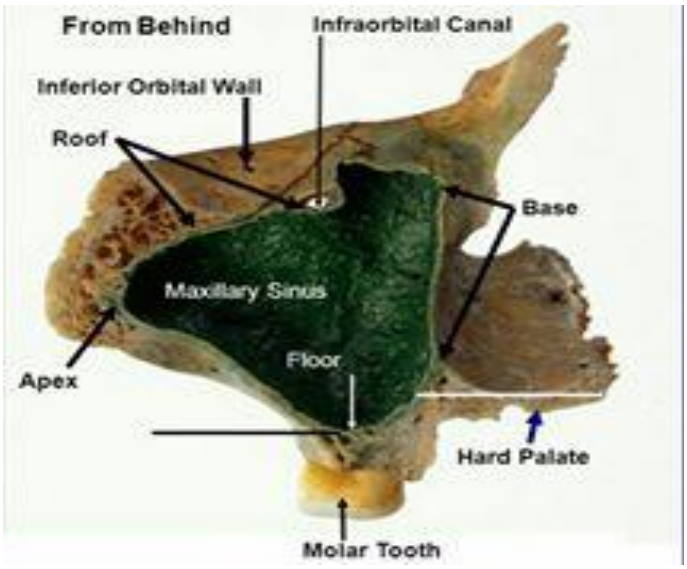
DISEASE OF MAXILLARY SINUS

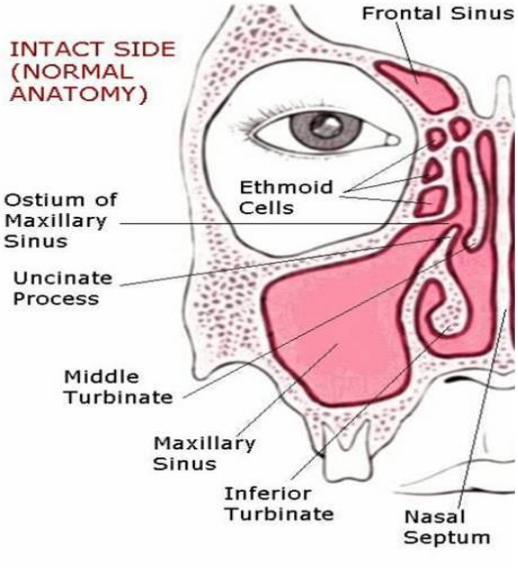
The maxillary sinus is part of para-nasal sinuses which are:

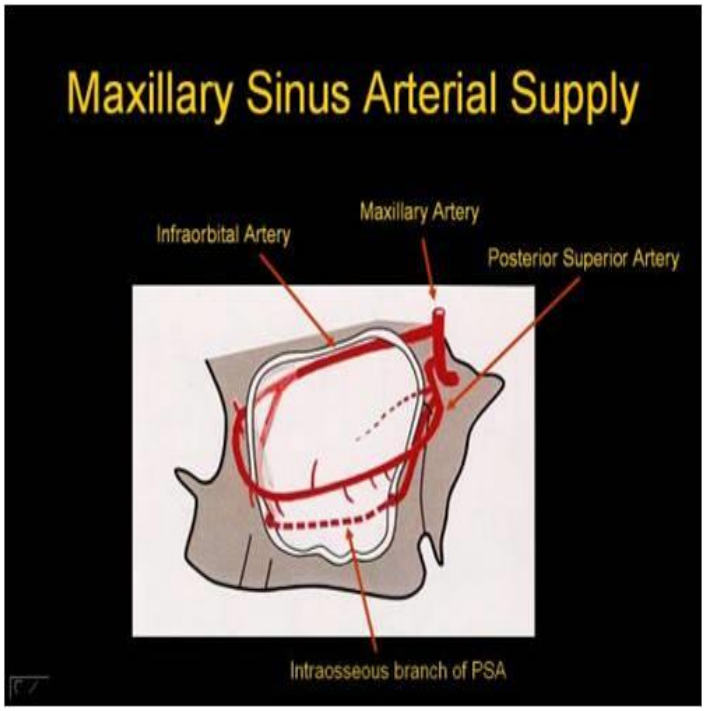
1. Frontal Sinus.
2. Ethmoid Sinus.
3. Sphenoid Sinus.
4. Maxillary sinus.

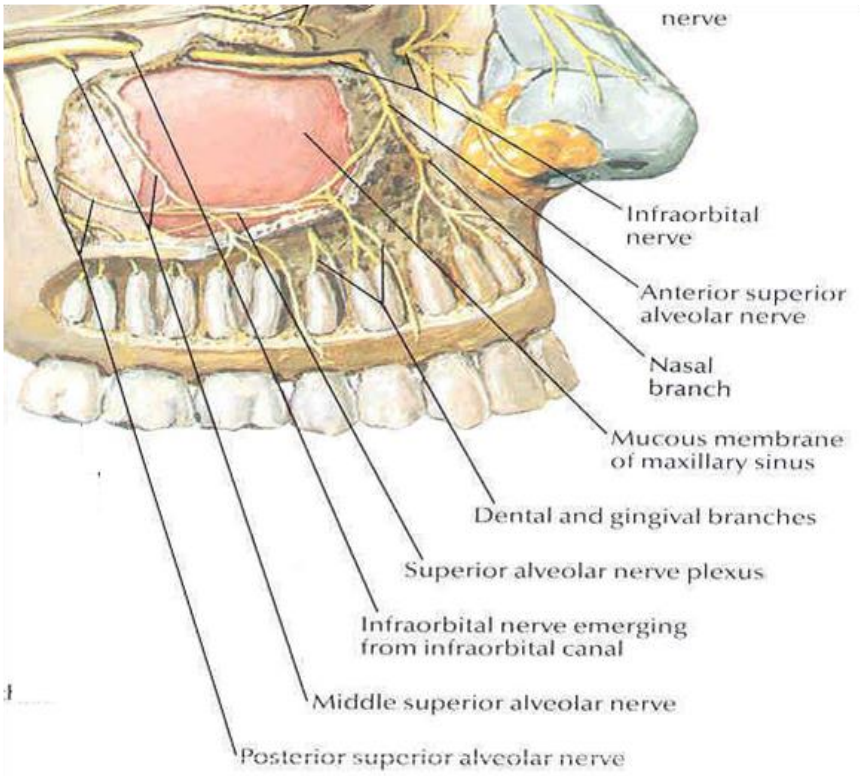
MAXILLARY SINUS

- Maxillary sinus is larger than the other sinuses & lies directly in the body of the maxilla, it called also maxillary antrum, because antrum meaning a cavity or hollow space specially found in bone.
- 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 antrum size is from 10 to 15 ml capacity, and 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, it has the infra-orbital canal, infra-orbital nerve & vessels passing through it. The floor of the sinus represent 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 lesion may 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 vary from (2-5 mm) in the roof, (5-10 mm) in the floor.
- The nerve supply to the sinus is from maxillary nerve which is the 2nd branch of trigeminal nerve, supply by posterior alveolar nerve supplying the lining of the mucous membrane. Blood supply from the infra-orbital artery, also it a branch of maxillary artery which is the terminal branch of external carotid artery, with some collateral circulation from the anterior superior alveolar artery, a branch also of the same vessel. The lymphatic drainage is to the retro-pharyngeal lymph node & to the sub mandibular lymph node.


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


INTACT SIDE
(NORMAL
ANATOMY)
Frontal Sinus
Ethmoid
Cells
Ostium of
Maxillary
Sinus
Uncinate
Process
Middle
Turbinate
Maxillary
Sinus
Inferior
Turbinate
Nasal
Septum


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



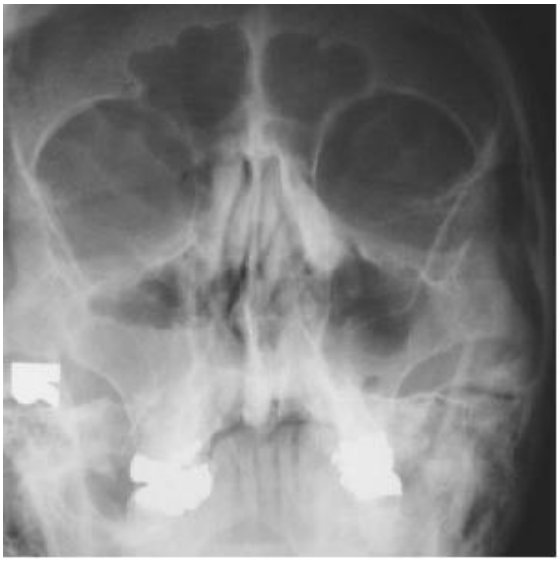
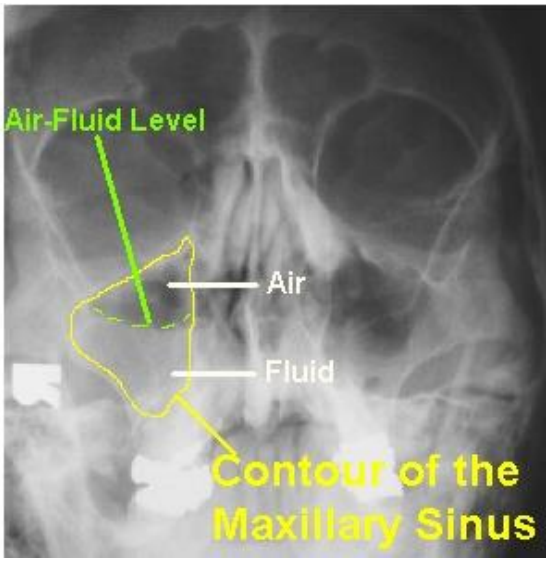
FUNCTION OF PARA-NASAL SINUSES

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.

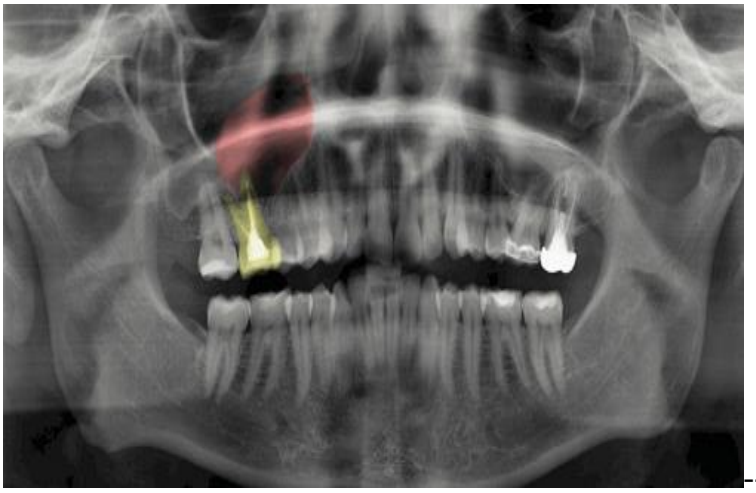
— 4. Act as shock absorbable to protect the base of the skull & brain from crushing due to trauma to the middle third of the face.

RADIOGRAPHICAL APPEARANCE

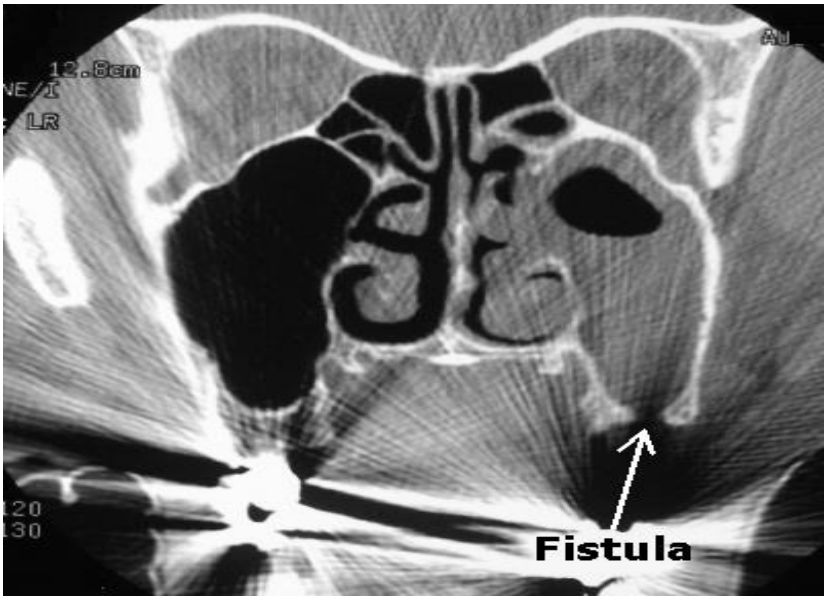
1. X-ray film best view for para-nasal sinuses is water view (occipitomental view) which demonstrate the para-nasal sinuses & fluid level in the sinus.
2. OPG (orthopantomogram).
3. CT-Scan film mainly coronal section.
4. MRI magnetic resonance image.
5. Cone -Beam CT (CBCT).

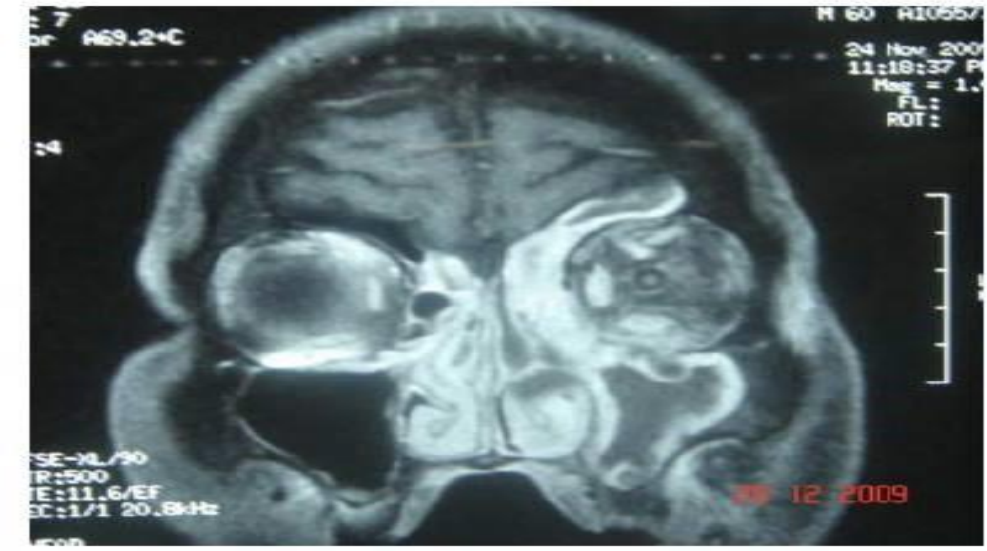
Occipito-mental view for the para-nasal sinus



---OPG shawing maxillary sinus---



CT-SCAN CORONAL SECTION



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

The first method is the most available & easy technique(OM –occipitomental view). Maxillary sinuses appear with X-ray film usually large with root ends appear directly in the floor of the antrum .

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.

A. SINUSITIS: -

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

❖ *Acute Maxillary Sinusitis: -*

The symptoms are 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 effect 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. In the type of sinusitis that which due to infected teeth the secretion has a very foul odor. General toxemia develops with the disease, producing chills, sweats, elevation of temperature, dizziness, and nausea, difficult breathing is common.

❖ *Subacute Maxillary Sinusitis:*

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:*

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 osteom to the nasal cavity 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 sinusitis treated by antibiotic. Surgical treatment "antrostomy" when its needed.

B. ORO-ANTRAL FISTULA (OAF): -

Oroantral fistula is an abnormal connection between the oral cavity and the maxillary sinus . The term OAC and OAF are used as being the same ,although they have different features ,many authors found , that 7-8 days to be the average time for an oroantral perforation to epithelialize and become a chronic fistula .

CAUSES OF ACCIDENTAL OAF: -

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 relation ship 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 during extraction 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 fused 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 a vital 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 may be create an OAF.

DIAGNOSIS OF OAF: -

If the dentist suspected that the antrum has been opened, he should attempt to confirm his suspicions by mean of (nasal blowing) 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 carry the risk of contamination of the antrum with oral micro-organism.

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

TREATMENT: -

By surgical closure. *The patient should be warned that even the most suitable operation may fail & fistula be re-established, however, to avoid failure of the surgical procedure we must do: -*

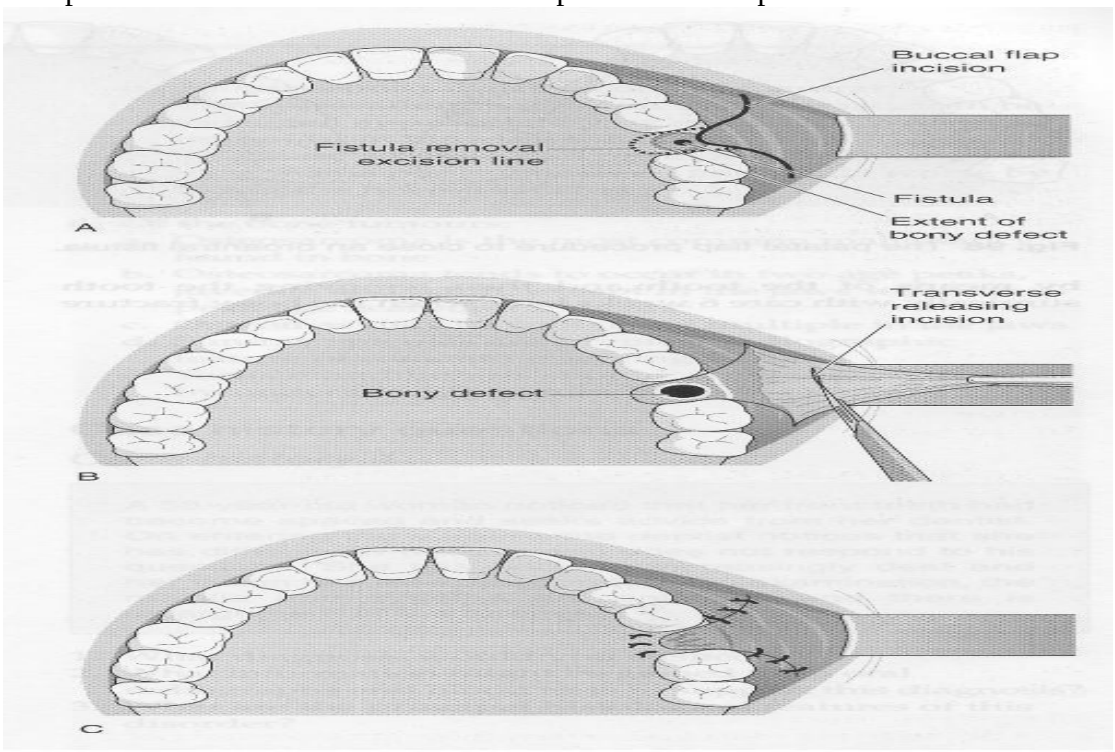
1) The mucoperiosteal flap should cover not only the fistula but also the bone which will support the suture line.
2) The flap should have a good blood supply & should be handled gently & not grasped or crushed with dissecting forceps.
3) The flap should be sutured without tension.
4) Good homeostasis 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.

The simplest method for closure of small newly created OAF by raising a mucoperiosteal flap buccaly & palataly, and reduce the height of bone buccaly, then sutured by mattress suture without tension to close the defect, the suture should be left in place for 2 weeks, a heavy dose of antibiotic with nasal decongestant drops & analgesics, also ask the patient to not sneeze or cough or shout.

Other methods which is mostly used for closure of OAF are buccal advancement flap & palatal transpositional 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 buccaly, the flap is grasped gently by toothed tissue forceps & everted & pulled so as to tense the inelastic fibrous periosteum which lines its under surface, this tens 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 inter-erupted sutures to 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 brlow



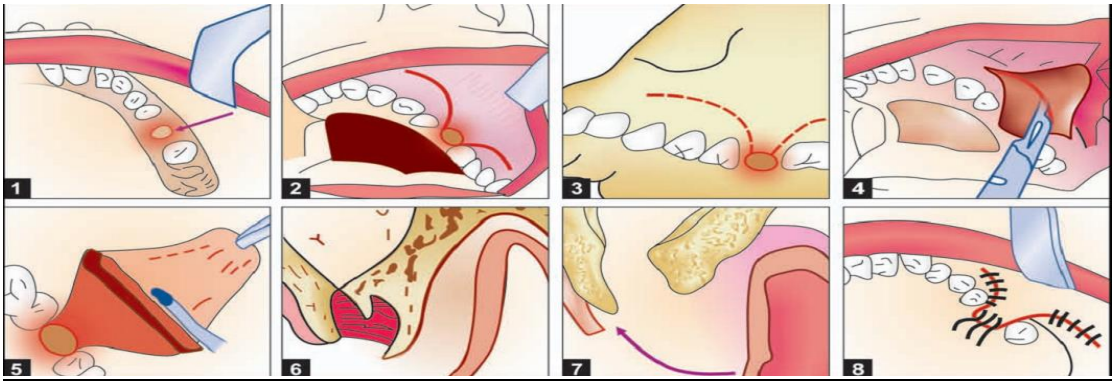
Buccal Advancement Procedure to close an Oro-Antral Communication

The vertical incisions of the flap buccaly also sutured by simple interrupted suture or 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, which produce 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 by few 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.



Modified Rehrmann's Buccal Advancement Flap

Palatal pedicled flap (rotational advancement flap) technique: *Palatal Transpositional Flap*

This type of flap used for chronic fistula or where there have been a previous unsuccessful attempts to close the fistula using a buccal advancement flap, because the buccal 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.

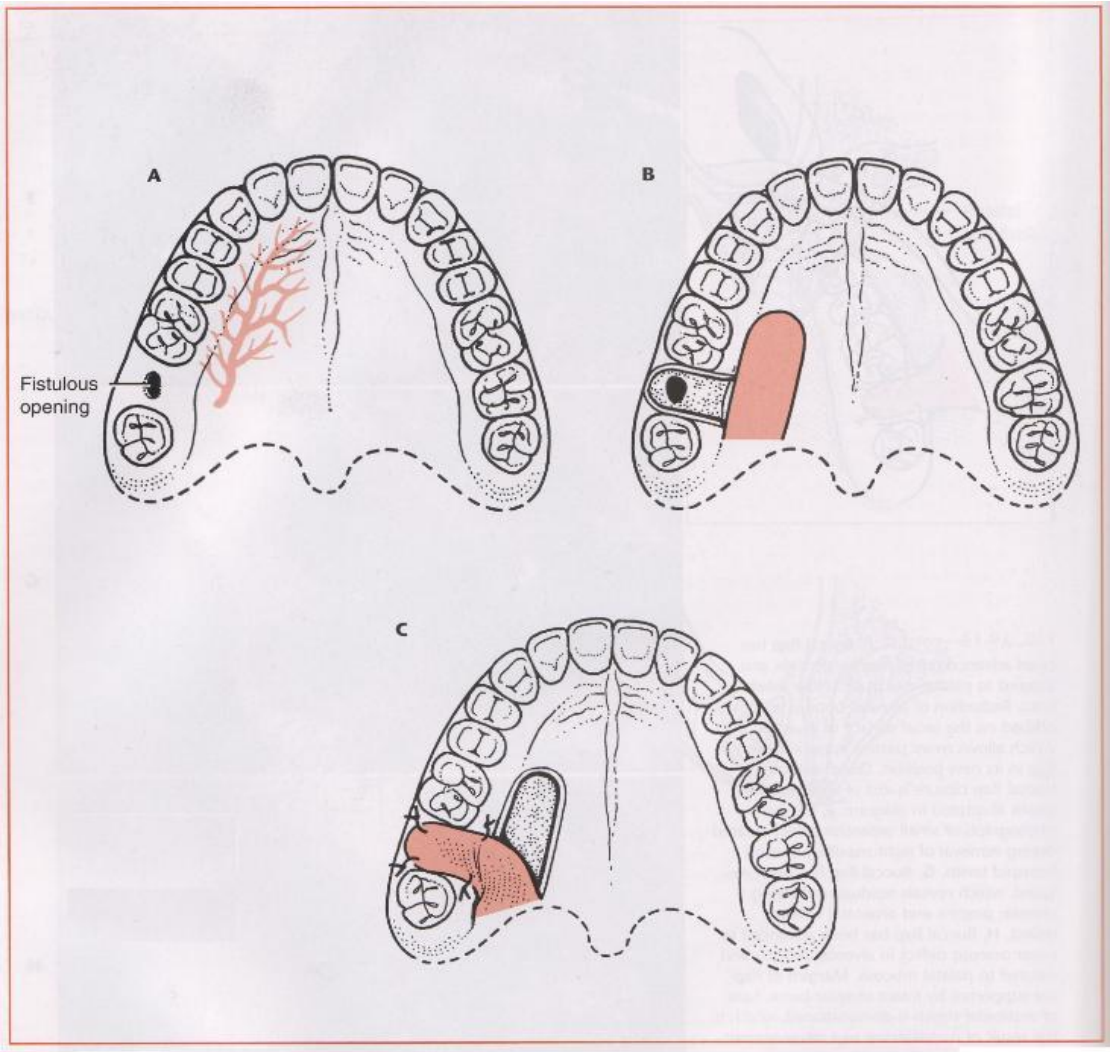
A pedicle or finger-like strip flap from the palate which is thick & contain the greater palatine vessels is raised. Such flap has high success rate because of it good blood supply, this flap its more difficult to transposed because of it thickness than buccal flap.

The flap incision is carried towards the incisive papilla & so has a convex buccal margin & concave toward palatal one, then its 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 by mattress suture, which should be occlude the cut artery.

The palatal flap should supported with further multiple interrupted sutures to the buccal 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;

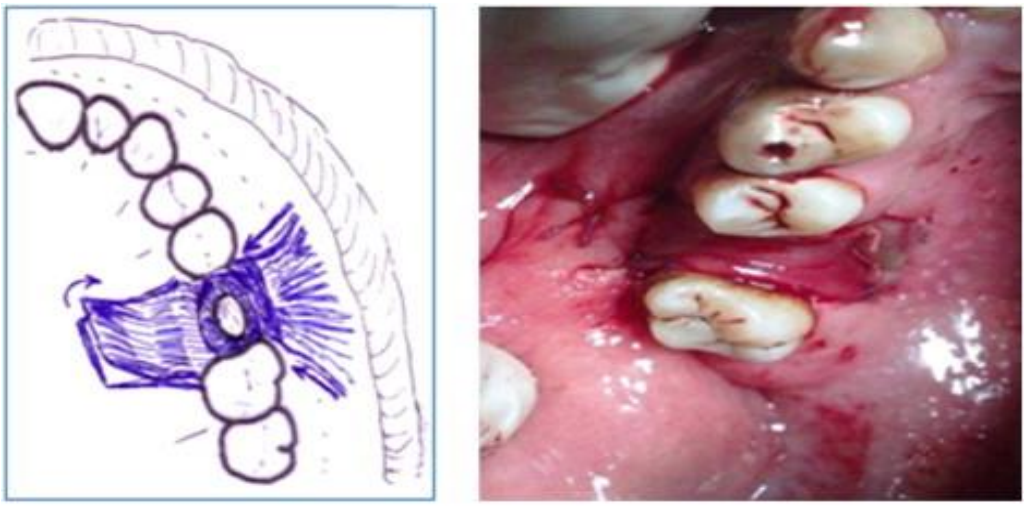
- Nasal decongestant drops (Ephedrine nasal drops)for 3 days.
- Benzoin inhalation.
- Antibiotic; Amoxicillin 500g 8-hourly.
- Analgesic.

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 this procedure ; bone of the hard palate is exposed, and re-epithelialization requires from 2 to 3 months, healing by secondary intension .

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 was 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 .



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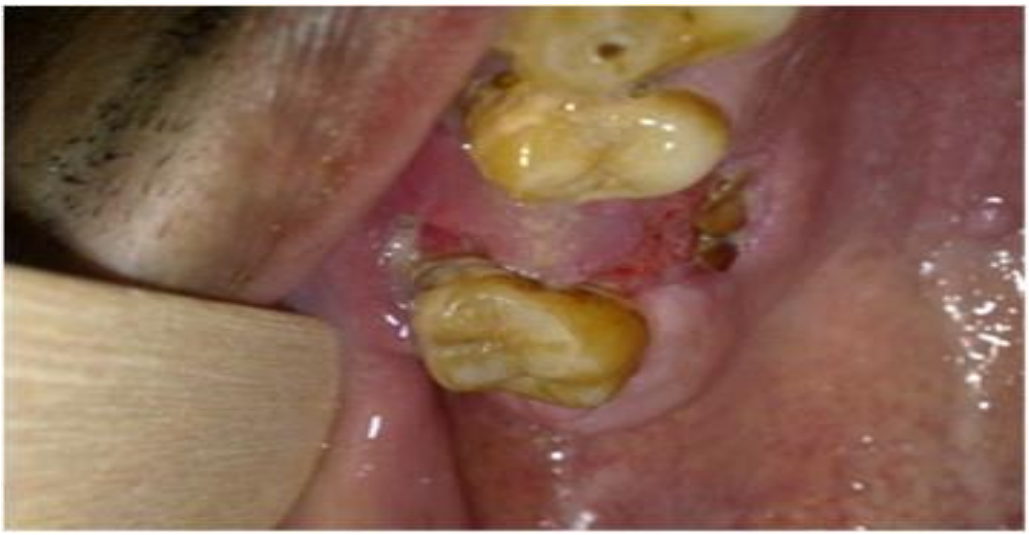
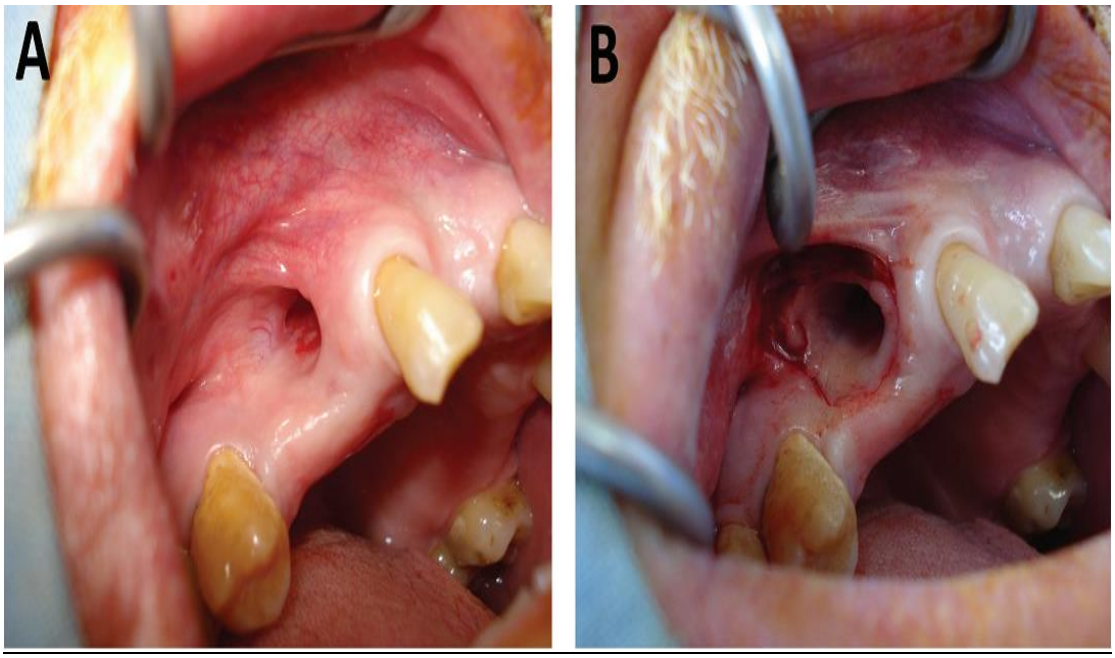


OAF healed after 1 month of surgery by this combination

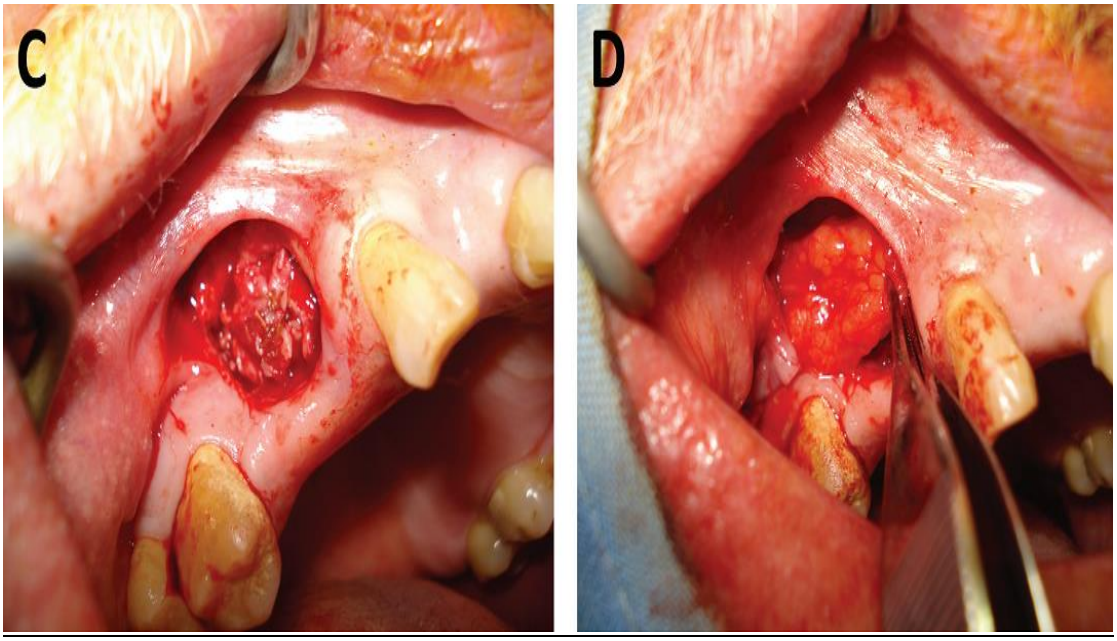
Buccal pad of fat flap technique

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 ramous 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 conjunctive tissue within a 30-40-day postoperative period, without any functional damage to the treated site .The Disadvantage that could araise with this type of flap 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 and reduction in buccal sulcus depth .



FISTULECTOMY

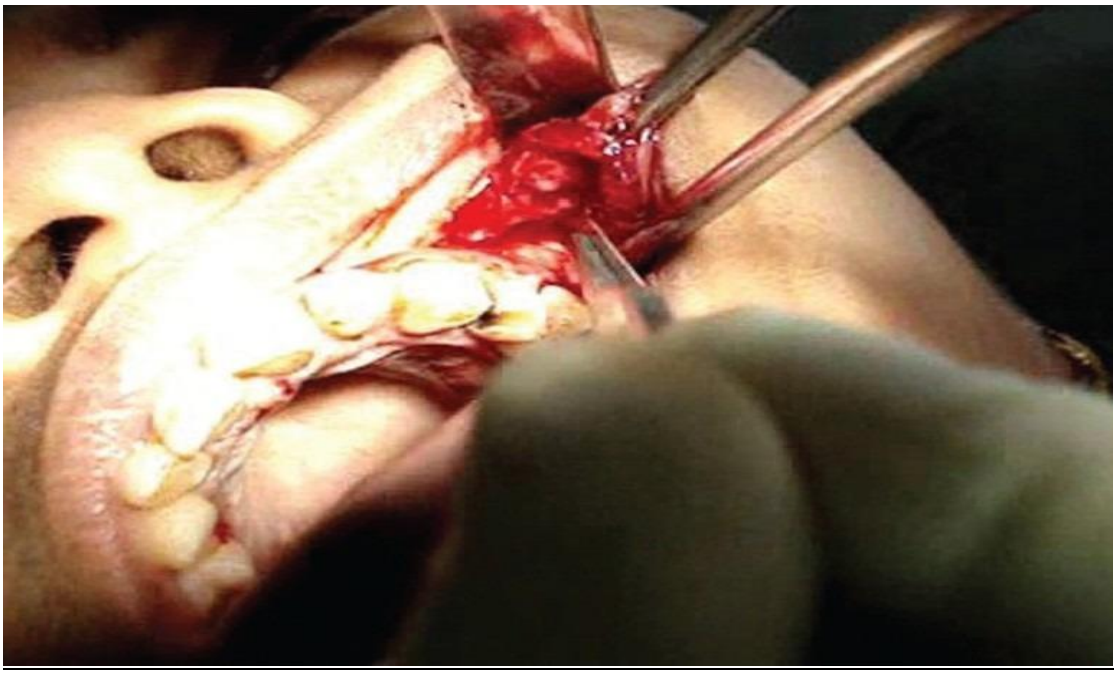


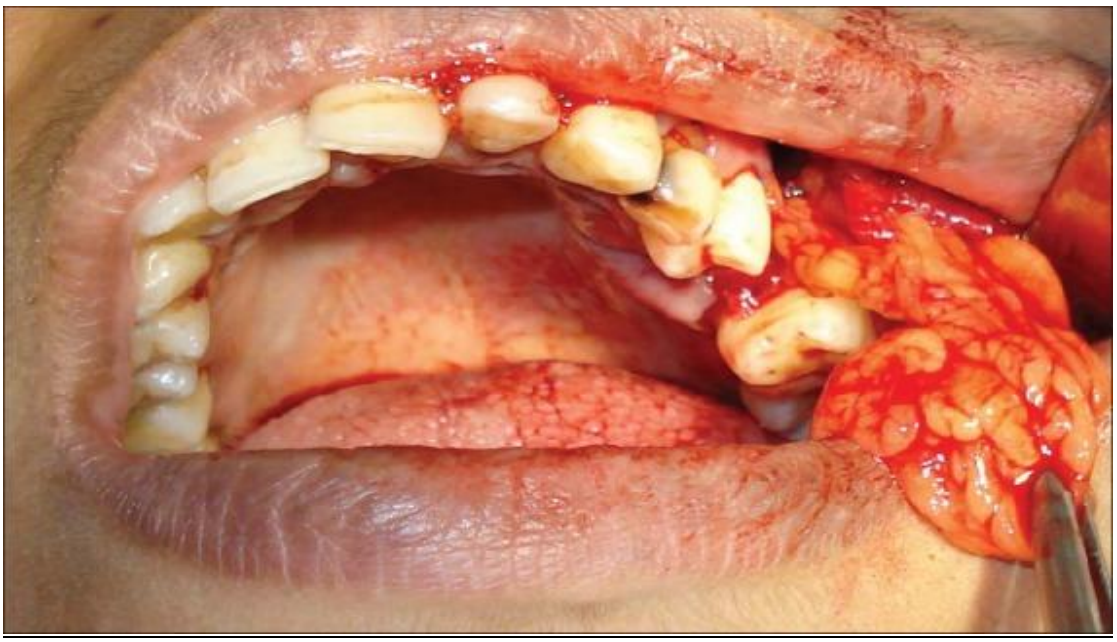
Buccal fat bad harvested in site of fistula

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

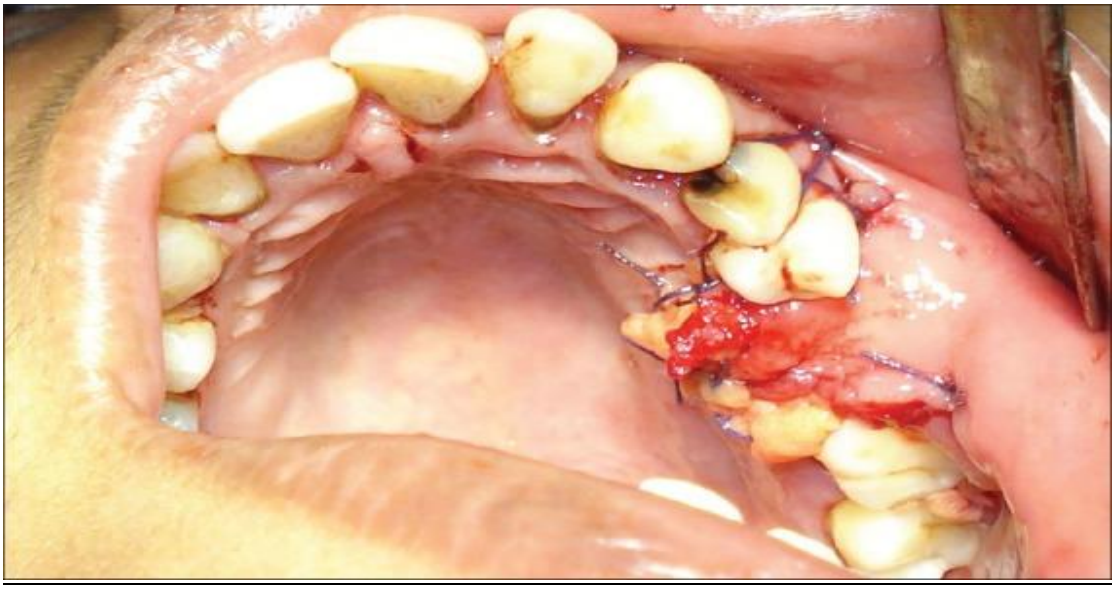
wide and large defects, i.e. defects about 5-10mm, can also be better managed with the use of BFP with buccal advancement flap than BFP alone . the use of BFP with buccal advancement flap (combination technique) provides more stability, can be used to cover BFP and as additional tissue for closure where there is a deficient BFP for closure. cases with 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 over the bony defect where it was sutured to the palatal mucosa and buccal advancement flap was utilized 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



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 which cause 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 base plate (obturator) which covers the defect without entering inside the socket.

2) Any polyp or purulent granulation tissues should be excised to promote drainage through 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.

C. DISPLACEMENT OF A TOOTH OR ROOT INTO THE SINUS

These complication occurs 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 to remove such teeth by dissection & have pre-operative radiograph.
4) Faulty technique by dentist, applying of heavy force & wrong handling of the instrument.

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 are 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 by means 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, but if the root is pushed into the antrum raising three sided flap then the defect is explores with the sucker tip & the root may be picked up by the sucker, if not catched, we must irrigate the sinus with saline while continuing to move the sucker tip around the cavity & ask the patient to pinch the nostril & to blow, by this method the tooth may be caught, if not, we must extend the flap mesially to the central incisor for Cald Well-Luc approach, to

remove the root, or suture the flap & take another radiograph for more localization of the root & give the patient appointments for Cald Well-Luc approach.

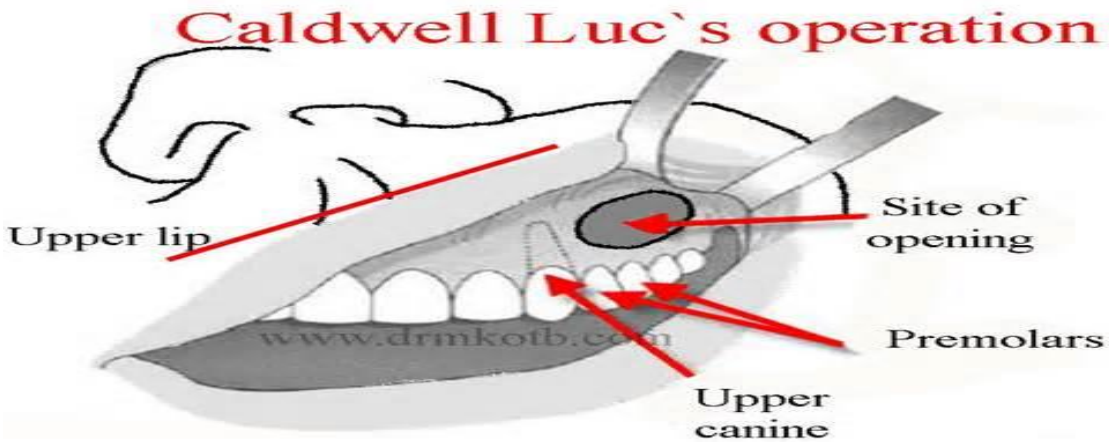
*Cald Well-luc Operation 1*893 *:*

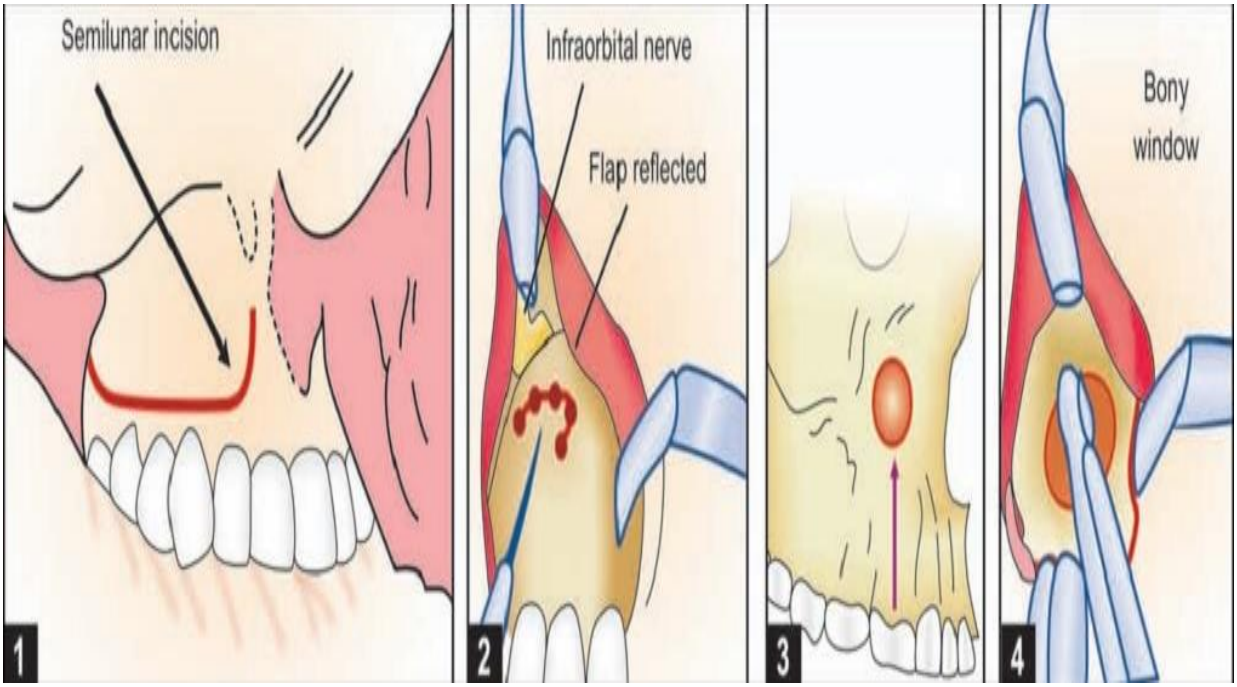
Indications:

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 Procedures:

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 opend with scalpel, and the cavity entered. Good lighting is essential, when the root is found, it lifted with sucker or grasped with a toothed forceps & withdrown. Then irrigation of the sinus with saline & suture the flap & five days of systemic anti- biotic should be given.

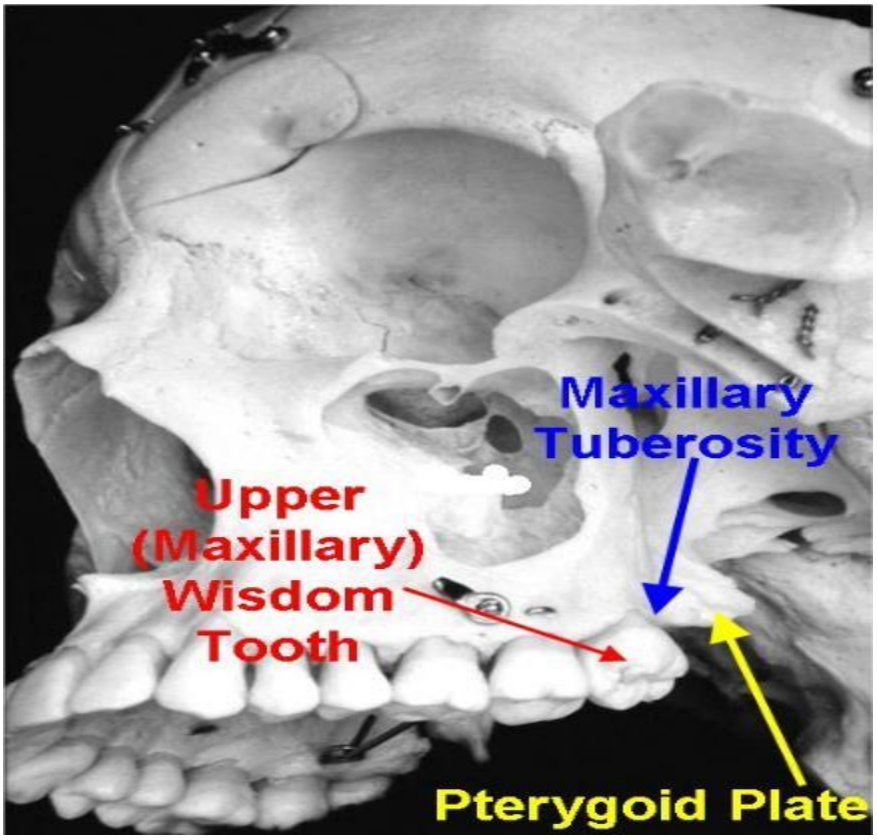




Resorbable guided tissue regeneration membrane bone substitute sandwich technique

GTR is a pure collagen membrane obtained by standardized controlled manufacturing processes. The collagen is extracted from veterinary certified pigs and carefully purified to avoid antigenic reactions. It is sterilized in double blisters by gamma irradiation, it is as such a bilayer structure. The porous surface facing the bone will allow the in-growth of bone-forming cells. The dense surface facing the soft tissue will prevent the in-growth of fibrous tissue into the bony defects. The membrane is made of type I and type III collagen . When used as a barrier membrane in bone cavities, it will resorb within 24 weeks. Adverse reaction to Bio-Gide has not been observed .

D. FRACTURE OF MAXILLARY TUBEROSITY



Occasionally, during extraction of upper 1st or 2nd molars by forceps. The supporting bone & maxillary tuberosity felt to move with the tooth, also during distal elevation of an impacted 3rd molar. This complication occurs due to the invasion of the tuberosity by the antrum which is common when an isolated maxillary molar is present, especially if the tooth has divergent or hypercementosed root or is overerupted.

When fracture of the maxillary tuberosity is present (occurs), forceps should be discarded & a large mucoperiosteal flap raised. The bony fragment & the tooth should be freed from the palatal soft tissue by blunt dissection & removed from the wound to prevent laceration of the soft tissue & bleeding or hematoma . the flap should be sutured with mattress suture which evert the margins & left in site For 14 days.

E. MALIGNANT DISEASES OF MAXILLARY ANTRUM

The dentist play an important role in the detection of malignant disease of maxillary antrum & 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 compact bony wall of the sinus or the roots of the maxillary molar teeth.

TREATMENT: -

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

Dental Implantology

5th year **Dr. Auday M. Al-Anee**

Implant Treatment: Basic Concepts and Techniques

Dental implants have given the profession and the patient an extremely predictable and effective means of tooth replacement. The partially edentulous patient can now undergo replacement of a single tooth or several missing teeth with implant retained crowns and enjoy the function and esthetics they had with their natural teeth. The completely edentulous patient no longer has to live with compromised function and the reduced confidence that traditional full denture wearers have historically experienced. Dental implants can offer the edentulous patient comfort, function, and confidence with either fixed prosthetics or implant-retained removable prosthetic options.

The history of modern implant dentistry began with the introduction of titanium implants. In the 1950s, Per-Ingvar Brånemark, a Swedish professor of anatomy, had a serendipitous finding while studying blood circulation in bone that became a historical breakthrough in medicine. He coined the phenomenon osseointegration and developed an implant system with a specific protocol to achieve it predictably. The first patient was successfully treated in 1965.

Implant Geometry (Macrodesign)

Numerous implant systems with various geometric (macrodesign) designs have been developed and used before the current implant systems in use today. Previous implant designs included blade vents (narrow, flat shape; tapped into bony trough prepared with rotary burs), press-fit cylindrical (bullet shape; pressed or tapped into prepared hole), subperiosteal (custom-made framework; adapted to the surface of jawbone), and transmandibular (long rods or posts; placed through the anterior mandible).Some of these implant systems were initially stable and appeared to be successful over short-term periods (e.g., 5 years) but failed to remain stable, became symptomatic or loose, and failed over longer periods. Lacking predictability, these implant systems are no longer used. Since the time of the Brånemark studies, millions of patients have been treated worldwide using variations of these techniques with implants of different geometries and surface characteristics. Similar research including

that of André Schroeder in Switzerland in the mid-1970s contributed to the success of endosseous dental implants.

The serendipitous finding of Brånemark was that when a hole is prepared into bone without overheating or otherwise traumatizing the tissues, an inserted biocompatible implantable device would predictably achieve an intimate bone apposition, as long as micromovements at the interface were prevented during the early healing period.

Currently, most endosseous implants have a cylindrical or tapered, screwshaped/ threaded design. The disastrous results with other implant configurations were largely responsible for the evolution toward the current popular designs.

The most common implant design being used today is the screw-shaped or threaded cylindrical implant. A threaded implant design is preferred because it engages bone well and is able to achieve good primary stabilization. Even systems that started with cylindrical press-fit (nonthreaded) designs progressively evolved to a threaded geometry. The (longitudinal) shape of implants may be parallel or tapered. Although a majority of all implants have been parallel walled, the use of a tapered implant design has been advocated because it requires less space in the apical region (i.e., better for placement between roots or in narrow anatomic areas with labial concavities). Tapered implants have also been advocated for use in extraction sockets.

Implant Surface Characteristics (Microdesign)

Implant surface characteristics (microtopography) have been shown to positively influence the healing process. Accordingly, modification of implant surface characteristics has been a major area of research interest and development. Modifications in surface energy, chemical composition, and surface topography are known to influence cellular activity and tissue responses, leading to enhanced osteogenesis. At the molecular level, modified implant surfaces increase adsorption of serum proteins, mineral ions, and cytokines, which subsequently promote cellular migration and attachment. Implant surface characteristics can also aid in the retention of a fibrin clot, thus providing a migratory pathway for the differentiating osteogenic cells to reach the implant surface. Today, implants are treated

with a variety of technologies to modify surface characteristics (microscale or nanoscale) to enhance bone formation.

Additive Processes

The additive process modifies the microstructure/macrostructure and chemical nature of the implant surface by adding materials or chemicals to the existing surface. Several methods are used to add materials or chemicals to the implant surface, such as inorganic mineral coatings, plasma spraying, biocoating with growth factors, fluoride, and particulates or cements containing calcium phosphates, sulfates, or carbonates. The addition of materials, such as hydroxyapatite, to the implant surface has been shown to enhance or accelerate the initial bone cells, adaptation or proliferation. In general, additive surface modifications tend to increase the surface texture greater than subtractive surface modifications, resulting in topographically “rougher” implant. Surface roughness can also be increased by oxidizing or adding an oxide layer.

Subtractive Processes

The subtractive process modifies the microstructure and chemical nature of the implant surface by removing or altering the existing surface. The roughness of implant surface can be modified by machining, acid etching, blasting, or a combination of these processes to enhance the amount or speed of osseointegration. Implant surfaces that are modified at the microscopic level with techniques such as acid etching are thought to promote favorable cellular responses and increased bone formation in close proximity to the surface.

Implant Surface Chemical Composition

There have been unsuccessful trials with oral implants made of carbon or hydroxyapatite. The lack of resistance, because of material properties, to occlusal forces led to frequent fractures. The so-called noble metals or alloys, however, do not resist corrosion and have thus been abandoned. Today, the majority of oral implants are made of commercially pure (CP) titanium or titanium alloys. Titanium is a reactive metal that oxidizes within nanoseconds when exposed to air. Because of this passive oxide layer, the titanium then becomes resistant to corrosion in its CP form. Some alloys, such as titanium-aluminum 6%, vanadium 4% (Ti6Al4V), are known to

provoke bone resorption as the result of leakage of some toxic components. The oxide layer of CP titanium reaches 10 nm of thickness. It grows over the years when facing a bioliquid. It consists mainly of titanium dioxide (TiO2).

Hard Tissue Interface

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.

The osseointegration process observed after implant insertion can be compared with bone fracture healing. Implant site osteotomy preparation (bone wounding) initiates a sequence of events, including an inflammatory reaction, bone resorption, release of growth factors, and attraction by chemotaxis of osteoprogenitor cells to the site. Differentiation of osteoprogenitor cells into osteoblasts leads to bone formation at the implant surface. Extracellular matrix proteins, such as osteocalcin, modulate apatite crystal growth. Specific conditions, optimal for bone formation, must be maintained at the healing site to achieve osseointegration.

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

1. A biocompatible material (the implant)

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

Titanium is the material of choice for dental implants. Titanium is biologically inert and therefore does not elicit a foreign body rejection reaction from host tissue. For the implant to have intimate contact with

bone, the implant site must be prepared with a precise technique. All implant systems have specially designed drills that are used in a specific sequence to remove bone as atraumatically as possible. The drill sizes are matched to the size and shape of the implant being placed, creating the precision necessary for developing initial bony contact and stability.

Atraumatic surgical technique in an aseptic environment is critical to minimize mechanical and thermal injuries to bone. This involves using sharp, precision osteotomy drills run at slow speed with high torque while maintaining gentle, intermittent pressure and providing copious irrigation. Irrigation can be accomplished either externally or internally using special handpieces and burrs with internal ports. The goal is to maintain bone temperatures below 47°C during implant site preparation. Any variance causing temperatures to exceed 47°C is likely to cause bone necrosis and failure of osseointegration.

Initial stability of the implant must be achieved and maintained for formation of bone at the implant surface. Stability at the time of placement is predicated on the volume and quality of bone that intimately contacts the implant as well as the length and diameter of the implant.

During the time required for osseointegration to occur, it is imperative that immobility of the implant be maintained. A mild inflammatory response enhances the bone healing, but moderate inflammation or movement above a certain threshold is detrimental. When micromovements at the interface exceed 150 μm, the movement will impair differentiation of osteoblasts and fibrous scar tissue will form between the bone and implant surface. Therefore it is important to avoid excessive forces, such as occlusal loading, during the early healing period.

New bone formation follows a specific sequence of events. Woven bone is quickly formed in the gap between the implant and the bone; it grows fast, up to 100 μm per day, and in all directions. Characterized by a random orientation of its collagen fibrils, high cellularity, and limited degree of mineralization, the biomechanical capacity of woven bone is poor. Thus any occlusal load should be well controlled or avoided in the early phase of healing.

After several months, woven bone is progressively replaced by lamellar bone with organized, parallel layers of collagen fibrils and dense

mineralization. Contrary to the fast-growing woven bone, lamellar bone formation occurs at a slow pace (only a few microns per day).

Clinically, both primary stability and secondary stability of an implant are critical to success. Primary stability, achieved at the time of surgical placement, depends on the implant geometry (macrodesign), as well as the quality and quantity of bone available for implant anchorage at a specific site. Studies using resonance frequency analysis (RFA) have reported decreased implant stability in the early weeks of post-insertion healing. Secondary stability, achieved over time with healing, depends on the implant surface (microdesign), as well as the quality and quantity of adjacent bone, which will determine the percentage of contacts between the implant and bone. For example, areas such as the anterior mandible have dense cortical bone and provide rigid primary stabilization and good support throughout the healing process. Conversely, areas such as the posterior maxilla have thin cortical bone, and large marrow spaces provide less primary stability. For this reason, the posterior maxilla has been associated with lower success rates compared with other sites with greater bone density and support.

Once osseointegration is achieved, implants can resist and function under the forces of occlusion for many years.

Soft Tissue–Implant Interface

Historically, most basic science and clinical efforts were spent on studying the bone-implant interface of osseointegration. Considerably less attention was given to overlying soft tissues. In contemporary implant dentistry, however, this subject is being researched with great zeal. Driven primarily by the need for satisfactory esthetics as well as maintenance of a soft tissue seal or barrier against bacterial invasion, soft tissue has become a major focus of interest.

It is critical to understand both the striking similarities and the obvious differences between the peri-implant soft tissue and periodontal soft tissue. Peri-implant and periodontal soft tissues do share a number of similarities and only subtle differences. Each emerges from alveolar bone through soft tissue. Soft tissue consists of connective tissue covered by epithelium, which is continuous with an epithelium-lined gingival sulcus, the apical-most portion being lined with junctional epithelium forming an attachment.

From that point down to the level of alveolar bone, both types of soft tissue possess a zone of dense connective tissue. This zone of supracrestal connective tissue is responsible for maintaining a stable interface between soft tissue and the implant and acts as a seal or barrier to the oral environment. It is the orientation of the connective tissue fibers adjacent to an implant that differ from a natural tooth. This zone of connective tissue has been measured to be 1 to 2 mm in height. Clinically this becomes important when examining the health of peri-implant soft tissue. Probing depths in a healthy implant would be approximately 1 to 2 mm less than the total measured dimension from the crest of the sulcus to the alveolar bone crest. The other obvious difference between teeth and implants is that teeth have a periodontal ligament with connective tissue fibers that suspend teeth in alveolar bone. The implant, however, is in direct contact with bone without any intervening soft tissue. This difference has a dramatic impact on the biomechanics, proprioception, and prosthetic consideration for implants versus natural teeth. Because an implant, unlike a tooth, does not have cementum, most connective tissue fibers run in a direction more or less parallel to the implant surface.

Questions emerged decades ago, as it did for the natural dentition, about the need for keratinized tissue to surround implants. Keratinized mucosa tends to be more firmly anchored by collagen fibers to the underlying periosteum than non-keratinized mucosa, which has more elastic fibers and tends to be movable relative to the underlying bone. In clinical studies evaluating intraoral implants, with or without peri-implant keratinized mucosa, no clinically significant difference in implant success was reported. However, when there is a lack of keratinized tissue, patients tend to complain about pain and discomfort while performing oral hygiene procedures or other functions in the area. The symptoms are alleviated by increasing the amount of keratinized (firmly bound) tissue around the implant(s) via soft tissue grafting.

Biomechanical Considerations

Once the implant is properly placed, the long-term success is heavily dependent on restorative biomechanical factors— that is, how the stresses imposed on the functioning implant or prosthetic unit or units will be controlled or distributed. The axiom is simple: The load-bearing capacity of the integrated implant has to be greater than the anticipated load during

function. If applied loads are greater than the load-bearing capacity, it is likely to lead to mechanical failure, biologic failure, or both. Mechanical failure may present simply as porcelain fracture or as a loosened or fractured prosthetic screw (the screw that attaches the abutment or framework to the implant). The most devastating mechanical failure occurs when the force is destructive enough to actually fracture the implant fixture. A biologic failure can occur when the functional load exceeds the load-bearing capacity of the implant-bone interface. This initially presents clinically as bone loss around the platform of the implant. If the loss is severe enough and the provocation is long enough, the bone loss may progress around the entire implant and result in complete failure of the implant. The clinician must remember that an implant-retained restoration lacks the “shock absorbing” periodontal ligament that a natural tooth-retained restoration possesses. The periodontal ligament allows slight physiologic movement of teeth, and in the absence of microbe-induced inflammation, natural teeth can move and adapt to the forces without pathologic bone loss. This, however, is not possible with an osseointegrated implant.

The load-bearing capacity of implants is qualified by several factors, including the number and size of the implants, the arrangement and angulation of the implants, and the volume and quality of the bone-implant interface. The same factors that maximize initial implant stability in hard tissue continue to be important. Thick cortical bone and dense trabecular bone surrounding a long, wide-diameter implant that is positioned to be in line with the functional load, would offer the greatest load-bearing capacity and the best prognosis for long-term success. Conversely, a short, narrow-diameter implant placed in an area of thin cortical bone and less dense trabecular bone and in an off-axis angulation would have far less load-bearing capacity and a poorer prognosis for success. The angulation of the implants as it relates to the occlusal plane and the direction of the occlusal forces is an important determinant in optimizing the translation of the forces to the implants and the surrounding bone. Loads directed through the long axis of the implants are tolerated very well. Slight off-axis loads are usually not clinically detrimental, but loads applied at angles greater than 20 degrees or more can result in load magnification and initiate bone loss at the implant-bone interface. Again, if excessive loads persist, bone loss will continue and will likely lead to implant failure.

The number of implants placed in multi-tooth edentulous spans affects the load-bearing capacity of the implanted prosthesis. If there is a three-tooth edentulous span, the fixed prosthetic options would be to place three implants with three splinted crowns, three implants with three single-unit crowns, two implants as terminal abutments for a three-unit fixed partial denture, or two adjacent implants with a fixed partial denture with a cantilevered pontic. The load-bearing capacity decreases with each successive option.

Straight-line or linear arrangement of multiple implants should be avoided as this provides the least biomechanical advantage and is the least resistant to torqueing forces caused by off-center occlusal and lateral loads. Implants should be placed in a more curvilinear or staggered fashion.

Connecting a single integrated implant to one natural tooth with a fixed partial denture will effectively create an excessively loaded cantilever situation. Because of the immobility of the implant compared with the mobility of the natural tooth, when the loads are applied to the fixed partial denture, the tooth can move within the limits of its periodontal ligament. This can create stresses at the implant abutment junction up to two times the applied load on the prosthesis. Additional problems with a tooth to implant-supported, fixed partial dentures include breakdown of osseointegration, cement failure on the natural abutment, screw or abutment loosening, and possible failure of the implanted prosthetic components.

Detrimental forces can be applied iatrogenically by placing non-passive, ill-fitting frameworks on implants. When the screws are tightened in an attempt to seat the ill-fitting framework, compressive forces are placed on the implant-bone interface. This excessive force can lead to bone loss and potential implant failure.

Preoperative Assessment and Treatment Planning

The ultimate goal of dental implant therapy is to satisfy the patient’s desire to replace one or more missing teeth in an esthetic, functional manner with long-term success. To achieve this goal, clinicians must accurately and comprehensively assess the dentoalveolar condition as well as the overall physical and mental well-being of the patient.

Chief Complaint

What is the problem or concern in the patient's own words? What is the patient's goal of treatment? How realistic are the patient's expectations? The patient's chief concern, desires for treatment, and vision of the successful outcome must be taken into consideration.

The patient will measure implant success according to his or her personal criteria. The overall comfort and function of the implant restoration are often the most important factors, but satisfaction with the appearance of the final restoration will also influence the patient's perception of success. Furthermore, patient satisfaction may be influenced simply by the impact that the treatment has on the patient's perceived quality of life. Patients will evaluate for themselves whether the treatment helped them to eat better, look better, or feel better about themselves.

The clinician could consider an implant and the retained prosthesis a success using standard criteria of symptom-free implant function, implant stability, and lack of peri-implant infection or bone loss. At the same time, however, the patient who does not like the aesthetic result or does not think the condition has improved could consider the treatment a failure. Therefore it is critical to inquire, as specifically as possible, about the patient's expectations before initiating implant therapy and to appreciate the patient's desires and values. With this goal in mind, it is often helpful and advisable to invite patients to bring their spouses or family members to the consultation and treatment-planning visits to add an independent “trusted” observer to the discussion of treatment options. Ultimately, it is the clinician's responsibility to determine if the patient has realistic expectations for the outcome of therapy and to educate the patient about realistic outcomes for each treatment option.

Medical History and Medical Risk Assessment

A thorough medical history is required and must be documented for every dental patient. As with any patient planning a surgical procedure, the patient must be assessed preoperatively to evaluate his or her ability to tolerate the proposed procedure, heal, and to have a favorable prognosis.

There are only a few absolute medical contraindications to implant therapy. Absolute contraindications to implant placement based on surgical and

anesthetic risks are limited primarily to patients who are acutely ill and those with uncontrolled metabolic disease. Often these contraindications are limited in duration; once the illness resolves or the metabolic disease is controlled, the patient may become a good candidate for implant therapy. Relative contraindications are concerned with medical conditions that affect bone metabolism or the patient's ability to heal. These include conditions such as 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).

Some psychological or mental conditions could be considered absolute or relative contraindications, depending on their severity. Patients with psychiatric syndromes (e.g., schizophrenia, paranoia) or mental instabilities (e.g., neurosis, somatic symptom disorder), those who have mental impairment or are uncooperative, or those who have irrational fears, phobias, or unrealistic expectations may be poor candidates for implant treatment. Certain habits or behavioral considerations such as smoking, tobacco use, substance abuse (e.g., drugs and alcohol), and parafunctional habits (bruxing and clinching) must be scrutinized as potential contraindications as well. Smoking, in particular, has been documented as a significant risk factor resulting in decreased long-term stability and retention of implants.

Contraindications

Absolute contraindications to implant placement

- Acute illness
- Magnitude of defect/anomaly
- Uncontrolled metabolic disease
- Bone and/or soft tissue pathology/infection

Relative contraindications

- Diabetes
- Osteoporosis
- Parafunctional habits
- HIV
- AIDS
- Bisphosphonate usage—oral and intravenous
- Chemotherapy
- Irradiation of head and neck
- Behavioral, neurologic, psychosocial, psychiatric disorders

Dental History

A review of a patient's past dental experiences can be a valuable part of the overall evaluation. Does the patient report a history of recurrent or frequent abscesses, which may indicate a susceptibility to infections or diabetes? Does the patient have many restorations? How compliant has the patient been with previous dental recommendations? What are the patient's current oral hygiene practices?

The individual's previous experiences with surgery and prosthetics should be discussed. If a patient reports numerous problems and difficulties with past dental care, including a history of dissatisfaction with past treatment, the patient may have similar difficulties with implant therapy. It is essential to identify past problems and to elucidate any contributing factors. The clinician must also assess the patient's dental knowledge and understanding of the proposed treatment, as well as the patient's attitude and motivation toward implants.

Intraoral Examination

The oral examination is performed to assess the current health and condition of existing teeth, as well as to evaluate the condition of the oral hard and soft tissues. It is imperative that no pathologic conditions are present in any of the hard or soft tissues in the maxillofacial region. All oral lesions, especially infections, should be diagnosed and appropriately treated before implant therapy.

Additional criteria to consider include the patient's habits, level of oral hygiene, overall dental and periodontal health, occlusion, jaw relationship, temporomandibular joint condition, and ability to open wide.

After a thorough intraoral examination, the clinician can evaluate potential implant sites. All sites should be clinically evaluated to measure the available space in the bone for the placement of implants and in the dental space for prosthetic tooth replacement. The mesial-distal and buccal-lingual dimensions of edentulous spaces can be approximated with a periodontal probe or other measuring instrument. The orientation or tilt of adjacent teeth and their roots should be noted as well. There may be enough space. Conversely, there may be adequate space between roots, but the coronal aspects of the teeth may be too close for emergence and

restoration of the implant. If either of these conditions is discovered, orthodontic tooth movement may be indicated. Ultimately, edentulous areas need to be precisely measured using diagnostic study models and imaging techniques to determine whether space is available and whether adequate bone volume exists to replace missing teeth with implants and implant restorations.

How Much Space Is Required for Placement of One or More Implants?

Alveolar Bone

Assuming an implant is 4 mm in diameter and 10 mm long, the minimal width of the jawbone needs to be 6 to 7 mm, and the minimal height should be 10 mm (minimum of 12 mm in the posterior mandible, where an additional margin of safety is required over the mandibular nerve). This dimension is desired to maintain at least 1 to 1.5 mm of bone around all surfaces of the implant after preparation and placement.

Interdental Space

Edentulous spaces need to be measured to determine whether enough space exists for the placement and restoration with one or more implant crowns. The minimal mesial-distal space for an implant placed between two teeth is 7 mm. The minimal mesial-distal space required for the placement of two standard-diameter implants (4-mm diameter) between teeth is 14 mm. The required minimal dimensions for wide-diameter or narrow-diameter implants will increase or decrease incrementally according to the size of the implant. For example, the minimal space needed for the placement of an implant 6 mm in diameter is 9 mm (7 mm + 2 mm).

Whenever the available space between teeth is greater than 7 mm and less than 14 mm, only one implant, such as placement of a wide-diameter implant, should be considered. Two narrow diameter implants could be positioned in a space that is 12 mm. However, the smaller implant may be more vulnerable to implant fracture.

Interocclusal Space

The restoration consists of the abutment, the abutment screw, and the crown (it may also include a screw to secure the crown to the abutment if it is not cemented). This restorative “stack” is the total of all the components

used to attach the crown to the implant. The dimensions of the restorative stack vary slightly depending on the type of abutment and the implant-restorative interface (i.e., internal or external connection). The minimum amount of interocclusal space required for the restorative “stack” on an external hex-type implant is 7 mm.

Diagnostic Casts and Photographs

Mounted study models as well as intraoral and extraoral photographs complete the records collection process. Study models and photographs are often overlooked in preoperative history taking, but both contribute significantly to the assessment and treatment planning phases of implant dentistry.

Study models mounted on a semi-adjustable articulator using a face-bow transfer give the clinician a three-dimensional working representation of the patient and provide much information required for surgical and prosthetic treatment planning.

Elements that can be evaluated from accurately mounted models include the following:

1. Occlusal relationships
2. Arch relationships
3. Inter-arch space
4. Arch form, anatomy, and symmetry
5. Preexisting occlusal scheme
6. Curve of Wilson and curve of Spee
7. Number and position of the existing natural teeth
8. Tooth morphology
9. Wear facets
10. Edentulous ridge relationships to adjacent teeth and opposing arches
11. Measurements for planning future implant locations

12. Visualizing force vectors, both present and planned

Medicolegally, the mounted study models are preserved as an exact reference of the preoperative condition.

Intraoral photographs are equally important. They allow visual evaluation of the patient's soft tissue (e.g., quantity, quality, location, texture, color, symmetry). Extraoral photographs provide views of the patient from many different esthetic perspectives. Elements that are easily assessed are as follows:

1. Facial form

2. Facial symmetry

3. Patient's degree of expression and animation

4. Patient's appearance (e.g., facial features, facial hair, complexion, eye color)

5. Smile line

6. Incisal edge or tooth display

7. Buccal corridor display

8. Potential esthetic demand

Hard Tissue Evaluation

The amount of available bone is the next criterion to evaluate. Wide variations in jaw anatomy are encountered, and it is therefore important to analyze the anatomy of the dentoalveolar region of interest both clinically and radiographically.

A visual examination can immediately identify deficient areas, whereas other areas that appear to have good ridge width will require further evaluation. Clinical examination of the jawbone consists of palpation to feel for anatomic defects and variations in the jaw anatomy, such as concavities and undercuts. If desired, it is possible with local anesthesia to probe through the soft tissue (intraoral bone mapping) to assess the thickness of the soft tissues and measure the bone dimensions at the proposed surgical site.

The spatial relationship of the bone must be evaluated in a three dimensional view because the implant must be placed in the appropriate position relative to the prosthesis. It is possible that an adequate dimension of bone is available in the anticipated implant site, but that the bone and thus the implant placement might be located too lingual or too buccal for the desired prosthetic tooth replacement. Bone augmentation procedures may be necessary to facilitate the placement of an implant in an acceptable prosthetic position despite the availability of an adequate quantity of bone (i.e., the bone is in the wrong location).

Soft Tissue Evaluation

Evaluation of the quality, quantity, and location of soft tissue present in the anticipated implant site helps to anticipate the type of tissue that will surround the implant(s) after treatment is completed (keratinized vs. nonkeratinized mucosa). For some cases, clinical evaluation may reveal a need for soft tissue augmentation. Areas with minimal or no keratinized mucosa may be augmented with gingival or connective tissue grafts. Other soft tissue concerns, such as frenum attachments that pull on the gingival margin, should be thoroughly evaluated as well.

Debate continues about whether it is necessary to have a zone of keratinized tissue surrounding implants. Despite strong opinions and beliefs about the need for keratinized mucosa around implants versus this mucosa being unnecessary, neither argument has been proved.

Some studies have concluded that, in the presence of good oral hygiene, a lack of keratinized tissue does not impair the health or function of implants. Others strongly believe that keratinized mucosa has better functional and aesthetic results for implant restorations. Keratinized mucosa is typically thicker and denser than alveolar mucosa (nonkeratinized). It forms a strong seal around the implant with a cuff of circular (parallel) fibers around the implant, abutment, or restoration that is resistant to retracting with mastication forces and oral hygiene procedures.

Radiographic Examination

Several radiographic imaging options are available for diagnosis and for planning of dental implantation. 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], conebeam computed tomography [CBCT]).

Multiple factors, however, influence the selection of radiographic techniques for any particular case. Such factors as cost, availability, radiation exposure, and the type of case must be weighed against the accuracy of identifying vital anatomic structures within a given bone volume and being able to perform the surgical placement without injury to these structures. 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 (best evaluated with the use of lateral cephalometric images)

Radiographic images allow for quantifying dimensions or for taking measurements. Traditional radiographs must be calibrated for potential magnification. Magnification on a traditional panoramic image can be as much as 25%. One way to determine magnification is to place a metal sphere near the plane of occlusion when taking the radiograph. By comparing the radiographic size with the actual size of the sphere, the magnification can be determined. Digitally acquired periapical, panoramic, lateral cephalometric images and CT and CBCT scans have bundled software applications that allow for very accurate measurement.

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

CT and CBCT image data files can be reformatted and viewed on personal computers using simulation software. This allows the diagnosis and treatment planning processes to be more accurate with regard to measurements and dimensions. Critical anatomic structures can be visualized in all three coordinate axes so that their superoinferior, anteroposterior, and buccolingual locations can be identified.

Key Fact

The American Academy of Oral and Maxillofacial Radiology recommends panoramic radiography as the initial evaluation of the dental implant patient, supplemented with periapical radiographs as needed.

Surgical Treatment Planning Considerations

Surgical treatment planning takes the diagnostic data that have been gathered and combines them with the surgeon's clinical judgment to determine the potential surgical options. The surgeon must be mindful of the proposed prosthetic goals, typically driven by the number of implants required in suggested locations for a specific prosthetic design. Because implant dentistry is often a team endeavor, it is advantageous for the surgeon to have a reasonable understanding of the prosthetics and for the restoring dentist to have an understanding of the surgical aspects of implant placement.

After evaluating all of the previously described information, the surgeon must determine the prognosis of implant placement based on specific limitations as a result of anatomic variations, bone quality, and bone quantity in different areas of the jaw. The anterior mandible is usually tall enough and wide enough to accommodate implant placement. Bone quality is usually excellent, typically the densest of any area in the two arches. Primary surgical concerns in this area include proper angulation of the implants and avoiding the mental foramen and mandibular canal. Implants should be placed at least 5 mm anterior to the most anterior portion of the mental foramen, avoiding the anterior loop of the mandibular canal.

The posterior mandible limits the length of the implants based on the position of the mandibular canal that traverses the body of the mandible in this region. Ideally, the tip of the implant should be at least 2 mm from the inferior alveolar nerve (IAN). It is important to consider the buccolingual position of the nerve as well. The width of the posterior mandible must also be considered. If the nerve is located very near the buccal cortex, a longer implant could be placed, with the implant extending lingual to the IAN, even though the implant extends vertically past the nerve. CT or CBCT can be helpful in making this determination. The mandibular canal also precludes any posterior implants from engaging the inferior cortical plate, which could lessen the initial primary stability of the implant. The attachment of the mylohyoid muscle helps maintain the bony width along the superior aspect of the ridge, although this can often be deceiving because a deep lingual depression, "the lingual undercut," usually is present immediately below this attachment. This is a critical area to be examined and palpated during the clinical examination.

In planning the implant placement, if primary stability is questionable, increased time for osseointegration may be considered. The clinician may also want to consider “over-engineering” the case by using more implants (e.g., three implants replacing three teeth, vs. two implants replacing three teeth).

The posterior maxilla poses two specific concerns related to implant placement. The first is the quality of bone in this area. As previously discussed, bone quality in the posterior maxilla is typically the poorest of any area, limited by thin cortical bone at the ridge crest and the least dense trabecular bone. This often results in less implant stability at the time of placement. For this reason, more time (6 months or longer) may be required for osseointegration to occur in this region. The second concern is the proximity of the maxillary sinus to the edentulous ridge. Often, as a result of bone resorption and increased pneumatization of the sinus, a limited height of bone remains for implant placement. If an adequate height of bone is present, the implant should be placed, leaving 1 mm of bone between the sinus and the implant. If there is inadequate bone height, then either a “sinus bump” or “sinus lift” procedure would be necessary to augment the height of bone.

The anterior maxilla, even though it is the most surgically assessable area, may be one of the most difficult regions for implant placement. This area, even when healthy teeth are present, usually has a thin buccal plate. After tooth loss, the resorption of the ridge follows a pattern of moving apically and palatally, only exacerbating an already tenuous anatomy. The residual ridge anatomy results in a ridge that is narrow and angulated such that ideal implant positioning may be impossible and the esthetic outcome may be compromised. The nasal cavity and the incisive canal are vital structures that also define the anatomic limitations of anterior implant placement. Implants should be placed 1 mm short of the nasal floor and should not be placed in the maxillary midline.

Final Treatment Planning

The final stage of treatment planning involves consolidating all of the clinical and radiographic information in combination with surgical options and limitations to produce the best final result of the prosthetic treatment. The positioning and angulation of implant placement is critical to the

biomechanical stability and esthetics required for long-term success. 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 because even slight variations of angulation can have large effects on the appearance of the final restoration. The construction of the surgical guide template is nearly indispensable in patients for whom it is necessary to optimize implant placement to ensure correct emergence profiles in the anterior esthetic zone. 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, and (4) identifying the level of cementoenamel junction or tooth emergence from soft tissue. This template can be constructed by using a diagnostic wax-up over the preoperative cast to construct a clear resin template with a guide hole. This provides the surgeon ease of access to bone and uninterrupted visual confirmation of frontal and sagittal positions and angulation. Although underlying bone may dictate some minor variation, the surgeon must stay as close as possible to the template during implant placement. With the aid of computer technology, accurate “virtual” treatment planning can be accomplished. CBCT data are used to produce a three-dimensional reconstruction, which offers the ability to view anatomic structures in cross-section. The ideal prosthetic position can be simulated and the position and angulation of the implant determined. A computer-generated splint can then be constructed with guide sleeves matched to implant drill sizes. This allows precise placement of the implant at the time of surgery. The ultimate result should allow the surgeon to place the implant optimally in bone while maintaining the angulation that provides the best foundation for the final restoration.

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Dental Implantology

5th year **Dr. Auday M. Al-Anee**

Basic Implant Surgical Procedures

Surgical procedures always start with detailed surgical preparation. Preparation for implant surgery requires a thorough review of the patient's chart, including medical and dental histories, operatory notes, radiographs, anticipated implant sizes and locations, surgical guides, surgical sequencing and strategy, possible complications, patient management, anesthesia, operating time, instrumentation, postoperative management, and restorative plan. 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. No postoperative antibiotic administration is necessary.

Once the patient has been draped in a sterile fashion and the surgical team has been gloved and gowned, the patient is anesthetized. In many cases, the implants can be placed using local anesthetic block or infiltration techniques. However, in more complex and lengthy procedures, some type of sedation or general anesthesia may be preferred. Local anesthetics containing vasoconstrictors are usually used for hemostasis. Additional long-acting anesthetics for postoperative pain control may be warranted. It is imperative to have good access to the operative site via effective retraction of cheeks and the tongue. A mouth prop is invaluable.

The surgical site should be kept aseptic, and the patient should be appropriately prepared and draped for an intraoral surgical procedure. Pre-rinsing with chlorhexidine gluconate for 1 to 2 minutes immediately before the procedure will aid in reducing the bacterial load present around the surgical site. Every effort should be made to maintain a sterile surgical field and to avoid contamination of the implant surface. Implant sites should be prepared using gentle, atraumatic surgical techniques with an effort to avoid overheating the bone.

Successful osseointegration occurs predictably for submerged and non-submerged dental implants when proven clinical guidelines are followed. Well-controlled studies of patients with good plaque control and appropriate occlusal forces have demonstrated that root form, endosseous dental implants show little change in bone height around the implant over years of function. After initial bone remodeling in

the first year (1 to 1.5 mm of resorption described as “normal remodeling around an externally hexed implant”), the bone level around healthy functioning implants remains stable for many years afterward. The average annual crestal bone loss after the first year in function is expected to be 0.1 mm or less. Hence, implants offer a predictable solution for tooth replacement.

Regardless of the surgical approach, the implant must be placed in healthy bone with good primary stability to achieve osseointegration, and an atraumatic technique must be followed to avoid damage to bone. Drilling of the bone without adequate cooling generates excessive heat, which injures bone and increases the risk of failure. The anatomic features of bone quality (dense compact versus loose trabecular) at the recipient site influences the interface between bone and implant. Compact bone offers a much greater surface area for bone-to-implant contact than cancellous bone. Areas of the jaw exhibiting thin layers of cortical bone and large cancellous spaces, such as the posterior maxilla, have lower success rates than areas of dense bone. The best results are achieved when the bone-to-implant contact is intimate at the time of implant placement.

One-Stage versus Two-Stage Implant Placement Surgery

Currently, most threaded endosseous implants can be placed using either a one-stage (nonsubmerged) or a two-stage (submerged) protocol. In the one-stage approach, the implant or the abutment emerges through the mucoperiosteum/ gingival tissue at the time of implant placement, whereas in the two-stage approach, the top of the implant and cover screw are completely covered with the flap closure. Implants are allowed to heal, without loading or micromovement, for a period of time to allow for osseointegration. In two-stage implant surgery, the implant must be surgically exposed following a healing period. Some implants, referred to as “tissue level,” are specifically designed with the coronal portion of the implant positioned above the crest of bone and extending through the gingival tissues at the time of placement in a one-stage protocol. Other implant systems, referred to as “bone level,” are designed to be placed at the level of bone and require a healing abutment to be attached to the implant at the time of placement to be used in a one-stage approach.

A one-stage surgical approach simplifies the procedure because a second-stage exposure surgery is not necessary. The two-stage, submerged approach is advantageous for situations that require simultaneous bone augmentation procedures at the time of implant placement because membranes can be submerged, which will minimize postoperative exposure. Mucogingival tissues can be augmented if desired at the second-stage surgery in a two-stage protocol or as part of the one-stage protocol.

Implant Site Exposure

Exposure of the implant site can be accomplished in several ways, including flapless surgery or with 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. This creates the least soft tissue trauma and may provide the best postoperative esthetics in patients with excellent presurgical anatomy and papilla shape. In flapless surgery, the implant and the healing or provisional restoration are placed in a single stage.

When a flap is required, the incision should be designed to allow convenient retraction of soft tissue for unimpeded access for implant placement. This is usually necessary when better access and visualization of the underlying bone is necessary and when additional procedures such as bone or soft tissue grafting are done at the time of implant placement.

• Midcrestal incision: The incision should be made through the keratinized tissue, being sure to place the blade up against the mesial-distal surfaces of the teeth adjacent to the edentulous space. In areas with a narrow zone of keratinized tissue, the incision can be made slightly to the palatal or buccal aspect to allow for keratinized tissue transfer to the buccal or facial aspect and better soft tissue closure. If sulcular incisions are necessary, great care is taken to follow the contour of the sulcus so as not to damage the soft tissue architecture.

• Vertical releasing incision: Using a sharp no. 15 blade, a curvilinear, beveled (~45 degrees), papilla sparring incision should be made to reduce or eliminate incision scarring. It must be ensured that the vertical releasing incision is extended apically enough to allow complete release of the flap.

Implant Placement

Flap Reflection

• Reflection at the papilla is initiated with a periosteal or elevator, using gentle, well-directed, controlled pressure. The periosteal elevator's edge can be used in a "light painting stroke" to cleanly release the subperiosteal fibers. At this point, the flap is developed from the papilla up along the vertical release.

• The dissection is then directed along the sulcular tissue to the point where it meets the crestal portion of the incision. The index finger of the opposing hand supporting the facial aspect of the ridge allows greater control and protection of the flap during reflection.

• The reflection is continued by the elevation sulcularly to the distal extent of the incision.

• Once the buccal flap is reflected, the palatal or lingual flap can be reflected enough to visualize the width of the ridge. Any soft tissue tags should be carefully removed.

• When the buccal flap has been reflected completely, a retractor can be positioned against the bone inside the flap. This allows good visualization of the operative site while protecting the integrity of the flap. It is extremely important to avoid inadvertent trauma to the flap with the tip if the retractors.

Preparing the Osteotomy

The surgeon must confirm that the handpiece and motor are functioning properly: the speed setting on the motor should be checked; it must be confirmed that the drill is spinning in the forward mode. The speed should be set to the appropriate speed as recommended by the manufacturer of the implant system being used.

• All drills, including osteotomy drills, should be copiously irrigated internally, externally, or both when preparing the bone.

• The depth indicator markings on the precision and pilot drills should always be reviewed.

• The entry point and its ideal angulation should be determined with the precision drill. The proper angulation should be verified from different vantage points. A surgical guide is usually used to facilitate orientation.

• Drilling is done with the precision drill at full speed to a depth of 1 to 2 mm short of the depth of the intended implant (e.g., 8 mm deep for a 10-mm implant).

• The area is irrigated and the 2-mm pilot drill positioned in the exact same location after verifying the correct angulation. Once position and angulation are confirmed, the 2-mm pilot drill is run at full speed to the intended depth of the implant (e.g., 10 mm deep for a 10-mm implant).

• The area is rinsed, and the guide pin that corresponds to the intended final size of the planned implant is placed. Use of the guide pin allows the surgeon to evaluate the position, spacing, and angulation of the developing osteotomy. It also helps evaluate where the pin lines up against the opposing dentition.

• The surgeon then determines the location on the twist drill that corresponds to the intended platform position of the implant to the ridge. Typically, the top of the platform would be even with the mesial and distal bone height.

• The tip of the narrowest twist drill is placed into the pilot hole, and the correct position and angulation of the drill are verified. Once confirmed, the drill is run at full speed in a gentle pumping motion. It may be necessary to remove the drill and clean the accumulated bone off the drill. The osteotomy is rinsed, and the drill is then repositioned and the angulation confirmed. The drill is again run at full speed and taken to the final depth of the intended implant. The site is sequentially prepared in this manner.

• The osteotomy is rinsed, and the appropriate guide pin is placed to reevaluate position and alignment.

• The tip of this final twist drill is placed into the opening of the osteotomy; then its position and angulation are verified. Great care is taken to achieve perfect position and angulation, as this is the drill that finalizes the osteotomy.

• Once the drill is properly positioned, it is run at full speed in a gentle pumping motion to the final depth of the intended implant. The osteotomy is then inspected with a thin instrument for possible bone perforation (e.g., sinus communication or buccal wall perforation).

• Immediately after completing the osteotomy, the speed of the motor is changed to the desired and/or recommended torque, measured in newton centimeters (Ncm—typically around 30 Ncm) for the insertion of the implant. If the speed is not changed and the implant is put in at the original setting of 800 to 1500 rpm, the osteotomy could easily be damaged, the implant seated too deep, or primary stability lost.

Inserting Implant

• The implant is opened and placed on the driver that has been inserted into the handpiece. The handpiece must be held such that the tip of the implant is pointing up. This will lessen the likelihood of the implant falling off the driver.

• The tip of the implant is inserted into the osteotomy, and the position and angulation are verified again. The implant is driven into position by keeping light pressure in an apical direction until the implant is almost completely seated or until the motor torques out (approximately 1 to 2 mm short of complete seating).

• Using the hand torque wrench, the surgeon continues to seat the implant, using the torque lever of the wrench to quantify the amount of torque present. If the torque exceeds the lever, the implant is hand torqued to its final position by using the handle of the torque wrench.

• The seating of the implant is finalized by verifying that the platform is even with the mesial and distal heights of bone and that any orientation marker is pointed in the correct position.

• The area is irrigated thoroughly.

• It should be determined if there will be a single- or two-stage healing period. This is determined by the torque value measured on the surgical motor or the hand torque wrench. An implant with a torque value of 35 Ncm or greater is considered

to have good primary stability, and single-stage healing is possible. If so, an appropriate-sized healing abutment is placed. If a two-stage process is required, then an appropriate-sized cover screw is placed.

• The abutment should protrude 1 to 2 mm through the tissue. A tapered abutment rather than a parallel abutment must be determined. The intended tissue emergence of the planned restoration helps determine whether the healing abutment is tapered or parallel.

• The healing abutment is placed onto the insertion wrench, again by holding the screw pointing up. The abutment is screwed into the implant and tightened with finger pressure, making sure that no tissue is caught under the abutment.

Suturing Flap

- The flap is sutured using some type of resorbable suture (chromic gut or Vicryl) or nonresorbable suture (proline).
- The anterior papilla is secured first. The buccal aspect of the papilla is entered with the suture needle, which is passed through the embrasure to engage the palatal tissue. The needle is then positioned lower on the palatal tissue and penetrated and brought through the embrasure to the buccal and the papilla engaged apically to the first entry point.
- The vertical release is then sutured, followed by the mesial and distal sides of the abutment. These are simple interrupted sutures tied in the same fashion as the first suture described.

Postoperative Management

A radiograph should be taken postoperatively to evaluate the position of the implant in relation to adjacent structures such as the sinus and the inferior alveolar canal and relative to teeth and other implants. This radiograph also serves to verify the complete seating of the cover screw or healing abutment.

Patients should be given analgesics. Mild to moderate strength analgesics are usually sufficient. Antibiotics are often given prophylactically before surgery but are usually not required in the postoperative period. Patients may also be instructed

to use 0.12% chlorhexidine gluconate rinses for 2 weeks after surgery to help keep bacterial populations at a minimum during healing. The patient is evaluated weekly until soft tissue wound healing is complete (approximately 2 to 3 weeks). If the patient wears a tissue-borne denture over the area of implant placement, the denture can be relined with a soft liner after 1 week. Interim partial dentures or orthodontic retainers with an attached pontic may be worn immediately but must be contoured to avoid soft tissue loading over the implant site.

Uncovering

The healing time or the length of time necessary to achieve osseointegration varies from site to site and from patient to patient. Insertion torque values, quality of bone, bone grafts, patient health, location, number of implants, and soft tissue health all have an impact on healing time. Typical healing times are 4 to 6 months. In single-stage surgery, no surgical uncovering is necessary. The implant stays exposed via the healing abutment after surgery and throughout the healing phase. After an appropriate integration time, restoration of the implant can proceed.

In a two-stage system, the implant must be surgically uncovered and a healing abutment placed. The goals of surgical uncovering are to attach the healing abutment to the implant, preserve keratinized tissue, and modify the form or thickness of tissue. A soft tissue healing period after uncovering must be allowed before restoration of the implant can take place, typically 2 to 4 weeks.

The simplest method of surgical uncovering is the “tissue punch”. This method of uncovering utilizes a soft tissue punch equal to or slightly larger than the diameter of the implant placed. The implant is palpated through the tissue to determine its location. The tissue punch is placed directly over the implant circumference and twisted through the soft tissue thickness, taking care not to damage the bone at the level of the implant platform. The punch is then removed, along with a precisely determined piece of tissue that was lying directly above the implant, easily exposing the implant cover screw. The cover screw is then removed, and an appropriate sized and appropriate-shaped healing abutment is placed. The advantage to this technique is that it is less traumatic, no periosteum needs to be reflected, and only a short soft tissue healing time is required. This technique does, however, require an adequate zone of keratinized tissue so that the implant can be

accurately located. Disadvantages to this technique include sacrifice of a portion of the keratinized tissue, inability to visualize the bone surrounding the implant, and the inability to directly visualize the precise abutment–implant interface.

If the implants cannot be accurately located, if the clinician needs to visualize underlying bone, or if a slight keratinized tissue transfer is indicated, then a crestal incision with the creation of a slight soft tissue flap is required to uncover the implants. If an adequate zone of keratinized tissue is present, the soft tissue flap can be contoured with a scalpel, scissors, or a punch to conform to the shape of the healing abutment. This allows for a nicely shaped and contoured soft tissue cuff around the healing abutment and eventually the final implant restoration. Obvious advantages to this technique include easy access, minimal invasiveness, and ability to directly visualize the bone surrounding the implant and to precisely fit the healing abutment to the implant platform. The disadvantage to reflecting a flap during uncovering is the possibility of bone loss due to stripping the periosteum from bone during the uncovering. Advanced techniques for cases with an inadequate zone of attached tissue include tissue transfer procedures, tissue grafting, and split-thickness apically repositioned flaps.

Implant Stability

Initial implant stability is one of the most important predictors of long-term implant success. This depends on the depth and density of bone, implant size, and precision of the surgical technique. A good sense of implant stability can be obtained during the seating process and by verifying adequate torque resistance capability of the seated implant.

Radiofrequency analysis has been used to measure and verify implant stability. This technology involves attaching a transducer to an implant and applying a steady-state resonance frequency to the implant. The advantage of this technology is that it is not dependent on measuring implant movement in just one direction but rather by evaluating the complete bone-implant interface.

Complications

Implant placement surgery can be performed with great accuracy and with little complication if the case has been diagnosed, planned, and surgically performed well. However, as with any surgical or clinical procedures, complications are possible and include the following:

• 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. The implant may be placed too close to an adjacent tooth root or too far to the mesial, distal, or buccal aspect, thus compromising bony support. The implant can be placed too far into bone, making prosthetic access difficult. If the implant is not placed deep enough into bone, leaving threads of the implant body above the osseous crest, there will be compromise to bony support, soft tissue health, hygiene, and esthetics.

• Surgical technique complications such as a tear of the soft tissue flap, poor closure of the incision, or excessive soft tissue trauma from retraction may result in tissue dehiscence, infection, and eventual loss of the implant. Poor attention to detail in preparation of the osteotomy such as overdrilling the diameter of the osteotomy could result in poor prognosis for integration.

• 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 (altered sensation that the patient does not find painful, e.g., numbness, tingling), or dysethesia (altered sensation that the patient finds painful or uncomfortable). If the implant invades the maxillary sinus or the nasal cavity, this may result in an infection. Bone structure compromise can present as overthinning of the buccal or facial plate or dehiscence or fenestration of overlying tissue. Bone perforation can occur at the inferior border of the mandible because of inaccurate drilling depth or on the lingual aspect of the posterior mandible because of the lingual undercut from poor positioning or angulation of the implant drills.

• Mechanical complications can present as an implant platform fracture because of excessive insertion torque. If the osteotomy is improperly prepared in dense bone,

it is possible to get the implant "stuck" in bone, short of complete seating, making it extremely difficult to retrieve the implant.

• Incision line opening can occur from inadequate suturing or not having tension-free closure.

• Esthetic complications can occur from poor implant positioning or angulation, making proper prosthetic restoration unrealistic.

Implant Components

❖ Implant Body or Fixture

The implant body, or fixture, is the implant component placed within bone during the first stage of surgery. Most contemporary implant fixtures are referred to as root form implants, taking the form of a cylinder or a tapered cylinder, and are made of titanium or titanium alloy. Most current implant fixtures have an external threaded design, although historically, there have been smooth-surfaced implants that were pressed into position. A wide variety of external thread designs and different surface textures and coatings that attempt to maximize implant stability and the process of osseointegration have been offered by manufacturers. Most implant fixtures incorporate an antirotational design feature at the interface of the adjoining prosthetic components. This antirotational feature may be located internally or externally to the implant platform.

❖ Cover or Healing Screw

After placement of the implant fixture in a two-stage surgical approach, prior to suturing, the implant fixture is sealed at its platform with a low profile, intra-implant cover screw. It is important that the surgeon be sure that the cover screw is fully seated on the implant platform prior to suturing the flap to prevent bone from growing between the screw and the implant. In the second-stage uncovering procedure, the cover screw is removed and replaced with a healing abutment.

❖ Healing or Interim Abutment

Healing abutments are dome-shaped intra-implant screws that provide permucosal access to the implant platform. Healing abutments are placed at the completion of the implant placement surgery in a one-stage surgical approach or after uncovering in a two-stage surgical approach. Healing abutments are made of titanium or titanium alloy. The abutments can be parallel walled or tapered and range in height from 2 to 10 mm. The height of the abutment used is determined by the thickness of tissue present. The healing abutment should project 1 to 2 mm superior to the height of the gingival tissue. A tapered healing abutment is used to help shape soft tissue to a more appropriate emergence for the planned restoration (e.g., a crown). A parallel-walled abutment would be used where the tapered emergence is not necessary (e.g., a retentive bar for an overdenture). It is important to allow for sufficient healing of soft tissue after placing the healing abutment prior to making any impressions for the final prosthetics.

- Impression Coping

Impression copings facilitate transfer of the intraoral location of the implant to the same position on the laboratory cast. Impression copings can be either screwed into the implant body or screwed or snapped onto an implant abutment.

Typically, the impression transfer can be either closed-tray transfer or open-tray transfer. The closed-tray technique captures the index of the impression coping, and after the impression is removed from the mouth, the impression coping is unscrewed from the implant and placed along with an implant analog back into the impression. An open-tray transfer uses a specific impression coping that is designed to emerge through the impression tray. When the impression is ready to be removed from the mouth, the impression coping is unscrewed and pulled out in the impression. The open-tray method is considered the more accurate transfer method and is indicated when large-span frameworks or bar structures are planned or when the implants are too divergent to easily remove the impression tray in the closed-tray technique. A heavier-bodied polyvinyl siloxane or polyether impression material is recommended. Prior to making the transfer impression, it is imperative that the clinician take a radiograph to confirm that the impression coping is accurately seated on the implant platform. If the impression coping is not properly seated, the accuracy of the transferred location of the implant will be incorrect. On

completion of the transfer impression, an implant analog is screwed onto the impression coping to allow the fabrication of a laboratory cast.

- Implant Analog or Replica

Implant analogues are manufactured to replicate exactly the top of the implant fixture (fixture analog) or abutment (abutment analog) in the laboratory cast. Both are screwed directly into the impression coping. The impression coping or analog component is then placed back into the impression (closed-tray transfer) or is maintained in the impression (open-tray transfer), and the impression is ready to be poured. It is tremendously beneficial to create a soft tissue moulage in the impression prior to pouring. The soft tissue moulage is an elastomeric product that simulates the soft tissue portion on the dental cast. This allows the laboratory technician to have an accurate and flexible representation of soft tissue. The laboratory technician then has a working model that can be used to fabricate either the abutment or the framework for the intended prosthetic design.

- Implant Abutment

The abutment is the portion of the implant that supports or retains a prosthesis or implant superstructure. A superstructure is defined as a metal or zirconia framework that attaches to either the implant platform or the implant abutment(s) and provides retention for a removable prosthesis (e.g., a cast or milled bar retaining an overdenture with attachments) or the framework for a fixed prosthesis. Abutments are described by the method in which the prosthesis or superstructure is retained to the abutment. Abutments can be divided into three main categories: (1) screw retained, (2) cement retained, and (3) prefabricated attachment abutments. A screw-retained abutment uses a screw to retain the prosthesis or superstructure, whereas a cement-retained abutment uses cement to retain the prosthesis or superstructure. A prefabricated attachment abutment (e.g., locator or O-ring attachments) helps retain a removable prosthesis.

- Prosthesis Retaining Screw

Prosthesis retaining screws are intended to attach prosthetic abutments, screw-retained crowns, or frameworks to the implant fixture or implant abutment. The screws are generally made of titanium, titanium alloy, or gold alloy and are sized specific to the type, size, and design of the implant or abutment system. The screws typically have a hex or square design to accept a specific size and shape of wrench or driver. Most prosthesis screws are tightened to specific tolerance by a torque wrench or handpiece. The torque value is measured in newton centimeters and typically ranges from 10 to 40 Ncm.

Defining implant outcomes

Some implant outcomes are reported as the presence or absence of the implant at the time of the last examination, regardless of whether the implant was functional, suffered from bone loss, or had other problems. This type of assessment is a measure of **implant survival** and should not be confused with implant success. In contrast to such an overly simplified assessment, some investigators report implant outcomes using specific criteria to determine implant success.

Implant success is defined by specific criteria used to evaluate the condition and function of the implant. Criteria for implant success have been proposed in the literature but have not been used consistently. The problem is that a universally accepted definition of implant success has not been established. In the classic definition, Albrektsson and colleagues defined success as an implant with no pain, no mobility, no radiolucent peri-implant areas, and less than 0.2 mm of bone loss annually after the first year of loading.

Implants that are osseointegrated but not functional are referred to as **sleepers** and should not be considered successful merely because they are present and osseointegrated.

Aesthetic Results and Patient Satisfaction

The ultimate goal of treatment is to achieve natural-appearing, optimally functioning, implant-supported tooth replacements. Proper tooth dimensions and contours, and ideal soft tissue support are key factors for successful aesthetic outcomes. If crown form, dimension, and shape and gingival harmony around the implants are not ideal, the patient may consider the implant restoration

unacceptable, because the result does not represent a natural dental profile. For some patients, such as those with severe alveolar deficiency, an ideal aesthetic outcome may be impossible because reconstructive surgical procedures are complex, require extensive time, and remain unpredictable. For others, a less-than ideal aesthetic outcome may be acceptable.

Aesthetic problems and dissatisfaction happen when results do not match a patient's expectations. Satisfaction with the aesthetic outcome of implant prosthesis varies among patients. The risk of failure is greater among those with high aesthetic demands and risk factors such as a high smile line, thin periodontal soft tissues, or compromised bone support.

Good Luck

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Laser and Cryosurgery in oral and maxillofacial surgery

In conventional surgery the scalpel is used to cut or excise tissue during surgical procedures. The scalpel, however, has limitations as a surgical tool. When an area of tissue is excised hemorrhage may be difficult to control and a flap or graft may be needed to cover the defect and prevent infection and scarring. Benign and hyperplastic lesions are mostly treated by conventional surgical excision of the lesion; however, there are other modalities for the treatment of such lesions by laser or cryosurgery.

Laser

Laser is an acronym derived from 'Light Amplification by Stimulated Emission of Radiation'. Lasers have been used in surgery since more than five decades and becoming standard equipment in most major hospitals around the world, and many surgical procedures now indicate their preferred use. Different types of lasers are used in many branches of surgery and medicine. The properties of laser light depend on wavelength which is measured by nanometer (nm). It emits light within or beyond the visible wavelengths, and its power may vary from a milliwatt to megawatts. Ordinary light waves from a normal source not produce a powerful cutting beam because they emerge randomly at various wavelengths, while laser light is **"coherent"**; this means that the waves are in the same phase, **"monochromatic"** all have the same wavelength, and **"unidirectional"** all waves are parallel. So that none of the energy from the laser light source is lost by interference. Compare a 60 W ordinary light bulb producing light and heat with a 60 W laser beam that would cut metals. Output may be in a continuous wave or pulsed. Pulse waves are with duration of 0.1 second or less. Q-switched lasers produce pulses of less than 1 µs, which deliver very high energy without generating excessive heat.

Laser effects on tissue may be: Photothermal, Photomechanical or Photochemical therapy.

There are different types of lasers and each type has a specific biological effect. For that reason, it is imperative for the clinician to select the laser type according to the requisite.

Classification of laser according to power:

There are two types of lasers according to the power:

1. The low-energy laser: Diode laser; the active medium of the diode laser is a solid-state semiconductor made of aluminum, gallium, arsenide, and occasionally indium. All diode wavelengths are primarily absorbed primarily by tissue pigment (melanin) and hemoglobin. These are poorly absorbed by the hydroxyapatite and water. Diode laser as Gallium-Arsenide laser (average power of 5 mW) has a biostimulation effect by stimulating cell growth of the epithelium, connective tissue, bone and stimulate regeneration of nerve cells. Furthermore, it has anti-inflammatory effect, pain alleviation. Biolase laser is GaAsP Semi-conductor diode utilized for TMJ pain relief and teeth whitening. Helium-neon laser produces visible light which used as aiming

beams, pointers, caries detector and stimulation of wound healing. Argon laser produces visible light; it is passes through water but is absorbed by pigment such as melanin or hemoglobin so mainly used for treatment of vascular lesions.

The high–energy laser as CO2 (Carbon dioxide), Nd:YAG (Neodymium: Yttrium Aluminum Garnet), Er:YAG (Erbium: Yttrium Aluminum Garnet), and Er,Cr:YSGG (Erbium, Chromium: Yttrium Scandium Gallium Garnet) laser produces invisible UV light. The CO2 laser wavelength has a very high affinity for water, resulting in rapid soft tissue removal and hemostasis on contact. It has a very shallow depth of penetration. Cell structure is destroyed by expansion as water boils, denaturation of protein also occurs but with a very narrow layer of tissue damage below the treated area and better healing, so it is used for cutting, coagulating, cauterizing and destructive effect; that if the high energy laser is focused, the laser can be used as a bloodless scalpel, and when the beam is defocused the laser will vaporize soft tissue, which is surrounded by a thin layer of heat coagulated tissue in which blood vessels and lymphatic channels are sealed. Carbonization during treatment leaves black particles on the surface. The CO2 laser has the ideal properties for soft tissue treatment; it is used mainly for biopsy, surgical excision of benign and premalignant lesions, gingivectomy, frenectomy, flap incision, implant exposure and preprosthetic surgery with minimal bleeding, scarring and postoperative complications.
The Nd: YAG laser wavelength is highly absorbed by the pigmented tissue, making it a very effective surgical laser for cutting and coagulating soft tissues, with good hemostasis.
The Erbium wavelengths have high affinity for hydroxyapatite and water. It is the laser of choice for treatment of dental hard tissues (cavity preparation, apicoectomy) and can also be used for soft tissue ablation.
Waterlase laser (the active medium Er,Cr:YSGG), 2780 nm used for tooth cavity preparation, gingivectomy, frenectomy, biopsy, and treatment of peri-implantitis with minimum amount and in some cases without anesthesia. In addition, it has a biostimulation effect which promote wound healing and hemostasis.
Dual diode laser 10 W (5 W, 810 nm coagulation and 5 W, 980 nm ablation) used for the treatment of aphthous ulcer, denture sore, flap incision, and gingivectomy.
The specific tissue cut and the ability to support the healing process, makes laser really different from an electrosurgical scalpel (cautery). Electrosurgery damages minimum 200-400 cells layers, while a Diode maximum 2 to 5 cell layer, thus allowing a faster healing. Laser can target in a very specific way depending on its wavelength (water and hydroxyapatite for Er:YAG, on the other hand, dark pigments as melanin and hemoglobin for Nd:YAG laser). In contrast, electrosurgery is absolutely nonspecific.
Er:YAG, CO2 and Diode lasers used for treatment of peri-implantitis by complete elimination of bacteria loaded titanium dental implant and these lasers do not disturb titanium surface. However, bone graft along with implant decontamination treatment may be more favorable for the treatment of peri-implantitis than nonsurgical decontamination procedure alone.

Table: Therapeutic lasers (Types, wavelength & uses):

Type and mode	Wavelength and color	Uses
Excimer (pulsed)	190-351nm UV	Tooth surface conditioning & dentine hypersensitivity.
Argon (continuous)	488 nm blue - 515 nm green	Vascular lesions (port-wine naevus), composite curing.
KTP (potassium-titanyl phosphate), (pulsed)	532 nm green	Telagiectasia, tonsillectomy, salivary duct stricture, tattoo removal.
Tunable dye laser (cont. or pulsed)	504 nm green - 632 nm red	Vascular lesion, tattoo removal, dentine hypersensitivity
Helium-neon (cont.)	633 nm red	Guiding beams and pointers, caries diagnosis, stimulation of wound healing.
Diode laser (pulsed or cont.)	650 nm - 950 nm IR	stimulate the healing process and reduce postoperative complications, treatment of aphthous and herpetic stomatitis, and teeth whitening.
Dual diode (pulsed or cont.)	810 nm and 980 nm IR	gingivectomy, excision of hypertrophic tissue, frenectomy.
Nd: YAG (cont., pulsed or Q-switched)	1060 nm IR	gingivectomy, peri-implantitis, excision of hypertrophic tissue.
Er: YAG (pulsed)	2940 nm IR	Skin resurfacing, caries removal, cutting of enamel, dentine & bone.
Carbon dioxide (cont., pulsed or Q-switched)	10600 nm IR	Tumor removal, coagulation of small vessels, gingivectomy, implant exposure, denture induced hyperplasia, scaling, cutting of enamel, dentine & bone.

The advantages of laser using:

1. Excision of wide area with minimum scarring.
2. Reduce bleeding during surgical operation.
3. Moderate pain and swelling postoperatively.
4. Reduce healing time.
5. Bacterial decontamination of the periodontal pocket and in peri-implantitis.
6. No potentiating of malignant changes.
7. No need for mucosal or skin graft.

Hazards and precautions required when using laser:

When laser is performed in oral and maxillofacial surgery some precautions must be taken:

1. Special measures are carried out to protect the endotracheal tube as well as the adjacent and peripheral tissues such as teeth and lips from damage, so wet towels must be placed over them. Anesthetic tube may be pierced, resulting in ignition of anesthetic gases within the lungs, which is fatal.
2. Laser protective eye glasses must be worn by all persons in the operating room which is specific for the used laser wavelength, and use non-reflective instruments (achieved by sand blasting). The laser beam is destructive on direct exposure and by the reflection of laser from shiny metal objects into the operator's eyes, will cause severe thermal damage to the cornea, lens and retina.
3. The potential effects of plume or surgical smoke produced by high energy laser. Toxic chemicals are produced when tissue is burned also blood aerosols and viruses such as human papilloma virus in the laser plume is thought to be capable of transmitting disease. A face mask alone does not provide adequate protection, and smoke evacuation (vacuum) is recommended.
4. Training and certification of users.
5. Restricted access to laser area, warning lights and notices

Cryosurgery

The physical effect of cryosurgery offers alternative method of removing or devitalizing tissue. Cryosurgery mechanism relies on the fact that rapid freezing and thawing of tissues causing cell death and necrosis. Cryosurgery is thought to make ice crystals in and around cells; causing disruption of cell membranes and contents. Blood flow to the area is reduced so that a larger and colder ice ball is achieved at the next application. Vascular damage also results in ischemic necrosis.

The technique of freezing selected areas in the oral cavity is accomplished by a cryoprobe tip contacting lesion tissue after refrigerant liquid has entered the tip in controlled amount. The temperature of the contacted tissues is lowered to around –150 °C by liquid Nitrogen, so cell injury and subsequent necrosis occur as a result of this brief contact. Recently cryosurgery machine uses liquefied Argon gas, this gas creates ice ball at the tip of the cryoprobe and freeze the lesion tissue at temperature of – 40 °C. Furthermore, Nitrous oxide units are commonly available in hospitals and are suitable for most oral applications.

The temperature of the refrigerant liquid is determined by the boiling point. Cryoprobe tips come in a variety of shapes and sizes. Flat or dome-shaped tips from 3-10 mm are useful in the mouth. Long, narrow and insulated probes are available for freezing nerves.

Refrigerant properties of liquid cryoprobe systems		
Type	**Boiling point**	**Surface temperature**
Liquid nitrogen	-196 °C	-150 °C
Nitrous oxide	-89 °C	-75 °C
Carbon dioxide	-78 °C	-50 °C
Liquid nitrogen spray	-196 °C	-196 °C

Cryosurgery technique:

Under local anesthesia the probe is applied to the lesion and switched on. The probe is held firmly onto the lesion until an ice-ball forms and freezing is continued. The time of application will usually be about 1 minute. The probe should not pull away because it will be adherent to the lesion. For vascular lesions, the effect is enhanced by compressing the lesion with the probe, which decreases blood flow. On turning the machine off there should be a rapid thaw and the probe is released. One or two further applications are made after 1 minute to allow a complete damage to the lesion.

Protocols suggest that for most benign mucosal lesions a 1–2 minutes freeze/thaw cycle using a cryoprobe is sufficient. Premalignant lesions are recommended to undergo three 2-minute freeze/thaw cycles. For smaller lesions, shorter freeze cycles (20–30 seconds) are adequate. Experience is necessary to judge the amount of treatment and the extent of the freeze.

Uses of cryosurgery:

1. Ablation of surface lesions such as viral warts and small benign tumors.
2. To destroy fungating masses so improve patient comfort because of little postoperative created defect.
3. Treatment of hemangiomas. The large lesion should be treated by multiple sessions, while small lesion within the oral cavity can be treated by one or two freeze/thaw cycles on one session. Capillary haemangioma of the skin are best treated by multiple short (10 seconds) freezes at fortnightly intervals so as to avoid scarring.
4. Cryosurgery also used for the treatment of trigeminal neuralgia because nerve can be blocked without causing the secondary neuralgia that often follows nerve section, avulsion, or alcohol blocks. Pain relief lasts for several months, although there is a recurrence but the return of sensation before recurrence of the pain is said to be an advantage to avoid irreversible nerve damage. Repeated applications to the affected nerve mainly by intra oral approach may need for the treatment of neuralgia.
5. Treatment of bone cavity after curettage of odontogenic keratocyst or central giant cell granuloma to reduce recurrence. A water-soluble gel may be used to aid contact liquid nitrogen with the bone surface to provide adequate effect. A liquid nitrogen spray would be preferable because it produces a much faster and deeper freeze. Care must be taken to protect mucosal flap and adjacent soft tissue, especially with liquid nitrogen gas.

The advantages of using cryosurgery:

1. Used for medically compromised patient with advanced neoplastic fungating mass.
2. Minimal blood loss
3. Minimum postoperative pain
4. Maintain bone structure
5. Good recovery of nerve function
6. Excellent for hemangiomas

The disadvantages and complications of using cryosurgery:

1. Recurrence of the lesion because difficult in assessing extent of tissue destruction.
2. Damage to nearby healthy tissue especially nervous tissue led to alteration of sensation.
3. Significant postoperative edema (airway embarrassment).
4. Not used to cut tissues.
5. The whole lesion not available for histopathological study.
6. Dysplastic changes can be potentiated. Tumor growth may be accelerated after cryotherapy, so malignant and premalignant lesions are therefore better treated by other methods.
7. Hypertrophic scarring.
8. Hypo or hyperpigmentation.

Non- odontogenic tumors

Important points

- Nonodontogenic tumors of the jaws are common in the pediatric population; these tumors include giant cell lesions, fibro-osseous lesions, and desmoplastic fibroma.
- Giant cell lesions of the maxillofacial skeleton range clinically from slowly growing, asymptomatic radiolucency discovered on routine radiographs to rapidly expanding, aggressive tumors characterized by pain, root resorption, and a high recurrence rate.
- Fibro-osseous lesions represent a group of benign conditions that are characterized by replacement of normal bone with fibrous connective tissue that gradually undergoes mineralization.
- Desmoplastic fibroma is recognized as a benign bony neoplasm and as the intraosseous counterpart of soft tissue fibromatosis.

Giant cell lesions

Giant cell lesions of the maxillofacial skeleton range clinically from slowly growing, asymptomatic radiolucency discovered on routine radiographs to rapidly expanding, aggressive tumors characterized by pain, root resorption, and a high recurrence rate. They are generally considered to be nonneoplastic, although some lesions tend to behave aggressively like a neoplasm. Names such as central giant cell granuloma, giant cell lesion, giant cell tumor, or giant cell reparative granuloma have added to the complexity and confusion of this lesion. The reparative term has been rejected in recent times because the lesions are typically destructive and aggressive, never reparative. The term granuloma is also a misnomer; however, the central giant cell granuloma has now become synonymous with a lesion in the maxillofacial skeleton.

Central giant cell granuloma (CGCG) was first described by Jaffe in 1953 as a reparative granuloma to convey that it was not a neoplasm. The central giant cell lesion is a benign localized proliferation that is osteolytic and sometimes aggressive, consisting of fibrous tissue containing multinucleated giant cells,

hemorrhagic areas, and deposits of hemosiderin, and occasionally involving a bone reaction.

Clinical Findings

These lesions occur in all ages; however, they are seen predominantly in children and young adults and are usually diagnosed before 30 years of age. Female patients are affected more often than male patients, and some studies have shown a rate of about 60% in women. The mandible is affected more often than the maxilla. The premolar and molar regions of the mandible are more affected than the ascending ramus region, and, rarely, there is involvement of the mandibular condyle or the maxillary sinus. In most cases it presents as an asymptomatic lesion detected on routine radiographic examination; however, pain, paresthesia, perforation of cortical bone, mobility, and loss of teeth are reported in aggressive lesions.

Demographics:

- ❖ Predilection for women
- ❖ Occurrence in the first 3 decades of life
- ❖ Mandible more than maxilla, most often anterior to the first molar
- ❖ Most often a solitary lesion

Physical examination:

- Asymptomatic, but can be associated with discomfort, pain, paresthesia
- Teeth can be displaced or nonvital
- Maxillary lesions may present as nasal obstruction or epistaxis
- May present as a bulge of the alveolar ridge

Imaging

Radiographically, these lesions are usually mixed radiolucent/radio-opaque and multilocular. Other findings have been described, such as loss of lamina dura, root resorption, and displacement of teeth, and cases with localization in the region mimicking periapical cysts or periapical granulomas have been reported. They typically appear as an expansile radiolucency with scalloped margins containing numerous thin septa of wispy bone and osteoid.

Characteristic findings on radiographs:

- Loss of lamina dura
- Resorption of teeth in aggressive lesions
- Smooth or scalloped margins
- Ill-defined or corticated
- Can cross the midline
- Contains numerous thin septa of wispy bone and osteoid

Pathology

A giant cell lesion is a localized tumor of multinucleated giant cells that represent osteoclasts in a matrix of spindle-shaped mesenchymal cells.

Histopathology:

- Lobulated bluish mass of proliferating vascular connective tissue
- Osteoclast-like giant cells
- Hemosiderin deposition
- Spindle-shaped fibroblastic or myofibroblastic cells in a fibrous or fibromyxoid vascularized tissue

Diagnostic Dilemma

Several other lesions can resemble a giant cell lesion microscopically and must be considered in the differential diagnosis, which include:

Brown tumor of hyperparathyroidism

It is histologically indistinguishable from CGCG. In the pediatric population this is associated with chronic renal failure and secondary hyperparathyroidism. Primary hyperparathyroidism is rare in children. This lesion is a result of bone resorption in a setting of increased parathyroid hormone level. To help to differentiate this tumor, serum calcium and alkaline phosphate levels are increased and serum phosphate levels are low. Chronically increased serum creatinine and blood urea nitrogen levels are also seen in patients with chronic renal disease.

Cherubism

This is indistinguishable from CGCG; however, lesions are symmetric and occur near the angles of the mandible. They do not affect the condyle or the body of the mandible. In the maxilla the tuberosities are affected and sometimes the anterior portion of the orbits. It is an autosomal dominant familial disease and has been mapped to chromosome 4p16.3, which codes for a c-Abl binding protein. It is seen in early childhood, as early as 14 months. These lesions regress as the patient ages and bone growth ceases.

Aneurysmal bone cysts

These lesions are seen mostly in patients younger than 30 years, with peak occurrence in the second decade. These lesions on histologic examination contain giant cells as well as reactive bone. It is unlikely that they are result of trauma and some of them are considered to be neoplastic. They are localized mostly to the posterior mandible and radiographically appear unilocular or multilocular, predominantly radiolucent. The involvement of soft tissue increases the chances of recurrences.

Fibrous dysplasia

On histologic examination they have limited foci of giant cells. They can also appear similarly on radiographs during the early stages.

Treatment

Clinicians must take into account the behavior, clinical components, and biological components of the giant cell lesions when determining how to manage them. For all intents and purposes, clinicians attempt to identify giant cell lesions as either aggressive or nonaggressive. Nonaggressive giant cell lesions predictably respond to enucleation and curettage. Adjuvant therapies such as steroids or calcitonin are rarely used because patients with nonaggressive lesions typically respond to curettage and enucleation alone. Recurrence for these lesions is low. Aggressive giant cell lesions clinically present as rapidly expanding masses in younger patients. These giant cell lesions should be resected with a 1.0-cm histologically clear margin. Postoperative adjuncts such bisphosphonates, intralesional steroid injection, calcitonin therapy, or systemic interferon alfa therapy have all been

reported with various levels of success. Brown tumor of hyperparathyroidism can be treated by curettage but usually regresses once the endocrine abnormality has resolved.

Fibro-osseous lesions

Fibro-osseous lesions (FOLs) of the craniofacial complex represent a group of benign conditions that are characterized by replacement of normal bone with fibrous connective tissue that gradually undergoes mineralization. The name given to this group presents a process rather than a diagnosis.

Nature of the Problem

The subtypes of these benign FOLs present similar microscopic features, but clinical classification has represented a challenge. These lesions are fibrous dysplasia (FD), ossifying fibroma, and osseous dysplasia. Each of these subtypes has different clinical and radiological presentations. They show a wide range of biological behavior from dysplasia to benign neoplasia with occasional recurrence. Radiologic examination is central to their diagnosis because histopathology for all FOLs is similar. Furthermore, once diagnosed the management of each is different.

Fibrous Dysplasia

Monostotic fibrous dysplasia

As described by its name, this disease is limited to 1 bone. This disease is the most common of 2 types with an incidence of 80% of reported cases. The jaws are the most commonly involved bone, in particular the maxilla. They are associated with the GNAS1, which can occur anytime during pregnancy, childhood, or adulthood.

Polyostotic fibrous dysplasia

FD is considered polyostotic once 2 or more bones are involved. It can be considering syndromic if other abnormalities are found:

1. Jaffe-Lichtenstein syndrome

- Polyostotic FD
- Cafe´ au lait spots

2. McCune-Albright syndrome

- Polyostotic FD
- Cafe´ au lait spots
- Multiple endocrinopathies: sexual precocity, pituitary adenoma, and hyperthyroidism

3. Mazabraud syndrome

- Polyostotic FD
- Intramuscular myxomas

These children typically have a facial asymmetry. In the long bone counterpart, they are plagued with pathologic fractures with ensuing pain and leg length discrepancy. Renal phosphate wasting is typically seen in these patients. This condition is caused by the release of fibroblast growth factor 23 (FGF23), which is produced and released by affected bone. The cafe´ au lait pigmentation is irregular (looking like the coast of Maine) compared with those of neurofibromatosis, which are regular (like the coast of California).

Ossifying Fibroma

Among FOLs, this one represents a true neoplasm. It is generally accepted that there are 2 forms based on histology and clinical behavior. They are the trabecular ossifying fibroma (TOF) and psammomatoid ossifying fibroma (POF). They were first distinguished as 2 entities based on histology and age. TOF occurs mostly in children 8 to 12 years old and POF in those 16 to 33 years old. Most of the reported cases of POF occur in the orbit, paranasal sinus, and calvaria, with only 25% in the maxilla and mandible. TOF overwhelming occurs in the jaws, in particular the maxilla. Radiographically these lesions are indistinguishable.

Osseous Dysplasia

These lesions are rarely seen in the pediatric population but are categorized with the FOLs. Other names for this disease include cemento-osseous dysplasia, and it can be seen in a focal, periapical, or florid pattern, hence the names: focal cementoosseous dysplasia, periapical cemento-osseous dysplasia or cementoma, or cemental dysplasia; and florid cemento-osseous dysplasia.

Clinical Findings

These lesions are benign and non-inheritable. They are typically seen in the second and third decades, with the pediatric variant seen much earlier. There is an equal male/female predilection in FD, whereas ossifying fibroma tends to occur mostly in female patients and in the mandibles. Small lesions are discovered as incident findings on radiographs. Larger lesions presents as painless swelling of the involved bone. There is usually a resultant facial asymmetry, which is striking in some cases.

Imaging

The radiographic appearances of these lesions have been key to helping with the diagnosis and ultimately the management. They typically have varying degrees of radio-opacity based on their maturity.

Characteristic findings on radiographs:

FD:

- Ground-glass appearance
- Expansion of buccal and lingual cortices
- Displacement of the inferior alveolar canal
- Ill-defined lamina dura
- Not well demarcated from adjacent tissue
- Radiolucent or mixed

Ossifying fibroma

- Well demarcated
- Unilocular with sclerotic border
- Can be radiolucent or radio-opaque
- Root resorption or divergence possible

Osseous dysplasia

- Mixed radiolucent/radiopaque
- Well defined with irregular borders
- Usually associated with dentition

Treatment

Management of FOLs depends on their diagnosis. The histopathology is often limited in aiding the diagnostic dilemma. It is critical to put the entire clinical picture together to arrive at the diagnosis and hence render the appropriate treatment. For FD, this can be particularly challenging in cases that are polyostotic and involve the craniofacial bones. With skeletal maturity the growth of these bones tends to stabilize. The cosmetic deformity, ensuing psychological issues, and function problems are what drive the surgical intervention. Despite recontouring, there are reported cases of 25% to 50% regrowth of the bone, especially when this is done at a young age. For the polyostotic variant, treatment with intravenous pamidronate and oral alendronate have shown success, especially in pain relief and skeletal strength. Clinicians must keep in mind the risk of transformation to osteosarcoma if it is treated with radiotherapy.

The treatment of ossifying fibroma involves enucleation of the tumor. If there is considerable bony destruction, resection and bone grafting are warranted. The prognosis is good and the rate of recurrence is slow. There is no reported case of malignant transformation of ossifying fibroma.

Desmoplastic Fibroma

Desmoplastic fibroma is recognized as a benign bony neoplasm and as the intraosseous counterpart of soft tissue fibromatosis. It has a locally aggressive behavior and a high recurrence rate. It is rare, with an incidence of less than 1% of all bone tumors. This fibroma represents the osseous manifestation of aggressive fibromatosis that was first reported by Jaffe in 1958.

Clinical Findings

The desmoplastic fibroma is typically seen in the younger population with an average age around 16 years. There is no sex predilection. These lesions are commonly seen in the mandible (22%), femur (15%), pelvic bones (13%), radius (12%), and tibia (9%), with the ascending ramus being the most common of the gnathic sites. Typically they present as a painless swelling with symptoms presenting as the tumor invades adjacent structures.

Physical examination:

- Asymptomatic: 65%
- Pain: 15%
- Trismus with or without malocclusion: 11%
- Tooth mobility: 7%
- Dysesthesia: 2.65%
- Proptosis, elevated earlobe, infection: 2.6%

Imaging

They appear as a multilocular, occasionally unilocular, radiolucent area. There is expansion and thinning of the cortices and the borders of the lesions can be well or ill defined. If left long enough, perforation of the cortices will occur. The adjacent teeth can show displacement and root resorption. This condition often mimics other jaw disorders like ameloblastoma, odontogenic myxoma, aneurysmal bone cyst, and central hemangioma.

Pathology

This tumor consists of abundant collagen fibers and fibroblasts. The degree of cellularity may vary in different regions of these lesions. At the periphery of the lesion, reactive bone can be seen and this can be confused with an FOL if biopsy size is inadequate. This tumor lacks abundant cellular pleomorphism, hyperchromatism, and mitotic figures. An increase in atypical cells can lead to a diagnosis of a malignancy, such as fibrosarcoma.

Diagnostic Dilemma

The diagnostic dilemma in the management of desmoplastic fibroma lies in the challenge in differentiating it from a low-grade fibrosarcoma. This lesion has a similar clinical and radiographic appearance. This lesion is a slow-growing malignant tumor of fibroblasts, often asymptomatic until reaching a significant size. They most commonly occur in the paranasal sinuses and nose, which is the reason for late presentation or nasal obstructive symptoms. Like desmoplastic fibroma, they are commonly seen in the pediatric population. On histology, they have spindle-shaped cells that form a herring-bone pattern, whereas desmoplastic fibroma favors a single-cell pattern. There is increase in mitotic figures,

pleomorphism, and decreased collagenous background. In the cases in which the desmoplastic fibroma extends into the soft tissue, the clinical picture can be confused. Treatment of fibrosarcoma is resection with wide margin, with 5-year survival ranging from 40% to 50%.

Treatment

This is a benign, aggressive lesion that is locally destructive and easily extends into soft tissue. Therefore treatment of desmoplastic fibroma is resection of the lesion with margins. Some clinicians have argued that treatment of desmoplastic fibroma, confined within the bone, with curettage has a 70% recurrence rate, whereas resection with margins has shown recurrence rates around 20%. Radiotherapy and chemotherapy have also been proposed, with limited success and risk for malignant transformation. For this reason, these patients need to be followed for several years.

Odontogenic tumors

INTRODUCTION

Odontogenic tumors are pathologic outcomes from tissue elements that are part of the tooth-forming apparatus, that is, odontogenic tissues. These tumors occur exclusively in the bones of the jaw particularly around the teeth-bearing segments. Patients with odontogenic tumors usually present with symptomatic or asymptomatic swelling in the oral and maxillofacial region. Most of these swellings have either tooth-associated symptoms or tooth-associated radiological changes.

The general dentist possesses a unique opportunity to be the first health care professional to see anatomic or radiographic changes in the maxillofacial region due to proximity of the neighboring structures that they routinely treat. Because general dentists serve as the preliminary point of patient contact and see patients on a regular basis, it is imperative that they become familiar with the recognition and diagnosis of odontogenic tumors.

Odontogenic tumors comprise neoplastic growths of benign, malignant, or tumor-like malformations originating from odontogenic tissues. The interactions between ectodermal and mesenchymal elements from odontogenic tissues can initiate tumor formation due to disturbance in signaling mechanism for their growth and proliferation.

The World Health Organization (WHO) has a classification system for odontogenic and maxillofacial bone tumors (5th edition, 2022) which is:

Benign epithelial odontogenic tumours

- Adenomatoid odontogenic tumour
- Squamous odontogenic tumour
- Calcifying epithelial odontogenic tumour
- Ameloblastoma, extraosseous/peripheral
- Ameloblastoma, unicystic

- Ameloblastoma, conventional
- Adenoid ameloblastoma
- Metastasizing ameloblastoma

Benign mesenchymal odontogenic tumours

- Odontogenic fibroma
- Odontogenic myxoma
- Cementoblastoma
- Cemento-ossifying fibroma.

Benign mixed epithelial and mesenchymal odontogenic tumours

- Ameloblastic fibroma
- Primordial odontogenic tumour
- Odontoma
  - Odontoma, compound type
  - Odontoma, complex type
- Dentinogenic ghost cell tumour.

Clinical Considerations

Odontogenic tumors, as a group, are relatively uncommon; several are rare, and a few are very rare. The clinical importance of odontogenic tumors is not measured by their numbers, but because some lesions are very destructive and surgical management involves the face, oral tissues, and jaws of both young and old patients. Correlation of clinical, radiographic, and histologic analyses is necessary to prevent over- or under-treatment.

There are no clinical signs, symptoms, or physical findings that permit diagnosis of specific odontogenic tumors. The age and sex of the patient and location characteristic of lesions are derived from pooled data compiled from the literature

and unpublished cases. Such information is useful only when combined with other diagnostic features.

Imaging

Because most odontogenic tumors emanate from or involve the jaws, imaging modalities, including plain radiography (periapical, occlusal, panoramic), computed tomography (CT), CT three-dimensional (3D) reconstruction, computer-generated models, magnetic resonance imaging (MRI), and positron emission tomography (PET) scan CT, offer an unparalleled opportunity to view the tumor in relation to the jaws and adjacent soft tissues.

Radiographic images do not provide pathognomonic identification of odontogenic lesions, because several odontogenic tumors as well as nonodontogenic lesions may share imaging characteristics. However, highly useful visual information can be gathered to study a lesion for presumptive differential diagnoses, selection of biopsy sites, and management decisions. A lesion's position, size, and shape; presence or absence of lesional calcifications; estimation of soft tissue volume in relation to calcified tissue, cyst formation, and impingement on or inclusion of vital anatomic structures; displacement of teeth or root resorption; and interface boundaries between lesion and host bone help the clinician to form a characterization of the tumor's activity and aggressiveness.

Odontogenic tumors are most often discovered by dental radiography (periapical, occlusal, or panoramic) as part of routine screening during a dental visit, examination of a patient with a specific complaint (e.g., pain or oral soft tissue or facial enlargement), or elective consultation (e.g., orthodontic or orthognathic surgery). The judgment of the clinician will determine the extent and types of imaging that are needed or most useful for the management of a specific case. Yet, in many instances, there is a tendency to use fewer imaging modalities than are desirable—which is usually later regretted, as imaging provides a valuable documentary and study tool.

Overall viewing of bone and soft tissue by consecutive anatomic "slices" and planes is provided by CT and MRI, respectively. The volume of the tumor and the interface margins between the tumor and surrounding bone and soft tissue is roughly revealed by PET-CT, obtained after injection of a glucose isotope

conjugate metabolized by the tumor. The 3D CT (three-dimensional computerized tomogram) permits viewing the lesion in almost kaleidoscopic anatomic displays; the 3D CT generated model provides an excellent physical reproduction of the anatomic part and tumor. The model is useful for planning or carrying out a mock surgical procedure and provides a mechanical frame on which to contour a reconstruction appliance.

Diagnostic considerations (Biopsy)

Definitive diagnosis is established only after incisional, excisional, or intraoperative frozen section biopsy for histologic analysis. The specific biopsy technique is selected after careful assessment of the patient (age, physical health, and emotional status) and of the use of local, sedation, or general anesthesia to ensure patient cooperation, gain access to the lesion, and obtain sufficient tissue for study.

An *incisional biopsy* performed several weeks before definitive management often precludes excision or frozen section diagnostic "surprises." Thus, time is gained to receive a soft or calcified tissue diagnosis, plan the surgical procedure, prepare and/ or obtain special presurgical requirements, and fully discuss management with the patient or guardian.

Excisional biopsy should be performed for completely calcified odontogenic lesions (i.e., malformations radiographically demonstrating only teeth or a cementum-like tissue) in which histologic diagnosis is not immediately essential; for physically impaired patients for whom several anesthetic or surgical exposures should be avoided; or for small lesions (approximately 1.0 to 1.5 cm in diameter) that can be excised completely and can reasonably be expected not to require further operation after histologic study.

Intraoperative frozen section should be used to study questionable soft tissue encountered in areas not sampled by the incisional biopsy, and to examine the adequacy of the boundary between lesion and host bone and/or soft tissue in instances in which extensive resection is not planned. The preparation of a good frozen section is technique-sensitive and requires proper specimen orientation and avoidance of incorporated dense bone (which nicks the microtome blade and disrupts the tissue section).

Management

The objectives of the surgical management of odontogenic tumors are the eradication of the lesion, preservation of normal tissue to the extent possible, and restoration of significant tissue loss, form, and function. All agree that the surgical procedure should be sufficient to the need; however, in many instances there is disagreement among surgeons and pathologists about the extent of surgery that specific tumors require.

Some surgeons maintain an almost mystical adherence to a conservative surgical approach, in the conviction that all odontogenic tumors are benign. This viewpoint amounts to a planned recurrence for some lesions. The basis for this opinion is the belief that a recurrence or recurrences (more properly, regrowth of residual lesion) can be managed by a simpler procedure that can avoid jaw resection. However, one of the results of such an approach is the creation of a shotgun pattern of recurrence by which the lesion is spread throughout a larger area, thus compounding the surgical problem. Other surgeons are routinely aggressive in their approach to all odontogenic tumors, and so sacrifice more normal tissue than is necessary to ablate the lesion. The argument has been made that a well-planned and executed resection and reconstruction serves the patient physically and emotionally better than repeated surgical procedures.

All excisions involving bone can best be described by the following designations: enucleation, curettage, marsupialization, recontouring, resection without continuity defect, resection with continuity defect, and disarticulation.

Enucleation means completely separating the lesion from the adjacent bone and removing it. Curettage involves raking out the lesion together with part of the adjacent bone (generally, 1-2 mm) using mechanical, physical, and chemical materials. Marsupialization is the surgical technique of cutting a slit into an abscess or cyst and suturing the edges of the slit to form a continuous surface from the exterior surface to the interior surface of the cyst or abscess. Sutured in this fashion, the site remains open and can drain freely. Disarticulation resections are rarely required variants of segmental resection of the mandible, and they are required by a variety of pathologic processes of the jaws and contiguous structures, when they extend into the condylar region, thereby requiring its sacrifice.

Certainly at present, there are no absolute standards of management for many odontogenic tumors and the treatment of several lesions continues to be debatable.

Odontoma

Odontoma is a benign tumor of mixed odontogenic origins consisting of both odontogenic hard and soft tissue. It is thought to be the most frequently encountered odontogenic tumor. Odontomas are composed of both epithelial and ectomesenchymal components that contribute to enamel- and dentin-like structures within the lesion. Although odontomas may consist of normal-appearing enamel/ dentin structures, they have defects in their structural arrangement and hence they are considered as hamartomas, or tumor-like malformations, rather than true neoplasms.

The odontoma is seen predominantly in the second and third decade of life and has a slight female predilection. There are 2 main types: compound and complex. The lesion is easily recognized in radiographic examinations and appears as a radiopaque mass with thin radiolucent rim. Odontomas are usually managed by conservative enucleation but more extensive surgical procedures may be necessary for larger, more extensive lesions.

Clinical features

Odontomas are slow-growing, expanding, and painless intrabony lesions. Pain and inflammation may, however, result from secondary infection. The 2 types of odontomas are complex and compound odontoma. The distinction between these 2 types is based on either the appearance of tooth-like structures or disorganized mass of dental tissue. The complex type is unrecognizable as dental structures, appearing as a radiopaque mass with varying densities. The compound odontoma has recognizable enamel, dentin, and cementum and consists of individual recognizable small teeth. The complex odontomas are located in the posterior mandible and identified based on disorganized mass of dental tissues, that is, enamel and/or dentine. Compound odontomas are located in the anterior maxillae and identified based on well-organized, multiple tooth-like structures. Odontomas

can also be associated with other odontogenic tumors such as calcifying odontogenic cyst, ameloblastic fibroodontoma (AFO), and odontogenic fibromas. The association of odontoma with Gardner syndrome and coronoid hypoplasia has also been reported.

Diagnostic modalities

In most cases odontomas can be diagnosed based on their radiographic appearance alone. The radiologic appearance depends on the stage of the lesion. The first stage is characterized by a radiolucent appearance due to lack of calcification. Partial calcification or radiopacity are seen in second or intermediate stage. The third stage is characterized by predominance of radiopaque masses of dental hard tissues with a thin radiolucent zone. Resorption or adjacent tooth or roots are uncommon. Association with unerupted teeth may be seen. Radiographically compound odontomas seem as collection of multiple tooth-like structures of varying size and shape with periphery of narrow radiolucent zone, whereas complex odontomas seem as calcified mass with radiodensity of tooth structures with periphery of narrow radiolucent zone.

Microscopically odontomas are observed with multiple mineralized structures resembling small, single-rooted teeth with loose fibrous matrix. Pulp tissue may be seen in coronal and radicular zone of toothlike structures.

Differential diagnosis

Differential diagnosis may include supernumerary tooth, AFO, and osteomas. Based on formation and the number of toothlike structures present, a supernumerary tooth can be easily differentiated from odontomas. Distinguishing AFO from odontoma can be challenging. Radiographically, the radiopacity seen in AFO is usually scattered, whereas the odontomas will have a central area of radiopacity. Radiographic appearance of complex odontoma may be confused with osteoma due to mineralized mass of tissue. However, the radiolucent zone at the periphery of the odontoma, which represents the dental follicle along with the radiodensity of the mass having a density similar to teeth, will differentiate odontomas from osteomas.

Management

Odontomas are managed with conservative surgical excision and special surgical considerations are given for large odontomas. The prognosis of the condition is usually excellent with minimal to no recurrence.

Ameloblastoma

Ameloblastomas are the second most common benign odontogenic tumor. They are potentially aggressive, locally invasive, slow-growing benign tumors that may originate from cell rests of dental lamina, epithelium from the enamel organ, epithelial lining of odontogenic cyst (ie, dentigerous cyst), and basal cell layer of oral mucosa. Based on clinical, radiologic, histologic, and prognosis aspects, ameloblastomas are classified as (1) conventional (classic)/solid/multicystic ameloblastomas, (2) unicystic type, (3) peripheral,and (4) desmoplastic ameloblastoma.

Histopathologic examination is mandatory for confirmation of diagnosis. Ameloblastomas are managed by wide surgical resection, and recurrences have been reported.

Clinical features

Ameloblastomas are uncommon among children and is predominantly seen in third and fourth decades of life with a male predilection. The mandible is the favored site over the maxilla by about a 4.5:1 ratio. The posterior mandible is the most commonly affected site (70% found in angle of mandible). The ameloblastoma is asymptomatic and remains undiscovered until lesional growth produces intraoral and/or external jaw swelling, tooth and dental occlusion disturbances, or incidental radiographic examination reveals a lesion. Paresthesia is an uncommon symptom and pain is rarely a presenting symptom unless the lesion causes root resorption and/or tooth mobility. The clinical signs such as pain and disfigurement may be seen as the lesion advances in the size. The pain occurs due to pressure effects from the mass size on peripheral nerves and secondary infection. Ameloblastomas that present with large expansile mass of the jaw can cause thinning of cortical plate, and crepitation or egg shell crackling may be elicited while palpating jaw.

Rarely the lesion can perforate jaw bone leading to ulcerated growth in oral cavity and sometimes the skin. Peripheral ameloblastomas present as painless, slow-growing gingival swelling that may produce shallow depression in the underlying bone rather than infiltration.

Diagnostic modalities

Radiographic examination can greatly assist in the diagnosis of ameloblastomas. The frequent presentation type of ameloblastoma is solid/multicystic type, which appears as multilocular radiolucent destruction of bone. A well-defined, small or large radiolucent area in the bone gives the appearance of honeycomb or soap bubble appearance. The destructive changes of the jaw bone may be either confined to alveolar bone or half the mandible. Buccal and lingual cortical plate expansions are observed. Cortical plate expansions can be well recognized in occlusal radiographs. Resorption of adjacent roots of teeth is frequently observed. Association of unerupted tooth is common and adds a layer of complexity in differentiating ameloblastoma with circumferential type of dentigerous cyst. Although ameloblastoma frequently shows irregular scalloping border, this is not a consistent finding in all the cases. Mixed radiographic appearance is due to osseous septa in the lesion but not a true mineralized content in the lesion. Unicystic ameloblastoma shows a large unilocular radiolucent destruction of the involved jaw bone.

Microscopic examination shows ameloblast-like cells and stellate reticulum–like cells with fibrous stroma. Histologic variants of ameloblastomas include follicular, plexiform, acanthomatous, granular cell, desmoplastic, clear cell, basal cell, keratoameloblastoma, papilliferous type, mucous cell, hemangiomatous, and extragnathic types. (Several microscopic subtypes – do not affect prognosis).

Differential diagnosis

Differential diagnosis of ameloblastoma can be categorized into radiolucency with and without mineralization changes. Differential diagnosis of uni-/multilocular radiolucency without mineralization includes odontogenic keratocyst, central giant cell granuloma, and dentigerous cyst, whereas differential diagnosis panel of uni-/ multilocular radiolucency with mineralization includes odontogenic myxoma,

calcifying odontogenic cyst, and calcifying epithelial odontogenic tumor. One must look for size, location, and presence/absence of mineralization while formulating differential diagnosis. Central giant cell granulomas are commonly reported in anterior mandible, whereas ameloblastomas are seen in posterior region. Odontogenic keratocyst has a tendency to expand in anteroposterior region, whereas ameloblastomas tend to expand in a buccal-lingual direction. Dentigerous cyst tends to show pericoronal radiolucency, whereas ameloblastomas show impacted tooth in the lesion, not necessarily pericoronal radiolucency. Mineralization density is greatly appreciated in calcifying epithelial odontogenic tumor and calcifying odontogenic cyst.

Unicystic Ameloblastoma

A unicystic ameloblastoma may form de novo or develop secondarily in an odontogenic keratocyst or dentigerous cyst. These have the best prognosis, and a lower recurrence rate.The lesion may remain small, become large, or even develop into a multicystic form. Small or large unicystic lesions that contain unerupted (impacted) teeth, or those without unerupted teeth, are usually identified radiographically as a dentigerous cyst or odontogenic keratocyst. However, an often-overlooked radiologic feature of unicystic ameloblastoma involving a dentate area is the partial resorption of tooth roots (permanent or deciduous), a rare occurrence in dentigerous or odontogenic keratocyst.

The unicystic ameloblastoma exhibits two other notable clinical differences from the multicystic, solid, and peripheral forms, besides its physical shape. First, the lesion usually occurs in adolescents, teenagers, and young adults; and second, the lesion exhibits the previously described peripheral-encompassing connective tissue wall of varying thickness.

Recognition of the proliferative pattern of the unicystic ameloblastoma has clinical importance. Growth within the cyst cavity (intraluminal), growth along the cavity surface (luminal), or proliferation into the connective tissue of the cyst wall (mural) a greatly affects treatment.

Management of luminal or intraluminal subtype is usually enucleation, whereas mural subtypes are managed by resection with a 1.5cm margin. Curettage of the bone is discouraged because it may implant foci of ameloblastoma more deeply

into bone. Adjunctive treatment of the bone tumor bed by chemical fixation with Carnoy solution is of theoretical but unproven value, and cryosurgery gives inconstant benefit, as well as risk of sequestration or pathologic fracture

Conventional (Solid and Multicystic) Ameloblastomas

These are the most common type. They are usually radiolucent on radiography and clinically are partially or completely solid. Management is resection with a 1.5cm margin.

As both conventional Ameloblastoma and unicystic ameloblastoma have been found to harbor BRAFp.V600E mutations, aggressive and destructive tumours could be candidates for BRAF-targeted therapy that has the potential to reduce tumour size and ultimately enable a conservative surgical procedure. Preliminary data of biological treatment show effectiveness in selected cases.

BRAF is a human gene that encodes the B-Raf protein, which is responsible for cell proliferation. When the BRAF gene is mutated, it is constantly activated. This leads to uncontrolled cell proliferation (independent of any external stimulus), a condition that may result in the generation of tumors. Somatic oncogenic mutations in the BRAF gene (specifically the BRAF-V600E mutation) occur in more than 60% of mandibular ameloblastomas.

This is a big breakthrough, which is a genetically based patient specific treatment, to ameloblastoma. In the cases treated, the BRAF inhibitor resulted in substantial tumor regression, allowing for non-mutilating complete surgical removal, bone regeneration and organ preservation.

Peripheral /ExtraosseousAmeloblastoma

These have a good prognosis, arise from the gingivae rather than tooth and are most common in premolar area of mandible, then tuberosity of the maxilla. A radiograph should be taken to exclude a perforating intraosseous ameloblastoma. Management is conservative excision. Long term follow is required.

Malignant (Metastasising) Ameloblastoma and Ameloblastic Carcinoma

Ameloblastoma sometimes exhibit behavior of metastases that are most often found in the lungs. The diagnosis of malignant ameloblastoma should be made when a tumor in both primary and metastatic locations demonstrate histopathologic features of ameloblastoma. if surgically feasible, wide resection and reconstruction should be performed on the primary and metastatic lesions by a surgical team. Radiation and chemotherapy are questionable modalities for adjunctive treatment and should be reserved for palliation.

The diagnosis of ameloblastic carcinoma should be made when microscopic examination of ameloblastoma cases shows cytologic features of malignancy in the primary tumor. Ameloblastic carcinomas show local aggressive behavior but do not demonstrate the character of metastasis.

Oral and Maxillofacial surgery/Fifth year

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Potentially malignant disorders of oral mucosa

Oral carcinogenesis involves a complex, multistage process of cumulative sequence of cellular (atypia) and tissue (dysplasia) changes resulting from multiple genetic alterations during a protracted period, some of these changes may be reversible, but when the overall effect of these changes surpasses the inherent reparative ability of the cells, they will be transformed ultimately into invasive malignant cells.

In the course of this process, many physical and morphological alterations of the oral tissues that are of diagnostic and prognostic relevance occur; these changes are termed **premalignant or precancerous changes**.

Classification and terminology

In 1978 the WHO proposed that clinical presentations of the potentially malignant disorders of the oral cavity to be classified into two broad groups; lesions and conditions.

Premalignant lesions were defined as morphologically altered tissue in which cancer is more likely to occur than its apparently normal counterpart. Examples: leukoplakia; erythroplakia; Palatal changes associated with reverse smoking

Premalignant conditions were defined as generalized state or condition associated with significantly increased risk for cancer development. Examples: oral submucous fibrosis; lichen planus; discoid lupus erythematosus; actinic keratosis.

The terms (pre-cancer), (precursor lesions), (premalignant), (intra epithelial neoplasia), and (potentially malignant) have been used in the international literature to broadly describe clinical presentations that may have a potential to become cancer.

The term “premalignant” conveys the idea that all the lesions subsumed under this heading will, necessarily, transform into malignancy, which is

not true. This is why; recently, the term “potentially malignant” is preferred by many as a more accurate term for these lesions.

Risk factors

- Inherent susceptibility; genetic predisposition, age (usually older than 45 years), ethnicity, and socioeconomic status.
- Tobacco use; smoking and smokeless.
- Betel quid (pan) use; betel nut, slaked lime, tobacco and spices wrapped in betel leaf.
- Alcohol use.
- Diet and nutrition; nutritional deficiency, high intake of processed meat products
- Poor oral health and dental hygiene
- Infective agents; human papillomavirus 16, candida, syphilis.
- Immunodeficiency; congenital, immunosuppression, HIV infection and AIDS.
- Ultraviolet irradiation.

Diagnostic method

Patient history

A detailed history is obtained from the patient with emphasis on identification of risk factors and recognition of medical conditions predisposing to premalignant lesions or conditions.

Clinical examination

Careful and thorough inspection of the mucosal surfaces by a trained clinician in a good light remains the standard method for identifying suspicious oral lesions. Any detected lesion should be palpated by a gloved finger to determine its texture. Leukoplakic lesions should be wiped away by careful use of a damp swab, in which case the diagnosis may well be that of an acute pseudomembranous candidiasis. All findings must be recorded, clinical photographs of the lesions may be helpful during follow up visits.

Investigations

These may include blood investigations, oral swab for microbiological assessment, and incisional or excisional biopsy for histopathological examination and diagnosis. In case of incisional biopsy, it is important to

select a specific site for biopsy that includes the most representative and/or clinically severe-looking region, together with the lesion margin and adjacent normal-looking tissue.

Diagnostic aids for clinical detection of oral premalignant lesions

Vital tissue staining

It is based upon the principle that neoplastic and dysplastic tissue may preferentially take up an applied chemical dye which results in staining and thus identification of abnormal mucosa compared with adjacent normal tissue. Vital stains include: Toluidine blue, Lugol's iodine, and 5-aminolevulenic acid, the latter is visualized by subsequent fluorescence imaging.

Light-based detection

These systems act as visualization aids to facilitate accurate localization of dysplastic or neoplastic mucosa.

Brush biopsy and exfoliative cytology

It is based on the analysis and interpretation of the characteristics of cells shed from mucosal surfaces.

Salivary analysis

It consists of analysis of salivary composition and the shed oral epithelial cells.

Potentially malignant disorders

Leukoplakia

It is the most common of all potentially malignant lesions (60%-70%). It is defined as a white patch or plaque which cannot be wiped off and cannot be characterized clinically or pathologically as any other disease. This definition is, therefore, a **diagnosis of exclusion** and only a clinical descriptive term and has no diagnostic or prognostic implication.

Oral leukoplakia has a reported prevalence of 2–4% worldwide and is significantly more common in males although, females are also affected. leukoplakias are usually seen in middle-aged or elderly patients (between

5th and 7th decade of life), however, there is a significant increase in the number of younger patients presenting with leukoplakic lesions. It is six times more common among smokers than non-smokers and can affect any part of the oral cavity and oropharynx, although the most common sites include buccal mucosa, gingiva, alveolar mucosa, and lower lip.

Clinical appearance

Based on clinical appearance (surface color and morphological or thickness characteristics), leukoplakia can be described as:

- ✓ Early, mild or thin; it is flat or slightly elevated, gray or white plaque, which may be somewhat translucent, fissured, or wrinkled.
- ✓ Thick (homogenous); it is thickened, leathery, distinctly white plaque with deepened fissures.
- ✓ Granular (nodular); it has increased surface irregularities.
- ✓ Verrucous; with sharp or blunt, wart-like projections.
- ✓ Speckled; it demonstrate scattered patches of redness where epithelial cells are so immature or atrophic that they can no longer produce keratin, this type is also called **erythroleukoplakia** which frequently exhibit high degree of dysplasia.
- ✓ Proliferative verrucous leukoplakia (PVL) is characterized by the development of multiple, slowly spreading, keratotic plaques with rough surface projections. It is a high risk type and its relation with the verrucous leukoplakia is uncertain.

Some lesions may exhibit a mixture of these subtypes. Lesions may disappear, remain indefinitely in one stage or change and progress over time.

Histological features

Leukoplakia is characterized by a thickened keratin layer of the surface epithelium **(hyperkeratosis),** with or without a thickened spinous layer **(acanthosis).** Some leukoplakias demonstrate surface hyperkeratosis but show atrophy or thinning of the underlying epithelium. Frequently, variable numbers of chronic inflammatory cells are noted within the subjacent connective tissue.

Malignant transformation

A systematic review and meta-analysis published in 2020 presented an estimated overall mean proportion of malignant transformation rate of 9.7%.

Risk factors for malignant transformation include:

- ✓ The site of leukoplakia; leukoplakia of the floor of mouth had the highest risk of malignant transformation followed by the tongue and lip.
- ✓ Type of leukoplakia; speckled leukoplakia has the highest malignant potential among all subtypes with a rate of about 44% and a dysplasia rate of 51%, PVL also has a high risk of dysplasia/malignancy.
- ✓ Thickness of leukoplakia; the probability of dysplasia or malignancy increases as the lesion increases in thickness.
- ✓ Long duration of leukoplakia.
- ✓ Leukoplakia in non-smokers.
- ✓ Female patients.
- ✓ Presence of Candida albicans within the lesion.

Differential diagnosis

- White sponge nevus.
- Frictional keratosis.
- Morsicatio buccarum.
- Chemical injury.
- Acute pseudomembranous candidiasis.
- Leukoedema.
- Lichen planus.
- Lichenoid reaction.
- Discoid lupus erythematosus.
- Hairy leukoplakia.
- Skin graft.

Diagnosis

- ❖ Elimination of other white lesions (differential diagnosis).
- ❖ Biopsy; regardless of the subtype or location, all leukoplakias should be considered at risk for malignant transformation and biopsy should be obtained after diagnosis and elimination of other white lesions. Biopsies should be taken from areas of a lesion most likely to harbor

dysplasia or carcinoma (e.g., red atrophic areas in speckled leukoplakia).

Following biopsy, if no other disorder is confirmed, the lesion is further characterized as leukoplakia with or without dysplasia.

The grade of epithelial dysplasia refers to its severity or intensity:

1. **Mild epithelial dysplasia** refers to alterations limited principally to the basal and parabasal layers.
2. **Moderate epithelial dysplasia** demonstrates involvement from the basal layer to the midportion of the spinous layer.
3. **Severe epithelial dysplasia** demonstrates alterations from the basal layer to a level above the midpoint of the epithelium.
4. **Carcinoma in situ** is defined as dysplasia involving the entire thickness of the epithelium.

Treatment

After establishing the diagnosis and identifying and quantifying epithelial dysplasia, the management is as follows:

- **No dysplasia or mild dysplasia**; the decision to observe versus definitively treat the lesion may be influenced by the site and clinical subtype of leukoplakia.
- **Moderate to severe dysplasia, and mild dysplasia in high-risk sites**; treatment is indicated with variable treatment options.
- **Carcinoma in situ or early invasive SCC**; excision with free margins

Options of treatment

❖ **Observation**

This is reserved for mild lesions with no dysplasia, any possible cause should be removed and patients are instructed to discontinue detrimental habits.

❖ **Surgical excision**

Using a scalpel, this may or may not involve removing clinically uninvolved margins. It is the traditional method of treatment indicated for smaller, localized lesions.

Possible disadvantages:

- ✓ Inability to excise widespread or diffuse lesions without causing significant morbidity.
- ✓ Scarring of the residual tissue bed.
- ✓ Excessive bleeding especially in the floor of mouth and tongue.
- ✓ The defect may require reconstruction.

❖ **Cryosurgery**

This modality essentially ablates soft tissue by therapeutic freezing, it is easy to perform.

Disadvantages:

- ✓ Lack of depth control in the freezing process.
- ✓ Lack of specimen availability because of the ablative process.
- ✓ Pain and swelling.

❖ **CO_2 Laser**

It can be used either to ablate the entire lesion without obtaining tissue for biopsy or to excise a lesion and provide a tissue sample.

Advantages:

- ✓ Decreased morbidity.
- ✓ Adequate hemostasis.
- ✓ Healing is by secondary intention (no need for reconstruction).
- ✓ Decreased tissue distortion.

❖ **Non-surgical treatment**

This may include vitamin A, retinoids, beta-carotene, vitamin E, bleomycin, and alpha tocopherol used topically or systemically.

Erythroplakia

It is defined as a red patch that cannot be characterized clinically or pathologically as any other definable disease.

It is uncommon lesion with a reported prevalence of 0.02% to 5.7%. It occurs in middle-aged or older adults. The floor of mouth, buccal mucosa, soft palate and tongue are the most commonly involved sites.

The lesions appear as well-demarcated, erythematous patches or plaques with soft, velvety texture.

The epithelium is atrophic and lacks keratin production allowing the underlying microvasculature to show through and produce a red appearance. The underlying connective tissue frequently demonstrates chronic inflammation.

It has the highest risk for malignant transformation compared with all other premalignant and potentially malignant oral mucosal lesions and 90% of erythroplakic lesions histopathologically represent severe epithelial dysplasia, carcinoma in situ, or superficially invasive squamous cell carcinoma. Malignant transformation rate ranges from 14% to 50%.

Differential diagnosis

- Infections (Mycotic infections e.g., erythematous candidiasis, histoplasmosis or Bacterial infections e.g., Tuberculosis).
- Mucosal diseases (e.g., atrophic oral lichen planus, systemic lupus erythematosis, pemphigus, pemphigoid).
- Hamartomas and neoplasms (e.g., hemangioma, vascular malformations Kaposi sarcoma).
- Others (e.g., telangiectasias, lingual varices, oral purpura).

Diagnosis and Treatment

Any source of irritation identified is removed, if the lesion does not regress after 2 weeks then biopsy is indicated and subsequent treatment is guided by the histopathological diagnosis. Because of the high incidence of significant epithelial dysplasia, carcinoma in situ, or early invasive squamous cell carcinoma at diagnosis, surgical intervention is necessary. Complete excision of the lesion with clear margins down to the submucosal level provides a specimen that can be assessed adequately for margin control and may reduce the risk for local recurrence significantly.

Palatal changes associated with reverse smoking

This disorder (lesion) is specific to populations who smoke with the lighted end of the cigar or cigarette inside the mouth, resulting in red, white or mixed lesions of the palate. There are no difficulties in

diagnosing this lesion once this particular habit is noted. The reported malignant transformation rate is 0.3%.

Treatment

The treatment consists of discontinuation of habit and follow-up of the patient. If suspicious red areas, ulcerations, patches persist, then biopsy should be carried out. Subsequent treatment is guided by histopathological diagnosis. Surgical excision is indicated for dysplastic lesions.

Oral submucous fibrosis

It is a chronic disorder characterized by fibrosis of the lining mucosa of the upper digestive tract involving the oral cavity, oropharynx and frequently the upper third of the esophagus. It is seen primarily in the India with a prevalence rate of 0.2% to 0.5%, and other regions like Southeast Asia, Taiwan, and southern China.

The etiology is linked to chewing of betel quid (paan); other factors have been implicated like excessive consumption of spices, deficiencies of iron, vitamin B, and protein and genetic susceptibility.

Histologically there is submucosal deposition of densely collagenized, hypovascular connective tissue with variable numbers of chronic inflammatory cells. Epithelial changes include hyperkeratosis, atrophy, epithelial dysplasia in 10%-15% and carcinoma in 6% of the cases.

Treatment

Oral submucous fibrosis does not regress with habit cessation, and treatment depends on the severity of the condition. Treatment options are:

- **Nutritional**; vitamins and minerals; antioxidants (e.g., lycopene, B complex).
- **Physiotherapy**; forceful mouth opening and heat therapy.
- **Intralesional injections**; of corticosteroids, interferon gamma, or proteolytics (e.g., collagenase, hyaluronidase, chymotrypsin, and human placental extract). These are used to prevent or suppress inflammatory reaction, thereby preventing fibrosis by decreasing fibroblastic proliferation and deposition of collagen.

- **Surgical**; for moderate to severe cases may require surgical splitting or excision of the fibrous bands with or without grafting by skin graft, or using flaps followed by lifelong physiotherapy.

Actinic cheilitis (cheilosis)

It is a common potentially malignant alteration of the lower lip vermilion that results from long term or excessive exposure to the ultraviolet component of sunlight, other risk factors are fair complexion, old age, immunosuppression, arsenic exposure, certain genetic abnormalities and HPV. There is a similar cutaneous condition termed actinic keratosis.

Clinically it usually occur in individuals older than 40 years with male predilection, early clinical changes include atrophy of the lower lip vermilion border, blurring of margin between the vermilion zone and cutaneous portion of lip is seen. As the lesion progresses, rough scaly areas develop on the vermilion, these areas thicken and may appear as leukoplakic lesions. Chronic focal ulceration may develop which often suggest progression to early squamous cell carcinoma. Malignant transformation to SCC occurs in 6%-10% of actinic cheilitis cases.

Treatment

- ✓ Instruction of patients to avoid direct exposure to sun and using sunscreens.
- ✓ Areas of indurations, thickening, ulceration should be submitted for biopsy to rule out carcinoma.
- ✓ Lip shave (vermilionectomy) should be performed in cases of dysplasia. The vermilion mucosa is excised and the labial mucosa is advanced to reconstruct the vermilion.
- ✓ Alternative treatments include laser ablation, electrodesiccation, cryotherapy, 5-fluorouracil, topical imiquimod, and photodynamic therapy. Long-term follow-up is recommended.
- ✓ If a squamous cell carcinoma is identified, then the involved lip is treated accordingly.

Lichen planus

It is a chronic mucocutaneous disease that can affect the skin or mucosa. The cause is suggested to be an immunologically induced degeneration of the basal cell layer of the mucosa is the cause.

The prevalence of oral lichen planus is between 0.1% and 2.2%. It occurs in middle-aged adults with female predilection. Buccal mucosa, gingiva, and lateral tongue are the most commonly involved sites. Two main types of oral lichen planus have been described; reticular and erosive, but other types of oral lichen planus were described in the literature; papular, plaque-like, atrophic (erythematous), and bullous.

Reticular; most common type, usually arises in the buccal mucosa bilaterally and characteristically has fine, radiating white striae known as Wickham striae, which may be surrounded by a definite erythematous border. It is usually asymptomatic and usually can be diagnosed by its clinical features.

Erosive; it appears as irregularly shaped which may be covered with a fibrinous plaque or pseudomembrane over the erosion. This type is symptomatic and has a greater potential to undergo malignant change.

The skin lesions of lichen planus have been classically described as purple, pruritic, polygonal papules usually affecting the flexor surfaces of the extremities.

Malignant transformation

Although it is considered to be a controversial issue, the malignant transformation rate has been reported to range from 0.3% to 3%. The two types with an increased potential to undergo malignant transformation are the erosive and atrophic forms.

Treatment

Topical or systemic corticosteroid therapy is the mainstay in management of symptomatic oral lichen planus. Other agents have been used such as; cyclosporine, tacrolimus, griseofulvin, dapsone, azathioprine, and levamisole.

Preprosthetic Surgery

Preprosthetic surgery comprises a unique and evolving group of soft and hard tissue procedures. Preprosthetic surgery exists to serve the needs of dentists who provide patients with replacements for missing teeth and associated tissues. The purpose is to facilitate the fabrication of prostheses or to improve the outcome of prosthodontic treatment.

BONY RECONTOURING PROCEDURES

Preoperative Planning:

As with any other surgical procedure, planning begins with

1. Thorough history and physical examination with Special emphasis is placed on systemic conditions that may directly affect bone healing.
2. Clinical examination focuses on bony projections and undercuts, large palatal and mandibular tori, and other gross ridge abnormalities. The inter-arch relationship should be evaluated in 3 dimensions.
3. Radiographs are reviewed for bony pathology, impacted teeth, retained root tips, degree of maxillary sinus pneumatization, and the position of the inferior alveolar canal and mental foramina.

Alveoloplasty

Alveolar bone irregularities may be found at the time of tooth extraction or after healing and remodeling has occurred. The goal for alveoloplasty is to achieve optimal tissue support for the planned prosthesis, while preserving as much bone and soft tissue as possible.

1- An incision along the crest of the alveolus, Generally, flap extension approximately 1 cm mesial and distal to the site is adequate.

2. A full-thickness envelope flap is then elevated. Note that Extensive flap reflection may lead to devitalization of bone and should be avoided. Why!?

3. Smaller irregularities at an extraction site may only require digital compression of the socket walls. While A rongeur, bone file, handpiece with bur, or a mallet and osteotome can be used larger one. Irrigation with normal saline during the procedure is critical to maintain bony temperature less than 47 C°.

4. The site is inspected carefully and irrigated copiously with normal saline. Undetected residual free bony fragments may lead to delayed postoperative healing or possibly infection.

5. The mucoperiosteal flap is reapproximated. Excess soft tissue should also be removed at this time. The flap is then closed with a running resorbable suture, as fewer knots may be more comfortable and hygienic for patients.

Maxillary Tuberosity Reduction (Hard Tissue)

1. Find the cause: A preoperative radiograph or selective probing with a local anesthetic needle is often useful to determine the extent to which bone and soft tissue contribute to this excess and to locate the floor of the maxillary sinus.

2. Relation with sinus: A panoramic view is recommended to ensure an adequate assessment of the relationship between the maxillary sinus and residual alveolus, particularly if bony reduction is contemplated.

3. Intermaxillary distance: it should be at least 1 cm. A dental mirror passing freely between the tuberosity and retromolar tissue suggests adequate vertical clearance. The mirror can then be placed on the lateral aspect of the tuberosity, and patients are instructed to open and close. If the mirror intrudes on the mandible's path during function, horizontal reduction of the tuberosity may be required.

4. Surgery: it can be accomplished using local anesthetic infiltration. a crestal incision that extends up the posterior aspect of the tuberosity area. Reflection of a full-thickness mucoperiosteal flap in the buccal and palatal directions. Bone can be removed using a side-cutting rongeur or rotary instruments with copious irrigation. The flaps can then be readapted. Sutures

should remain in place for 7 days. Initial denture impressions can be completed 4 weeks after surgery.

Mylohyoid Ridge Reduction

Reasons for removal

1. interfering with proper denture construction
2. its easily damaged thin covering of mucosa
3. the muscular attachment to this area often is responsible for dislodging the denture.
4. denture pressure may produce significant pain in this area.

Procedure

1. Inferior alveolar, buccal, and lingual nerve blocks
2. A linear incision is made over the crest of the ridge in the posterior aspect of the mandible. Not to the lingual aspect to avoid lingual nerve injury
3. A full-thickness mucoperiosteal flap is reflected, which exposes the mylohyoid ridge area and mylohyoid muscle attachments.
4. The mylohyoid muscle fibers are removed from the ridge by sharply incising the muscle attachment at the area of bony origin.
5. A rotary instrument with careful soft tissue protection or bone file can be used to remove the sharp prominence of the mylohyoid ridge.
6. Immediate replacement of the denture is desirable because it may help to facilitate a more inferior relocation of the muscular attachment.

Genial Tubercle Reduction

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.

1. Local anesthetic infiltration and bilateral lingual & mental nerve blocks.
2. A crestal incision is made from premolar-to-premolar area
3. A full-thickness mucoperiosteal flap is dissected lingually to expose the genial tubercle.

The genioglossus muscle attachment can be removed by a sharp incision. Smoothing with a burr or a rongeur followed by a bone file removes the genial tubercle. The genioglossus muscle is left to reattach in a random fashion.

Tori Removal

Maxillary tori

Maxillary tori are approximately twice the prevalence rate in males. Tori present few problems when the maxillary dentition is present and only occasionally interfere with speech or become ulcerated from frequent trauma to the palate. However, when the loss of teeth necessitates full or partial denture construction, tori often interfere with proper design and function of the prosthesis. Nearly all large maxillary tori should be removed before full or partial denture construction. Smaller tori may often be left because they do not interfere with prosthetic construction or function. Even small tori necessitate removal when they are irregular, extremely undercut, or in the area where a posterior palatal seal would be expected.

Surgical Steps:

1. Anesthesia: bilateral greater palatine and incisive blocks and local infiltration provide the necessary anesthesia for tori removal.
2. Incision: A linear incision in the midline of the torus with oblique vertical-releasing incisions at one or both ends is generally necessary.
3. Sectioning: For larger tori, it is usually best to section the tori into multiple fragments with a burr in a rotary handpiece. Careful attention must be paid to the depth of the cuts to avoid perforation of the floor of the nose.

4. Tori removal: After sectioning, individual portions of the tori can be removed with a mallet and osteotome or a rongeur; then the area can be smoothed with a large bone burr.

5. Suturing: Then mucosa is reapproximated and sutured & To prevent hematoma formation,

6. Pressure dressing: some form of pressure dressing must be placed over the area of the palatal vault or A temporary denture or prefabricated splint with a soft liner placed in the center of the palate to prevent pressure necrosis can also be used to support the thin mucosa and prevent hematoma formation.

Mandibular tori

Mandibular tori are bony protuberances on the lingual aspect of the mandible that usually occur in the premolar. Occasionally, extremely large tori interfere with normal speech or tongue function during eating, but these tori rarely require removal when teeth are present. After the removal of lower teeth and before the construction of partial or complete dentures, it may be necessary to remove mandibular tori to facilitate denture construction.

Surgical Steps

1. Anesthesia: Bilateral lingual and inferior alveolar injections provide adequate anesthesia for tori removal.

2. Incision: A crestal incision should be made, extending 1 to 1.5 cm beyond each end of the tori to be reduced.

   Note: When bilateral tori are to be removed simultaneously, it is best to leave a small band of tissue attached at the midline. Leaving this tissue attached helps to eliminate potential hematoma formation in the anterior floor of the mouth and maintains as much of the lingual vestibule as possible in the anterior mandibular area.

3. Tori removal: The use of a burr and handpiece can be a more controlled technique versus the use of a mallet and osteotome, due to potential trauma to anatomic structures within the floor of the mouth.
4. Suturing: An interrupted or continuous suture technique is used to close the incisions.
5. Pressure Dressing: Gauze packs placed in the floor of the mouth and retained for several hours are generally helpful in reducing postoperative edema and hematoma formation.

Alveolar Ridge Preservation

It's a procedure that aimed to minimize the amount of alveolar bone resorption after tooth extraction by using a variety of bone materials can aid in the minimizing of alveolar bone height and width.

Materials used in preservation:

alloplastic materials, allogeneic and xenogeneic bone materials have been used. These inorganic materials are derived from a bovine source (xenograft) or processed cadaveric bone (allograft) or synthetic hydroxyapatite crystals and tri calcium phosphate (alloplastic).

Note: Atraumatic extraction with maintenance of the buccal and lingual cortical walls is essential to preservation of alveolar bone.

Surgical procedure:

1. The site is curetted and irrigated after removal of the tooth in entirety.

2. The graft material is placed into the extraction site and compressed to the level of the alveolar crest.

3. Closure: The extraction site usually is not closed primarily. In most cases the graft material is covered with some type of collagen material that is held in place with resorbable sutures. The use of a resorbable membrane requires limited soft tissue reflection of the adjacent margins to place the membrane under the attached gingiva. Mucosal re-epithelialization occurs over the grafted site within a few weeks. Implant placement in a site preserved with grafted bone material usually proceeds in 2 to 6 months.

-The End-

Oral and Maxillofacial Surgery

5th grade

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Pre-prosthetic Surgery

Soft Tissue Abnormalities

Immediately after tooth removal, muscular and frenal attachments initially do not present problems but may eventually interfere with proper denture construction as bony resorption takes place.

Maxillary Tuberosity Reduction (Soft Tissue)

1. Local anesthetic infiltration in the posterior maxillary area is sufficient for a tuberosity reduction.
2. incision: initial elliptical incision is made over the tuberosity in the area requiring reduction, and this section of tissue is removed
3. flap margins preparation: the medial and lateral margins of the excision must be thinned to remove excess soft tissue, which allows further soft tissue reduction and provides a tension-free soft tissue closure.

Mandibular Retromolar Pad Reduction

Indications: real indication for hypertrophic tissue is rare

Note: it is important to verify that the patient is not posturing the mandible forward or vertically over-closed during clinical evaluation and with treatment records and mounted casts. (false indications)

Surgical procedure:

1. anesthesia: Local anesthetic infiltration in the area requiring excision is sufficient.
2. incision: An elliptical incision is made to excise the greatest area of tissue thickness in the posterior mandibular area.

3. Flap margins preparation: Slight thinning of the adjacent areas is carried out with the majority of the tissue reduction on the labial aspect. Excess removal of tissue in the submucosal area of the lingual flap may result in damage to the lingual nerve and artery.
4. Suturing: The tissue is approximated with continuous or interrupted sutures.

Unsupported Hypermobile Tissue

Excessive hypermobile tissue without inflammation on the alveolar ridge is generally the result of 1- resorption of the underlying bone 2- ill-fitting dentures.
Management:

1. If a bony deficiency is the primary cause of soft tissue excess, then augmentation of the underlying bone is the treatment of choice.
2. If adequate alveolar height remains after reduction of the hypermobile soft tissue, then excision may be indicated.

Surgical procedure:

1. A local anesthetic is injected adjacent to the area requiring tissue excision.
2. Removal of hypermobile tissue in the alveolar ridge area consists of two parallel full-thickness incisions on the buccal and lingual aspects of the tissue to be excised.
3. A tangential excision of small amounts of tissue in the adjacent areas may be necessary to allow for adequate soft tissue adaptation during closure.

***Denture impressions can usually be taken 3 to 4 weeks after surgery.

Inflammatory Fibrous Hyperplasia (epulis fissurata or denture fibrosis)

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Definition: it is a generalized hyperplastic enlargement of mucosa and fibrous tissue in the alveolar ridge and vestibular area, which most often results from ill-fitting dentures.

Management:

-Early stages: when fibrosis is minimal, nonsurgical treatment with a denture in combination with a soft liner is frequently sufficient.

-Delayed stage: when significant fibrosis exists within the hyperplastic tissue. excision of the hyperplastic tissue is the treatment of choice.

Surgical procedure:

1. Local anesthetic infiltration in the area of the redundant tissue is sufficient for anesthesia.
2. The redundant areas of tissue are grasped with tissue pickups, a sharp incision is made at the base of the excessive fibrous tissue down to the periosteum,
3. the hyperplastic tissue is removed. The adjacent tissue is gently undermined and reapproximated using interrupted or continuous sutures.

Labial Frenectomy

Labial frenal 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 crest of the alveolar ridge and even to the incisal papilla area in the anterior maxilla. With the exception of the midline labial frenum in association with a diastema, frenal attachments generally do not present problems when the dentition is intact.

Movement of the soft tissue adjacent to the frenum may create discomfort and ulceration and may interfere with the peripheral seal and dislodge the denture.

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Surgical procedure:

1. Local anesthetic infiltration is often sufficient for surgical treatment of frenal attachments
2. For the
    a. simple excision technique, a narrow elliptical incision around the frenal area down to the periosteum is completed. The fibrous frenum is then sharply dissected from the underlying periosteum and soft tissue, and the margins of the wound are gently undermined and reapproximated. Placement of the first suture should be at the maximal depth of the vestibule and should include both edges of mucosa and underlying periosteum at the height of the vestibule beneath the anterior nasal spine. This technique reduces hematoma formation and allows for adaptation of the tissue to the maximal height of the vestibule. The remainder of the incision should then be closed with interrupted sutures. Occasionally it is not possible to approximate the portion of the excision closest to the alveolar ridge crest; this will undergo secondary epithelialization without difficulty.
    b. In the Z-plasty technique, an excision of the fibrous connective tissue is performed similarly to that in the simple excision procedure. After excision of the fibrous tissue, two oblique incisions are made in a Z fashion, one at each end of the previous area of excision. The two-pointed flaps are then gently undermined and rotated to close the initial vertical incision horizontally. This technique may decrease the amount of vestibular ablation sometimes seen after linear excision of a frenum.

Lingual Frenectomy

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An abnormal lingual frenal attachment usually consists of mucosa, dense fibrous connective tissue, and, occasionally, superior fibers of the genioglossus muscle. This attachment binds the tip of the tongue to the posterior surface of the mandibular alveolar ridge. Even when no prosthesis is required, such attachments can affect speech. After loss of teeth, this frenal attachment interferes with denture stability. Surgical technique:

1. Bilateral lingual blocks and local infiltration in the anterior area provide adequate anesthesia for a lingual frenectomy.
2. The tip of the tongue is best controlled with a traction suture.
3. Placement of a hemostat across the frenal attachment at the base of the tongue for approximately 3 minutes provides vasoconstriction and a nearly bloodless field during the surgical procedure.
4. After removal of the hemostat, an incision is created through the area previously closed within the hemostat.

Soft Tissue Surgery for Ridge Extension of the Mandible

The primary goals of soft tissue preprosthetic surgery are to provide an enlarged area of fixed tissue in the primary denture-bearing or implant area and to improve

extension in the area of the denture flanges by removing the dislodging effects of muscle attachments in the denture-bearing or vestibular areas.

- **Transpositional Flap Vestibuloplasty (Lip Switch)**

A lingually based flap vestibuloplasty was first described by Kazanjian. In this procedure a mucosal flap pedicled from the alveolar ridge is elevated from the underlying tissue and sutured to the depth of the vestibule. The inner portion of the lip is allowed to heal by secondary epithelialization. This procedure has been modified, and the use of a technique transposing a lingually based mucosal flap and a labially based periosteal flap (transpositional flap) has become popular.

- **Vestibule and Floor-of-Mouth Extension Procedures**

on the lingual aspect of the mandible. Trauner described detaching the mylohyoid muscles from the mylohyoid ridge area and repositioning them inferiorly, effectively deepening the floor of the mouth area and relieving the influence of the mylohyoid muscle on the denture. Macintosh and Obwegeser later described the effective use of a labial extension procedure combined with the Trauner procedure to provide maximal vestibular extension to the buccal and lingual aspects of the mandible. The technique for extension of the labial vestibule is a modification of a labially pedicled supraperiosteal flap described by Clark. After the two vestibular extension techniques have been performed, a skin graft can be used to cover the area of denuded periosteum. The combination procedure effectively eliminates the dislodging forces of the mucosa and muscle attachments and provides a broad base of fixed keratinized tissue on the primary denture-bearing area. Soft tissue grafting with the buccal vestibuloplasty and the floor-of-mouth procedure is indicated when adequate alveolar ridge for a denture-bearing area is lost but at least 15 mm of mandibular bone height remains.

Tissue other than skin has been used effectively for grafting over the alveolar ridge. Palatal tissue offers the potential advantages of providing a firm, resilient

tissue, with minimal contraction of become keratinized, is generally mobile, and often results in an inadequate denture-bearing surface.

Soft Tissue Surgery for Maxillary Ridge Extension

- **Submucosal Vestibuloplasty**

The submucosal vestibuloplasty can generally be performed with local anesthetic and intravenous sedation in an outpatient setting. A midline incision is made in the anterior maxilla, and the mucosa is undermined and separated from the underlying submucosal tissue. A supraperiosteal tunnel is then developed by dissecting the muscular and submucosal attachments from the periosteum. The intermediate layer of tissue created by the two tunneling dissections is incised at its attachment area near the crest of the alveolar ridge. This submucosal and muscular tissue can be repositioned superiorly or excised. After closure of the midline incision, a preexisting denture or prefabricated splint is modified to extend into the vestibular areas and is secured with palatal screws for 7 to 10 days to hold the mucosa over the ridge in close apposition to the periosteum. When healing takes place, usually within 3 weeks, the mucosa is closely adapted to the anterior and lateral walls of the maxilla at the required depth of the vestibule.

These techniques provide a predictable increase in vestibular depth and attachment of mucosa over the denture-bearing area. A properly relined denture can often be worn immediately after the surgery or after removal of the splint, and impressions for final denture relining or construction can be completed 2 to 3 weeks after surgery.