Diseases of maxillary sinus

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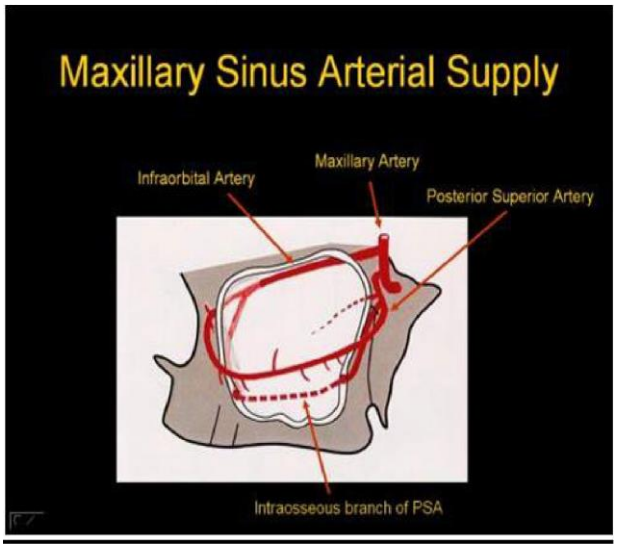
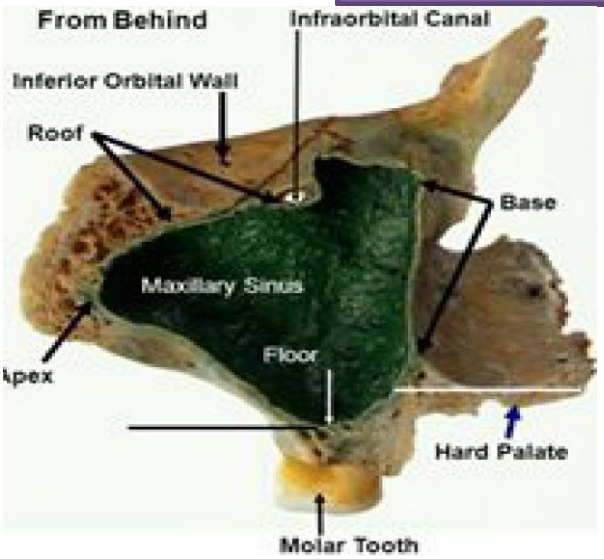
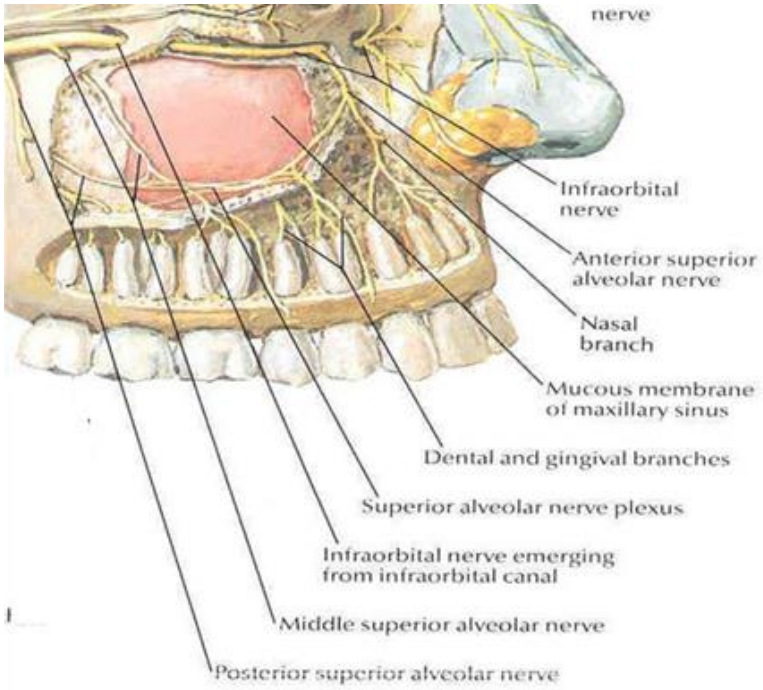
Introduction

- The pyramid-shaped maxillary sinus (or antrum of Highmore) is the largest of the paranasal sinuses, and drains into the middle meatus of the nose through the osteomeatal complex.
- Maxillary sinus presents at birth as a small cavity starting its development during third fetal month & reaching it maximum size in early adult life about eighteenth year. The adult maxillary sinus averages 34 mm in the anteroposterior direction, 33 mm in height, and 23 mm in width. The adult antrum size is from 10 to 15 ml capacity.
- Complete absence is rare, often sub compartments & crypts are present, formed by osseous & membranous septa always shows by X-ray film. In its development Maxillary sinus is tubular at birth, ovoid in childhood and pyramidal in adulthood.
- Maxillary sinus is pyramidal in shape with its base at the nasoantral wall & its apex in the roof of zygoma. The upper wall (roof) is thin represent the floor of the orbit, ithas the infra-orbital canal, infra-orbital nerve & vessels passing through it. The floor of the sinus represents the alveolar process of the maxilla. The antrum has (outlet), opening to the nasal cavity called ostium maxillae lies beneath the middle conchae.
- The inner walls of the sinus are covered with mucous membrane (Schneiderian membrane), which is covered by pseudo-stratified columnar ciliated epithelium formed by basal cells, columnar cells and goblet cells fixed to the basal membrane.The cilia hold foreign material at their tips, waves of ciliary action carry the material from one ciliated region to another toward the ostium. Pathological lesionmay cause area which is deficit in cilia. Normally the thickness of the Schneiderian membrane varies from 0.13mm to 0.5 mm.
- The thickness of sinus wall is varying from (2-5 mm) in the roof, (5-10 mm) in the floor.
- The nerve supply: posterior alveolar nerve supplying the lining of the mucous membrane. Blood supply: infra-orbital artery (a branch of maxillary artery) with some collateral circulation from the anterior superior alveolar artery, a branch also of thesame vessel. The lymphatic drainage: the retro-pharyngeal lymph node & to the submandibular lymph node


Maxillary Sinus Arterial Supply
Infraorbital Artery
Maxillary Artery
Posterior Superior Artery
Intraosseous branch of PSA


From Behind
Infraorbital Canal
Inferior Orbital Wall
Roof
Base
Maxillary Sinus
Floor
Apex
Hard Palate
Molar Tooth

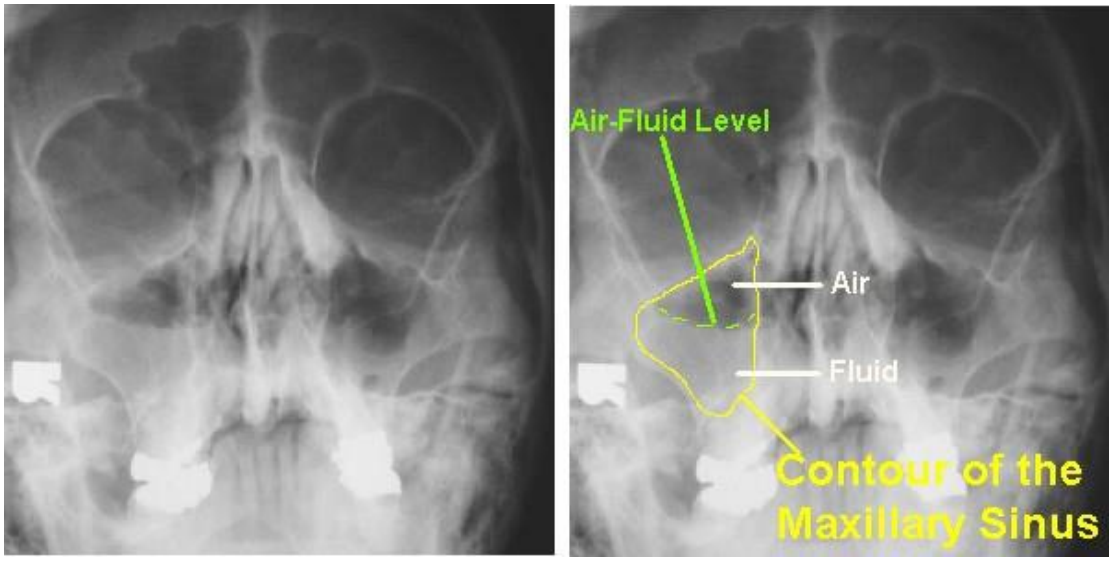

nerve
Infraorbital nerve
Anterior superior alveolar nerve
Nasal branch
Mucous membrane of maxillary sinus
Dental and gingival branches
Superior alveolar nerve plexus
Infraorbital nerve emerging from infraorbital canal
Middle superior alveolar nerve
Posterior superior alveolar nerve

FUNCTIONS OF PARA-NASAL SINUSES

1. Reduce the weight of the skull and maintain proper head balance
2. Maintain humidification, warming and Filtration of inspired air.
3. Give resonance to the voice.
4. 4. Act as shock absorbable to protect the base of the skull & brain from crushingdue to trauma to the middle third of the face.

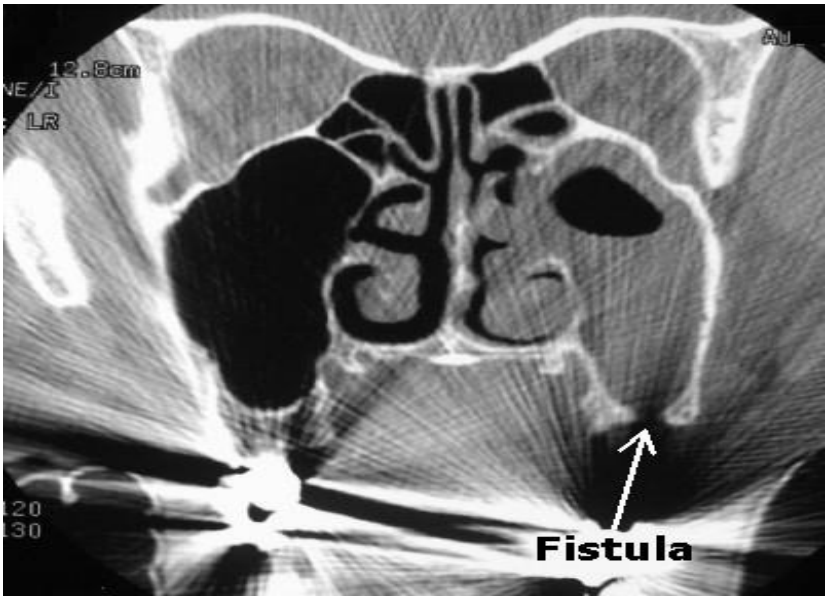
RADIOGRAPHICAL APPEARANCE

1. X-ray film best view for para-nasal sinuses is water view (occipitomental view)which demonstrate the para-nasal sinuses & fluid level in the sinus.
2. OPG (orthopantomogram).
3. CT-Scan film mainly coronal section.
4. MRI magnetic resonance image.
5. Cone -Beam CT (CBCT).

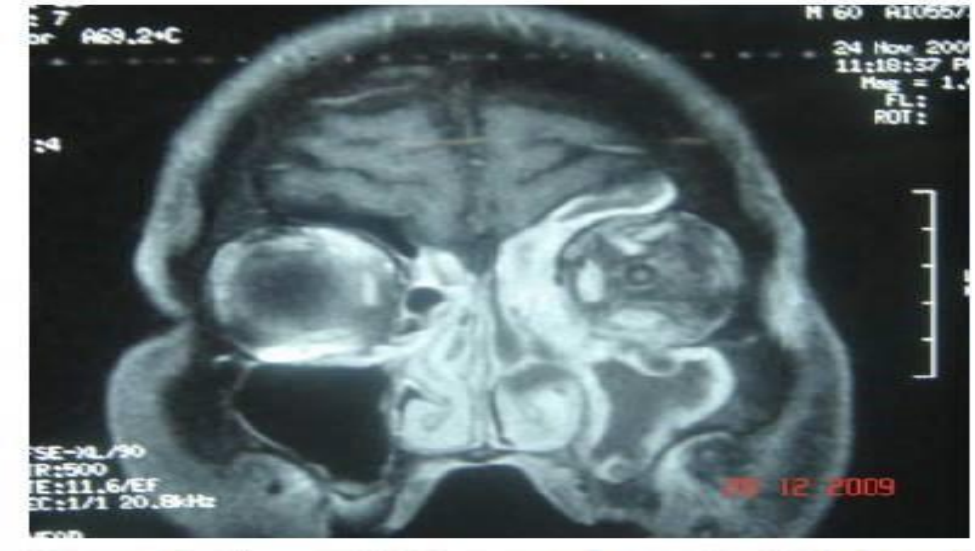


Occipito-mental view for the para-nasal sinus

OPG



CT



Coronal MRI showed oroantral fistula and collection of pus in the left maxillary, ethmoidal and orbit.

DISEASES OR COMPLICATIONS AFFECTING THE MAXILLARY SINUS

1. Sinusitis**.**
2. OAF (Oro-Antral Fistula).
3. Displacement of root or tooth into the maxillary sinus.
4. Fracture of maxillary tuberosity.
5. Malignancy of maxillary sinus.

SINUSITIS

May be an allergic condition or due to an infection. The infection may be viral orbacterial & it's either acute or chronic sinusitis.

❖ ***Acute Maxillary Sinusitis: - (symptoms less than 4 w)***

The symptoms depend on the activity or virulence of the infecting organism & the presence of an occluded ostium. The main symptom is severe pain which is constant& localized. It may affect the eyeball, cheek, and frontal region, the teeth in the region may become extremely sore & painful. The nasal discharge at first is thin & watery & serous but soon it becomes mucopurulent in form. Due to infected teeth the secretion has a very foul odor.

General toxemia develops withthe disease, producing chills, sweats, elevation of temperature, dizziness, and nausea, difficult breathing is common.

❖ ***Subacute Maxillary Sinusitis: (more than 4 w but less than 12 w)***

May be the intermittent stage between acute & chronic sinusitis. Proper medical & surgical treatment is important to prevent the acute case from becoming a chronic one.The relief may come slowly or suddenly, but it usually takes place soon after improvement of drainage from the sinus reaches the point that secretions are able to leave the cavity as rapidly as they form.

❖ ***Chronic Maxillary Sinusitis:(symptoms more than 12 week)***

It's produced by following factors;

- Repeated attacks of acute sinusitis or persist of acute to chronic state.
- Untreated dental focus.
- Chronic infection in frontal or ethmoid sinuses.
- Debilitating disease of all kinds.

In chronic maxillary sinusitis, the lining appear thick & irregular in radiograph.

Due to thickening of the sinus membrane, the opening of the sinus ostium to the nasalcavity may be occluded which make difficulty in the draining of excretion & lead to accumulation of fluid inside the sinus, so antibiotic is of little value, the treatment is best be done by performing an intra-nasal antrostomy.

TREATMENT:- If it is allergic condition treated by antihistamine or steroid; bacterial sinusitistreated by antibiotic. Surgical treatment "antrostomy" when its needed**.**

ORO-ANTRAL FISTULA (OAF)

Q1: what is Oroantral Fistula (OAF) and *oroantral communication (OAC)?*

Oroantral fistula is a persistent epithelialized communication between the maxillary antrum and the oral cavity, present for more than 48 hours. The epithelial lining of the fistula grows from the gingival epithelium, periodontal pocket lining or the antral lining, and it may take up to 7 days for the epithelium to completely line the walls of the communication. If the tract is not lined by epithelium, it is known as an *oroantral communication* or *perforation*. Oroantral communications either close spontaneously or become epithelialized and persist as fistulae.

Q2: What is the Aetiology of Oroantral Fistula?

The vast majority of OAF result from dental extraction. Up to 10% of upper molar extractions may create oroantral communications. Other causes include malignant neoplasms arising in the oral cavity or in the antrum.

Causes of accidental OAF: (risk factors)

1) **Increases size of the maxillary sinus**: extends downwards into the alveolar process between the palatal & buccal roots & into the inter-dental bone of the premolars &molars, specially the palatal roots of the upper 2nd molar may be in close relationship to the antrum. In some cases, the apices separated from the antrum by thin lamellar bone, so heavy rocking movement of the tooth during extraction leads to OAF.

2) **The thin bone between the tooth & the antrum may be destroyed by pathological process** related to the apices of the teeth ((periapical granuloma or cyst)), so duringextraction of such teeth an OA communication may be created & either the whole tooth or root be displaced into the antrum.

The dentist should never attempt to apply forceps to upper molar tooth or root,unless sufficient amount of palatal & buccal surface to be well grasped and/or direct vision.

3) **Hypercementosis:** bulbous root apex or the two buccal roots of a molar may fuse at the apices embracing the inter-radicular bone, so that segments of socket wall are then turn off during the extraction, during rough extraction technique will increase the size of such fragment & the chance of OAF is more frequent.

As a general role, it's better to leave in situ *the apical one third of palatal root of avital maxillary* molar if it's fractured during forceps extraction because its removal need to sacrifice of a large amount of alveolar bone & such root fragments seldom cause symptoms, but the patient should be informed that a root fragment has been left & told the reason for this decision.

4) **For extraction of an isolated maxillary molar or there is a history of antral involvement complicating previous extraction.** The removal of the tooth should be evaluated by pre-extraction radiograph. Extraction of such tooth with forceps maybe create an OAF.

DIAGNOSIS OF OAF: -

1. **Clinical features**: The symptoms depend on the size of the fistula. The most characteristic symptoms are the escape of fluids from the mouth into the nose on eating, or air or fluid into the mouth on blowing the nose. Passage of saliva, food and bacteria into the antrum causes sinusitis, unpleasant salty discharge into the mouth from the opening and sound resonance.
2. **Investigations:** If the dentist suspected that the antrum has been opened, he should attempt to confirm his suspicions by mean of (**nasal blowing test) or called Valsalva test** in which the patient attempts to blow through his occluded nostril with his mouth open in the presence of an OA communication, air will be heard to pass through the defect & the blood in the socket will be seen to bubble, whilst the nose-blowing test is not always

positive in the presence of OA communication. it's wrong to explore the socket with sucker or push silver probe into the freshly open antrum to confirm the diagnosis. Such maneuver carries the risk of contamination of the antrum with oral micro-organism.

3. **Radiographs** used for diagnosis are periapical, occlusal & OPG films to help in diagnosis.

TREATMENT: -

- For openings <2 mm, no surgical treatment is necessary, providing adequate hemostasis is achieved.
- For openings of 2 to 6 mm, conservative treatment is indicated, including placement of a figure-of-eight suture over the tooth socket and sinus precautions (avoid blowing the nose, violent sneezing, sucking on straws, and smoking), antibiotics and antihistamine.
- For openings >6 mm, primary closure should be obtained with flap.

Principles of surgical closure of OAF:

1) If pus is present in the fistula or if symptoms are severe, consider treating the sinusitis first and closing the fistula later after the sinusitis has partially resolved.
2) Excise the fistula (fistulectomy), otherwise remnants of the epithelial lining may proliferate to reform the tract.
3) The mucoperiosteal flap should cover not only the fistula but also the bone Which will support the suture line.
4) The flap should have a good blood supply & should be handled gently & notgrasped or crushed with dissecting forceps.
5) The flap should be sutured without tension.
6) Good homeostasis should be obtained before suturing because hematoma formation will cause tension on the flap lead to re-opening & also may a nidus for infection will lead to delay healing.

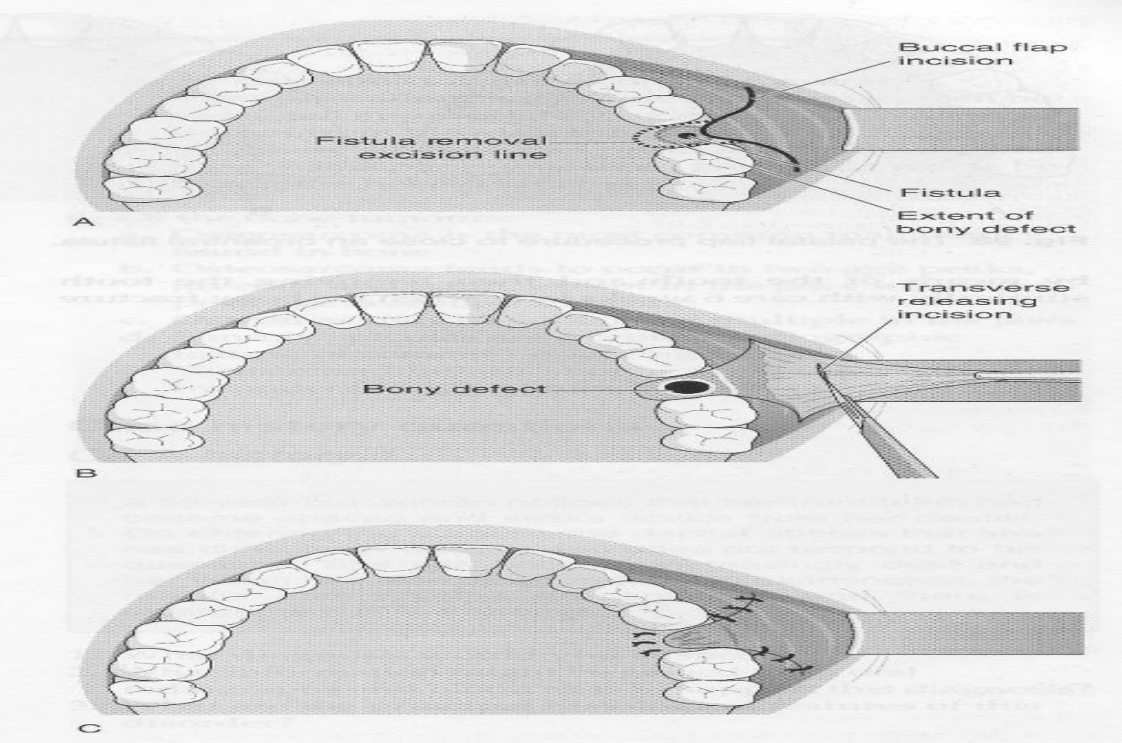
Types of flap used for closure of OAF:

1. *Buccal Advancement Flap*
2. Modified Rehrmann's Buccal Advancement Flap
3. *Palatal Transpositional Flap*
4. Combination of Buccal and Palatal Flaps
5. Buccal pad of fat flap

6. Buccal fat pad and buccal advancement flap
7. Tongue flap

Buccal Advancement Flap:

This type of flap used to close newly created opening at the time of extraction or to close a fistula in combination with exploration of the maxillary sinus to remove a displaced root under local anesthesia. Three-sided mucoperiosteal flap is raised buccally, the flap is grasped gently by toothed tissue forceps & everted & pulled so as totense the inelastic fibrous periosteum which lines its under surface, this tense layer is incised lightly from distal to mesial. Elevated the palatal flap slightly just to exposure the edge of palatal bone about 2-3 mm, then the buccal flap is advanced & sutured in eversion against the palatal flap & sutured mesially & distally by interrupted suturesto held the flap in position, then a horizontal mattress suture is inserted between them, this should be done without tension, otherwise ischemia of the margin of the flap take place with necrosis & failure of the flap. As shown in picture below.



Buccal Advancement Procedure to close an Oro-Antral Communication

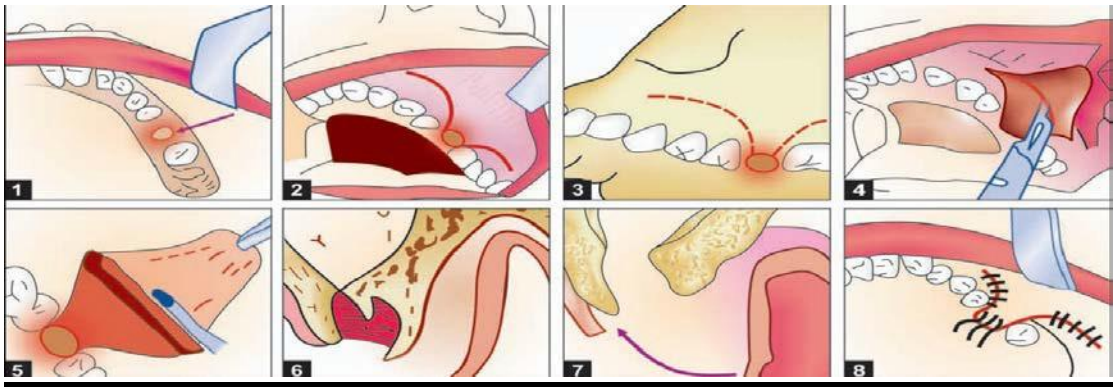
The vertical incisions of the flap buccally also sutured by simple interrupted sutureor mattress suture and left in situ for 2 weeks.

During the initial healing period, the patient must be advised to avoid movement which stretch the cheek or activities such as mouth rinsing, coughing, smoking, whichproduce pressure difference between the two sides of the wound.

This procedure of closure of OAF leave a shallow buccal vestibule (sulcus).

Modified Rehrmann's Buccal Advancement Flap

Here, after mobilization of the buccal flap and after taking the releasing periosteal incision, the free end of the flap which is to be sutured to the palatal mucosa is modified. A step is created along the entire length of the free end of the buccal flap in the submucosal area by removal of 1-2 mm of mucosal layer, keeping the submucosal layer intact (de- epithelialization). This denuded flap margin is then pulled below the palatal mucosal edge byfew vertical mattress sutures. By this procedure, the step in the submucosa will come in approximation with palatal edge, which is closed by means of interrupted sutures. This ensures double layer closure.



Palatal pedicled flap (rotational advancement flap) technique:

Palatal Transpositional Flap

This type of flap used for **chronic fistula** or where there has been a previous **unsuccessful attempt to close the fistula** using a buccal advancement flap, because thebuccal mucosa teared or scarred & unsuitable for further surgery or sometime the opening of the fistula may be towards the palatal aspect of the ridge.

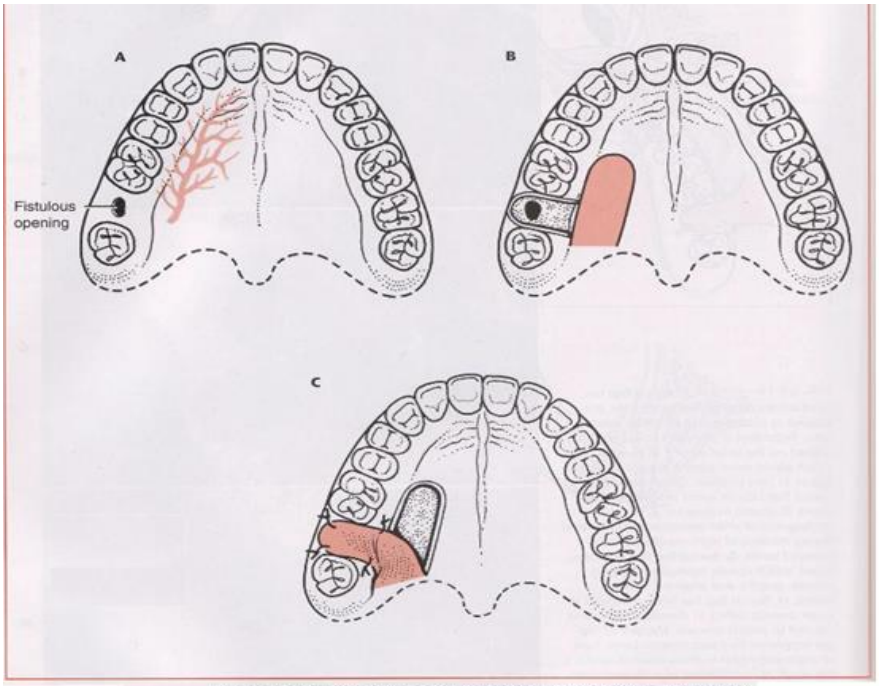
In case of chronic fistula, there is fibrous tract connect the oral cavity & maxillary sinus, this tract should be excised & a shelf of bone exposed after removing this lining around the opening mouth of the fistula.

A pedicle or finger-like strip flap from the palate which is thick & contain the greater palatine vessels is raised. Such flap has high success rate because of its goodblood supply, this flap its more difficult to transposed because of it thickness than buccal flap.

The flap incision is carried towards the incisive papilla & so has a convex buccal margin & concave toward palatal one, then it turned laterally to cover the fistula

A V-shaped section of the tissue may be excised at the region of greatest bend to prevent folding & wrinkling. Then its sutured with freshened end of buccal tissue bymattress suture.The palatal flap should be supported with further multiple interrupted sutures to thebuccal tissue.

Sutures should be left for 14 days, the exposed part of palatal bone (donor area) covered by dressing such as ribbon gauze & white head varnish or by co-pack for gingivectomy & sutured with periosteal tissue of the palate which is not related to the flap.



Palatal flap closure of oroantral communications. A, Diagrammatic illustration of oroantral fistulous tract in right maxillary alveolar process in region of second molar, which is to be closed with rotation of palatal flap. Anterior palatine artery must be included in flap to provide adequate blood supply to transpositioned soft tissues. B, Soft tissues surrounding oroantral opening are excised, exposing underlying alveolar bone around osseous defect. Palatal flap is outlined, incised, and elevated from anterior to posterior. Flap should be full thickness of mucoperiosteum, should have broad posterior base, and should include anterior palatine artery. Its width should be sufficient to cover entire defect around oroantral opening, and its length must be adequate to allow rotation of flap and repositioning over defect without placing undue tension on flap. C, Palatal flap has been rotated to cover osseous defect in alveolar process and sutured in place. Exposed bone on palate, which remains after rotation of flap, will heal by secondary intention with minimal discomfort to patient and little or no alteration in normal soft tissue anatomy.

Postoperative instructions: -

The same as buccal advancement flap;

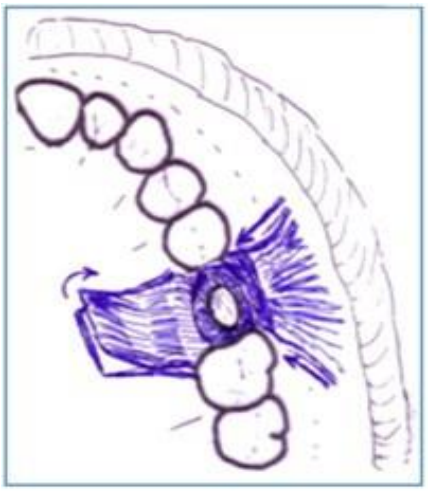
- Nasal decongestant drops (Ephedrine nasal drops) for 3 days
- Antibiotic; Amoxicillin 500g 8-hourly.
- Analgesic.

Combination of Buccal and Palatal Flaps

This combination is indicated for the **Closure of large defect** and When there is a **history of earlier repair and failure**. The Advantages gained from this combination are the Double layer flap so improve strength and Minimize contraction and risk of infection. Disadvantage of thisprocedure; bone of the hard palate is exposed, and re-epithelialization requires from 2 to 3 months, healing by secondary intention.

Fistulectomy was done initially by incising the wound edges of the fistula followed by removal of all diseased bones and smoothening of the bony edge.

This was followed by designing the palatal inversion flap on the basis of the greater palatine vessels. Once the flap raised, the residual palatal raw surface was left to heal by secondary intension with the formation of granulation tissue. **The horizontal palatal flap was then inverted so that the oral palatal epithelial surface was covering the bone defect and facing the maxillary sinus.** Then it will be covered by the buccal advancement flap that was released by extending the incision into the inside of the cheek from the gingivolabial sulcus in order to have a wide base to ensure a good blood supply. The mucosal surface of the buccal flap is facing the oral cavity. The combined palatal buccal flaps are kept in position by a single suture that passes from the epithelial surface of the palatal flap out from the raw surface and into the raw surface of the buccal flap out from the mucosal surface and then back again through the reverse route and when suture was tied the flaps are coapted and the knot was facing upwards in the maxillary sinus



A

B

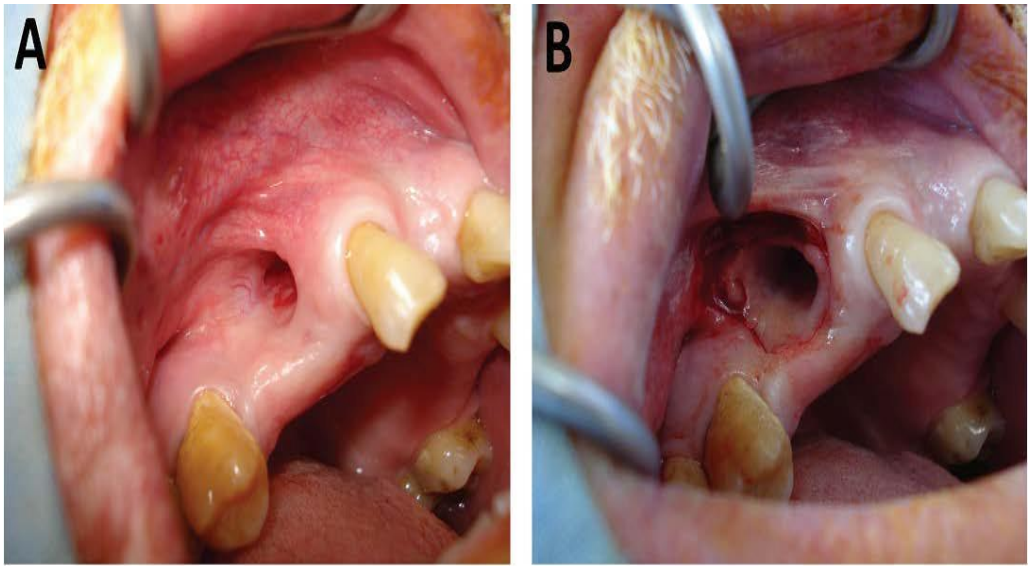
Buccal pad of fat flap technique

Egyedi was the first to report the use of BFP as a pedicled graft for the closure of oro-antral and oronasal communications. The buccal pad of flap (also known as Boule de Bichat) is a simple lobulated mass covered by a thin layer or capsule located between the buccinator muscle medially ,the anterior margin of masseter muscle and mandibular ramus and zygomatic arch laterally. **Blood supply** is provided by the vestibular and deep branches of the maxillary artery, the transverse facial branches of the superficial temporal artery and branches of the facial artery. Buccal fat pad flaps have been recommended for the closure of fistulas and communications of varied sizes and locations; the use of pedicled

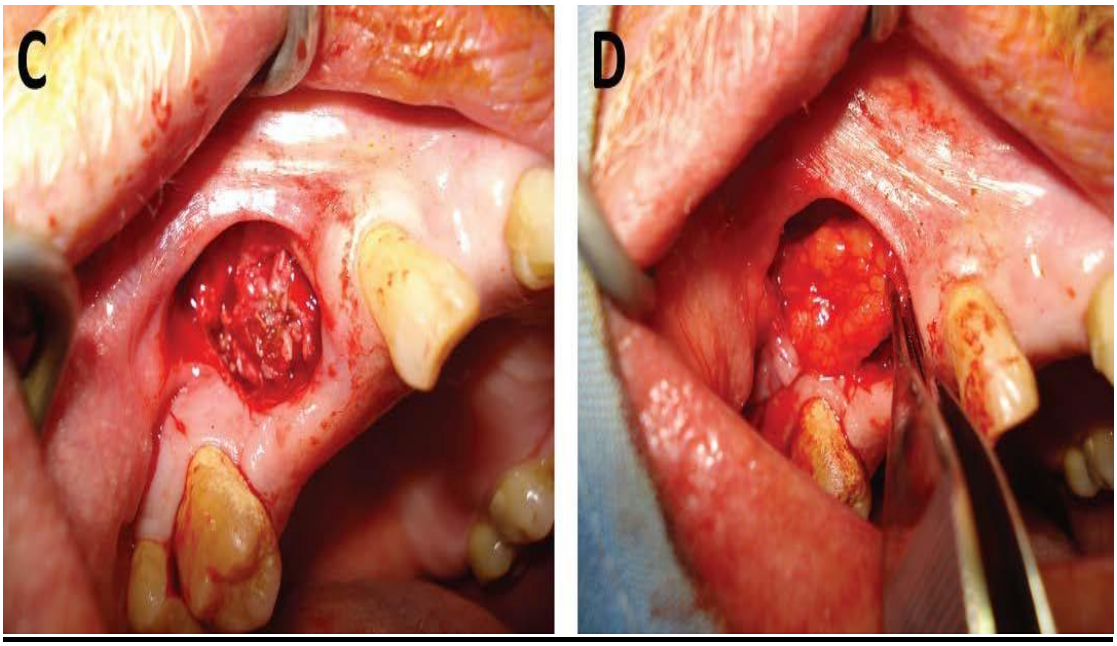
buccal fat pad flaps has also been employed in the **resolution of unsuccessful surgical cases** in which lesions have developed. Among the advantages of this technique are the **low morbidity rate**,

maintenance of the **vestibular sulcus depth**, its **high applicability**, the **low incidence of failure,and the good flap vascularization and size**. when fat tissue is exposed to the oral environment, it becomes epithelialized and is gradually replaced by fibrous connective tissue within a 30-40-day postoperative period, without any functional damage to the treated site. **The Disadvantage**s: mild reduction in the vestibular height ,a low rate of recurrence of fistulas requiring a second surgery in order to achieve closure and postoperative infection, partial necrosis, excessive scarring and granulation.

The surgical procedure consisted of a circular incision on the fistula's border to free the mucosa from the bone tissue to allow the closing of the borders by means of an absorbable 4-0 catgut suture. In order to reach the BFP an incision of the posterior mucosa must be made in the area of the zygomatic buttress, followed by a light incision of the periosteum and of the fascial envelope of the buccal pad. A gentle dissection with fine curved artery forceps exposes the yellowish-colored buccal fat. The buccal fat pad was dragged into the fistula site so that the latter was completely covered then sutured with simple 4-0 silk thread stitches, without tension The buccal fat pad flap, preferably of the pedicled type, has been used most commonly for the closure of the OAF ·Problems and complications that can be noted while harvesting BFP ranges from perforation to shrinkage of BFP andreduction in buccal sulcus depth ·



Fistulectomy

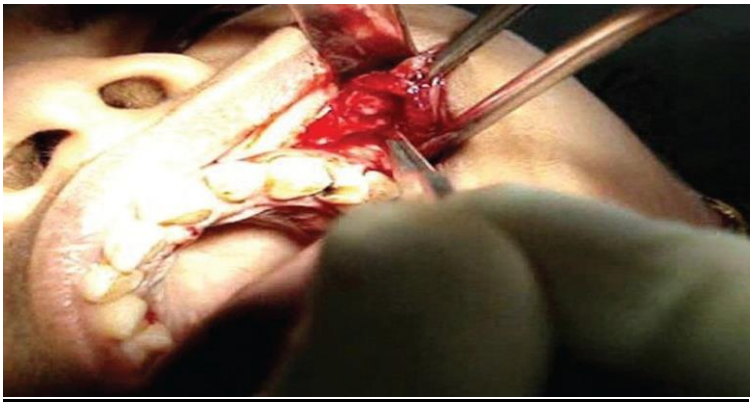


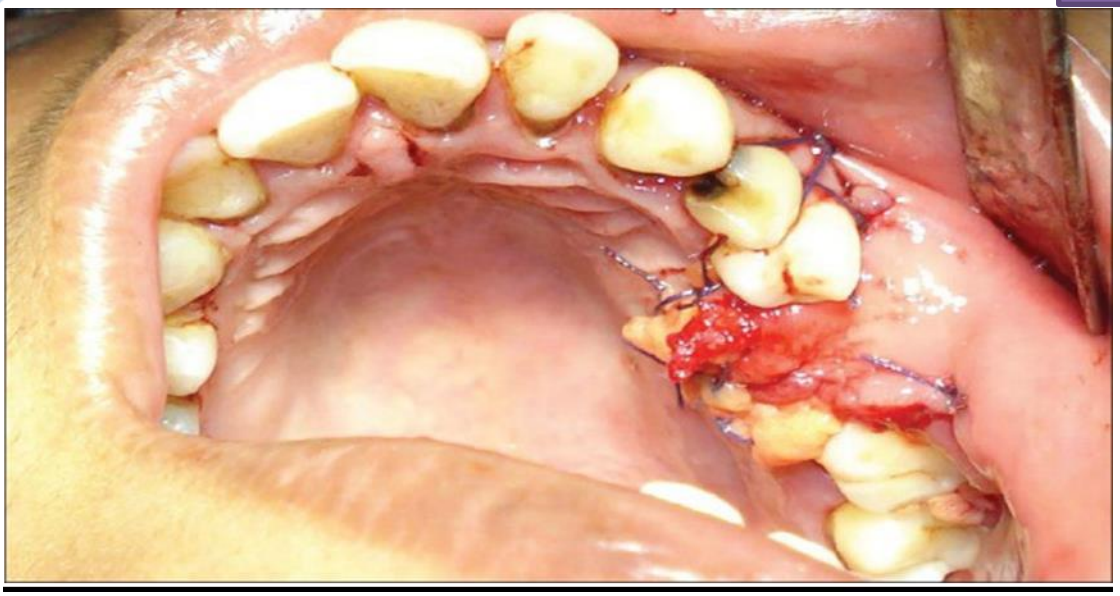
Buccal fat bad harvested in site of fistula

Double-layered closure of oroantral fistula using buccal fat pad and buccal advancement flap

Wide and large defects, i.e. defects about 5-10mm, can also be better managed with the useof BFP with buccal advancement flap than BFP alone. The use of BFP with buccal advancement flap (combination technique) provides more stability, can be used to coverBFP and as additional tissue for closure where there is a deficient BFP for closure. caseswith perforation and shrinkage of BFP .

surgical procedure include;1- cm vertical incision was made in the reflected periosteum posterior to the zygomatic buttress to allow exposure BFP and advancement of the BFP overthe bony defect where it was sutured to the palatal mucosa and buccal advancement flap wasutilized to cover the fat pad The flap was sutured in place with simple interrupted 3/0 polygalactin sutures The patient was warned against blowing the nose for 2 weeks .





Double-layered closure of OAC using BFP and buccal advancement flap

CHRONIC OAF

If the creation of OA Communication is not recognized, untreated or spontaneous closure does not occur, then a chronic fistula becomes established lead to contamination of the antrum, reflux of food & drink from the mouth to the nose whichcause trouble to the patient.

CAUSES OF PERSISTENCE FISTULA: -

1) Unrecognized fistula.
2) Advanced periodontal diseases (shallow pocket).
3) Pre-existing infection, drain from the socket lead to the communication.
4) Insert of packs, sponges prevent clot formation.
5) General condition.
6) Flap under tense suturing.

TREATMENT OF CHRONIC OR PERSISTANT FISTULA: -

The aim of treatment is to eliminate any existing antral infection & to prevent oro-antral reflux of fluids by:

1) Oro-antral reflux can be prevented by the construct of a well-fitting acrylic baseplate (obturator) which covers the defect without entering inside the socket.
2) Any polyp or purulent granulation tissues should be excised to promote drainagethrough the fistula**.**

3) Irrigate the sinus with warm saline using 20 ml syringe & a soft plastic catheter.
4) Prescribed antibiotic to control the infection.
5) Consultation with ENT specialist for intra-nasal or extra-nasal antrostomy for chronic fistula.
6) Close the fistula with either buccal advancement flap or palatal transpositional flap,so in such cases you should excised a rim of mucosa from the edge of the opening exposing a rim of bone to support the flap.

Displacement of tooth or root into maxillary sinus

These complications occur when there are:

1) Large maxillary antrum.
2) Erosion of the floor of bone of the antrum by periapical lesion.
3) Isolated upper molar tooth, the antral cavity tends to invade the surrounding edentulous areas (pneumanisation) while the supporting alveolar bone is often condensed in response to the increased occlusal load, for this reason it is better toremove such teeth by dissection & have pre-operative radiograph.
4) Faulty technique by dentist, applying of heavy force & wrong handling of theinstrument.

Sometime the whole tooth may be displaced inside the sinus due to severe maxillofacial trauma, in surgical procedure of impacted tooth with poor pre-operation assessment & without good radiograph. When this happened, the position of the tooth or root should be demonstrated by radiographs in more than one view such as periapical, occlusal, OPG & PA view, to know the position of the tooth or root exactly where it lies.

Head shaking test is helpful & the procedure is performed as follows:

Intra-oral radiograph (periapical) are taken to show the position of the root, identical view is taken after the patient has bent his head forwards & shaken the head from side to side. If the root is revealed to change the position it is said to be

within the antral cavity proper, if it not means the root lies between the antral lining & floor.

However, some roots lying inside the antral cavity proper are stuck to the lining bymeans of blood clot or granulation tissue or bony crypts & fail to move.

TREATMENT: -

- **If the root is lying at side the antral lining & not enter into the maxillary sinus which is shown by radiographs:** three sided flaps buccally should be raised & the buccal alveolar bone above apical area should be removed with large round bur & remove the root gently with the elevator,
- **If the root is pushed into the antrum**: place the patient in an upright position to prevent posterior displacement and obtain a radiograph or CT to determine its location and size. If the fragment is found to be in the sinus, local measures of retrieval should be attempted first, such as:
  • Having the patient blow through the nose with the nostrils closed, and observing the perforation for the root to appear in the socket
  • Using a fine suction tip to bring the root back into the defect
  • Performing antral lavage with sterile isotonic saline in an effort to flush the root out through the defect
  If local measures are unsuccessful, direct entry into the maxillary sinus via the Caldwell-Luc approach in the area of the canine fossa should be performed. Postoperative management includes a figure-of eight suture over the socket (or flap closure if the opening is sizable), sinus precautions, antibiotics, and a nasal spray to keep the sinus ostium open and infection free.

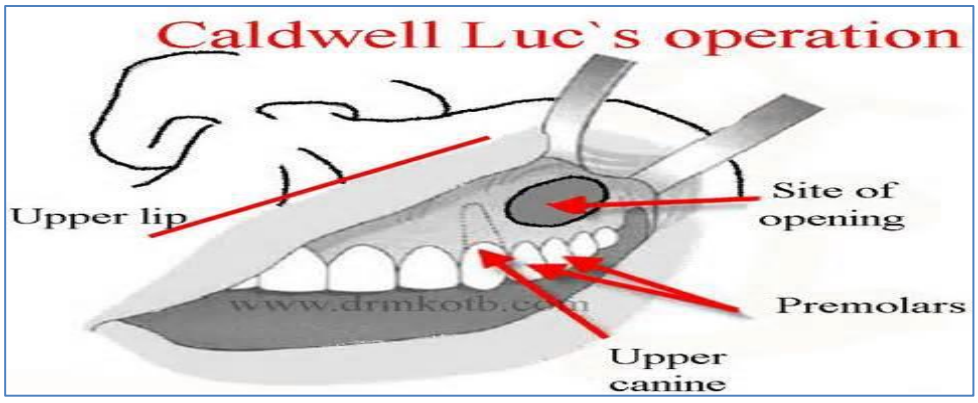
Caldwell-luc Operation 1893 :

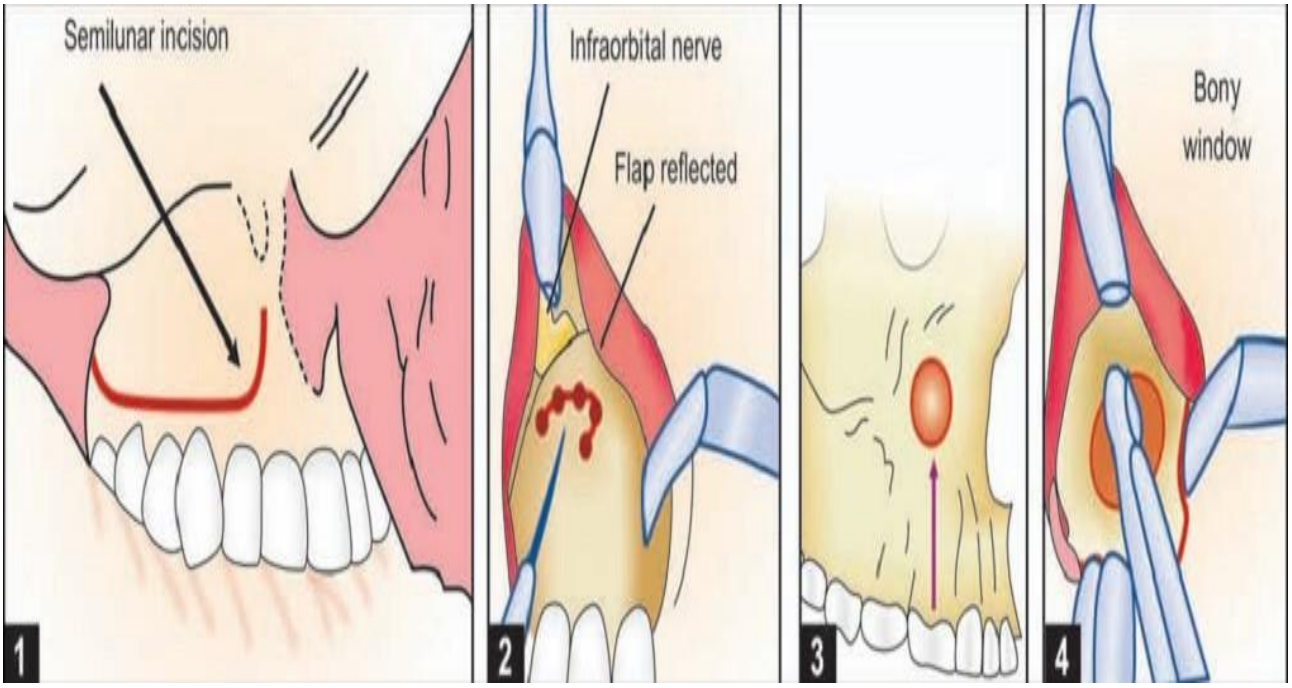
Indications:

1) Removal of tooth or root fragments in the sinus, because it provide better vision.
2) Trauma of the maxilla when the walls of the maxillary sinus are crushed or when the floor of the orbit has dropped.
3) Management of hematoma of the antrum with active bleeding through the nose.
4) Chronic maxillary sinusitis with polypoid degeneration of the mucosa.
5) Cysts in maxillary sinus.
6) Biopsy from maxillary sinus in the presence of tumor mass.

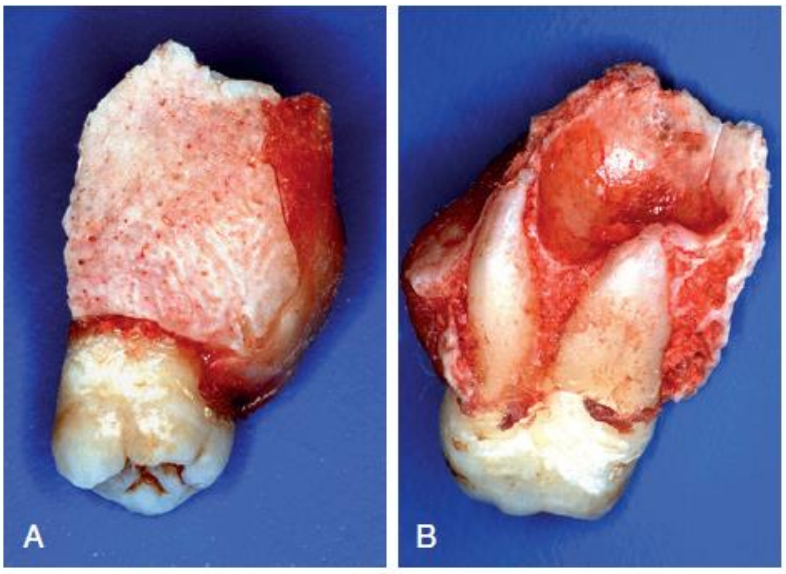
The Surgical Procedure:

The incision through mucoperiosteum in the upper buccal sulcus running horizontally at the area opposing to the 1st molar & running forward to the central incisor. The vertical incision is made anteriorly corresponding to canine & posteriorly to the 2nd molar. Then the flap is reflected until the infra-orbital foramen & infra- orbital nerve are identified to avoid nerve injury. A window of about 1.5 cm diameter is made with a surgical round bur in the antrolateral surface of the maxilla & care must be taken not to approach too close to the apices of the bicuspid teeth. Once the lining of sinus exposed, it is opened with scalpel, and the cavity entered. Good lighting isessential, when the root is found, it lifted with sucker or grasped with a toothed forceps& withdrawn. Then irrigation of the sinus with saline & suture the flap & five days of systemic antibiotic should be given.





Fracture of maxillary tuberosity



• **Fig. 11.13** Tuberosity removed with the maxillary second molar, which eliminates the important prosthetic retention area and exposes the maxillary sinus. (A) Buccal view of bone removed with the tooth. (B) Superior view, looking onto the sinus floor, which was removed with the tooth. If possible, the bony segment should be dissected away from the tooth and the tooth should be removed in the usual fashion. The tuberosity is then stabilized with mucosal sutures as previously indicated. (Courtesy Dr.

Risk factors:

- Dental anatomy characteristics or anomalies: long or bulbous roots, hypercementosis, multi-rooted teeth, lone standing upper molars, and highly pneumatized alveolus
- Pathoses: sinus disease, odontogenic cysts, periapical infection, ankylosis, osteoporosis and alveolar atrophy or, conversely, very dense bone
- Elevator use, particularly large elevators and elevators used as levers, rather than in a rotary fashion.

Treatment:

1. **if the tuberosity is excessively mobile and can be dissected from the tooth,** the segment is repositioned using finger pressure and stabilized by mucosal sutures.
2. **if the tuberosity is excessively mobile and cannot be dissected from the tooth**, the surgeon has several options. The first is to splint the tooth being extracted to adjacent teeth and defer the extraction by 6 to 8 weeks, allowing time for bone to heal. The tooth is then extracted with an open surgical technique.
3. **If the maxillary tuberosity is completely separated from soft tissue**, the usual steps are to smooth the sharp edges of the remaining bone and reposition and suture the remaining soft tissue. The surgeon must carefully check for an oroantral communication and provide the necessary treatment.

Malignant diseases of maxillary antrum

The dentist plays an important role in the detection of malignant disease of maxillaryantrum & diagnosis done by history, clinical examination, and radiograph in addition to biopsy for histopathological examination.

The patient mainly complaining of maxillary pain & there is no dental cause can be found, or swelling of the cheek & also no dental or soft tissue infection detected.

Epistaxis, loosening of the upper molar teeth without demonstrable cause, excessive bleeding after dental extraction, failure of maxillary pocket to heal normally, specially if proliferation of the soft tissue is present in the affected area. Intra-orally swelling in the buccal sulcus may be present. Radiograph may reveal erosion of either the compactbony wall of the sinus or the roots of the maxillary molar teeth.

TREATMENT: -

By CaldWell-Lac operation to remove the maxillary sinus lining, with polypoid malignant tissue or by hemimaxillectomy or maxillectomy & combination of radiotherapy & chemotherapy.

Orofacial pain

Dr. sabah alheeti

Orofacial pain

Pain is a complex human psychophysiologic experience associated with actual or potential tissue damage. It is a multifaceted experience influenced by multiple factors such as past pain
experiences, physical, cultural, cognitive, emotional and medical aspects.
The physiologic aspects of pain experience involve several processes: transduction, transmission, and modulation. The sum of these processes, when integrated with higher centers, yields the human experience of pain.

Classification of orofacial pain

Multiple classification systems for orofacial pain have been proposed.

I. At the most basic level, it is appropriate to classify orofacial pains as: **somatic, neuropathic, and psychological**.

Somatic pain arises from musculoskeletal or visceral structures interpreted through an intact pain transmission and modulation systems.
Neuropathic pain is defined as pain caused by a lesion or disease of the somatosensory nervous system. The etiology includes trauma, ischemia, infection, or metabolic disturbances. It arises from damage or alteration to the pain pathways; it can be classified into paroxysmal (episodic) and continuous neuropathic pain.

II. ***2nd classification: according to origin of pain***

Category	Type of pain
Local	Dental (include pulpitis, dentin hypersensitivity, periapical periodontitis, cracked tooth syndrome)
	Gingival (e.g. primary herpetic gingivostomatitis, ulcerative gingivitis)
	Mucosal (e.g. ulceration)
	Salivary gland (e.g. sialadenitis)
	Temporomandibular joint (dysfunction and others)
	Maxillary sinuses (sinusitis, malignancy)
	Ear disease (otitis media, neoplasm)
Neurological	Trigeminal neuralgia
	Glossopharyngeal neuralgia
	Postherpetic neuralgia
	Ramsay- hunt syndrome
Vascular	Giant cell arteritis
	Migraine and variants
	Cluster headache, Tension headache

Psychogenic	Atypical facial pain
	Atypical odontalgia
	Burning mouth syndrome
Referred pain	Cardiac pain

Diagnostic evaluation

The formal diagnostic evaluation contains the following components: chief complaint, history of present complaint, medical history, physical examination, diagnostic imaging, and other investigations.

- **Chief complaint** It is the patient's description of the pain. It may provide valuable information to reach diagnosis; pulpal pains are usually provoked by thermal stimulation, neuralgias are frequently described as sharp and lancinating, vascular headaches are throbbing, and muscle pain is described as a deep, dull ache. Many of these descriptions may overlap.
- **History of present complaint:** It should include the following points:

☐ The intensity of the pain needs to be measured against the patient's own experience of pain, need for medication, and effect on lifestyle.
☐ The patient should be asked to indicate the site of the pain or the site of maximum pain intensity and its anatomic distribution should be traced accurately in terms of local anatomy.
☐ The patient should be encouraged to remember the events surrounding the onset of the pain.
☐ The time relations of the pain should be clarified in terms of duration and frequency.
☐ Aggravating and relieving factors should be determined.
☐ The presence or absence of associated factors (redness or swelling of the face, flushing, tearing, nasal congestion, eyelid ptosis, facial numbness, or facial weakness) needs to be ascertained.

- **Medical history:** A careful medical history should be taken. A thorough review of organ system disease should be performed, including surgical history, hospitalizations with special emphasis to history of trauma to the face, mouth or head, allergies, current medical treatments, and current medications, habit history, and psychosocial history.

- **Physical examination:** Patients with orofacial pain should undergo a complete oral cavity, face, head, and neck examination which should include inspection, palpation, percussion, and auscultation. Muscles of mastication and muscles of neck and shoulder should be assessed and palpated for tender and trigger points. Intraoral examination includes dental occlusion and dentition for caries, gingival and periodontal health in addition to inspection and palpation for any swellings, masses, lesions, or areas of discoloration.

An important part of the examination is the neurological examination of all the cranial nerves especially trigeminal and facial nerves in addition to the upper cervical nerve roots (C2–C5), since afferents from the upper cervical spinal segments are relayed through the trigeminal brainstem complex forming trigeminocervical network which

includes the 3 branches of the trigeminal nerve (the ophthalmic branch [V1], the maxillary branch [V2], and the mandibular branch [V3]) as well as the sensory nerves for the posterior head and neck (C2, C3, C4, C5).
Activation of this network may result in referred pain perceived on one or both sides of the head, the eyes or sinuses, and the posterior head and neck. Neurological examination may include; sensory testing with directional sense, sharp (pain) touch, light touch, hot, cold and pressure.

- **Imaging**

Plain radiographs like panoramic (OPG) and periapical radiographs provide detailed evaluation for the jaws and teeth. More detailed imaging for the maxillofacial skeleton can be provided by computed tomography scan (CT scans), Magnetic resonance imaging (MRI) is best for soft tissue evaluation. Ultrasonography can be used to evaluate the major salivary glands, carotid arteries, and masses in the neck.
Scintigraphy or bone scan with technetium-99m will highlight areas of increased metabolic activity within the bone and can help to identify infection, tumor, or degenerative changes in the TMJ.

- **Other investigations**

These may include blood investigations, microbiological studies, diagnostic injections like local anesthetic, and biopsy of any suspicious mass or lesion.

Odontogenic pain

Dental pain is usually well localized, and the quality of the pain can range from a dull ache to severe, depending on the specific cause and extent of disease. NSAIDs and non-opiate analgesics can be used to alleviate most odontogenic pain but definitive treatment is dental.

Pulpal
Pain may be sharp, throbbing, or dull, it can be spontaneous or provoked or exacerbated by percussion, thermal or electrical stimuli. It is associated with compromised dental pulp due to deep caries, crown fracture or recent dental work. Treatment is by removal of carious lesion, tooth restoration, endodontic treatment, or tooth extraction.

Periodontal
Pain is localized, deep continuous associated with compromised periodontium (gingiva or periodontal ligament) exacerbated by biting, chewing or percussion. Usually there are signs of periodontal inflammation or abscess with or without tooth mobility, periapical radiographs may aid in diagnosis. Treatment options include: drainage and débridement of periodontal pocket, scaling and root planning, periodontal surgery, endodontic treatment, or tooth extraction.

Cracked tooth
It is associated with fractured tooth with history of trauma or restorative dental work, pain is usually sharp, spontaneous or brief provoked by biting, chewing or percussion. Treatment depends on the level of the tooth fracture; restoration or extraction of the tooth.

Dentinal pain

Brief, sharp pain provoked by different kinds of stimuli to the dentin (e.g., hot or cold drinks), it is caused by stimulation exposed dentin or cementum that may result from recession of periodontium or possible erosion of dentinal structure. Treatment options may include; mouthwash (fluoride), desensitizing toothpaste, tooth restoration, endodontic treatment.

Oral mucous membrane disorders

Diseases of the oral mucosa are numerous and have a variety of local and systemic causes. Pain may be a symptom of the disease process, secondary to an associated process (infection), or related to damaged oral mucosa (chewing food, thermal, chemical stimuli). Typically, pain is associated with oral mucosal lesions including; ulcers, vesicles, bullae, erosions, erythema, or red and white patches. Treatment depends on the proper diagnosis; options may include topical or systemic analgesics and corticosteroids.

Temporomandibular disorders (TMD)

TMD encompasses a number of clinical problems that involve the masticatory musculature, the TMJ, and associated structures. TMD symptoms are more commonly seen in women than in men, and many symptoms seem to arise in adolescence or the early twenties and may continue intermittently, well into middle age.

TMJ disorders

Disorders of the TMJ include mainly;

☐ The internal derangements, such as disc displacements with and without reduction.
☐ myofascial pain syndrome
☐ TMJ subluxation and dislocation.
☐ Inflammatory disorders (e.g., capsulitis or synovitis).
☐ Osteoarthritis.
☐ Rheumatoid arthritis.

In TMJ disorders pain is localized to the preauricular area during jaw function with presence of painful click or crepitus during mouth opening, in addition to limited mouth opening (<35 mm) and deviated or painful jaw movements. There is pain on palpation of the TMJ with possible swelling in the acute phase. CT and MRI may be needed to reach the diagnosis.

Treatment is by:

☐ Patient education and self-care instructions.
☐ Medication: NSAIDs, non-opiate analgesics.
☐ Physical therapy through exercise program.
☐ Occlusal splints.
☐ Surgery; is only indicated when non-surgical therapy has been ineffective, and it is not indicated in patients who are asymptomatic or mildly symptomatic or as a preventive measure. Surgical interventions include; arthrocentesis, arthroscopic surgery, and open surgery.

Neuropathic pain

It has been estimated that the incidence of orofacial neuropathic pain is 5-10 per 100,000 people. It is divided into episodic (paroxysmal) pain disorders, including trigeminal neuralgia and glossopharyngeal neuralgia, and continuous pain disorders that frequently result from deafferentation after injury in the peripheral and central nervous system, which is the case in neuromas and idiopathic trigeminal neuropathic pains such as atypical odontalgia.

Trigeminal neuralgia (Tic douloureux)

It is a chronic paroxysmal neuropathic pain condition that is described as a severe, lancinating, and electric-like unilateral pain. It is localized most often to trigger zones in both the V2 and V3 distribution (the most common distribution), after which they occur alone (and in decreasing order of incidence) in the V3, V2, and VI distributions.

There is usually a trigger zone in the trigeminal distribution which, when stimulated, can result in an excruciatingly painful attack. Pain will occur following mild stimulation of this trigger area (e.g., washing the face, shaving, eating, brushing one's teeth, or being exposed to a breeze).

The pain attacks last seconds to minutes (about 2 minutes) followed by a refractory period in which stimulation of the trigger zone will not elicit another attack. Numerous pain episodes can be present daily. This pattern of pain must be met in order for the diagnosis of trigeminal neuralgia to be made otherwise alternative terms such as atypical trigeminal neuralgia can be applied.

It may go through periods of remission where the pain can remit for months or even longer. This disorder is characterized by a protracted clinical course with increasing frequency and severity of pain. It has one of the highest suicide rates of any disease and is regarded as one of the most painful conditions known.

It typically affects individuals older than 50 years of age, although it can develop at any age, including young children. Women are affected more often than men by a ratio of 1.5: 1. The right side of face is more commonly affected. The majority of cases occur sporadically; however, several reports of familial trigeminal neuralgia have been described.

Etiology

Primary or idiopathic (classical) trigeminal neuralgia has no definite cause but localized demyelination may be implicated, the superior cerebellar artery compression on the trigeminal root has been shown to be responsible for attacks of trigeminal neuralgia pain.

Secondary or symptomatic trigeminal neuralgia results from nonvascular compression by a cerebellopontine angle neoplasm, such as acoustic neuromas, meningiomas, cholesteatomas, and neurofibromas, has also been shown to result in trigeminal neuralgia. Therefore, MRI and CT scan of the brain should be requested in order to rule out any intracranial pathology.

Myelin loss due to multiple sclerosis has been shown to be a causative disorder related to the trigeminal neuralgia.

Treatment

Treatment of trigeminal neuralgia consists of medical and surgical therapies.

Medical treatment

☐ Anticonvulsants (e.g., carbamazepine which is the drug of first choice, gabapentin).

Drug	Initial Dose (mg)	Target or Maximal Dose (mg)*	Dose Increase (Titration)*	Schedule
Carbamazepine	100-200	1200	100-200 mg/2 days	×3-4/day

☐ Antidepressants (e.g., amitriptyline, nortriptyline).
☐ Non-opiate analgesics.
☐ Botulinum toxin injection.
☐ Combination of baclofen (muscle relaxant) and anticonvulsants when anticonvulsants alone are not effective, or if the therapeutic range cannot be achieved due to side effects.

Surgical treatment

If medical therapy is unsuccessful or not tolerated, surgical treatment should be considered which consists of numerous peripheral and intracranial procedures.

Peripheral procedures all have the goal of inducing nerve damage:
☐ Trigeminal nerve block which provide only temporary relief, high concentration lidocaine (10%) have been used.
☐ Alcohol injection may be effective for about 1 year but are painful, and fibrosis makes repeat injections technically difficult. The use of alcohol is associated with many complications include tissue toxicity, inflammation, and fibrosis.
☐ Peripheral neurectomy involves the avulsion or severing of the terminal branches of the trigeminal nerve with or without obturation of the foramen. Pain may recur after 2 years
☐ Cryotherapy of peripheral branches may provide pain relief for 6 months and may be repeated with good results.

Central procedures:
☐ Percutaneous trigeminal rhizotomy. These procedures are directed at the trigeminal ganglion aims to use controlled injury to interfere with the nerve's ability to transmit signals. They include **radiofrequency thermal rhizotomy**, **glycerol injection**, or **balloon compression**. The three modalities provide approximately equal initial pain relief (around 90%) but are each associated with different rates of recurrence and complications. Overall, radiofrequency rhizolysis consistently provides the highest rates of sustained pain relief but is associated with high frequencies of facial and corneal numbness.
☐ Posterior fossa exploration and microvascular decompression of the trigeminal root. It is based on the premise that trigeminal neuralgia caused by vascular compression of the nerve root, and surgically separating them may offer a permanent cure. Initial success rates for microvascular decompression are very high (approximately 90%), but

long-term follow-up shows that after 10 years 30% to 40% of patients will experience a relapse

☐ Gamma Knife stereotactic radiosurgery; it is a minimally invasive technique that precisely delivers radiosurgical doses of 70 to 90 Gy to the trigeminal nerve root at the point of vascular compression as mapped using MRI, it provides good to excellent (60%–90%) initial pain relief.

Glossopharyngeal neuralgia

Glossopharyngeal neuralgia is a rare condition (0.2-1.3% of facial pain syndromes) associated with pain in the area supplied by the glossopharyngeal nerve (9th cranial nerve). Painful sites may include the nasopharynx, posterior part of the tongue, throat, tonsil, larynx, and ear.

This disorder presents shooting paroxysms of pain that can occur multiple times a day with stimulation of the oropharyngeal region. Common triggers may include mechanical stimulation of the trigger zone as well as activities including chewing, swallowing, coughing, talking, and head movement.

It occurs in middle-aged or older individuals with no sex predilection. Due to the proximity of the vagal sensory nerves, glossopharyngeal neuralgia may coincide with a cardiac dysrhythmia such as bradycardia, asystole, and syncope in about 10% of the cases (**vagoglossopharyngeal neuralgia**). Like trigeminal neuralgia, it can be classified as classical or secondary but it is uncommon for glossopharyngeal neuralgia to be associated with multiple sclerosis.

Treatment

The management of GN typically parallels that of TN.

Postherpetic neuralgia

It is a potential sequela of shingles, also known as herpes zoster which is the clinical manifestation of the reactivation of a lifelong latent infection with varicella zoster virus, usually contracted after an episode of chickenpox in early life where the virus lay dormant in the ganglia of peripheral nerves but in 10-15% of the cases the trigeminal nerve is involved in which the dermatome of the ophthalmic branch (V1) is affected in about 80% of the cases.

Postherpetic neuralgia occurs immediately after the skin rash or after about 1, 3 or 6 months. Pain is spontaneous burning and tingling, but may present as dull and aching and occasional lancinating evoked pain. Clinically there may be small cutaneous vesicles or scarring, usually affecting the forehead, loss of normal skin color, corneal ulceration can occur. Sensory changes in affected area (e.g., hyperesthesia, dysesthesia).

Treatment is by acyclovir in the acute phase, anticonvulsants, antidepressants, non-opiate analgesics. Rhyzotomy and Gamma knife may be indicated in nonresponsive cases.

A related condition, **Ramsay Hunt Syndrome**, is a herpes zoster infection of the sensory and motor branches of the facial nerve (VII) and in some cases the auditory nerve (VIII). Symptoms include facial paralysis, vertigo, deafness, and herpetic eruption in the external auditory meatus

Vascular pain

Giant cell arteritis (Temporal arteritis)

It is an immune-mediated vasculitis that affects medium-sized and larger arteries, leading to vascular occlusion and ischemia, although it is considered as a systemic condition and can affect any vessel but the superficial temporal artery is the most commonly affected site. Patients are usually above 50 years of age with female predilection, presenting with symptoms of severe headache and scalp tenderness.

A highly characteristic feature is jaw claudication, which is described as cramping pain of the masseter and temporalis muscles that increases with usage (chewing or talking) but is relieved by rest. The superficial temporal artery is sensitive to palpation and eventually appears erythematous, swollen, tortuous, or sometimes ulcerated.

Rare examples of unilateral or bilateral tongue necrosis secondary to lingual artery involvement also have been described. The most significant complication in the head and neck region is vision loss, which usually is due to vasculitis of the posterior ciliary artery and ischemic optic neuropathy. If pain and stiffness affecting the shoulders, upper arms and pelvis are present in addition to the characteristic unilateral headache, a diagnosis of **polymyalgia rheumatica** should be considered.

Investigations include elevated ESR, biopsy of the temporal artery is required which shows skip lesions of inflammatory tunica intima and media with giant cells, and usually there is narrowing of the lumen.

Treatment

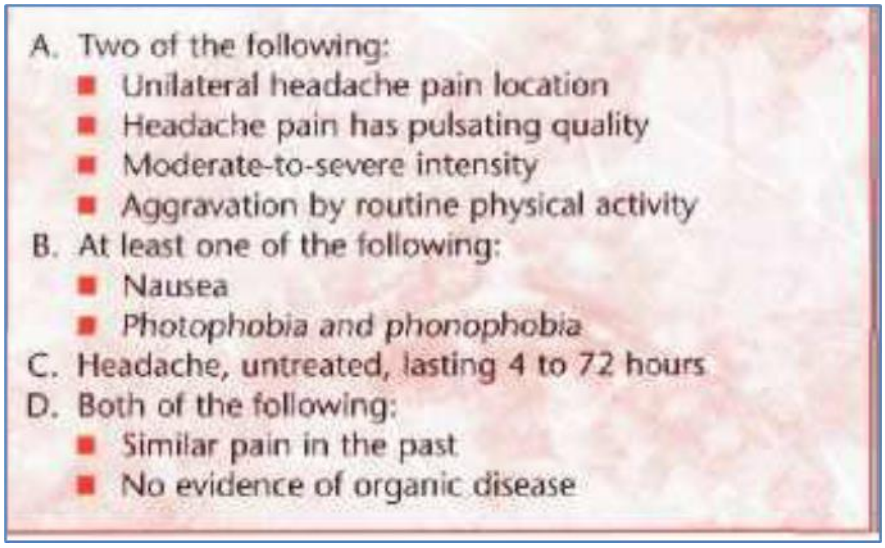
Treatment is by high-dose systemic corticosteroid therapy, the dose can be reduced as the ESR starts to fall. Methotrexate or azathioprine sometimes will be added for their steroid-sparing effects.

CHRONIC HEADACHE

When headaches recur regularly, the majority will be diagnosed as one of the primary (no other cause) headaches: migraine, tension-type headache, or cluster headache. Although most headaches are centered in the Orbits and temples, many may present in the lower half of the face, teeth, or jaws.

Migraine

Migraine is a common headache afflicting approximately 18% of woman and 8% of men. The first migraine headache typically occurs in the teenage years or in young adulthood. An "aura" may develop several minutes to 1 hour before headache onset in approximately 40% of patients. The aura is a neurologic disturbance, frequently expressed as flashing or shimmering lights or a partial loss of vision.



INH criteria for migraine without aura

The mechanism for migraine headache appears to involve neurogenic inflammation of intracranial blood vessels secondary to neurotransmitter imbalance in certain brain stem centers.

Preventive treatment is directed at normalizing neurotransmitter imbalance with antidepressants, anticonvulsants, beta-blockers, and other drugs. Treatment of acute attacks is with the "triptans" (e.g., sumatriptan, zolmitriptan), ergots (ergotamine and dihydroergotamine), nonsteroidal anti-inflammatory drugs (NSAIDs), opioid analgesics, antiemetics, and other agents

Cluster Headache

Cluster headache is an overwhelmingly unilateral head pain typically centered around the eye and temporal regions.

Common Cluster Headache Features

Sex: Mainly male
Frequency: Up to 8 per day
Quality: Throbbing/stabbing
Intensity: Severe

BOX 29-9

IHS Criteria for Cluster Headache

A. Severe unilateral orbital, supraorbital, or temporal pain (or a combination) lasting 15 to 180 minutes *(Note: Frequently in posterior maxillary dentoalveolar region as well)*
B. At least one of the following on the headache side:
- Conjunctival injection
- Facial sweating
- Lacrimation
- Miosis
- Nasal congestion
- Ptosis
- Rhinorrhea
- Eyelid edema

C. No evidence of organic disease

Treatment, as in migraine, is either preventive or symptomatic. Preventive treatment is accomplished with verapamil, lithium salts, anticonvulsants, corticosteroids, and certain ergot compounds. Symptomatic treatment is with "triptans," ergots, and analgesics. Oxygen inhalation at 7 to 10 L/min may be an effective abortive treatment.

Atypical odontalgia

Atypical odontalgia presents as pain in a tooth or site of dental extraction in the absence of clinical or radiographical evidence of pathological dental condition. This pain may affect 3-6% of patients who undergo endodontic therapy. Its most common in the 5th decade with female bias. Molar and premolar sites are involved more frequently, and maxillary teeth are more likely.

The pain is a persistent sharpness, aching, burning or throbbing of moderate severity. The patient may have increased sensitivity to pressure, unresponsive to analgesics, surgery or other

dental procedure, not lessen entirely to local anesthesia. Sleep is not affected although the pain recommences on awakening. The patient has other symptoms like headache, hyperesthesia, alloydynia and exacerbation of pain by temperature, palpation or percussion.

The exact pathogenesis of atypical odontalgia remains unknown. The present favored theory is mild trauma to the orofacial structures (including even inferior alveolar nerve block) alters neural continuity of the tissue and create deafferentation.

The treatment of atypical odontalgia remains unsatisfactory. The treatment includes:

i. Topical application of capsaicin (0.025%) and EMLA 5% (mixture of lidocaine and prilocaine)
ii. TAD
iii. Anxiolytics such as clonazepam
iv. Gabapentin

Salivary Gland Diseases

Dr. Sabah Alheeti

The salivary glands may be classified as major and minor glands. Major glands are paired glands. They are: (i) Parotid, (ii) Submandibular and (iii) Sublingual glands. There are numerous minor salivary glands, which are widely distributed in the oral cavity.

These glands function to produce saliva, which serves as a lubricant and also has immunologic, digestive and cleansing properties.

Based on the type of secretion, the salivary glands may be grouped as: (i) Serous, (ii) Mucous and (iii) Mixed.

Parotid gland secretion is serous in nature; the minor glands secrete mucous saliva. The sublingual glands secretes both serous and mucous, but predominantly mucous, whereas the submandibular gland secretion is also mixed, but is predominantly serous. Salivary gland secretions contain water, electrolytes, urea, ammonia, glucose, fats, proteins and other substances.

All salivary glands develop from epithelium and have the same basic structure. The submandibular, the parotid, and the sublingual glands appear in the sixth, seventh, and ninth week of embryonic life. The submandibular and the parotid glands develop capsules; in the sublingual gland, a capsule is missing.

SALIVARY GLANDS ANATOMY

Parotid Gland

The parotid gland is the largest salivary gland, the secretion of which is serous in nature. It is pyramidal in shape; the apex is towards the angle of the mandible, the base at the external acoustic meatus. Anteriorly, the gland extends up to the buccal pad of fat and posteriorly encircles the posterior border of the mandible. Parotid gland has two lobes: (i) The superficial and (ii) The deep. They are connected by an isthmus at the posterior part of the gland. The entire gland is covered by a fibrous capsule.

The parotid duct (Stenson's duct) emerges at the anterior part of the gland. It passes horizontally across the masseter muscle, then pierces through thebuccinator, to turn at right angles to reach the oral cavity. Stenson's duct opening is seen as a papilla in the buccal mucosa opposite the maxillary second molar.

Parotid gland has close association with external carotid artery, the retromandibular vein and the facial nerve. The facial nerve emerges from the stylomastoid foramen , branches out from anterior and inferior margins of the gland.

Clinical Considerations

• Because the fibrous fascia is covering the parotid, its inflammatory swelling is tense and hard.
• The parotid duct is wider at some distance before the opening. This leads to the storage of saliva. The epithelial cells and other organic matters can get lodged here causing obstructions, stone formation etc.
• The right angle turn of the parotid duct also leads to stagnation of saliva.
• The close association of the facial nerve with the gland is very important consideration, during the surgical procedures.

Submandibular Gland

The submandibular gland secretion is both serous and mucous in nature. This gland is located in the submandibular space, extending inferiorly up to the digastric muscle, superiorly the mylohyoid muscle, posteriorly up to the angle of the mandible and anteriorly till the mid portion of the body of the mandible.

The submandibular duct (Wharton's duct) starts from the deep part of the gland, turns sharply at the posterior border of the mylohyoid muscle anteriorly and superiorly, crosses the hyoglossus muscle, then reaches the oral cavity. It opens at the sublingual papilla in the floor of the mouth. The submandibular gland is in close association with the facial artery, facial vein, Chorda tympani, branch of the facial nerve and lingual nerve.

Clinical Considerations

• The submandibular gland and duct are placed at a lower level to the oral cavity. It makes the gland prone to retrograde infection by oral flora
• Similar to the parotid duct, the Wharton's duct is also wider before reaching the papilla. This can lead to the stagnation of saliva and the organic matter.
• The long and tortuous course of the duct also leads to stagnation of saliva.
• The sharp bend of the Wharton's duct at the posterior border of the mylohyoid muscle allows stasis of the saliva favoring the formation of salivary stones.

Sublingual Gland

The sublingual glands secrete predominantly mucous saliva. This gland is located in the sublingual space. It is present in association with the sublingual folds below the tongue, and is divided into anterior and posterior parts. It has got many small ducts. In the posterior part, these ducts open through the sublingual folds. The ducts of the anterior part may join to form a large main duct called Bartholin's

duct. This either opens though the sublingual papilla or joins with the Wharton's duct.

Minor Salivary Glands

More than 800 minor salivary glands may be present in the oral cavity. These are in groups scattered all over the mouth. The minor glands secrete mucous secretions. These glands have numerous small ducts.

Clinical Considerations

• The sublingual gland and the minor salivary glands have short ducts, where the chances of stasis are less. Thus, the obstructive lesions don't occur in these glands.

• Since the minor glands are placed superficially on the mucosa, the traumatic lesions such as mucoceles commonly affect these glands.

CLASSIFICATION OF SALIVARY GLAND DISEASES:

I. Developmental:

1. Aplasia—absence of the gland
2. Atresia—absence of the duct
3. Aberrancy—ectopic gland

II. Enlargement of the gland:

A. Inflammatory:

1. Viral: Mumps, coxsackie A, CMV, echovirus, parainfluenza virus I and influenza virus
2. Bacterial
3. Allergic
4. Sarcoidosis
5. Obstructive

B. Non-inflammatory:

1. Autoimmune: Sjögren's syndrome and Mickulicz's disease
2. Alcoholic cirrhosis
3. Diabetes mellitus
4. Nutritional deficiency
5. HIV associated

III. Cysts:

1. Extravasation cysts
2. Retention cysts
3. Ranula

IV. Tumors of salivary glands:

A. Benign tumors

1. Pleomorphic adenoma
2. Warthin's tumor

3.Basal cell adenoma
4.Myoepithelioma
5.Canalicular adenoma
6.Ductal papilloma

B. Malignant tumors
1.Mucoepidermoid carcinoma
2.Adenoid cystic carcinoma
3.Malignant pleomorphic adenoma
4. Acinic cell carcinoma

V. Necrotizing sialometaplasia

VI. Salivary gland dysfunction

1. Xerostomia
2. Sialorrhea

SIALOLITHIASIS

Sialolithiasis: is the formation of sialolith (salivary calculi, salivary stone) in the salivary duct or the gland resulting in the obstruction of the salivary flow.

Sialolith: is a calcareous substance, which may form in the parenchyma or the duct of the major or minor salivary glands. It results from the crystallization of salivary solutes. The sialolith is yellowish white in color, single or multiple, may be round, ovoid or elongated having the size of 2 cm or more in diameter. It is said that the sialoliths grow at the rate of 1 mm/year

Though any of the salivary duct may be obstructed by the formation of the sialolith, about 90 percent of the sialoliths form in the submandibular gland. This is because the long, curved Wharton's duct has increased chance of entrapment of organic debris, plus the secretion of this gland is higher in calcium content and thick in consistency and the position of the gland increases the chances for the stagnation of the saliva.

The factors like inflammation; local irritation or drugs can cause stagnation of saliva leading to the build up of an organic nidus, which eventually will calcify. Though the metabolic cause for their formation is suggested, it is not yet established.

Clinical Features

- *Pain and swelling of the submandibular gland at mealtimes*
- *Tenderness to palpation of submandibular gland*
- *Cervical lymphadenopathy*
- *Constitutional symptoms (e.g., fever, malaise)*
- *Reduced salivary flow, or purulence, from Wharton duct*
- *Palpable stone at orifice of Wharton or Stensen duct*
- *Occlusal film, Panorex, or cone-beam computed tomography may show stone in duct.*

Investigations

Radiographs: AP view, lateral, lateral oblique or occlusal view.

Sialography: The radiographs demonstrate the presence of salivary calculi; whichcan be appropriately located by the sialography.

Complications

• Bacterial infection of the gland may result in the obstruction of long duration.
• The retention of the saliva may result in the formation of mucoceles, especially the mucous retention phenomenon.
• Rarely, the complete obstruction of the duct may result in the atrophy of thegland.

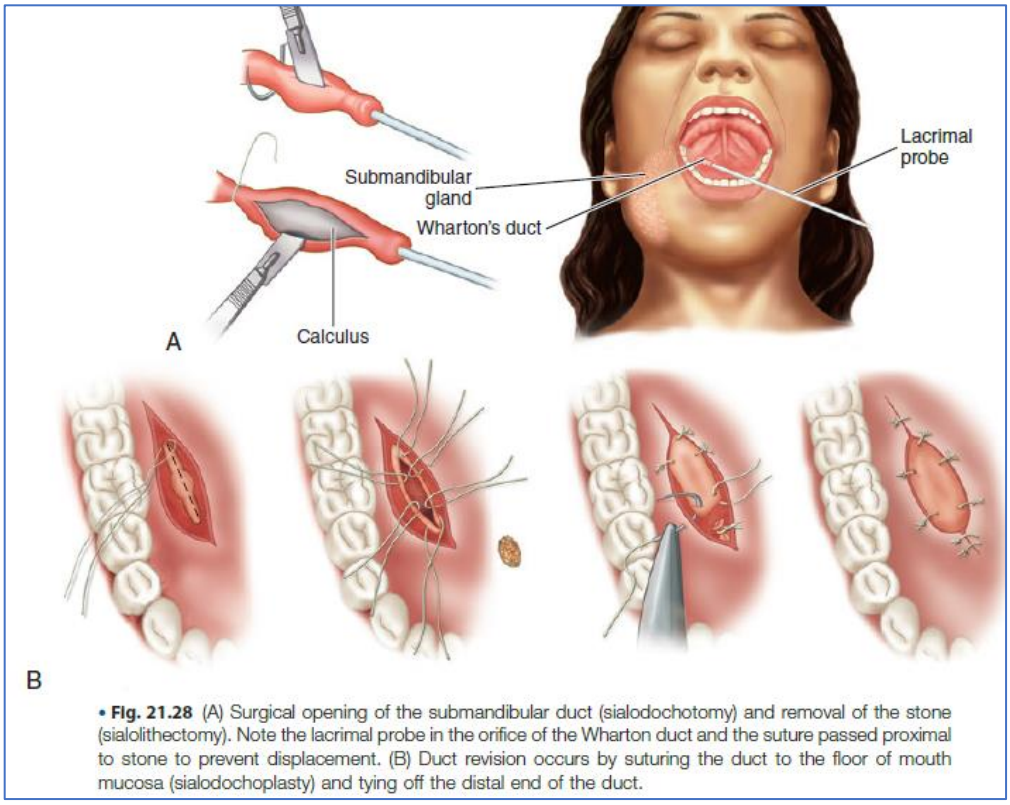
Management

There are several techniques available for the removal of the sialolith. A suitable procedure is selected depending upon the number, size, and site of the stone in the duct or the gland and age of the patient, etc.

The management of submandibular gland calculi:
1. For anterior stones *(which is located anterior to transverse line between mandibular 1st molar): intraoral removal is used. Small anteriorly located stones may be retrieved through the ductal opening after dilation of the orifice (**milking the gland**).*
*Occasionally it becomes necessary to remove submandibular stones via an incision made in the floor of the mouth to expose the duct and the stone (**sialodochotomy**). A suture is passed around the duct proximal to the stone to prevent propagation of the stone further toward the hilum of the gland. Following exposure of the Wharton duct, a longitudinal incision is made in the duct directly over the palpable stone, the stone is retrieved, and the ductal lining is sutured to the mucosa of the floor of the mouth. The duct is not repaired directly, since this might lead to scarring and stricture following healing that might lead to recurrence of the obstruction **(sialodochoplasty** i.e., revision of the salivary duct).*
2. In cases of posterior stones*: an extraoral approach for removal of the gland (**sialoadenectomy**) and the associated stone(s) may be required.*

Parotid sialoliths:
1-If found in the distal third of the Stensen duct, which can be palpated intraorally, may be removed after dilation of the duct orifice, if slightly more proximal, may require surgical exposure to gain access to the stone.
2-the presence of a parotid stone at the hilum of the gland or within the gland itself may necessitate an extraoral approach to remove the stone and possibly the superficial lobe of the parotid gland (superficial parotidectomy).

Lithotripsy*:The recent method of destruction of stone by shock wave Lithotripsy which may be extracorporeal with piezoelectric or electromagnetic techniques or intracorporeal using electrohydraulic, pneumatic, or laser endoscopic devices*



• **Fig. 21.28** (A) Surgical opening of the submandibular duct (sialodochotomy) and removal of the stone (sialolithectomy). Note the lacrimal probe in the orifice of the Wharton duct and the suture passed proximal to stone to prevent displacement. (B) Duct revision occurs by suturing the duct to the floor of mouth mucosa (sialodochoplasty) and tying off the distal end of the duct.

SIALADENITIS

Inflammation of the salivary glands is known as sialadenitis. Viral infections, bacterial infections, allergic reactions and systemic diseases are the major causes for sialadenitis. It may be acute or chronic.

Viral Infections

Mumps (epidemic parotitis) is the most common viral infection affecting the salivary glands; which is caused by a paramyxovirus. It is an acute, contagious disease, usually affecting the parotid gland. Occasionally, the submandibular or the sublingual glands may also be involved.

This disease is self-limiting one and not dangerous. In these days, the number of cases are reduced, because of the use of the mumps vaccine. It is a disease of the childhood, but when it affects the adults, it leads to greater complications.

Patients suffering from mumps give the history of local epidemic or contact with mumps' patients. This disease has the incubation period of 2-3 weeks.

Clinical features:Initially, the patient may suffer from mild fever, headache, chills, vomiting, etc. followed by pain below the ear and sudden onset of firm, rubbery or elastic swelling of the salivary glands, frequently elevating the ear lobe. In viral

parotitis, the glands of both the sides enlarge, which may be simultaneous or one following the other in 24 to 48 hrs. There is excruciating ear pain during mastication. Xerostomia, trismus, cervical lymphadenitis, tender glands, edema of the overlying skin may also be present. These symptoms usually last for a week. The disease spreads through droplet dissemination as the virus is present in the saliva.

Management: It is self-limiting. Symptomatic relief can be given by antipyretics. Antibiotics can be given to prevent the secondary infection.

Bacterial infection

Acute Bacterial Sialadenitis

The commensal organisms such as *Staph. aureus, Staph. pyogenes, Strep. viridans, Pnuemococcus, Actinomycetes,* etc. can cause the bacterial sialadenitis. It affects either the neonate and children or debilitated adults with poor oral hygiene. Some drugs like tranquilizers, antiparkinson drugs, diuretics, anti-histamines, tricyclic antidepressants, etc. decrease the salivary flow, with increased chance of infection of salivary glands.

Clinical features:The disease is characterized by sudden onset of pain at the angle of the jaw, which is unilateral. The affected gland is enlarged and tender and extremely painful. The inflammatory swelling is very tense and doesn't show much fluctuation. The overlying skin is warm and red. There is purulent discharge from Stenson's duct, which can be seen upon pressing the papilla. Patient might present with fever and other symptoms of acute inflammation.

Investigation:

The leukocyte count is high—leukocytosis.

Sialography should not be performed in the presence of suppuration. The pus is collected from Stenson's duct taking care not to contaminate the swab with oral microfloa, for the culture and sensitivity test.

Management:

• Antibiotics

• Palliative

a. Hydrating the patient.

b. Stimulate the salivation by chewing sialogogues.

c. Improve the oral hygiene by debridement andirrigation. If there is no improvement.

• Surgical drainage may be done using needle aspiration guided by CT scan or ultrasonography.

Chronic Bacterial Sialadenitis

The chronic or the recurrent type of bacterial sialadenitis may be seen in children and adults. It may be idiopathic or with factors like duct obstruction, congenital stenosis, Sjögrens syndrome and viral infection. All these factors except the duct

obstruction by stone are seen commonly in the parotid glands. The microorganisms may be *Strep. viridans*, *Escherichia coli*, *Proteus* or Pneumococci. Because these have low virulence, the changes are not sudden.
Clinical features: The disease starts as an unilateral swelling at the angle of the jaw. The recurrent sialadenitis shows periods of remissions. The gland may undergo atrophy, which results in decreased salivary flow.
Management:
1. Antibiotics
2. Intraductal infusion of erythromycin or tetracycline
3. Occluding ductal system with a protein solution to induce atrophy
4. In intractable cases, excision of the gland.

CYSTS OF THE SALIVARY GLANDS:
1. Mucocele
2. Ranula

Mucocele: there are two types of mucocele:

- True retention cyst which is lined by epithelium
- Mucous extravasation cyst which occurs because of the pooling of mucus, it does not have any epithelial lining and is surrounded by connective tissue cells.

Etiology: Mainly due to either obstruction of a salivary duct or trauma.

Incidence: Affect the minor salivary glands. No age or sex predilection. However, retention cysts occurred more frequently in older patients, whereas the extravasation cysts occur more commonly in the younger age group.

Site: Majority of mucocele are seen to affect the lower lip. With the exception of the anterior half of the hard palate which is devoid of salivary glands, they can occur anywhere in the oral cavity, i.e. cheeks, ventral surface of the tongue, floor of the mouth and retromolar area.

Clinical features: Small superficial, painless, well circumscribed swellings on the mucosa. Often vary in size from 1 mm to 2 cm. In deep seated, fluctuation is positive. Color is variable, it may be translucent or bluish. The mucocele may rupture spontaneously with the liberation of a viscous fluid.

Treatment: Enucleation of mucocele is frequently followed by recurrences. They are best treated by surgical excision together with the associated minor salivary

gland tissue and surrounding connective tissue. The mucosal margins are then undermined and sutured in apposition.

Ranula is variant of a mucocele that is present on the floor of the mouth, beneath the tongue. Owing to its resemblance to a frog's belly, it has been termed ranula. Two types have been identified, i.e. superficial ranula and plunging ranula.

Etiology: It has been reported that the majority of ranula occur because of extravasation of mucous due to trauma to the excretory ducts of the sublingual salivary gland. In the plunging type, this extravasated mucus passes through the mylohyoid muscle and collects in the submandibular region.

Clinical features: A dome-shaped bluish swelling of a superficial ranula may be seen located laterally in the floor of the mouth beneath the tongue. The tongue maybe raised or displaced as it enlarges. The swelling may cross the midline. At times, if the swelling is punctured or traumatized, a mucous secretion may be evident. In the 'plunging' type a fluctuant extraoral, submandibular swelling will be seen.

Treatment: Marsupialization results in recurrence. It is advisable to surgically remove the sublingual gland from an intraoral approach for both the superficial or plunging variety. This removes the secreting source and thereby avoids any recurrence.

TUMORS OF THE SALIVARY GLANDS

Salivary gland tumors occur much more commonly in the major glands (80% to 85%) as opposed to the minor glands (15% to 20%). About 75% to 80% of major gland tumors are benign, and 50% to 55% of minor gland tumors are benign. The overwhelming majority of salivary tumors occur in the parotid gland, and the majority of those are benign (most commonly pleomorphic adenoma).

Pleomorphic Adenoma

Pleomorphic adenoma constitutes more than 50% of all tumors and 90% of all the benign tumors of the salivary glands. It can affect both the major and minor salivary glands; it commonly affects the parotid gland.

Most of the workers believe that the tumor arises from the myoepithelial cell of the salivary gland. The different tissue types of both epithelial and connective tissue elements are seen in the tumor giving the name “mixed tumor”.

Clinical features:Pleomorphic adenoma most commonly affects the parotid gland, followed by minor salivary glands of the palate, lip, less frequently affects the submandibular gland. Majority of the lesions are seen between 4th to 6th decades, more commonly in females. The tumor starts as a small painless nodule, either at the angle of the mandible or beneath the earlobe. The nodule slowly increases in size, which may characteristically show intermittent growth. The tumor is well-circumscribed, encapsulated, firm in consistency, and may show areas of cystic degeneration. The tumor is readily movable without fixity to the deeper tissues or to the overlying skin. The tumor can grow to a very large size, but does not ulcerate. Tissue destruction, pain or facial paralysis is not seen.

- Pleomorphic adenoma should be differentiated from other benign tumors and hyperplastic lymph nodes. Though the painless nodular, firm growth with no ulceration of the overlying skin, is suggestive of this tumor, it can be confirmed by biopsy. In case of minor salivary gland lesions, which are usually not more than 2 cm in diameter, it is better to perform excisional biopsy.

Treatment: Pleomorphic adenomas are treated by surgical excision. The parotid tumors are removed with adequate margins, whereas the intraoral lesions can be treated little more conservatively. In case of submandibular tumors, excision of the gland with the tumor is performed

The removal of pleomorphic adenoma should be performed with careful dissection and preserving the facial nerve in case of the parotid tumors. Also, one should take care not to spill any tumor tissue, as they are highly implantable.

Irradiation is contraindicated as the tumor is radio- resistant.

Complications:

1. The incomplete excision of the tumor may lead to recurrence.
2. The long standing untreated benign pleomorphic adenomas may undergo malignant transformation. A tumor, which is hard, ulcerates, causes facial paralysis or lymph node involvement could have transformed into a malignant one.

Warthin's tumor

This benign tumor affects the parotid glands. Involvement of the submandibular or the minor salivary glands is very rare. Usually, males are affected more commonly in the 5th decade.

Recently, some investigators have highlighted the association of smoking habit in the pathogenesis of this tumor.

The tumor is seen as a firm, non-tender, circumscribed mass in the region of angle or ramus of the mandible or beneath the ear lobe. Though both side parotid glands may be affected, the swelling might start on one side following the other.

Sialography:When the tumor attains sufficient size, the sialogram show non-filling, space occupying, tissue displacing tumor. The diagnosis may be confirmed by biopsy.

Treatment: The tumor is surgically excised.

Monomorphic adenoma: is an uncommon solitary lesion composed of one cell type affecting predominantly the upper lip minor glands (canalicular adenoma) and the parotid gland (basal cell adenoma). The mean age of occurrence is 61 years, and the lesion usually presents as an asymptomatic, freely movable mass. Histopathologic examination reveals an encapsulated lesion composed of one type (monomorphic) of salivary ductal epithelial cell.
The treatment of an adenoma is simple surgical excision.

Malignant Tumors
Mucoepidermoid Carcinoma
It is the most common malignant salivary gland tumor. The grading of mucoepidermoid carcinoma into low- grade, intermediate grade and high-grade has cleared the doubts about it's behavior. The low-grade tumor behaves almost like a benign tumor with very good prognosis, whereas the high- grade tumor behaves very aggressive. It occurs with an equal distribution between males and females

The clinical features: depend upon the grade of the tumor. Thus, it may grow slowly or rapidly; usually as a painless swelling of the parotid or other major salivary gland, or in the minor salivary glands. Intraorally, it may affect the minor glands of the palate, buccal mucosa, tongue and retromolar areas. The high-grade tumor may produce pain, ulceration or facial paralysis, local destruction and metastasis to regional lymph nodes and distant metastasis to the lung, bone and to the brain in later stages.
It is common for intraoral mucoepidermoid carcinoma to undergo cystic degeneration thus mimicking a mucocele clinically. The diagnosis should be confirmed by biopsy.
Treatment:The tumor should be surgically excised, the excision should be more radical than for pleomorphic adenoma.

Adenoid Cystic Carcinoma
The adenoid cystic carcinoma is also called as cylindroma, because of its histologic appearance. It may arise as a slow growing swelling, sometimes may mimic a benign tumor clinically and histologically, but has greater potential for local destruction and invasiveness, commonly perineural invasion (neurotropism).
Treatment: Adenoid cystic carcinoma is treated by radical excision. As the tumor is radio resistant, irradiation is not a mode of primary treatment

NECROTIZING SIALOMETAPLASIA

is a reactive, nonneoplastic inflammatory process that usually affects the minor salivary glands of the palate. Lesions usually appear as large (1 to 4 cm), painless or painful, deeply ulcerated areas lateral to the palatal midline and near the junction of the hard and soft palates. This condition is of considerable concern because, clinically and histologically, it resembles a malignant carcinoma. The ulcerations of necrotizing sialometaplasia usually heal spontaneously within 6 to 10 weeks after onset and require no surgical management.

NON-INFLAMMATORY AUTOIMMUNE DISEASE

Sjögren's Syndrome

This is a condition originally described as a triad, consisting of dry eyes, xerostomia and rheumatoid arthritis. Now it has been found that patients may present either with dry eyes and xerostomia only (primary Sjögren's syndrome) or with the above two symptoms and accompanying rheumatoid arthritis, systemic lupus erythematosus, polyarteritisnodosa, etc. (secondary Sjögren's syndrome).

Though the etiology is unknown, various causes suggested are genetic, hormonal, infection and immuno- logic among others. Most authorities support the immunologic mechanism to be the main intrinsic factor in the etiology of this disease.

Clinical Features:

Clinically, this disease occurs predominantly in women over 40 years of age, although children or young adults may be affected. The female to male ratio is 10:1.

Typically, patients present with dry eyes and dry mouth due to hypofunction of lacrimal and salivary glands. This leads to pain, burning sensation and ulcerations on the oral/conjunctival mucosa. Various other glands like nasal, bronchial, vaginal, etc. may also show hyposecretion. Rheumatoid arthritis most frequently accompanies the above symptoms in secondary Sjögren's syndrome. But patients with primary Sjögren's syndrome are seen to manifest parotid gland enlargement, purpura, lymphadenopathy, etc.

Salivary gland function in suspected cases can be measured by using parotid flow rate, biopsy and salivary scintigraphy. Sialochemistry studies have shown elevated levels of IgA, K, Na, etc. in these patients. Sialography demonstrates the cavitary defects which are filled with radiopaque contrast media, producing the "branchless fruit laden tree" or "cherry blossom" appearance.

Sialorrhea or Ptyalism

It is excessive salivation seen in affected patients. It can be mild, intermittent or continuous profuse drooling. It can cause severe drooling, choking and social embarrassment to the patient. This condition is not so common and can occur due to various causes.

- Minor sialorrhea can be seen due to local irritation like aphthous ulcers or ill fitting dentures. Idiopathic paroxysmal sialorrhea will have short episodes for 2 to 5 minutes.
- Profuse salivation is seen in rabies, heavy metal poisoning or after certain medications like lithium and cholinergic agonists.
- Mentally retarded children also have excessive salivation.
- Neurologically disabled persons (cerebral palsy) also suffer from this disorder.
- Drooling of the saliva isalso seen after the resection of the mandible, because of poor neuromuscularcontrol.

The treatment is conservative. Anticholinergic medication can be tried (atropine). Behavioral modification, physical therapy has been tried.

Suggested Surgical Treatment:

• Submandibular gland resection
• Transposition of parotid duct
• Parotid duct ligation.

Xerostomia

This is a subjective sensation of a dry mouth. It affects women more than the men, and seen more commonly in older people, because of decreased glandular secretion due to aging as well as due to some medications which reduce the secretion. Antihistamines, decongestants, antidepressants, antipsychotics, antihypertensives, anticholinergics are known to cause xerostomia.

Other causes of xerostomia are salivary gland aplasia, aging, excessive smoking, mouth breathing, local radiation therapy, Sjögren‘s syndrome, HIV infection, etc.

Clinically, dry mouth with foamy, thick, ropy saliva can be noticed. The tongue may have leathery appearance and fissures with atrophy of the filiform papillae. These patients are more prone for oral candidiasis due to reduction in cleansingand antimicrobial action of saliva. Dental decay is rampant with more of cervical and root caries.

Treatment is conservative, maintainance of oral hygiene, use of sialagogues (pilocarpine), modification of medications in elderly patients may help to improve the condition.

SURGICAL MANAGEMENT

Parotid Gland: Superficial Parotidectomy

Indications:

a. Tumor: The most common is pleomorphic adenoma,

b. Massive enlargement secondary to: (i) Sjögren's syndrome, or (ii) Calculus in the hilum of gland- calculus is removed without removal of the gland, (iii) Chronic infection.

Approaches:

i. Preauricular

ii. Submandibular

iii. Combination of the two approaches.

Preauricular incision:

- Incision is taken in the skin. Platysma and superficial fascia dissected.
- The duct is identified at the anterior border of the gland. The duct is followed backwards through the substance of gland until the calculus; identified and recovered.
- Extreme caution should be exercised for the preservation of branches of facial nerve, particularly the lower zygomatic branch, which lies on the surface of the duct just below the accessory parotid.
- The fascial sheath encasing the gland is closed completely. This prevents saliva leaking into the tissues.
- A piece of corrugated rubber drain is placed, and the wound is closed over the drain in layers. A pressure dressing is applied over the site of surgery.

Preventing Injury to the Facial Nerve

Sternocleidomastoid muscle is followed superiorly to find the main trunk. In cases, this route is not successful, a peripheral branch; usually the marginal mandibular, may be found and traced proximally.

Identification of facial nerve may be accomplished by one of the three methods:

i. Direct identification of the main trunk as it exits through the stylomastoidforamen (Lathrop 1949).

ii. Retrograde approach to the trunk from either the mandibular branch, where it passes over the retromandibular vein (Byars 1952), or the peripheral branches alongside the parotid duct (State 1949).

iii. Supravital staining of parotid gland, contrasting the blue normal gland from the unstained tumor and the gleaming white facial nerve fibers.

Complete Excision of Parotid Gland

During complete removal of parotid gland, the prime concern is to conserve the facial nerve and its branches. In malignant lesions, however, this may not be possible and the resultant deformity should be explained to the patient.

Submandibular Salivary Gland

Extra-oral Procedure

Procedure for biopsy or excision of the gland:

- An incision, 4 to 5 cm in length, is taken in the skin in the submandibular region. The incision is placed in, or parallel to the skin creases, about 2 cm below the submandibular border.
- The wound is deepened through platysma and deep fascia. The branches of facial nerve in the field are identified, mobilized and retracted. The facial vein is identified and ligated.
- The lower pole of the gland is exposed, grasped with Allis's forceps and turned upwards and forwards. The posterior belly of digastric and stylohyoid muscles are retracted downwards and backwards to expose facial artery lying deeper to the gland. It is ligated and divided.
- The gland is separated from the lower border of mandible. Here again the facial artery lies lateral to the gland. It is divided and ligated again. With the help of Allis's forceps, the gland is held from the front of lower pole, and the gland is turned backwards, so that the attachment to the posterior border of mylohyoid can be exposed.
- The gland then can be mobilized and brought down to display the lingual nerve. The nerve is in relation with the upper pole of the gland from the point of emergence of the duct. Extreme caution has to be taken while carrying out the dissection. At times, due to scarring caused by inflammation around an adjoining calculus, the nerve may be adherent. Once the lingual nerve is carefully dissected, and the duct is identified, the mylohyoid muscle is retracted. Then a ligature is passed anterior to ductal pathosis, if it exists. The second ligature is passed posterior to the first one, but still anterior tothe ductal pathosis and the duct is sectioned between the ligatures. This prevents the seepage of infected material into the wound. The deep part of the gland, then can be excised. This is preferably ligated and divided.
- A vacuum drain is kept in the wound, and the wound sutured in layers

COMPLICATIONS OF SURGERY OF SALIVARY GLANDS

Most of the complications of salivary gland surgery are as a result of damage to nerves. Hence, the complications should be explained to the patient, and informed consent taken, prior to embarking on the surgery.

Frey's Syndrome (Gustatory Sweating)

It is a condition wherein sweating and sometimes flushing of the skin in the area of distribution of the auriculotemporal nerve occurs; which is caused by a stimulus to secretion of saliva. It is thought to be the result of damage to auriculotemporal nerve postganglionic parasympathetic fibers from the otic ganglion become united to sympathetic fibers arising from superior cervical ganglion going to supply the sweat glands of the skin.

It rarely occurs and has no treatment. The syndrome can occur in the following circumstances: (i) Surgery of parotid gland, (ii) Surgery of TM Joint, (iii) Injuries to this area of the face, (iv) Injections into this region.

Facial Nerve Paralysis

Commonly, postoperative patients may experience transient facial nerve weakness, primarily involving the marginal mandibular branch, but also occurring in the zygomatic branch. This affects the depressor muscle of the lip and the orbicularis muscle of the eye, respectively. The onset of paresis is usually 1-3 hours postoperatively. Supportive care to prevent corneal irritation may be required during this phase of paresis. Full recovery usually occurs within days to months.

Salivary Fistulae and Sialoceles

Salivary fistulae and sialoceles are uncommon. They consist of a collection of saliva under the skin flap with drainage through the wound. Treatment consists of aspiration of fluid, compression dressings, and removal of salivary stimulants. The problem usually resolves gradually with this simple treatment regimen.

Implantology

Dr. Sabah Alheeti

Dental implant is a structure made of alloplastic materials implanted into the oral tissues beneath the mucosa and/or periosteum and/or within or through the bone to provide retention and support for a fixed or removable dental prosthesis.

Advantages of implant over fixed bridge:

- High success rate (above 97% for 10 years)
- A decreased risk of caries and endodontic problems of adjacent teeth
- Improved maintenance of bone in edentulous site
- Decreased sensitivity of adjacent teeth

Biologic and Functional Considerations

The primary goal in implant placement is to achieve and maintain an intimate bone-to-implant connection. This concept is known as *osseointegration*.

Histologically defined, osseointegration is the direct structural and functional connection between organized, living bone and the surface of a load-bearing implant without intervening soft tissue between the implant and bone.

Osseointegration clinically is defined as the asymptomatic rigid fixation of an alloplastic material (the implant) in bone with the ability to withstand occlusal forces.

For osseointegration to occur in a predictable fashion, several important factors are required:

1. A biocompatible material (the implant) (Titanium is the material of choice for dental implants.)
2. Atraumatic surgery to minimize tissue damage
3. Implant placement in intimate contact with bone
4. Immobility of the implant, relative to bone, during the healing phase

Initial stability of the implant depends on:

- volume and quality of bone that intimately contacts the implant
- the length and diameter of the implant

Thus The best-case scenario would be a long wide-diameter implant that engages a thick superior cortical plate surrounded by dense cancellous bone and terminally engages a thick inferior cortical plate (i.e., anterior mandibular) Fig.1.

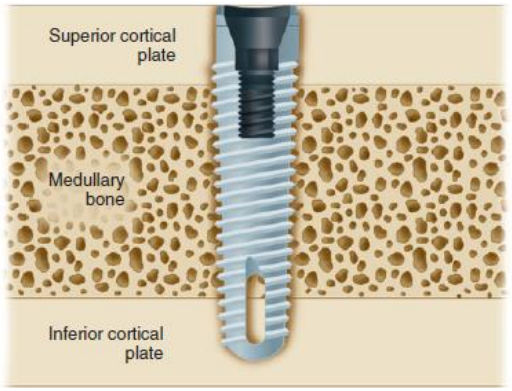


Fig.1: Whenever possible, implants should engage two cortical plates of bone.

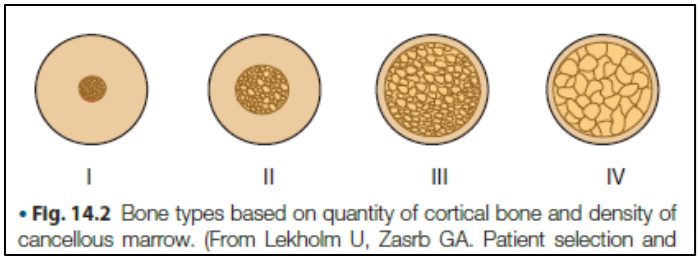
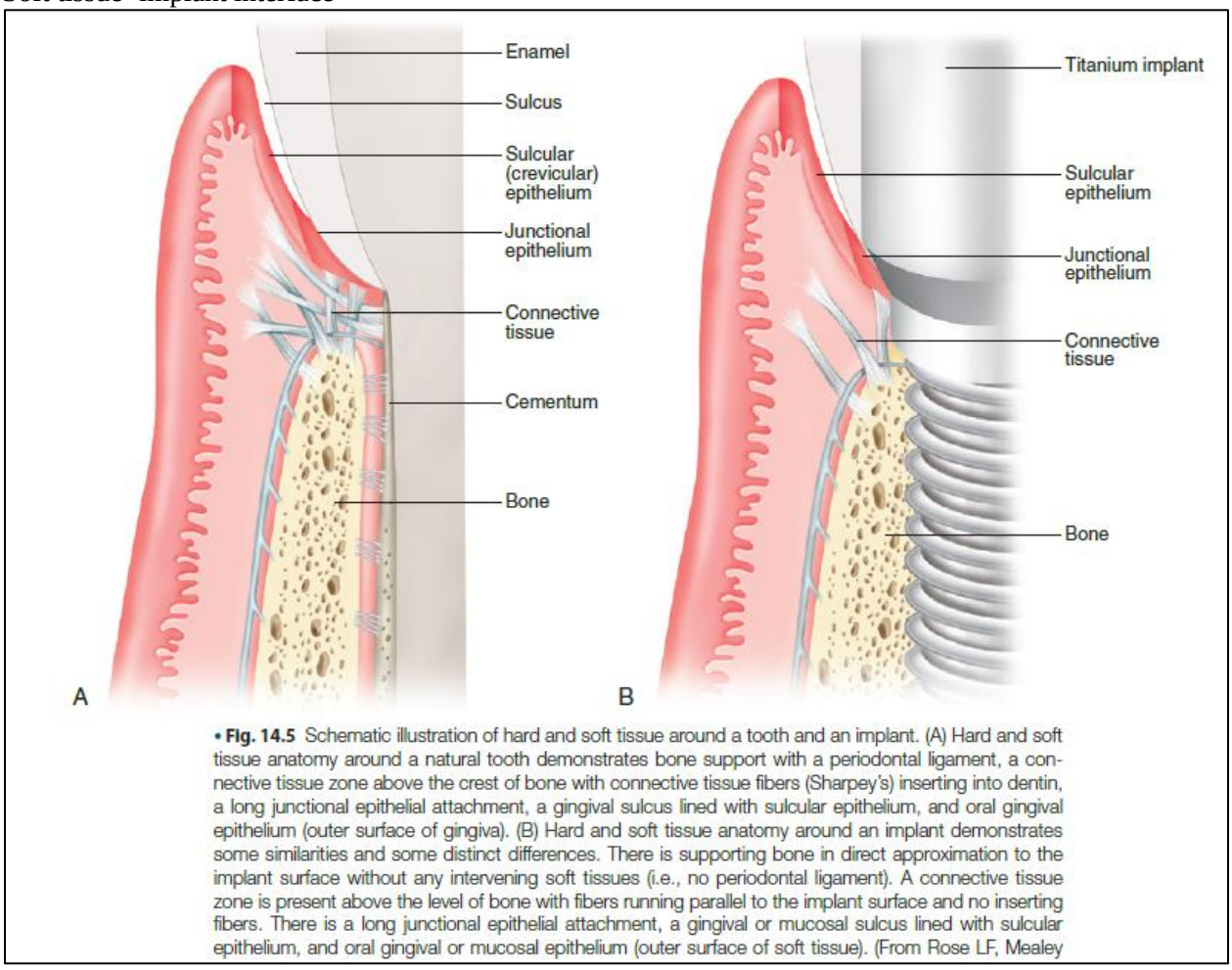


Fig.2: bone types according to density.

Soft tissue- implant interface



What are the different dental implant categories?

1. Subperiosteal
2. Endosteal (root form or plate form) } only considered true
3. Transosseous osseointegrated imp

What became the criteria for successful implants after 1986?

In 1986, with the introduction of osseointegration, the criteria for successful implants were revised:

1 Implant clinically immobile
2 No radiographic evidence of any periimplant radiolucency
3 Vertical bone loss of <0.2 mm after the first year of function
4 Absence of any symptoms, such as pain, infection, numbness, or maxillary sinus or nasal symptoms
5 Success rate of 85% after 5 years and 80% after 10 years

Preoperative Assessment and
Treatment Planning

- Chief Complaint
- Medical History and Medical Risk Assessment:
  i. Absolute contraindications: acutely ill and those with uncontrolled metabolic disease.
  ii. Relative contraindications include diabetes, osteoporosis, immune compromise (e.g., human immunodeficiency virus infection, acquired immunodeficiency syndrome), medications (e.g., bisphosphonates—oral and intravenous), and medical treatments such as chemotherapy and irradiation (e.g., of the head and neck).

- Dental history
- Intraoral Examination: address the following the restorative or structural integrity of existing teeth, existing prosthetics, vestibular depths, palatal depths, edentulous ridge topography, periodontal status, oral lesions, infections, occlusion, orthodontic assessment, jaw relationships, interarch space, maximum opening, parafunctional habits, and oral hygiene, zones of keratinization (e.g., quantity and location) and clinical biotype (e.g., thin, moderate, or thick)
- Diagnostic Casts and Photographs:
- Radiographic Examination: Options range from standard intraoral projections (e.g., periapical, occlusal) and extraoral projections (e.g., panoramic, cephalometric), to more complex cross-sectional imaging (e.g., computed tomography [CT], cone beam computed tomography [CBCT]).

  Areas of study radiographically include the following:

  1. Location of vital structures
  • Mandibular canal
  • Anterior loop of the mandibular canal
  • Anterior extension of the mandibular canal

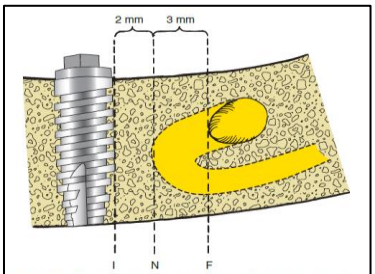
- Mental foramen
- Maxillary sinus (floor, septations, and anterior wall)
- Nasal cavity
- Incisive foramen

2. Bone height
3. Root proximity and angulation of existing teeth
4. Evaluation of cortical bone
5. Bone density and trabeculation
6. Pathology (e.g., abscess, cyst, tumor)
7. Existence of anatomic variants (e.g., incomplete healing of extraction site)
8. Cross-sectional topography and angulation (best determined by using CT and CBCT)
9. Sinus health (best evaluated by using CT and CBCT)
10. Skeletal classification

Critical measurements specific to implant placement include the following:
- At least 1 mm inferior to the floor of the maxillary and nasal sinuses
- Incisive canal (maxillary midline implant placement) to be avoided
- 5 mm anterior to the mental foramen
- 2 mm superior to the mandibular canal
- 3 mm from adjacent implants
- 1.5 mm from roots of adjacent teeth
    - Space between implant and buccal or lingual plate 1 mm

Surgical Treatment Planning Considerations

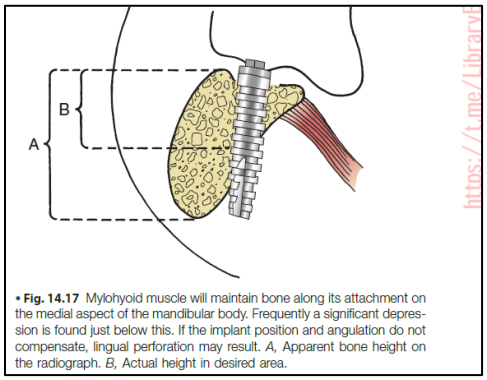
1 Anterior mandible:
- 5 mm anterior to the most anterior portion of the mental foramen
- typically the densest of any area in the two arches
- Proper angulation of implants



• **Fig. 14.15** The most anterior extent of the bony mental foramen *(F)* is frequently located posterior to the most anterior extent of the mental nerve before its exit from bone *(N)*. The most posterior aspect of the implant *(I)* should be placed a minimum of 2 mm from the nerve. This means that the implant must be placed 5 mm anterior to the most anterior aspect of the bony mental foramen.

2. Posterior Mandible:

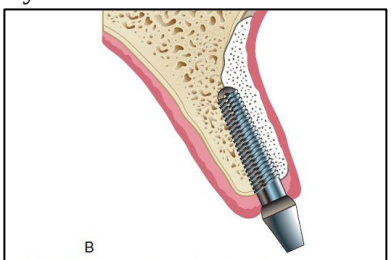
- At least 2 mm from the inferior alveolar nerve (IAN)
- Deep lingual depression, “the lingual undercut,” usually is present immediately below Mylohyoid muscle attachment.



• **Fig. 14.17** Mylohyoid muscle will maintain bone along its attachment on the medial aspect of the mandibular body. Frequently a significant depression is found just below this. If the implant position and angulation do not compensate, lingual perforation may result. *A*, Apparent bone height on the radiograph. *B*, Actual height in desired area.

3. Posterior maxilla:

- usually has a thin buccal plate
- 1 mm short of the nasal floor and should not be placed in the maxillary midline



• **Fig. 14.13** Deficient anterior maxillary ridge. (A) After tooth loss there is often significant vertical and buccolingual loss of alveolar bone (original position of tooth shown). (B) To facilitate implant placement, this type of bone defect will have to be grafted prior to implant placement.

4. Posterior maxilla: poses two specific concerns related to implant placement.

- The first is the quality of bone in this area.is typically the poorest of any area. For this reason, more time (6 months or longer) may be required for osseointegration to occur in this region
- the proximity of the maxillary sinus to the edentulous ridge (should leave 1 mm)

To facilitate ideal implant placement, **surgical guides** are frequently utilized. The surgical guide template is a critical factor for implants placed in an esthetically important area.
The four objectives of using a surgical template for the partially edentulous patient are as follows:
(1) delineating the embrasure,
(2) locating the implant within the tooth contour,
(3) aligning the implants with the long axis of the completed restoration
(4) identifying the level of cementoenamel junction or tooth emergence from soft tissue

Preoperative antibiotic prophylaxis is sometimes recommended. An oral dose of 2 g amoxicillin 1 hour preoperatively or, in patients unable to take oral medications, cefazolin 1 g or ampicillin 2 g intramuscularly or intravenously 1 hour before the dental procedure are effective.

Alternative medications include 600 mg of clindamycin orally or intravenously.

Surgical Technique

I. Flapless surgery by using punch kit.

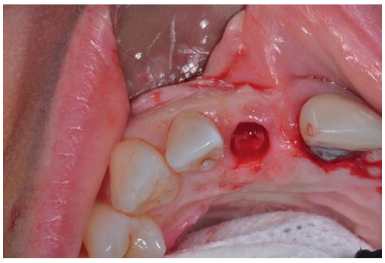
II. *Flap surgery:* tissue elevation that may include sulcular, midcrestal, and vertical releasing incisions

Flapless surgery may be indicated when there is adequate keratinized tissue over an ideal ridge form.

Advantages:

1. Faster healing of soft tissue
2. No disturbance of blood supply of bone
3. Minimal bleeding, low morbidity

Disadvantages :
1.blind technique
2. impossibility of flap handling for aesthetic reasons
3. damaging anatomic structures



Punch Kit

Preparing the Osteotomy

- The surgeon must confirm that the handpiece and motor are functioning properly
- Drilling is done with the precision drill (pilot drill) at full speed to a depth of 1 to 2 mm short of the depth of the intended implant
- Then Series of different diameter osteotomy-widening drills (e.g. 2.8, 3.2, 3.7, 4.2 mm diameters) are used to the same depth
- The final depth drill should be 0.3–0.8 mm less than the diameter of the implant. (Example : implant diameter 5 mm, so the final drill is about 4.2 If bone density D3/D4 and 4.7 if bone density D1/D2.)

Inserting Implant

- The implant is carried to the prepared osteotomy and screwed in with clockwise rotations at very slow speed (30–40 rpm) using a rotary handpiece or hand ratchet. Torque

Uncovering

Once the implant gets osseointegrated with the bone, the implant is uncovered by making a small crestal

incision or using the tissue punch. The cover screw is removed and replaced with a long **gingival former/healing abutment/permucosal extension.**

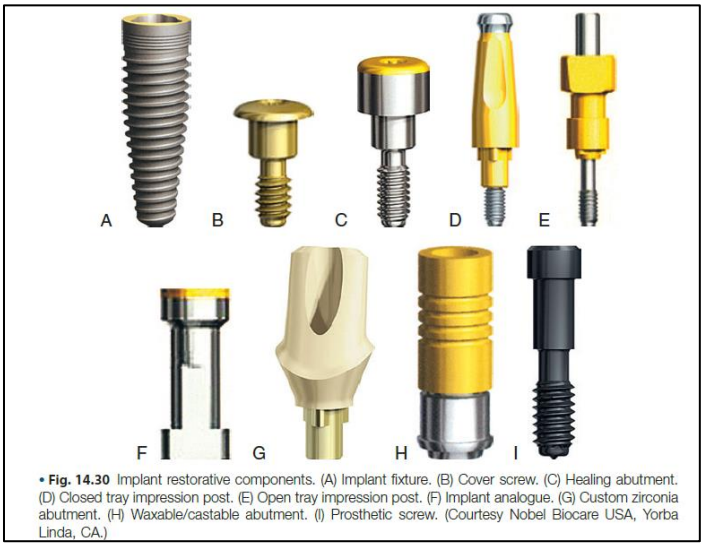
What are some tests to evaluate osseointegration at the time of implant uncovering?

- Torque testing: 20 Ncm
- percussion and immobility when placing fixture mount or impression coping on the implant
- lateral force of 5 lb is applied, no movement should be seen. Horizontal mobility of >1 mm indicate failure.
- Resonance frequency analysis: (ISQ

Complications

- Complications that can occur with any surgical procedure, including pain, bleeding, swelling, or infection.
- A positioning error resulting in implants placed at a compromised angulation or position.
- Surgical technique complications such as a tear of the soft tissue flap, poor closure of the incision.
- Invasion of critical anatomic structures can create more serious complications. If the implant invades or impinges on the canal of the IAN, this may result in paresthesia.
- Mechanical complications can present as an implant platform fracture because of excessive insertion torque
- Esthetic complications can occur from poor implant positioning or angulation, making proper prosthetic restoration unrealistic.

Implant Components



• **Fig. 14.30** Implant restorative components. (A) Implant fixture. (B) Cover screw. (C) Healing abutment. (D) Closed tray impression post. (E) Open tray impression post. (F) Implant analogue. (G) Custom zirconia abutment. (H) Waxable/castable abutment. (I) Prosthetic screw. (Courtesy Nobel Biocare USA, Yorba Linda, CA.)

Implantology: advanced concepts

Immediate Postextraction Placement of Implants

The implant may be placed immediately (i.e., at the time of extraction), early (i.e., 2 months after extraction), or late (i.e., more than 6 months after extraction). Each of these times has its indications, advantages, and disadvantages.

Advantages of immediate placement:

1. shortest healing time
2. combines tooth extraction with surgical implant placement.
3. Placing a provisional restoration at the same procedure may provide the best opportunity for maintenance of soft tissue anatomy

The primary disadvantages of immediate placement :

1. difference in the anatomy of the root or roots of the extracted tooth compared with the shape and size of the implant ⟹ difficult placement
2. the implant is exposed to excessive occlusal forces ⟹ long-term stability fail

Criteria of success immediate implant placement

1. Immediate placement can be considered if the tooth to be removed is not infected and can be removed without the loss of alveolar bone.
2. at least 4 mm of the implant apex should be precisely seated in firm bone to provide this initial stability
3. The implant should be countersunk slightly below the height of crestal bone to allow for resorption of bone resulting from extraction
4. implant is also positioned 1 mm palatal to the center of the extracted tooth root
5. The gap between the implant and the residual tooth socket: If the gap is less than 1 mm and the implant is stable, often no treatment modification is needed. If the gap is greater than 1 mm, grafting with a particulate bone material may be indicated.

Sinus Lift

Extension of the maxillary sinuses into the alveolar ridge may prevent placement of implants in the posterior maxillary area because of insufficient bony support. The sinus lift is a bony augmentation procedure that places graft material inside the sinus cavity but external to the membrane and augments the bony support in the alveolar ridge area.

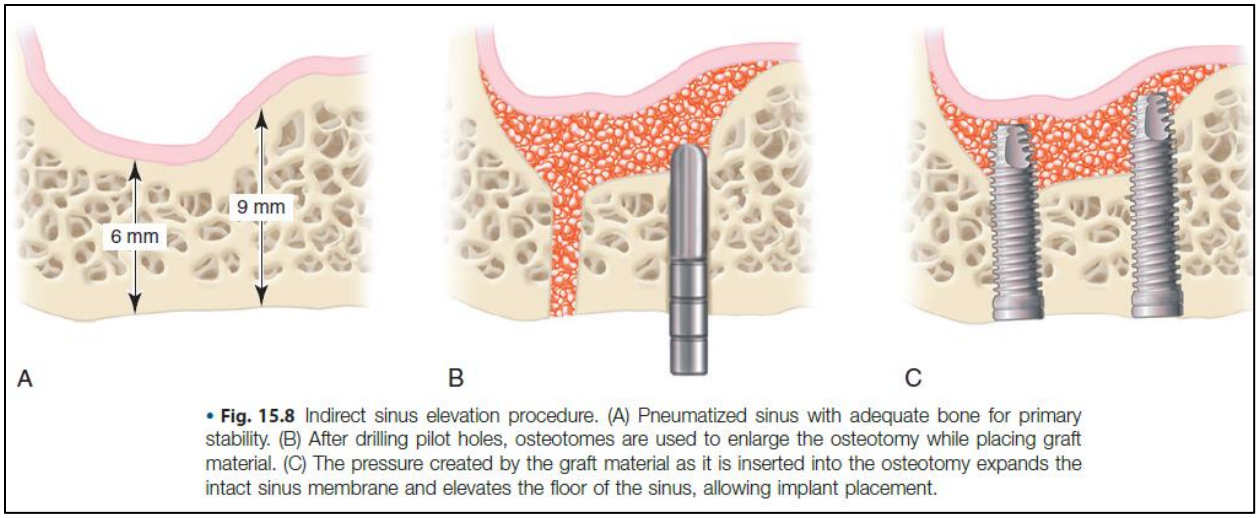
Types :

A. Indirect sinus lift: When only a few millimeters of augmentation are needed in conjunction with simultaneous implant placement.

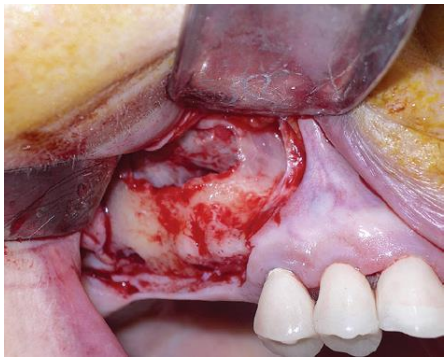
B. Direct sinus lift: In this technique, an opening is made in the lateral aspect of the maxillary wall, and the sinus lining is carefully elevated from the bony floor of the sinus (Fig. 15.9). After elevation of the sinus membrane, the graft material is placed in the inferior portion of the sinus, below and external to the sinus membrane.

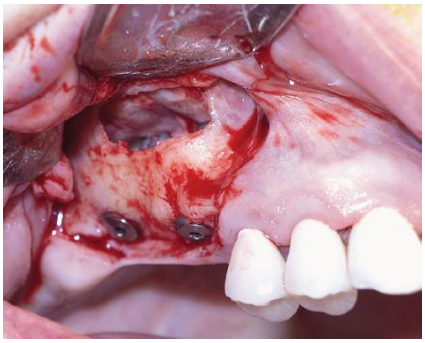
   Perforations are usually covered with redundancy of the elevated membrane and a “patch” of resorbable membrane material. If insufficient bone is available to provide initial implant stability, the graft is allowed to heal for 3 to 6 months, after which the first stage of implant placement can begin in the usual fashion.

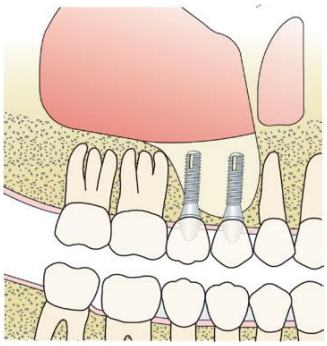
   If enough bone is available to obtain initial implant stability (usually 4 to 5 mm), then implant placement can be accomplished simultaneously with sinus grafting



• **Fig. 15.8** Indirect sinus elevation procedure. (A) Pneumatized sinus with adequate bone for primary stability. (B) After drilling pilot holes, osteotomes are used to enlarge the osteotomy while placing graft material. (C) The pressure created by the graft material as it is inserted into the osteotomy expands the intact sinus membrane and elevates the floor of the sinus, allowing implant placement.



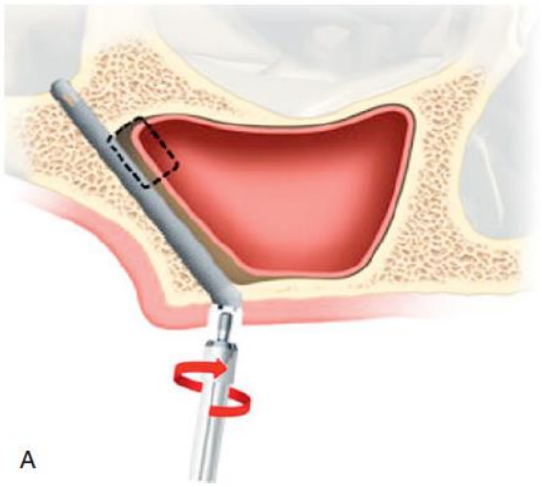


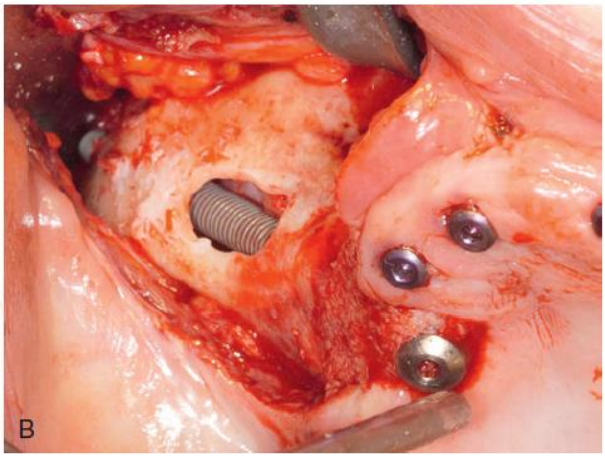


Direct sinus lift (lateral approach)

Zygomatic Implants

- Indicated where grafting of the sinus floor may not be feasible due to health compromised or patient reluctant long staged surgeries.
- The implant was originally developed in the early 1990s by Brånemark
- The implants are extremely long, ranging from 35 to 55 mm.
- The implants are placed intraorally, with exposure to the crest of the alveolar ridge and the body of zygoma and visual access to the maxillary sinus
- The portion of the implant embedded just medial to the alveolar crest or zygomatic bone undergoes osseointegration similar to other implants.
- The posterior zygomatic implants are usually combined with four anterior implants, all supporting a fixed prosthesis.





• **Fig. 15.13** Zygomaticus implant. (A) Diagram showing placement of zygomatic implant. The implant engages the body of the zygoma, medial alveolar ridge, and lateral aspect of the maxilla. (B) Clinical image of placement of the zygomatic implant. (A, Courtesy Nobel Biocare USA, Yorba Linda, CA.)

Extraoral Implants

Extraoral implants are currently used to anchor prosthetic ears, eyes, and noses for patients with defects resulting from congenital conditions, trauma, or pathologic Conditions.

Augmentation of maxilla and mandible

Previously mentioned in preprosthetic surgery.

Temporomandibular joint Disorders

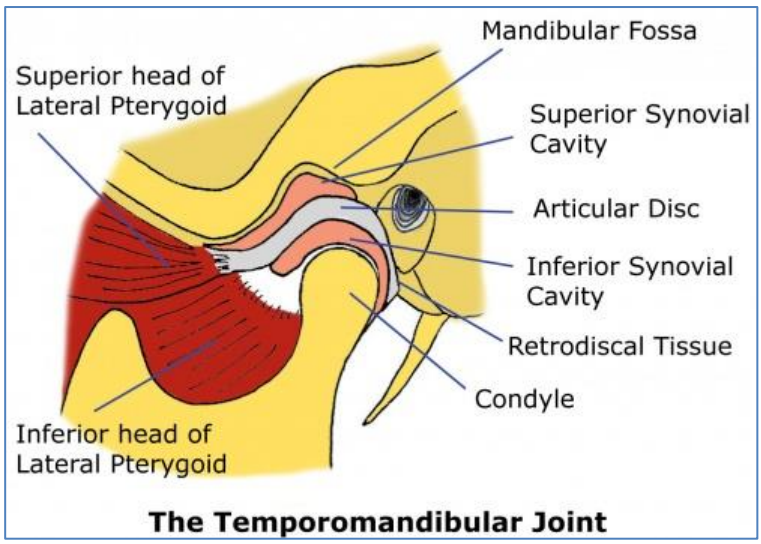
Dr.Sabah Alheeti

The surgical anatomy of TMJ

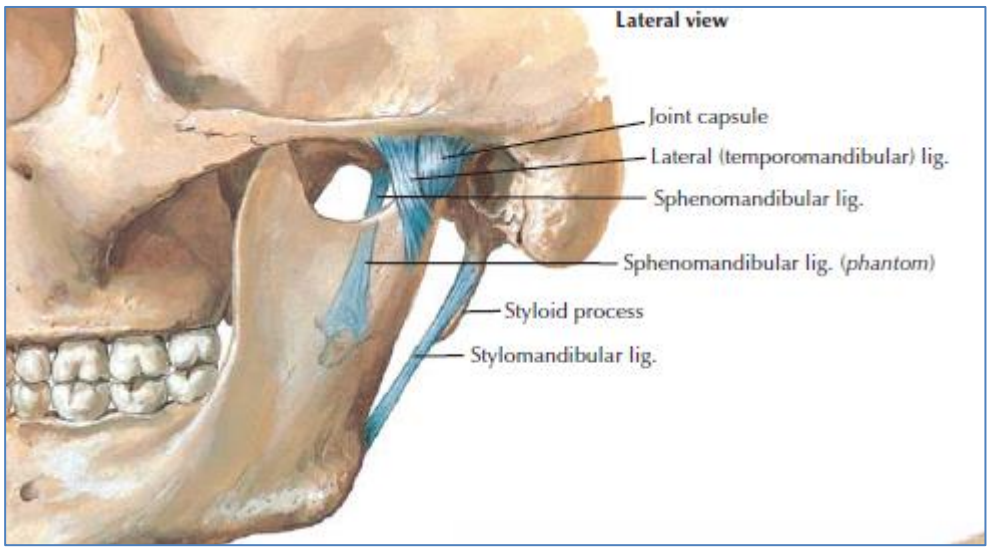
The TMJ is a ginglymoarthrodial joint (allow both hinge and gliding movement), make up of articulation between cranium and mandible (cranio-mandibular articulation).

- **The bony components** include: the **condyles** below and **squamous temporal bone** above. The articular space of each TMJ is divided into upper and lower compartments by interposition of fibrous articular disc. Gliding movement occur primarily in upper compartment while hinge or rotary movement occur primarily in lower compartment. **The glenoid (mandibular) fossa**, is a concavity within the temporal bone that houses the mandibular condyle. **Articular eminence** is a bony tubercle at the anterior boundary of glenoid fossa.
- **Articular Disk** is a biconcave, nonvascularized and noninnervated fibrocartilaginous structure located between the mandibular condyle and the temporal bone component of the joint. Its function to accommodate a hinging as well as the gliding actions between the temporal and mandibular articular bone. Posteriorly, the disk blends with a highly vascular, highly innervated structure (retrodiskal tissue or bilaminar zone).
- **The fibrous capsule** is a thin sleeve of tissue completely surrounding the joint.
- **Synovial membrane** is Highly vascularized layer of connective tissue lines all structures of the articulation that don't experience compressive forces. It produces the **synovial fluid** that fills these cavities
- **Ligaments:** There are
  I. **Collateral (discal)Ligaments:** composed of 2 ligaments (medial and lateral) which connect the medial and lateral aspect of disc to medial and lateral pole of condyle, respectively.
  II. ***Temporomandibular ligament:*** which reinforce the lateral aspect of capsule and Prevents lateral and posterior displacement of the condyle.
  III. **Sphenomandibular and stylomandibular ligaments** which are considered accessory ligaments of the TMJ because not directly attached to any part of the joint.
- **Muscles:** All muscles attached to the mandible influence its movement to some degree. Only the four large muscles (**Temporalis, Masseter, Medial pterygoid and Lateral pterygoid muscles**) that attach to the ramus of the mandible are considered the muscles of mastication.
- **The vascular supply of the TMJ:** arises primarily from branches of the superficial temporal and maxillary arteries posteriorly and the masseteric artery anteriorly.

- **The nerve supply to the TMJ**: is predominantly from branches of the auriculotemporal nerve and masseteric branches of mandibular branch of the trigeminal nerve.



The Temporomandibular Joint



EVALUATION

The evaluation of the patient with temporomandibular pain, dysfunction, or both is like that in any other diagnostic workup. This evaluation should include a thorough history, a physical examination of the masticatory system, TMJ radiograph.

Interview

The patient's history may be the most important part of the evaluation, because it furnishes clues for the diagnosis. The history begins with the chief complaint then HPI.

Examination

1. Chief complaint
2.Histoy of present illness HPI
3.Medical and dental history Hx.
4. Clinical examination:

I. Palpation (preauricular, intrameatal and muscles of mastication)

II. The TMJs are examined for tenderness and noise. The location of the joint tenderness (e.g., lateral, posterior) should be noted. If the joint is more painful during different areas of the opening cycle or with different types of functions, this should be recorded. The most common forms of joint noise are clicking (a distinct sound) and crepitus (i.e., multiple scraping or grating sounds)

III. The mandibular range of motion should be determined. Normal range of movement of an adult's mandible is about 45 mm vertically (i.e., interincisally) and 10 mm protrusively and laterally.

Figure 1: Systematic evaluation of muscles of mastication. **A,** Palpation of masseter muscle. **B,** Palpation of temporalis muscle. **C,** Palpation of temporalis tendon attachment on coronoid process and ascending ramus.

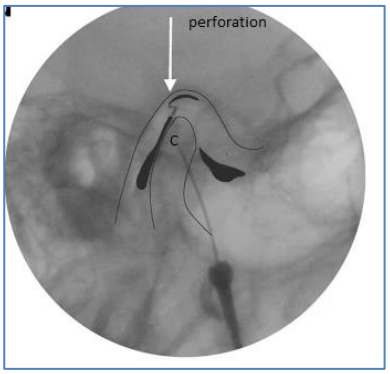
Figure 2: manual palpation of joint during closing and opening.

Radiographic Evaluation

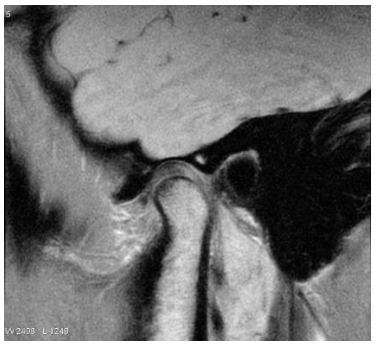
Radiographs of the TMJ are extremely helpful in the diagnosis of intraarticular, osseous, and soft tissue pathology. The use of radiographs in the evaluation of the patient with TMD should be based on the patient's signs and symptoms instead of routinely ordering a

"standard" set of radiographs. In many cases the panoramic radiograph provides adequate information as a screening radiograph in evaluation of TMD. A variety of other radiographic techniques are available that may provide useful information in certain cases.

1. ***Panoramic radiography:*** provide a good assessment of the bony anatomy of the articulating surfaces of the mandibular condyle and glenoid fossa, coronoid**.**
2. ***Temporomandibular joint arthrography.*** This imaging method was the first technique available that allowed visualization (indirect) of the intraarticular disk. Arthrography involves the injection of contrast material into the inferior or superior spaces of a joint, after which the joint is radiographed. This technique also demonstrates the presence of perforations and adhesions of the disk or its attachments.



3. ***Computed tomography.*** This technique allows evaluation of a variety of hard and soft tissue pathology in the joint. CT images provide the most accurate radiographic assessment of the bony components of the joint.
4. ***Magnetic resonance imaging.*** The most effective diagnostic imaging technique to evaluate TMJ soft tissues is magnetic resonance imaging **(MRI)** (disc morphology and position)



5. ***Others: U/S, CBCT and Nuclear imaging.***

CLASSIFICATION OF TEMPOROMANDIBULAR DISORDERS

Articular Disorders	*Nonarticular Disorders*
Noninflammatory arthropathies: ex: osteoarthrosis, disc displacement	Muscle disorders: such as • Muscle spasm (strain) • Myofascial pain and dysfunction (MPD) • Fibromyalgia
Inflammatory arthropathies: ex: Synovitis Capsulitis, Rheumatoid arthritis	Growth disorders
Growth disorders: hypoplasia, hyperplasia, dysplasia	
Neoplasms: ex, osteoma, chondroma	
Miscellaneous articular disorders	

Myofascial Pain

Myofascial pain and dysfunction (MPD) is the most common cause of masticatory pain and limited function for which patients seek dental consultation and treatment.

- **Etiology**: One of the most commonly accepted causes of MPD is bruxism secondary to stress and anxiety, with occlusion being a modifying or aggravating factor. MPD may also occur secondary to internal joint problems, such as disk displacement disorders or degenerative joint disease (DJD).
- **Features:** Patients with MPD generally complain of diffuse, poorly localized, preauricular pain that may also involve other muscles of mastication, such as the temporalis and medial pterygoid muscles. In patients with nocturnal bruxism, the pain is frequently more severe in the morning.

  Patients generally describe decreased jaw opening with pain during functions such as chewing. Headaches, usually bitemporal in location, may also be associated with these symptoms. Because of the role of stress, the pain is often more severe during periods of tension and anxiety.

  The TMJs are frequently nontender to palpation. In isolated MPD, joint noises are usually not present.

  The range of mandibular movement in MPD patients may be decreased and is associated with deviation of the mandible toward the affected side.

  Radiographs of the TMJs are usually normal.
- **Treatment modalities** for MPD. Such treatments include occlusal adjustments (for gross discrepancies), nightguard appliances (for joint unloading, jaw repositioning, and occlusal protection), nonsteroidal anti-inflammatory medications, muscle relaxants, and physical therapy.These treatment modalities, alone or in combination, remain the standard of care for the treatment of nonarticular TMJD, particularly MPD.

Disk Displacement Disorders (internal derangement)

Wilkes classification of internal derangement:
Stage I Early reducing disk displacement
Stage II Late reducing disk displacement
Stage III Non reducing disk displacement: acute/subacute
Stage IV Non reducing disk displacement: chronic
Stage V Non reducing disk displacement: chronic with osteoarthritis

Anterior disk displacement with reduction. In anterior disk displacement the disk is positioned anterior and medial to the condyle in the closed position. During opening the condyle moves over the posterior band of the disk and eventually returns to the normal condyle and disk relationship, resting on the thin intermediate zone. During closing the condyle then slips posteriorly and rests on the retrodiscal tissue, with the disk returning to the anterior, medially displaced position.
Signs *of anterior disc displacement* with reduction:

1- Joint noise: Clicking during opening the mouth. If it occurs during opening and closing, it is called reciprocal clicking
2- Painless but Joint tenderness and muscle tenderness may be seen
3- Maximal opening can be normal or slightly limited
4- Plain TMJ radiography in patients with anterior disk displacement may be normal. MRI images usually demonstrate anterior displacement of the disk

Anterior disk displacement without reduction

In this type of internal derangement, the disk displacement cannot be reduced, and thus the condyle is unable to translate to its full anterior extent, which prevents maximal opening and causes deviation of the mandible to the affected side.

Signs of non reducing disc displacement:

1- No clicking occurs, because they are unable to translate the condyle over the posterior aspect of the disk.
2- Restricted opening, deviation to the affected side, and decreased lateral excursions to the contralateral side due to displacement of the disk which restrict translation
3- Joint tenderness and muscle tenderness
4- Radiographic evaluation of disk displacement without reduction is similar to findings in anterior disk displacement with reduction

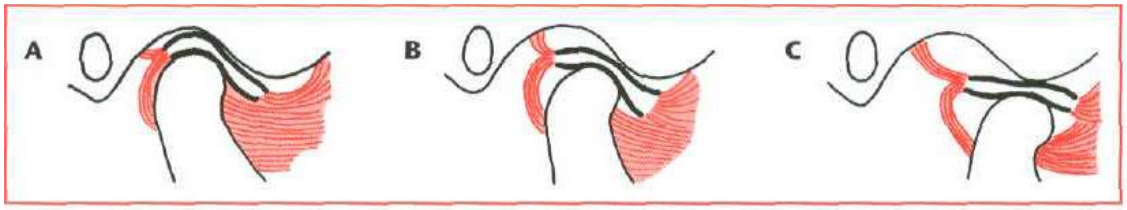


FIG. 1: Normal disk and condyle relationship**. A**, Biconcave disk is interpositioned between fossa and condyle in closed position. **B,** When condyle translates forward, thin intermediate zone stays in consistent relationship with condyle. **C,** Maximum open position

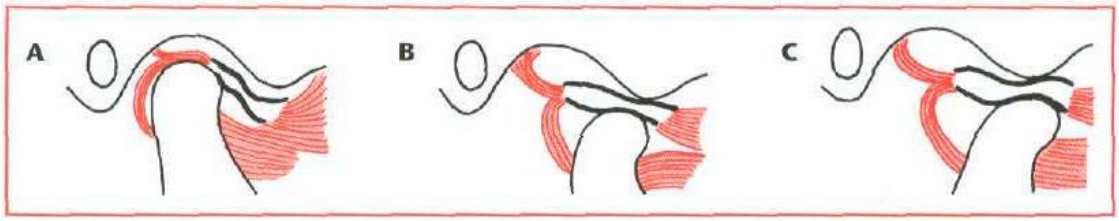


Fig.2: Anterior disk displacement with reduction. A, Biconcave disk is situated anterior to articulating surface of condyle. When condyle translates forward, it eventually passes over thickened posterior band of disk, creating clicking noise. B, After click occurs, disk remains in appropriate relationship with condyle through remainder of opening cycle. C, Maximum opening position. When mandible closes, condyle and disk relationship will return to position as shown in A.

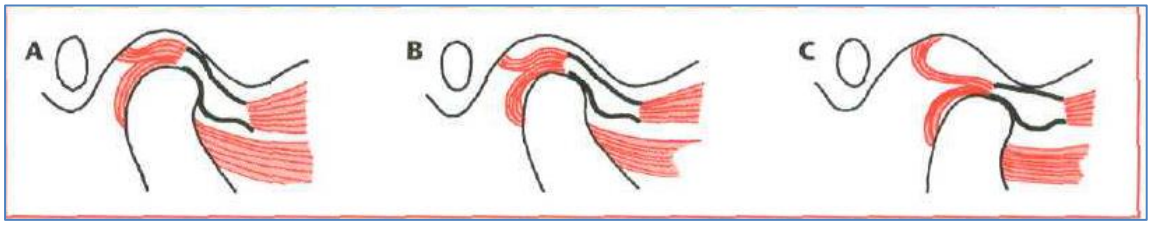


FIG. 3: Anterior disk displacement without reduction. A, Disk that has been chronically anteriorly displaced now has amorphous shape rather than distinct biconcave structure. B, When condyle begins to translate forward, disk remains anterior to condyle. C, In maximum open position, disk tissue continues to remain anterior to condyle, with posterior attachment tissue interposed between condyle and fossa.

Degenerative Joint Disease (Arthrosis, Osteoarthritis)

DJD includes a variety of anatomic findings, including irregular, perforated, or severely damaged disks in association with articular surface abnormalities, such as articular surface flattening, erosions, or osteophyte formation (Fig. 4).

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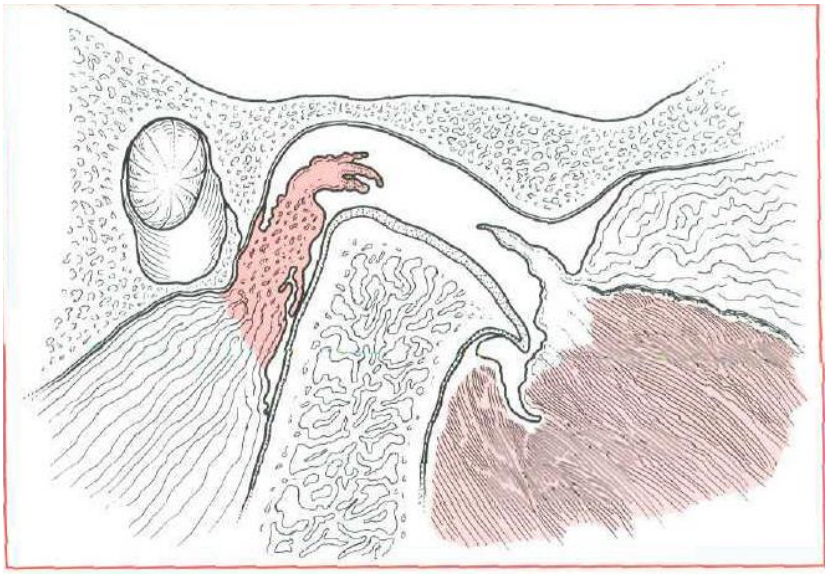


Fig.4: Degenerative joint disease demonstrates large perforation of disk tissue and erosion and flattening of articulating surfaces of both condyle and fossa

Patients with DJD frequently experience **pain associated with clicking or crepitus**, located directly over the TMJ. Usually, an **obvious limitation of opening is present**, and symptoms usually increase with function. **Radiographic findings** are variable but generally exhibit decreased joint space, surface erosions, osteophytes, and flattening of the condylar head.

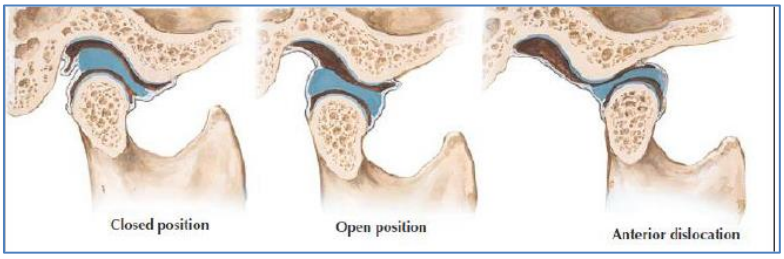
Systemic Arthritic Conditions

A variety of systemic arthritic conditions are known to affect the TMJ. The most common of these is rheumatoid arthritis. In these cases, symptoms are rarely isolated to the TMJs, and several other signs and symptoms of arthritis are usually present in other areas of the body. In the case of rheumatoid arthritis, an inflammatory process results in abnormal proliferation of synovial tissue in a so-called pannus formation (Fig. 30-15). TMJ symptoms that result from rheumatoid arthritis may occur at an earlier age than those associated with DJD. As opposed to DJD, which is usually unilateral, rheumatoid arthritis (and other systemic conditions) usually affects the TMJs bilaterally.

Radiographic findings of the TMJ initially show erosive changes in the anterior and posterior aspects of the condylar heads. These changes may progress to large eroded areas that leave the appearance of a small, pointed condyle in a large fossa. Eventually the entire condyle and condylar neck may be destroyed. Laboratory tests, such as rheumatoid factor and erythrocyte sedimentation rate, may be helpful in confirming the diagnosis of rheumatoid arthritis.

Hypermobility of TMJ:

1. Subluxation: the condyle out of glenoid fossa that can be returned by patient (self-reducing dislocation)
2. Dislocation: the condyle out of glenoid fossa that can't be returned by patient. occurs when the mandibular condyle translates anteriorly in front of the articular eminence and becomes locked in that position.



Causes:

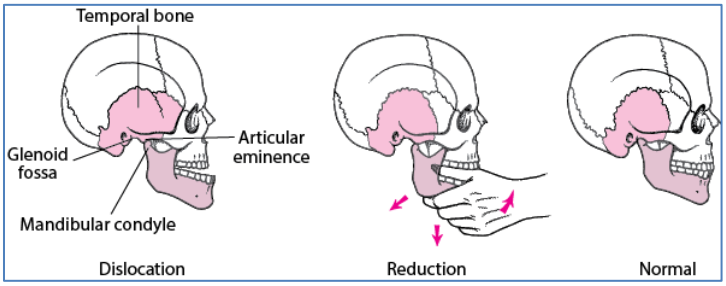
1. Extrinsic trauma: force against a partially opened mandible
2. Intrinsic trauma: excessive opening of the mandible (such as may occur during yawning and dental procedures
3. Connective tissue disorders: Marfan syndrome.
4. Psychogenic: habitual
5. Drugs induced; phenothizine

Symptoms and signs: The most common clinical symptom is the inability to close the mouth, i.e., "open lock," difficulty in speech, drooling of saliva, and lip incompetency. In acute dislocation, pain in the pre auricular region is present, but chronic recurrent dislocation is rarely associated with it. Usually bilateral and gives pseudo-prognathism appearance but may be unilateral dislocation and lead to deviation of the chin to the contralateral side. Palpation over the preauricular region may suggest emptiness in the joint space. The patient may look anxious

Management:

A) Acute:

-Manual reduction followed by IMF for 2w. and this reduction is accomplished by applying downward pressure on the posterior teeth and upward pressure on the chin, accompanied by posterior displacement of the mandible. Anesthesia of the auricular temporal nerve and the muscles of mastication may be necessary to relieve muscular spasms. Sedation to reduce patient anxiety and provide muscular relaxation may also be required.



B) Chronic:

-Manual reduction

-Condylotomy

- Condylectomy

C) Chronic recurrent dislocation (Subluxation)

-Conservative:

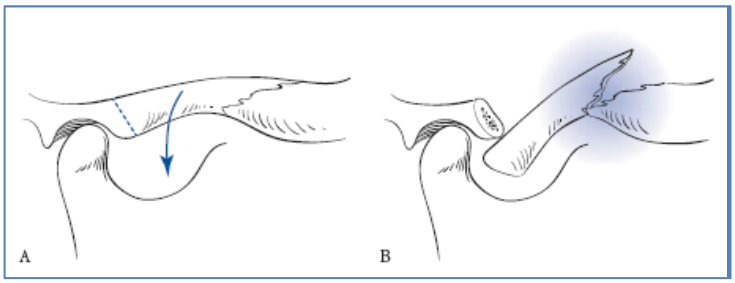
a. Prolonged IMF (Intermaxillary fixation) for 2_6 weeks

b. Chemical capsulorrhaphy: includes injection of sclerosing agents like alcohol, sodium tetradecyl sulfate in TMJ capsule to induce fibrosis.

c. Injection botulinum toxinA (BTX-A) in lateral pterygoid muscle.

-Surgical:

1. Capsular plication
2. Augmentation of articular eminence by bone graft or L shaped pin
3. Inferior displacement of zygomatic arch (LeClerc procedure: vertical fracture of zygomatic arch in front of the joint and the proximal segment is lowered to obstruct the condylar path, modified by Dautery: downward and forward osteotomy)
4. Eminectomy
5. Lat pterygoid myotomy



Hypomobility Disorders of the Temporomandibular Joint

-Classification of hypomobility:

1)True ankylosis (persistent limitation of mouth opening. It may be bony, fibrous or mixed Ankylosis)

Trauma: intracapsular fracture (child)
Infection: otitis media, suppurative arthritis
Inflammation: rheumatoid arthritis, Still's disease, ankylosing spondylitis
Surgical: postoperative complications of temporomandibular joint or orthognathic surgery.

2)Pseudoankylosis (Extra articular)

Depressed zygomatic arch fracture
Fracture dislocation of the condyle
Adhesions of the coronoid process
Hypertrophy of the coronoid process
Fibrosis of the temporalis muscle
Tumor of the condyle or coronoid process

3)Trismus (temporary limitation of mouth opening usually caused by muscle spasm)

Odontogenic: myofascial pain, malocclusion, erupting teeth

Infection: pterygomandibular, lateral pharyngeal, temporal spaces
Trauma: fracture of the mandible, muscle contusion
Tumors: nasopharyngeal tumors, tumors that invade jaw muscles
Psychologic: hysteric trismus
Pharmacologic: phenothiazines
Neurologic: tetanus

True Ankylosis

Or **Intracapsular ankylosis**, or fusion of the joint, leads to reduced mandibular opening that ranges from partial reduction in function to complete immobility of the jaw. Intracapsular ankylosis results from a fusion of the condyle, disk, and fossa complex, as a result of the formation of fibrous tissue, bone fusion, or a combination of the two. The most common cause of ankylosis involves macrotrauma, most frequently associated with condylar fractures.

Topazian classification of TMJ ankylosis:

Stage 1: Ankylotic bone limited to the condylar process
Stage 2: Ankylotic bone extending to the sigmoid notch
Stage 3: Ankylotic bone extending to the coronoid process

Features of long standing ankylosis:

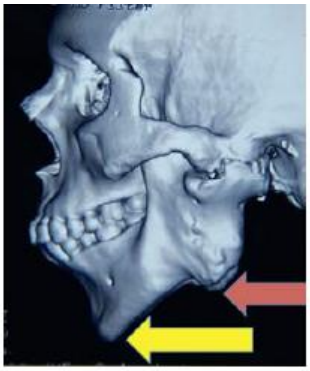
Facial Features

-Deviation of the chin and the mandible toward the side of the defect
-Unilateral vertical deficiency of the side of the defect
-Retrognathic mandible
-Micrognenia
-Convex facial profile
-Obtuse cervicomental angle
-Larger nasolabial angle
-Bird face deformity: “Andy Gump deformity”
-Prominent antegonial notch
-Markedly elongated coronoid process
-Obstructive sleep apnea in some cases

Oral Features

-Occlusal canting with deviation of maxillary and mandibular midlines toward the affected side
-Generally, a Class II malocclusion, sometimes a Class I occlusion may be seen
-Posterior crossbite
-Deviation toward affected side on opening
-In bilateral ankylosis, an anterior open bite may be seen
-Severe oral hygiene maintenance problems, leading to caries and periodontal problems.

Radiographic evaluation reveals irregular articular surfaces of the condyle and fossa, with varying degrees of calcified connection between these articulating surfaces.



Management: The basic principle in surgical release of ankylosis is the aggressive resection of the ankylotic mass. The surgical techniques are:

1-Gap arthroplasty: resection of ankylotic mass and creation gap for at least 1 cm between roof of glenoid fossa and the ramus.

2- Interpositional arthroplasty: insertion of interpositional materials after resection of the ankylosis to prevent recurrence. Such as

-temporalis myofascial flap
-temporalis fascia alone
-full thickness temporalis pericranial flap
-alloplastic materials

3- Reconstruction of the joint after resection of the ankylotic mass with autogenous or alloplastic grafts : Goals are
restore joint function**,** reestablish vertical height of ramus and provide growth potential in children: Based on the concept that condylar cartilage is the major growth center of mandible, autologous costochondral graft gained popularity. Usually the fifth or sixth costochondral junction is harvested from the right side, but in females sixth or seventh costochondral junction is harvested**.**

Non -surgical Treatment of TMJ disorders

Although the cause of TMJ pain and dysfunction can arise from several different sources, initial treatment is frequently aimed at **nonsurgical methods** of reducing pain and discomfort, decreasing inflammation in muscles and joints, and improving jaw function. In some cases, such as ankylosis or severe joint degeneration, surgical treatment may be the preferred initial course of therapy.
The nonsurgical methods include:

1-Patient Education and behavior modification: Modification of diet is important part of the patient's educational process via

- Cutting food into small pieces
- Eliminates gum chewing
- liquid diet and elimination of hard chewy food

2- Medications:

(1) NSAlDs: meloxicam (Mobic)
(2) Corticosteroids: dexamethasone
(3) Analgesics: range from acetaminophen to narcotics like codeine
(4) Muscular relaxants: Centrally acting cyclobenzaprine/ peripheral acting baclofen
(5) Tricyclic antidepressants: amitriptyline
(6) Anxiolytics: Benzodiazepines
(7) local anesthetics: can be used as diagnostic blocks intra-articularly and/or intramuscularly to alleviate pain and increase range of motion.

3-Physical Therapy

The most common modalities used include thermal therapy (by hot moist wash clothes 15_20 min) or deep heat by U/S and Jaw exercises.

Passive jaw exercise has received a great deal of attention recently. Many authors report significant improvement in pain and mobility in the nonsurgical phase of treatment for TMD. Passive jaw exercise is also very effective for patients experiencing muscular trismus and myofascial pain dysfunction (MPD). It may be contraindicated in patients with severely displaced disks, due to the possibility of damage to the disk or retrodiskal tissues. Passive jaw exercise allows the patient to manually (or with a device such as Therabite Jaw.

Active exercise: using the patient's jaw musculature may be incorporated into a home therapy program. One regimen allows the patient to activate, for example, their suprahyoid muscles (geniohyoid, mylohyoid, digastric, and stylohyoid), thereby inactivating the elevators of the jaw (medial pterygoid, masseter, temporalis).

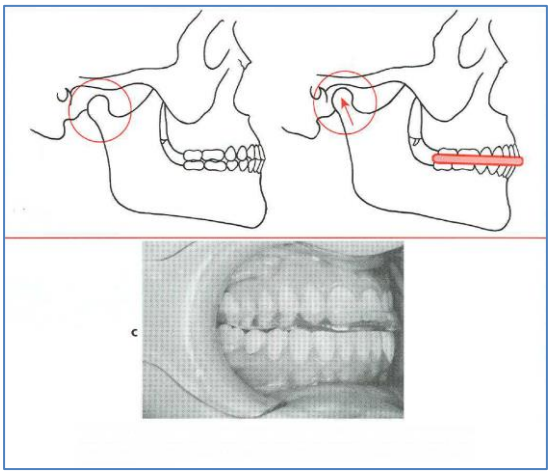
This may allow for relaxation of hyperactive muscles of mastication and may assist in increasing maximal incisal opening. In the active stretch phase patients are advised to keep their mouth open for several seconds and relax. They are instructed to open until they perceive pain and then advised to hold for several seconds and repeat this exercise several times a day.

4-Splints

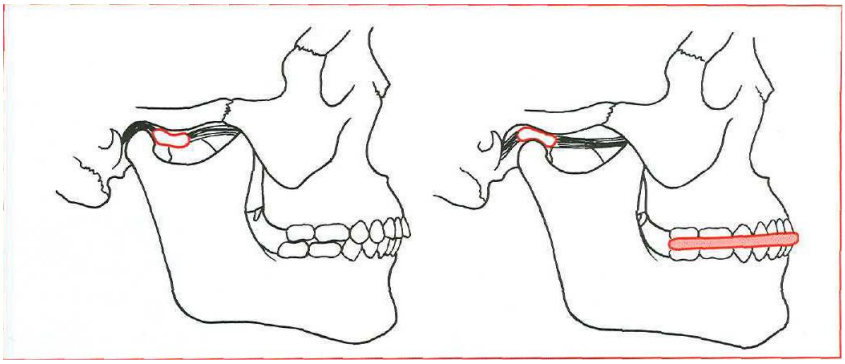
Occlusal splints are generally considered a part of the reversible or conservative treatment phase in the management of TMD patients. Splint designs vary; however, most splints can be classified into two distinct groups: (1) autorepositioning splints and (2) anterior repositioning splints.

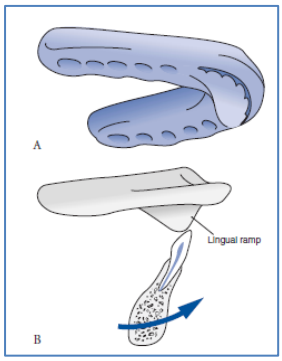
- **Autorepositioning splints** : most frequently used to treat muscle problems or eliminate TMJ pain when no specific internal derangement or other obvious pathology can be identified. The splint is usually designed to provide full-arch contact without working or balancing interferences and without ramps or deep interdigitation, which would force the mandible to function in one specific occlusal position. An example of this type of splint would be in a patient with a class II

malocclusion and significant overjet who continually postures forward to obtain incisor contact during mastication.



❖ ***Anterior repositioning splints.*** Anterior repositioning splints are constructed so that an anterior ramping effect forces the mandible to function in a protrude position.





6. Occlusal management: (e.g. correction of overjet)

TEMPOROMADIBULAR JOINT SURGERY

Despite the fact that many patients with internal joint pathology will improve with reversible nonsurgical treatment some patients will eventually require surgical intervention to improve masticatory function and decrease pain. Several techniques are currently available for correction of a variety of TMj derangements.

1- Arthrocentesis: The term means "joint puncture (aspiration)," togather with lavage for flushing out the proinflammatory cytokines, pain mediators, and cartilage matrix degradation products. It is effective for reduction of pain and disability. It is a simpler, less invasive technique than arthroscopy and is popular with comparable treatment outcomes to arthroscopic lysis and lavage.

Indications:

(a) Acute and chronic limitation of opening because of anteriorly displaced disk without reduction

(b) chronic pain with good range of motion and anterior disk displacement with reduction.

Procedure:

The procedure can be carried out under local analgesia. The upper joint cavity is punctured with a small needle (19 to 21 gauge) via the skin in front of the tragus to irrigate, and the fluid is expelled via an outflow needle. The first needle is placed 10 mm anterior and 2 mm below the line from the midpoint of the tragus to lateral canthus, and the outflow needle is placed 20 mm anterior and 10 mm below. The volume of irrigation was originally 500 mL of lactated Ringer's solution, although the literature currently suggests 100 to 200 mL of lavage is sufficient.

(Holmlund–Hellsing line (H-H line): A line extending from the lateral canthus of the eye to a point bisecting the tragus of the ear. The 10-2 point (10 mm anterior and 2 mm inferior to the mid-tragus along the line) correlates with the posterior recess/glenoid fossa. The 20-10 point (20 mm anterior to the mid-tragus point along the line and 10 mm below the line) correlates with the prominence of the articular eminence).

2. Arthroscopy: one of the most popular and effective methods of diagnosing and treating TMJ disorders. This technique involves placement of a small cannula into the superior joint space. An arthroscope with light source is then inserted through the cannula into the superior joint space. It is used or diagnosis of TMJ pathology and treatment like disc plication or removal of adhesion

3-Disc repositioning(discopexy)

4.**Disc repositioning & discoplasty**.

5. Disc repositioning & arthroplasty for condyle or fossa.
6. Disc repair.
7. Discectomy
8. Discectomy with replacement by:
Temporalis muscle/fascia flap
Ear cartilage
Dermal graft
Abdominal dermis/fat graft

9-Condylotomy: a osteotomy performed through condylar neck.
10-Total Joint Replacement In some cases, joint pathology results in destruction of joint structures so that reconstruction or replacement of components of the TMJ is necessary.
Examples of such situations include severe degenerative or rheumatoid arthritic disorders, severe cases of ankylosis, neoplastic pathology, posttraumatic destruction of joint components, and multiple failed surgical procedures. Surgical techniques may involve replacement of the condyle or fossa but most commonly include both elements.

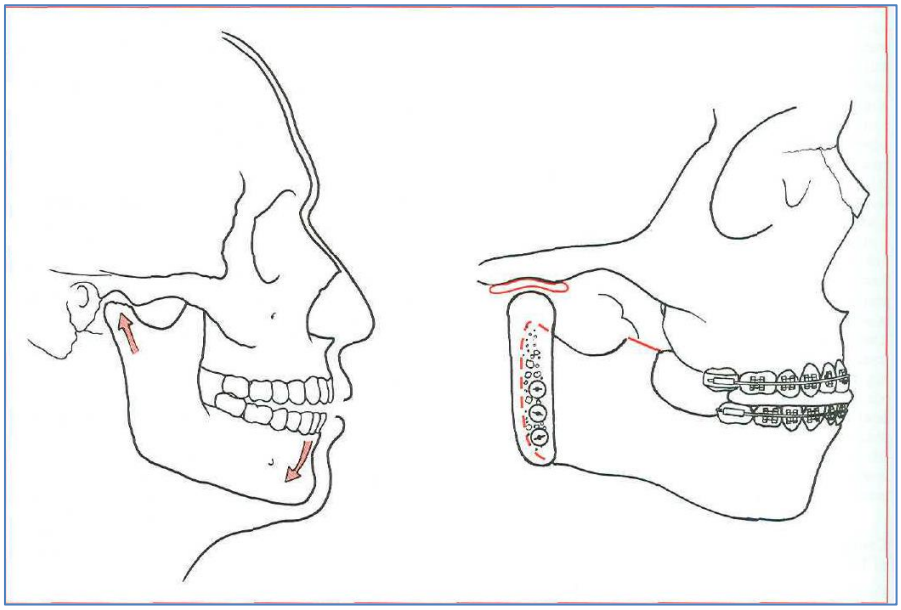


FIG- Total joint replacement. A, Severe degeneration of condyle, resulting in malocclusion, pain, and limited opening. B, Costochondral bone graft placed along posterior aspect of mandible to reconstruct severely damaged condyle. Tissue grafts or alloplastic implants can be used as disk replacement technique in combination with costochondral grafting.

Surgical approaches of TMJ:

1. Preauricular
2. Endaural
3. Postauricular.

Preprosthetic Surgery

Dr. sabah alheeti

Introduction

Following the loss of natural teeth after extraction, the bone begins to resorb. The results of this resorption is accelerated by wearing dentures and tend to affect the mandible more severely than the maxilla owing to muscle attachments and functional surface area.

Preprosthetic surgery can be defined as the surgical procedures designed to facilitate fabrication of prosthesis or to improve the prognosis of prosthodontic care.

Objectives and goals of the preprosthetic surgery

The **objective** of pre-prosthetic surgery is to create proper supporting structures for subsequent replacement of prosthetic appliance. The **goals** of pre-prosthetic surgery are to

- Provide a broad and flat ridge form with enough vertical height (minimum 5 mm), and non-undercut bony walls in both upper and lower jaws.
- Provide a firm resilient mucosal covering with nicely shaped buccal and lingual sulci, which are uninterrupted by frenae, scars or redundant tissue folds.
- Provide bone bulk for strength and protection for the neurovascular bundles in bony dehisced mandibular canals.
- Provide proper jaw relationship in the antero-posterior, transverse and vertical dimensions.
- Adequate form and tissue coverage for possible implant placement.

Patient evaluations before preprosthetic surgery

Preprosthetic surgical treatment must begin with a thorough history and physical examination of the patient. Specific attention should also be given to a possible systemic disease that may be responsible for the severe degree of bone resorption. Laboratory tests such as serum levels of calcium, phosphate, parathyroid hormones and alkaline phosphates, could be useful in pinpointing potential metabolic problems that may affect bone resorption. In addition to, examination of the supporting bone should include visual inspection, palpation (No undercuts neither bony exostosis in both jaws), radiographic examination (such as OPG or/and CBCT), and in some cases, evaluation of models. In order to reach our objective that is providing the best possible tissue contour for prosthesis support.

Residual ridge form has been described and classified by Cawood and Howell as follows:

- Class I—dentate
- Class II—postextraction
- Class III—convex ridge form, with adequate height and width of alveolar process
- Class IV—knife-edge form with adequate height but inadequate width of alveolar process
- Class V—flat-ridge form with loss of alveolar process
- Class VI—loss of basal bone that may be extensive but follows no predictable pattern

Indications for preprosthetic treatment

In general, preprosthetic surgery is indicated in those patients with developmental or acquired deformity of the jaws and craniofacial region who are unable to tolerate even a well constructed prosthesis due to unfavourable soft tissue or hard tissue environment.

Contraindications for preprosthetic treatment

- Patient's age.
- Physical and mental health status.
- Financial constraint.
- Condition of soft and hard tissues of the alveolar bone.

Hard tissue procedures

Alveoloplasty

Alveoloplasty can be defined as shaping of alveolar process **(Figure 1)**, which is indicated after almost every tooth extraction, whether it is single or multiple. A technique is essentially that the bony areas in which requiring recontouring should be exposed using an envelope type of flap. The procedure is done by creating a mucoperiosteal incision along the crest of the ridge with adequate extension anteroposterior to the area to be exposed; the re-contouring can be accomplished with a rongeur, a bone file, or a bone bur in a hand piece that can be used alone or in combination. In any case normal saline cooling irrigation should be used throughout the procedure to avoid overheating and bone necrosis. After that the flap should be re-approximated by digital pressure and the ridge palpated to ensure that all irregularities have been removed.

Maxillary tuberosity reduction

Indicated in case of reduced inter-arch distance. Also, to reduce bilateral undercuts in tuberosity. There can be vertical or lateral excess of the maxillary tuberosity. Vertical excess interferes with proper orientation of occlusal plane and teeth setting. The lateral excess limits the thickness of the buccal flange of denture between itself and the coronoid process and also cause problems in path of insertion. Examination of mounted diagnostic cast is mandatory to assess the amount of removal. Careful radiographic evaluation should be done to rule out any chance of sinus perforation.

The reduction is initiated with an elliptical incision and reflection of mucoperiosteum to expose the tuberosity. Bone is removed with rongeurs or burs then smooth the area with bone file and irrigate with copious amount of saline. The wound is closed primarily **(Figure 2)**.

Prominent mylohyoid ridge reduction

Resorption in ridge height of posterior mandible makes the mylohyoid ridge prominent and limits the extension of the denture in this area. This is a common area of painful denture irritation. At times, the tonicity of the mylohyoid ridge itself can cause problems with denture retention. The mylohyoid ridge should be reduced whenever the ridge is found to be at the same level as or a higher level than the alveolar process. The procedure is done by anaesthetizing the inferior alveolar, buccal and lingual nerves, after that linear incision is made over the crest of the ridge in the posterior aspect of the mandible. Extension of the incision too far to the lingual aspect should be avoided because this may cause potential trauma to the lingual nerve **(Figure 3)**. A full-thickness mucoperiosteal flap is reflected which exposed the mylohyoid ridge area and the attached muscle. This attachment is removed from the ridge by incising the muscle attachment at its bony origin. When the muscle is released and the underlying fat is visible in the surgical field then a rotary instrument or bone file can be used to remove the sharp prominence of the mylohyoid ridge.

Genial tubercle reduction (Figure 4)

As the mandible begins to undergo resorption, the area of the attachment of the genioglossus muscle in the anterior portion of the mandible may become increasingly prominent, which require reduction to construct the prosthesis properly. Bilateral lingual nerve blocks should provide adequate anesthesia to carry out the surgical procedure if required. Crestal incision from the midbody of the mandible to the midline bilaterally is necessary for proper exposure. A subperiosteal dissection exposes the tubercle and its adjacent muscle attachment. Sharp excision of the muscle from its bony attachment may be performed with electrocautery, with careful attention to hemostasis. About ½ of genioglossus attachment should remain intact to ensure proper tongue function.

A subsequent hematoma in the floor of the mouth may lead to airway embarrassment and life-threatening consequences if left unchecked. Once the muscle is detached, the bony tubercle may then be relieved using rotary instrumentation or a rongeur

Buccal exostoses

These are usually encountered on the buccal side of the upper ridge (**Figure 5)**. They interfere with proper adaptation of the flanges and border seal. They also impede with proper flange contouring and teeth setting. They are managed by surgical reduction; however this procedure may result in a narrowed crest in the alveolar ridge area with a less desirable area of support for the denture, and an area that may rapidly resorb.

Torus palatinus (palatal torus)

This is a benign, slowly growing, bony projection of the palatine processes of the maxillae and occasionally of the horizontal plates of the palatine bones **(Figure 6)**. Their etiology is unknown. Heredity, superficial trauma, malocclusion, and functional response to mastication have been suggested as possible etiological factors.

linear midline incision with posterior and anterior vertical releases (double Y-incision) or a U-shaped incision in the palate followed by a subperiosteal dissection is used to expose the defect. The treatment of choice is sectioning the torus with fissure bur. Once sectioned into several pieces, the torus is easily removed with an osteotome. Closure is performed with a resorbable suture and surgical stent (made from dental models with the defect removed) in combination with a tissue conditioner helps to eliminate resulting dead space, increase patient comfort, and facilitate healing in cases in which communication occurs with the nasal floor.

Torus mandibularis (mandibular torus)

This is an exostosis that usually occurs bilaterally on the medial surface of the body and alveolar process of the mandible **(Figure 7)**. They are generally located in the canine-premolar region but are also found as multiple bony nodules extending from the incisor to the molar region. The etiology of mandibular tori is unknown, but they are thought by some to be a functional reaction to masticatory stresses. Mandibular tori are composed of dense cortical bone with minimal amounts of a medullary core. The overlying mucoperiosteum is very thin, as it is on the entire medial surface of the mandible. Laceration or traumatic ulceration of the mucosa is not uncommon. Mandibular tori are removed in the following situations (1) when they become so large that they cause speech impairment or difficulty in eating, (2) when the covering mucosa ulcerates as a result of trauma and fails to heal, and (3) to facilitate the construction of removable partial and complete dentures.

Soft tissue procedures

Hypermobile ridge

Excessive hypermobile tissue without inflammation on the alveolar ridge is generally the cause of resorption of the underlying bone and/or ill-fitting denture (**Figure 8)**. If the bone deficiency is the primary cause of soft tissue excess, then augmentation of the underlying bone is the treatment of choice. However, if the height of alveolar bone is adequate then excision of hypermobile tissue is indicated.

Usually infiltrative local anesthesia can be performed in selected areas. Sharp excision parallel to the defect in a supraperiosteal fashion allows for removal of mobile tissue to an acceptable level. Closure with resorbable suture then placing stent or denture to allow for adequate soft tissue remodeling.

Inflammatory fibrous hyperplasia (epulis)

Also can be named denture fibrosis, is a generalized hyperplasic enlargement of mucosa and fibrous tissue in the alveolar ridge or vestibular area, regularly resulted from ill-fitting dentures **(Figure 9)**. The proper treatment could be done in two techniques either by (electrosurgical or laser technique) or by grasping the tissue with tissue forceps then sharp incision is made at the base of fibrous tissue down to the periosteum. The adjacent tissue is gently under mined and reapproximated using interrupted or continuous sutures.

Labial frenectomy

These frenum attachments consist of thin bands of fibrous tissue covered with mucosa extending from the lip and cheek to the alveolar periosteum. The level of frenal attachments may vary from the height of the vestibule to the alveolar ridge and even to the incisal papilla area in the anterior maxilla. Four surgical techniques options are effective in removal of frenal attachments (1) The simple (diamond) excision for narrow frenum, (2) The Z-plasty, (3) V-Y advancement technique, (4) Vestibuloplasty is often indicated for frenum attachments with a wide base **(Figure 10).**

An elliptic incision around the proposed frenum is completed in a supraperiosteal fashion. Sharp dissection of the frenum using curved scissors removes mucosa and underlying connective tissue leading to a broad base of periosteum attached to the underlying bone. closure can proceed with resorbable sutures in an interrupted fashion and should encounter the periosteum, especially at the depth of the vestibule to maintain alveolar ridge height

Lingual frenectomy

An abnormal frenal attachment usually consists of mucosa, dense fibrous connective tissue. This attachment binds the tip of the tongue to the posterior surface of the mandibular alveolar ridge. Surgical release of the lingual frenum requires incising the attachment of the fibrous connective tissue at the base of the tongue in a transverse fashion followed by closure in a linear direction which completely releases the anterior portion of the tongue **(Figure 11)**. As a tongue function test, the patient should be able to touch the upper lip with the tip of the tongue without dislodging the lower denture. Otherwise, frenectomy is indicated.

Careful attention must be given to Wharton's ducts and superficial blood vessels in the floor of the mouth and ventral tongue

Ridge extension procedures

Vestibuloplasty is the surgical procedure designed to restore alveolar ridge heights by lowering muscle attachment on the buccal, labial, and lingual aspects of the residual ridges.
The primary indications for the procedure include

- adequate anterior mandibular height (at least 15 mm)
- inadequate facial vestibular depth from mucosal and muscular attachments in the anterior mandible, and the presence of an adequate vestibular depth on the lingual aspect of the mandible.

The disadvantages of this procedure include

- unpredictable amount of relapse of the vestibular depth
- scarring in the depth of the vestibule and problems with adaptation of the peripheral flange area of the denture to the depth of the vestibule.

Types of Ridge extension procedures:

1. ***Submucous Vestibuloplasty*** : In 1959 Obwegeser described the submucous vestibuloplasty to extend fixed alveolar ridge tissue in the maxilla (**figure 12**). Postsurgical stent or denture rigidly screwed to the palate is necessary to maintain the new position of the soft tissue attachments.

2. *Maxillary Vestibuloplasty:* When a submucous vestibuloplasty is contraindicated, mucosa pedicled from the upper lip may be repositioned at the depth of the vestibule in a supraperiosteal fashion. The exposed periosteum can then be left to epithelialize secondarily. Split-thickness skin grafts may be used to help shorten the healing period.

3. *Mandibular Vestibuloplasty and Floor-of-Mouth Lowering Procedures:*

Include Kazanjian flap vestibuloplasty (figure 13), Transpositional flap (lip-switch) Vestibuloplasty (figure 14) and Floor-of-mouth lowering (figure 15).
In Kazanjian flap vestibuloplasty : an incision in the lower lip and submucosa undermining to the alveolus is followed by a supraperiosteal dissection to the depth of the vestibule.
The mucosal flap is then sutured to the depth of the vestibule and stabilized with a stent or denture. The labial denuded tissue is allowed to epithelialize secondarily.
In the transpositional vestibuloplasty, the periosteum is incised at the crest of the alveolus and transposed and sutured to the denuded labial submucosa. The elevated mucosal flap is then positioned over the exposed bone and sutured to the depth of the vestibule.

Hard Tissue Augmentation

Maxillary Augmentation

When severe resorption results in severely atrophic ridges (Cawood and Howell Classes IV–VI), some form of augmentation is indicated. Onlay, interpositional, or inlay grafting are the procedures of choice to reestablish acceptable maxillary dimensions.

I. **Ridge Split Osteoplasty** Ridge-splitting procedures geared toward expanding the knife-edged alveolus in a buccolingual direction (figure 16).
II. **Onlay Grafts:** When clinical loss of the alveolar ridge and palatal vault occur (Cawood and Howell Class V), vertical onlay augmentation of the maxilla is indicated. The crest of the alveolus is exposed and grafts are secured with 1.5 to 2.0 mm screws (figure 17).
III. **Interpositional Grafts:** indicated of severe alveolar atrophy (Cawood and Howell Class VI). This method involves a Le Fort I osteotomy (figure 18).
IV. **Sinus Lifts and Inlay Bone Grafts** Sinus lift procedures and inlay bone grafting play a valuable role in the subsequent implant restoration of a maxilla that has atrophied

posteriorly and is unable to accommodate implant placement owing to the proximity of the maxillary sinus to the alveolar crest(figure 19).

V. ***Alveolar Distraction Osteogenesis:***

Mandibular ridge augmentation

I. **Superior border augmentation:** This procedure is indicated when mental foramen is situated in the superior border. In this procedure, autogenous bone graft is used. The rib graft can be fixed to the superior border of the mandible.

II. **Inferior border augmentation:** Cadaveric tray filled with autogenous bone is rigidly fixed to the inferior border of atrophic mandible with autogenous cancellous bone sandwiched between native and cadaveric bone (figure 20).

III. **Pedicled and Interpositional Grafts:** based on the maintenance of the lingual periosteum.The lingual periosteum maintains ridge form and its presence results in minimal resorption of the transpositioned basilar bone (figure 21, *Visor osteotomy (pedicled graft) and Sandwich osteotomy(interpositional graft)).*

IV. ***Alveolar Distraction Osteogenesis:*** is the formation of new bone between the surfaces of bone segments that are gradually separated by incremental traction. Firstly, horizontal osteotomy is done through alveolar process. Then, distraction device is secured to osteotomized segments and left for 4-7 days (**latency period**). The second phase is **distraction phase** at increment 1mm/day. The third phase (**consolidation phase**) commences when the distraction is complete.

Note: Mental nerve repositioning

In patients with gross atrophy of the mandibular alveolar process, the mental foramen may be found at or near the crest of the residual ridge. When this occurs, the mental nerve may be subjected to pressure from a denture flange. Patients with this condition often complain of a dull, burning sensation or a sudden sharp, severe pain of short duration is similar to the pain of trigeminal neuralgia. The pain may be initiated during mastication; it may also be produced by digital pressure on the mental foramen. Some patients complain of both pain and numbness in the lower lip. For many patients, these symptoms can be eliminated merely by relieving the denture to avoid pressure on the mental foramen. However, in some cases, relief of the denture flange alone is not sufficient to provide relief. In these instances, the mental foramina should be enlarged, and the neurovascular bundles surgically repositioned.

Appendix: Figures

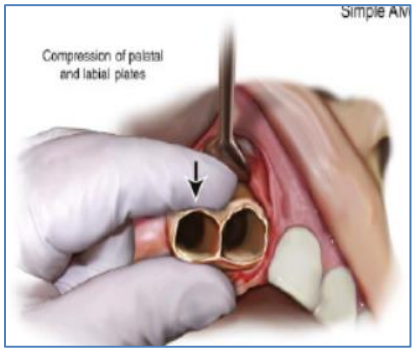


Figure 1: simple alveoloplasty

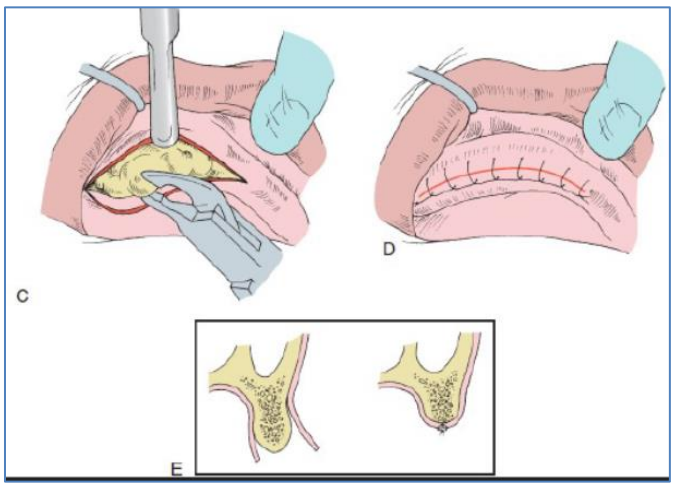


Figure 2: Maxillary tuberosity reduction

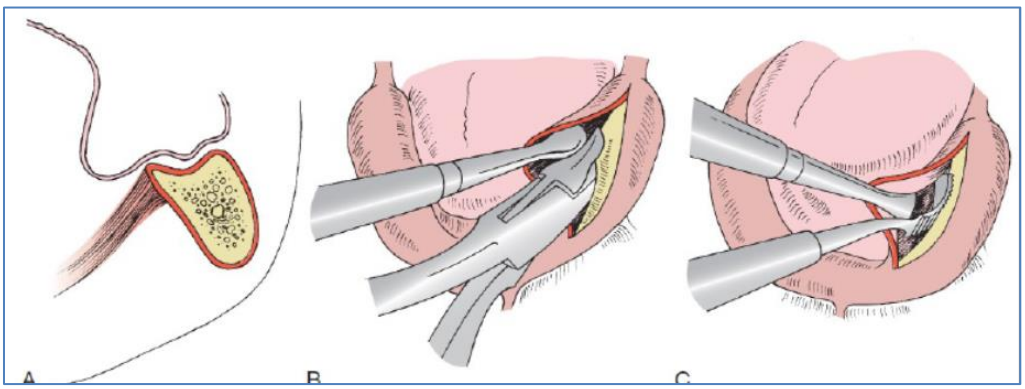


Figure 3: mylohyoid ridge reduction

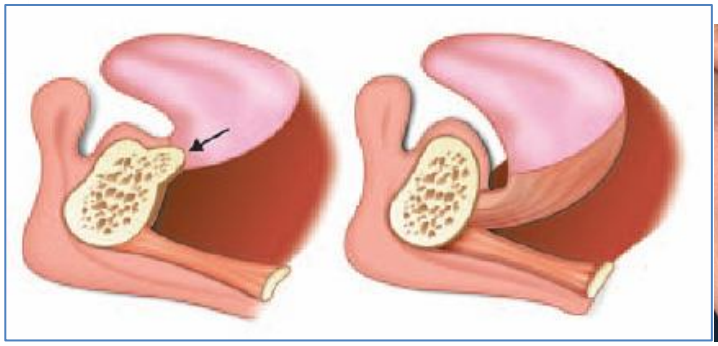


Figure 4: genial tubercle reduction

Figure 5: exostoses

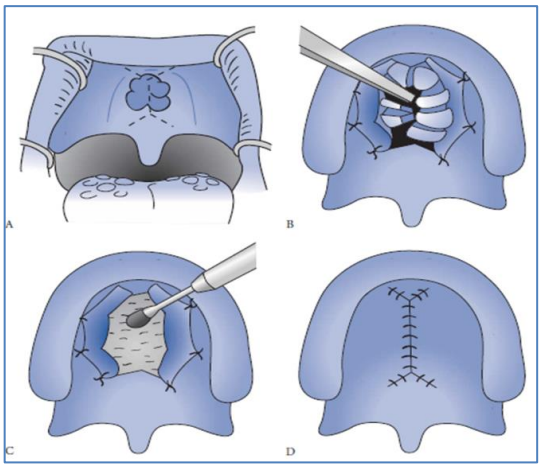


Figure 6: torus palatinus

Figure 7: torus mandibularis

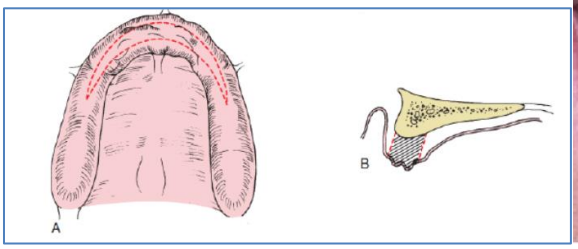


Figure 8: hypermobile tissue

Figure 9: epulis fissuratum

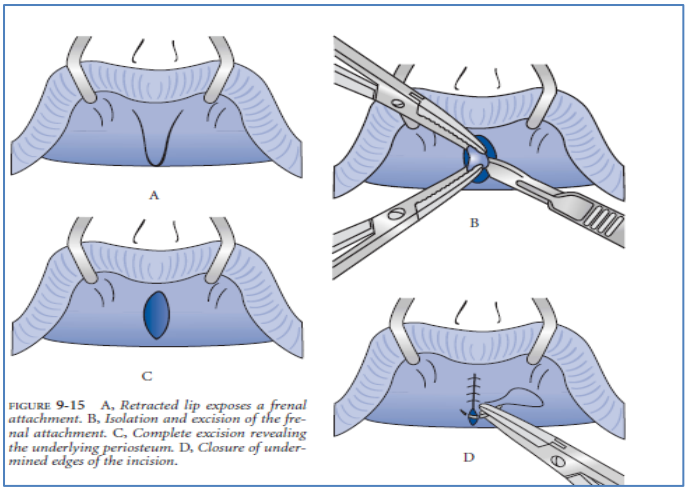


FIGURE 9-15 A, *Retracted lip exposes a frenal attachment.* B, *Isolation and excision of the frenal attachment.* C, *Complete excision revealing the underlying periosteum.* D, *Closure of undermined edges of the incision.*

Figure 10: labial frenectomy

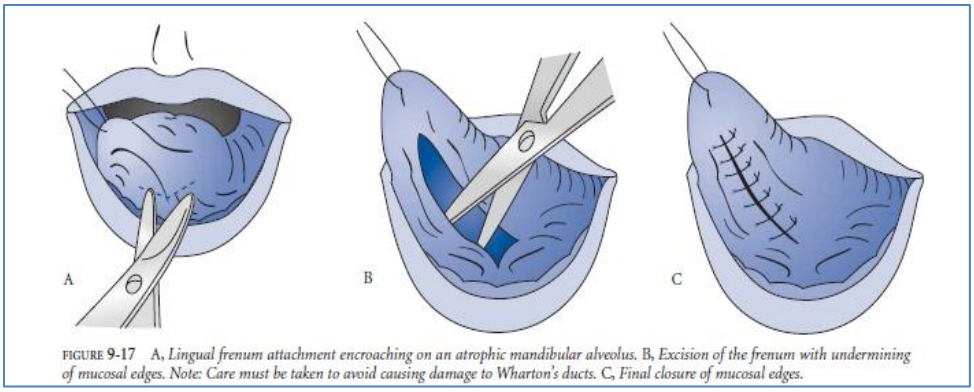
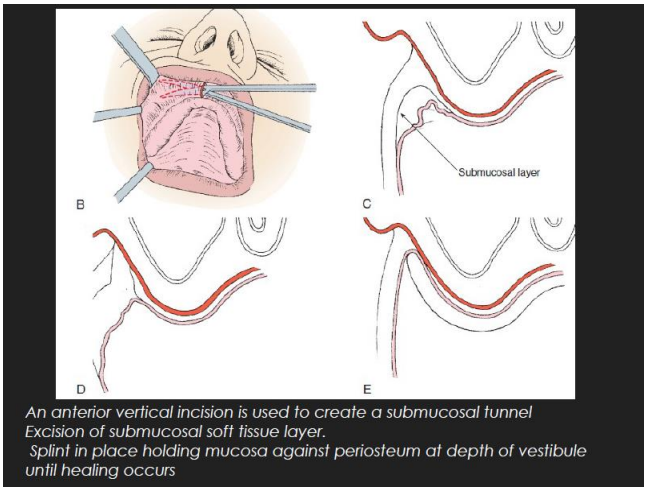


FIGURE 9-17 A, *Lingual frenum attachment encroaching on an atrophic mandibular alveolus.* B, *Excision of the frenum with undermining of mucosal edges. Note: Care must be taken to avoid causing damage to Wharton's ducts.* C, *Final closure of mucosal edges.*

Figure 11: lingual frenectomy



An anterior vertical incision is used to create a submucosal tunnel
Excision of submucosal soft tissue layer.
Splint in place holding mucosa against periosteum at depth of vestibule until healing occurs

Figure 12: submucous vestibuloplasty

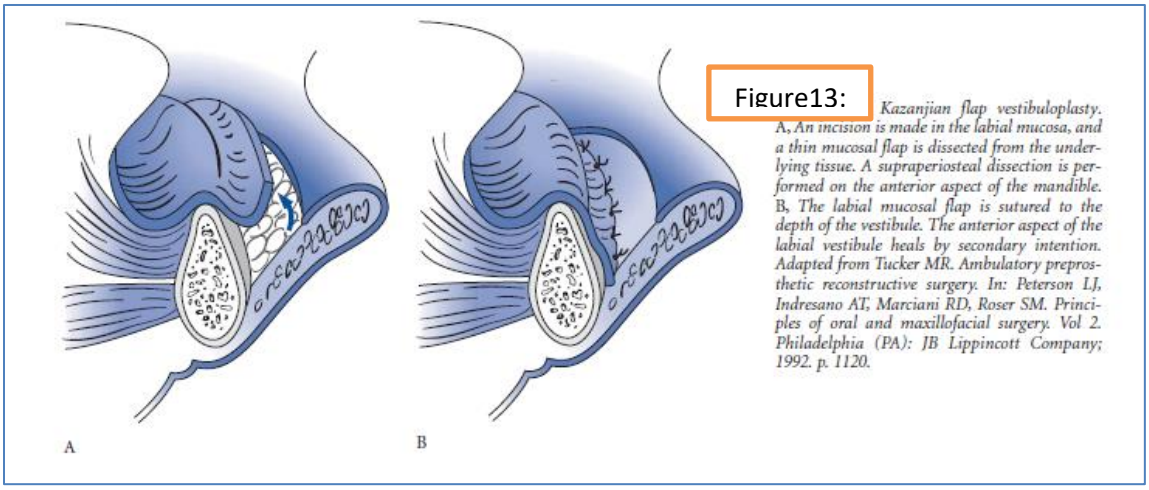


Figure13: *Kazanjian flap vestibuloplasty. A, An incision is made in the labial mucosa, and a thin mucosal flap is dissected from the underlying tissue. A supraperiosteal dissection is performed on the anterior aspect of the mandible. B, The labial mucosal flap is sutured to the depth of the vestibule. The anterior aspect of the labial vestibule heals by secondary intention. Adapted from Tucker MR. Ambulatory preprosthetic reconstructive surgery. In: Peterson LJ, Indresano AT, Marciani RD, Roser SM. Principles of oral and maxillofacial surgery. Vol 2. Philadelphia (PA): JB Lippincott Company; 1992. p. 1120.*

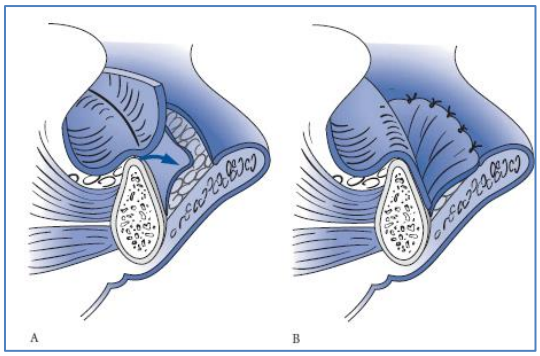


Figure 14: lip- switch

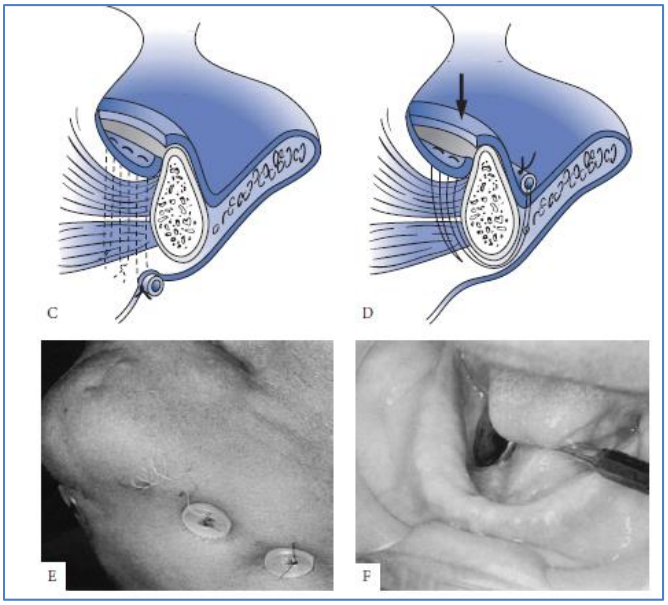


Figure 15: floor of mouth lowering

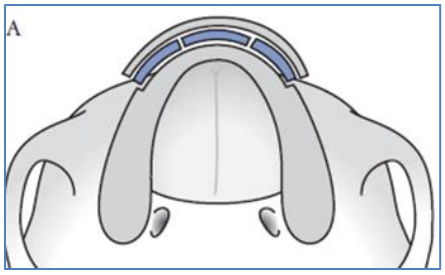


Figure 16: ridge split.

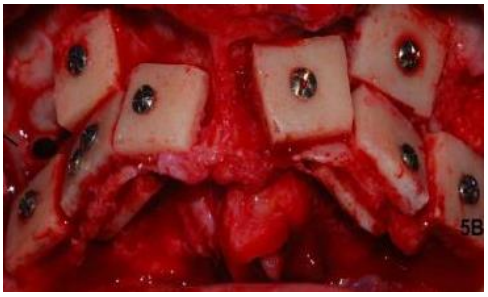


Figure 17: onlay graft

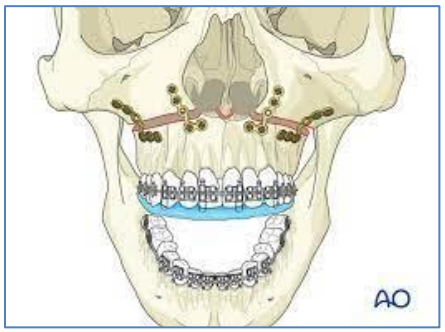


Figure 18: lefort I

Figure 19: sinus lift

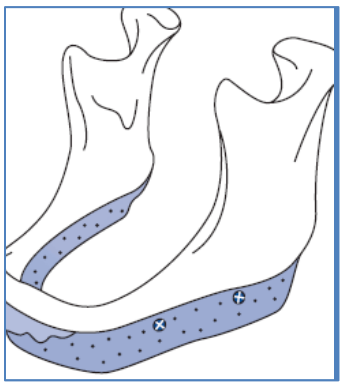


Figure 20: inferior border augmentation.

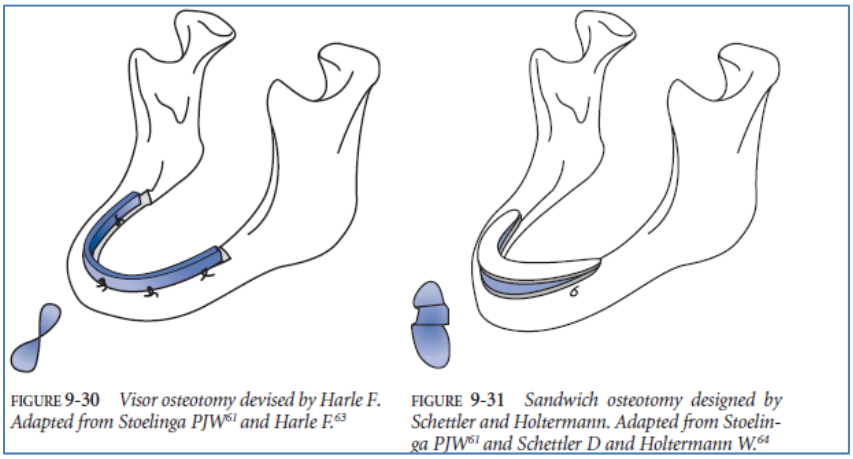


FIGURE 9-30 *Visor osteotomy devised by Harle F. Adapted from Stoelinga PJW[61] and Harle F.[63]*

FIGURE 9-31 *Sandwich osteotomy designed by Schettler and Holtermann. Adapted from Stoelinga PJW[61] and Schettler D and Holtermann W.[64]*

Figure 21: visor osteotomy, sandwich osteotomy.

Principles of reconstruction

Dr.Sabah Alheeti

Defects of the facial bones, especially the jaws, have a variety of causes, such as eradication of pathologic conditions, trauma, infections, and congenital deformities. The size of the defects that are commonly reconstructed in the oral and maxillofacial region varies considerably from small alveolar clefts to mandibulectomy defects.

The reconstructive ladder: This graduated range of reconstructive choices includes

- Healing by secondary intention, primary closure, delayed closure.
- skin graft
- tissue expansion
- flap
- free tissue transfer .

Goals of Reconstruction

- Restoration of function
- Restoration of cervicofacial symmetry and form
- Creation of barriers between cavities and spaces in the head and neck that should not communicate
- Facial reanimation
- Dental rehabilitation
- Return of sensation

Biologic Basis of Bone Reconstruction

The graft can be defined as tissue taken from one site and transplanted to another site on the body, or from another person, without bringing its own blood supply with it.

The healing of bone and bone grafts is unique among connective tissues because new bone formation arises from tissue regeneration rather than from simple tissue repair with scar formation.

Two-Phase Theory of Osteogenesis

Two basic processes occur on transplanting bone (graft) from one area to another in the same individual .

1) The first process that leads to bone regeneration arises initially from transplanted cells in the graft that proliferate and form new osteoid. Obviously, when the graft is first removed from the body, the blood supply has been severed. Thus, the cells in the bone graft depend on diffusion of nutrients from the surrounding graft bed (i.e., the area where the graft is placed) for survival. A considerable amount of cell death occurs during the grafting

procedure. Still, this phase is responsible for the formation of most of the new bone. The more viable cells that can be successfully transplanted with the graft, the more bone that will form .

2) **Second phase of bone regeneration** beginning in the second week. Intense angiogenesis and fibroblastic proliferation from the graft bed begin after grafting, and osteogenesis from host connective tissues soon begins. Fibroblasts and other mesenchymal cells differentiate into osteoblasts and begin to lay down new bone. Evidence shows that a protein (or proteins) found in the bone induce these reactions in the surrounding soft tissues of the graft bed. This second phase is also responsible for the orderly incorporation of the graft into the host bed with continued resorption, replacement, and remodeling.

Immune Response

Two basic approaches are used clinically to prevent graft rejection :

- Suppression of the host individual's immune response. Immunosuppression with various medications is most commonly used in organ transplant patients. This approach is not used routinely in oral and maxillofacial surgical bone grafting procedures because of the potential complications from immunosuppression.

- Another approach that has been used extensively in oral and maxillofacial surgical procedures is the alteration of the antigenicity of the graft so that the host's immune response will not be stimulated. The methods of treating grafts including boiling, deproteinization, use of thimerosal (Merthiolate), freezing, freeze-drying, irradiation, and dry heating. All of these methods, potentially helpful for use in bone grafts, are obviously not helpful in organ transplants.

Osteoinduction, Osteoconduction and Osteogenesis

Osteoinduction: refers to new bone formation from the differentiation of osteoprogenitor cells, derived from primitive mesenchymal cells, into secretory osteoblasts. This differentiation is under the influence of bone inductive proteins or bone morphogenic proteins (agents from bone matrix). Osteoinduction implies that the pluripotential precursor cells of the host will be stimulated or induced to differentiate into osteoblasts by transplanted growth factors and cytokines.

Osteoconduction: is the formation of new bone from host-derived or transplanted osteoprogenitor cells along a biologic or alloplastic framework, such as along the fibrin clot in tooth extraction or along a hydroxyapatite block. Osteoconductive grafts provide only a passive framework or scaffolding. These grafts are biochemically inert in their effect upon the host. The grafted material therefore does not have the ability to actually produce bone. This

type of graft simply conducts bone-forming cells from the host bed into and around the scaffolding.

Osteogenesis: is the formation of bone from osteoprogenitor cells. Spontaneous osteogenesis is the formation of new bone from osteoprogenitor cells in the wound. Transplanted osteogenesis is the formation of new bone from osteoprogenitor cells placed into the wound from a distant site.

Osteogeneic grafts include the advantages of osteoinductive and osteoconductive grafts in addition to the advantage of transplanting fully differentiated osteocompetent cells that will immediately produce new bone. Autogenous bone is the only graft that possesses all these criteria

Types of Grafts

- Autograft Graft taken from the same host
- Allograft Graft taken from a genetically similar donor, as in cadaveric graft
- Xenograft Graft taken from a genetically dissimilar donor, most commonly bovine or porcine source
- Synthetic graft: Graft not taken from a living donor. No cellular or protein products in this graft

Autograft (Autologous or autogenous bone graft)

- is considered the “gold standard” for grafting, as it possesses all the necessary features of an ideal graft.
- It is osteoinductive and osteogenic, as well as osteoconductive.
- Several forms: Block, Particulate marrow and cancellous bone grafts.
- Types according to vascularity:
    1. Nonvascularized autograft: the graft is detached completely from its own blood supply.
    2. Vascularized autograft: the graft is maintaining the blood supply and this type can be pedicled graft such as clavicle transferred to the mandible, pedicled to the sternocleidomastoid muscle, or free graft in which bone grafting with vascular anastomosis at recipient area using microsurgical techniques such as transfer of fibula for reconstruction of mandible where the artery and vein of soft tissue which cover the fibula is anastomosed (reconnected) with blood vessels of head or neck .

When both artery and vein are anastomosed during transplantation, approximately 90% of the osteocytes survive and there is no osteoclastic resorption of the bone for incorporation.

- Site of harvesting: Ilium, rib, skull calvarium, mandibular symphysis and ramus.

- The advantages: provides osteogenic cells for phase I bone formation, and no immunologic response occurs.
- A disadvantage: necessitates another site of operation for procurement of the graft.

Allogeneic Grafts (allografts or homografts)

- Allogeneic grafts are grafts taken from another individual of the same species .
- The most commonly used allogeneic bone is freeze-dried .
- Allogeneic bone grafts cannot participate in phase 1 osteogenesis. The assistance of these grafts to osteogenesis is purely passive; they offer a hard tissue matrix for phase II induction.
- The health of the graft bed is much more important than it is if autogenous bone were to be used.
- Advantages:

.1 Do not require another site of operation in the host

.2 Similar bone shape to that being replaced can be obtained (e.g., an allogeneic mandible can be used for reconstruction of a mandibulectomy defect).

- Disadvantage is that an allogeneic graft does not provide viable cells for phase I osteogenesis.

Xenogeneic Grafts (xenografts or heterografts)

- Xenogeneic grafts are taken from one species and grafted to another .
- The antigenic dissimilarity of these grafts is greater than with allogeneic bone .
- Bone grafts of this variety are rarely used in major oral and maxillofacial surgical procedures.
- Advantages are that xenografts do not require another site of operation in the host, and a large quantity of bone can be obtained.
- Disadvantages are that xenografts do not provide viable cells for phase I osteogenesis and must be rigorously treated to reduce antigenicity

Alloplasts

- Alloplasts are synthetic biocompatible bone graft materials such as calcium phosphate (hydroxyapatite derived), calcium carbonate , or bioactive glass ceramics.
- Advantages: osteoconductivity + no donor site morbidity.
- Disadvantages: incomplete graft material resorption + no osteogenesis or induction.

Q1: What is creeping substitution?

It describes the process by which a wave of osteoclasts, and subsequently a wave of osteoblasts, systematically remove nonviable bone and then replace it with viable bone.

Q2: What are osteoprogenitor cells found?

Osteoprogenitor cells are found within bone marrow, endosteum, and the cambium layer of periosteum.

Q3: What are the advantages and disadvantages of cancellous bone grafts?

Advantages: are mostly based on its rich cellular capability: (1) cancellous bone grafts provide an immediate reserve population of viable bone-forming cells as well as the population of progenitor cells that are capable of differentiating into osteoblasts;

(2) the porous microstructure of cancellous grafts allow ingrowth of endothelial buds and provides a large surface area for osteoblastic/osteoclastic activity. The result is an immediate increase in graft density and rapid graft incorporation. These qualities also make the graft more resistant to infection and sequestration if soft tissue coverage is compromised.

Disadvantages: arise from the fact that cancellous bone grafts do not possess any macroscopic structural integrity. Thus the graft can not be rigidly fixed and will deform, migrate or resorbed if placed under tension or compressive forces.

Q4: What are the advantages and disadvantages of cortical bone grafts?

Advantages: are based on its structural capability: (1) Its rigid lamellar architecture does not deform with compression or tension, allowing rigid fixation of graft and its use in weight-bearing or structural applications; (2) cortical bone also has a higher concentration of BMP, and cortical chips incorporated into cancellous bone grafts enhance osteoinductive potential of the graft.

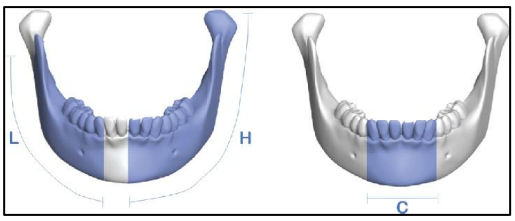
Disadvantage: (1) does not carry a large population of osteocompetent cells.

(2) lamellar bone provides little surface area for remodeling activity, so that the graft density initially decreases, and the graft weakens as osteoclasts begin a very slow process of incorporation (may take 2 months while rate of vascularization in cancellous bone graft commences within hours and complete within 2 weeks). (3) lamellar bone makes the graft more susceptabile to infection.

Mandibular Reconstruction

A. Defect Types and Localizations

Jewer and colleagues introduced the HCL system, which is often referred to in literature. They considered three main defects (H, lateral segment from midline including the condyle; C, anterior segment including the canines; L, lateral segment from midline to the ascending branch excluding the condyle) resulting in eight defect classes when combined. This approach, for example, aims to figure all possible units of defects and encompasses reconstructive aspects.



B. Stepladder of Mandibular Reconstruction

- Autologous nonvascularized bone transplants in combination with internal or external osteosynthesis :

Disadvantages: Extensive resorption, lack of engraftment of the transferred bone, and instability of the osteosynthesis material.

- Pediculated osseomyocutaneous flaps e.g. major pectoralis muscle flap in combination with a rib.

Disadvantages: high donor site morbidity and the poor outcome in terms of function and esthetics.

- Vascularized osseous free flaps: the gold standard for mandibular reconstruction .

C. Surgical Principles of Maxillofacial Bone Grafting Procedures:

1. Control of residual mandibular segments:

If the mandibular condyle has been resected or is unusable, reconstruction of the condyle with a costochondral junction of a rib or alloplastic condyle is necessary to maintain the forward position of the reconstructed mandible.

2. A good soft tissue bed for the bone graft:

All bone grafts must be covered on all sides by soft tissues to avoid contamination of the bone graft and to provide the vascularity necessary for revascularization of the graft.

3. Immobilization of the graft:
Immobilization for 8 to 12 weeks is usually necessary for adequate healing between the graft and the residual mandibular fragments

4 . Aseptic environment:
The first is to use an extraoral incision where possible. Bone grafts inserted through the mouth are exposed to the oral flora during the grafting procedure

5 .Systemic antibiosis:
The prophylactic use of antibiotics may be indicated when transplanting osseous tissue

Maxillary Reconstruction

A. Maxillary reconstructions have typically had lower success rates than comparable mandibular defects due to:

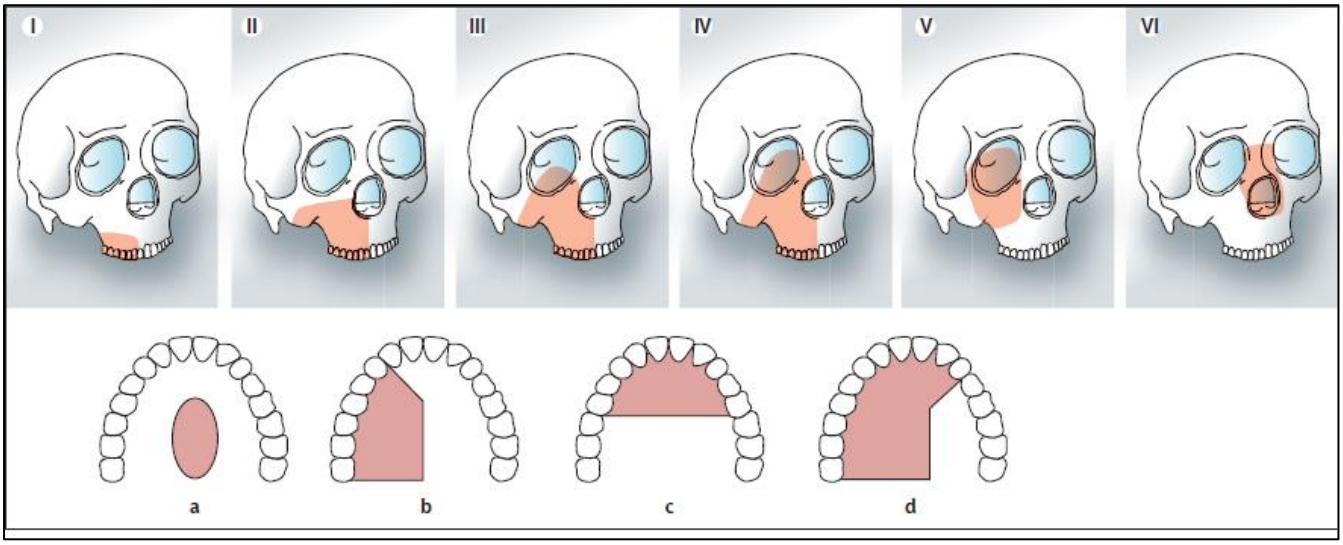
- Complex geometry
- Distance of target vessels for revascularization
- Impaired access and visibility without transfacial incisions
- Exposure to the sinus, nasal, and oral cavities

B. Defect Classification:

I. Brown classification of Maxillary Defects:

Vertical classification: I—maxillectomy not causing an oronasal fistula; II—not involving the orbit; III—involving the orbital adnexae with orbital retention; IV—with orbital enucleation or exenteration; V—orbitomaxillary defect; VI—nasomaxillary defect.

Horizontal classification: a—palatal defect only, not involving the dental alveolus; b—less than or equal to 1/2 unilateral; c—less than or equal to 1/2 bilateral or transverse anterior; d—greater than 1/2 maxillectomy.



C. Maxillary defect reconstruction:

Defect	Option of reconstruction
I	local flaps or with an obturator
IIa	local and pedicle flaps or obturator or combination
III	composite vascularized flap
IV	composite **free** tissue transfer

D. Reconstruction in pediatric patients

Wherever possible, pediatric patients should be obturated while they are growing. If a bone flap is placed, there is a risk that the flap will not grow.

E. Computerized assisted surgical planning

A stereolithographic model of the patient's skull with the proposed resection completed is an invaluable tool for flap shaping ex vivo. Fixation may also be shaped and applied to the flap using the model, greatly facilitating inset and saving significant amounts of operating room time.

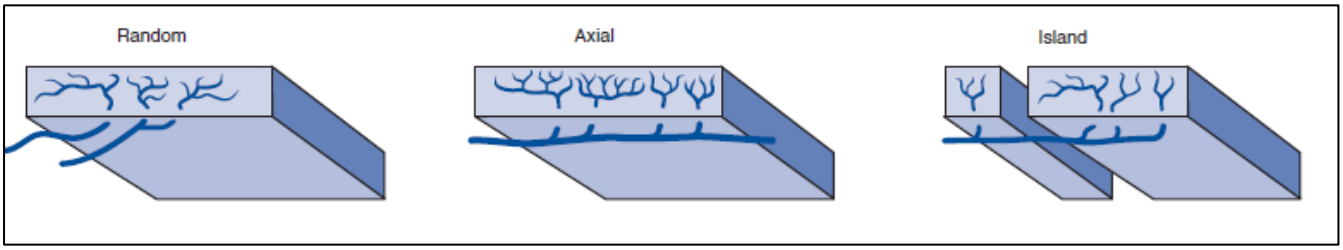
Flaps for Maxillofacial Reconstruction

Flap surgery is a technique in plastic and reconstructive surgery where any type of tissue is lifted from a donor site and moved to a recipient site with an intact blood supply.

Classification of flaps

A. According to *Blood Supply:*

1. **Axial Pattern Flap** – A single flap which has an anatomically recognized arterio-venous system running along its long axis.
2. **Random Pattern Flap** - has no named blood supply, rather, it uses the dermal (mucosal) and subdermal (submucosal) plexus as its blood supply.
3. **Pedicled flaps-** remain attached to the donor site via a pedicle that contains the blood supply (in contrast to a free flap).
4. **Free tissue transfer** refers to flaps that are harvested from a remote region and have the vascular connection reestablished at the recipient site



B. Tissue configuration: rhomboid, bilobed, z-plasty, v-y.

C. Tissue Content: cutaneous (skin and subcutaneous tissue), myocutaneous (composite of skin, muscle, and blood supply), and fasciocutanous (deep muscle fascia, skin, regional artery perforators).

D. location of the donor site. Local flaps are considered adjacent to the primary defect. Regional flap donor sites are located on different areas of the same body part. If different body parts are used as the donor site, the flap is termed a distant flap.

E. *Method of Transfer:* The most common method of classifying flaps. It includes:

I. ***Advancement flaps:*** are mobilized along a linear axis toward the defect.
II. ***Rotation flaps:*** pivot around a point at the base of the flap

III. ***Transposition flap:*** refers to one that is mobilized toward an adjacent defect over an incomplete bridge of skin. Examples of transposition flaps include rhombic flaps and bilobed flaps.

IV. ***Interposition flaps:*** differ from transposition flaps in that the incomplete bridge of adjacent skin is also elevated and mobilized. An example of an interposition flap is a Z-plasty.

V. ***Interpolated flaps:*** are those flaps that are mobilized either over or beneath a complete bridge of intact skin via a pedicle. These flaps often require a secondary surgery for pedicle division.

VI. ***Microvascular free tissue transfer:*** from a different part of the body relies on reanastomosis of the vascular pedicle

Examples of Flaps used in Maxillo-Mandibular Reconstruction

1. **Palatal Flap:**

- represents the most commonly used local reconstruction in oral and maxillofacial surgery for the closure of oro-antral fistulas following dental extractions
- **Pedicle:** palatal artery and vein.

2. Tongue Flap:

- reconstruction of local defects of the floor of the mouth as well as in palatal defects
- **pedicle:** lingual artery **(**Tongue flap can be anteriorly based or posteriorly based)

3. Buccal Fat Pad Flap:

- for small retromolar and posterior maxillary defects.
- **pedicle:** buccal and deep temporal branches of the maxillary artery, the transverse facial branch of the superficial temporal artery, and buccinator branches from the facial artery.
- the volume of the fat pad remains fairly constant and has been estimated to be approximately 10 ml.
- Provide flap with 7 and 9 cm of length.

4. Facial Artery Musculomucosal Flap:

- reconstruct the palate, nasal septum, floor of the mouth, lips, as well as the tongue and alveolus.
- **Pedicle:** facial vessels

5. Temporalis muscle flap:

- The external cheek, orbital exenteration, as well as maxillary and oral defects can be reconstructed using this flap.
- **Pedicle:** has dual blood supply (middle temporal vessel + deep temporal arteries, which arise from the second portion of the maxillary artery)

6. Submental Flap:

- ideal for reconstructing bearded areas in men
- **pedicle:** submental branch of the facial artery

7. Vascularized Iliac Crest Grafts (example on free composite flap)

- bony reconstruction of head and neck defects following resection of benign or malignant conditions of the mandible and maxilla
- **Pedicle:** deep circumflex iliac artery (DCIA), which originates from the external iliac artery
- Contraindications for this flap include a previous iliac crest bone harvest, an inguinal hernia repair or abdominal surgery affecting the harvest site, such as appendicectomy.

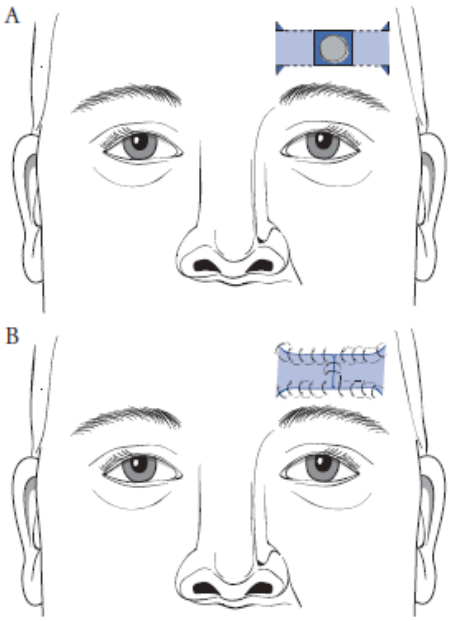


FIGURE 38-2 A, *Double advancement flaps with Burow's triangles.* B, *Closure of the defect.*

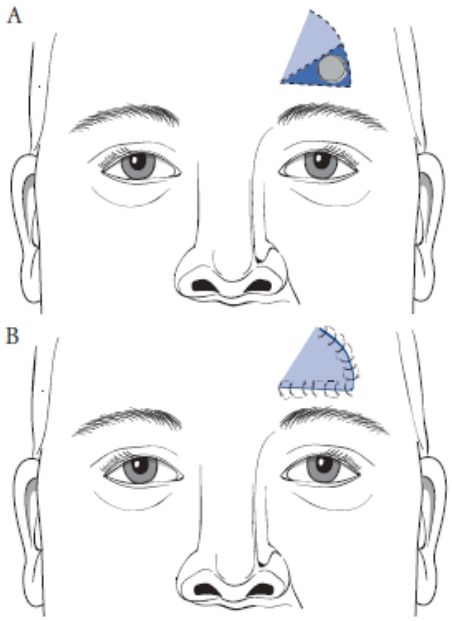


FIGURE 38-3 A, *Rotation flap for closure of a forehead defect.* B, *Closure of the defect.*

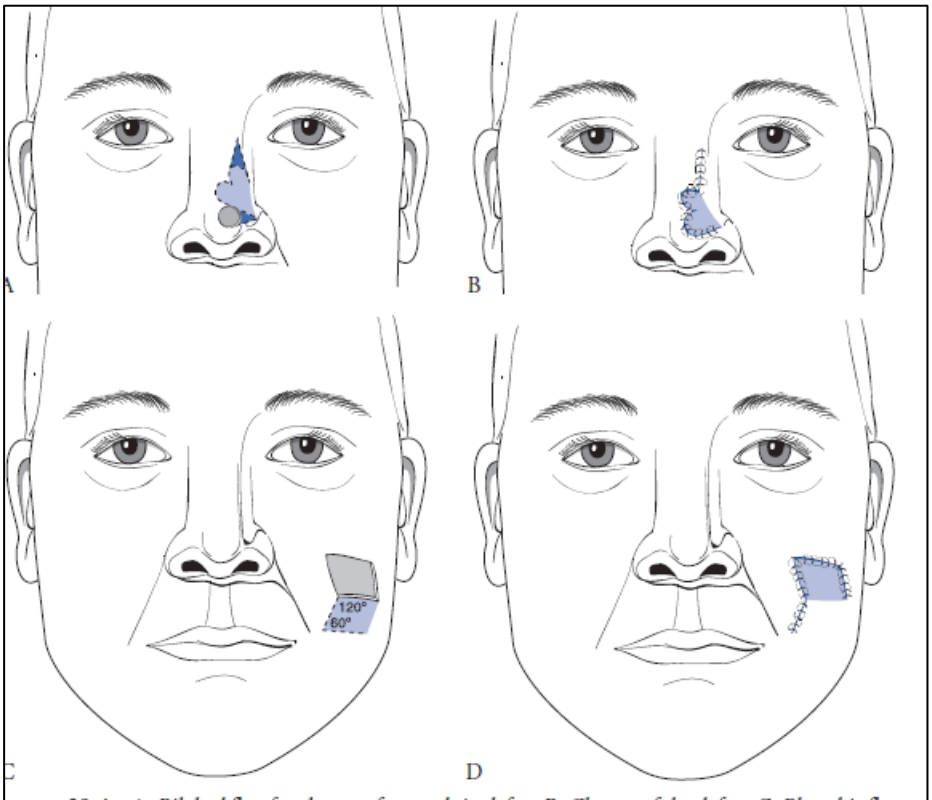


FIGURE 38-4 A, *Bilobed flap for closure of a nasal tip defect.* B, *Closure of the defect.* C, *Rhombic flap for closure of a check defect. Note the 120 and 60° angles.* D, *Closure of the defect.*

د.صباح الهيتي

Orthognathic surgery

Orthognathic surgery is surgery to treat facial disproportion or surgery for correction of dentofacial deformities. Orthognathic comes from the Greek orthos (straight) and gnathos (jaw).

Treatment objectives:

i. Function: to establish a functional occlusion aiming to achieve normal overbite/overjet and transverse relationship.
ii. Aesthetics : to normalize facial balance in three dimensions, in addition to provide stable results in the long term.
iii. Tmj dysfunction
iv. Sleep apnoea
v. Traumatic occlusion and dental health

The management protocol for facial deformity should comprise the :

- History
- Clinical examination
- Investigations
- Initial diagnosis
- Treatment planning
- Presurgical orthodontics
- Surgery
- Post- surgical orthodontics
- When appropriate, restorative dentistry, psychological support and speech therapy will be required.

History

Direct attention to the patient perceived needs as well as assess their motivation and expectation. Full medical, dental , family and social history is important to be taken.

Clinical examination

The patient is assessed sitting upright in good light with head in the natural head position and the Frankfort horizontal parallel to the floor.

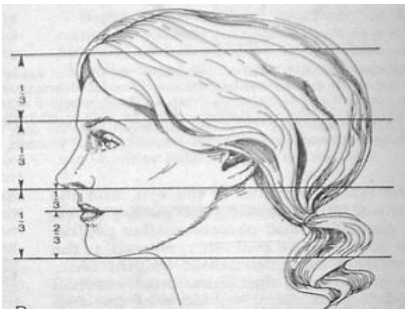
Facial evaluation: for vertical facial analysis, the face is divided into equal thirds . The upper facial third extend from hairline to the glabella. The middle third extend from glabella to the subnasale. The lower third extend from the subnasale to the soft tissue menton. Orthognathic surgery most commonly alters the lower third of the face with some influence on the middle third. Evaluation should address the frontal and lateral view.

A) Evaluation from Frontal view:

1. The height-to-width facial proportions are 1.3:1 for females and 1.35:1 for males. The bigonial width should be approximately 30% less than the bizygomatic dimension and the width and shape of the chin should form a harmonious part of the overall facial contour.
2. rule of fifths for transverse dimension.
3. The normal intercanthal distance is 32 ± 3 mm.
4. The normal interpupillary distance is 65 ± 3 mm.
5. The intercanthal distance , alar base width, and palpebral fissure should be equal.
6. The upper lip length is measured from subnasale to upper lip stomion. The normal value is 22 ± 2 for male and 20 ± 2 mm for female. During treatment planning it should be kept in mind that the upper lip length will increase with age.
7. A normal tooth to upper lip relationship exposes 2.5 ± 1.5 mm of incisal edge with the lips in repose.
8. The facial midline, nasal midline, lip midline, dental midline and chin midline should be congruent. Transversely, the occlusal plane should parallel the pupillary plane, providing there is no orbital dystopia.
9. When patient smile, the vermilion of upper lip should fall at the cervicogingival margin with no more than 1-2 mm of exposed gingiva.
10. The length of the upper lip should be one third of the length of the lower facial third.
11. The lower eyelid should be level with or slightly above the most inferior aspect of the iris. The sclera between the inferior aspect of the iris and the lower lid (sclera show) may indicate infraorbital hypoplasia or exophthalmos.

B) Evaluation from Lateral view

1. The distance from glabella to subnasale and from subnasale to soft tissue menton should be in a 1:1 ratio if the upper lip length is normal.
2. When the maxilla in the normal anteroposterior position, the ideal chin projection is 3 ± 3 mm posterior to a line through subnasale that is perpendicular to the clinical F-H plane.
3. Evaluate the cervicomandibular angle in reference to the chin position.
4. A line perpendicular to F-H plane and tangent to the globe should fall on the infraorbital soft tissues ± 2 mm.
5. Nasolabial angle : is measured between the columella of the nose and the upper lip. The angle should be 90 ± 10° and is guide to the upper lip support by the maxillary incisors. Also is influenced by decreased vertical dimension.
6. The lip-chin-throat angle: is formed between the lower border of the chin and a line connecting the lower lip, and soft tissue pogonion (110 ± 10°). Its acute in Cl. II and obtuse in Cl.III and is exacerbated by microgenia.
7. Labiomental angle: is formed by the intersection of the lower lip and the chin and is measured at soft tissue B- point. (Mean = 120 ± 10°).
8. Ricketts has projected a line from nasal tip to soft tissue pogonion, and suggested the upper lip be 4 mm and the lower 2 mm behind this line. It is very useful in planning.



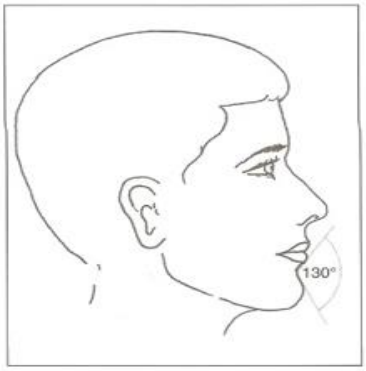


Fig 2-28 Labiomental fold.

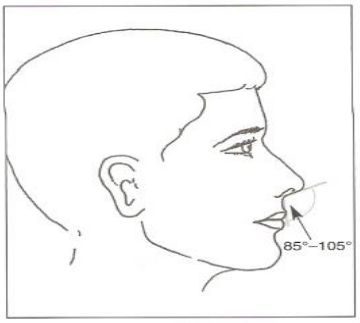


Fig 2-29 The nasolabial angle, measured between the columella of the nose and the upper lip (Sn–Ls), should be 85 to 105 degrees.

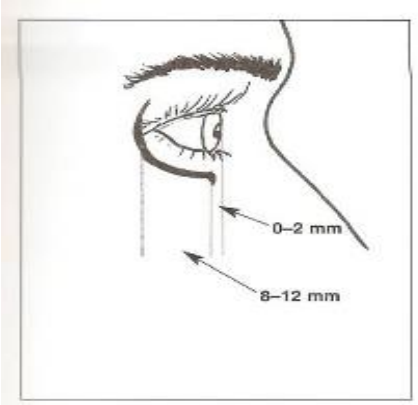


Fig 2-22 The lateral orbital rim lies 8 to 12 mm behind the globe, while the globe projects 0 to 2 mm ahead of the infra-orbital rim.

Fig 2-30 Chin-throat angle and length.

Other examination :

1- Oral examination: to identify functional and esthetic deformities of the dentoosseous and soft tissue structures.it should address : occlusal relation, overbite and overjet, crossbite, curve of Wilson and spee…….ect.
2- Periodontal evaluation
3- Temporomandibular joint examination: the TMJ provide the foundation for orthognathic surgery. Presurgical TMJ dysfunction or undiagnosed TMJ pathosis can result in unfavourable outcomes such as postoperative pain, condylar resoption and malocclusion.
4- Nose: morphology and nasolabial angle.

Investigations

Include photographs, radiographs, study model and laboratory investigations.

Radiographical evaluation

The radiographs mostly used as routine in the diagnosis of dentofacial deformities are lateral and postero- anterior cephalometric, panoramic radiograph and periapical radiograph.
Other radiographical imaging such as TMJ tomograms, CT and MRI may be required by the needs of each individual case.
Lateral cephalometric radiograph: is used to analyze skeletal, dentoalveolar and soft tissue relationship in anteroposterior and vertical dimensions. Hard tissue landmarks are as follows:

Nasion (N) : the most anterior , inferior point on the frontonasal suture in the midsagittal plane.

Sella (S): located in the centre of the sella turcica.

Orbitale (Or) : the lowest point on the inferior orbital rim.

Anterior nasal spine (ANS): anterior tip of the nasal spine.

Posterior nasal spine (PNS): the most posterior point of the hard bony palate in midsagittal plane.

Point A : the most posterior midline point in the concavity where the lower anterior edge of the anterior nasal spine meets the alveolar bone overlying the maxillary incisors.

Point B : the most posterior midline point in the concavity of the mandible between the alveolar bone overlying the lower incisors and pogonion.

Pogonion (Pog): is located at the most anterior point on the shadow of the chin.

Menton (Me): is located at the most inferior point on the shadow of the chin.

Gnathion (Gn): is located at a point on the shadow of the chin midway between pogonion and menton.

Gonion (Go): is the midpoint of the angle of the mandible found by bisecting the angle formed by the mandibular and ramus planes.

Porion (P): the most superior point of the external auditory meatus (anatomic point).

Condylion (Co): the most posterio-superior point on the head of the condyle.

The following constructed hard tissue facial planes are mostly used:

Frankfort horizontal plane (FH): extend from P- Or.

Anterior cranial base (SN): extend from S- N

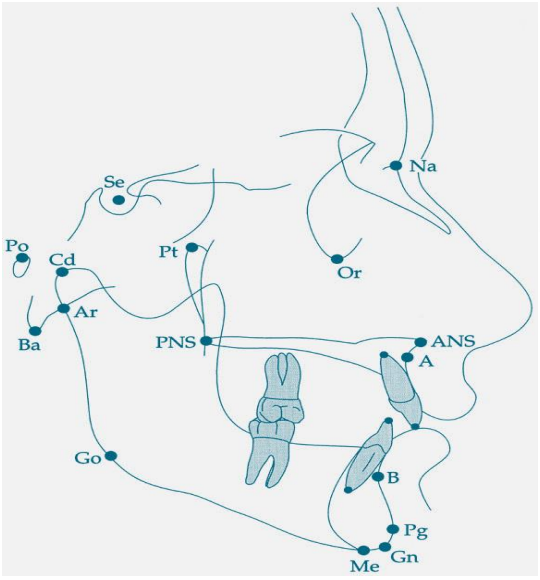
Occlusal plane (OP): formed by line drawn through the mesial cusp contact of the first molar teeth and dividing the incisor overbite.

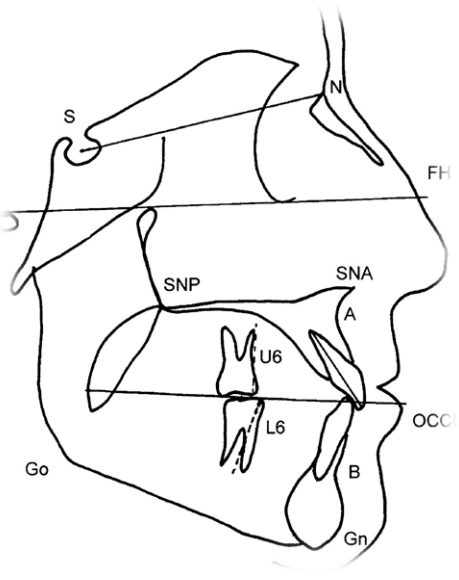
Mandibular plane (MP): extend from Go- Me.

Cephalometric analysis :

Many analyses are available for clinical decision making.

1. Maxillary depth : angular measurement formed between (FH) – (NA line). Normal value is 90 ± 3°.
2. Mandibular depth: angular measurement formed between (FH) – (NB line). Normal value is 88 ± 3°.
3. The Frankfort mandibular plane angle : is the angle created by a line from the menton through the gonion relative to (FH) plane. The normal value is 25 ± 5°.
4. SNA = 81± 3° , SNB= 78 ± 3°, ANB= 3 ± 2°.
5. Occlusal plane angle is determined from a line drawn tangent to the buccal groove of mandibular second molar through the cusp tips of premolars and the angle of this line relative to (FH) plane. Its 8 ± 4°.
6. Facial height: lower anterior facial height (maxillary plane- menton) represent 55 ± 2% of total anterior facial height (nasion- menton)





Dental model analysis (study casts)

The models allow analyzing the:

- occlusion
- shape of the dental arches
- position
- size and shape of the teeth
- position of the jaws in relation to the skull base

Usually two sets of models are used. One is kept to analyze and document the preoperative situation. The second set of models is used to perform mock surgery.

Presurgical orthodontics

The aim of presurgical orthodontic therapy are

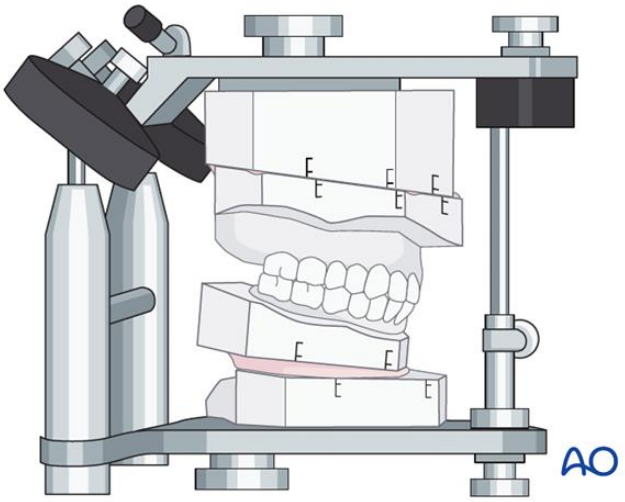
1. Alignment of dental arch (relieve of crowding, rotation and occlusal interferences)
2. Levelling of occlusal plane
3. Decompensation of incisors and buccal segment
4. Arch coordination: correct transverse arch width discrepancies.
5. Means of fixation to facilitate surgical correction

After the completion of the pre-surgical periodontics, restorative dentistry, and orthodontics, the patient returns to the oral and maxillofacial surgeon for final pre-surgical planning. The patient's facial structure and the malocclusion are reexamined. Pre-surgical digital photographs and radiographs are obtained. Pre- surgical models, a centric relation bite registration, and face-bow recording for model mounting are completed. Model surgery on a duplicated set of pre- surgical dental casts determines the exact surgical movements necessary to accomplish the desired postoperative occlusion.

Mock surgery and fabrication of splints

Based on the results of the clinical and cephalometric analysis, a problem list and treatment plan are generated. The mounted models can then be moved into the planned position for correction of the skeletal disorder. Keeping in mind that treatment of facial bone abnormalities is usually a combined endeavor for both surgeon and orthodontist, this position has to be agreed upon by both parties.

It is important that all movements become visible in a three dimensional fashion. This can be achieved using reference lines scribed on the models before performing the movements. The models are fixed in the new positions with wax or glue.

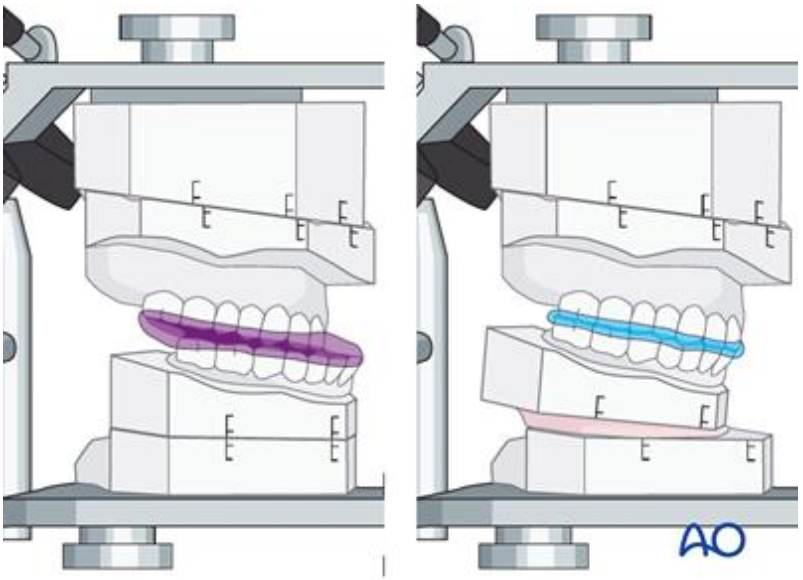


Mock surgery is performed to mimic the planned surgical procedure. It is also a powerful tool to demonstrate the treatment plan to the patient. Finally the reoriented models after mock surgery are used to fabricate the surgical splints that will be used in the operating room to reposition the osteotomized segments.

Mock surgery can also be performed using individual stereolithographic models. This is indicated for severe and mostly asymmetric deformities.

Fabrication of splints

Splints are made of acrylic and used in orthognathic surgery to intraoperatively position a mobile osteotomized jaw against the other stable jaw before an internal fixation procedure is performed. In case of two-jaw surgery two splints need to be fabricated. The first one is used after osteotomy of the first jaw as an intermediate splint, the other one after the second jaw has been osteotomized as a final splint. Usually the two splints are colour coded to avoid confusion.



Timing of orthognathic surgery: as a general rule, surgery should be delayed until growth is complete in patients who have problems in excess growth ,although surgery can be considered earlier for patients with growth deficiencies.

Surgical procedures

Mandibular procedures:

1- **Genioplasty** : is surgical procedure that can alter the position of the chin in all three planes of space (anteroposterior, vertical, transverse) . Chin position most commonly is changed by use of sliding osteotomy or addition of alloplastic implant as onlay graft.
Types of genioplasty:
I. Advancement genioplasty. II. Reduction genioplasty. III. Rotation genioplasty IV. Vertical augmentation. V. Vertical reduction. VI. Alloplastic genioplasty.

2- **Mandibular subapical procedures**: are designed to alter portions of the mandibular dental alveolus and can be divided into three types: anterior, posterior, total subapical osteotomies. Examples of their indications are leveling of occlusal plane, change of anteroposterior position of mandibular teeth.

3- **Mandibular ramus surgery** :
- **Mandibular sagittal split osteotomy** is the most common mandibular orthognathic procedure. This is originally described by trainer and obwegeser in 1957. Indications include mandibular advancement , setback and correction of mandibular asymmetries. Contraindications include severe decreased posterior body height, extreme thin medial-lateral width of ramus, severe ramus hypoplasia and severe asymmetry. Disadvantages include potential trauma of the inferior alveolar nerve.
- **Vertical oblique osteotomy** (subcondylar osteotomy): for mandibular prognathism
- **Inverted L- osteotomy:** Basically used for mandibular retrognathism correction

4- **Mandibular body surgery**: can be divided into anterior body and posterior body surgery depending on its relation to mental foramen.

Surgical technique of Mandibular sagittal split osteotomy:

Sagittal split osteotomy can be done by Intraoral incision , mucoperiosteal reflection to expose medial and anterior surface of ramus as well as buccal surface of mandibular body. Osteotomy cut is done through medial surface of ramus between sigmoid notch and lingula then extend anteriorly along external oblique ridge and continue on the lateral surface of mandible.

Splitting is done by osteotomies, two segments are separated and tooth-bearing segment is advanced or setback (according to case). Stabilization of segments by fixation plate and screws with or without intermaxillary fixation (IMF) then wound is closed.

Maxillary procedures: can be used to reposition maxilla superiorly, inferiorly, anteriorly, posteriorly and transversely and in one or more segments, depending on nature of deformity. These include:

Lefort I osteotomy : the bone cut extend from piriform rim, antrum wall to pterygoid plate area posteriorly. There are four basic designs : traditional Le Fort I osteotomy, step osteotomy, high Le Fort I osteotomy and horseshoe osteotomy.

- Segmental alveolar maxillary osteotomy: which include
  - ❖ Anterior segmental osteotomy (Wassmund procedure)
  - ❖ Posterior segmental osteotomy
  - ❖ Combined anterior and posterior osteotomy
- Le Fort II osteotomy
- Le Fort III osteotomy

Dentofacial abnormalities : frequently can be treated by isolated procedures in the mandible or maxilla and midface. Because abnormalities can involve both jaw , bimaxillary surgery is recommended.

Types of Dentofacial abnormalities

Mandibular excess (mandibular prognathism)

Excess growth of mandible frequently results in:

- Cl. III molar and cuspid relation, reverse overjet and prominence of the lower third of face, particularly in the area of the lower lip and chin in the antero-posterior and vertical dimensions.

Treatment include

- ❖ Mild case (overjet < 8 mm): Bilateral sagittal split osteotomy (BSSO) or Vertical oblique osteotomy to retrude the mandible backward.
- ❖ Severe case : BSSO to retrude the mandible + Lefort I to advance the maxilla
- ❖ When the reverse overjet relationship is isolated to the anterior dentoalveolar area of the mandible, a subapical osteotomy technique can be used for correction of mandibular dental prognathism.

Mandibular deficiency

Facial features of mandibular deficiency are retruded chin (retrogenia), excess labiomental fold with a procumbent appearance of lower lip, Cl. II molar and canine relation with increased overjet.

Treatment include BSSO to advance the mandible forward ± Le Fort I impaction of maxilla if there is no satisfactory lip-incisor relation.

If the anteroposterior position of the chin is adequate but a Class II malocclusion exists, a total subapical osteotomy may be the technique of choice for mandibular advancement.

If projection of the chin is insufficient, an inferior border osteotomy (i.e., genioplasty) with advancement may also be performed

Maxillary deficiency

Characterized by hypoplasia of paranasal with or without infraorbital rim areas, inadequate tooth exposure during smile and Cl. III malocclusion with reverse overjet. **The maxillary deficiency may occur in A-P, vertical or transverse planes.**

In the case of **anteroposterior** deficiency, The primary technique is Le Fort I osteotomy to advance the maxilla forward. If O.J. > 9 mm bimaxillary surgery is required (Le Fort I + BSSO)

In the case of **vertical deficiency**, Le Fort I with reposition of maxilla inferiorly and using bone graft to bridge the gap is recommended.

In case of **midface deficiency (infraorbital rim and malar hypoplasia)**, Le Fort III or modified Le Fort II osteotomy is necessary. These procedures advance the maxilla and malar bones. This type of treatment is commonly required in patients with craniofacial deformities such as Apert or Crouzon syndrome.

Maxillary excess

Excessive growth of maxilla may occur in the A-P, vertical or transverse dimensions. **Features of vertical maxillary excess (long face syndrome):**

- elongation of the lower third of the face; a narrow nose, particularly in the area of the alar base
- excessive incisal and gingival exposure and lip incompetence. These patients may exhibit Class l, Class II, or Class III dental malocclusions.
- Anterior open-bite (apertognathia), this results from excessive downward growth of the maxilla, causing downward rotation of the mandible as a result of premature contact of posterior teeth.
- A transverse maxillary deficiency with a posterior cross-bite relationship, constricted palate, and narrow arch form is often seen with this deformity

Treatment of vertical maxillary excess:

Lefort I to reposition the maxilla superiorly (impacted), particularly in the posterior area. This allows the mandible to rotate upward and forward, establishing contact in all areas of the dentition.

Features of anterior-posterior maxillary excess: convex facial profile usually associated with incisor protrusion and a Class II occlusal relationship

Treatment : in growing child require orthodontic therapy (headgear and multibanded fixed appliance). In non-growing patient, treatment is either by anterior maxillary segmental osteotomy (Wassmund/Wunderer) to setback canine-incisor segment after extraction of upper 1st premolars or by Le Fort I setback of entire maxilla.

DISTRACTION OSTEOGENESIS

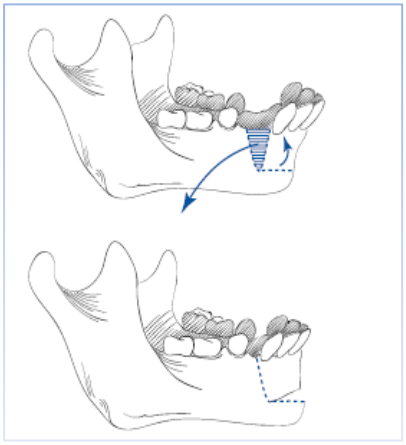
One new approach to correction of deficiencies in the mandible and the maxilla involves the use of distraction osteogenesis (DO) . When correcting deformities associated with these deficiencies, **the conventional osteotomy techniques have several potential limitations**. When large skeletal movements are required, the associated soft tissue often cannot adapt to the acute changes and stretching that result from the surgical repositioning of bony segments. This failure of tissue adaptation results in several problems, including surgical relapse, potential excessive loading of the TMJ structures, and increased severity of neurosensory loss as a result of stretching of nerves. In some cases the amount of movement is so large that the gaps created require bone grafts harvested from secondary surgical sites such as the iliac crest.

DO involves cutting an osteotomy to separate segments of bone and the application of an appliance that will facilitate the gradual and incremental separation of bone segments. The gradual tension placed on the distracting bony interface produces continuous bone formation. Additionally, the surrounding tissue appears to adapt to this gradual tension, producing adaptive changes in all surrounding tissues, including muscles and tendons, nerves, cartilage, blood vessels, and skin. Because the adaptation involves a variety of tissue types in addition to bone, this concept should also include the term **distraction histogenesis**.

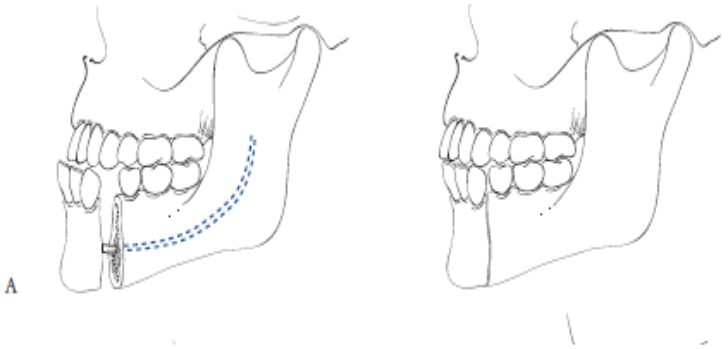
A Russian surgeon, Gavril Ilizarov, developed the current concept of correcting bony deficiencies in the 1950s. The result of his work was not widely disseminated to the rest of the world until the late 1 970s and early 1980s. Since that time, the application of these principles has extended to all forms of orthopedic correction, including craniofacial surgery.

DO involves several phases, **including the osteotomy or surgical phase, latency period, distraction phase, consolidation phase, appliance removal, and remodeling**. During the surgical phase an osteotomy is completed and the distraction appliance is secured. The **latency phase** is the period when very early stages of bone healing begin to take place at the osteotomy bony interface. The latency phase is generally 7 days during which time the appliance is not activated. After the latency period the distraction phase begins at a rate of 1 mm per day. This distraction rate is usually applied by opening or activating the appliance 0.5 mm twice each day. The amount of activation per day is termed **the rate of distraction**; the timing of appliance activation each day is termed the **rhythm**. During the distraction phase the new immature bone that forms is called the **regenerate**. Once the appropriate amount of distraction has been achieved, the appliance remains in place during the **consolidation phase**, allowing for mineralization of the regenerate bone. The appliance is then removed, and the period from the application of normal functional loads to the complete maturation of the bone is termed the **remodeling period**.

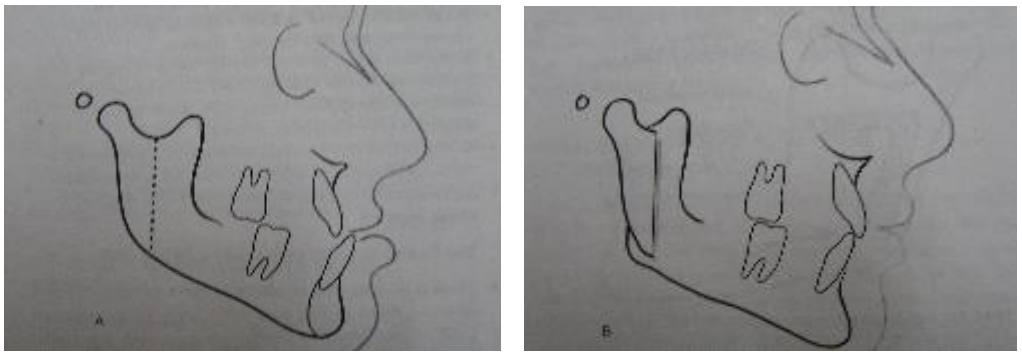
Possible advantages of DO include the ability to produce larger skeletal movements, elimination of the need for bone grafts and the associated secondary surgical site, better long-term stability, less trauma to the TMJs, and decreased neurosensory loss. **DO also has certain disadvantages**: The placement and positioning of the appliance to produce the desired vector of bone movement is technique sensitive and sometimes results in less than ideal occlusal positioning, resulting in discrepancies such as small open bites or asymmetries. Other disadvantages include the need for two procedures: (1) placement and (2) removal of the distractors, as well as increased cost and longer treatment time, with more frequent appointments with the surgeon and the orthodontist.



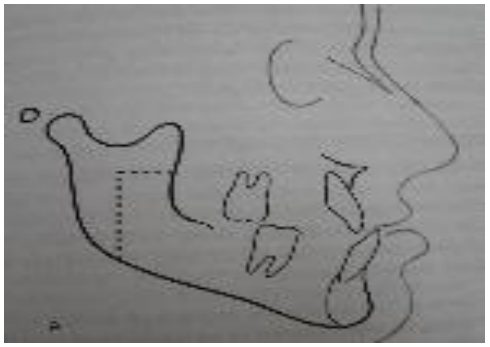
Mandibular subapical osteotomy

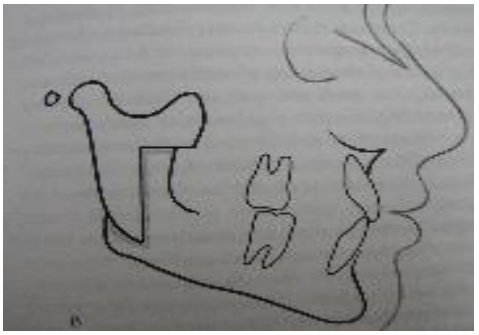


Body osteotomy

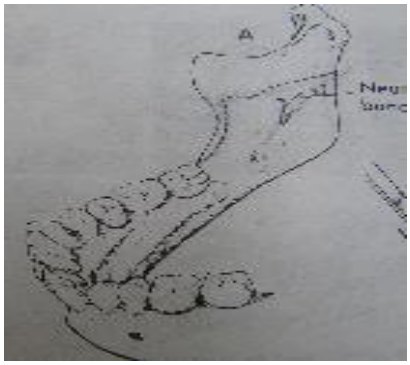


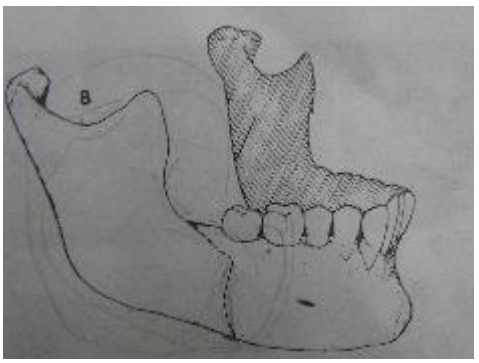
Vertical oblique osteotomy

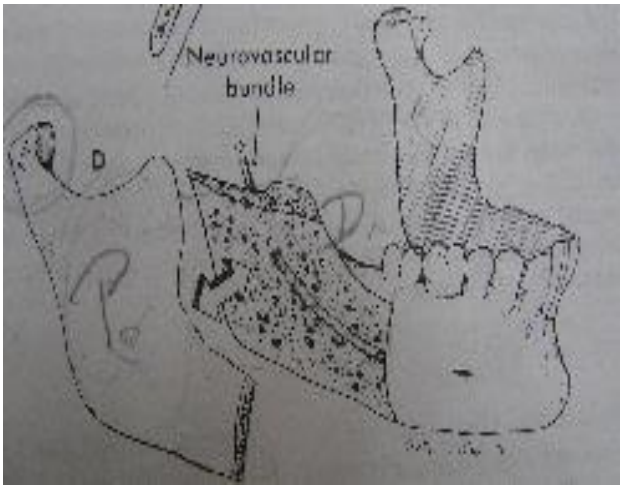


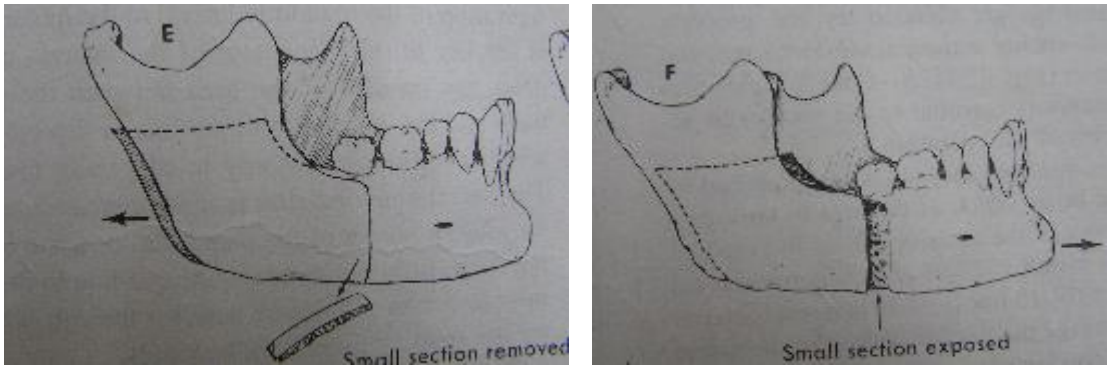


inverted L osteotomy

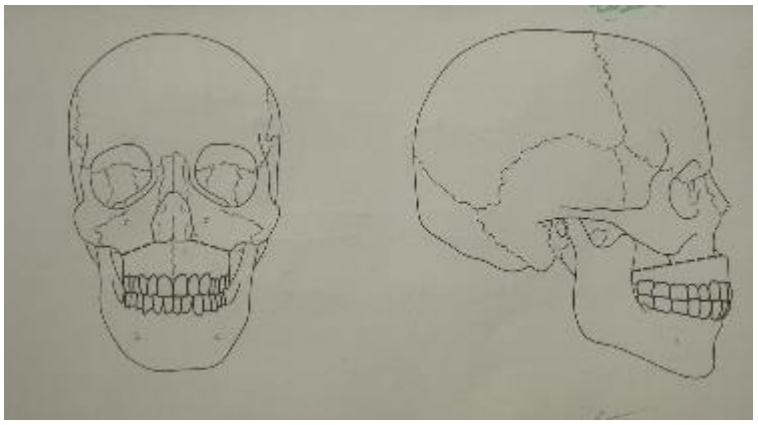




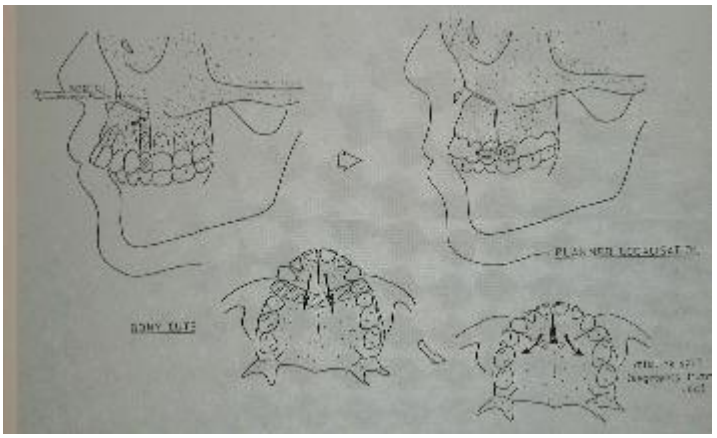




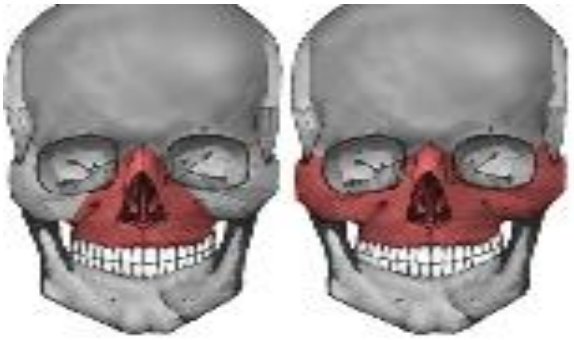
Mandibular sagittal split osteotomy



Le Fort I osteotomy



Wassmund procedure



Le Fort II, III osteotomy