ا.د. علي الحسيني

Odontogenic Diseases of the Maxillary Sinus

Embryology and Anatomy

The maxillary sinuses are air-containing spaces that occupy maxillary bones bilaterally.

The paranasal sinuses (maxillary, ethmoid, frontal, and sphenoid) development begins in the third month of fetal development as pouching of the ethmoid infundibula.

At age 12 or 13 years, the sinus will have expanded to the point at which its floor will be on the same horizontal level as the floor of the nasal cavity.

In adults, expanded to the point at which its floor will be 7 mm below the floor of the nasal cavity. The sinus will pneumatize after the removal of one or more posterior maxillary teeth, to occupy the residual alveolar process. The maxillary sinus is significantly larger in adult patients who are edentulous in the posterior maxilla compared with patients with complete posterior dentition.

The maxillary sinus is the largest of the paranasal sinuses. It is also known as the antrum of Highmore. The MS is a pyramid shaped pneumatic space with its base (medial wall) corresponds to the lateral nasal wall and the apex extends into the zygoma. The anterior wall corresponds to the facial surface of the maxilla; it includes canine fossa and the infraorbital foramen. The posterior wall separates the sinus from the structures of the infratemporal and pterygomaxillary fossae. The superior wall (roof) formed by a thin triangular orbital floor, and it contains the infraorbital canal. The inferior wall (floor) formed by the alveolar and palatine processes of the maxilla. It is in close relation to the roots of the posterior maxillary teeth.

The adult maxillary sinus averages 34 mm in the anteroposterior direction, 33 mm in height, and 23 mm in width. The volume of the sinus is approximately 15-20 mL. The sinuses are primarily lined by mucus-secreting pseudostratified ciliated columnar epithelium. The cilia and mucus are necessary for the drainage of the sinus because the sinus opening (ostium) is not in a dependent (inferior) position but lies two-thirds the distance up the medial wall, in the middle meatus of the nasal cavity between the inferior and middle nasal conchae.

Beating of the cilia moves the mucus produced by the lining epithelium and any foreign material contained within the sinus toward the ostium, from which it drains

into the nasal cavity. The cilia beat at a rate of up to 1000 strokes per minute and can move mucus a distance of 6 mm/min.

Clinical Examination of the Maxillary Sinus

1. Visual examination of the patient's face and intraoral vestibule for swelling or redness.
2. Nasal discharge may be evident during the initial evaluation.
3. Tapping of the lateral walls of the sinus externally over the prominence of the zygomatic bones and palpation intraorally on the lateral surface of the maxilla between the canine fossa and the zygomatic buttress. The affected sinus may be very tender to gentle tapping or palpation.
4. Patients with maxillary sinusitis frequently complain of dental pain to percussion of several maxillary posterior teeth, which is often indicative of an acute sinusitis.
5. Transillumination of the maxillary sinuses. This is done by placing a bright fiberoptic light against the mucosa on the palatal surfaces of the sinus and observing, in a darkened room, the transmission of light through the sinus. The involved sinus shows decreased transmission of light because of the accumulation of fluid, debris, or pus and the thickening of the sinus mucosa.

Sinoscopy can be performed to obtain additional information regarding anatomic factors that may be contributing to sinus disease.

Radiographic Examination of the Maxillary Sinus

Standard dental radiographs that may be useful in evaluating the maxillary sinus include periapical, occlusal, panoramic, and occipitomental views.

A periapical radiograph is limited in that only a small portion of the inferior aspect of the sinus can be visualized. In some cases, the apices of the roots of posterior maxillary teeth may be seen to project into the sinus floor.

Panoramic radiograph provides a view of both maxillary sinuses for comparison. Because a panoramic radiograph provides a focused image within a limited focal trough, structures outside of this area may not be clearly obvious.

Periapical, occlusal, and occasionally panoramic radiographs are of value in locating and retrieving foreign bodies within the sinus, particularly teeth, root tips that have been displaced by trauma or during tooth removal.

Waters, lateral, and posteroanterior views are useful. The Waters view (occipitomental) is taken with the head tipped 37° to the central beam provides clearer view of the sinuses than a standard posteroanterior view of the skull.

Computed tomography and cone beam computed tomography provide precise images when compared to conventional radiographs.

The findings in the normal antrum are air-filled cavity surrounded by bone and dental structures. The body of the sinus should appear radiolucent and be outlined in all peripheral areas by a well-demarcated layer of cortical bone.
Comparison of one side with the other is helpful in examining radiographs. Partial or complete opacification of the maxillary sinus may be caused by the mucosal hypertrophy and fluid accumulation of sinusitis, by blood filling the sinus following trauma, or by neoplasia.
Radiographic changes indicative of chronic maxillary sinusitis includes mucosal thickening, sinus opacification, and nasal or antral polyps. Air-fluid levels in the sinuses are more characteristic of acute sinus disease but may be seen in chronic sinusitis during periods of acute exacerbation.
Dental pathologic conditions such as cysts or granulomas may produce radiolucent lesions that extend into the sinus cavity. These conditions may be distinguished from normal sinus anatomy by their association with the tooth apex and the presence of a radiopaque osseous margin on the radiograph, which generally separates the periapical lesion from the sinus itself.

Nonodontogenic Infections of the Maxillary Sinus

The maxillary sinus is usually not colonized by any bacteria and is essentially sterile. Even though some microorganisms may be present in the normal sinus, this appears to be minimal, and the dynamic nature of the sinus with active epithelium moving mucus toward ostium prevents any significant colonization.
Inflammatory diseases of the sinus, such as infection or allergic reactions, cause hyperplasia of the mucosa and may cause obstruction of the ostium. If the ostium becomes obstructed, the mucus produced by the secretory cells lining the sinus collects over a long period. Bacterial overgrowth may then produce an infection, which results in the signs and symptoms of sinusitis.
When inflammation develops in any of the paranasal sinuses, whether caused by infection or allergy, the condition is termed *sinusitis*. Inflammation of most or all of the paranasal sinuses simultaneously is known as *pansinusitis* and is usually caused by infection. Similar conditions of individual sinuses are known as *maxillary sinusitis* or *frontal sinusitis*.
Acute maxillary sinusitis may occur at any age mainly due to infection. The onset is usually described by the patient as a rapidly developing sense of pressure, pain, fullness, or all of these in the vicinity of the affected sinus. The discomfort rapidly increases in intensity and may be accompanied by facial swelling and erythema, malaise, fever, and drainage of foul-smelling mucopurulent material into the nasal cavity and nasopharynx.
Chronic maxillary sinusitis is usually a result of bacterial or fungal infections that are low-grade and recurrent, obstructive nasal disease, or allergy. Chronic maxillary

sinusitis is characterized by episodes of sinus disease that respond initially to treatment or that remain symptomatic in spite of treatment.
Aerobic, anaerobic, or mixed bacteria may cause infections of the maxillary sinuses. The organisms usually associated with maxillary sinusitis of nonodontogenic origin include those usually found within the nasal cavity. Mucostasis that occurs within the sinus allows for colonization of these organisms. *The causative bacteria are primarily aerobic, and a few are anaerobes*. The important aerobes are *Streptococcus pneumoniae, Haemophilus influenzae,* and *Branhamella catarrhalis*. Anaerobes include *Streptococcus viridans, Staphylococcus aureus,* Enterobacteriaceae, and *Fusobacterium*.

Odontogenic Infections of the Maxillary Sinus
Odontogenic sources account for approximately 10% to 12% of all maxillary sinusitis cases. This condition may readily spread to involve the other paranasal sinuses if left untreated or inadequately treated. In rare cases, these infections become life threatening and can include orbital cellulitis, cavernous sinus thrombosis, and death.
Sources of odontogenic infections that involve the maxillary sinus include acute and chronic periapical diseases and periodontal diseases. Infection and sinusitis may also result from trauma to the dentition or from surgery in the posterior maxilla, including removal of teeth, alveolectomy, tuberosity reduction, sinus lift grafting and implant placement, or other procedures that create an area of communication between the oral cavity and the maxillary sinus.

Clinical manifestations of maxillary sinusitis:
Nasal congestion, nasal discharge, midface pressure, pain, and headache.
Acute maxillary sinusitis usually resolves within 2 weeks with an initial presentation of fever, malaise, facial swelling, and pain when bending forward.
the most common bacterial pathogens in odontogenic acute sinusitis include the aerobic S pneumoniae and Staphylococcus aureus, as well as the anaerobic gram-negative bacilli, Peptostreptococcus spp, and Fusobacterium spp.
Chronic maxillary sinusitis usually lasts more than 4 weeks with symptoms of postnasal drainage, halitosis, and diminished sense of taste and smell. The predominant pathogens in odontogenic chronic maxillary sinusitis involve a mixture of aerobic and anaerobic bacteria similar to those found in odontogenic acute sinusitis.

Treatment of sinusitis:
1. Augmentin 875 mg twice daily, Clindamycin 300 mg 4 times daily, or Cefixime 400 mg once daily for at least 10 days, depending on the resistance pattern.
2. Culture and sensitive tests should be performed if purulent discharge is noticed.

3. Nasal decongestant, antihistamines, and steroids to improve clinical symptoms.
If medical attempts fail, surgical options such as a functional endoscopic sinus surgery or Caldwell-Luc antrostomy should be considered to achieve proper drainage of the maxillary sinuses. Functional endoscopic sinus surgery is a minimally invasive approach that allows for transnasal management of chronic sinusitis and optimization of drainage from the maxillary sinus.

Antral cysts

Pseudocysts, mucoceles, and retention cysts are accumulations of fluid underneath or surrounded by sinus epithelium.
The antral pseudocyst is seen in 2% to 10% by panoramic radiographs. This pseudocyst is a result of the accumulation of serum (not sinus mucus) under the sinus mucosa. The cause of these accumulations is not clear but may be related to inflammation of the sinus lining. These lesions are of no clinical consequence, require no treatment, and often disappear over time.
Sinus mucoceles are actually cystic lesions in that they are lined by epithelium. One of the most common causes of true mucoceles is surgery on the sinus, which results in separation of a portion of the sinus lining from the main portion of the sinus. This area can then become filled with mucus and be walled off, forming a separate cystic lesion. These lesions are termed surgical ciliated cysts or postoperative maxillary cysts. They can become expansile and may expand or erode the walls of the sinus and must be differentiated, usually through removal and biopsy.
Retention cysts in the maxillary sinus result from blockage of ducts within the mucus-secreting glands of the sinus. The accumulated mucin becomes surrounded by epithelium, forming a true cystic lesion. These lesions are usually so small that they are not visible on radiographic images.

Complications of Oral Surgery Involving the Maxillary Sinus

The most common dental complications of oral surgical procedures that subsequently involve the maxillary sinus include the displacement of teeth, roots, or instrument fragments into the sinus or the creation of a communication between the oral cavity and the sinus during surgery of the posterior maxilla.
Retrieval of a tooth, root fragment, or broken instrument can be accomplished in several ways:

- In many cases, the opening created during initial displacement can be enlarged slightly and the tooth or other object can be visualized and retrieved with small forceps or the use of suction. Irrigating or flooding the sinus followed by suction

can often accomplish retrieval or can position the object close to the opening for easy recovery.

- In some cases, however, the sinus must be opened through the Caldwell-Luc approach and the object retrieved.

Causes for an iatrogenic OAC

1. Extractions: most frequently following extraction of maxillary premolars and molars due to the close proximity of the roots within the maxillary sinus. Traumatic extractions of teeth with large divergent roots.
2. Foreign bodies
3. Maxillary sinus lift procedures
4. Poorly positioned dental implants
5. Tuberosity fracture following maxillary posterior teeth extractions,
6. Maxillary tumor or cyst enucleation, and a Caldwell-Luc procedure complication.

Valsalva test (nose blowing test) was used to predict the oroantral communication. Treatment of oroantral communications is accomplished immediately, when the opening is created, or later, as in the instance of a long-standing fistula or failure of an attempted primary closure.

Treatment options for an OAC/OAF

Treatment of OAC/OAF is based on the following:

1. Size of the defect,
2. Time of diagnosis,
3. Presence of sinus infection,
4. Amount of tissue available for repair.

Treatment options for an OAC/OAF

- ❑ OAC should be closed within 24 hours, as the longer the communication persists, the more likely to sustain sinusitis. Maxillary sinusitis should be treated either medically or surgically first before the communication is repaired to avoid impaired drainage.
- ❑ Most OACs are able to close spontaneously if the diameter is less than 2 mm in patients with healthy maxillary sinuses.
- ❑ When the diameter of the defect is between 2 and 5 mm, a gel foam or collagen plug can be placed and secured with figure-of-8 sutures within the defect. Regular follow-ups are recommended to ensure that the communication does not persist.

- ❑ Surgical repair of OACs/OAFs are indicated when the diameter of opening is more than 5 mm, as a defect of this size does not tend to close spontaneously.

Treatment of Oroantral Communication/ fistula

- Buccal Advancement Flap (defect size about 5mm)
- Buccal Fat Pad (defect size 4x5 mm)
- Palatal Flap (defect larger than 10 mm)
- Tongue Flap (defect is larger than 15 mm)
- Platelet-Rich Fibrin membrane
- Resorbable Collagen Membrane
- Titanium mesh or Metal plates

Oroantral Fistula: Delayed Treatment

- Before closure of an oroantral fistula, it is imperative to eliminate any acute or chronic infection within the sinus.
- Consultation with ENT specialist.
- Excision of the epithelium present in the fistula tract and all the granulation tissues should be removed from the OAC before attempting any definitive closure technique. This should be accomplished before elevating the buccal or palatal flap so that the actual size of the bony defect can be inspected and the size of the flap designed appropriately to allow the flap to cover the entire defect with the margins lying over bone. Regardless of the technique used, one must remember that the osseous defect surrounding the fistula is always much larger than the clinically apparent soft tissue deformity.
- Adjacent teeth must be carefully evaluated for possible involvement. If the fistula has developed in approximation to the root of an adjacent tooth, closure is further complicated; to be successful, removal of the tooth may be necessary.
- It may also be helpful to construct a temporary appliance (obturator) to cover the fistula to prevent food and other oral contaminants from getting into the sinus.

Buccal Advancement Flap

- The oldest and likely the most common surgical method to close an OAC is the buccal advancement flap, which is also known as the “Rehrmann technique”.
- This flap has been known to be successful in the closure of small to moderately sized OACs (about 5 mm).
- It is a trapezoidal mucoperiosteal flap with a wide base.
- First, the epithelized margins of the flaps are excised. This is to permit successful wound healing.

- Next, 2 vertical divergent incisions are made extending from the extraction site to the buccal vestibule.
- The buccal flap is elevated, the periosteum is released, and the flap is then extended over the defect and carefully.
- Wound closure (suturing).
- Prescribe antibiotic for 7 days, nasal decongestant for 5 days, and analgesic.
- Suture removal after 14 days.

Disadvantage to the buccal advancement flap: is the shortening of the buccal vestibule following the procedure (reduction in vestibule was permanent in 50% of the cases following the buccal advancement flap). This has the potential to make the use of a dental prosthesis challenging in the future.

Buccal Fat Pad (BFP)

The BFP functions as a pedicle flap meaning that the buccal fat pad remains attached to its original site via a band of tissue. The BFP lies between the buccinator and masseter muscle and is surrounded by a thin fascial envelope. It is composed of a central body and 4 extensions.

Advantages:

- ensures blood supply to the area of reconstruction.
- resistance to contraction,
- its close proximity to the potential defect.
- close defects of 5x4 mm.

Complications

- The most common cause of failure is necrosis resulting in a recurrent OAC.
- A depression in the cheek following reconstruction also has been noted.
- Trismus is usually reported after reconstruction using the BFP. To mitigate this, mouth opening exercises starting day 5 postoperatively.

Palatal rotation Flap

- robust blood supply (greater palatine artery),
- preservation of the buccal vestibule,
- keratinized mucosa for the reconstruction.
- the palatal flap is also thicker than the buccal mucosa and hence less prone to ruptures and tears.

Indications:

- recommended for the closure of large defects (larger than 10 mm).
- previous repair has failed.

Contraindications and limitations:

- previous palatoplasty or traumatic injury to the palate.
- smoking history.
- coagulopathy can compromise the healing process.

Tongue Flap

- This flap has been used in cases in which the buccal and palatal flaps have failed.
- The defect is larger than 15 mm.

Advantages and Limitation:

Rich vascularity and flexibility; however, flap failure can be greater due to the mobility of the tongue during speech and swallow. To mitigate this risk, several investigators have recommended placing patients in maxillamandibular fixation (MMF) postoperatively.

Tongue flaps can be developed as anterior-based or posterior-based flaps.

Titanium mesh or Metal plates or Resorbable Collagen Membrane

Another technique for fistula closure: excision of the fistula, elevation of flaps on the buccal and palatal aspects of the defect, covering of the defect with some type of alloplastic material, and approximating the flaps as closely as possible over the alloplast. Thin metallic foil such as gold foil or thin titanium mesh has been used for this purpose and must be closely adapted to the contour of the bony surface. The sinus lining and, in some cases, crestal bone heal over the superior surface of the metal. In some cases, the foil remains permanently, but more frequently a small portion of the metal eventually becomes exposed and the material is gradually exfoliated.

An identical closure technique may also be performed using material such as collagen membrane that is eventually resorbed.