
SURGICAL ANATOMY OF
MAXILLARY SINUS

DEFINITION

The maxillary sinus is the pneumatic space that is lodged inside the body of maxilla and that communicates with the environment by the way of middle meatus and nasal vestibule

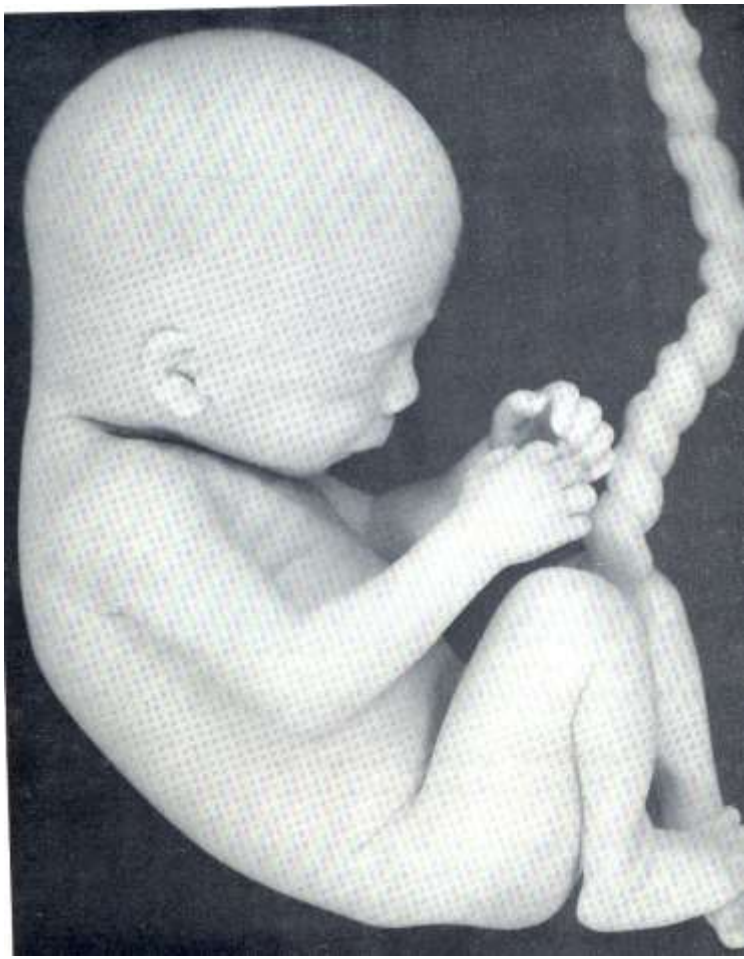
ORBAN'S

HISTORICAL REVIEW

- Antros- greek word- cave
- The Earliest description of maxillary sinus is from drawings & Notes of Leonardo da Vinci in 1489 and by Vesalius in his book De Humani corporis fabrica (1543).
- Nathaniel Highmore (1651) described Maxillary Antrum in his book Corporis human disquisto anatomica.
- Cowper in his book Anatomy of Humane Bodies (1698) described Antrum maxillae superioris.
- Also k/s antrum of HIGHMORE

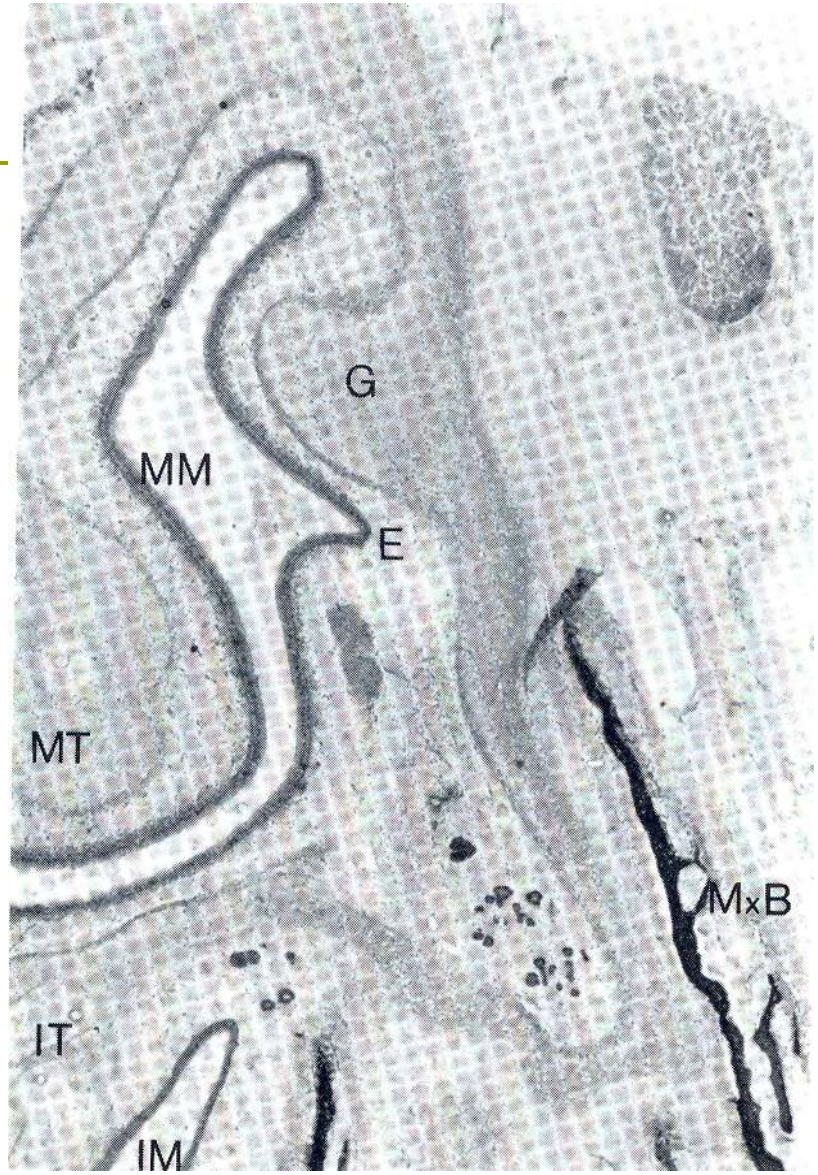
EMRROLOGY

(Development & age changes)



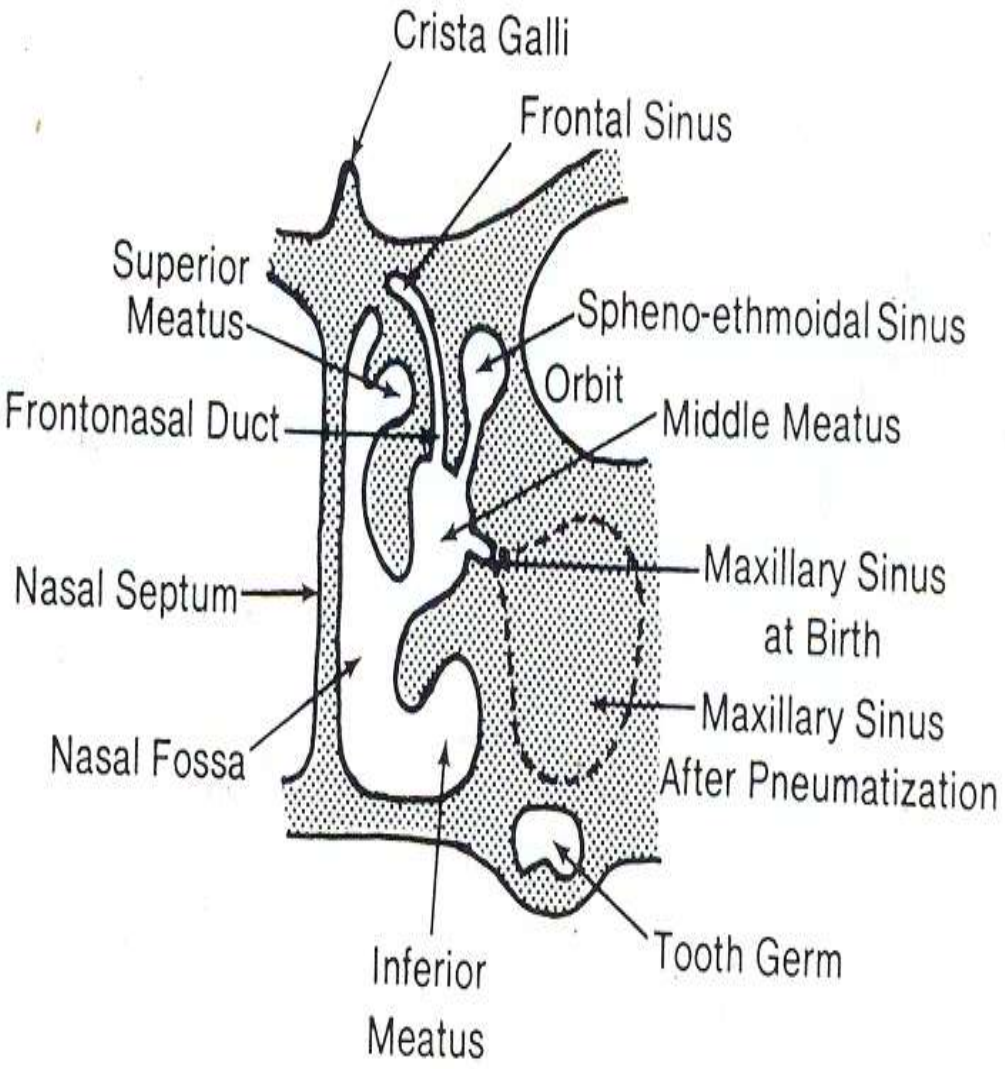
- ***first Paranasal sinus to develop during 3rd month of fetal life.***

- *starts to develop at about 12 wks (80mm crown-Rump length) as an Evagination of Primitive Ethmoid infundibulum in lateral wall of middle meatus of the corresponding nasal cavity when nasal Epithelium invades maxillary mesenchyme*



- *The Infraorbital vessels & nerves are initially in an Open groove on the Orbital floor but its anterior part converted into a canal by a bony lamina growing in from the Lateral side*
- *Initially Maxillary sinus is a mere Anteroposterior groove between Inferior & middle turbinates*
- *Primary Pneumatization of sinus cavity continues to develop until late in the 5th month of fetal life as a slit like Invagination of the nasal Epithelium off the Infundibulum into cartilaginous nasal capsule The Initial Evagination site Which persists as ANTRONASAL DUCT.*
- *Secondary Pneumatization occurs in the 5th month, occur in downwards, backwards & forward direction; volume is approximately 6 to 8 ml.*

Figure 1.5 Diagram showing that downward growth of the maxillary sinus leaves the ostium in a position unfavourable for gravitational drainage. From Sperber (1989)



Age changes

1st year	Lateral expansion n extend beneath Infraorbital canal
20th month	posteriorly ; position of Rudimentary first permanent molar
2nd yr	half of the adult size
3rd & 4thyr	growth in width ; relate to deciduous 2nd molar n crypt of 1st molar; accompanied by resorption of Internal surfaces Exception is Medial wall

7th yr	Height 17mm,AP length 27mm,Width 18mm
12th yr	. Surgically accessible through the inferior meatus of nose.
Adults	Height 35mm, AP length 32mm, width 25 mm

Volume: 15ml to 20 ml (Neivert, 1930) upto 30ml=volume of Orbit (swinson & Mecrusk 1991)

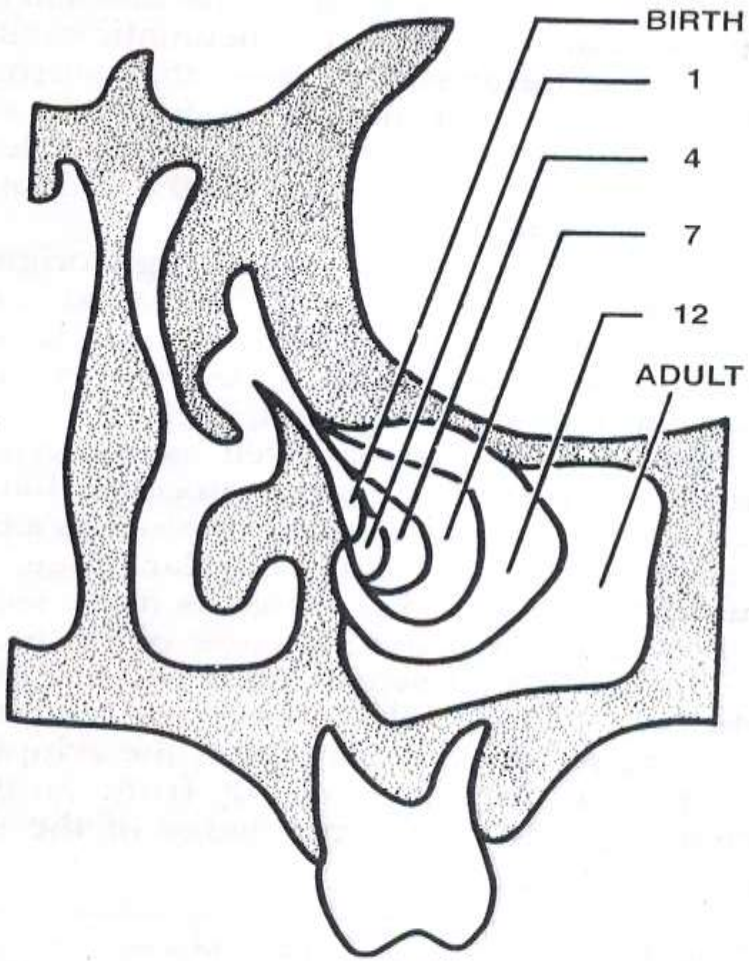
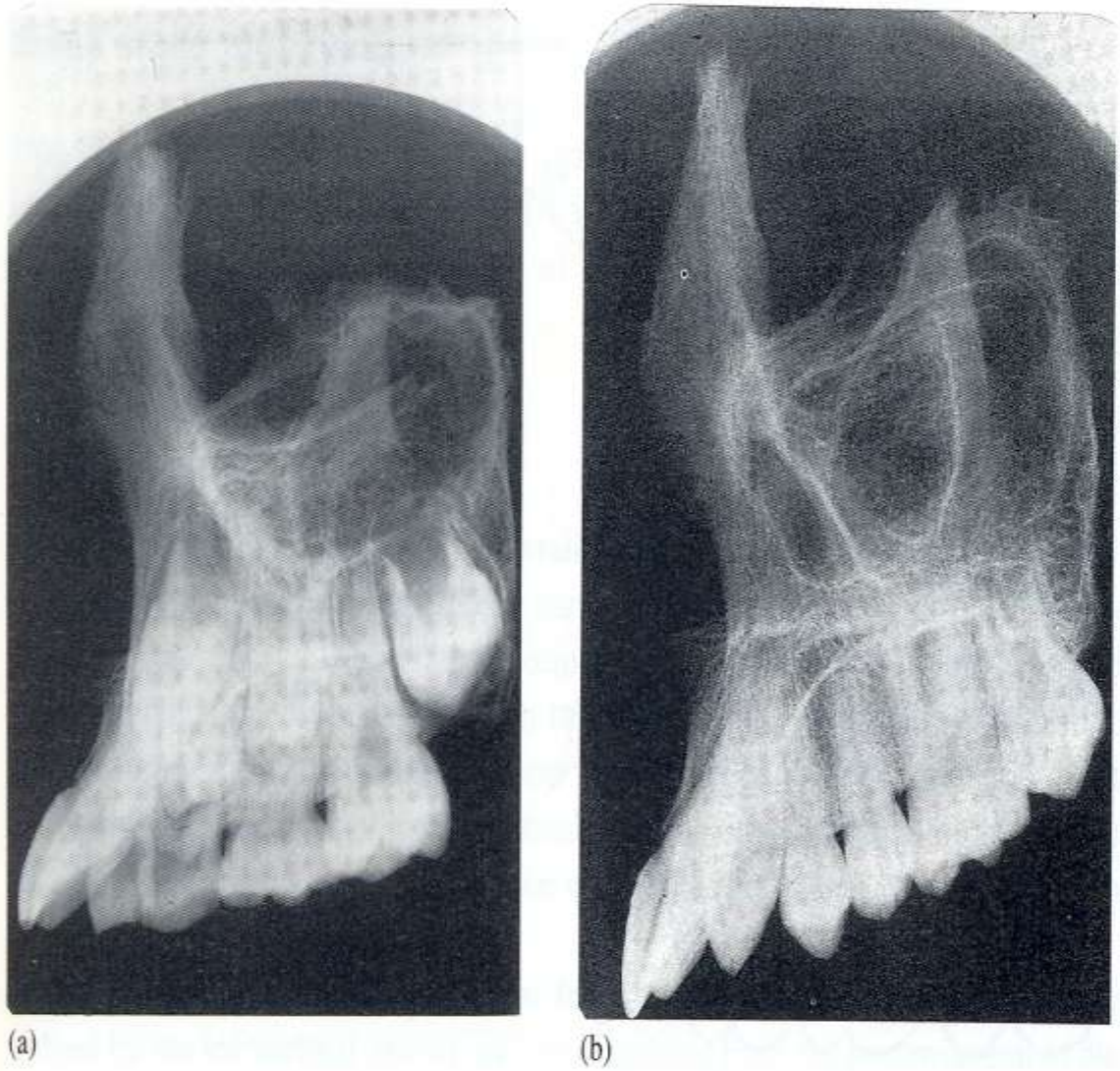


Figure 1. The growth of the maxillary sinus from birth to adulthood. (*Adapted from* Kelley HC, Kay LW: The Maxillary Sinus and Its Dental Implications: Dental Practice Handbook. Bristol, England, John Wright & Sons, 1975, p 6; with permission.)

- *In older edentulous maxilla, resorption of alveolar process and pneumatization leaves a thin layer of cortical bone separating nasal & sinus mucosa*

- *In dentate adult sinus floor is 1 cm or below the nasal floor*

- *In children & edentulous state the sinus floor is at the same level to that of nasal floor.*



(a) (b)

Figure 1.7 Lateral radiographs of right disarticulated maxillae in (a) an 8-year-old; and (b) a 14-year-old, showing the increase in height of the sinus with the eruption of the permanent premolars and molars

Postnatally growth spurts

3 in number

1. *Birth to 2.5 yrs*
2. *7.5 to 10yrs*
3. *12 to 14 yrs*

Shape

- *at birth- tubular*
- *9 years- ovoid*
- *Adult- pyramidal*

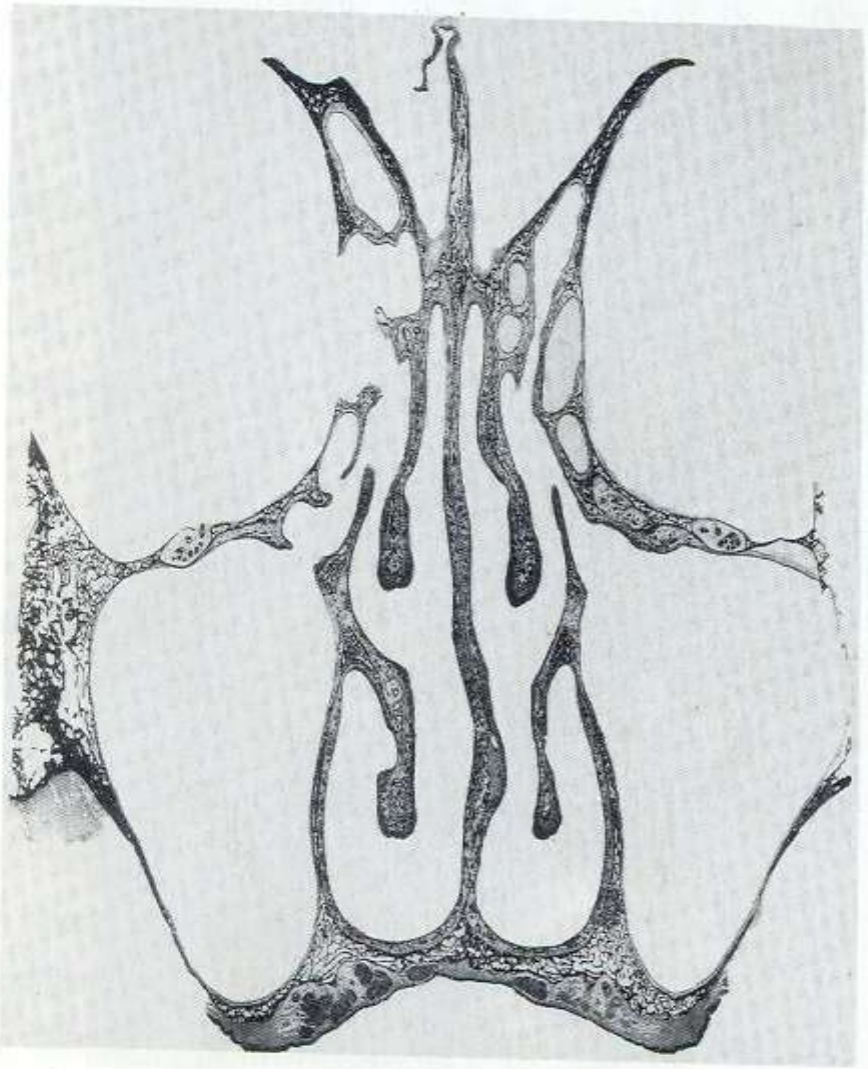
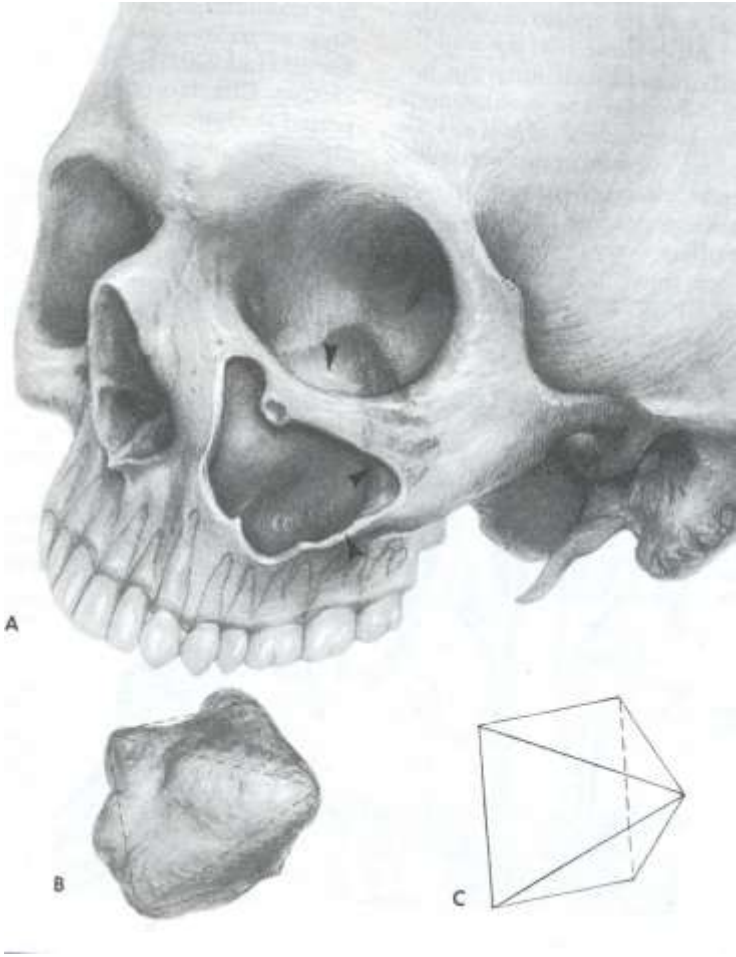


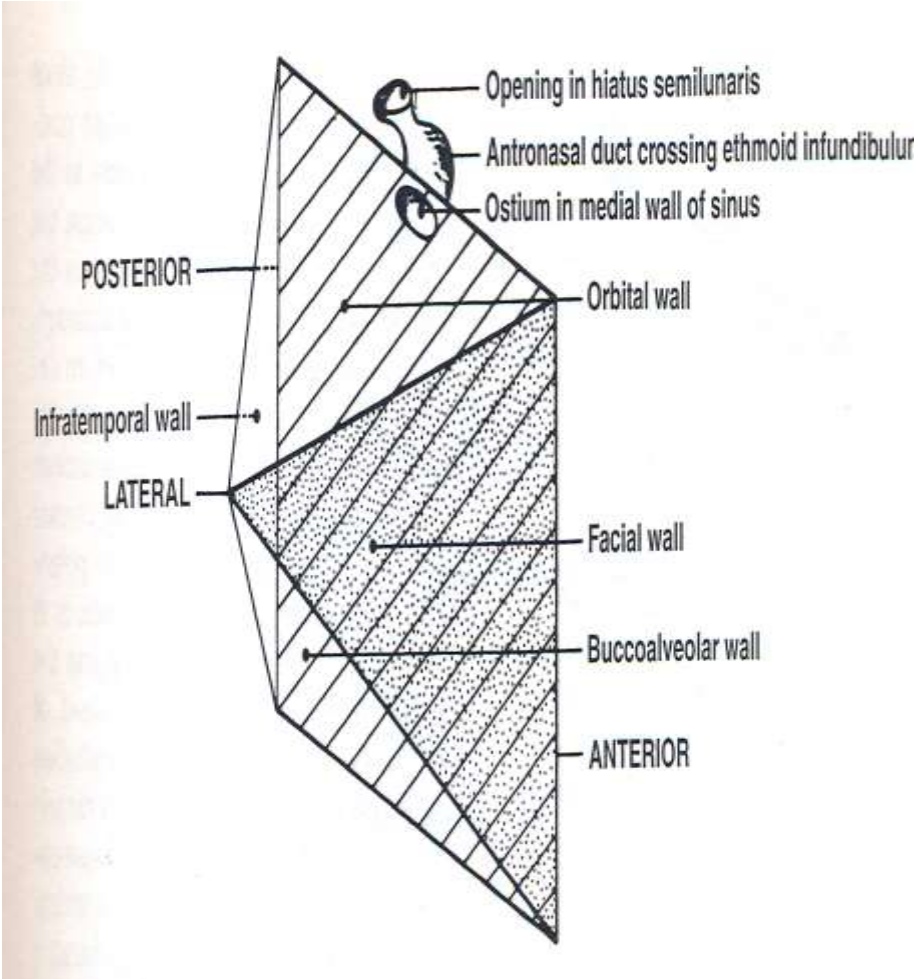
Figure 1.8 Coronal section through the mid-face showing the thin layer of bone separating the sinus mucosa from the oral mucosa in the edentulous patient. From Lund (1987)

ANATOMY



CHARACTERS

- *Largest of the air filled spaces surrounding the nose*
- *Located in body of maxilla; may extend into Zygomatic & palatine bones*
- *Paired structures; mirror images*
- *horizontal pyramidal in shape having base, an apex & four sides*



- *Based on its shape sinus is classified into 4 types*

1. *SEMI-ELLIPSOID (15 %)*
2. *PARABLOID (30%)*
3. *HYPERBOLIC (47 %) &*
4. *CONE-SHAPED (8 %)*

- *thickness of the bony walls of the sinus*

- *Depends on :-*

1. *the individual wall*
2. *amount of bone resorption that occurred in these walls during growth except medial wall which shows apposition due to resorption in lateral wall of sinus*

- *Importance*

1. *tumors can erode them readily*

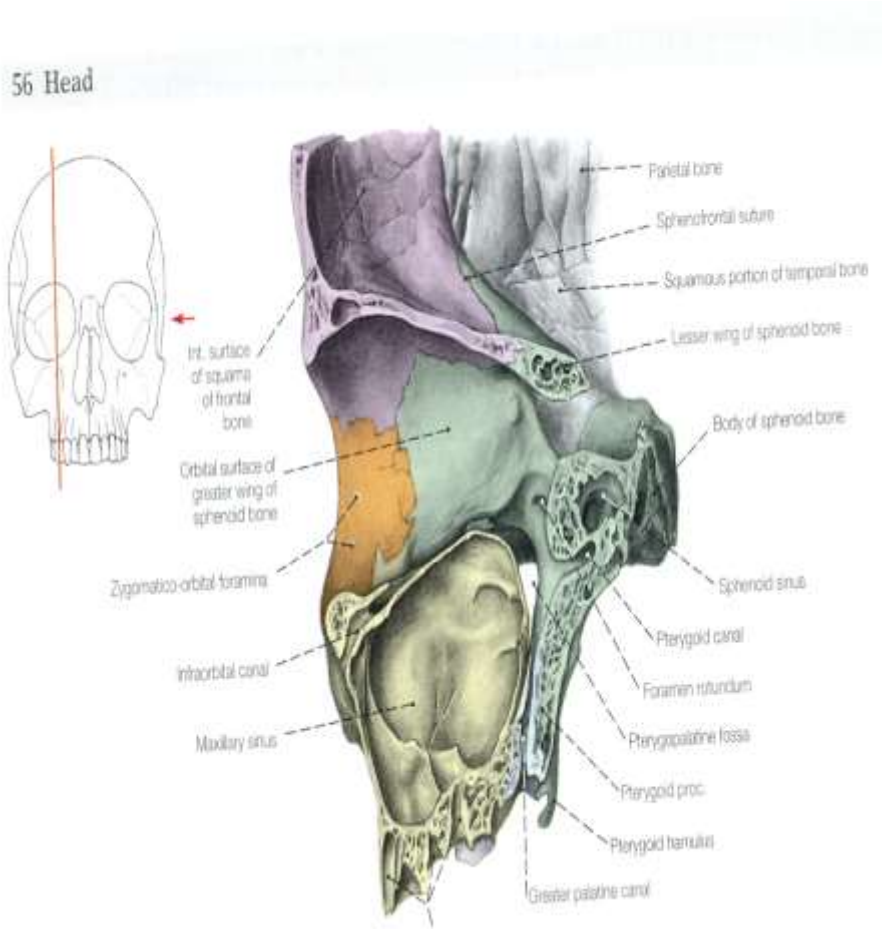
- *Swelling in cheek*
- *Epiphora*
- *Proptosis of eye*
- *Pupillary level*

2. *may fracture readily from direct or indirect trauma to the Midface*

MEDIAL WALL

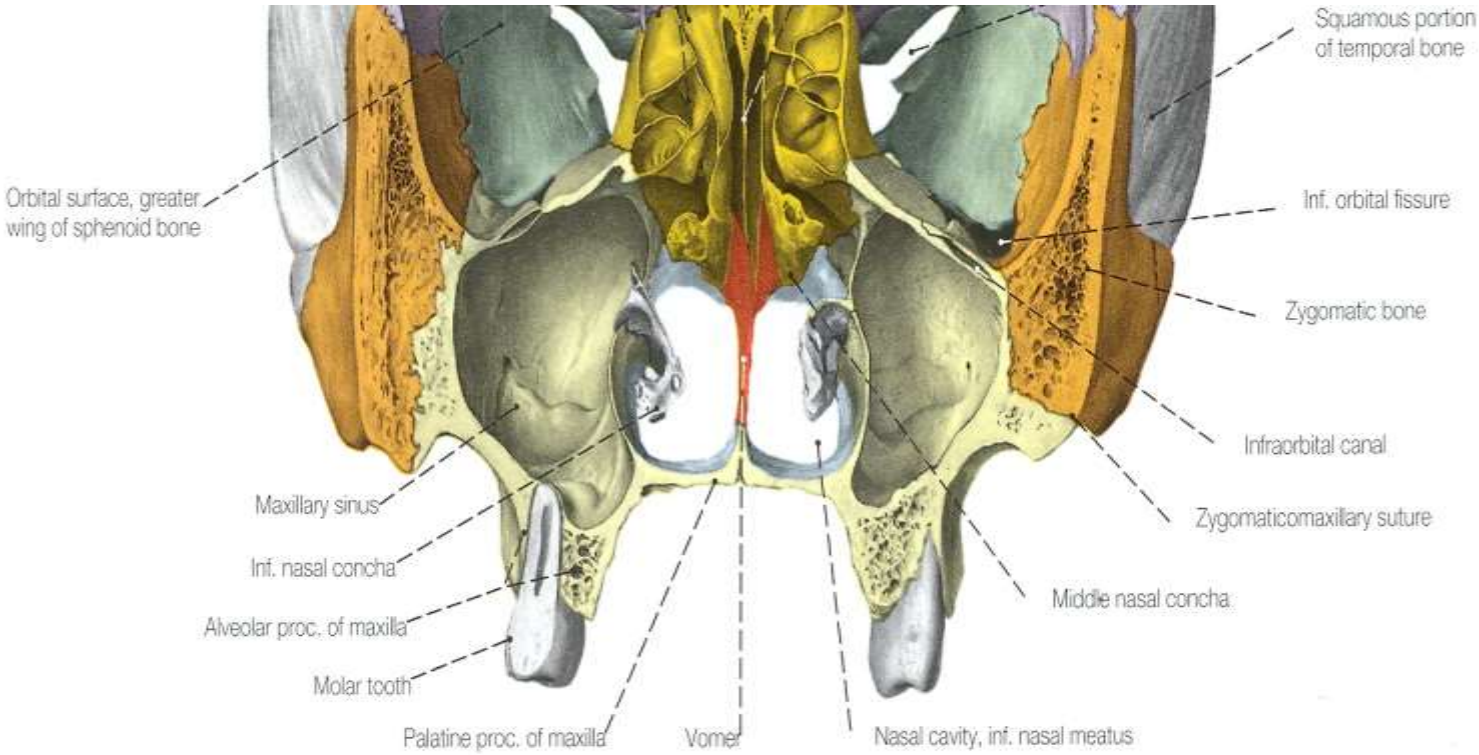
- Forms the base of sinus when sinus is large distance b/w sinus & apex is 25mm
- Occupies a parasagittal plane
- descriptive purposes divided into thirds vertically.

1. Inferior 1/3rd: formed by palatal alveolar process of maxilla
2. Middle 1/3rd: formed by part below Inferior concha ;superior central part is thinest
3. superior 1/3rd: formed by part above Inferior concha



- *Skeleton of medial wall is complex*

- *Upper limit: Floor of Orbit*
- *Inferiorly: Maxillary process of Inferior concha*
- *Behind: Perpendicular plate of palatine bone*
- *Above: Lower border of Ethmoidal labyrinth & lateral wall of bulla ethmoidalis.*
- *Anterosuperiorly: Descending process of lacrimal bone as it forms a part of naso lacrimal duct.*


Squamous portion of temporal bone
Orbital surface, greater wing of sphenoid bone
Inf. orbital fissure
Zygomatic bone
Infraorbital canal
Zygomaticomaxillary suture
Maxillary sinus
Inf. nasal concha
Middle nasal concha
Alveolar proc. of maxilla
Molar tooth
Palatine proc. of maxilla
Vomer
Nasal cavity, inf. nasal meatus

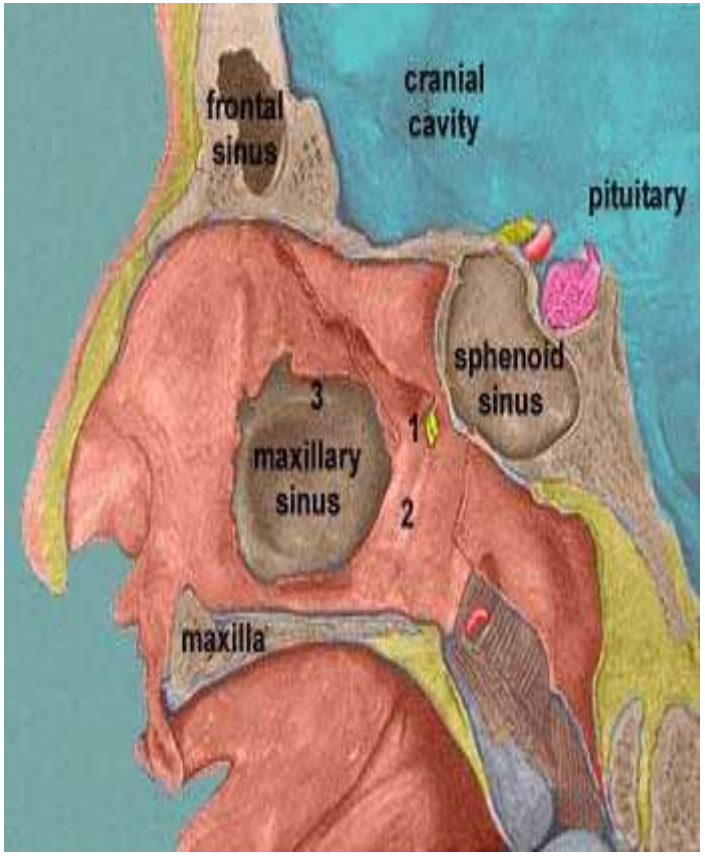
Importance of medial wall

Related to several important structures present on the lateral wall of nose includes

- *Ostium*
- *Hiatus semilunaris*
- *Ethmoidal bulla*
- *Uncinate process*
- *Infundibulum*

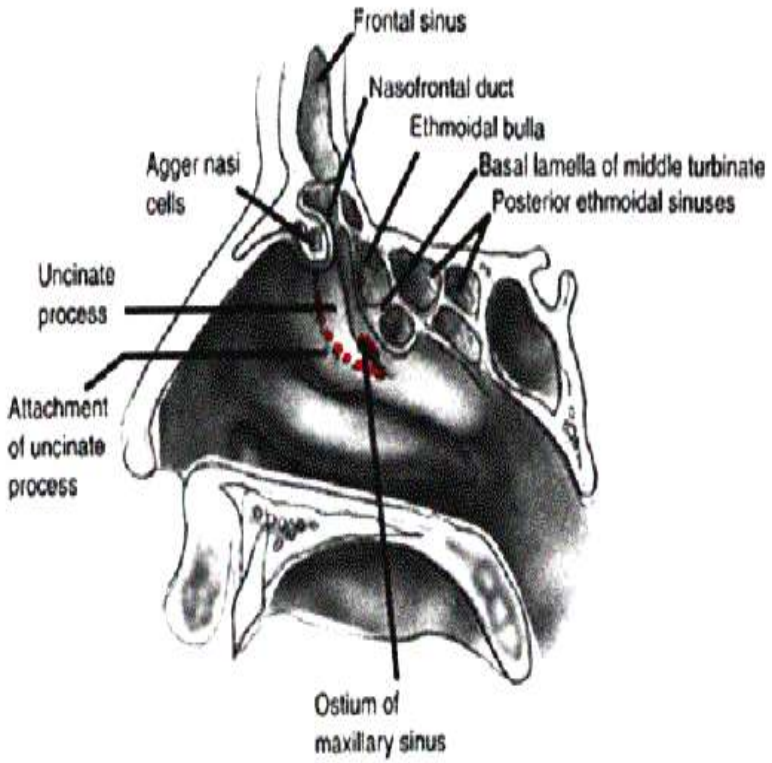
Involved in

- *Midface # & trauma*



Uncinate process of Ethmoid (uncinus- Hook)

- posteroinferior projection from Inferomedial wall of Anterior Ethmoidal cells
- 3mm medial to junction of maxilla, Lacrimal & Ethmoid bones.
- Passes from an anterosuperomedial to PosteroInferolateral direction, into lateral wall of middle meatus to articulate with inferior concha.
- Medial wall of sinus is covered by Respiratory mucosa comes together with nasal mucosa to form 2 fontanelles [one Anterior, One Posterior] to occlude maxillary hiatus.
- Short arm of uncinate process projects into medial wall of sinus & may cause a ridge within posterior fontanelle. contains an opening the maxillary sinus ostium.


Frontal sinus
Nasofrontal duct
Ethmoidal bulla
Agger nasi cells
Basal lamella of middle turbinate
Posterior ethmoidal sinuses
Uncinate process
Attachment of uncinate process
Ostium of maxillary sinus

Maxillary Ostium

- *elliptical or hourglass shaped*
- *Located on the superior aspect of Medial wall halfway between Anterior & Posterior boundaries (2cm from Anterior & 2cm from posterior, 4cm from floor).*
- *Opens into posterior part of hiatus semilunaris*
- *Size of the ostium is approximately 4x10mm*

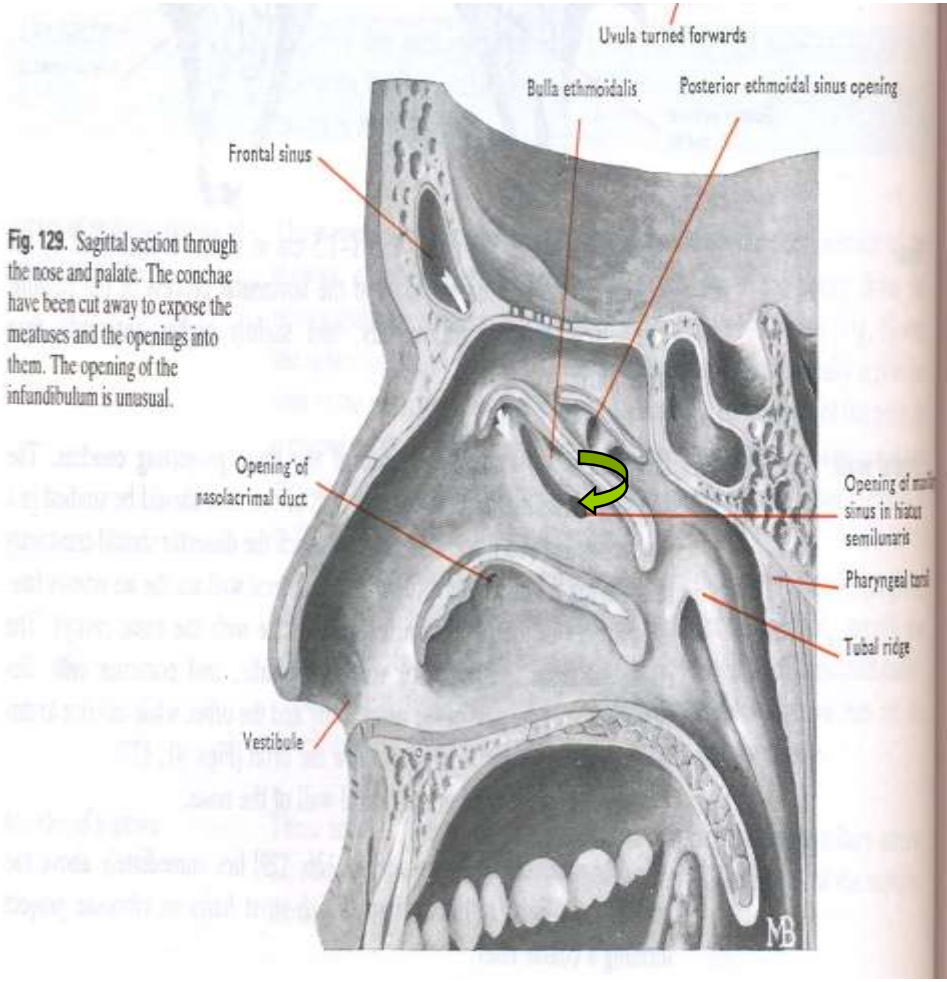
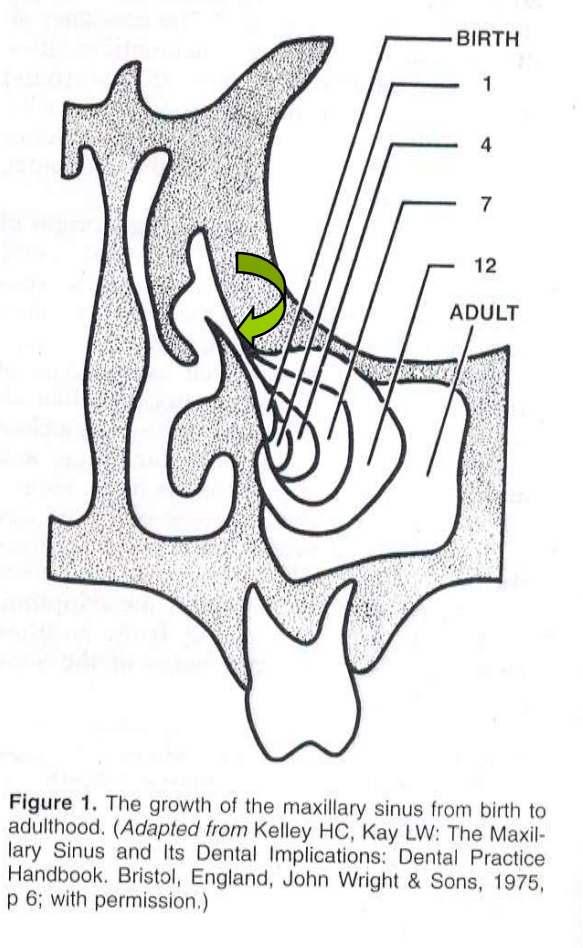


Fig. 129. Sagittal section through the nose and palate. The conchae have been cut away to expose the meatuses and the openings into them. The opening of the infundibulum is unusual.

- *Location of ostium is related to embryology & Development. Its location is the first site of Invagination of nasal mucosa .*
- *Accessory ostia are usually found below & behind the main ostium, 10% of 100 sinus*
- *sinus floor lies below the level of nasal floor NASAL ANTROSTOMY does not allow complete gravity dependent drainage.*



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HIATUS SEMILUNARIS

- Flat crescent shaped defect in the parasagittal plane

BOUNDARIES

1. AnteroInferiorly formed by superior edge of uncinate process &
2. Posterosuperiorly formed by convex lower surface of ethmoidal bulla

- Funnel shaped passage highest & widest at the anterior end of Ethmoidal labyrinth beneath frontal sinus
- Frontal sinus drains through frontonasal duct or directly/Indirectly via anterior ethmoidal air cell.

SUPERIOR WALL

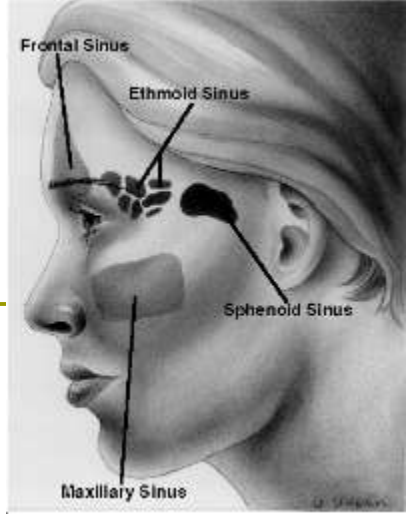
- forms the roof of the sinus & the floor of the orbit
- thin , flat and slopes slightly anteriorly and laterally
- Infraorbital canal runs along this wall
- probably the most vulnerable of all the walls of the sinus
- wall is thin on either side of the canal but is thinner lateral to the Infraorbital canal than medial to it

IMPORTANCE

1. involved frequently in orbital and maxillary trauma
2. relative thinness of this wall & the position of the Infraorbital nerve within it may lead to

- proptosis,
- alteration of the interpupillary level,
- and neurologic symptoms related to pressure on the infraorbital and the anterior superior alveolar nerves.

POSTEROLATERAL WALL



- made up of the zygomatic bone and the greater wing of the sphenoid bone
- separates the maxillary sinus from the infratemporal fossa and the pterygopalatine fossa.
- thick wall laterally and a thin wall medially.
- The posterolateral wall is pierced by, and contains, the posterior alveolar canals, which transmit the posterior superior alveolar nerves to supply the upper molars.

IMPORTANCE

- PSA canals occasionally project into the sinus as ridges, and when there is thinning of this wall, these nerves are in immediate contact with the lining membrane of the sinus.

In such instances, acute sinusitis can be accompanied by pain in multiple posterior maxillary teeth.

- Immediately posterior to this wall, several important structures are located within the pterygopalatine fossa.

These structures include

- maxillary nerve,
- maxillary artery,
- sphenopalatine ganglion, and
- nerve of the pterygoid canal.

Surgical access to these structures and to the fossa is obtained by careful removal of a segment of this wall.

ANTERIOR WALL

- formed by the anterior aspect of the maxilla

BOUNDARIES

- anteriorly pyriform aperture
- Laterally zygomaticomaxillary suture
- Superiorly Infraorbital rim
- Inferiorly alveolar process and maxillary teeth
- thickness 2 to 5 mm
- Infraorbital foramen lies in this wall ~1.5cm above the first and second premolars
- also contains the anterior and middle superior alveolar nerves

IMPORTANCE

- approach to the sinus through this wall may jeopardize the nerve supply to these teeth

  Limiting the access to less than 1 cm in the central depressed area of this wall

- labial levator muscles and the inferior portion of the orbicularis oculi muscle are attached to this wall above the Infraorbital foramen

  usually direct the spread of infection from the maxillary teeth and from the maxillary sinus

FLOOR OF THE SINUS

- Not a true wall
- junction of the anterior sinus wall and the lateral nasal wall forms the floor of the sinus.
- the adult, the floor of the sinus is approximately 1 to 1.25 cm below the level of the floor of the nasal cavity.

significance

- relationship to the roots of the maxillary teeth and the alveolar process
- inner surface of the maxillary sinus floor not smooth, but rather it is often occupied by bony septa that protrude from the sinus into several chambers

- *The root apices of the second molar are in closest proximity to the sinus floor, followed in order of frequency by the*

first molar, third molar, second premolar, first premolar, and canine

- *apex of the mesiobuccal root of the maxillary second molar was the closest to the sinus floor (mean, 1.97mm).*

- *The apex of the buccal root of the maxillary first premolar was the farthest from the floor of the sinus (mean, 7.5mm).*

PHYSIOLOGY

- *lined with a respiratory mucosa*
- *lining is a mucoperiosteum*

1. *epithelial covering,*
2. *lamina propria,*
3. *the periosteum*

The thickness of the combined layers is generally less than1 mm

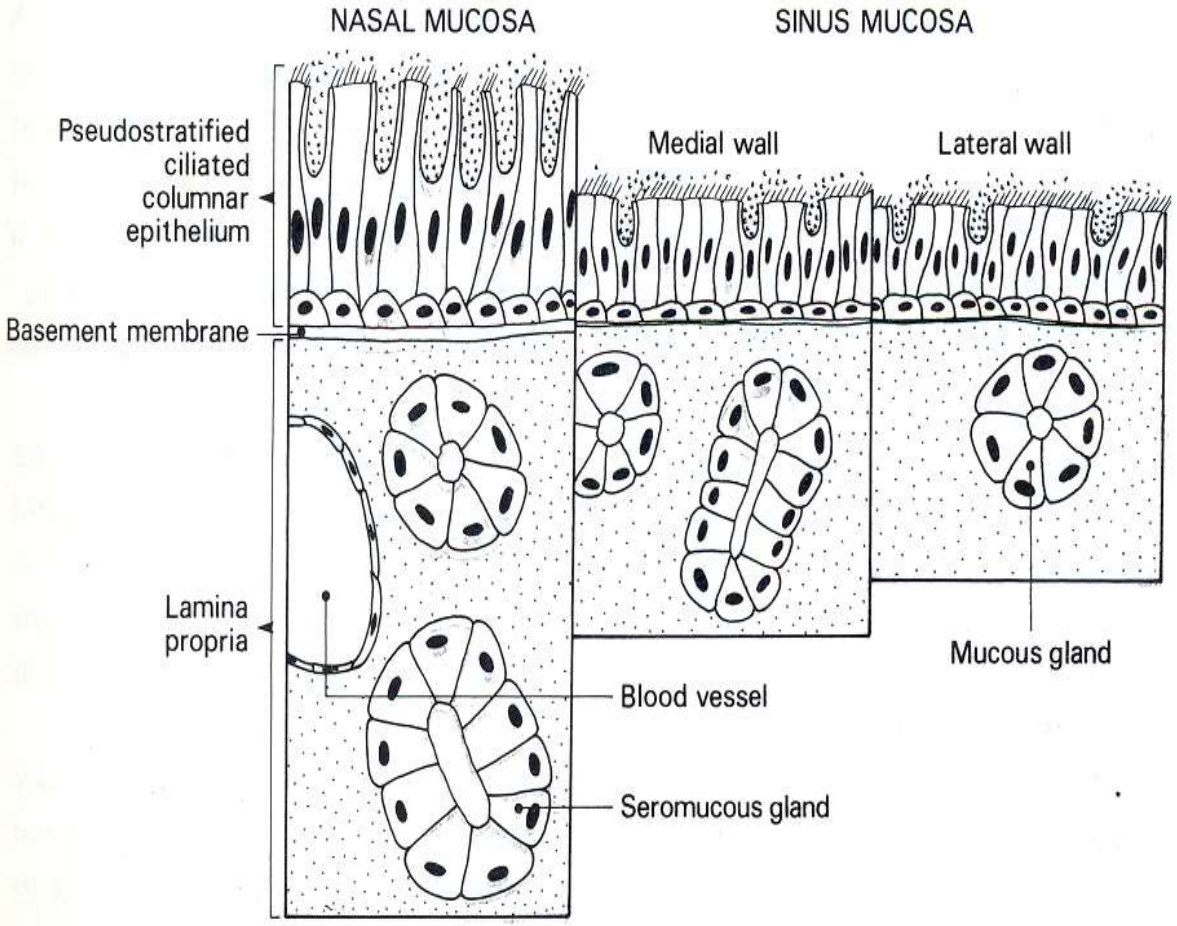


Figure 2.1 A diagrammatic comparison of nasal and sinus mucosa After Strachan (1987)

MUCOUS MEMBRANE OF THE MAXILLARY SINUS

- mucous membrane of the respiratory type respiratory mucosa lining the maxillary sinus is continuous with that of the nose and the other paranasal sinuses through their ostia
- pseudo stratified columnar ciliated epithelium
- density of ciliated cells is high in all parts of the maxillary sinus, ranging from 91.3% to 97.7%, except near the ostium, where the density is decreased by half (With scanning election microscopy, Halama et al)
- Normally, they can clear the sinus in 10 to 30 minutes under physiologic conditions

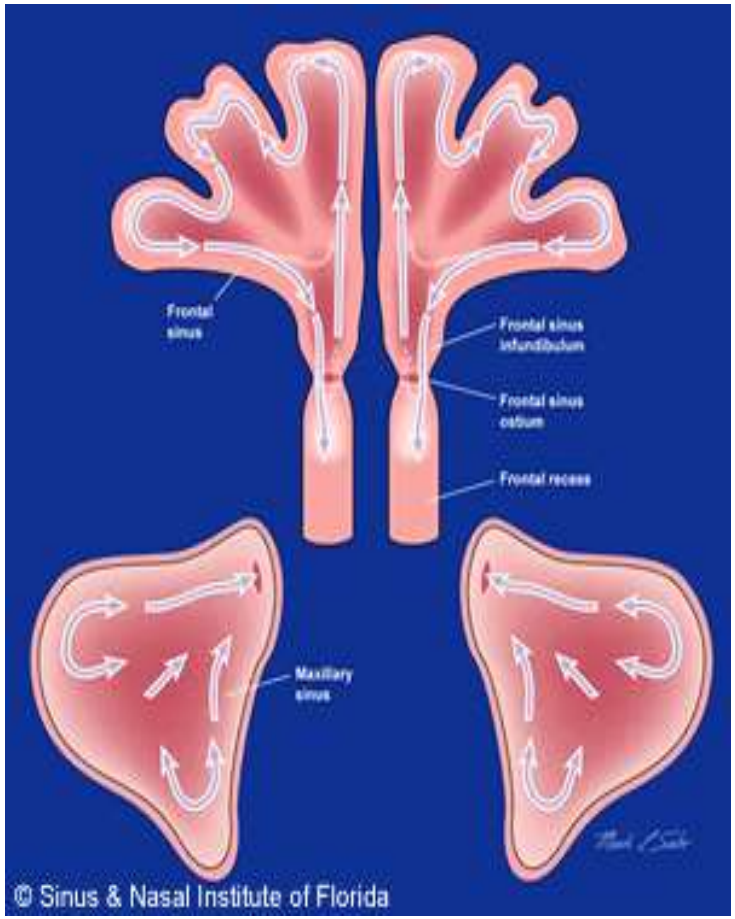
- *The mucociliary blanket is produced by the goblet cells*

COMPOSITION

- *96% water,*
- *1% to 2% inorganic salts,*
- *and 2% to 3% mucin*.
- *consists of two layers: a viscous, mucinous outer layer and a serous inner layer in contact with the cilia.*

The mucosa is supplied by both sympathetic and parasympathetic innervation

MUCOCILIARY BLANKET



- mucus production between ½ quart and up to 1 ½ quarts of mucus /day.
- It is drained from the sinuses by tiny hair-like structures called cilia that beat the mucous out of the sinuses into the nasal passages and down into our throat where is usually imperceptibly swallowed
- Each epithelial cell has about 200 cilia
- beat at a frequency of about 10-20Hz at body temperature.

Cilia undergo a regular and synchronous undulating movement, like a dancing effect.

- *The epithelial cilia beat continuously, moving at a rate of 6 mm/min,*
- *The cilia move the mucus and other debris in approximately 1000 times per minute while moving the mucociliary blanket.*
- *The speed of mucociliary transport in humans varies from 5 to 20 mm per minute*
- *Three types of mucociliary flow have been described:*

  1. Smooth, moving at 0.84 cm/min,

  2. Jerky, moving at 0.3 cm/ min, and

  3. Mucostasis, moving at less than 0.3cm/min.

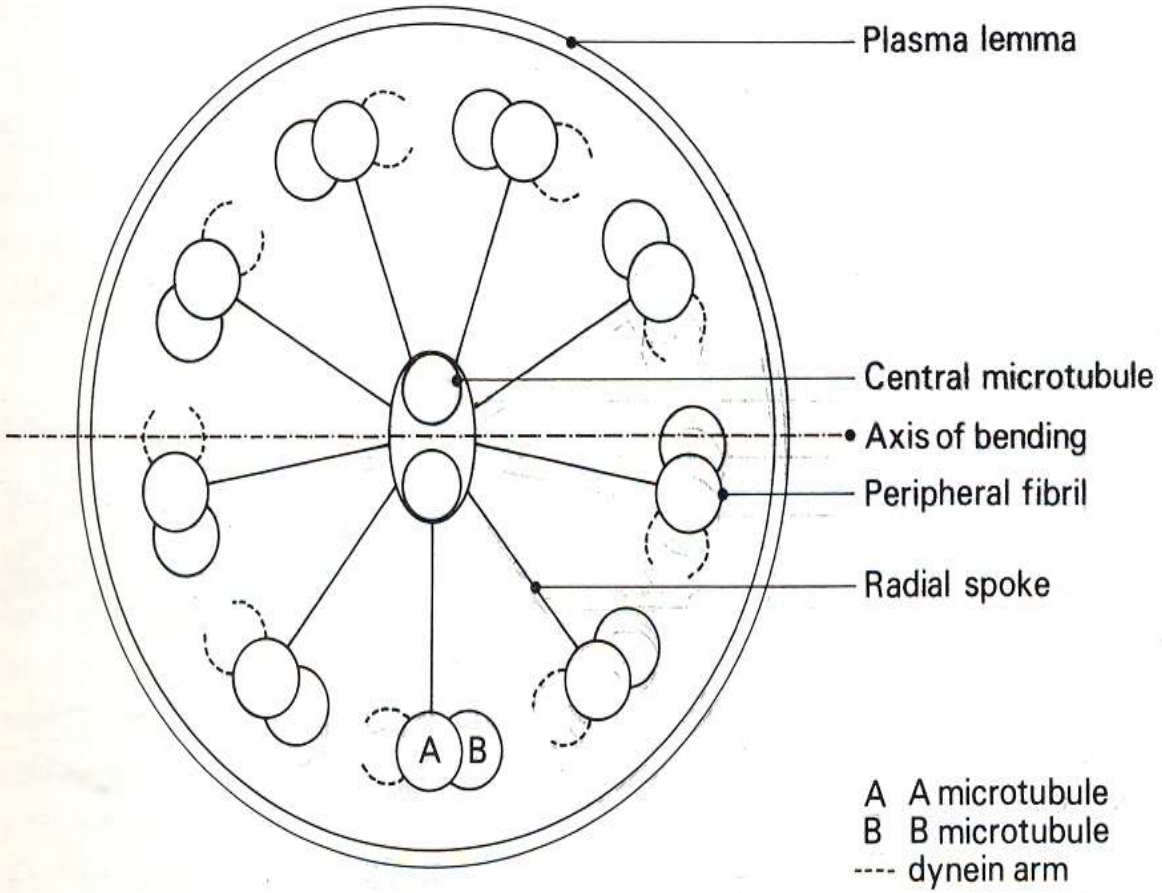


Figure 2.2 Transverse section of a cilium

FUNCTION

- serves to filter our air of tiny particles which can contain infection.
- contains defensive proteins that help protect us from invasion by organisms.
- helps humidify the air.
- mucosa is rich with blood vessels and nerve endings that serve many purposes that include our sense of smell and “sneeze reflex”.

- **Factors stimulate mucociliary activity are**

1. *Tissue Kallikrein*
2. *Prostaglandin E1 and F2*

- **Factors decreases mucociliary activity are**

1. *neuropeptide Y*

- **decreases blood flow but has little effect on mucociliary activity.**

1. *Ligature of the external carotid artery*
2. *Phenylpropanolamine*

- **decreases both blood flow and mucociliary activity.**

1. *xylometazoline –otrivin nasal drops*

Regeneration

- high regenerative capacity
- epithelial regeneration from the margins of the operative opening into the sinus but also, to a lesser extent, from islands of mucosa left behind.
- The maxillary sinus lamina propria is much thinner than that of the nasal mucosa.
- It contains fewer mucous and seromucous glands, and very few of the serous glands that are copious throughout the nose

  serous glands are important for humidification of inspired air and contribute to the maintenance of the serous periciliary layer of the mucous blanket

Physiology

1. Reduction of weight of the facial skeleton
2. Phonetic resonance and auditory feedback
3. Insulation
4. Air conditioning
5. Water conservation
6. Filtration
7. Olfaction

Vascularization and Innervation of the maxillary sinus.

ARTERIAL SUPPLY

Possible contributions from branches of the

1. Infraorbital artery,
2. Posterior superior artery
3. and palatine artery- greater & spenoplalatine

branches of third part of maxillary artery

Venous Drainage

- the medial sinus wall drains via the sphenopalatine vein.

- The other sinus walls drain via the pterygomaxillary plexus.

LYMPHATIC DRAINAGE

- submucosal lymphatic converge;which pass through the ostium unite with the lymphatic in middle meatus along the lateral wall of nose.
- The well developed lymph drainage of the lateral nasal wall is posteriorly towards the pharyngeal opening of the auditory tube where pierce or pass above the superior constructor muscle to join the upper deep cervical nodes.

NERVE SUPPLY

1. **General sensory Innervation** from the branches of the maxillary nerve,
2. **sympathetic** from the superior cervical ganglion &
3. **parasympathetic** from the spehnopalantine ganglion.

These fibers are distributed via the

- posterior & middle superior dental & Infraorbital branches of the maxillary nerve &
- via the greater palatine &
- nasal branches from the pterygopalatine ganglion

MICROBIOLOGY OF MAXILLARY SINUS

- *debatable.*

  The question of whether the paranasal sinuses are sterile or have normal micro flora is still controversial

- *difficult Specimen collection*

- ***newer issues***

1. *resistance to antimicrobial drugs.*
2. *of microbes other than bacteria associate with sinusitis continue to grow,*

Association of bacteria with acute sinus infection:

Acute sinusitis

In adults frequently associated bacteria are

- *S. pneumoniae &*
- *Hemophilus influenzae*

In children

- *Branhamella catarrhalis is also common*

Chronic sinusitis

- *S. pneumoniae,*
- *Hemophilus influenzae &*
- *Branhamella catarrhalis remain common.*
- *In addition anaerobes, viridans streptococci and staphylococci*

Pathophysiology

- *function - unknown*
- *clinical significance*

1. *gas exchange of the maxillary sinus mucosa,*
2. *patency of the ostium, blood flow,*
3. *mucus production and mucociliary transport, and*

young`s, kartagener syndrome, cystic fibrosis

4. *pressure changes in flying and diving.*

air pass out of it during ascent (expansion) and back in during descent (contraction)

EFFECTS OF DENTAL CONDITIONS ON THE SINUS

1. Dental implants
2. Periodontal and pulpal disease
3. Periapical inflammation
4. Gas Exchange of the maxillary sinus mucosa
5. patency of the antronasal duct *For optimum function the bore should be at least 5mm2, which is provided by a diameter of 2.5mm*
6. Mucus production and mucociliary transport
7. Flying and diving

APPROACHES TO MAXILLARY SINUS

Accessory, surgical, opening into the maxillary sinus may be either Intranasal or facial

Intranasal approach

- penetrate the lateral nasal wall
- commonly through inferior meatus
- nasolacrimal duct can be damaged
- Prevention - can be done above the attachment of the inferior concha.

Extranasal approach

- *through the canine fossa*

- *transmitted light is often useful to locate the anterior superior alveolar nerve and vessels*

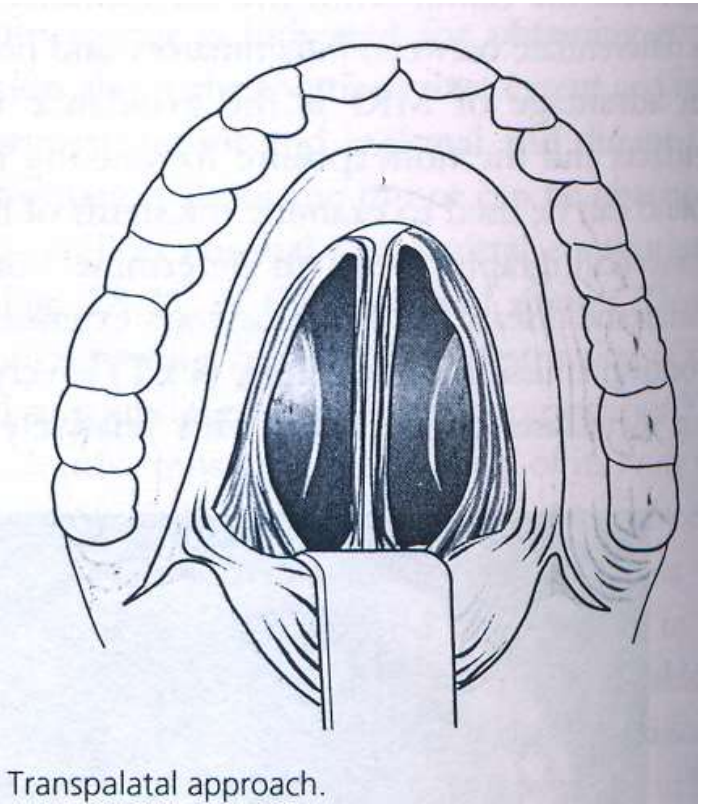
Complications

- *anesthesia or paresthesia of the cheek, upper lip or teeth*
- *more with vertical incisions into the mucosa as compared to the horizontal one*

but vertical exposure includes more exposure & less bleeding.

- *Artificial opening into the sinus is effective ;may upset the normal physiology of the sinus*

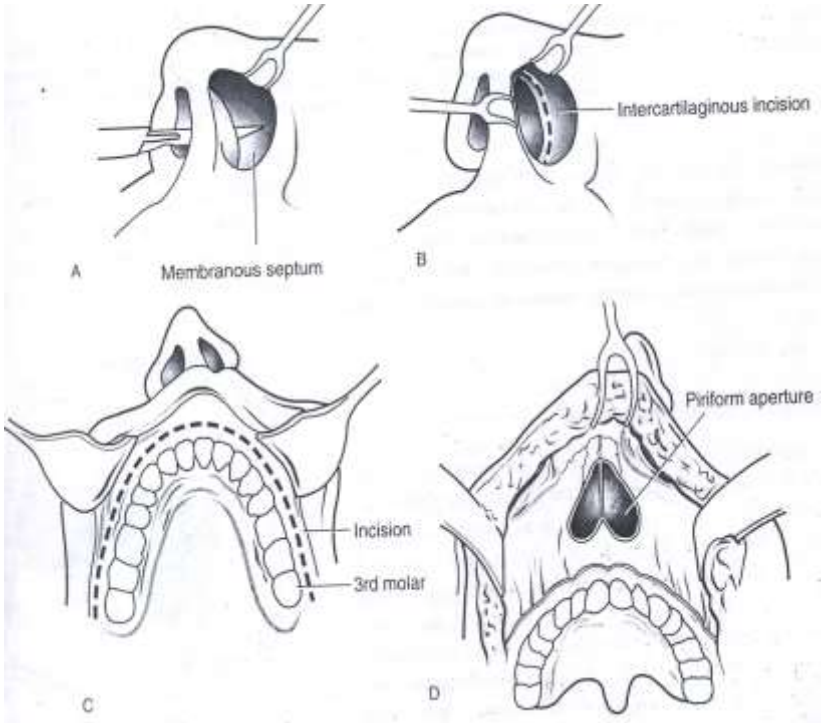
Transoral and transpalatal approach



Transpalatal approach.

Midface Degloving

Maniglia and Phillips

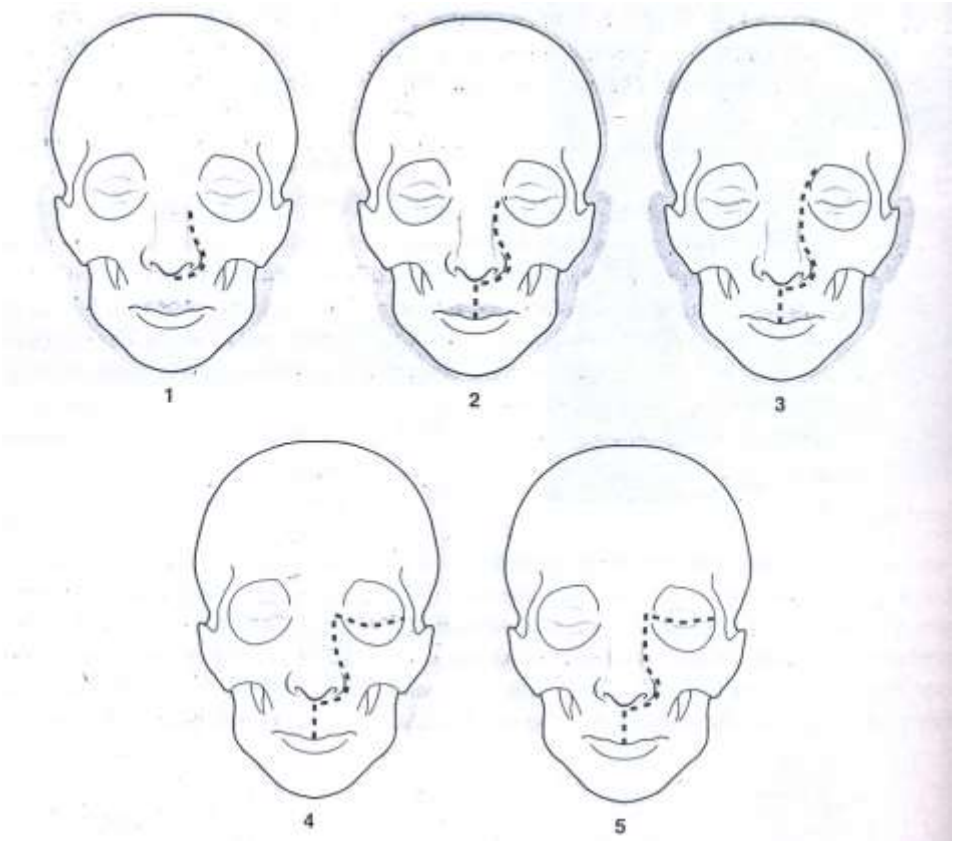


(1) Bilateral intercartilaginous incisions,

(2) A full-thickness septocolumellar transfixion incision, and

(3) Bilateral piriform aperture incisions

Weber-Fergusson approach



- *Le Fort I - osteotomy approach*
- *Combined craniofacial approach*

CONCLUSION

Due to the common embryologic origin of paranasal sinus from the nasal cavity, they share certain physiological characteristic with each other & with nasal chamber and with respiratory system, such as type of lining membrane as well as type of disease and inflammatory process that affect them. The maxillary sinus has close proximity to the orbit, alveolar ridge and maxillary teeth and it shares its nerve supply with this.

accurate knowledge of anatomy and embryology of maxillary sinus is essential to clinicians.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