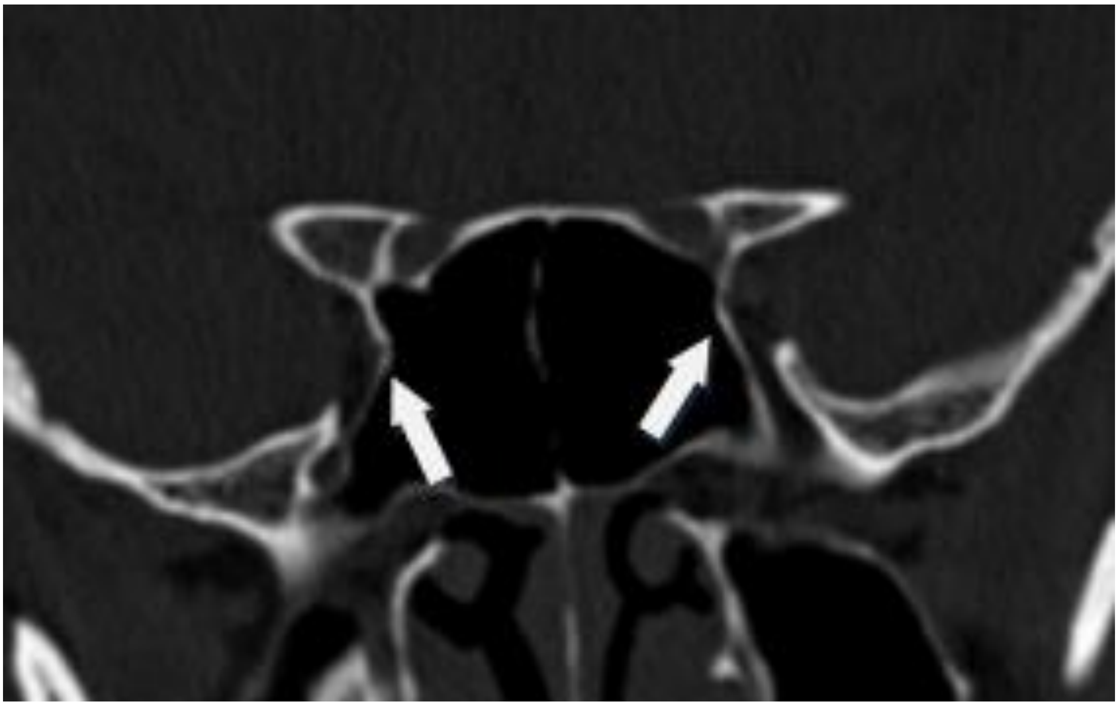


FIGURE 16: CT coronal section of sphenoid sinus showing protrusion of internal carotid artery. (arrows)

Optic nerve

In case of protrusion or dehiscence optic nerve injury can occur due to either surgical trauma or as complication of sinusitis leading to high risk of blindness.

Compression of optic nerve from mucoceles or any other mass can cause ischemia and venous congestion of the nerve.

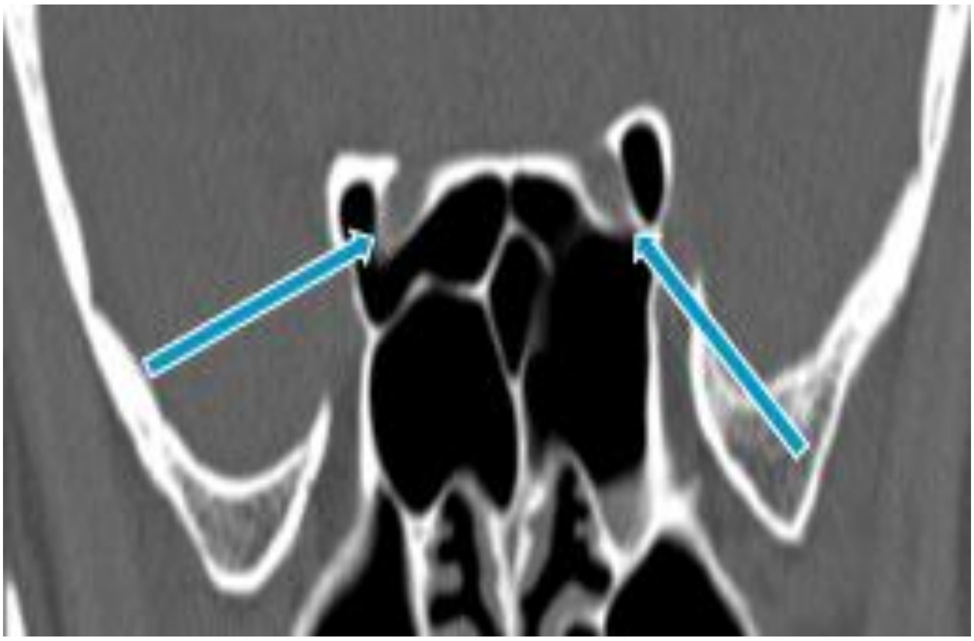


FIGURE 17: CT coronal section of sphenoid sinus showing protrusion and dehiscence of optic nerve.

Maxillary nerve:

A protruded or dehiscent maxillary nerve is liable to iatrogenic injury and neuritis of a dehiscent nerve may result from sphenoid sinusitis presenting as trigeminal neuralgia.

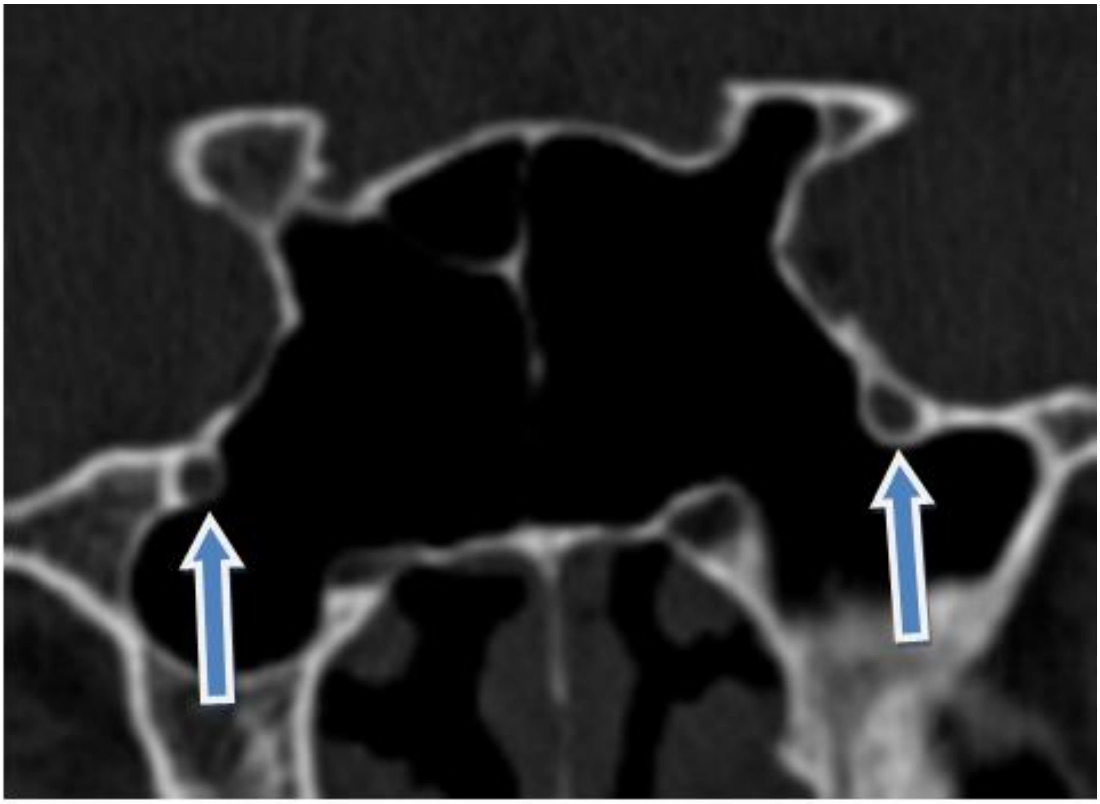


FIGURE 18: CT coronal section of sphenoid sinus showing protrusion of bilateral maxillary nerves (arrows).

Vidian nerve:

Position of the vidian canal within the sinus cavity can favor the involvement of the vidian nerve in sinus diseases.

Knowledge of this helps in improving the results and decreasing the complications of the endoscopic transsphenoidal and vidian neurectomy surgery.

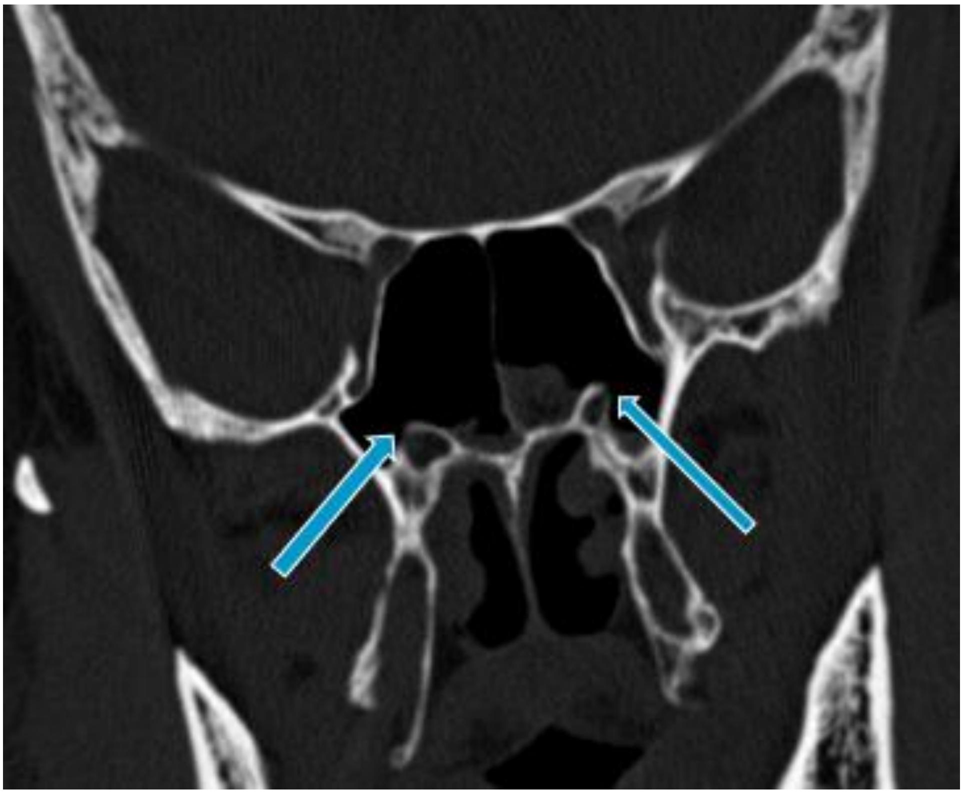


FIGURE 19: CT coronal section of sphenoid sinus showing protrusion and dehiscence of vidian nerve (arrows)

RESULTS

During the period of 18 months of the study 127 patients who fulfilled inclusion criteria were studied, out of which 56 were female and 71 were male (Chart 1).

Out of 127 cases studied the anatomical variations detected are described below.

	Bilateral	**Right**	**Left**	**Total(%)**
PNEUMATIZATION				
Anterior clinoid process	**28**	**5**	**3**	**36 %**
Greater wing of sphenoid	**5**	**3**	**2**	**10 %**
Pterygoid process	**55**	**10**	**6**	**71 %**
PROTRUSION				
Internal carotid artery	**12**	**8**	**3**	**23 %**
Optic nerve	**30**	**6**	**3**	**39 %**
Maxillary nerve	**22**	**10**	**5**	**37 %**
Vidian nerve	**60**	**11**	**6**	**83 %**
DEHISCENCE				
Internal carotid artery	**03**	**1**	**1**	**4 %**
Optic nerve	**3**	**2**	**3**	**8 %**
Maxillary nerve	**4**	**2**	**2**	**8 %**
Vidian nerve	**24**	**5**	**6**	**35 %**

In our study

- 71% patients showed pneumatized pterygoid process.
- 36% of patients showed pneumatization of anterior clinoid process.
- 10% of patients showed pneumatization of greater wing of sphenoid.
- Vidian nerve protrusion was seen in 83% and dehiscence of nerve in 35%.
- Internal carotid artery protrusion into the sphenoid was noted in 22% and dehiscence in 4%.
- Protrusion of optic nerve in this study was seen in 39% and dehiscence of optic nerve in 8%.
- Maxillary nerve protrusion was noted in 37% and dehiscence of nerve in 8%.

DISCUSSION

Pterygoid process:

Pterygoid process pneumatization is recognized if it extends beyond a horizontal plane crossing the vidian canal.

In our study 71% of patients showed pneumatized pterygoid process.

Without explaining their criterion, Bolger et al[11] identified pterygoid process pneumatization in 43.6% of patients. This wide range of prevalence may be attributed to the use of different criteria. It is noteworthy that review of CT scan images for the presence of pterygoid process pneumatization is much more sensitive than cadaveric dissection. Pterygoid process pneumatization, when present, is an important pathway for access to the central skull base.

For instance, extended transnasal endoscopic approaches may reach the pterygoid process through the medial part of the posterior maxillary wall[12]. These techniques may provide a route for endoscopic repair of cerebrospinal fluid leaks and endoscopic biopsy of skull base lesions. Such information may be important in preoperative planning for skull base surgery. Pneumatization of pterygoid process thins the bony floor of the scaphoid fossa to as little as 0.2mm, producing an intimate relation between the sinus and the auditory tube[13].

Sirikci et al[14] reported pneumatization of the pterygoid process in 29.3%. They recognized pterygoid process pneumatization if it extended beyond a plane tangential to the most infero-lateral aspect of the maxillary division of the trigeminal and vidian nerves. Despite the different criterion used to define pneumatization of the pterygoid process, the results reported by Sirikci et al. and those reported here are almost the same.

Anterior clinoid process:

Our study reports anterior clinoid process pneumatization in 36%.

Obviously, the reported prevalence rates vary considerably. This may reflect differences among the studied populations; however, it is more likely that thin CT scan sections are substantially more precise.

The prevalence of anterior clinoid process pneumatization has been well documented in the literature.

Bolger et al[11] found anterior clinoid process pneumatization in 13% of 202 paranasal sinus CT scans. These authors reviewed coronal sinus CT scans with a slice thickness of 3 mm.

In a review of 150 paranasal sinus CT scans, De Lanoet al[10] found anterior clinoid process pneumatization in only 13 of 300 sides (4%).

Of note, these CTs included only coronal images obtained at a slice thickness of 4 mm.

Sirikci et al. found anterior clinoid process pneumatization in 29.3% of 92 paranasal sinus coronal CT scans studied at 2.5 mm slice thickness[14].

Birsenet al[15] encountered pneumatization of anterior clinoid process in 24.1% of 260 patients, for whom coronal sinonasal CT cuts were obtained at 3 mm slice thickness.

Thus, the previous reports of prevalence of anterior clinoid process pneumatization based on thick-cut CT scan review may underestimate the prevalence of this anatomic variant.

Pneumatization of anterior clinoid process forms the optico carotid recess, i.e. the small space on the lateral wall of the sphenoid sinus, between the optic canal, superiorly, and the carotid prominence inferiorly. The optico carotid recess is supposed to concur with ipsilateral optic nerve and/or internal carotid artery protrusion into the sphenoid sinus. That was what we observed in our series as well.

Two previous studies suggested that there is a significant relationship between the pneumatization of anterior clinoid process and the protrusion of optic nerve, which is consistent with our results[14,15].

In case of hypertrophic mucosa or polyps of the sphenoid sinus, optic nerve and internal carotid artery protrusion may not be clearly recognized by a routine sinus CT scan.

Radiological experience reveals that carefully tracing the course of the optic nerve and internal carotid artery seems to underestimate the presence of protrusion. Therefore, as a rule, ipsilateral anterior clinoid process pneumatization is a good indicator of optic nerve and internal carotid artery protrusion.

Greater wing of sphenoid:

We observed pneumatization of greater wing of sphenoid in 10%.

We defined pneumatization of greater wing of sphenoid as extension beyond a vertical line crossing foramen rotundum. Pneumatization of the floor of the middle cranial fossa in the presence of arachnoid granulations along the inner surface of the greater wing of the sphenoid, where this appendage forms the anterior wall of the middle cranial fossa.

Pneumatization of greater wing of sphenoid, i.e. floor of middle cranial fossa, is inadequately reviewed in the literature.

John Earwaker[16] discovered pneumatization of greater wing of sphenoid in 10.7% of patients.

These granulations form “pit-holes” on the floor of the middle cranial fossa, and although they are not pathologic in and of themselves, enlargement of these pits has been casually implicated in the development of non-traumatic cerebrospinal leaks[17].

Internal carotid artery:

We found protrusion of internal carotid artery into the sphenoid in 22% of patients, and dehiscence of the artery in 4%.

Fuji et al[18] studied 25 cadaver sphenoid bones and found 8% of carotid arteries dehiscent of bone in the lateral sphenoid. Kennedy et al[19] found dehiscence on the bony wall of the internal carotid artery in 25% of patients. Occasionally, they found the artery, only with a mucoperiosteal covering, coursing through the sphenoid sinus.

Sareenet al[7] studied sagittal sections of 20 dried skulls and found dehiscence of the carotid artery in 5%.

Sirikciet al[14] reported protrusion of internal carotid artery in 26.1% of patients and dehiscence of the artery in 23%.

Birsenet al[15] encountered protrusion of internal carotid artery in 30.3% and dehiscence in 5.3% of patients.

Both Sirikci and Birsen recognized protrusion of internal carotid artery or optic nerve into the sphenoid sinus as the presence of more than half the circumference of the concerned structures into the sinus cavity.

In our present study, presence of the circumference into the sinus cavity, at any degree, was enough to define protrusion.

Without explaining their criteria, Sethiet al[20]identified carotid protrusion in 93% and Elwany etal[30] observed protrusion of carotid artery in 29% and dehiscence in 4.8% of patients.

If the surgeon is unaware of dehiscence or protrusion of the artery, even fatal hemorrhage may happen, because is hardly possible to control bleeding from an injured internal carotid artery within the sphenoid sinus. Even so, neurological sequelae are inevitable. Sphenoid sinus infection may also make dehiscent or protruded internal carotid artery vulnerable to damage[14].

Optic nerve:

In our study, the protrusion of the optic nerve was found in 39%, and dehiscence of the optic nerve was observed in 8% of the patients.

However, previous studies reported a wide range of protrusion rates of 8 to 70% [31, 32].

Fuji et al[18] found that 4% of optic nerves were dehiscent of bone in the lateral sphenoid. They also reported that most optic nerves were covered by thin bone, measuring 0.5 mm or less in 78% of cases. They attributed the difference in the prevalence of anatomic variations to ethnic background. In the case of protrusion or dehiscence, optic nerve injury can occur due either to surgical trauma or as a complication of sinus disease. The risk of blindness is high if the surgeon damages the nerve within the sinus[24].

Moreover, visual deficits may result from a sphenoid sinus infection or from a mucocele compressing the optic canal or nerve. Compression of the optic nerve can cause ischemia and venous congestion of the nerve. Furthermore, the optic canal is the place where optic nerve is least nourished, which makes it very susceptible to injury[25]. Protrusion of the optic nerve and/or internal carotid artery may coexist with ipsilateral pneumatization of the anterior clinoid process or with migration of the posterior ethmoidal air cells posteriorly into the upper sphenoid (spheno-ethmoidal or Onodi cells)[14]. Our patients were not examined for the presence of spheno-ethmoidal cells.

Maxillary nerve:

We observed maxillary nerve protrusion in 37% of the patients and dehiscence of the nerve in 8%.

Birsen et al[15]encountered maxillary nerve protrusion in 30.3% and dehiscence in 3.5%.

Sareenet al[7]in their anatomical study found neither of the sinuses with protrusion nor dehiscence of maxillary nerve.

The discrepancy between these prevalence rates may be due to different techniques or else it may reflect ethnic differences between the populations.

In endoscopic sphenoid surgery, a protruded or dehiscent maxillary nerve is liable to iatrogenic injury. Furthermore, neuritis of a dehiscent maxillary nerve may result from sphenoid sinusitis and present as trigeminal neuralgia[26].

Vidian nerve:

In our study, protrusion of the vidian nerve was found in 83% and dehiscence of the nerve in 35%.

Lang and Keller[27] reported that the vidian nerve was protruded into the sinus cavity in 18%.

Pandolfo etal[28] emphasized that there is a variable relationship between the vidian canal and the sphenoid sinus.

They also suggested that the vidian nerve can cause a clinical syndrome characterized by pain referred deeply in the nasal cavity (vidian neuralgia).

Anatomic relationship of the vidian canal to the sphenoid sinus cavity help in decreasing the complication of the endoscopic transsphenoidal and vidian neurectomy surgery.

CONCLUSION

A comprehensive knowledge of the variable regional anatomy of the sphenoid sinus will undoubtedly reduce the surgical complications associated with transsphenoidal and functional endoscopic sinus surgery.

Computed tomography of the sphenoid sinus has improved the visualisation of sphenoid sinus anatomy and has allowed greater accuracy in evaluating sphenoid sinus and adjacent neuro-vascular structures.

It helps in the evaluation of anatomical variations which is not possible with other imaging modalities.

Improvement in FESS and CT technology has concurrently increased interest in the sphenoid sinus anatomy and its variations.

The radiologist must pay close attention to anatomical variations in the preoperative evaluation.

It is important for surgeon to be aware of variations that may predispose patients to increased risk of intraoperative complications and help avoid possible complications and improve success of management strategies.

SUMMARY

- This study was taken to evaluate the anatomical variations of sphenoid sinus by CT scan and related structures on computed tomography to help in the transsphenoidal and functional endoscopic sinus surgery and reduce complications due to it.
- The study includes 127 patients referred for CT PNS.
- Unenhanced CT of the PNS was performed for these patients in the coronal plane.
- Vidian nerve protrusion was the most common variation (83%) followed by pneumatized pterygoid process (71%), anterior clinoid process (36%) and greater wing of sphenoid(10%). Internal carotid artery protrusion into the sphenoid was noted in 22% and dehiscence in 4%. Protrusion of optic nerve in this study was seen in 39% and dehiscence of optic nerve in 8%. Maxillary nerve protrusion was noted in 37% and dehiscence of nerve in 8%. Vidian nerve dehiscence was noted in 35%.
- The presence of anatomical variation does not mean a predisposition to sinus pathology but these variations may predispose patients to increased risk of intraoperative complications. The radiologist must pay close attention to anatomical variations in the preoperative evaluation and provide a road map to the surgeon and help avoid possible complications and improve success of management strategies.

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ANNEXURE I

B.L.D.E. UNIVERSITY'S

SHRI.B.M.PATIL MEDICAL COLLEGE, BIJAPUR-586 103

INSTITUTIONAL ETHICAL COMMITTEE

Ethical Committee BIJAPUR-586103 OUT WARD No 27/2011 Date 21-10-11 Shri B M. PATIL Medical College

INSTITUTIONAL ETHICAL CLEARANCE CERTIFICATE

The Ethical Committee of this college met on 20-10-2011 at 10-30 am, to scrutinize the Synopsis/Research projects of postgraduate/undergraduate student/Faculty members of this college from Ethical Clearance point of view. After scrutiny the following original/corrected & revised version synopsis of the Thesis/Research project has been accorded Ethical Clearance.

Title "Computed tomographic study of anatomical variations of sphenoid sinus and related structures"

Name of P.G./U.G. student/Faculty member Dr Sanjay P. Dept of Radiodiagnosis

Name of Guide/Co-investigator Dr. B.R.Shamangaonkar. Prof Radiodiagnosis

DR.M.S.BIRADAR,
CHAIRMAN
INSTITUTIONAL ETHICAL COMMITTEE
BLDEU'S, SHRI.B.M.PATIL
MEDICAL COLLEGE, BIJAPUR.

Chairman
Ethical Committee
BLDEA'S Shri. B.M. Patil
Medical College
Bijapur-586103

Following documents were placed before E.C. for Scrutinization

1) Copy of Synopsis/Research project.
2) Copy of informed consent form
3) Any other relevant documents.

ANNEXURE II

CASE SHEET PROFORMA

Name:
Date:

Age/Sex:	O.P.No./I.P.NO

Address:

History of presenting complaints :

General complaints	:	Fever Headache Bleeding per nose Cough
Past history	:	History of similar complaints History of Hypertension/Diabetes History of allergic reactions to drugs.

CT findings:

Results of pneumatization of anterior clinoid process, greater wing sphenoid and pterygoid process with protrusion and dehiscence of adjacent neurovascular structures.

	Bilateral	**Right**	**Left**
PNEUMATIZATION			
Anterior clinoid process			
Greater wing of sphenoid			
Pterygoid process			
PROTRUSION			
Internal carotid artery			
Optic nerve			
Maxillary nerve			
Vidian nerve			
DEHISCENCE			
Internal carotid artery			
Optic nerve			
Maxillary nerve			
Vidian nerve			

ANNEXURE – III

SAMPLE INFORMED CONSENT FORM

B.L.D.E.U's SHRI B.M. PATIL MEDICAL COLLEGE HOSPITAL AND RESEARCH CENTRE, BIJAPUR – 586103, KARNATAKA

TITLE OF THE PROJECT: ANATOMICAL VARIATIONS OF SPHENOID SINUS AND RELATED STRUCTURES ON COMPUTED TOMOGRAPHY.

PRINCIPAL INVESTEGATOR : DR.SANJAY P
DEPARTMENT OF RADIODIAGNOSIS
EMAIL: sanjayp_yadava@yahoo.co.in

PG GUIDE: DR.B R DHAMANGAONKAR
M.D.(RADIODIAGNOSIS)
PROFESSOR OF RADIODIAGNOSIS
DEPARTMENT OF RADIODIAGNOSIS
B.L.D.E. UNIVERSITY's
SHRI B.M. PATIL MEDICAL COLLEGE
& RESEARCH CENTRE, SHOLAPUR
ROAD, BIJAPUR - 586103

PURPOSE OF RESEARCH:

A comprehensive knowledge of the variable regional anatomy of the sphenoid sinus will undoubtedly reduce the surgical complications associated with transsphenoidal and functional endoscopic sinus surgery .

PROCEDURE:

I have been explained that I will be subjected to a computed tomography scan.

RISKS AND DISCOMFORTS:

I understand that my/my wards participation in this study, there will be risk of radiation exposure.

BENEFITS:

I understand that my/my wards participation in this study will help in finding out the variable regional anatomy of the sphenoid sinus which will undoubtedly help to reduce the surgical complications associated with transsphenoidal and functional endoscopic sinus surgery.

CONFIDENTIALITY:

I understand that medical information produced by this study will become a part of this Hospital records and will be subjected to the confidentiality and privacy regulation of this hospital. Information of a sensitive, personal nature will not be a part of the medical records, but will be stored in the investigator’s research file and identified only by a code number. The code key connecting name to numbers will be kept in a separate secure location.

If the data are used for publication in the medical literature or for teaching purpose, no names will be used and other identifiers such as photographs and audio or video tapes will be used only with my special written permission. I understand that I may see the photograph and videotapes and hear audiotapes before giving this permission.

REQUEST FOR MORE INFORMATION:

I understand that I may ask more questions about the study at any time. Dr. Sanjay P is available to answer my questions or concerns. I understand that I will be informed of any significant new findings discovered during the course of this study, which might influence my continued participation.

If during this study, or later, I wish to discuss my participation in or concerns regarding this study with a person not directly involved, I am aware that the social worker of the hospital is available to talk with me.

And that a copy of this consent form will be given to me for careful reading.

REFUSAL OR WITHDRAWL OF PARTICIPATION:

I understand that my participation is voluntary and I may refuse to participate or may withdraw consent and discontinue participation in the study at any time without prejudice to my present or future care at this hospital.

I also understand that Dr.Sanjay P will terminate my participation in this study at any time after he has explained the reasons for doing so and has helped arrange for my continued care by my own physician or therapist, if this is appropriate.

INJURY STATEMENT:

I understand that in the unlikely event of injury to me/my ward, resulting directly to my participation in this study, if such injury were reported promptly, then medical treatment would be available to me, but no further compensation will be provided.

I understand that by my agreement to participate in this study, I am not waiving any of my legal rights.

I have explained to ____ the purpose of this research, the procedures required and the possible risks and benefits, to the best of my ability in patient's own language.

Date: Dr. B R Dhamangaonkar (Guide) Dr. Sanjay P (Investigator)

ANNEXURE IV
MASTER CHART

				PNEUMATIZATION			PROTRUSION				DEHISCENCE			
Sl No	**Name**	**Age**	**Sex**	**Anterior clinoid process**	**Greater wing of sphenoid**	**Pterygoid process**	**Internal carotid artery**	**Optic nerve**	**Maxillary nerve**	**Vidian nerve**	**Internal carotid artery**	**Optic nerve**	**Maxillary nerve**	**Vidian nerve**
1	MANJUNATH	**25**	**M**	**-**	**-**	**BL**	**-**	**-**	**-**	**BL**	**-**	**-**	**-**	**-**
2	PARVATI	**64**	**F**	**-**	**R**	**BL**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**BL**
3	AYYANGOUDA	**58**	**M**	**-**	**-**	**R**	**-**	**-**	**-**	**-**	**-**		**R**	**-**
4	BABURAY	**37**	**M**	**-**	**-**	**-**	**-**	**-**	**-**	**BL**	**-**	**-**	**-**	**-**
5	BHAGYASHREE	**43**	**F**	**-**	**-**	**BL**	**-**	**-**	**-**	**BL**	**-**	**-**	**-**	**-**
6	KASHINATH	**36**	**M**	**-**	**-**	**BL**	**-**	**-**	**-**	**BL**	**-**	**-**	**-**	**-**
7	NAYADO	**28**	**M**	**-**	**-**	**-**	**-**	**-**	**-**	**BL**	**-**	**-**	**-**	**-**
8	AMBAJI	**43**	**M**	**R**	**-**	**-**	**R**	**R**	**-**	**-**	**-**	**-**	**R**	**L**
9	MUKUNDGOUDA	**52**	**M**	**BL**	**-**	**BL**	**R**	**BL**	**-**	**BL**	**-**	**-**	**-**	**BL**

10	MAMTAJ	**31**	**F**	**BL**	**-**	**-**	**-**	**BL**	**-**	**-**	**-**	**-**	**-**	**-**
11	PRAVEEN KUMAR	**25**	**M**	**-**	**-**	**BL**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
12	M M TAKKEKAR	**43**	**M**	**BL**	**-**	**-**	**-**	**BL**	**-**	**-**	**-**	**-**	**-**	**-**
13	BHARATESH	**26**	**M**	**-**	**R**	**-**	**R**	**-**	**-**	**-**	**R**	**R**	**-**	**R**
14	CHANDRAKANT	**34**	**M**	**-**	**-**	**BL**	**-**	**-**	**BL**	**-**	**BL**	**-**	**-**	**L**
15	IRANNA	**55**	**M**	**BL**	**-**	**-**	**-**	**BL**	**-**	**-**	**-**	**-**	**-**	**-**
16	VIJAYLAKSHMI	**42**	**F**	**-**	**-**	**BL**	**BL**	**-**	**-**	**-**	**-**	**R**	**-**	**BL**
17	PARASHURAM	**32**	**M**	**-**	**-**	**L**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
18	RAJESHWARI	**36**	**F**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
19	PRAVEEN	**29**	**M**	**-**	**-**	**BL**	**-**	**-**	**BL**	**-**	**-**	**-**	**-**	**BL**
20	JAVEED	**46**	**M**	**-**	**-**	**L**	**-**	**-**	**-**	**L**	**-**	**-**	**-**	**L**
21	SHANTAWWA	**43**	**F**	**-**	**-**	**R**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**R**
22	SUNITA	**24**	**F**	**-**	**-**	**-**	**BL**	**-**	**-**	**-**	**-**	**BL**	**-**	**-**
23	LAGHMABHAI	**55**	**F**	**R**	**-**	**-**	**-**	**R**	**-**	**-**	**-**	**-**	**-**	**-**
24	MANJUNATH	**34**	**M**	**-**	**-**	**R**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**R**

25	SURESH	**36**	**M**	**-**	**BL**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
26	SRUTI	**22**	**F**	**L**	**-**	**BL**	**-**	**L**	**-**	**-**	**-**	**-**	**-**	**-**
27	VIKAS	**21**	**M**	**-**	**-**	**BL**	**-**	**-**	**-**	**BL**	**-**	**-**	**-**	**BL**
28	REKHA	**25**	**F**	**-**	**-**	**-**	**BL**	**-**	**-**	**-**	**BL**	**-**	**-**	**-**
29	MADIWALAPPA	**65**	**M**	**-**	**-**	**-**	**-**	**-**	**-**	**BL**	**-**	**-**	**-**	**-**
30	RUKMABAI	**45**	**F**	**-**	**-**	**BL**	**-**	**-**	**BL**	**BL**	**-**	**-**	**-**	**-**
31	MALANBEE	**44**	**F**	**-**	**-**	**-**	**-**	**-**	**BL**	**BL**	**-**	**-**	**-**	**R**
32	SHIVALEELA	**33**	**F**	**BL**	**-**	**-**	**-**	**BL**	**BL**	**BL**	**-**	**-**	**-**	**-**
33	MAHADEVI	**37**	**F**	**-**	**-**	**BL**	**-**	**-**	**BL**	**BL**	**-**	**-**	**-**	**-**
34	M H BIRADAR	**55**	**M**	**-**	**-**	**-**	**-**	**-**	**-**	**R**	**-**	**-**	**-**	**-**
35	HASINA BEGUM	**39**	**F**	**-**	**-**	**BL**	**-**	**-**	**-**	**BL**	**-**	**-**	**-**	**-**
36	PARVATHI MATH	**43**	**F**	**-**	**-**	**-**	**-**	**-**	**-**	**R**	**-**	**-**	**-**	**-**
37	PRAFUL	**24**	**M**	**BL**	**-**	**BL**	**-**	**BL**	**R**	**BL**	**-**	**-**	**-**	**BL**
38	R S BIRDAR	**38**	**M**	**-**	**R**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
39	RAJU WALIKAR	**46**	**M**	**-**	**-**	**-**	**-**	**-**	**-**	**BL**	**-**	**-**	**-**	**BL**

40	ANITA	**21**	**F**	**-**	**-**	**BL**	**BL**	**-**	**-**	**BL**	**-**	**BL**	**-**	**BL**
41	SIDAPPA	**57**	**M**	**-**	**-**	**-**	**-**	**-**	**-**	**R**	**-**	**-**	**-**	**-**
42	SANGAMESH	**22**	**M**	**-**	**-**	**R**	**-**	**BL**	**R**	**-**	**-**	**-**	**-**	**-**
43	MALLAPPA	**63**	**M**	**-**	**-**	**BL**	**-**	**-**	**R**	**BL**	**-**	**-**	**-**	**-**
44	RAJASHEKAR	**30**	**M**	**-**	**L**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
45	BANDAGISAB	**36**	**M**	**-**	**-**	**BL**	**BL**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
46	SIDRAM	**32**	**M**	**-**	**-**	**-**	**-**	**-**	**R**	**-**	**-**	**-**	**-**	**-**
47	RAJASHEKAR	**39**	**M**	**-**	**-**	**-**	**-**	**-**	**R**	**-**	**-**	**-**	**-**	**-**
48	GANGABAI	**47**	**F**	**BL**	**-**	**BL**	**-**	**BL**	**-**	**BL**	**-**	**-**	**-**	**BL**
49	JULLIS	**35**	**F**	**-**	**-**	**BL**	**-**	**-**	**-**	**BL**	**-**	**-**	**-**	**-**
50	LAXMI	**55**	**F**	**-**	**-**	**-**	**-**	**-**	**-**	**R**	**-**	**-**	**-**	**-**
51	SHARADA	**31**	**F**	**-**	**-**	**L**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
52	VAISHALI	**37**	**F**	**-**	**-**	**BL**	**-**	**-**	**-**	**BL**	**-**	**-**	**-**	**-**
53	BASALANGIYYA	**45**	**M**	**-**	**-**	**-**	**-**	**-**	**-**	**R**	**-**	**-**	**-**	**-**
54	RENUKA	**25**	**F**	**-**	**-**	**BL**	**L**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

55	SHARANAPPA	**37**	**M**	**-**	**-**	**-**	**-**	**-**	**-**	**BL**	**-**	**-**	**-**	**-**
56	VIDYA	**22**	**F**	**R**	**-**	**BL**	**-**	**R**	**-**	**-**	**-**	**-**	**-**	**-**
57	KMKUDALGI	**64**	**M**	**-**	**-**	**-**	**-**	**-**	**-**	**R**	**-**	**-**	**-**	**-**
58	SSJANAKI	**48**	**F**	**-**	**-**	**BL**	**R**	**-**	**BL**	**BL**	**-**	**-**	**-**	**-**
59	BOURAMMA	**49**	**F**	**R**	**-**	**BL**	**-**	**R**	**R**	**BL**	**-**	**-**	**-**	**-**
60	JR JOHN	**41**	**M**	**BL**	**-**	**BL**	**-**	**BL**	**-**	**BL**	**-**	**-**	**-**	**-**
61	AKKUBAI	**33**	**F**	**-**	**-**	**R**	**-**	**-**	**R**	**R**	**-**	**-**	**-**	**-**
62	PARVEEN	**39**	**M**	**L**	**-**	**-**	**-**	**L**	**-**	**-**	**-**	**L**	**-**	**-**
63	RAMANNA	**36**	**M**	**-**	**-**	**BL**	**-**	**-**	**BL**	**BL**	**-**	**-**	**-**	**-**
64	BIRADAR	**41**	**M**	**-**	**L**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
65	SIDDARM	**43**	**M**	**BL**	**-**	**BL**	**-**	**BL**	**BL**	**BL**	**-**	**-**	**-**	**-**
66	VISHVESHWAR	**35**	**M**	**-**	**-**	**-**	**-**	**-**	**-**	**BL**	**-**	**-**	**-**	**-**
67	MAHANANDA	**33**	**F**	**-**	**-**	**L**	**-**	**-**	**-**	**L**	**-**	**-**	**-**	**L**
68	RAZIYA	**26**	**F**	**-**	**-**	**-**	**BL**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
69	SAVITHA	**41**	**F**	**BL**	**-**	**BL**	**-**	**BL**	**BL**	**BL**	**-**	**-**	**-**	**BL**

70	SUJATA	**34**	**F**	**BL**	**-**	**BL**	**BL**	**BL**	**-**	**BL**	**-**	**-**	**-**	**-**
71	VISHWANATH	**55**	**M**	**BL**	**-**	**BL**	**-**	**BL**	**BL**	**BL**	**-**	**-**	**-**	**BL**
72	KAVITA	**43**	**F**	**-**	**-**	**BL**	**-**	**-**	**-**	**BL**	**-**	**-**	**-**	**-**
73	PINTU	**52**	**M**	**-**	**-**	**-**	**-**	**-**	**L**	**-**	**-**	**-**	**-**	**-**
74	BHIMARAO	**33**	**M**	**-**	**BL**	**BL**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
75	TIPPAYA	**61**	**M**	**-**	**-**	**-**	**R**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
76	MADEVI	**25**	**F**	**BL**	**-**	**BL**	**BL**	**BL**	**BL**	**BL**	**-**	**-**	**-**	**BL**
77	KAVITA	**36**	**F**	**-**	**-**	**BL**	**-**	**-**	**-**	**BL**	**-**	**-**	**-**	**-**
78	SANJEEVANI	**47**	**F**	**L**	**-**	**-**	**-**	**L**	**-**	**-**	**-**	**-**	**-**	**-**
79	NASEERBANU	**58**	**F**	**BL**	**-**	**BL**	**BL**	**BL**	**BL**	**BL**	**-**	**-**	**BL**	**BL**
80	SIDAPPA	**63**	**M**	**-**	**-**	**-**	**R**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
81	LALITHA BAI	**37**	**F**	**BL**	**-**	**-**	**R**	**BL**	**-**	**-**	**-**	**-**	**-**	**-**
82	SHIVAPPA	**54**	**M**	**-**	**-**	**BL**	**-**	**-**	**-**	**BL**	**-**	**-**	**-**	**-**
83	BASAVARAJ	**49**	**M**	**BL**	**-**	**R**	**-**	**BL**	**R**	**R**	**-**	**-**	**-**	**-**
84	SHRIDHAR	**51**	**M**	**BL**	**-**	**BL**	**BL**	**BL**	**-**	**BL**	**-**	**-**	**-**	**R**

85	BARIGADAD	**35**	**M**	**BL**	**-**	**R**	**-**	**BL**	**-**	**R**	**-**	**-**	**L**	**-**
86	SUNIL	**28**	**M**	**R**	**-**	**BL**	**-**	**R**	**BL**	**BL**	**-**	**-**	**-**	**-**
87	BERULAL	**41**	**M**	**-**	**-**	**-**	**-**	**-**	**-**	**R**	**-**	**-**	**-**	**-**
88	ANUSHA	**29**	**F**	**BL**	**-**	**BL**	**BL**	**BL**	**BL**	**BL**	**-**	**-**	**BL**	**BL**
89	SATISH	**23**	**M**	**-**	**-**	**-**	**-**	**-**	**-**	**BL**	**-**	**-**	**-**	**L**
90	AMBIKA	**38**	**F**	**-**	**BL**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
91	SACHIN	**27**	**M**	**-**	**-**	**BL**	**-**	**-**	**-**	**BL**	**-**	**-**	**-**	**BL**
92	JYOTHI	**19**	**F**	**-**	**-**	**BL**	**-**	**-**	**-**	**BL**	**-**	**-**	**-**	**-**
93	SAVITHA	**33**	**F**	**-**	**-**	**BL**	**R**	**-**	**BL**	**BL**	**-**	**-**	**-**	**BL**
94	PRADEEP	**31**	**M**	**-**	**-**	**-**	**-**	**-**	**-**	**BL**	**-**	**-**	**-**	**-**
95	ANAND	**44**	**M**	**-**	**-**	**L**	**-**	**-**	**L**	**L**	**-**	**-**	**-**	**L**
96	BHIMARAO	**52**	**M**	**-**	**-**	**-**	**-**	**-**	**-**	**BL**	**-**	**-**	**-**	**-**
97	DEVI	**37**	**F**	**BL**	**-**	**BL**	**-**	**BL**	**BL**	**L**	**-**	**-**	**L**	**BL**
98	KASHIM	**58**	**M**	**-**	**-**	**L**	**-**	**-**	**L**	**L**	**L**	**-**	**-**	**L**
99	RUKMABAI	**37**	**F**	**-**	**-**	**R**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

100	SHANKRAPPA	**47**	**M**	**-**	**-**	**-**	**-**	**-**	**-**	**BL**	**-**	**-**	**-**	**-**
101	MUDAKAPPA	**58**	**M**	**BL**	**-**	**BL**	**-**	**BL**	**R**	**BL**	**-**	**L**	**-**	**BL**
102	SACHIN	**22**	**M**	**-**	**-**	**BL**	**-**	**-**	**L**	**BL**	**-**	**-**	**-**	**L**
103	SANGAPPA	**54**	**M**	**BL**	**-**	**BL**	**-**	**BL**	**BL**	**BL**	**BL**	**-**	**-**	**-**
104	YAMUNA	**34**	**F**	**-**	**-**	**BL**	**-**	**BL**	**BL**	**BL**	**-**	**-**	**BL**	**L**
105	SHILPA	**32**	**F**	**-**	**BL**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
106	SHASHIKALA	**45**	**F**	**-**	**-**	**BL**	**-**	**-**	**-**	**BL**	**-**	**-**	**-**	**L**
107	BORAMMA	**55**	**F**	**BL**	**-**	**-**	**-**	**BL**	**-**	**-**	**-**	**-**	**-**	**-**
108	GIRIMALLAPA	**54**	**M**	**BL**	**-**	**BL**	**BL**	**BL**	**BL**	**BL**	**-**	**-**	**-**	**BL**
109	RAJU	**32**	**M**	**-**	**-**	**-**	**-**	**-**	**L**	**-**	**-**	**-**	**-**	**-**
110	INDRABAI	**53**	**F**	**-**	**-**	**-**	**-**	**-**	**-**	**BL**	**-**	**-**	**-**	**L**
111	LALITHA	**37**	**F**	**-**	**-**	**BL**	**L**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
112	ANUSHA	**21**	**F**	**-**	**-**	**R**	**-**	**-**	**-**	**BL**	**-**	**-**	**-**	**-**
113	AMBIKA	**46**	**F**	**-**	**-**	**-**	**-**	**-**	**-**	**BL**	**-**	**-**	**-**	**-**
114	JYOTHI	**33**	**F**	**-**	**-**	**-**	**-**	**-**	**-**	**L**	**-**	**-**	**-**	**L**

115	SAVITHA	**47**	**F**	**-**	**-**	**BL**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	
116	SHIVANAND	**45**	**M**	**BL**	**-**	**-**	**-**	**BL**	**-**	**BL**	**-**	**L**	**-**	**BL**
117	SUNIL	**46**	**M**	**BL**	**-**	**-**	**-**	**R**	**-**	**BL**	**-**	**-**	**-**	**BL**
118	SHRIDHAR	**49**	**M**	**-**	**BL**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
119	BASAVARAJ	**57**	**M**	**-**	**-**	**BL**	**-**	**-**	**-**	**BL**	**-**	**-**	**-**	**BL**
120	SURESH	**35**	**M**	**-**	**-**	**-**	**-**	**-**	**BL**	**-**	**-**	**-**	**BL**	**-**
121	ASHWINI	**22**	**F**	**BL**	**-**	**-**	**-**	**BL**	**-**	**-**	**-**	**BL**	**-**	**-**
122	SIDDAPPA	**44**	**M**	**-**	**-**	**-**	**L**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
123	RAJSHEKAR	**52**	**M**	**-**	**-**	**BL**	**-**	**-**	**-**	**BL**	**-**	**-**	**-**	**BL**
124	ANITA	**19**	**F**	**-**	**-**	**R**	**-**	**-**	**R**	**-**	**-**	**-**	**-**	**-**
125	MALLAPPA	**33**	**M**	**-**	**-**	**-**	**-**	**-**	**-**	**BL**	**-**	**-**	**-**	**BL**
126	SANGAMESH	**52**	**M**	**BL**	**-**	**-**	**-**	**BL**	**-**	**-**	**-**	**-**	**-**	**-**
127	PARVATI	**43**	**F**	**-**	**-**	**BL**	**-**	**-**	**-**	**R**	**-**	**-**	**-**	**-**

THANK YOU