Laser Application

(Dentistry & Maxillofacial Surgery)

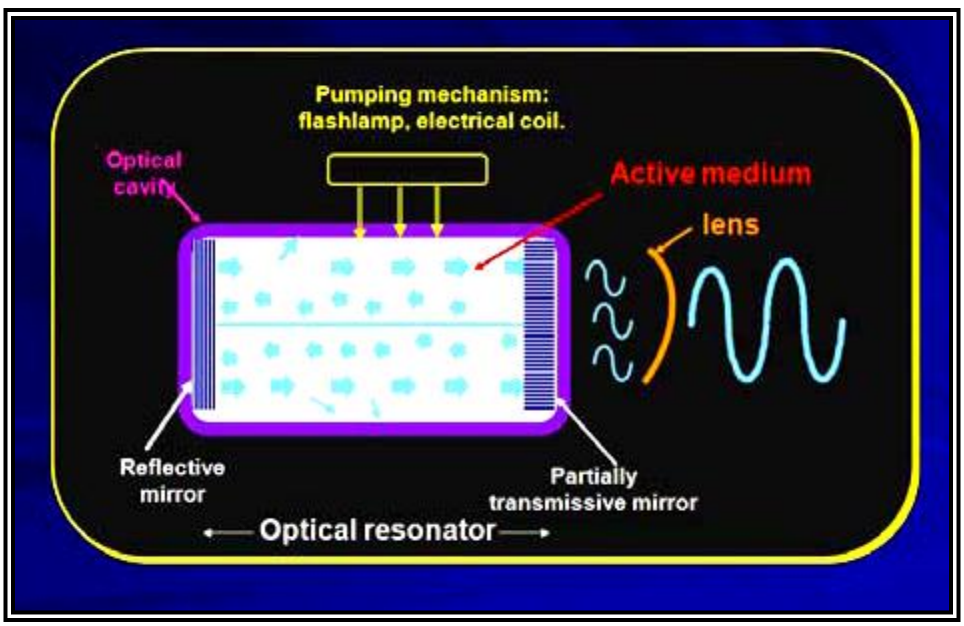
One of the oldest therapeutic methods is by light therapy, later as color light therapy and UV therapy further more the use of laser as light source was the last step in the development of light therapy. Laser therapy is a standard therapeutic procedure with unambiguous indications and contraindications, because of better understanding of the mechanisms of laser effects. The indications of laser therapy are presented on both soft and hard tissues, although laser cannot fully replace all the conventional techniques of dental medicine, the progress is obvious, and laser is expected to become an essential component of conservatory dental medicine. Laser therapy aims to restore the normal biological function of injured or stressed cells so 'Normalization' is the keystone of laser therapy. Some of the most important applications of laser technology are in the areas of major medical surgery, cosmetic and plastic surgery, dentistry, maxillofacial surgery as well as ophthalmology. Dentistry has entered an exciting era of high technology. The dental laser systems offer the dentist not only a window, but a door into this high technology**.** Acceleration of bone healing provides patients with a more comfortable post operative period, and in dentistry it provides shorter time for denture or artificial teeth construction, in addition to that the daily visit to dental clinic is discomfort to the patient so when decrease these visits by increasing times intervals between them make visiting to dental clinic more comfortable.

Laser basics

Laser energy is generated on the principle of light amplification by stimulated emission of radiation , and it is an acronym of this principle. The origin of laser is attributed to Albert Einstein in 1917 in his article entitled "Zur Quan-tum Theories der Strahlung" exposed the main physical principles of stimulated emission, which is the phenomenon of laser, this emission was later classified as high potency which has destructive potential and low-potency which has no destructive potential. Laser was proposed as a mechanism by the American physicians Hard Towner and Arthur L. Schawlow in 1953. Their achievement was a "Maser Optics" a device that could emit microwaves and not visible light. In 1960 the physicist Theodor Maiman fabricated the first laser device using a synthetic ruby .

There are three essential components to a laser system

1. **Lasing medium** or it is called gain, active or amplifying medium; which is consisting of atoms, molecules, ions or charged carriers, and it is a material that capable of being excited by an outside source and absorbing energy that produced after electron excitation, it can be either gas, liquid, solid or semiconductor. The selection of the lasing medium is important because it determines the wavelength out put from the laser device which is essential in penetration depth of the beam.
2. **Pumping or energy source** to excite the elements of lasing medium to their higher quantum mechanical states.
3. **A suitable arrangement of optical elements** to allow a single passage of light through the gain medium as in a laser amplifier or an optical resonator for repeated passage as in a laser oscillator.



Components of the laser system

Laser is not an electrical signal but optical field which is amplified, optical gain occurs by the process of stimulated emission, optical feed-back occurs when the amplified optical field is fed back into the active medium by reflection which occurs on both ends of the system so light will resonate back and forth with in the optical cavity so light makes repeated passes through the active medium which leads to build up of light intensity. One of the ends is fully reflecting but the other one need to be partially transmitting to let a constant amount of light passes out of the system which is the laser light. Stimulated emission a natural effect that was deduced by considerations relating to thermodynamic equilibrium and it is the process by which an electron in an exited state is relaxed to the ground state by the interaction of electron with an incident photon, this phenomenon is not ordinarily occur in nature .

Laser light characteristics:-

The light out put from a laser is electromagnetic radiation and is not fundamentally different from the light emitted from other sources. Laser light distinguishes itself from other sources of light in that it is coherent, monochromatic and directional.

1. **coherence** refers to the property of a light wave that's its phase and amplitude at one space (spatial coherence) and time (temporal coherence) points may be correlated to its phase and amplitude at some other space and time points . So that each wave maintains a precise spatial relationship with other waves and that this pattern is maintained over long distances. Laser light has high temporal and spatial coherences. Therapeutic effect of laser depends on the length of coherence in addition to the penetration depth due to absorption and scattering.
2. **monochromatisity** the light spectrum emitted by a laser is much limited, this means it has relatively well-defined frequency and wavelength, so that the out put signal from an ideal laser is a highly stable, constant amplitude single-frequency sine wave .
3. **directionality (collimation)** laser oscillator can produce a beam that can propagate from sizable distances with very little diffraction spread. Collimation becomes clinically important because the greater divergence mean larger spot size and lower power density. Direction and orientation of laser radiation could be important factors for some types of tissue such as dental tissue which has filament structure.

Types of lasers

Several types of lasers available for researches, medical, industrial and commercial uses.

Lasers are often described by the kind of lasing medium into:

1. Solid state lasers: the lasing medium distributed in a solid matrix, such as ruby laser.
2. Semiconductor lasers: the lasing medium is not solid state but made from semiconductor material, it is some times called diode laser such as Galium Arsinide.
3. Liquid lasers (dye lasers): the lasing medium is complex organic dyes such as rhodamine 6G in liquid solution or suspension.
4. Gas lasers: the lasing medium is either gas atoms as He-Ne laser, or molecules as CO_2 laser.
5. Excimer: the lasing medium is in gas state but it is composed of a mixture of reactive gas such as Chlorine and inert gas such as Argon, when excited it produce dimmer or pseudo molecule.

Lasers are also classified according to the duration of emission into:

1. Continuous wave lasers (CW): operate with a stable average beam power
2. pulsed lasers which sub-classified into:

*Normal mode lasers: most of lasers operate with pulse duration few hundred microseconds to a few milliseconds.

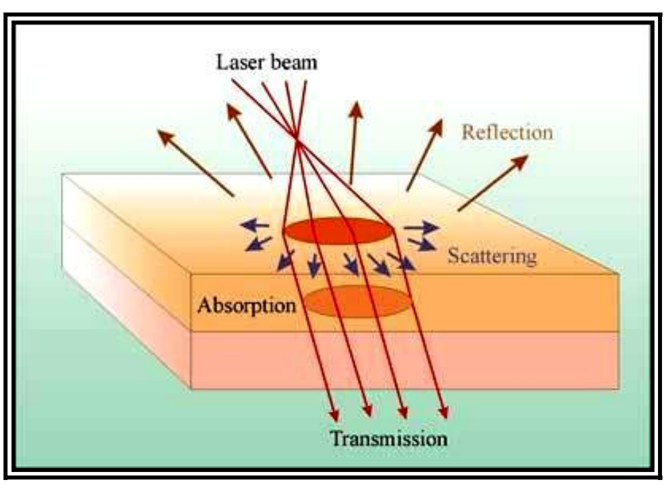
*Q-switched laser; which contain a shutter like device that doesn't allow emission of laser light until opened so that energy is built-up then released when the device is opened to produce intense pulse with short duration (about 10^{-8} s).

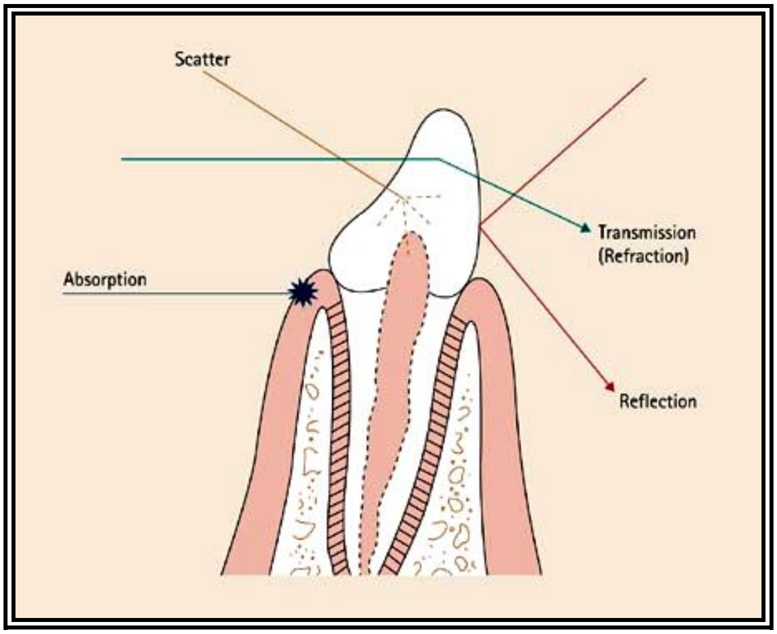
*Mode locked lasers: operate as a result of the resonant modes of the optical cavity which can affect the characteristics of the out-put beam. When the phases of different frequency modes are locked together, the different modes will interfere with one another to generate a beat effect. The result is a laser out-put which is observed as regularly spaced pulsations. Lasers operating in this mode-locked fashion, usually produce a train of regularly spaced pulses, each having duration of femtoseconds (10^{-15}) to pecoseconds (10^{-12}). A mode-locked laser can deliver extremely high peak powers than the same laser operating in the Q-switched mode. These pulses will have very high peak power reach to 10^{12} W.

Laser tissue interactions

Since biological tissue is turbid medium and the mean free path of the light involved in the irradiation is far less than the dimension of the medium, light propagation in tissue quickly become a random process.

The effect of laser depends on dose, frequency, pulse duration, irradiance, number of sessions and of laser wavelength used. Propagation of light in tissue is influenced by optical properties which are absorption and scattering coefficients and refractive index. The effects that optical radiation may have on tissue can be separated into categories depending on the portion of the spectrum (wavelength) that is incident on the tissue and the intensity of radiation. Knowledge about mechanisms of laser therapy allows us to separate the primary and secondary mechanisms. The primary mechanisms relate to the interaction between photons and molecules in the tissue, while the secondary mechanisms relate to the effect of the chemical changes are induced by primary effects. The two most important modes of light interaction with tissue during laser treatment is through absorption and scattering. Absorption is considered to be a conversion of energy from light to another form. Absorption properties of tissue depend on concentration of light accepting molecules like amino acids, cytochrom, chromophors and water. Scattering is considered to be a change in light propagation direction and occur due to varying shapes of biomolecules and varying tissue interface configuration. Depth of penetration and light distribution depend on wavelength and tissue type.Matter can act on light incident on it in different ways. Several effects are happened which are reflection, refraction, scattering, absorption and transmition.





Reflection is the returning of light when incident on a surface with an angle equal to incident angle.

Refraction When a light ray passes at an oblique angle from a medium of a lesser to a greater optical density (refractive index), it will bend toward the normal.

Scattering is the alteration of direction and intensity of a light beam that strikes an object. Scattering occurs during cold laser treatment and is considered to be a change in light propagation direction and thought to occur due to the varying shapes of biomolecules and varying tissue interface configurations.

Absorption is the attenuation in light intensity when passing through a medium. Absorption is considered to be a conversion of energy from light to another form. Tissue absorbing properties are dependent on their concentration of light accepting molecules such as amino acids, cytochromes, chromophores and water. Each of these interacts with light at specific wavelength ranges.

Transmission is the passing of the light through a matter with the same direction but with attenuation in intensity .

Laser tissue interaction mechanisms

There are many mechanisms by which laser light can interact with tissue. The most common interaction mechanisms for therapeutic and surgical applications are divided into two classes

A// wavelength dependent interaction mechanisms which includes

1/ photochemical reactions

2/ photo thermal interactions

3/ photo ablation

B// wavelength independent interaction mechanisms which includes

1/ plasma induced photo ablation

2/ photodisruption.

Wavelength dependent interaction mechanisms

Photochemical reactions

The electrons of molecules becomes more energetic when absorbing a photon and this energizing makes them easily to escape from the force of nucleus, the molecule becomes excited and hence it becomes more reactive. Photochemical reaction need low power density ($1W/cm^2$) and low energy density ($1\ J/cm^2$) with long exposure period reaching to continuous minutes. Photochemical reaction if require to photosensitizor and oxygen it then called photodynamic therapy (PDT) which is mainly used in oncology, on the other hand photochemical reactions has biostimulation effects.

Photodynamic therapy (PDT)

A photochemical reaction is one in which light initiates a chemical reaction, the set of reactions by which a plants and bacteria turn water and carbon dioxide into carbohydrates and oxygen. The basic ingredients for successful PDT are drugs, light and oxygen. With out photochemical reactions most of the life on the earth would not exist. For human production of vitamin D_3 from cholesterol in the skin is an important photochemical reaction. Vitamin D_3 is important role to promote bone formation, it also enhance calcium transport to the bone from blood.

Biostimulation

Laser light when reduced in its energy out put to a low level may be utilized for tissue healing shrinking and other therapeutic effects. It has been demonstrated with doses of red and infrared laser emission from as low as 0.001 J/cm^2 to 10 J/cm^2 for up to 30 seconds daily or alternate daily schedule with cytostatic effect above 240 J/cm^2. There were no macroscopic or microscopic damage to the tissue. No mutational effects have been seen resulting from light with wavelengths in the red or infrared ranges in doses used with in laser therapy. A poor result can occur due to a low dosage, too high dosage, wrong diagnosis, insufficient number of treatment sessions, unsuitable frequency, etc. Laser irradiation alters cellular processes in a non thermal, wavelength dependent manner by affecting protein synthesis, cell growth and differentiation, cell motility, membrane potential and binding affinities, neurotransmitter release, adenosin triphosphatase (ATPase) synthesis and prostaglandin synthesis. There is a strong relation ship first between light parameters and biostimulation effects on a cellular level, and second between the moment of radiation and limits of magnitude of biostimulation effects. The mechanism of low-power laser therapy at the cellular level was based on the absorption of monochromatic visible and near infrared radiation by components of the cellular respiratory chain cause changes in redox properties of these molecules and acceleration of electron transfer.

Specificity of the light action as follows:-

The radiation is absorbed by the components of the respiratory chain, and this is the beginning for redox regulation. Laser light affects the mitochondrial respiratory chain by changing the electric potential of cell membranes and then their selective permeability for sodium, potassium and calcium ions, or by increasing the activity of certain enzymes such as cytochrom oxidase and ATPase. It also increases DNA synthesis, collagen and pro-collagen production and may increase the cell proliferation or alter locomotory characteristics of the cells.

Irradiation stimulates collagen production, alters DNA synthesis and increases the function of damaged neurological tissue. Mechanisms of biostimulation include:-

1. Increase ATP production by the mitochondria and increase oxygen consumption on the cellular level which may result in muscle relaxation.
2. Increase serotonin and endorphins.
3. Increase anti-inflammatory effects through reduce prostaglandin synthesis.
4. Increase blood circulation to the skin in cases like neuralgia and diabetes mellitus.

5. Decrease permeability of the membrane of the nerve cells for Na^+/K^+ causing hyperpolarization.
6. Increase lymphatic flow and decrease edema.

Effect of LLLT appears to be increase macrophage activity in injured areas with quicker resolution of haematomata, faster resorption of edema and increase autoimunologic reaction.

Photothermal effects

With photothermal effects, the photons may be absorbed by any biomolecule and still lead to a thermal effect. Heat energy is deposited in the tissue by the absorption of light and its subsequent conversion to heat via vibrational relaxation. This causes a rise in temperature of the tissue, then the heat will diffuse through the tissue causing a rise in temperature in the surrounding tissue. The energy of photons absorbed by chromophores is converted to heat energy, which can cause a range of thermal effects from tissue hyperthermia to tissue melting. There are many different and varied medical application use a photothermal interaction, from vaporization of tumors, to welding gastrointestinal ulcer, and the removal of skin marks such as port wine stain birth marks or tattoos.

Effects of photothermal interaction can be summarized as follows:-

1. **Coagulation** when temperature reaches at least 60^{o}c, the tissue becomes coagulated and necrotic.
2. **Vaporization** it is also called thermo-mechanical effect due to the pressure build up involved during water expansion and vaporization. This is occurring when temperature reaching to boiling degree of water 100^{o}c. the resulting ablation is called thermal decomposition.
3. **Carbonization** when very high energy is applied and the local temperature of the tissue is suddenly increased and this is occur when temperature reaches to above 100^{o}c, carbon is released leading to blackening of the tissue.
4. **Melting** when the temperature reaches to a few hundred degrees Celsius to melt the tissue especially in mineralized tissues.

Photoablation

Occurs when high energy photons of ultraviolet spectrum of electromagnetic radiation are absorbed, and because they are more energetic than the chemical bonds holding the molecules together, they cause dissociation of molecules. This is followed by rapid expansion of the irradiated volume and ejection of the tissue from the surface. For materials to be removed, bonds that hold the tissue together must be broken. The photochemical model of ablation involves the direct absorption and breakage of the bonds by high energy photons in a process termed photoablative decomposition, while the photothermal model involves the rapid heating and subsequent denaturation of the structural matrix which allows for tissue decomposition. The primary tissue chromophore is the protein in UV ablation, while in IR ablation the chromophore is water surrounds the structural matrix. The mechanism of photoablation involves a purely photothermal interaction.

Wavelength independent interaction mechanisms

Plasma induced ablation

Plasma-induced ablation is also called plasma mediated ablation or laser induced breakdown. In this mechanism a free electron is accelerated by the intense electric field in the vicinity of a focused laser beam. When this very energetic electron collides with a molecule, it gives up some its energy to the molecule, when sufficient energy is transferred, a bound electron is freed and a chain reaction of similar collision is initiated resulting in plasma. In strongly absorbing tissue, the linear absorption will lead to a slight increase in temperature and electrons will be released through thermionic emission. In low absorbing tissue which does not increase in temperature, multiphoton absorption is required to generate sufficient free electrons through multiphoton ionization, this requires a very high irradiance.

The main advantages of plasma induced-ablation are

1. Thermal damage is minimal.
2. Transparent tissue ablation is possible.
3. The damage is well confined by using ps and fs pulses.
4. It is good for cutting close to tissue that must not be damaged.

Photodisruption

It is a mechanical effect that can accompany plasma generation such as bubbles formation, cavitations, jetting and shock wave, which has photodistruptive effects and are often undesirable as they can cause damage away from the focal region of the laser where the plasma has formed.

Shock waves as the plasma grows rapidly, a pressure travels out into the surrounding tissue. The magnitude of the wave depends on the pressure and therefore the temperature in the plasma which depends on the energy density. For longer pulses, when more energy is deposited, these shock waves will be of greater amplitude.

Cavitations a vapor bubble which forms around the plasma can grow to a critical size and then collapse violently sending out other shock waves. The cavitations bubbles near a solid boundary introduce liquid jet formation that is responsible for cavitation damage.

Jetting if the cavitation bubbles are close to a solid surface, it can form a jet as it collapses near the solid surface at very high speed. Collapsing bubbles generate a strong impulse of pressure. Plasma formation occurs only for high intensity laser radiation due to ablation or optical breakdown .

On what these interaction mechanisms are depend?

Because different interaction mechanisms dominate under different conditions, by carefully choosing the laser characteristics, the interaction can be restricted to a specific mechanism and therefore a specific effect on the tissue.

The dominant mechanism will depend on:-

1. Content of the tissue.
2. The frequency of the light (the energy associated with each individual photon).
3. The power per unit area delivered by the laser.
4. The duration of illumination and repetition rate of the pulses for a pulsed laser [25].

Laser and bone healing

Laser irradiation may increase, inhibit or have no effect on the function of cells. The physiological repair of LLLT is achieved by the light's re-energizing injured and malfunctioning cell membranes. It was suggested that LLLT stimulates cell growth directly by regulating the expression of specific genes, as well as indirectly by regulating the expression of the genes related to DNA synthesis and repair, and cell metabolism. When applied properly the gallium aluminum arsenide (Ga-Al-As) diode laser is emerging as one of the most efficient laser in low power laser therapy for a variety of applications including pain relieve, increase bone and wound healing, treatment of soft tissue trauma and normalization of abnormal metabolic state. LLLT is an effective tool used to prompt bone repair and modeling post surgery, this has referred to the biostimulation effect of LLLT [(28)], it is directly dependent on the dose applied.

These low level lasers do not deliver enough power to damage tissue, but do deliver enough energy to stimulate a response from the body tissue to initiate healing. Laser therapy really is a form of light therapy, red and IR light that must be absorbed to provide a biological response. Lasers can induce phenomena in injured tissues which promote acceleration of recovery after acute trauma. IR laser stimulated DNA and RNA synthesis rates, enzyme activity and cAMP levels. The respiratory chain is stimulated, provide critical increases in the molecular ATP and nitric oxide (NO), increasing H^+ , increase cellular metabolism, and ultimately triggering an increase in cell proliferation due to increase in mitochondrial respiration, molecular oxygen production, DNA synthesis, increase blood circulation and nerve function , activation of microcirculation and stimulate vasodilatation via stimulation of mast cells and macrophages which release histamine, nitric oxide (NO), serotonine and growth factors which control the development of granulation tissue.

Low level laser therapy precipitates a complex set of physiological interactions at the cellular level that reduces acute inflammation, reduces pain and accelerates tissue healing by a non-thermal and catalyzing effects which accelerate cell metabolism. Laser irradiation also increase the activity of fibroblasts and macrophages and increase prostaglandin synthesis which has inflammatory action, efficiently clears tissue from edema and causes vasodilatory agents.

Laser therapy increases cellular proliferation particularly in fibroblasts, motility of phagocytes, increases synthesis of collagen, protein, prostaglandin and intracellular matrix, neurotransmitter release, transmembrain potential, oxyheamoglobin dissociation and cell granule release, myofibroblast proliferation, increase in mitochondrial size, number and function by increase ATP synthesis with in the cell, monocyte stimulation and increase fracture healing which are the result of osteoblast proliferation and differentiation and intracellular changes in these cells . Stabilization of cellular membrane; Ca^{++}, Na^{+} and K^{+} concentration as well as the proton gradient over the mitochondrial membrane are increased. Laser therapy increase Ca^{++} up take in the mitochondria, the transport of nutrients and oxygen to the damaged cells and removal of non-viable cellular and tissue components.

Laser irradiation mediates the action of both lymphatic helper T-cells and suppressor T-cells in the inflammatory response and increase angiogenesis, also increase absorption of interstitial fluid and increase lymphatic circulation and drainage which result in better tissue regeneration. Laser therapy aims to restore the normal biological function of injured or stressed cells, so normalization is the keystone of the laser therapy. In order for a laser system to provide optimal penetration through the skin it must be in direct contact with the skin and perpendicular to the skin, this will minimize any reflection from the skin's surface and allow the best penetration into the tissue.

Laser safety and classification

A parallel light beam of small diameter of laser is dangerous for the eyes, that’s because it can enter the pupil in its entirety be focused by the lens of the eye to a spot with a diameter of hundredths of a millimeter. Laser light should not be directed to the eye. The use of normal sun glasses rather than wearing true laser lens protectors tends to increase the risk of eye injury, because the filtration mechanism of sun glasses is lower in the laser spectrum, and darkness of the sun glasses makes the pupil to dilate to let in more light to enter.

The five most important parameters that affect the classification of a laser safety are:

- **a.** The wavelength (nm).
- **b.** Minimum beam diameter or beam waist (cm).
- **c.** Minimum divergence (radians).
- **d.** Minimum pulse width (seconds) including pulse repetition rate [PRR] (Hz).
- **e.** Maximum out put power (W).

Lasers can be classified according to safety into:-

Class I lasers: lasers that are not hazardous for continuous viewing or are designed in such a way that prevent human access to laser radiation. These consist of low power lasers or higher power imbedded lasers. Maximum power 0.4µW .

Class II visible lasers: lasers that emit visible light, which because of normal human aversion responses, do not normally present a hazard but it present a hazard if viewed directly for extended period of time. This is like many conventional high intensity light sources. Maximum power 1mW for He-Ne laser.

Class IIa visible lasers: lasers emitting visible light not intended for viewing and under normal operating conditions would not produce an injury to the eye if viewed directly for less than 1s. Maximum power 40mW for He-Ne laser.

Class IIIa lasers: lasers that normally would not cause injury to the eye if viewed momentarily but would present a hazard if viewed using collecting optics. Such as power 1.0-5.0mW for He-Ne laser.

Class IIIb lasers: lasers that has an average power less than 500 mW and present a skin and eye hazard if viewed directly. This includes both intra-beam viewing and specular reflections; they do not produce a hazardous diffuse reflection except when viewed at close proximity. Such as visible Argon laser power 5.0mW to 500mW.

Class IV lasers: lasers that present an eye hazard from direct, specular and diffuse reflections. In addition such lasers may be fire hazards and produce skin burns. Power greater than 500mW.

Each laser system classified as a class IIIa laser should be incorporated by an emission indicator that provides a visible or audible signal in class I limits during emission of accessible laser radiation. That emission indicator should be located so that viewing does not require human exposure to laser or collateral radiation in excess of the accessible emission limits of class I.

Suggestive Readings

Robert A. Convissar. Principles and Practice of Laser Dentistry, 2nd Edition,Elsevier, 2016

Dental Implant

Dental implant is a prosthetic device made of alloplastic material(s) implanted into the oral tissues beneath the mucosal and/or periosteal layer and on or within the bone to provide retention and support for a fixed or removable dental prosthesis; a substance that is placed into and/or on the jaw bone to support a fixed or removable dental prosthesis

The composition and nature of the surface on an implant are important characteristics because of their effect on the biologic development of an interfacial relationship between the bone and the implant. To be successful, an implant must meet four conditions:

1) Be biocompatible so there is no undesirable reaction between the tissues and the implant (i.e. corrosion, dissolution and/or resorption;

2) Have an interface that stabilizes postoperatively in as short a time as possible;

3) Be capable of carrying and transferring the occlusal stresses that are placed upon it; and

4) Remain stable for a long period of time.

Knowledge of the composition of implant materials, their surfaces, and their forms are important factors when developing an understanding of the biocompatibility of implants and how they develop a symbiotic relationship with living tissues.

Dental implant

It is an artificial titanium fixture which is placed surgically into the jaw bone to substitute for a missing tooth and its root(s). Dental implantology aims at functional and esthetic rehabilitation of a patient affected by complete or partial edentulous.

What is an implant?

A “root replica” or a “root form” implant is a titanium fixture inserted in the jaw to act as a tooth root and anchors a restoration (single crown, bridge, or denture) The final restoration looks, feels, & functions like a natural tooth

Why an Implant?

They replace missing tooth roots and form a stable foundation for replacement teeth that look, feel and function like natural teeth. Dental implants also help preserve the remaining bone by providing the stimulation previously provided by the natural tooth roots & prevent future bone loss. Bone that disappears when a tooth is removed can only be replaced with a bone graft.

Osseointegration

A Swedish orthopedic surgeon, Prof. Branemark, in 1952 accidentally discovered osseointegration. When pure (Ti) comes in contact with the living bone tissue the two literally grow together to form a permanent biological adhesion.

Functional ankylosis-also called

1. The apparent direct attachment or connection of osseous tissue to an inert, alloplastic material without intervening fibrous connective tissue;
2. The process and resultant apparent direct connection of an exogenous material’s surface and the host bone tissues, without intervening fibrous connective tissue present;
3. The interface between alloplastic materials and bone.

Steps Of Osseointegration

Woven bone is quickly formed in the gap between the implant and the bone. It has low biomechanical capacity; the occlusal load should be controlled. After 1 to 2 months, under the effect of load, the woven bone will slowly transform in to lamellar bone

Indications for Implants

1. Replace one or more teeth as single units
2. Support a bridge and eliminate the need for a partial denture
3. Provide support for a denture, making it more comfortable
4. Prevent bone loss and gum recession
5. Enhance patient confidence in smiling/speaking
6. Improve overall psychological health
7. Improve esthetic appearance of the teeth and mouth

Advantages to Implants

1. Maintain Anatomy: If you have missing teeth, the bone begins to shrink over time. Unhealthy bone loss can make your jaw line recede and change your facial structure and cause drifting & shifting of the other natural teeth. Dental implants can help prevent deterioration of the jawbone so your face retains its natural shape.

2. Keep your healthy teeth, in many cases, a better long-term alternative to bridgework, dental implants eliminate the need to grind down healthy teeth when replacing one or more adjacent teeth. Your own natural healthy teeth are not compromised.

3. Security: Securely anchored dental implants do not slip or move. This eliminates some of the key problems of dentures, including poor fit, gum irritation and pain from exposed nerves. The result is superior comfort, reliability, and freedom from embarrassment.

Contraindications to Dental Implants

1. The financial investment is greater Treatment can take several months to complete

2. An implant may loosen and require replacement

3. Implant procedures may be emotionally challenging for some patients

4. Bruxism is a significant component of failed implants

5. The risk for infection is much greater with an implant than with a fixed bridge.

6. Patients with diseases of the cardiovascular, respiratory, and gastrointestinal systems are not good candidates for implants.

7. Patients with seriously compromised immune systems and other diseases that may slow the healing process are not good candidates.

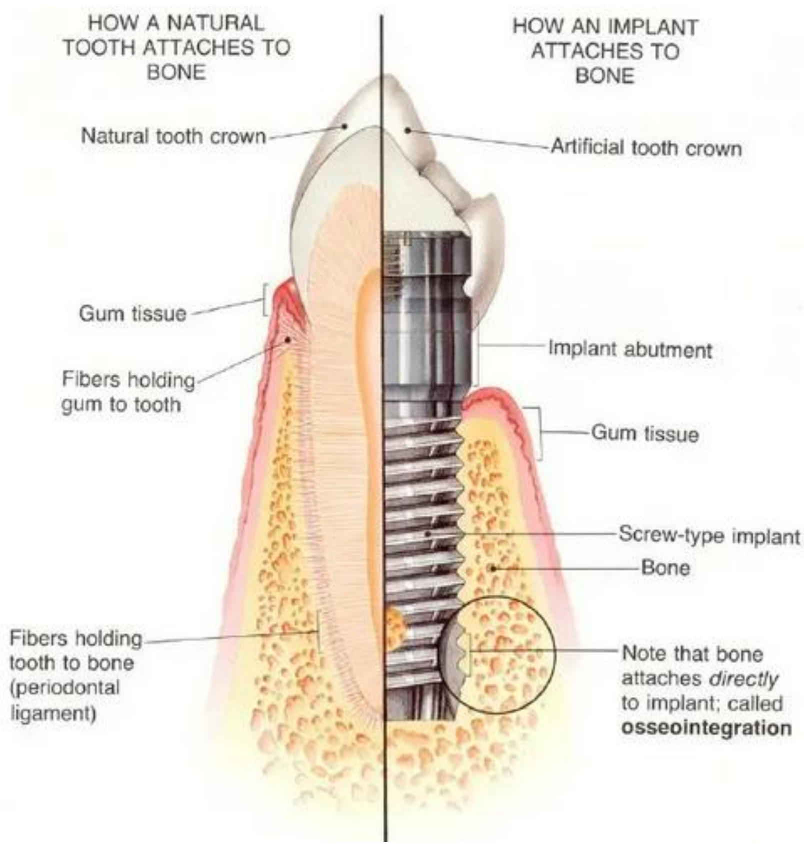
Implant Tissue Interface

Implant and bone interface: The glycoprotein layer on the bone is adsorbed on the implant surface with the help of adhesive macromolecules like Fibronectin, Laminin. They are bonded to the metallicoxide layer on the Tibycovalent bonds, ionic bonds or van-der-walls bonding.

Implant connective tissue interface

Gingival fibers forms the attachement, is strong enough to withstand the occlusal forces and microbial invasions.

Implant epithelial interface: Epithelium is attached to implant surface through hemidesomosomes and glycoproteins and considered as Biologic seal. It forms a sulcus depth of 3 to 4 mm.



General principles of implant planning.

Backward planning principle and objective.)

Treatment sequence:

pretreatment prophylaxis

history taking and clinical findings

assessment of findings (teeth present, jaw relations;soft and hard tissue, existing function and esthetic limitations)

Definition of the prosthetic objective (primary aim is fixed (if necessary bone augmentation) and prosthetic rehabilitation

Recall

Clinical considerations

Bone quality. It is a consistency, hence the desired mechanical stability and osseointegration capacity of the bone , factors influencing bone quality:

Patient's expectations

Reasonable or not

Oral hygiene status

Radiographic evaluation

- 2D-periapical, occlusal, panoramic, lateral cephalometric radiographs.
- 3D-CT,Tune daperture computed tomography, cone-beam CT

Study model analysis

- To determine Clinical length of the prosthetic crown that will be supported by the implant.
- Inter arch distance.: The implantaxis-it should be parallel to the axis of adjacent natural teeth.
- Number and size of implants.

Surgical guides

Helps to position the implants appropriately from the prosthetic point of view. Holes are drilled into the acrylic at appropriate locations with proper axis orientation.

Bone density

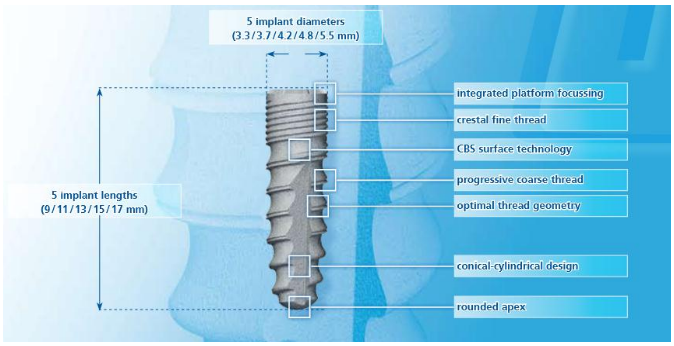
- For softer bone; number and diameter of implant must be increased with more and deeper threads.
- Bone density can be assessed by Misch classification on bone density (1988) from C.T using Hounsfield Units or C.T number.
- He classified it in to 4 groups D1 to D4. and D5 is immature bone
- Higher the CT number, denser is the tissue.
- D1: > 1250 HU; D2: 850 to 1250 HU; D3: 350 to 850 HU; D4: 150 to 350 HU; and D5: < 150 HU.

Misch Bone Quality Classification

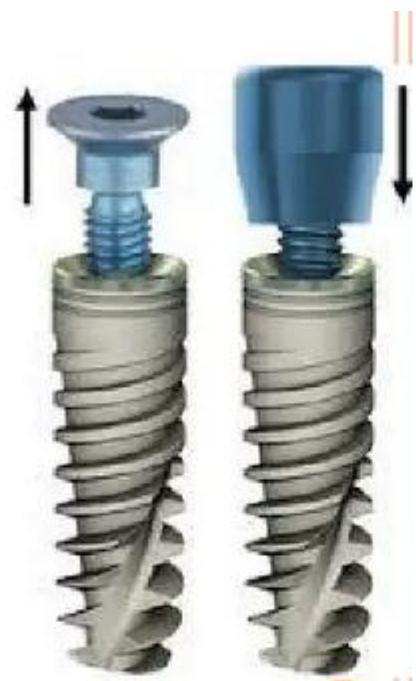
Bone Density	Description	Typical anatomical location
D1	Dense cortical	Anterior mandible
D2	Porous cortical and coarse trabecular	Anterior mandible Posterior mandible Anterior maxilla
D3	Porous cortical (thin) and fine trabecular	Posterior mandible Anterior maxilla Posterior maxilla
D4	Fine trabecular	Posterior maxilla

Implant Components

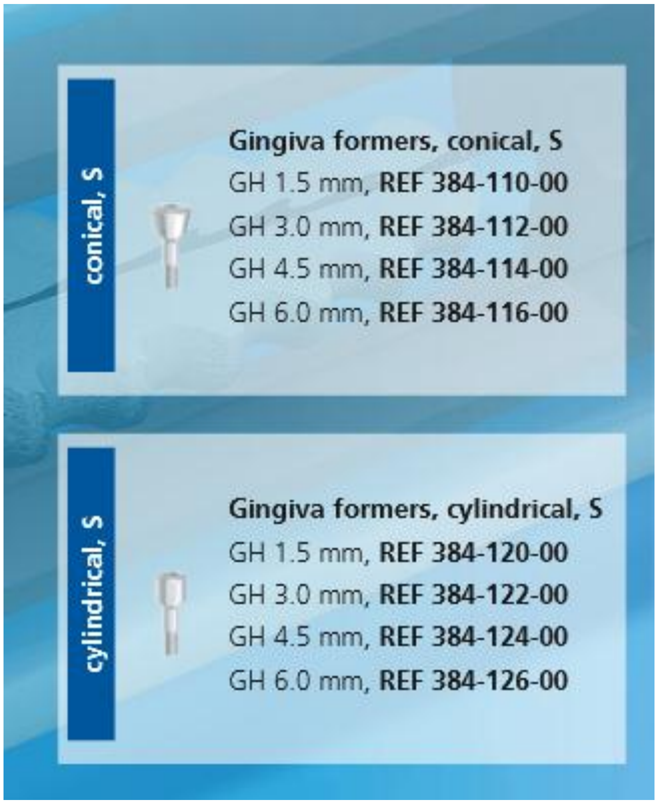
1. Implant body : The component that is placed within the bone during first stage of surgery. It was threaded conical or slindrical form, with a hydroxyapatite coating



2. Healing screw : (First stage cover screw) It is placed into the top of the implant to prevent bone, soft tissue or debris from invading the abutment connection area during healing.It facilitates suturing of the soft tissue

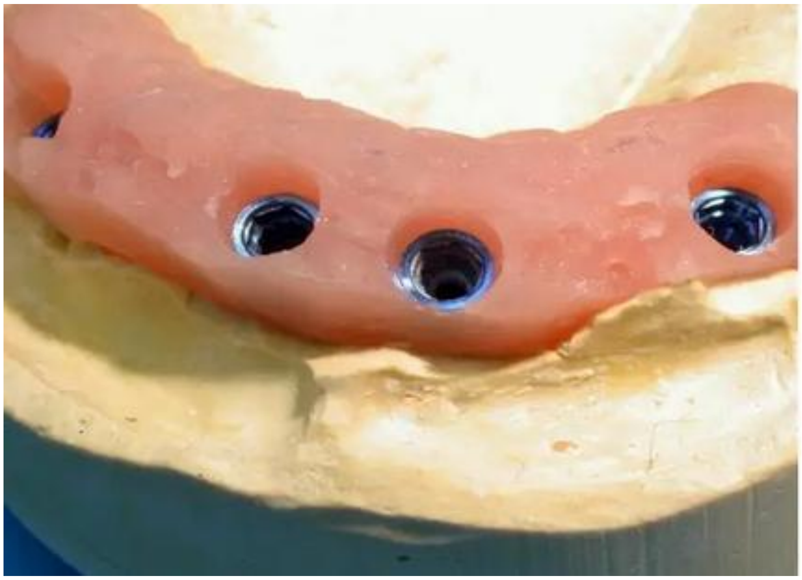


3. Healing abutment: It is a temporary part placed on the implant body to create a channel through the mucosa while the adjacent soft tissues heal and results in a perimucosal seal around the implant. Also called a spermucosal extension or gingivalformer.



4. Impression coping: Impression coping (impression cap), It is used to transfer the position of the implant body or the abutment to the working cast, The dentist screws the impression coping to the real implant body and then takes an impression. The impression coping remain fixed in the impression material and lab analogue is added prior to dispatching to the lab.

5. Analogue or Implant Replica: Analogues are used by lab technicians to replicate implants and their position in a patient's mouth. A model of the patient's dentition is made using an impression. Analogue provides a replica of the position of the implant from which the technician can place and shape the abutment and build the crown



6. Abutment: Intermediate connector between the implant and the restoration ,it may extend above the tissue, Supports or retains a prosthesis. Four types were present :cylindrical, shouldered, angled and customizable

7. Prosthetic part

Superstructure that could be crown or bridge (Ceramic, Zirconium) or acrylic (All over 4), cemented or screw retained

Surgical procedure

Surgery can be done in one stage or in two stage.

Two stage surgery:

In first stage implants are surgically placed under the gum and the patient is made to wait for 6 months for osseointegration.

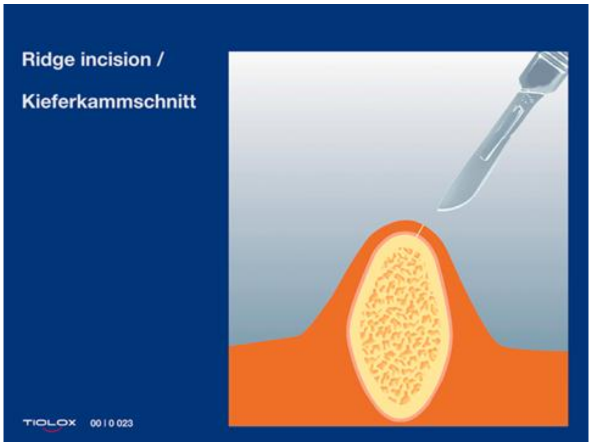
2nd stage surgery Is then performed where the healing gingival former is placed and after a week of satisfactory formation of a gingival collar for emergence profile is achieved, impressions are made for implant prosthesis, which may be cemented or screw retained

one-stage surgery

Implant is placed and left exposed through the gum.In this case, a second stage surgery in not needed

Implant Surgical Phase

- Surgical site preparation and isolation
- Preoperative antibiotic prophylaxis
- Local anesthesia
- Incision-Mid crestal incision with a margin of 1.5mm keratinized tissue buccally extending to the sulcus of adjacent teeth
- Flap should be reflected and elevated.



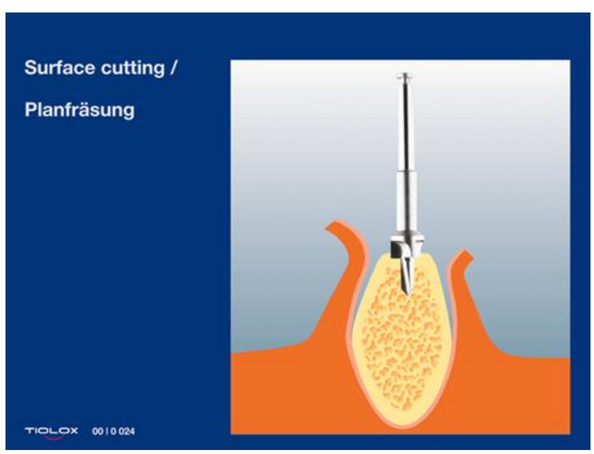
- Implant osteotomy
- After the bone is exposed the surgical guide template is positioned.It directs the angulation of the implant.

Diagnostic model with surgical stent (integrated guide sleeves)

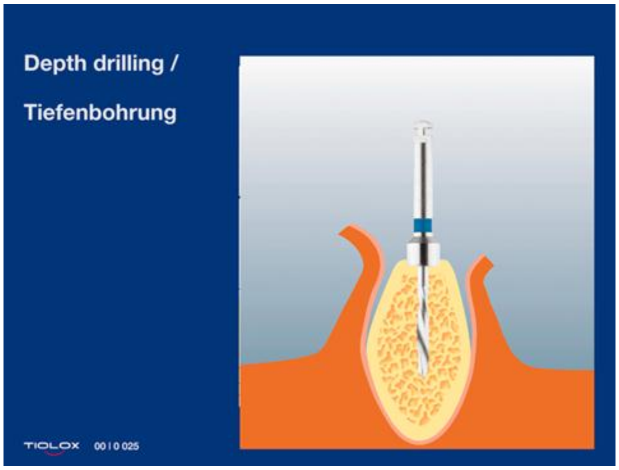

Surgical guided stent

- A low-speed (1500-2000[rpm]),high-torque handpiece and copious.

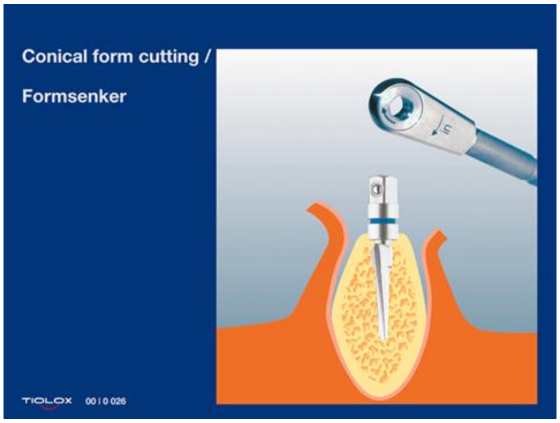
- Irrigation are necessary to prevent excess thermal injury to the bone. Irrigation keeps the local bone temperature at normal body temperature and also to flush out the bone debris from drill hole. Normal saline at room temperature is ideal.



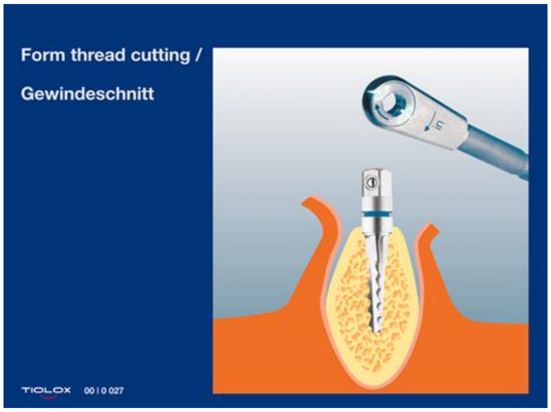
- Bone Drilling: The manufacturers give a guide to the sequence of drill(Sizes) to be used in order to make proper sized drill hole for a particular implant, The drills are marked for depth to guide the surgeon. Drills are used in ascending order of diameter. Recommended drilling speed 800-1000 rpm



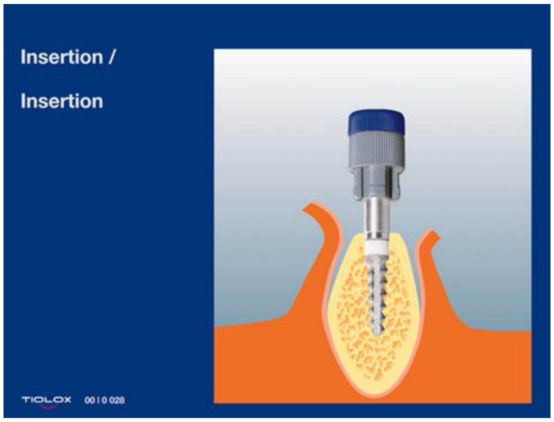
- With the initial drill, the center of the implant recipient site is marked and the initial pilot hole is prepared



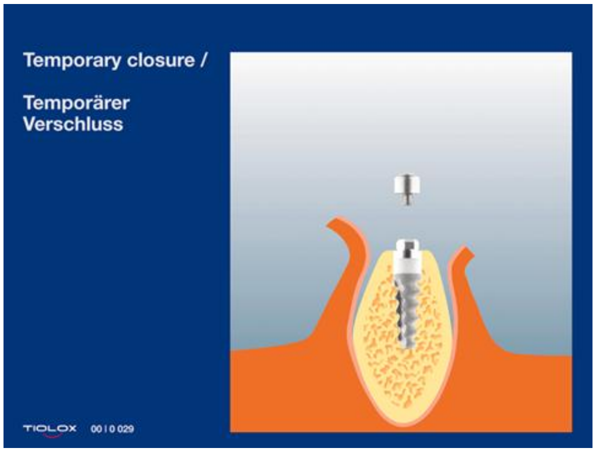
- A paralleling pin is placed in the initial preparation to check alignment and angulation.
- If it is appropriate ,drill hole is sequentially enlarged to dimensions of the implant.



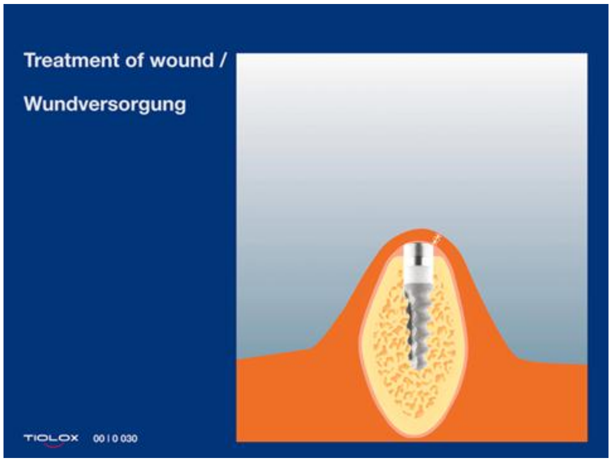
- After the desired depth and diameter of the recipient site is accomplished, the implant can be placed.
- Implant Insertion: After final osteotomy, the site is lavaged and aspirated to remove debris and blood For Tiimplants, an uncontaminated surface xi delayer is necessary to obtain osseointegration. So touching with gloves, soft tissue or a dissimilar metal should be avoided. The implant is rotated with 30-45 rpm by low speed high torque handpiece / handratchet. It should be rigid with no mobility on slight compression.



- Post insertion radiograph-to evaluate the position, adjacent vital structure.
- Cover screw is inserted.



- Flaps are sutured.



- If implant position is not correct, it may be removed and reinserted after several months later(4-6 momths).
- Second stage surgery: In second stage surgery in preferably a shaped incision is made in the overlying mucosa and the coverscrew is exposed and removed with a Hex Driver, and is replaced with a gingival former and is left for 14-21 days. The gingival former helps in formation of a gingival

collar around the future abutment which helps in giving the final prosthesis a more natural appearance

Prosthetic Phase

- Impression: After the healing period, gingival former is removed, impression copings are put onto the implant and impression is taken by open/closed technique.
- The implant analogue is fixed on the impression coping and the impression is poured in die stone.
- Now the analogue is seated in die with same angulation as in bone.
- Once the plaster is set the coping is removed and abutments are placed over the lab analogue.
- Then the crown is fabricated over the abutment.
- After the fabrication of prosthesis, the abutment is taken off the cast leaving the implant analogue in the cast.
- This abutment can now be transferred and screwed onto the implant and prosthesis affixed to it (either screwed or cemented to the abutment).
- Occlusal adjustments are undertaken if required

Complication in Implant Surgery

Intraoperative Complications

- Flap tear
- Insufficient irrigation
- Perforation of buccal or lingual cortex
- Inferior alveolar nerve injury

- Implant/Drill impinges on adjacent tooth root
- Perforation of maxillary sinus
- Perforation of pyriform fossa base
- Lack of primary stability of implants
- Fracture of implant

Immediate postoperative Complications

- Swelling
- Nerve injuries
- Pain(unusual)
- Haemorrhage(Rare)

Delayed Complications

- Infection
- Secondary Hemorrhage
- Nerve injury
- Loosening of implant
- Implant Exposure

Implant failure

- Mobility of implant during healing period
- Pain,
- Infection
- Radiolucency around implant.
- Whatever the cause, the implant should be removed and the condition caudle be treated in some case of peri-implantitis.
- Graftingandreinsertioncanbedoneafter8-10wks.

Suggestive Reading

Richard M Palmer, Brian J Smith, Leslie C How, Paul J Palmer. Implants in Clinical Dentistry. Taylor and Francis e-library, New York, 2002

Diagnostic Imaging

Maxillofacial imaging has evolved in parallel with the development of newer imaging technologies. Traditional plain radiography and dental imaging is now frequently supplemented by cross-sectional modalities, such as computed tomography (CT), magnetic resonance imaging (MRI) and ultrasound, together with functional imaging modalities, such as positron emission tomography (PET). It is important to be aware of the benefits and limitations of such imaging examinations such that they are applied to the appropriate clinical scenario.

Radiation Protection

Some imaging investigations use ionizing radiation which has the potential to result in biological damage. The aim of radiation protection is to provide a safe environment for the worker and patient. The Ionising Radiation (Medical Exposure) Regulations 2000 (IRMER) lay down basic measures required for protection against the harmful effects of medical radiation exposure. There are duties of the employer who provides a framework within exposures which take place, the operator who carries out the exposure, the practitioner who justifies the exposure and the referrer who requests the exposure. Key principles are that the examination should be of sufficient benefit to justify radiation exposure, that dose is optimized by the ALARA (as low as is reasonably achievable) principle and that dose limits should be recorded

Plain Radiographs

X-rays are produced by a point source and, after passing through the body part of interest, are detected by nonscreen (dental radiography) or intensifying screen/film combinations (extraoral radiography). Selected facial radiographic views are listed below. Tomography refers to a technique whereby the x-ray source and film move during the exposure. The aim is to demonstrate only a section which is in focus, whereas structures outside this section are blurred. Applications include conventional dental panoramic tomography, tomograms of the temporomandibular joints and mandibular tomograms for implant planning.

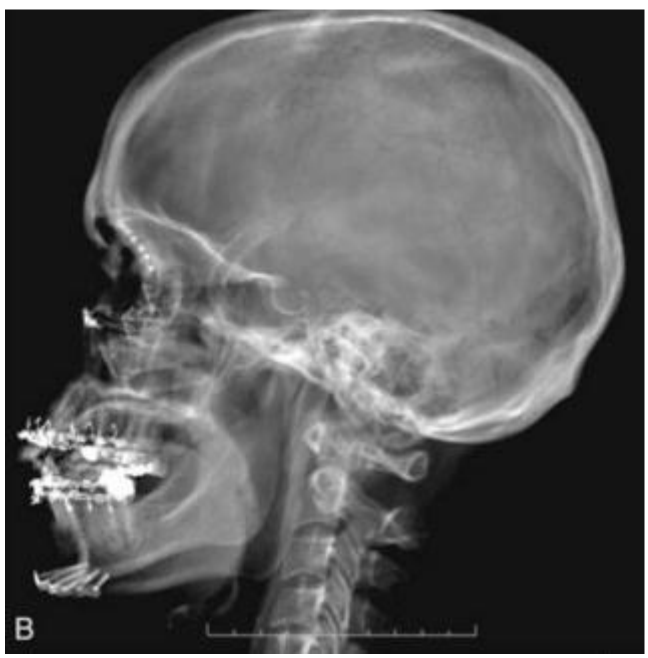
	Radiographic view	Comment
Mid and upper third	Occipito-frontal (OF) 15-20 (Caldwell view)	Used to visualize upper third of face
	OF 25 (modified Caldwell view)	Superior visualization of orbital floor relative to Caldwell view
	Occipito-mental (OM)	Used to visualize mid-third of the face
	OM 10	Less obscuration of maxillary antrum than an OM view
	OM 30	Superior view of malar arches and inferior orbital margins. Preferable to submentovertical (SMV) view
	Lateral	Supplementary for central midface injury
Lower third	Postero-anterior (PA) mandible	
	Lateral oblique	Replaces OPG if not available or impractical
	Reverse Townes	Better visualizes mandibular condyles
	Orthopantomogram (OPG)	

Digital radiography units (using digital receptors to intercept the x-ray beam rather than intensifying screens) are now replacing conventional units. This allows transmission of data to image processing and storage devices, as well as communications networks**.**

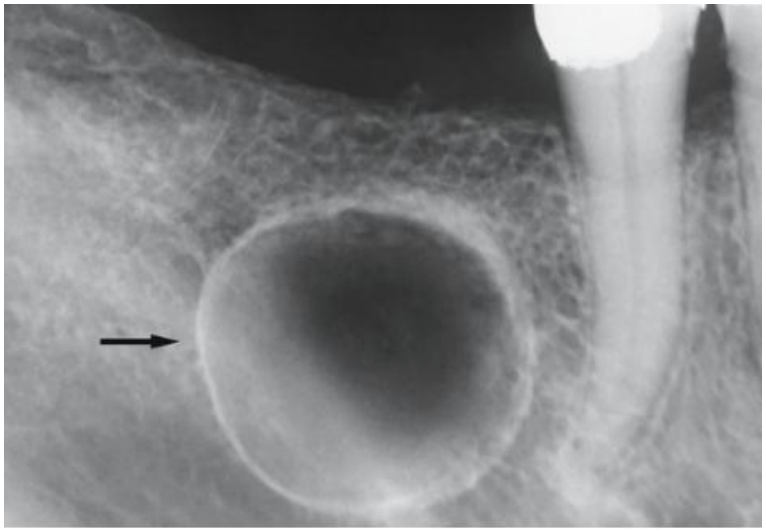
OPG Radiograph

Occiptomental radiograph

PA Skull (Mandible) Radiograph



True Lateral (Cephalometeric) Radiograph

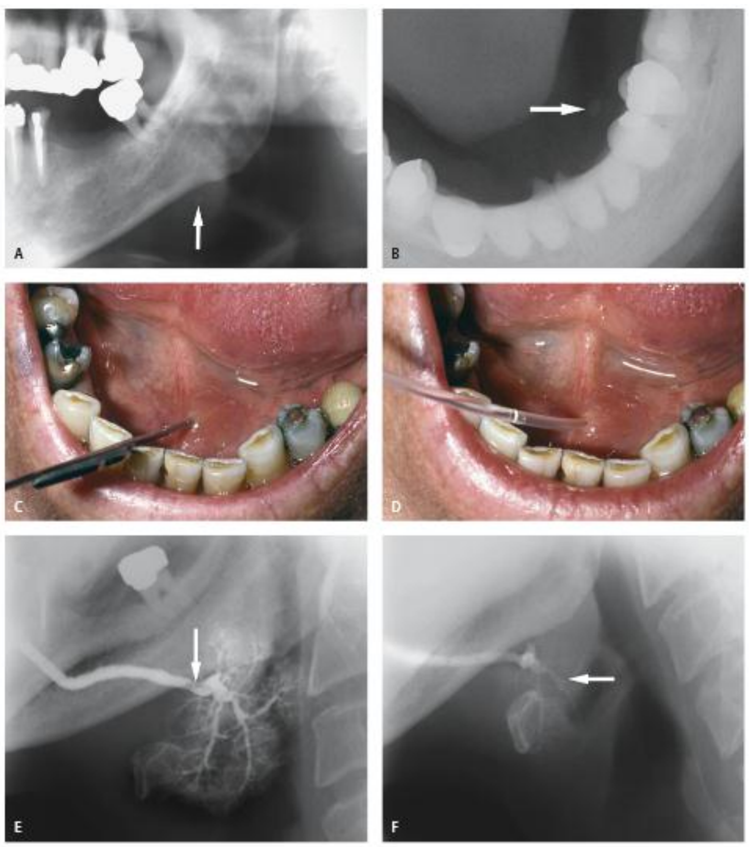


Periapical Radiograph

Occlusal Radiograph

Contrast Studies

Contrast media may be introduced into a vessel, lumen or cavity in order to render it radio-opaque and hence radiographically visible. This may then be viewed in real time with fluoroscopic imaging or with serial radiographs. Contrast media used for this purpose include barium sulphate suspensions and non-ionic iodinated contrast agents. There is a small risk associated with the intravascular iodinated contrast agents which must be weighed against the potential benefits. Information which should be sought from the patient before contrast injection includes previous contrast reactions, asthma, renal problems, diabetes and metformin therapy.



Contrast studies with maxillofacial applications are:

1 Angiography: Conventional angiography is generally performed as a precursor to interventional radiological techniques. CT and MR angiography have largely replaced diagnostic applications in maxillofacial pathology. It remains appropriate for the planning of embolization of high flow vascular malformations and tumours and for the evaluation of arterial injury (traumatic or tumour erosion). Angiographic catheters are generally introduced over a guidewire via a common femoral artery puncture. Small caliber microcatheters may be introduced into distal external carotid artery branches.

2 Barium/contrast studies: Barium swallows may be required to evaluate high dysphagia and pain. Rapid serial radiography or video recording may be used **to** assess the hypopharynx and upper oesophagus during deglutition. Barium may be combined with a gas-producing agent and an intravenous smooth muscle relaxant to produce double-contrast images of the lower oesophagus. If aspiration or tracheooesophageal fistulation is suspected, then a low osmolar iodinated contrast medium will be used.

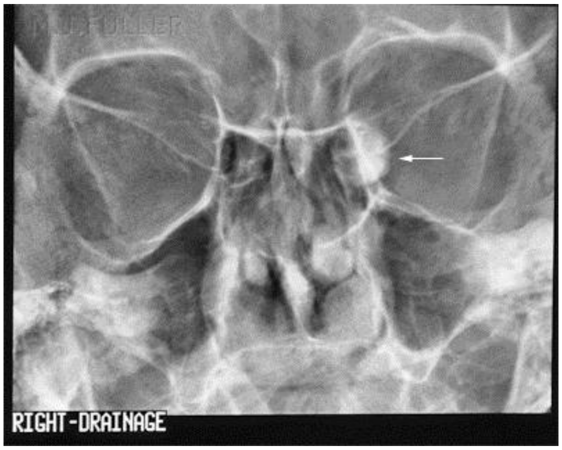
3 Sialogram: Iodinated contrast medium may be introduced into the salivary duct ostium via a polythene catheter. Fluoroscopy or radiography is used including delayed images after administration of a sialagogue. This is compared with preprocedure control films.

4 Sinogram/fistulogram: A sinogram involves the insertion of a fine catheter into the orifice of a sinus and injection of contrast medium in order to delineate a sinus or fistula. If there is a complex tract then it may be combined with CT.

5 Temporomandibular joint (TMJ) arthrogram:

Iodinated contrast medium is injected into the joint under fluoroscopic guidance and double-contrast studies may be achieved by contrast withdrawal and replacement with air.

6 Dacrocystogram: The nasolacrimal sac and duct may be cannulated and injected with contrast medium in patients with epiphora. The lacrimal drainage system may also be evaluated with CT and MRI following conjunctival application of contrast medium.



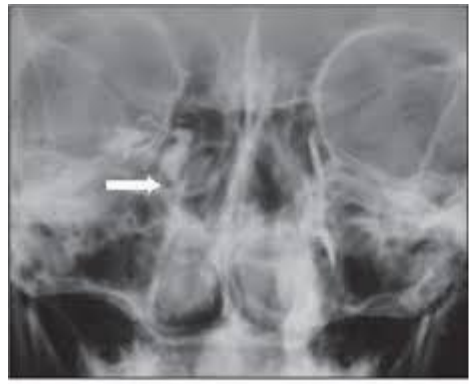
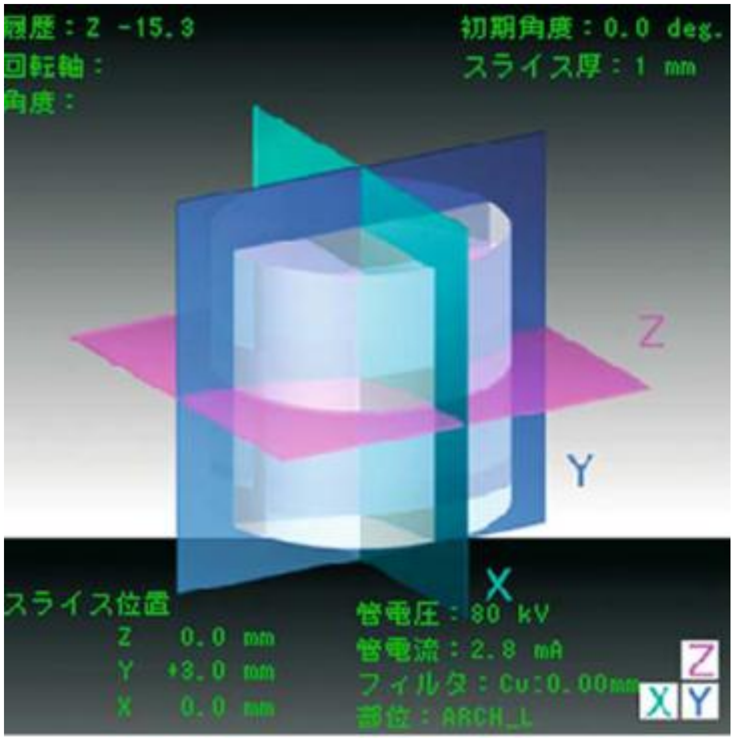


Figure 3. Conventional dacryocystography. Complete obstruction of the right lacrimal pathway at the level of the Krause's valve (arrow). Pervious and morphologically normal left lacrimal pathway.

7 Percutaneous venogram: Percutaneous venography may be used as a precursor to sclerotherapy for the assessment of volume and venous run off in the setting of low flow venous malformations. A similar technique (lymphogram) is used for a lymphatic malformation. Ultrasound is used to guide the needle placement if the lesion is not clinically palpable.

Computed Tomography

A CT scanner consists of an x-ray tube which sends a fan of x-rays through the patient and the attenuation of the beam by the patient is detected. The process is repeated as the tube and detectors rotate and the patient is advanced through the scanner. The degree of x-ray absorption by each volume of tissue (voxel) is displayed as a pixel which is allocated a number (Hounsfield unit). This information may be digitally manipulated so as to best demonstrate the tissues of interest (e.g. by changing the range of numbers in the grey scale or window width or by using algorithms to alter the sharpness of the image). The same information may be used to provide multiplanar reformats or rendering of three-dimensional objects to facilitate visual assessment. Imaging of soft tissues generally requires the administration of iodinated contrast medium to enhance pathological tissues and help delineate vascular structures from other soft tissue, such as lymph nodes. The availability of CT fluoroscopy and in-room CT controls/monitors has improved the safety and efficacy of CT-guided biopsies of deep facial and skull base lesions. Contemporary multislice computed tomography (MSCT) differs in that a number of slices (current scanners are typically 64 slice) are obtained per tube rotation. Multislice CT has the potential to scan standard volumes with shorter acquisition times so reducing movement artefact (e.g. due to swallowing) or the requirement for sedation and optimizing vascular opacification (e.g. for CT angiographic studies). It also allows the scanning of larger volumes or the use of narrower section thickness so optimizing the three-dimensional dataset for post-processing and interactive 3D image-guided surgery.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管電流：2.8 mA
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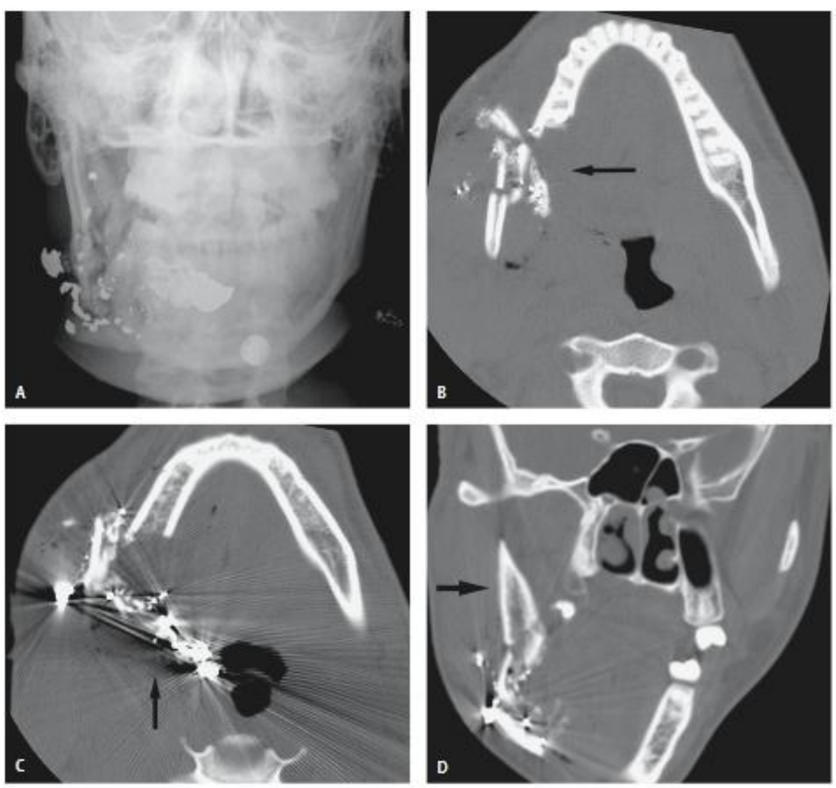
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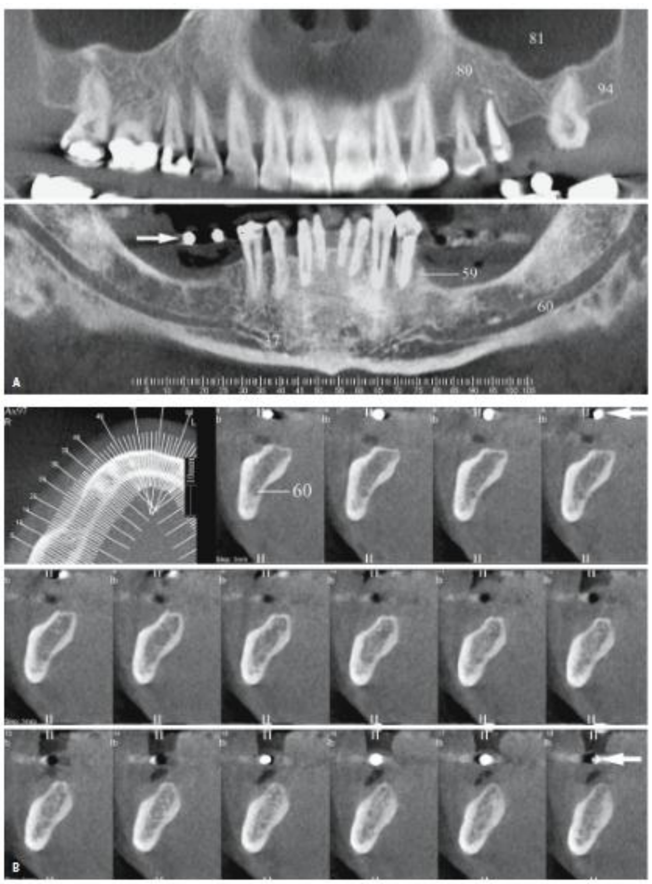
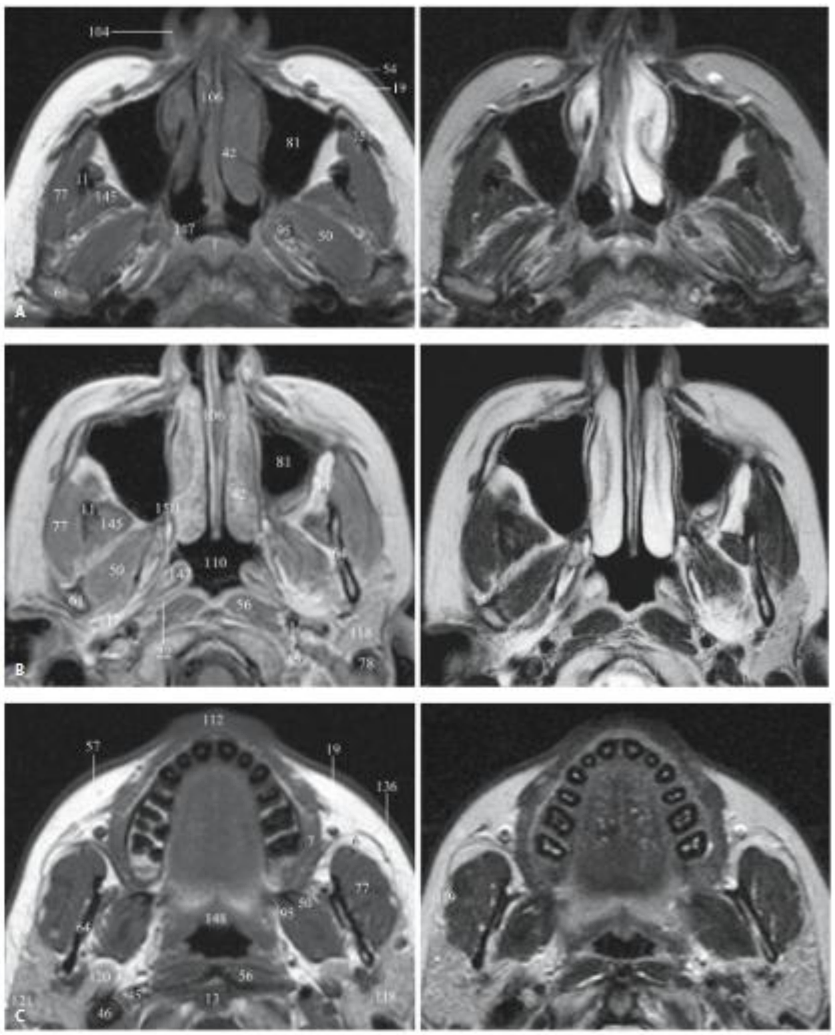
Cone beam CT has developed as a technique which povides high resolution 3D data at low radiation doses (e.g. equivalent to 2–8 OPGs). The equipment may resemble that of a conventional dental panoramic tomography unit (patient erect) or may mimic a conventional CT scanner (patient supine). A cylinder- or sphere-shaped volume of data is rapidly acquired with a single tube rotation. Some cone beam CT equipment is designed to simulate intraoral radiographs by imaging small volumes (e.g. two or three teeth) at high resolution, whilst other equipment is designed to image the whole maxillofacial region (e.g. 15-cm3 spheres). The low tube currents utilized to reduce the radiation dose unfortunately preclude adequate imaging of soft tissue structures.



Magnetic Resonance Imaging (MRI)

Magnetic resonance imaging does not require ionizing radiation so should be preferred in cases where it would provide similar information to CT and both are available. There are some definite contraindications to the use of MRI, including metallic foreign bodies in the orbit, intracranial aneurysm clips, cardiac pacemakers and cochlear implants.

MRI signal is tissue dependent and is based on the behaviour of protons within that tissue when they are exposed to radiofrequency pulses within a magnetic field. Signal can be resolved into two components (T1 and T2). Selecting appropriate pulse sequences allows images to reflect the T1-weighted or T2-weighted characteristics of tissues. Most pathology results in increased water content relative to normal tissues and thus is shown as decreased signal on T1-w images and increased signal on T2-w images. There are various other tissues and substances which may be distinguished by differing MRI signal. Pre- and post-gadolinium (contrast medium) sequences should be performed with T1-w. T1-w sequences may also be combined with fat saturation postgadolinium, such that increased signal due to enhancement is not masked by that due to fat. Pathological lesions undergo variable enhancement and gadolinium is used to help characterize lesions. Normal structures that markedly enhance include mucosal linings and lymphoid tissue. The STIR (short time inversion recovery) sequence has been shown to be very sensitive to pathology which generally demonstrates increased signal. Multiplanar imaging (coronal and axial imaging as a minimum) is routinely performed with 4–5-mm section thickness. Typical imaging sequences for a study of the face and neck would include: T1-w axial, T2-w axial, T1-w postgadolinium axial, STIR coronal, T1 fat saturated post-gadolinium coronal images. MR angiography may demonstrate flow in relation to a vessel lumen with or without the use of gadolinium. Other MRI techniques (such as spectroscopy, diffusion and perfusion imaging), higher field magnets (3 Tesla as opposed to standard 1.5 Tesla) and novel contrast agents, have been applied to the face and neck although clinical utility has not yet been established.

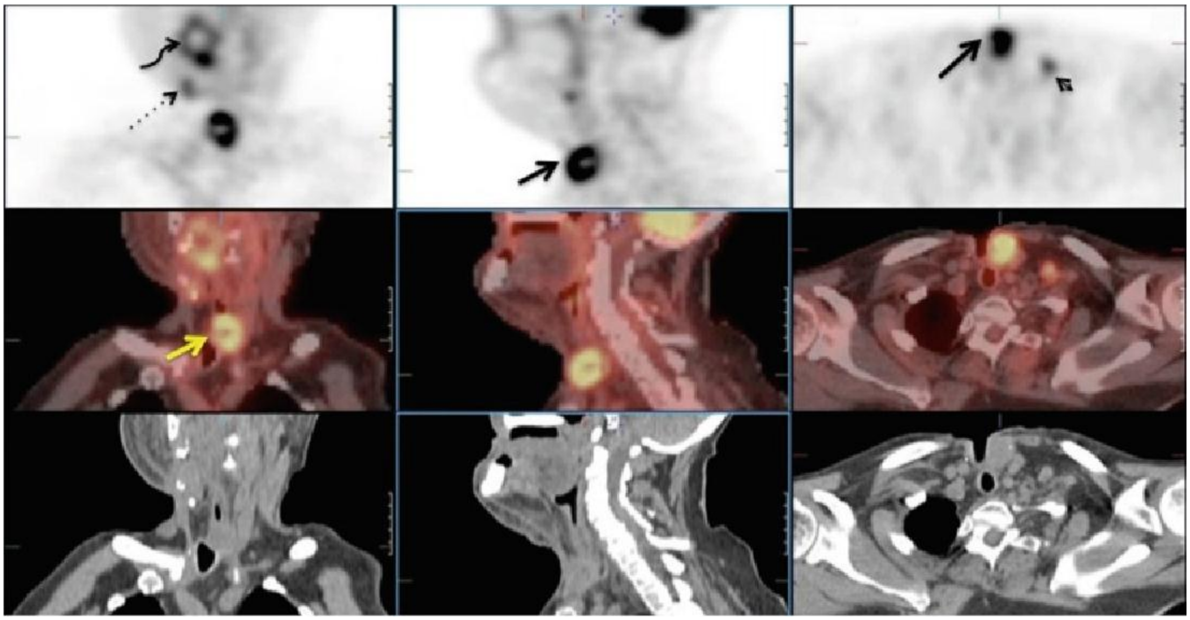


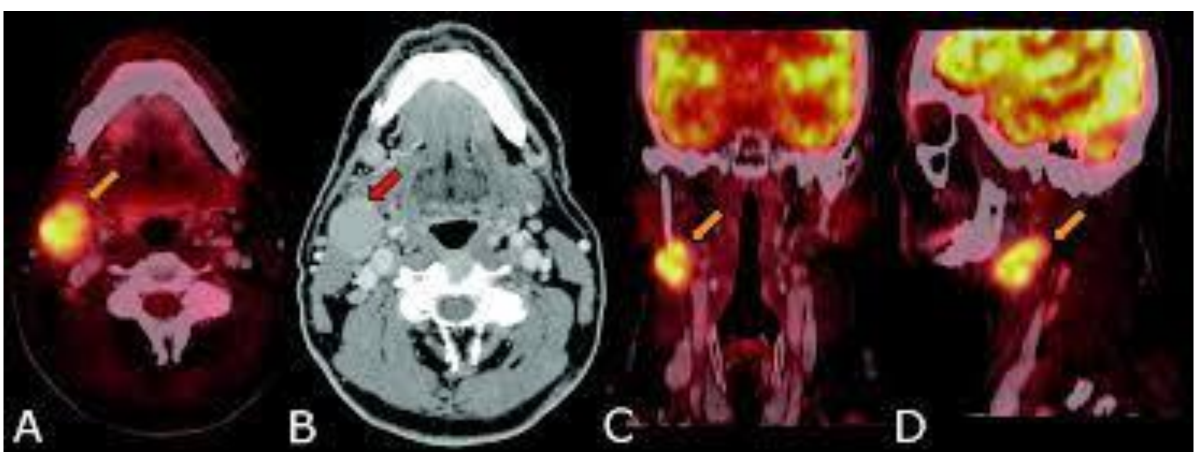
	CT	MRI
Advantages	Widely available	Does not require ionizing radiation
	Rapid so less prone to movement artefact	Usually less image distortion than CT from metallic foreign bodies
	Demonstrates cortical bone and calcification well	Delineates bone marrow pathology well (e.g. mandible/central skull base)
	May be combined with imaging of the lungs	Superior for skull base and intracranial imaging
	Excellent spatial resolution and 3D post-processing	Excellent contrast resolution with direct multiplanar imaging
Disadvantages	Ionizing radiation	Absolute contraindications preclude some patients
	May require iodinated contrast media (incidence of severe reactions is 0.04%)	Claustrophobia precludes some patients
		Time consuming and prone to motion artefact if patient breathless/unwell
		Expensive

Positron Emission Tomography (PET) And Other Radioisotope Imaging

Positron emission tomography differs from the previously mentioned anatomical techniques in that it provides functional imaging of metabolic activity. This has proved very useful in the setting of maxillofacial malignancy with improved diagnostic accuracy relative to CT and MRI. Most PET imaging studies of the head and neck use the short-lived radiotracer 18-fluorodeoxyglucose (18FDG) which allows an examination of altered glucose metabolism as a marker of tumour activity. This unstable radioisotope releases a positron over a short distance after which it annihilates with an electron and emits the photons that are detected. This process of photon production implies a lower limit of spatial resolution , so PET does not provide the same anatomical detail as CT or MRI. To improve the localization of pathology, PET images were initially co-registered with CT or MR images; however, techniques have now progressed such that functional and anatomical CT images (PET-CT) may be obtained on the same scanner. It should be noted that the CT component of such PETCT scanners may be performed without contrast medium and does not generally use the same parameters as diagnostic CT so is not a direct substitute. Multiple slices are obtained and multiplanar reformats are routine. A dedicated head and neck field of view may be followed by a separate half body study.

PET must be interpreted with an awareness of the limitations in detecting small volume (particularly <3–4 mm) disease, including superficial mucosal lesions, lymph node micrometastases and necrotic lymph nodes. Some tumours, such as salivary gland tumours, are not 18FDG avid. Some centres use an objective measure of FDG uptake standardized uptake value (SUV)) to help distinguish a malignant lesion. There are also pitfalls due to false-positive findings resulting from normal tracer distribution (e.g.salivary and thyroid gland, muscle activity and Waldeyer's ring) and inflammatory tissue (e.g. lymph nodes, early stages post-tumour treatment and healing bone).

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Other radioisotopes used in the investigation of maxillofacial disease include:

- 1 99mTc-MDP for the evaluation of bone disease (e.g. condylar hyperplasia, degree of activity in fibro-osseous lesions, bone metastases, bone invasion by tumour, osteomyelitis, integrity of blood supply in radionecrosis or vascularized grafts).
- 111Indium-labelled and 99mTc-HMPAO-labelled leukocytes together with 67Ga-gallium citrate for the diagnosis and localization of infection or inflammation in soft tissues.
- 99mTc-pertechnetate for dynamic salivary gland imaging or to detect ectopic thyroid tissue

Ultrasound imaging

Ultrasound imaging does not require ionizing radiation and is a relatively inexpensive, non-invasive and readily available technique which is well tolerated by patients. It is particularly useful in examining superficial structures (less than 5 cm deep to the skin surface), where the use of a high frequency linear probe (7.5–12 MHz) produces high definition images in multiple imaging planes. The spatial resolution achieved by ultrasound surpasses that of either computed tomography (CT) or magnetic resonance imaging (MRI), and when combined with tissue sampling techniques (percutaneous fine needle aspiration (FNA) for cytology or core biopsy for histopathology), ultrasound is a highly specific diagnostic tool.

Clinicians who have detailed knowledge of the anatomy of the head and neck region may choose to learn how to use ultrasound as an adjunct to clinical examination and as an aid to biopsy techniques. This chapter aims to give an overview of the use of ultrasound in the neck with relevance to clinicians who either want to gain a greater understanding of the technique or who wish to begin to use ultrasound in their practice of ultrasound waves caused by variation in acoustic impedance by the various tissues being scanned. A detailed discussion of the physics involved is beyond the scope of this text, but essentially the ultrasound probe acts as both transmitter and receiver for sound waves. Images are generated by computerized analysis of the sound waves reflected back to the probe. The higher the frequency of the sound wave generated, the greater the resolution obtained, but there is a resultant fall off in penetration with higher frequencies. Typically, 8–12 MHz probes are used in assessment of the neck, giving improved resolution for superficial structures but with reduced penetration, i.e. a failure to generate images of deeper structures. This trade off is not usually a problem in the neck. Air causes marked scattering of the ultrasound wave, hence gel is used as the interface between skin and probe to optimize the though put of the sound wave signal. Gas and bone represent a problem as far as ultrasound is concerned; gas will cause scatter which results in a ‘white out’, while bone and other calcified structures transmit little sound causing acoustic shadowing (black hole).

In general, highly reflective tissues appear echogenic (white) on an ultrasound image, whereas structures with poor reflectivity (e.g. blood within the internal jugular vein (IJV)) will be hypo-echoic (black) on an ultrasound image. The high reflectivity of some tissues may be desirable (e.g. identification of a core biopsy needle with ultrasound) or undesirable (e.g. a calcified thyroid lamina which prevents assessment of the larynx).

Sadly for the uninitiated, not all hypo-echoic structures are cystic or fluid in composition. Solid structures in the neck that may appear typically hypo-echoic or 'pseudocystic' (i.e. black) include lymphoma, salivary pleomorphic adenomata, nerve sheath tumours and parathyroid adenomata. Conversely, some cysts do not abide by the rules of physics – a true cyst should be hypo-echoic or black on ultrasound, but the congenital cysts of the neck (e.g. branchial and thyroglossal duct cysts) often appear echogenic, i.e. pseudosolid in appearance.

Colour and power Doppler may be used to assess flow in normal vascular structures (e.g. assessment of carotid arteriopathy and venous thrombosis) and abnormal flow in pathological processes (e.g. hilar vessels in metastatic nodal disease). Colour flow Doppler is standard on most modern machines and can help the beginner to find vascular structures. A power Doppler function is useful for assessing flow patterns, such as the vascularity in lymph nodes.

Indications for head and neck ultrasound

The following indications will be considered:

- lymph node assessment
- salivary glands
- imaging lumps and bumps
- ultrasound-guided FNA and percutaneous core biopsy

1. Lymph nodes

Sonographic criteria for lymph node assessment have been extensively described in the literature. Normal nodes have a well-defined ellipsoid or fusiform shape, with an intermediate to low reflectivity homogeneous cortex and highly reflective central hilus. Abnormal nodes display reduced reflectivity (i.e. tend to be hypo-echoic or 'black') with a tendency to lose the central echogenic hilus. Short axis measurements increase, giving a rounder rather than elongated shape. Vascularity may increase and have a disordered pattern. Peripheral or subcapsular vessels, in particular, are a strong sign of malignancy

2. Salivary glands

The most common problems encountered include sialolithiasis, inflammatory conditions and tumours.

- **Submandibular Gland**

The normal submandibular glands are homogeneous echogenic (bright) structures lying inferolateral to the mylohyoid muscle in the submandibular space. Intraglandular ducts are visible as short defined hyperechoic lines, but Wharton's duct is only usually visualized when it is dilated. Lymph nodes in the submandibular space are exclusively extraglandular.

- **Parotid Gland**

Sialolithiasis

Intraglandular calculi are easier to identify than ductal stones. Frank duct dilatation or sialectasis may be seen and ultrasound will also demonstrate the complications of calculi, abscess formation and sialocele. Ultrasound cannot definitively exclude calculi, if there is a strong clinical suggestion of salivary duct obstruction and ultrasound examination is negative, sialography will be required in order to exclude a stone/stricture.

Inflammation

Acute salivary gland inflammation occurs in response to suppurative sialadenitis and viral infection. Inflammation causes gland hypertrophy and hypo-echogenicity, i.e. the salivary glands lose their normal bright echotexture. Ultrasound can be used to exclude abscess formation and may demonstrate hyper-reflective microbubbles of gas in suppurative sialadenitis, which usually affects a single gland, along with reactive nodes. In the case of abscess formation in acute suppurative sialadenitis, ultrasound-guided percutaneous drainage combined with antibiotic therapy may avoid surgical intervention.

Tumours

Approximately 80 per cent of salivary tumours are benign, 80 per cent occurring within the parotid with 80 percent of these being pleomorphic adenomata. The vast majority of parotid tumours lie within the superficial portion of the gland, allowing easy assessment with ultrasound. However, in the case of large or deep masses, the deep extent of a lesion can be difficult to assess (necessitating CT or MRI). Ultrasound cannot always predict whether salivary gland lesions are benign or malignant (although irregularity, abnormal vascularity and the presence of enlarged or suspicious nodes aids accuracy), and is usually used in conjunction with fine needle sampling.

3. Miscellaneous lumps and bumps

Lipoma

Lipomas are benign encapsulated subcutaneous lesions which are frequently encountered in the neck. Typical sonographic features include hyperechogenicity, linear internal echoes perpendicular to the ultrasound beam , compressibility and a lack of internal vascularity on colour flow or colour Doppler imaging. Intramuscular lipomas can mimic muscle and may be difficult to define with ultrasound.

Haemangioma

The head and neck is a relatively common site for haemangiomas. They are frequently seen in the masseter, trapezius and sternomastoid muscles. Haemangiomata may have large cavernous spaces and possess capillary and/or lymphatic elements. Phleboliths may be demonstrated within the lesion in 70 per cent of cases. In large or intramuscular haemangiomas, MRI is better at depicting the extent of the lesion.

Branchial Cleft Cyst

Most branchial cysts arise from the second branchial arch remnants and present as a mass at the angle of the mandible, often following an infection. The typical location is abutting the posterior aspect of the submandibular gland, lying lateral to the carotid vessels and immediately anterior to the anterior border of the sternomastoid. On ultrasound, these lesions may be cystic, but more commonly the presence of debris, haemorrhage or infection gives rise to a pseudosolid appearance and the cyst wall thickens in the presence of infection. It may be impossible to distinguish between a second branchial cleft cyst and a necrotic lymph node metastasis due to squamous cell carcinoma. Branchial cysts may extend between the carotid artery and lateral pharyngeal wall or have associated sinuses and these features are better demonstrated on MRI or CT than ultrasound.

Thyroglossal Duct Cyst

Thyroglossal duct cysts can arise at any position along the course of the thyroglossal duct remnant, but the majority are related to the hyoid bone, with most occurring at the level of or inferior to the hyoid. On ultrasound, thyroglossal duct cysts may appear cystic, heterogeneous or pseudosolid due to varying content of debris, haemorrhage or infection. Classically, they are embedded in the strap muscles, often 'splitting' the strap muscles. Malignant degeneration of the epithelial lining occurs rarely and any solid component which appears to contain microcalcification (i.e. suggestive of papillary carcinoma) should undergo sampling.

Dermoid Cyst

Dermoids can be identified by their site, i.e. either midline or peri-orbital. In the peri-orbital region, they are typically (60 per cent) found in the upper outer quadrant of the orbit. These lesions arise from sequestration of the ectoderm from adjacent sutures, most commonly the frontozygomatic suture. Dermoid cysts arise from more than one germ cell layer and therefore will contain one or more dermal adnexal structures. Sebaceous glands, hair and fat are commonly found in dermoids, but they may also be purely cystic. They may therefore have a heterogenous appearance with the presence of fat manifesting as a fluid/fluid level or often as rounded echogenic masses within the cyst (representing sebaceous rests within the dermoid). The typical location for midline cysts is in the submental region either superficial or deep to mylohyoid.

Abscess

Infection in the submandibular region frequently arises from dental disease. Ultrasound can differentiate between infection with a fluid component (abscess) and cellulitis, and identify associated lymphadenopathy and venous thrombosis.

4. Ultrasound-guided fine needle aspiration and core biopsy

Ultrasound is a very useful adjunct in percutaneous sampling procedures, allowing direct visualization of the needle and structures to be avoided (such as vessels). A metallic needle is a reflective surface and if placed parallel or slightly oblique to the transducer surface the needle will be imaged as a very reflective or echogenic structure. Thus the needle must be in the plane of the ultrasound beam and as parallel to the probe surface as possible in order to optimally visualize it.

Suggestive Readings

- L. Baert, LeuvenK. Sartor, Heidelberg. Medical Radiology Diagnostic Imaging, Springer-Verlag Berlin Heidelberg 2006.
- T. A. LarheimP.-L. Westesson. MaxillofacialImaging. Springer-Verlag Berlin Heidelberg 2006

Principles of Reconstructive Surgery
(Flap Surgery)

Flap surgery is a technique in plastic and reconstructive surgery where any type of tissue is lifted from a donor site and moved to a recipient site with an intact blood supply. This is similar to but different from a graft, which does not have an intact blood supply and therefore relies on growth of new blood vessels. This is done to fill a defect such as a wound resulting from injury or surgery when the remaining tissue is unable to support a graft, or to rebuild more complex anatomic structures such as the jaw.

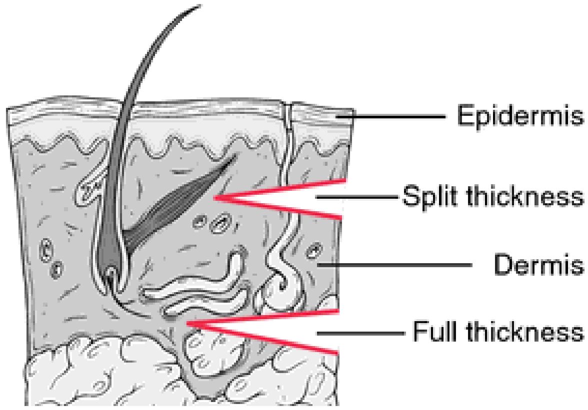
There are many causes of tissue loss, including

- Trauma
- Pathologic processes
- Congenital anomalies

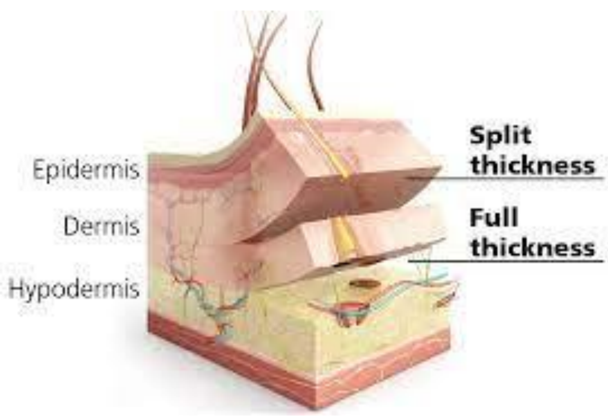
The resulting characteristics such as the size, geometry, and vascularity of the defects decide the surgical options available for treatment.

Choice for soft tissue reconstruction include

A-Full thickness skin or mucosal graft: Full thickness skin graft consist of entire thickness of epidermis and dermis. This graft taken from the donor area by using scalpel. Autogenous skin grafts have been used in oral and maxillofacial surgery, full thickness graft used in plastic surgical reconstruction of large facial defects., it is simple method of reconstruction, low complication rate, good colour match and minimal contracture also in the presence of failure, subsequent healing by secondary intention may give good result.

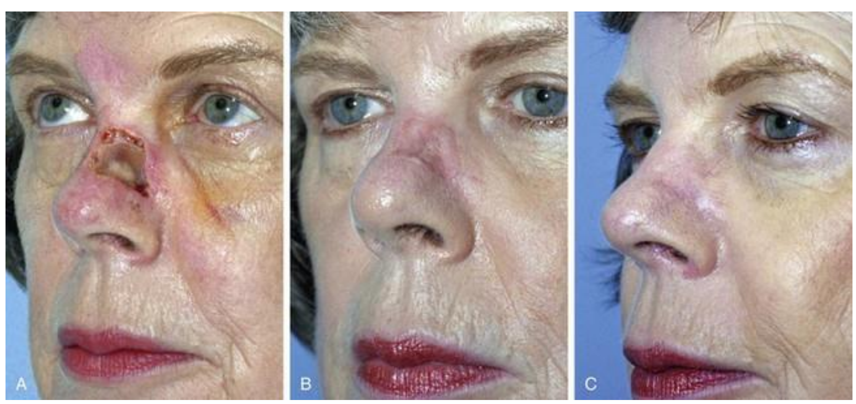


***B-Split skin grafts or mucosal graft*: ** Contain all of epidermis and only part of dermis .Further subdivided in to **thin,medium or thick** according to amount of dermis containt . The graft is taken by either dermatome or a humby knife. It is most commonly used graft in head and neck cancer surgery .Resurfacing occur due to the remnant tissue in the donar area, so little care needed for donar area. It may be used to cover donar sites or secondary defects, to line flaps, to cover muscle when flap pedicles are exposed or rotated to replace small area of skin loss.



***C-Dermal and fat graft*: ** Rarely used in head and neck surgery, dermal graft either pure dermis or dermis and fat, obtained by using dermatom , the epidermis is shaved off but left attached at one end then a strip of dermis is then taken as the graft, finally the epidermis is replaced and sutured.

***D-Full thickness skin and cartilage (composite) graft*:** consist of a full thickness skin graft with underlying cartilage may be taken from the auricular region used in reconstruction of small and moderate defects where tissue loss indicates that skin and underlying cartilage are required.



Transferring the grafts

Its life span depend on temperature, but when wrapped in gauze , moistened in saline and stored in fridge at 4c, it may live for up to 3 weeks. To survive permanently it must be planted. Skin graft adheres to its new bed by fibrin .Fibrous tissue form by 5 days reasonable anchorage has occurred

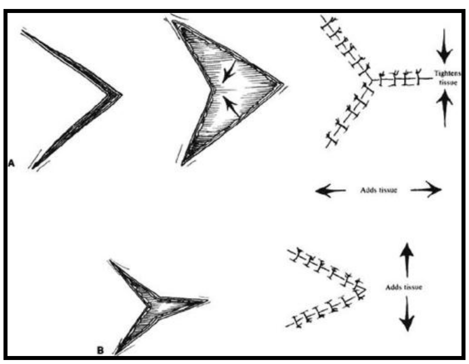
Site for grafting

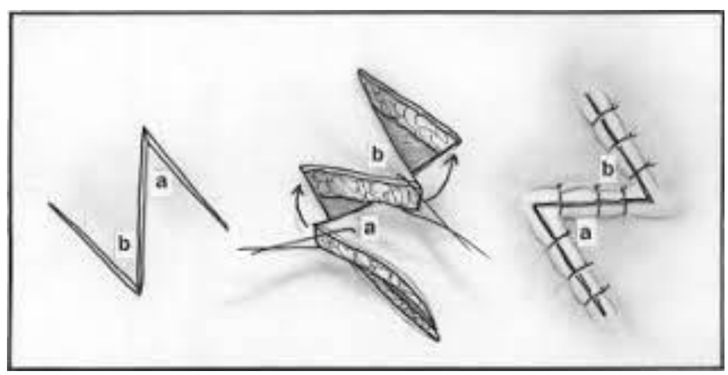
Split skin can easily be taken from the thigh, the upper arm and the flat surface of abdomen. Common head and neck full thickness skin graft donar sites are post auricular , preauricular and lower neck.

Classification of flaps

Flaps can also be classified according to tissue configuration

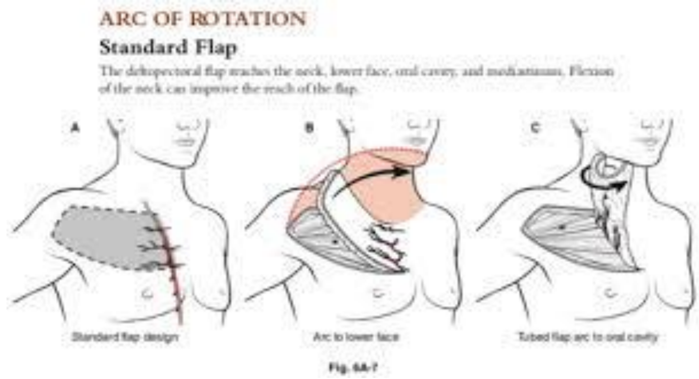
This describes the geometric shape of the flap. These flaps include rhomboid, bilobed, z-plasty, v-y, rotation, and others.

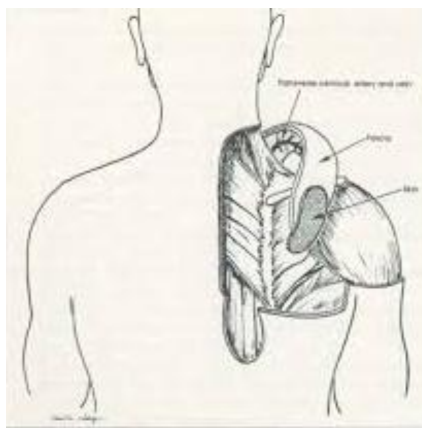




Flaps can also be classified by their tissue content.

These flaps include: *cutaneous* (skin and subcutaneous tissue), *myocutaneous* (composite of skin, muscle, and blood supply), and *fasciocutanous* (deep muscle fascia, skin, regional artery perforators).



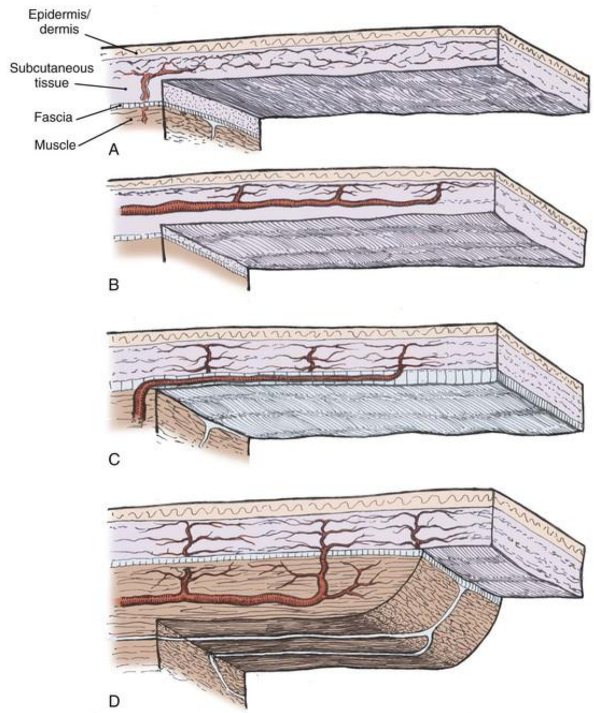


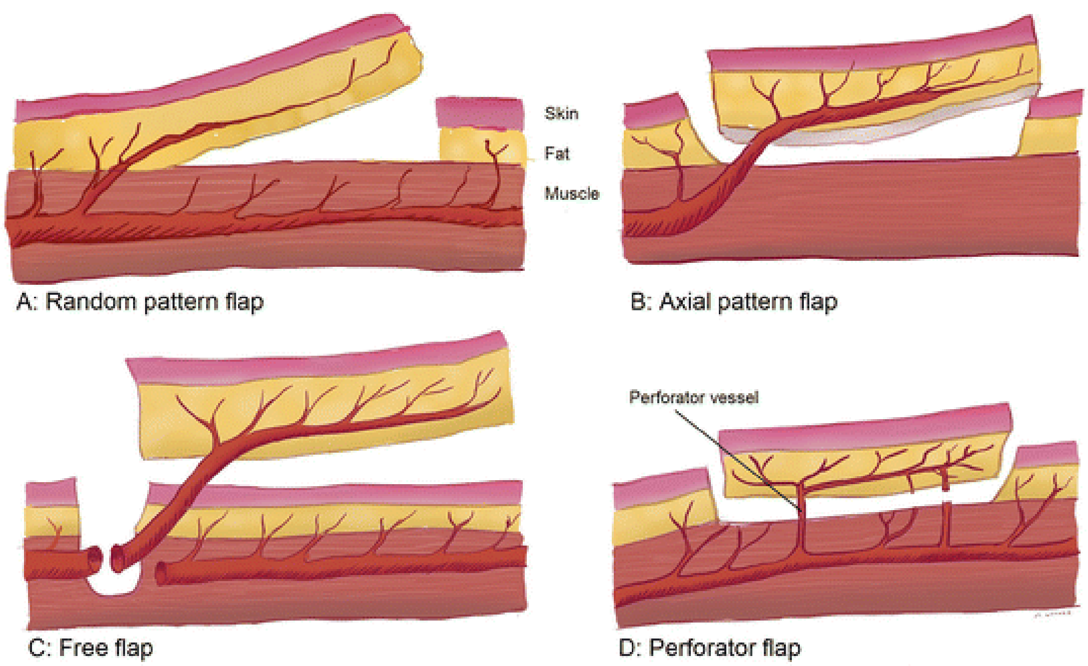
Flaps can also be classified according to arterial supply.

Axial Pattern Flap – A single flap which has an anatomically recognized arterio-venous system running along its long axis. Such a flap, because of the presence of its axial arterio-venous system, is not subject to many of the restrictions which apply to flaps in general.

Random Pattern Flap - has no named blood supply, rather, it uses the dermal (mucosal) and subdermal (submucosal) plexus as its blood supply.

Pedicled flaps- remain attached to the donor site via a pedicle that contains the blood supply (in contrast to a free flap).


Epidermis/
dermis
Subcutaneous
tissue
Fascia
Muscle
A
B
C
D

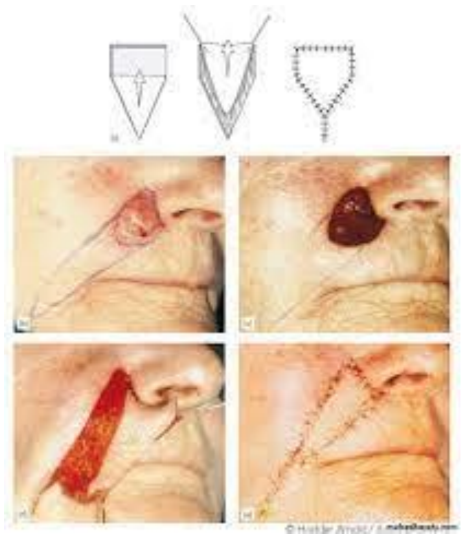

Skin
Fat
Muscle
A: Random pattern flap
B: Axial pattern flap
Perforator vessel
C: Free flap
D: Perforator flap

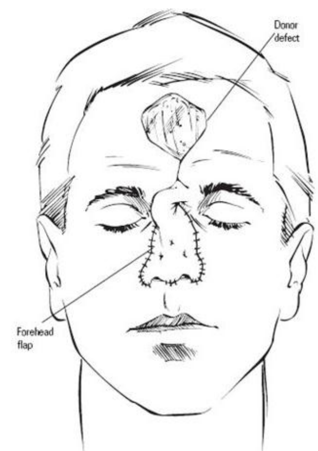
Classification can also be based on the relative location of the donor site.

Local flaps are considered adjacent to the primary defect.

Regional flap donor sites are located on different areas of the same body part.

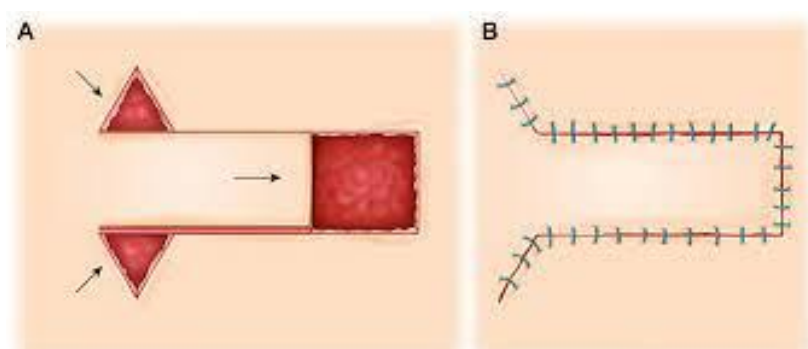
If different body parts are used as the donor site, the flap is termed a *Distant flap*.



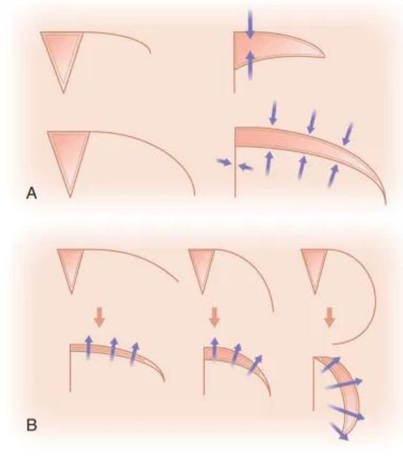


Classification can also be based on the flap movement.

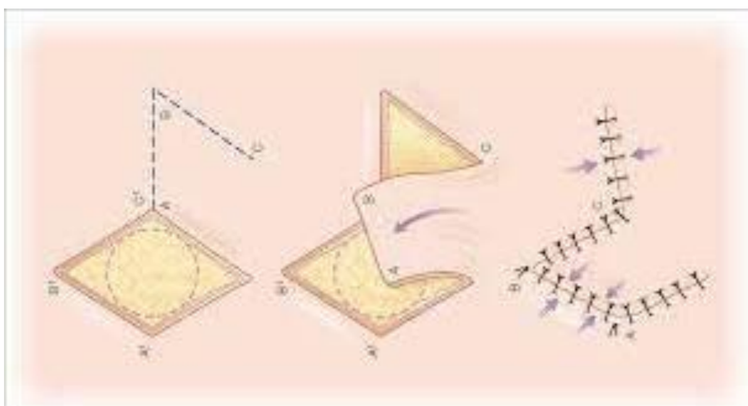
Advancement flaps use mobilized tissue in a direction toward the primary defect.



Rotation flaps pivot mobilized tissue around a point toward the primary defect.



Transposition flaps are mobilized tissues that traverse adjacent tissue by rotation and/or advancement in an effort to close the primary defect.



Interpolated flaps are mobilized tissues that traverse over or beneath an otherwise non-compromised skin bridge in the form of a pedicle to close the primary defect. The pedicle consists of skin (possibly subcutaneous fat and muscle) and/or an individual artery and vein used, with adjacent tissue, to maintain vascularity of the flap. At least one additional procedure is required to divide a pedicle.

Finally, *microvascular free tissue transfer* utilizes tissue transferred from a different part of the body and, unlike local or regional flaps, distant or microvascular free flaps require the detachment of the feeding vessels and transfer of the flap to the recipient site and anastomosing the vessels to a recipient artery and vein or veins. The advantage of this method of reconstruction is that the surgeon is no longer limited to the amount of tissue in the vicinity of the defect nor the arc of rotation of the flap. It enables the use of small to large or simple to complex tissue transfer. The obvious disadvantage is that when the skin in the head and neck needs to be reconstructed, the color match and texture will be significantly different.

Movement of the local tissue occur in one of two ways

1- The tissue may be advanced in a forward direction using **advancement technique**

2-Lateral movement using the pivot principle . When there is movement around a pivot point. The technique of **transpostion** and **rotation** based on this principle. When a flap is designed, it remains attached the body. Usually by its distal end which referred to as the base , and it is through this area that the blood supply enters.

Important consideration in flap planning

Appearance and amount

1- The anatomy and physiology of the skin including colour, texture ,

2-Local muscle anatomy, vascular supply, nerve supply and lymphatic drain

3-The esthetic of the area

4-Possible sites for incision placement.

5-Area of local tissue avaliable in relation to the area to be reconstructed.

Any one flap has advantages and disadvantages, Indications and contraindications

Local flaps

Because skin is elastic and stretches and it is possible to take tissue and move it from areas where it is redundant in to area where it is needed. The stretching of the skin is a mechanical property which related to the viscoelastic properties of the collagen bundles. It is time dependent ex- the longer one pulls the more it stretches.

Areas on the face which possible donar site

Particular areas on the face not only facilitate direct closure but also provide lax skin for transfer include, **glabellar area, temporal, nasolabial, mandibular and masseteric region.** The surgeon use pinch test to identify lax tissue, then the flap drawn out according to the size of primary defect.

1- Rotation flap-The flap defined as a large arc of semicircle where the triangular primary defect represent a small arc approximately one eighth the size of the flap, the flap is elevated then the difference in lengths of the two sides of the defect is made up by suturing with different tension. If closure is a little tight rotation may be facilitated by back cut. It is used to close oro-antral fistula (palatal flap).

2-Tranposition flap: It is rectangle which designed raised and elevated in to a triangulated defect. This leaves a donar site defect to be closed. This technique has little application in head and neck.

3-Panthographic expantion. This is variation of advancement

4-Transposition Z-plasty

The problem of skin advancement , when the tissue has been advanced, unless it is stopped where, it is, it tend to return whence it came one way to prevent this is to break up the scar with a Zplasty. This is ideal for reconstruction of lower eyelid which are excised as a triangle and tissue advanced laterally.

Flaps in Oral Surgery

The main concern of the dentist performing surgical procedures involves fundamental principles of surgery, asepsis and antisepsis, to prevent pathogenic microbes from entering the body as well as spread of certain infectious diseases from one patient to another. Sterilization of instruments, as well as preparation of the patient and dentist are therefore considered necessary.

The following fundamental rules apply to every surgical procedure, concerning the incision and flap:

- The incision must be carried out with a firm, continuous stroke, not interrupted strokes. During the incision, the scalpel should be in constant contact with bone. Repeated strokes at the same place, many times, impair wound healing.
- Flap design and incision should be carried out in such a way that injury of anatomic structures is avoided, such as: the mental neurovascular bundle, palatal vessels emerging from the greater palatine foramen and incisive foramen, infraorbital nerve, lingual nerve, submandibular duct, parotid duct, hypoglossal venous plexus, buccal artery (of concern when incision of an abscess of the pterygomandibular space is to be performed), facial nerve and facial artery and vein, which are of concern basically for the drainage of abscesses performed with extraoral incisions.

- Vertical releasing incisions should begin approximately at the buccal vestibule and end at the interdental papillae of the gingiva.
- Envelope incisions and semilunar incisions, which are used in apicoectomies and removal of root tips, must be at least 0.5 cm from the gingival sulcus.
- The elliptic incision, which is used for the excision of various soft tissue lesions, comprises two convex incisions joined at an acute angle at each end, while the depth of the incision is such that there is no tension when the wound margins are coapted and sutured.
- The width of the flap must be adequate, so that the operative field is easily accessible, without creating tension and trauma during manipulation.
- The base of the flap must be broader than the free gingival margin, to ensure adequate blood supply and to promote healing.
- The flap itself must be larger than the bone deficit so that the flap margins, when sutured, are resting on intact, healthy bone and not over missing or unhealthy bone, thus preventing flap dehiscence and tearing.
- The mucosa and periosteum must be reflected together. This is achieved (after a deep incision)when the elevator is continuously kept and pressed firmly against the bone.
- When the incision is not made along the gingival sulcus, for esthetic reasons, and especially in people with broad smiles, the scar that will result must be taken into consideration, particularly on the labial surface of the front teeth.
- Excessive pulling and crushing or folding of the flap must be avoided, because the blood supply is compromised and healing is delayed.

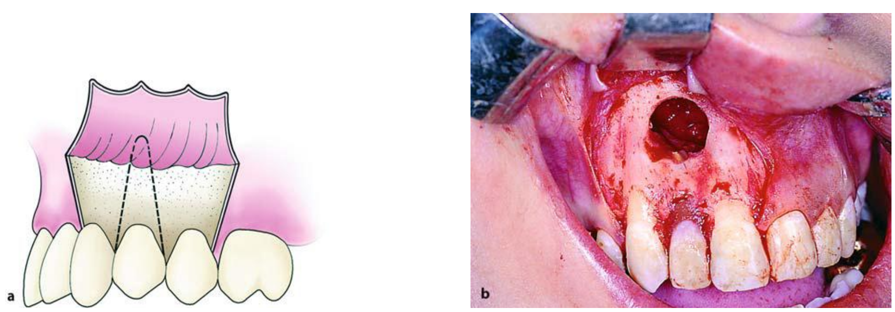
Local Flaps

The basic flap types are: trapezoidal, triangular, envelope, semilunar, flaps created by and incisions, and pedicle flaps.

- **Trapezoidal Flap:** The trapezoidal flap is created after a □-shaped incision, which is formed by a horizontal incision along the gingivae, and two oblique vertical releasing incisions extending to the buccal vestibule. The vertical releasing incisions always extend to the interdental papilla and never to the center of the labial or buccal surface of the tooth. This ensures the integrity of the gingival proper, because if the incisionwere to begin at the center of the tooth, contraction after healing would leave the cervical area of the tooth exposed. A satisfactory surgical field is ensured when the incision extends at least one or two teeth on either side of the area of bone removal. The fact that the base of the resulting flap is broader than its free gingival margin ensures the necessary adequate blood supply for the healing process. The trapezoidal flap is suitable for extensive surgical procedures, especially when the triangular flap would not provide adequate access.

  Advantages. Provides excellent access, allows surgery to be performed on more than one or two teeth, produces no tension in the tissues, allows easy reapproximation of the flap to its original position and hastens the healing process.

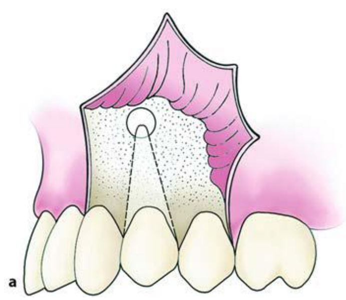
  Disadvantages. Produces a defect in the attached gingiva (recession of gingiva).



- **Triangular Flap:** This flap is the result of an L-shaped incision, with a horizontal incision made along the gingival sulcus and a vertical or oblique incision. The vertical incision begins approximately at the vestibular fold and extends to the interdental papilla of the gingiva. The triangular flap is performed labially or buccally on both jaws and is indicated in the surgical removal of root tips, small cysts, and apicoectomies.

Advantages. Ensures an adequate blood supply, satisfactory visualization, very good stability and reapproximation; it is easily modified with a small releasing incision, or an additional vertical incision, or even lengthening of the horizontal incision.

Disadvantages. Limited access to long roots, tension is created when the flap is held with a retractor, and it causes a defect in the attached gingiva.

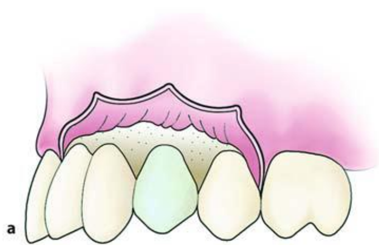


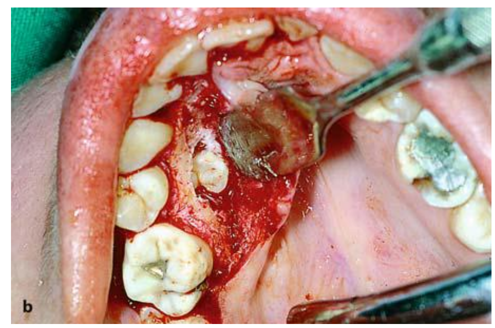
- **Envelope Flap:** This type of flap is the result of an extended horizontal incision along the cervical lines of the teeth. The incision is made in the gingival sulcus and extends along four or five teeth. The tissue connected to the cervical lines of these teeth and the interdental papillae is thus freed. The envelope flap is used
  for surgery of incisors, premolars and molars, on the labial or buccal and palatal or lingual surface , and is usually indicated when the surgical procedure involves

the cervical lines of the teeth labially (or buccally) and palatally (or lingually), apicoectomy (palatal root), removal of impacted teeth, cysts, etc.

Advantages. Avoidance of vertical incision and easy reapproximation to original position.

Disadvantages. Difficult reflection (mainly palatally), great tension with a risk of the ends tearing, limited visualization in apicoectomies, limited access, possibility of injury of palatal vessels and nerves, defect of attached gingiva.

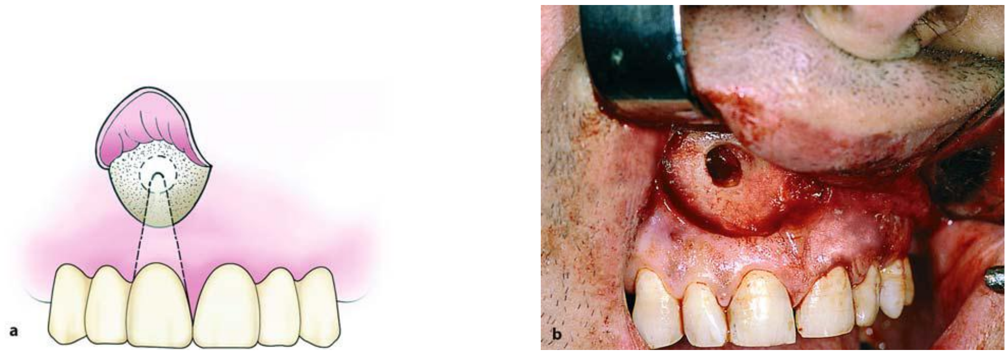




- **Semilunar Flap:** This flap is the result of a curved incision, which begins just beneath the vestibular fold and has a bowshaped course with the convex part towards the attached gingiva . The lowest point of the incisionmust be at least 0.5 cm fromthe gingivalmargin, so that the blood supply is not compromised. Each end of the incision must extend at least one tooth over on each side of the area of bone removal. The semilunar flap is used in apicoectomies and removal of small cysts and root tips.

Advantages. Small incision and easy reflection, no recession of gingivae around the prosthetic restoration, no intervention at the periodontium, easier oral hygiene compared to other types of flaps.

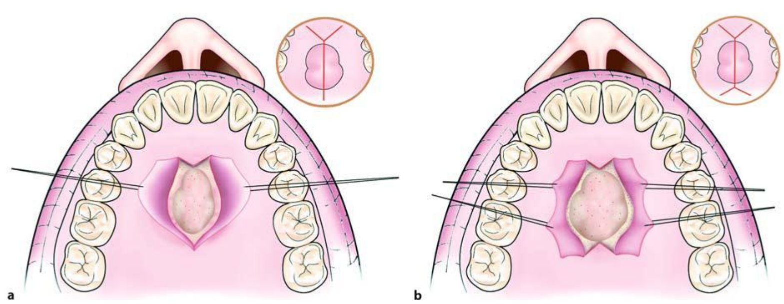
Disadvantages. Possibility of the incision being performed right over the bone lesion due to miscalculation, scarringmainly in the anterior area, difficulty of reapproximation and suturing due to absence of specific reference points, limited access and visualization, tendency to tear.



- **Other Types of Flaps:** Other types of flaps are the result of Y -shaped and X -shaped incision. These flaps are used in surgical procedures of the palate, mainly for the removal of exostoses (torus palatinus).

Flap Resulting from Y-shaped Incision. An incision ismade along themidline of the palate, as well as two anterolateral incisions, which are anterior to the canines. This type of flap is indicated in surgical procedures involving the removal of small exostoses.

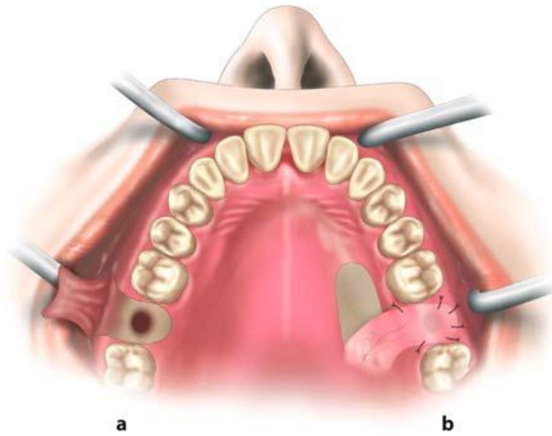
Flap Resulting from X-shaped Incision. This type of flap is used in larger exostoses, and is basically an extension of the -shaped incision. The difference is that two more posterolateral incisions are made, which are necessary for adequate access to the surgical field. This flap is designed such that major branches of the greater palatine artery are not severed.



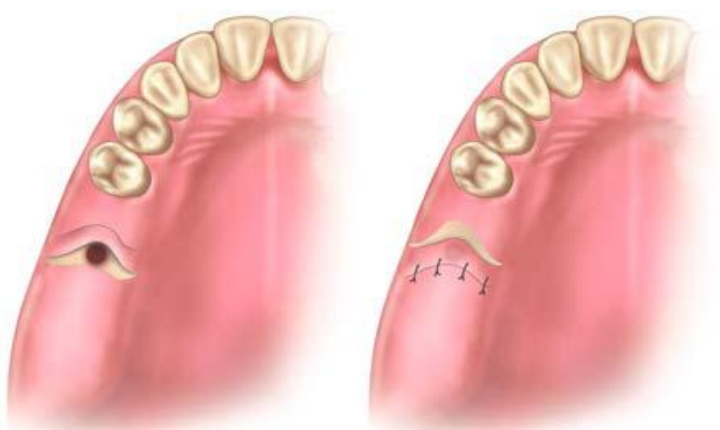
- **Pedicle Flaps:** The three main types of pedicle flaps used for closure of an oroantral communication are: buccal, palatal, and bridge flaps.

Buccal Flap. This is a typical trapezoidal flap created buccally, corresponding to the area which is to be covered, and is usually used on dentulous patients. It is the result of two oblique incisions that diverge upwards, and extend as far as the tooth socket . After creating the flap, the periosteum is incised transversally, making it more elastic so that it may cover the orifice that results from the tooth extraction. The oblique buccal flap is a variation of the buccal flap. It is the result of an anteroposterior incision, so that its base is perpendicular to the buccal area, posterior to the wound. The flap is rotated about 70°–80° and is placed over the socket. Both cases require that, before placing the flap, the woundmargins must be debrided.

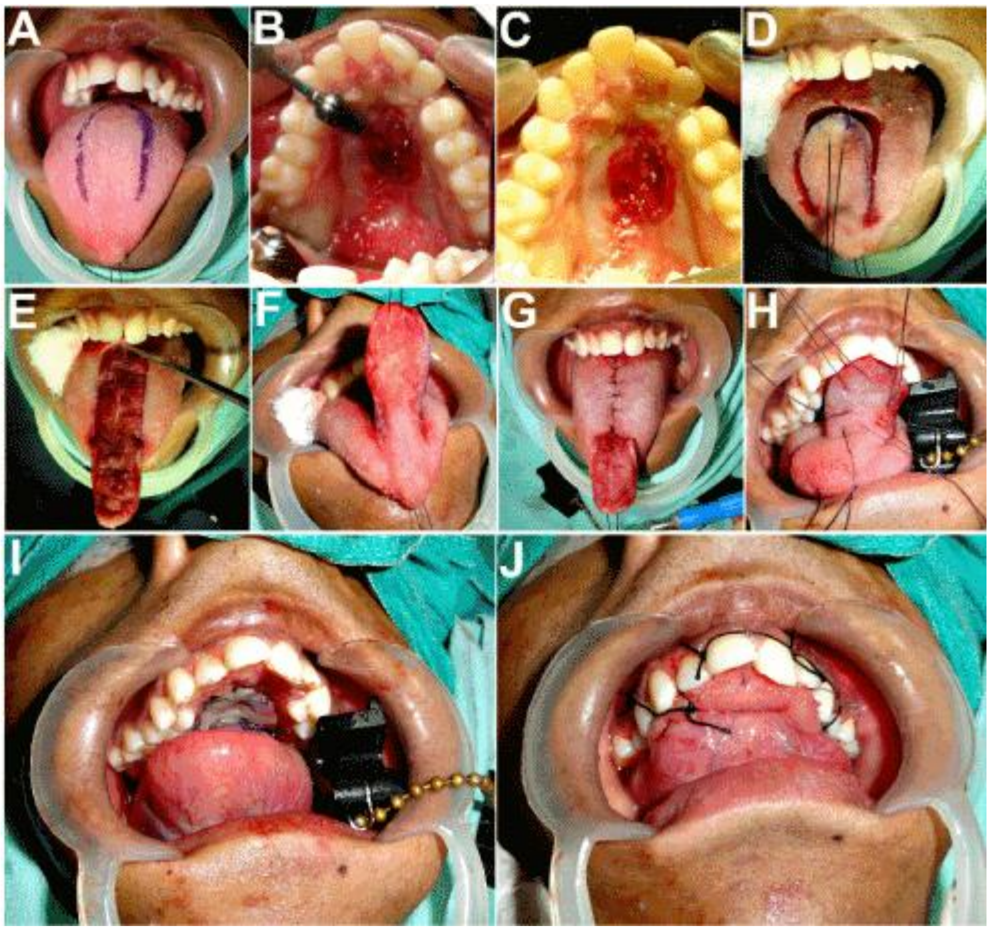
Palatal Flap. This type of flap is used in edentulous patients so that the vestibular depth is maintained. The resulting palatal mucoperiosteal flap is rotated posteriorly and buccally, always including the vessels that emerge from the corresponding greater palatine foramen. After rotation, the flap is placed over the orifice of the socket, the wound margins are debrided, and the flap is sutured with the buccal tissues. A gingival dressing is applied for a few days at the void created and healing is achieved by secondary intention.



Pedicle Bridge Flap. This flap is palatobuccal and is perpendicular to the alveolar ridge. After creation, the flap is rotated posteriorly or anteriorly, to cover the orifice of the oroantral communication, without compromising the vestibular fold. This type of flap is used only on edentulous parts of the alveolar ridge.

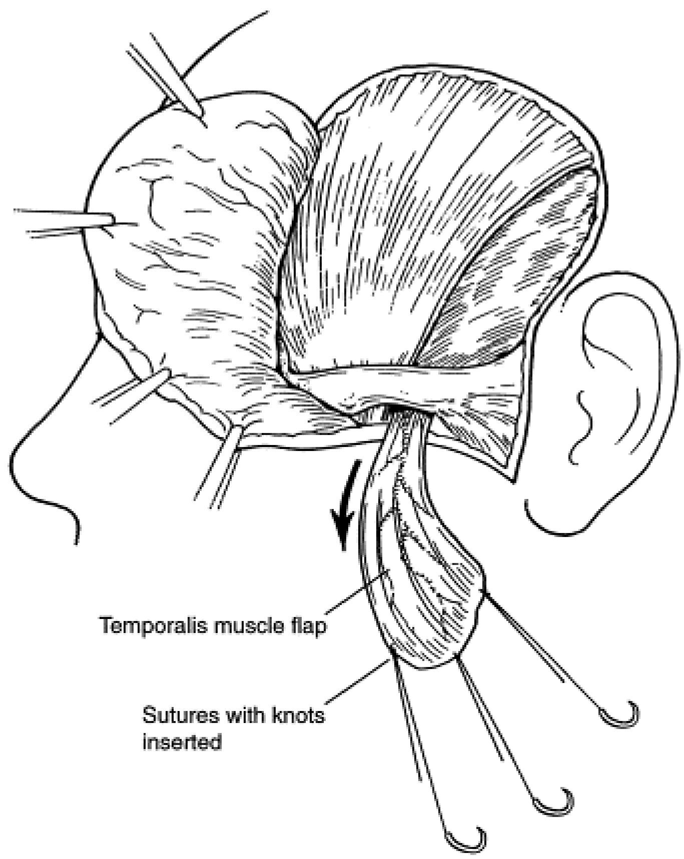


Tongue flap: The tongue flap is a robust, versatile flap that can be used for reconstruction of oral, pharyngeal, and perioral defects of congenital, traumatic, and ablative origin. The rich blood supply and ease of use make the tongue flap a reliable and predictable reconstructive technique for indicated defects.



Regional & Distant flaps

Temporalis muscle flap: The external cheek, orbital exenteration, as well as maxillary and oral defects can be reconstructed using this flap. The temporal muscle elevates the mandible from its origin in the temporalis line and the infratemporal crest for insertion into the coronoid process. The temporal fascia consists of the superficial temporoparietal and deep temporal fascia, further divided into superficial and deep layers. The muscle lies beneath the deep temporal fascia. These layers feature their own vasculature, with the superficial temporal fascia stemming from the superficial temporal vessels and the temporal muscle stemming from the deep temporal arteries originating at the internal maxillary artery. When harvesting the muscle flap, temporary removal of the zygomatic arch provides additional length to the flap. The flap measures from 12- to 16-cm-long and 0.5- to 1-cm-thick. Major drawbacks include a risk of injury to the facial nerve, postoperative trismus and temporal hollowing.

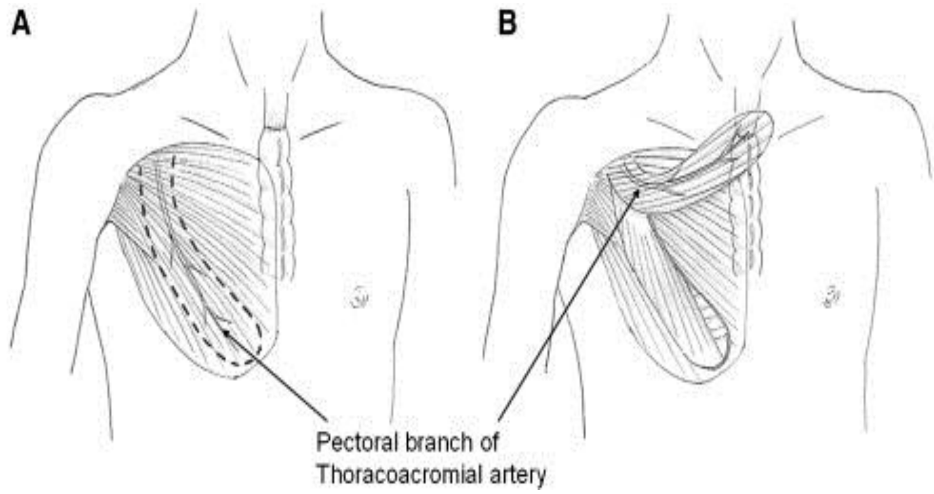


Submental Flap: In 1993, Martin presented the submental flap, a perforator or pedicled cutaneous flap from the submental region based on the submental branch of the facial artery. This flap features good colour match, good reach to the anterior mouth and the donor site is directly closed; typically, it offers an abundance of tissue, particularly in elderly patients. The skin paddle can reach up to 10 cm by 16 cm; the pedicle reaches up to 5 cm and the platysma muscle, a part of the mylohyoid, as well as the anterior digastricus muscle are included. The submental flap is also applicable in facial vessels proximally divided through a reverse flow, and can also be used as a free flap. The submental flap is ideal for reconstructing bearded areas in men.

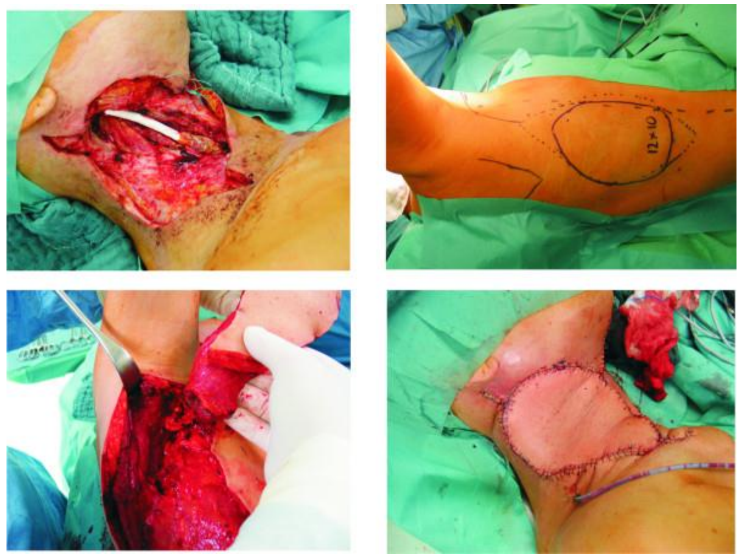
Deltopectoral flap : It is axial pattern flap designed on the anterior chest wall between the line of the clavicle and the level of the anterior axillary fold . It is based on branches of internal mammary artery. The flap will extend to any site in the neck and occasionally up to level of the zygoma. Tissues of the pectoral area such as skin and pectoralis major muscle are used in safe and extended flaps for cervical and neck reconstructions. As blood supply is derived from medial vessels (internal mammary artery) or lateral (thoracodorsal and lateral thoracic arteries), 2 different flaps can be constructed: medial and lateral deltopectoral flaps. Medial deltopectoral flap was developed by Bakamjian as an axial-pattern skin flap, and its blood supply depends on perforating branches from the internal mammary artery. The successful use of this lateral deltopectoral flap in an extended cervical and thoracic reconstruction after resection of a giant basal cell carcinoma demonstrates that it must be considered as an alternative technique.

(a) (b)

Pectoralis major flap: The pectoralis major myocutaneous (PMMC) flap has been used as a versatile and reliable flap since its first description by Ariyan in 1979**.** The flap receives its blood supply from the thoraco acromial artery and the secondary segmental perforators arising from the internal mammory artery. The lateral thoracic artery does not usually contribute significantly to the vasculature of the pectoralis muscle. The pectoralis major myocutaneous flap and myofascial flap variation are utilized in a large variety of head and neck reconstructive procedures that can include coverage of mucosal and/or cutaneous defects. The extent of coverage and the reach of the flap are dependent on the anatomy of the patient, modifications of the standard techniques of elevation, and inset. The upper limits are generally considered the zygomatic arch area externally and the superior tonsillar pole internally - patient body habitus may either limit extension short of these landmarks, or permit extension beyond The myofascial flap variation carries no skin paddle and is utilized primarily to close small mucosal defects, to protect major vascular structures, and to support primary mucosal closure in a patient at increased risk of wound breakdown (prior radiation, diabetic, weight loss).



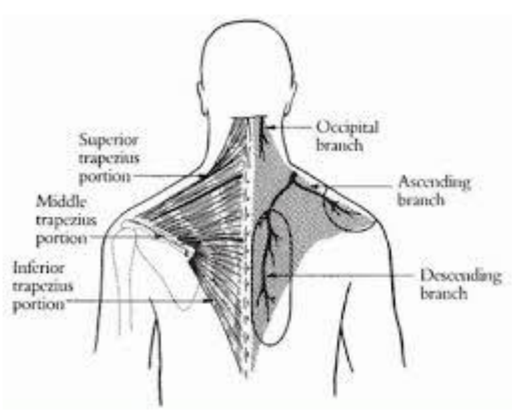
Latissmus dorsi flap: The latissimus dorsi flap was introduced by Tansini in 1906 for the coverage of extensive mastectomy defects. Subsequently forgotten, it was re-described by Olivari in 1976 for the coverage of large radiation ulcers of the chest wall. Boswick (1978) adopted Olivari's idea and developed a latissimus island flap for breast reconstruction. A further development, together with the technical progress of microsurgery, was its use as a free musculocutaneous flap. The latissimus dorsi flap, either as pedicled or as microvascular free tissue transfer, is one of the most commonly used flaps in reconstructive surgery, with large vessel diameters and a long reliable pedicle. Its size and versatility make it an extraordinary graft that has been a workhorse in reconstructive surgery for more than two decades. It can be elevated as a muscle, a musculocutaneous or an osteomyocutaneous flap. As a composite graft including variable amounts of muscle, skin, and subcutaneous tissue, it can be used in any variety for reconstruction in every area of the body. The harvested flap can be as large as 20 × 35, cm but numerous combinations with other flaps nourished by the subscapular system are possible to simultaneously reconstruct more complex defects with several flaps, based on a single pedicle.

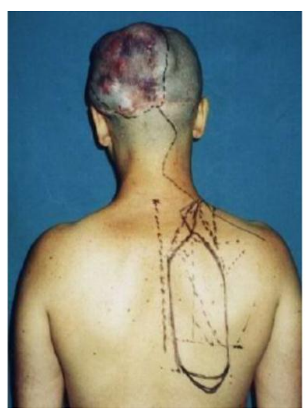


Sternomastoid flap: The sternocleidomastoid muscle has long been used for local reconstruction in the head and neck. It remains an incredibly versatile flap by providing bulk, an area of hairless skin with excellent color match for the face, and opportunity to transpose periosteum or bone for correcting head and neck defects. The middle third of the SCM muscle mostly receives its blood supply from 1 branch of the superior thyroid artery and the external carotid artery. In nearly one third of the specimens (8 [27%] on the right side and 8 [26%] on the left), these 2 arteries almost equally shared the blood supply

20.8

Trapezius flap: The trapezius flap is a large, thin, myocutaneous, pedicled flap. The wide arc of rotation and pliable tissue makes this flap ideal for reconstruction of H&N defects. The trapezius flap has been utilized for a range of H&N defects, The upper trapezius myocutaneous flap is based on the occipital artery , while the middle transverse trapezius myocutaneous flap is based on the transverse cervical artery (TCA) branches. The vertical paravertebral or lower trapezius myocutaneous flap is supplied by the deep branch of the TCA The trapezius muscle is the source of three myocutaneous flaps used in head and neck reconstruction: the superior trapezius flap, the lateral island trapezius flap, and the inferior or lower island trapezius flap. These flaps are used for lateral neck and lateral skull defects when a free vascularized flap is not considered. The lateral island trapezius flap, or trapezius osseomyocutaneous flap, is the only one of the three flaps that enables the transfer of bone pedicled with the muscle. It is the only reliable pedicled flap that enables the transfer of well-vascularized bone for mandibular reconstruction as well as skin for intraoral and extraoral defects. Before the use of microvascular techniques, this flap was used for mandibular reconstruction, and various authors report that its use has good functional and esthetic results. It is now accepted that osseointegrated implants are standard components of a complete mandibular reconstruction and the trapezius osseomyocutaneous flap fulfills the criteria of implantability.





Suggested Reading

- Robert Dolan,Facial plastic, Renstructive Truma Surgery, Marcel DeKker, NewYork,2003.
- Peter Ward Booth, Maxillofacial Surgery: Churchill Livingstone, 2006

Principles of Reconstructive Surgery

(Bone Graft)

Defects of the facial bones, especially the jaws, have a variety of causes, such as eradication of pathologic conditions, trauma, infections, and congenital deformities. The size of the defects that are commonly reconstructed in the oral and maxillofacial region varies considerably from small alveolar clefts to mandibulectomy defects. Each defect poses a unique set of problems that reconstructive surgical intervention must address.

Goals of Reconstruction

- Restoration of function
- Restoration of cervicofacial symmetry and form
- Creation of barriers between cavities and spaces in the head and neck
- Facial reanimation
- Dental rehabilitation
- Return of sensation

Types of Grafts

Several types of bone grafts are available for use in reconstructive surgery. A useful classification categorizes the bone grafts according to their origin and thus their potential to induce an immunologic response. Because of their origins and the preparations used to help avoid an intense immune response, the grafts have different qualities and indications for use.

i. Autogenous Grafts

Also known as autografts or self-grafts, autogenous grafts are composed of tissues from the same individual. Fresh autogenous bone is the most ideal bone graft material. The autogenous graft is unique among bone grafts in that it is the only type of bone graft to supply living, immunocompatible bone cells essential to phase I osteogenesis. The larger number of living cells that are transplanted, the more osseous tissue that will be produced.

Autogenous bone is the type used most frequently in oral and maxillofacial surgery. The bone can be obtained from a host of sites in the body and can be taken in several forms. Block grafts are solid pieces of cortical bone and underlying cancellous bone. The iliac crest is often used as a source for this type of graft. The entire thickness of the ilium can be obtained, or the ilium can be split to obtain a thinner piece of block graft. Ribs also constitute a form of block graft. Particulate marrow and cancellous bone grafts are obtained by harvesting the medullary bone and the associated endosteum and hematopoietic marrow. Particulate marrow and cancellous bone grafts produce the greatest concentration of osteogenic cells, and because of the particulate nature, more cells survive transplantation because of the access they have to nutrients in the surrounding graft bed. The most common site for the procurement of this type of graft is the ilium.

Autogenous bone may also be transplanted while maintaining the blood supply to the graft. Two methods can accomplish this:

The first involves the transfer of a bone graft pedicled to a muscular (or muscular and skin) pedicle. The bone is not stripped of its soft tissue pedicle, preserving some blood supply to the bone graft. Thus the number of surviving osteogenic cells is potentially great. An example of this type of autogenous graft is a segment of the clavicle transferred to the mandible, pedicled to the sternocleidomastoid muscle.

The second method by which autogenous bone can be transplanted without losing blood supply is by the use of microsurgical techniques. A block of ilium, tibia, rib, or other suitable bone is removed along with the overlying soft tissues after dissecting free an artery and a vein that supply the tissue. An artery and a vein are also prepared in the recipient bed. Once the bone graft is secured in place, the artery and veins are reconnected using microvascular anastomoses. In this way the blood supply to the bone graft is restored. Both of these types of autogenous grafts are known as composite grafts because they contain soft tissue and osseous elements. The first type described, in which the bone maintains a muscular origin, is a pedicled composite graft. The pedicle is the soft tissue remaining on it, which supplies the vasculature. The second type of composite graft is a free composite graft, meaning that it is totally removed from the body and immediately replaced, and its blood supply is restored by reconnection of blood vessels.

Although these types of grafts may seem ideal, they have some shortcomings when used to restore defects of the jaws. Because the soft tissues attached to the bone graft maintain the blood supply, there can be minimal stripping of the soft tissue from the graft during procurement and placement. Thus the size and shape of the graft cannot be altered to any significant degree. Frequently, inadequate bulk of bone is provided when these grafts are used to restore mandibular continuity defects. Another problem is the morbidity to the donor site. Instead of just removing osseous tissue, soft tissues are also removed with composite grafts, which cause greater functional and cosmetic defects.

The **advantages** of autogenous bone are that it provides osteogenic cells for phase I bone formation, and no immunologic response occurs.

A **disadvantage** is that this procedure necessitates another site of operation for procurement of the graft.

ii. Allogeneic Grafts

Also known as allografts or homografts, allogeneic grafts are grafts taken from another individual of the same species. Because the individuals are usually genetically dissimilar, treating the graft to reduce the antigenicity is routinely accomplished. Today, the most commonly used allogeneic bone is freeze-dried. All of these treatments destroy any remaining osteogenic cells in the graft, and therefore allogeneic bone grafts cannot participate in phase 1 osteogenesis. The assistance of these grafts to osteogenesis is purely passive; they offer a hard tissue matrix for phase II induction. Thus the host must produce all of the essential elements in the graft bed for the allogeneic bone graft to become resorbed and replaced. Obviously, the health of the graft bed is much more important in this set of circumstances than it is if autogenous bone were to be used.

Advantages are that allogeneic grafts do not require another site of operation in the host and that a similar bone or a bone of similar shape to that being replaced can be obtained (e.g., an allogeneic mandible can be used for reconstruction of a mandibulectomy defect).

The **disadvantage** is that an allogeneic graft does not provide viable cells for phase I osteogenesis.

iii. Xenogeneic Grafts

Also known as xenografts or heterografts, xenogeneic grafts are taken from one species and grafted to another. The antigenic dissimilarity of these grafts is greater than with allogeneic bone. The organic matrix of xenogeneic bone is antigenically dissimilar to that of human bone, and therefore the graft must be treated more vigorously to prevent rapid rejection of the graft.. Bone grafts of this variety are rarely used in major oral and maxillofacial surgical procedures.

Advantages are that xenografts do not require another site of operation in the host, and a large quantity of bone can be obtained.

Disadvantages are that xenografts do not provide viable cells for phase I osteogenesis and must be rigorously treated to reduce antigenicity.

Osteoinduction, Osteoconduction and Osteogenesis

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

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

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

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

Goals of Maxillofacial Reconstruction

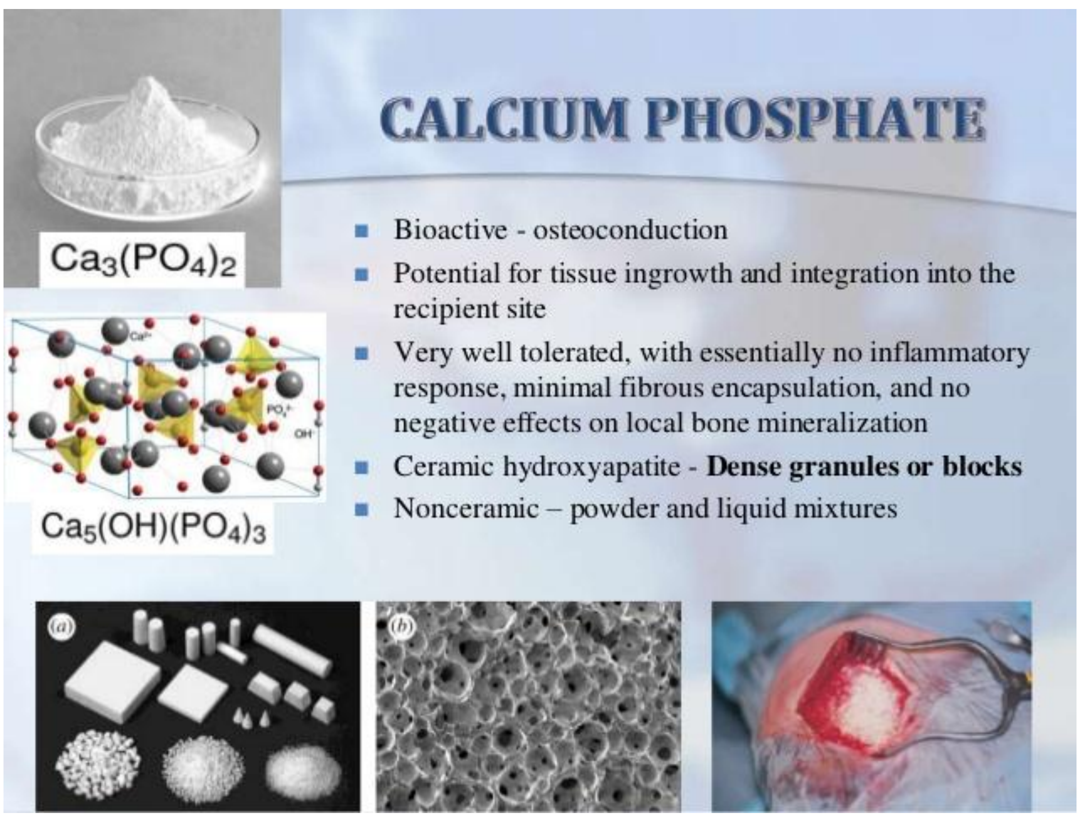
- *Restoration of continuity*
- *Restoration of alveolar bone height*
- *Restoration of osseous bulk*
- *Preservation of normal speech, swallowing, and velopharyngeal function*
- *Close oral-antral and/or oral-nasal fistulae*
- *Maintain nasal patency*
- *Obliterate postoperative dead space*
- *Expedite wound healing and transition to adjuvant therapy*
- *Maximize mouth opening and masticatory function*
- *Maintain functional lip competence*
- *Provide vertical support to the globe and associated facial soft tissues*
- *Create a stable preprosthetic framework for implant reconstruction and/or obturator fabrication*

Alloplastic Materials:

An **alloplastic graft** is composed of material that is not taken from an animal or human source. **Alloplastic grafts** can be derived from natural sources (such as an elements or minerals), synthetic (man-made) substances, or a combination of the two.

Alloplasty is a surgical procedure performed to substitute and repair defects within the body with the use of synthetic material. It can also be performed in order to bridge wounds. The process of undergoing alloplasty involves the construction of an alloplastic graft through the use of computed tomography (CT), rapid prototyping and "the use of computer-assisted virtual model surgery." Each alloplastic graft is individually constructed and customised according to the patient's defect to address their personal health issue. Alloplasty can be applied in the form of reconstructive surgery. An example where alloplasty is applied in reconstructive surgery is in aiding cranial defects. The insertion and fixation of alloplastic implants can also be applied in cosmetic enhancement and augmentation. Since the inception of alloplasty, it has been proposed that it could be a viable alternative to other forms of transplants. The biocompatibility and customisation of alloplastic implants and grafts provides a method that may be suitable for both minor and major medical cases that may have more limitations in surgical approach.

Although there has been evidence that alloplasty is a viable method for repairing and substituting defects, there are disadvantages including suitability of patient bone quality and quantity for long term implant stability, possibility of rejection of the alloplastic implant, injuring surrounding nerves, cost of procedure and long recovery times. Complications can also occur from inadequate engineering of alloplastic implants and grafts, and poor implant fixation to bone. These include infection, inflammatory reactions, the fracture of alloplastic implants and prostheses, loosening of implants or reduced or complete loss of Osseointegration.



Surgical Principles of Maxillofacial Bone Grafting Procedures

Several important principles should be followed during any grafting procedure. They must be strictly adhered to if a successful outcome is desired. The following are a few that pertain to reconstructing maxillofacial defects:

1- *Control of residual bone segments:*

2- *A good soft tissue bed for the bone graft:*

3- *Immobilization of the graft:*

4- *Aseptic environment:*

5- *Systemic antibiosis:*

Suggested Reading

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- *Peter Ward Booth, Maxillofacial Surgery: Churchill Livingstone, 2006*

SURGICAL AIDS TO ORTHODONTICS

Surgery in the orthodontic patient will often be an integral part of a treatment plan. Surgical interventions that may be required in orthodontic treatment include: extraction of erupted teeth, management of impacted, supernumerary and dilacerated teeth, corticotomy and excision of labial frenum.

Management of Impacted teeth

Impacted tooth is one that has failed to erupt into normal functional position beyond the time usually expected for such appearance.

It occurs where there is prevention of complete eruption due to:

- Lack of space in the dental arch (main cause).
- Obstruction by another tooth.
- Development in abnormal position.
- Dense overlying bone.
- Thick fibrous tissue.
- Odontogenic cysts or tumors.

The mandibular third molar is the most commonly impacted tooth in the mouth followed by maxillary third molar, maxillary canine, mandibular canine, mandibular second premolar, maxillary second premolar and second molars.

Medical History

A detailed medical history is necessary because useful information may be found concerning the general health of the patient to be operated on. This information determines the preoperative preparation of the patient, as well as the postoperative care instructions.

Clinical examination

The position of the tooth may be obvious by the presence of a bulge either palatally or buccally. The palatal impaction is more common than the buccal one. Palpation of the maxilla through the labiobuccal sulcus may reveal the presence of the bulge buccally. The lateral incisor may be proclined due to the presence of the canine labial to the root or may be retroclined if the canine is palatal.

Radiographic examination and assessment

The radiographic views that can be used include; periapical, occlusal, OPG, lateral skull view cone beam CT (CBCT) can also be used.

The periapical radiograph provides a detailed view of the tooth, surrounding bone, root formation, the presence of root resorption of the adjacent lateral incisor or the presence of any pathology.

Localization of the canine is important especially when it cannot be determined clinically. Methods of localization include:

- Buccal object rule (parallax method, tube shift technique); in which two periapical films are taken, shifting the tube horizontally distally between exposures, if the unerupted tooth moves in the same direction in which the tube is shifted it is localized palatally, if it moves in opposite direction it is buccally located, in a rule called SLOB (Same Lingual Opposite Buccal).
- Vertex occlusal projection; which produces an axial view of the incisors, will demonstrate the buccopalatal localization of the canine.
- Periapical-occlusal method; uses a standard periapical view and an occlusal view to give two different views of the impacted tooth.

- OPG; can be used to localize impacted canine on the basis that palatally impacted canine appear magnified. It can also demonstrate the vertical angulation and its height.
- Lateral skull view or cephalometric.
- CBCT.

Impacted Canines

Impacted maxillary canines are quite common, and approximately 12%–15% of the population present with impacted canines. They are localized palatally more often than labially. Even though positions vary, the impacted canine presents five basic localizations (contralateral or ipsilateral and deep in the bone) as follows:

1. Palatal localization
2. Palatal localization of crown and labial localization of root
3. Labial localization of crown and palatal localization of root
4. Labial localization
5. Ectopic positions

In young people aged 20 years or slightly older, impacted maxillary canines may be correctly aligned in the dental arch after surgical exposure and orthodontic treatment. In older patients, especially after the age of 30 years, the above procedure is not a method of choice, because the risk of failure is greater. In such cases, surgical removal is preferred, if deemed necessary of course. The technique for removing impacted canines depends on the position of impaction (palatal or labial), the relationship of the impacted tooth to adjacent teeth, as well as the inclination of its crown. These factors should be assessed before planning the surgical procedure.

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The localization of impacted canines is achieved using various radiographic techniques together with careful clinical examination. The most commonly used intraoral projections are occlusal projections, periapical radiographs and panoramic radiographs, while the technique employed for exact localization of the labial or palatal position of the impacted tooth is based on the tube shift principle. As far as the clinical examination is concerned, a palpable protuberance of the area designates the position of the tooth quite accurately. Based on the data from the clinical and radiographic examination, the surgical removal of impacted canines may be performed in three ways: with the labial approach, the palatal approach or a combination of the two.

Options of treatment

Retention or leave in situ; indicated when:

✓ The canine is asymptomatic and its extraction may lead to damage to the adjacent teeth.

✓ There is absence of any pathology like infection, abnormal widening of the follicle, resorption of the adjacent roots or any other associated pathology.

- ✓ Aesthetically acceptable.

The patient should be kept under annual review to verify that these complications have not arisen, the opinion of an orthodontist is important.

Surgical exposure and orthodontic traction; is the procedure that allows natural or orthodontically guided eruption of the impacted teeth, an active collaboration with an orthodontist is essential for planning this procedure. Certain criteria must be fulfilled:

- ✓ There should be adequate space in the arch to accommodate the tooth.
- ✓ There should be an unobstructed path of eruption.
- ✓ After eruption the tooth should be in near to normal position in all planes.
- ✓ The timing of the procedure should be as close as possible to the normal eruption time.

The approach is through a palatal envelope flap, extending from the first molar to the first molar on the other side in bilateral impaction cases, or from the first molar to the first premolar on the other side in unilateral impaction cases.

Buccally impacted teeth are approached through a 3-sided buccal flap, depending on its location.

After reflection of a full mucoperiosteal flap, the crown is exposed conservatively taking care not to expose the cementoenamel junction (CEJ) as this may result in increased incidence of external root resorption.

In palatally positioned canine, a window is excised in the soft tissue before replacing the flap, if the bracket is not attached at the same operation the window is packed with a suitable pack until it epithelializes for 2-3 weeks. In buccal approaches it is more appropriate to suture the flap above the crown (apically repositioned flap) and the area below covered with a pack to ensure that the tooth will erupt into an area of keratinized mucosa.





Transplantation; in this procedure the canine is carefully extracted and transferred to a surgically prepared socket in the dental arch with minimum delay. The transplanted tooth should be splinted in its new position for about a month with an orthodontic appliance.

It is essential to have sufficient space to accommodate the crown of the canine. Success rate is increased when the unerupted teeth still have open apex and when the handling of the root is kept to minimum to ensure the viability of the cementum and periodontal membrane. Endodontic treatment should be performed as soon as possible after surgery (about 6-8 weeks), periodic follow up is required to allow early detection of root resorption which is common.

Surgical Removal (Extraction); surgical extraction maybe performed when the other options are unavailable. The main indications include:

- ✓ Before construction of a dental prosthesis.
- ✓ To permit orthodontic alignment of other anterior teeth.
- ✓ When there is resorption of the roots of adjacent teeth.
- ✓ When a follicular cyst has developed.
- ✓ Infection although uncommon.

Extraction can be performed with retention of the primary canine with restorative procedures to improve esthetic contour, extraction can also be accompanied with extraction of the primary canine and orthodontic closure of the space by the first premolar. Implant supported crown can also be used to close the space created by extraction of the impacted canine and the primary canine.

Palatally positioned teeth are approached through palatal envelope flap, while buccal teeth are approached through buccal flap.

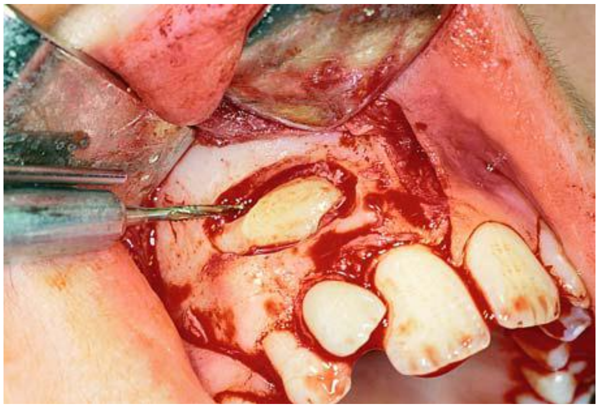
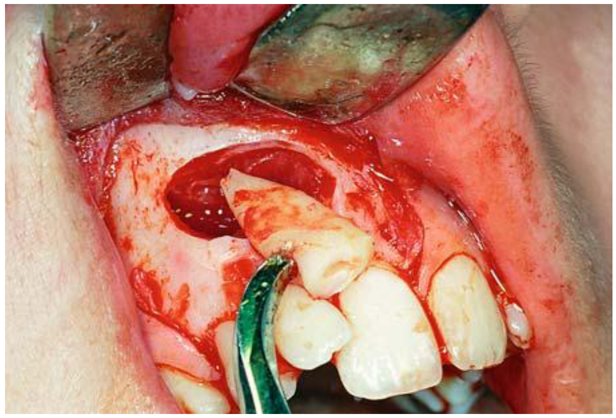
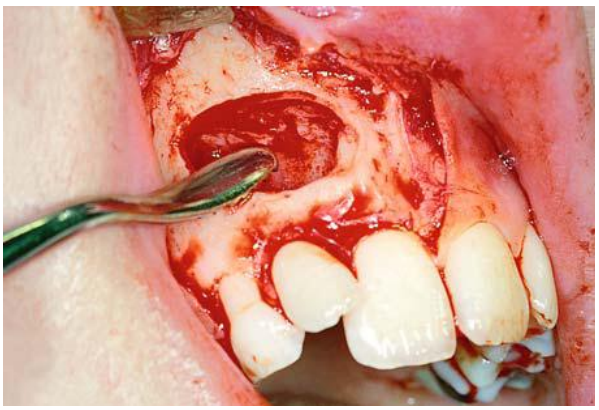
Occasionally tooth sectioning is required after bone removal and the tooth is extracted in segments.

Possible complications include:

- Palatal hematoma formation, this can be prevented by an acrylic splint to support the soft tissue.
- Perforation into the floor of the nose, but it rarely causes a problem.

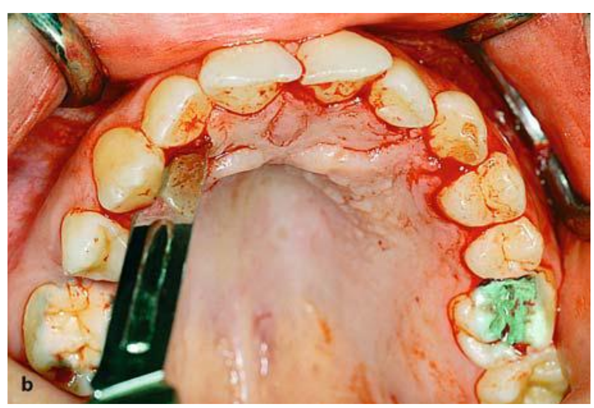
Extraction Using Labial Approach

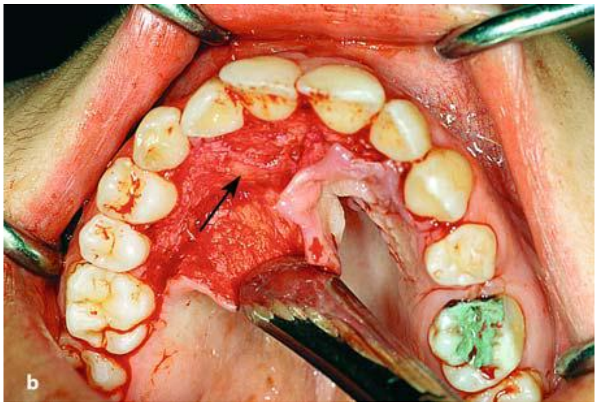
If the impacted tooth is localized labially and is entirely covered by bone, the procedure for its removal is as follows. First a trapezoidal incision is created and the mucoperiosteum is then reflected. The bone covering the tooth is removed using a round bur, with a steady stream of saline solution, until the entire crown of the tooth and part of the root are exposed. A groove is then created at the cervical line using a fissure bur, in order to separate the crown from the root. Separation is achieved using a straight elevator, which is placed in the groove. Upon rotation, the instrument separates the tooth into two segments. The crown is removed first and the root is then luxated, after creating a purchase point on the surface of the root for placement of the tip of the elevator blade. After smoothing the bone, the area is thoroughly irrigated with saline solution, and the wound is sutured. When the impacted tooth is not entirely covered by bone, but the crown of the tooth is covered by overlying soft tissues, removal of the tooth is easier, since it does not have to be sectioned into two pieces.

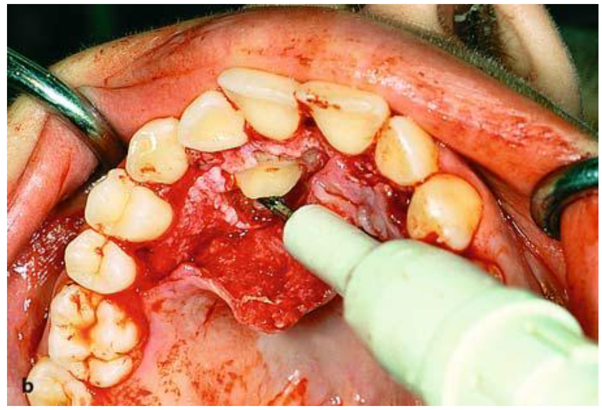




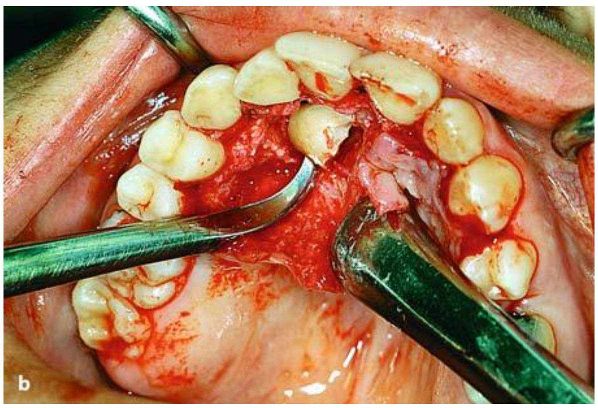

Extraction Using Palatal Approach

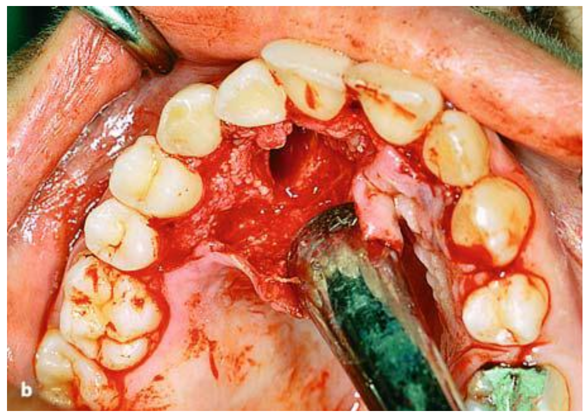
When the impacted tooth is positioned palatally , the approach is achieved using a bilateral palatal flap. The incision for creation of the flap begins at the first or second ipsilateral premolar and, after continuing along the cervical lines of the teeth, ends at the first premolar on the contralateral side. After careful reflection of the mucoperiosteum, part of the crown of the tooth may be exposed, or the entire crown may be covered by bone, resulting in protuberance at that site. Either way, enough bone must be removed to expose the entire crown, so that the tooth may be extracted using forceps or an elevator. If the tip of the crown is positioned between the roots of the lateral and central incisors, there is a risk of injuring their roots during the exposure attempt. That is why extraction of the canine must be achieved using the technique of separating the crown from the root. More specifically, a groove is created on the cervical line of the tooth using a fissure bur and, after placing the elevator blade in the groove created, the instrument is rotated until the crown is separated from the root. The crown is then removed, and, after using the round bur to create a purchase point on the root for placement of the angled elevator's tip, the root is elevated from its bed. After this procedure, the bone edges are smoothed, and the area is thoroughly irrigated with saline solution, while the flap is repositioned and sutured with interrupted sutures bone must be removed to expose the entire crown, so that the tooth may be extracted using forceps or an elevator. If the tip of the crown is positioned between the roots of the lateral and central incisors, there is a risk of injuring their roots during the exposure attempt. That is why extraction of the canine must be achieved using the technique of separating the crown from the root. More specifically, a groove is created on the cervical line of the tooth using a fissure bur and, after placing the elevator blade in the groove created, the instrument is rotated until the crown is separated from the root. The crown is then removed, and, after using the round bur to create a purchase point on the root for placement of the angled elevator's tip, the root is elevated from its bed. After this procedure, the bone edges are smoothed, and the area is thoroughly irrigated with saline solution, while the flap is repositioned and sutured with interrupted sutures .

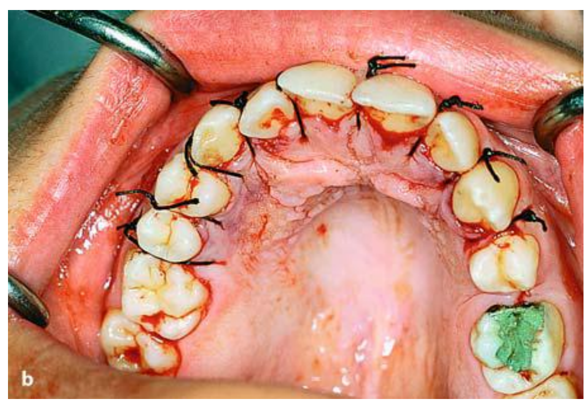








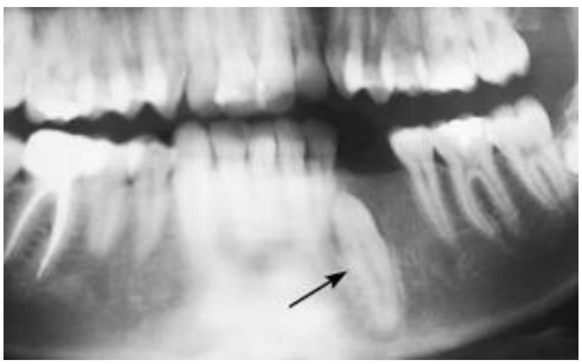




Impacted Mandibular Canine

Exposure of the tooth may be achieved in the area locating the impacted canine presents as light protuberance and the crown of the tooth is covered by soft tissue o

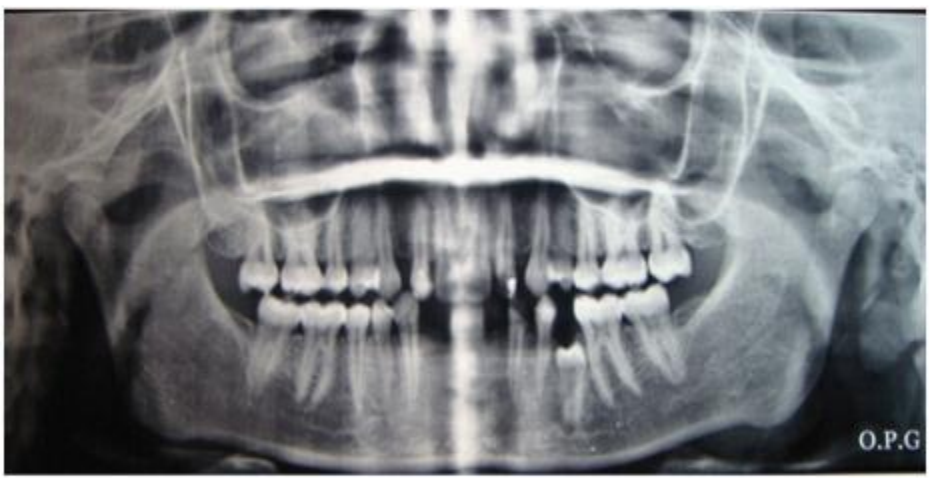
To expose the tooth, first an incision using an electrosurgical blade is made over the crown, and then the soft tissue is excised using scissors and a periosteal elevator, so that exposure is adequate. Afterwards, a surgical dressing is applied to the wound until the day the orthodontist bonds the bracket for traction of the tooth to its nor-malposition in the dental arch .The second technique involves exposure of the crown by creating a f lap. More specifically, after creating an L-shaped incision, a small flap is reflected and the crown of the impacted tooth is exposed. The tooth is then dried and after the orthodontist has placed the bracket on the crown of the tooth, the flap is repositioned and the wound is sutured.






Impacted lower premolars

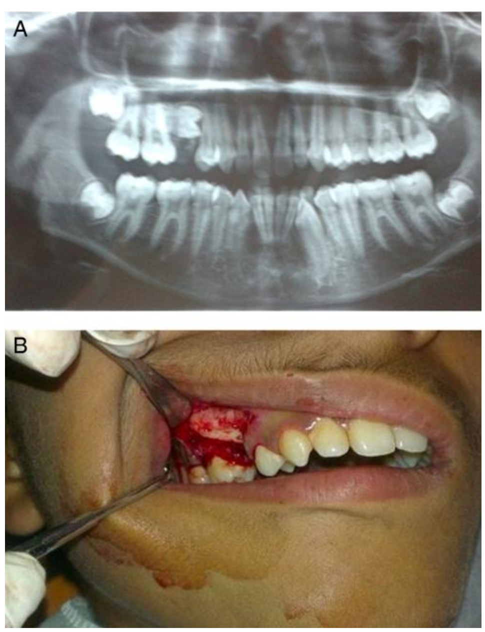
It occurs mostly due to loss of space by drifting forward of the first permanent molar after early extraction of the second deciduous molar. Localization is by periapical film, OPG with occlusal view to demonstrate the buccolingual position or CBCT. Removal is by raising a buccal flap, with preservation of the mental nerve, bone removal, sectioning of the tooth if needed and extraction of the tooth. Consultation with orthodontist before extraction is essential.



Impacted maxillary premolars

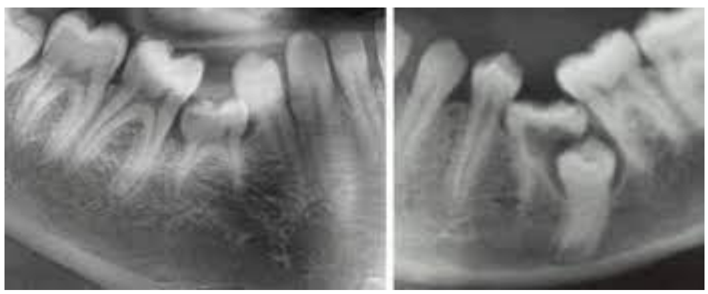
It is usually impacted with its crown palatally, or it may be within the arch between adjacent roots. It can be partially erupted, completely buried or the crown may be wholly exposed, in the latter case extraction is easy with an elevator or forceps. Completely impacted teeth require a palatal envelope flap extending from the second molar to the lateral incisor on the same side, bone removal and extraction of the tooth

Buccal approach is needed in cases where the tooth is within the arch between the standing teeth, sectioning of the tooth is needed when the root is curved. Care is taken not to damage the adjacent teeth.



Buried deciduous molars

These are usually ankylosed and should be removed surgically through buccal approach, bone removal and tooth sectioning if necessary.



Supernumerary teeth

These are more in the males than in the females, they can be present in the primary dentition as well as in the permanent dentition. Supernumerary teeth can be classified according to their position into:

Mesiodens; is situated in the premaxilla in the midline and it is commonly conical, it can have a horizontal or inverted position. Supplemental teeth may also occur in the anterior maxillary region.

Paramolar; appear in the premolar or molar region and is situated buccally to the teeth, they can be conical or supplemental.

Distomolar; appear as a fourth molar usually distal to the standing molars and they are either normal or smaller in size.

According to the shape they can be either; **conical (peg-shaped)** or **supplementary**; which have the shape and size of a normal tooth or they can have conventional shape with smaller or larger size.

Supernumerary teeth can have no effect on other standing teeth or they can cause failure of eruption of the other teeth, crowding, malposition or misalignment, resorption of the roots of the adjacent teeth or they can be associated with other pathologies (e.g. cysts). Erupted supernumerary teeth are extracted easily especially if they are conical in shape.If they need removal they should be localized accurately using periapical films (buccal object rule may be applied), vertex occlusal view or CBCT. OPG is needed to determine the vertical position of the tooth and its position in relation with the floor of the nasal cavity or maxillary sinus. They are approached palatally through palatal flap or buccally, bone removal and tooth sectioning may be needed, sometimes combined palatal and buccal approach is necessary.

Dilacerated incisors

Trauma to the deciduous incisors especially in the 2-3 years of age can cause damage to the underlying permanent incisor tooth germ causing root development to take place at an angle. Exposure and orthodontic traction can be performed if possible, but if not, these teeth should be removed and the lateral incisors allowed filling their space. It is essential to seek the opinion of an orthodontist.

Corticotomy-assisted orthodontic treatment

It can be defined as a linear cutting technique in the cortical plates surrounding the teeth to produce accelerated tooth movement. This process differs from the osteotomy, in which cortical and cancellous bone is cut for the purpose of repositioning blocks of bone with associated teeth. Corticotomy is contraindicated in patients with active periodontal disease or gingival recession. The traditional corticotomy procedure entails raising full-thickness buccal or buccal and palatal/lingual mucoperiosteal flaps and performing vertical linear interradicular corticotomy cuts (about 0.5 mm in depth), with or without joining horizontal subapical corticotomy cuts, or by drilling multiple holes that penetrated the cortical plate instead of linear cuts.After surgery orthodontic force can be applied either immediately or within 2 weeks after surgery.

Frenectomy

In many cases, the placement of a complete denture of the maxilla, or orthodontic procedures in younger persons requires the removal of the labial frenum, especially if it is hypertrophic . Also, in the mandible, the lingual frenum may create problems, causing partial or complete ankyloglossia. This case is due to attachment of the frenum to the floor of the mouth or to the alveolar mucosa. It may even be the result of an extremely short frenum that is connected to the tip of the tongue. Ankyloglossia greatly limits movements of the tongue, resulting in speech difficulties.

Maxillary Labial Frenectomy

Excision of the labial frenum is easy, within the reach of the general practitioner, andmay be performedwith various techniques. The method usually employed is that of excision using two hemostats. In this case, the procedure used is as follows. After local anesthesia, the lip is pulled upwards, and the frenum is grasped using two curved hemostats, which are positioned at the superior and inferior margins.The lip is then further retracted and a thin scalpel blade incises the tissue found behind the hemostat, first behind the lower hemostat and then behind the upper hemostat . If the frenum is hypertrophic and there is a large space between the central incisors, the tissues found between and behind the central incisors are also removed. Interrupted sutures are placed along the lateral margins of the wound in a linear direction, after the mucosa of the wound margins is undermined using scissors .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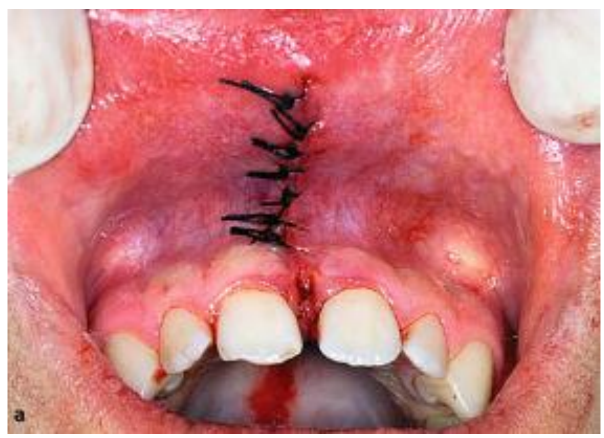
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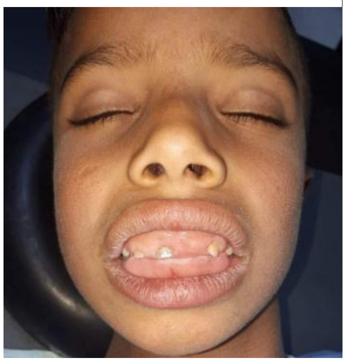
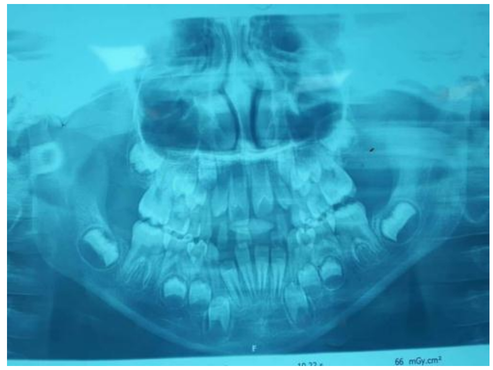
The laser-assisted frenectomy

Frenectomy can be performed by laser. Diod laser, Nd:YAG laser, Er:YAG laser and CO_2 Laser have been reported. The main advantages of laser are; less bleeding during surgery, no need for suturing or periodontal dressing, with minimal postoperative swelling and discomfort.

Gingival Fibromatosis

This is a benign condition, which is characterized by slow progressive swelling of the gingivae proper (attached gingivae) and alveolar mucosa (loose gingivae). The lesion may be generalized or localized and is due to hereditary or acquired causes. Clinically, gross hyperplasia of the gingivae is observed, which may partially or completely cover the crowns of the teeth, depending on the case. The surface of the gingivae is lobular, reddish, and firm to palpation, while the inflammation and bone resorption vary. Treatment is surgical and consists of segmental excision of the gingivae using cconventional surgical technogue or by laser application.





Suggestive Reading

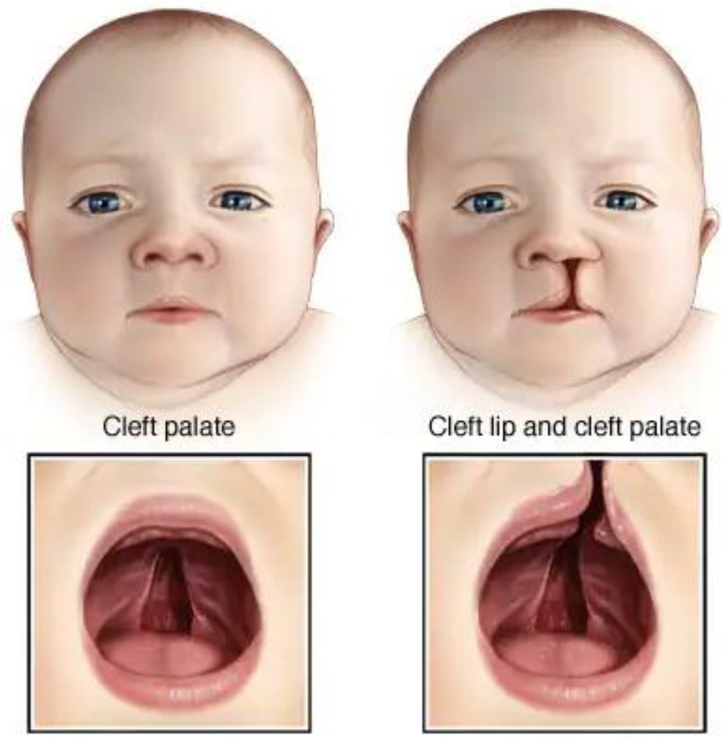
Fragiskos D. Fragiskos. Oral Surgery, Springer-Verlag Berlin Heidelberg 2007

Cleft Lip and Palate

Orofacial clefts include a range of congenital deformities most commonly presenting as cleft lip with or without cleft palate or isolated cleft palate. Cleft lip and cleft palate are openings or splits in the upper lip, the roof of the mouth (palate) or both. Cleft lip and cleft palate result when facial structures that are developing in an unborn baby don't close completely. Cleft lip and cleft palate are among the most common birth defects. They most commonly occur as isolated birth defects but are also associated with many inherited genetic conditions or syndromes. Having a baby born with a cleft can be upsetting, but cleft lip and cleft palate can be corrected. In most babies, a series of surgeries can restore normal function and achieve a more normal appearance with minimal scarring. Cleft lip and palate (CLP) is a three-dimensional deformity involving soft and skeletal tissue that changes with growth and function. Its comprehensive treatment requires thoughtful consideration of the anatomic complexities of the deformity and the delicate balance between intervention and growth.

Unilateral cleft lip

Bilateral cleft lip



History of the Procedure

Chinese physicians were the first to describe the technique of repairing cleft lip. The early techniques involved simply excising the cleft margins and suturing the segments together. The evolution of surgical techniques during the mid-17th century resulted in the use of local flaps for cleft lip repair. These early descriptions of local flaps for the treatment of cleft lip form the foundation of surgical principles used today. Tennison introduced the triangular flap technique of unilateral cleft lip repair, which preserved the Cupid's bow in 1952. The geometry of the triangular flap was described by Randall, who popularized this method of lip repair

Epidemiology

Cleft lip and palate are hereditary diseases in which environmental and genetic factors together play a role, leading to different clinical outcomes. Generally, cleft lip and palate cases are divided into two groups: cleft lip with/without cleft palate (CL/P) and isolated cleft palate (CP). Depending on the presence of certain anomalies, the cases are also classified as syndromic and non-syndromic (nsCLP) clefts.

Approximately 70% of CL/P patients and 50% of CP patients are non-syndromic. In the remaining patients, a wide range of malformation syndromes can manifest, including chromosomal anomalies and teratogens as well as more than 500 defined Mendelian syndromes

Children born with cleft lip and palate develop complications such as nutritional difficulties, respiratory failure, and hearing and speech difficulties. In addition to health problems, affected individuals face long-term social difficulties such as acceptance. Even if surgical intervention is performed in the early period, deformities due to scarring and abnormal facial development cause persistence of functional and psychosocial problems throughout the patient’s life.

It is necessary to understand the factors underlying these defects in order to foresee the long-term course of development of individuals with a cleft lip and palate that should be treated using a multidisciplinary approach including a plastic surgeon, otolaryngologist, speech therapist, audiologist, orthodontist, psychologist, social worker, and nurse. Epidemiological studies and observational reports have shown that folic acid supplements taken by the mother before pregnancy have a protective effect in reducing the incidence of cleft lip and palate, whereas smoking and alcohol consumption before pregnancy increase the risk of cleft lip and palate formation

The estimated incidence of CLP ranges from 1:500 live births to 1: 2000 live births, the incidence is highest in Asians (1:500) followed by whites (1:1000) while the lowest incidence is in African-Americans (1:2000), but this racial variation is not observed in cases of isolated cleft palate (CP) with reported incidence of 1:2000 live births.

- Isolated cleft lip (CL) is reported in 21%-25% of the cases.
- Isolated CP is reported in 33%-40% of the cases.
- CLP is reported in 35%-46%.
- Unilateral clefts are 9 times more common than bilateral clefts and they are more frequent on the left side than on the right.
- Males are predominant in CLP population, whereas isolated CP occurs more commonly in females.
- CLP can be associated with syndromes such as Van der Woude syndrome, hemifacial microsomia, velocardiofacial syndrome or DiGeorge syndrome, ectrodactyly-ectodermal dysplasia-clefting syndrome, Stickler syndrome, trisomy 13 and trisomy 18.

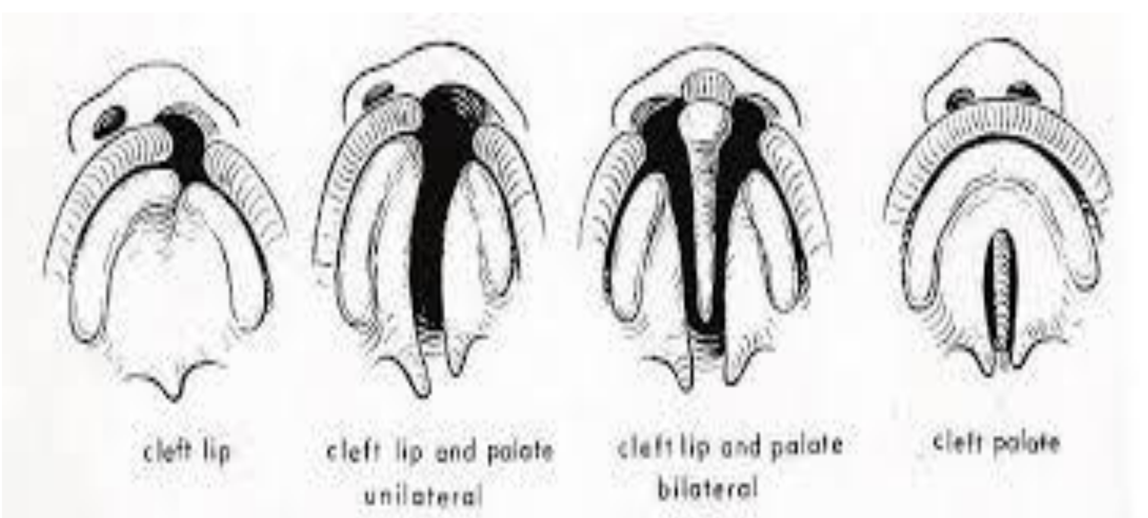
Aetiology

Cleft lip and or palate occurs secondary to a failure of fusion of the medial nasal swellings with the maxillary swellings. The vast majority of cases of cleft lip and/or palate are idiopathic; however, a number of drugs have been implicated, including phenytoin, carbamazepine, steroids and diazepam. In addition, chromosomal disease and malformation syndromes are also associated with facial clefting. In trisomy 13 the facial clefting is usually median (midline cleft) or bilateral cleft lip and palate, and occurs in up to 65% of cases. Facial clefting is seen in 30% of fetuses with triploidy, up to 15% of fetuses with trisomy 18 and 0.5% of fetuses trisomy 21.

Classification

Cleft lip is classified as being complete or incomplete based on the extent of the cleft, as well as unilateral or bilateral depending on whether it affects one or both sides. An incomplete cleft of the lip does not involve the complete thickness of the lip, but has a band of tissue intact across the cleft. Conversely, a complete cleft of the lip involves the entire vertical thickness of the lip and is more often associated with a cleft of the alveolus.

Cleft palate is defined in a similar fashion, as either complete or incomplete as well as unilateral or bilateral. A complete cleft of the palate involves both the primary and secondary palates as well as the alveolus. There is also the less common possibility of an isolated cleft palate which usually involves the secondary palate, posterior to the incisive foramen.



Successful management of the child born with CLP requires coordinated care provided by a number of different specialties including oral and maxillofacial surgery, plastic surgery, otolaryngology, genetics, speech therapy, orthodontics, prosthodontics and others.

Specific goals of treatment include the following:

- ✓ Normalized esthetic appearance of the lip and nose
- ✓ Intact primary and secondary palate
- ✓ Normal speech, language, and hearing
- ✓ Nasal airway patency
- ✓ Class I occlusion with normal masticatory function
- ✓ Good dental and periodontal health
- ✓ Normal psychosocial development

The management of CLP patients can be divided into:

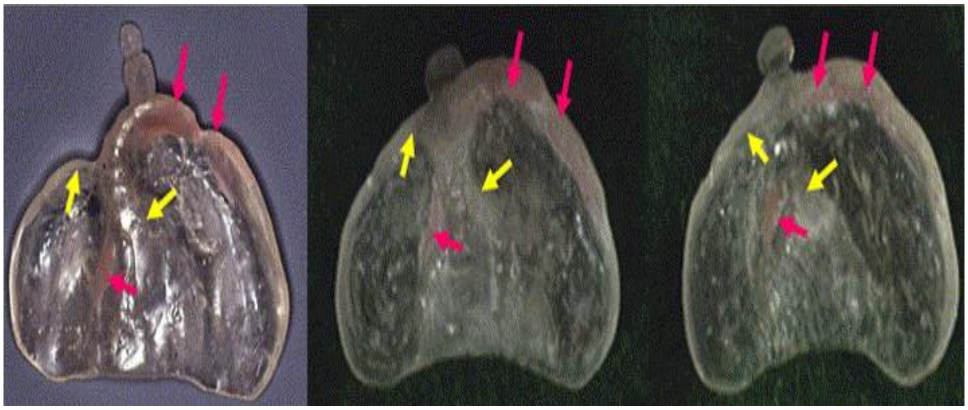
Preoperative management

Feeding : One of the major concerns during this phase of management is feeding, this concern is not very critical in children born with isolated CL, as they can feed quite well and even have the opportunity to breastfeed in most instances. Infants with cleft palate, on the other hand, can have difficulty in feeding due to the inability to form an adequate seal between the tongue and palate for creation of sufficient negative pressure to suck fluid from a bottle. Specialized nipples and bottles are necessary to improve feeding.

Presurgical orthopedics (PSO): PSO entails using devices to mold the perioral structures of the infant with a CLP to reposition the nasolabial and maxillary segments closer to each other. It is mainly used in the first few weeks after birth and in the months prior to palate repair.

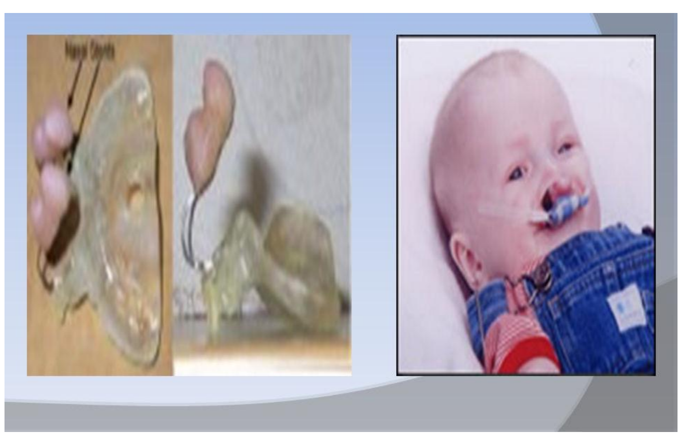
PSO treatment can be achieved by intraoral or extraoral devices or appliances or a combination of the two, examples of PSO are:

- Alveolar molding



- Lip strap/lip taping

- Nasoalveolar molding (NAM)



Treatment planning and timing

The timing of CLP repair is controversial. The decision to surgically manipulate the tissues of the growing child should take into account the possible growth restriction that can occur with early surgery. Historically the anesthetic risk-related data suggested that the safest time period for surgery in this population of infants could be outlined simply by using the "*rule of 10's*." This referred to the idea of delaying lip repair until the child was at least 10 weeks old, 10 pounds in weight, and with a minimum hemoglobin value of 10 g/dl.

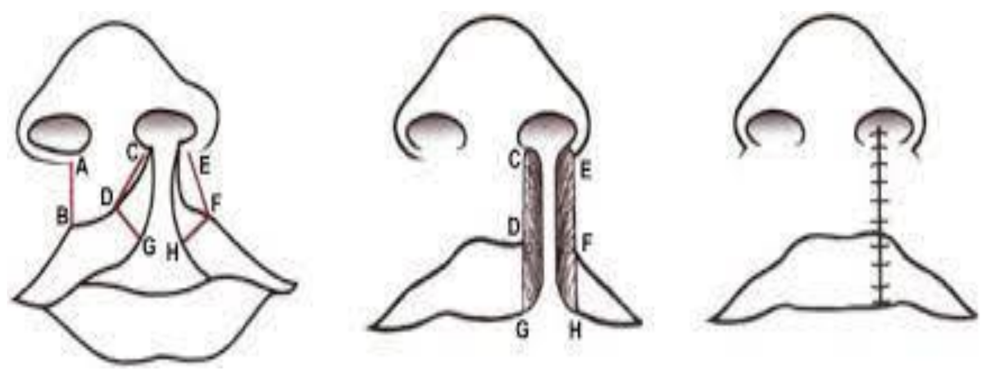
Procedure	**Timing**
CL repair	After 10 weeks
CP repair	9-18 months
Pharyngeal flap or pharyngoplasty	3–5 years or later based on speech development
Maxillary/alveolar reconstruction with bone grafting	6–9 years based on dental development
Cleft orthognathic surgery	14–16 years in girls, 16–18 years in boys
Cleft rhinoplasty	After age 5 years but preferably at skeletal maturity; after orthognathic surgery when possible
Cleft lip revision	Anytime once initial remodeling and scar maturation is complete but best performed after age 5 years

Primary operative management *(Surgical procedures for CL & CP)*

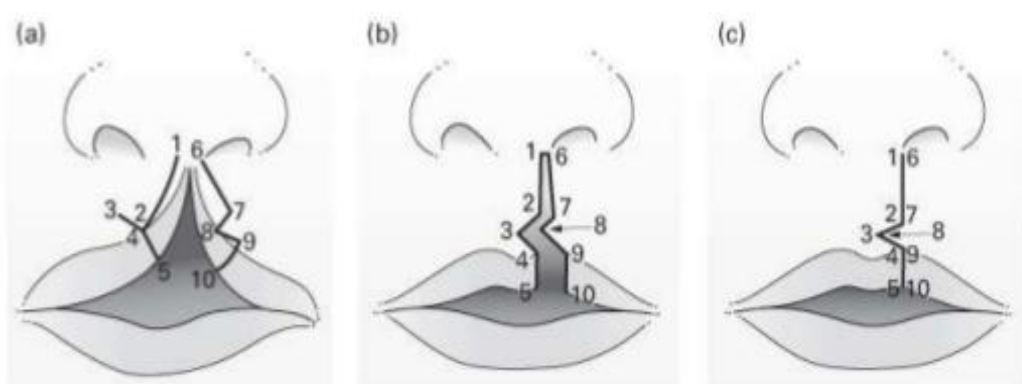
Surgical procedures for CL

The basic premise of the repair is to create a three-layered closure of skin, muscle, and mucosa that approximates normal tissue and excises hypoplastic tissue at the cleft margins. Numerous techniques, as well as modifications to popular techniques, have been extensively described in the literature

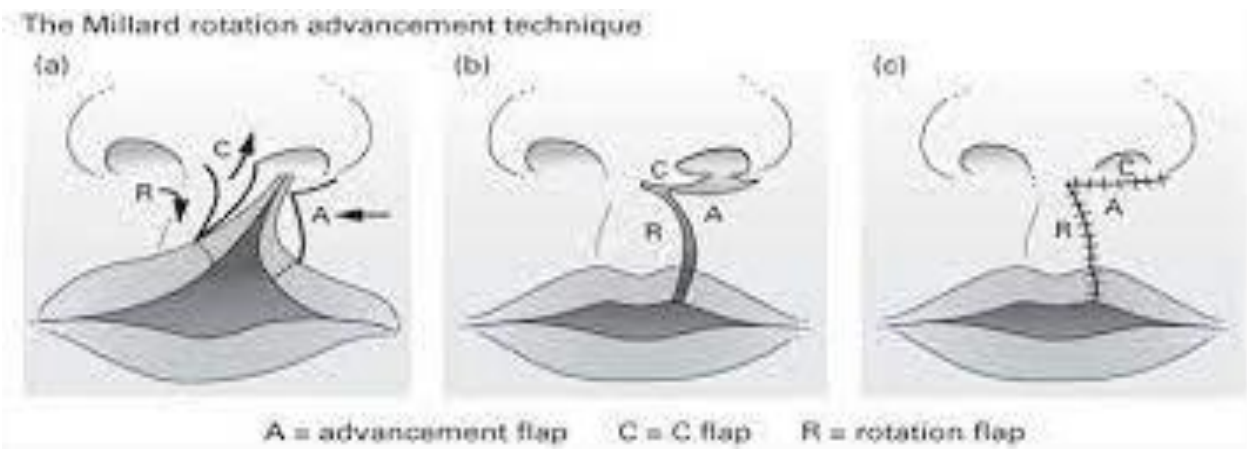
- **Straight line repair :** Straight line closure, or the Rose-Thompson closure may be indicated for microform clefts and it is rarely used as primary technique for cleft repair as it results in notching of the lip and vertical scar contracture.



- **Tennison-Randall triangular flap repair:** It utilizes the interdigitation of triangular flaps (geometric design). The concept underlying the technique can be similarly compared to a Z-plasty reconstruction of the lip. This technique is based on careful measurements of specific landmarks.



- **Millard's rotation-advancement flap repair:** It is the most prevalently used technique in cleft lip repair. The technique utilizes downward rotation of the superiorly displaced medial lip segment with advancement of the lateral lip flap to correct the defect below the nose. Many modifications for the original procedure were described.

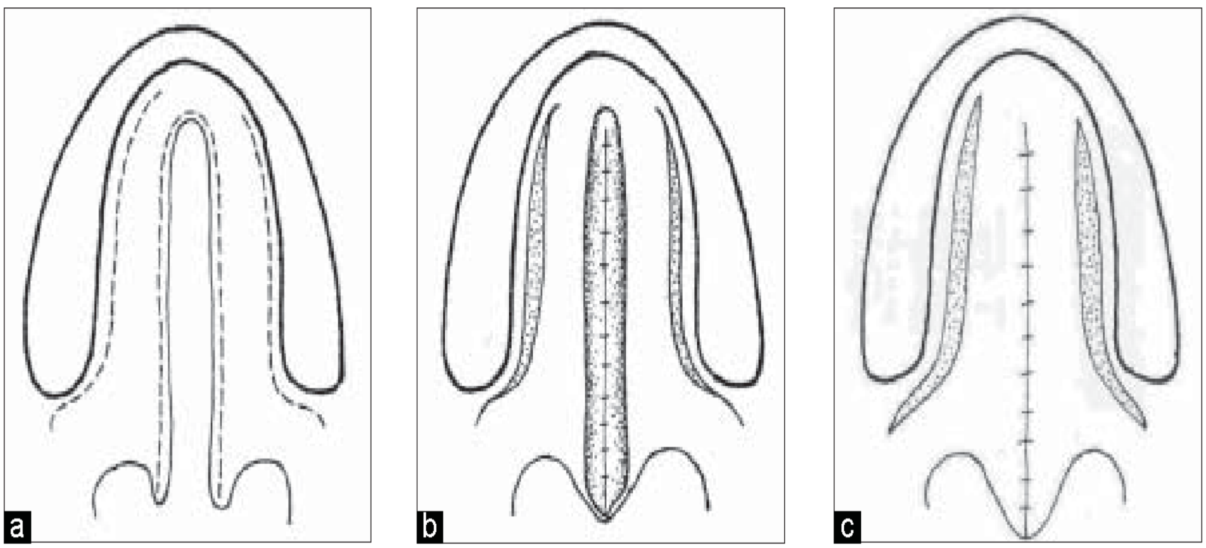


Surgical procedures for CP

CP repair requires the mobilization of multilayered flaps to reconstruct the defect in a layered fashion by first closing the nasal mucosa and then the oral mucosa, the surgeon must also reconstruct the musculature of the velopharyngeal mechanism. Therefore, the soft palate is closed in three layers by approximating the nasal mucosa, velar musculature, and the oral mucosa. The hard palate portion is closed in two layers using nasal mucosa flaps and then oral mucosa flaps. Both the hard and soft palate repairs must be done in a tension-free manner to avoid wound breakdown and fistula formation.

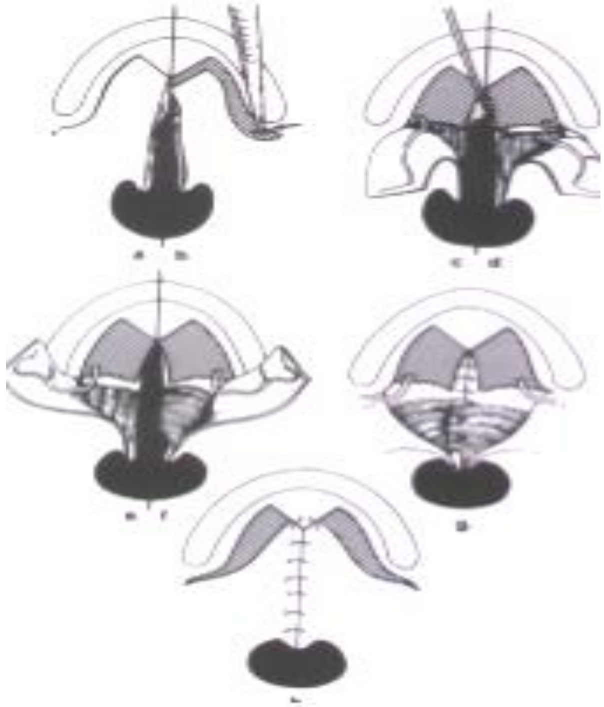
The von Langenbeck technique

It involves creating bipedicled mucoperiosteal flaps on both sides of the cleft. The nasal side of the cleft is closed first, using redundant mucoperiosteum from the incision along the cleft edge. Then the bipedicled flaps are approximated to cover the oral surface of the cleft.



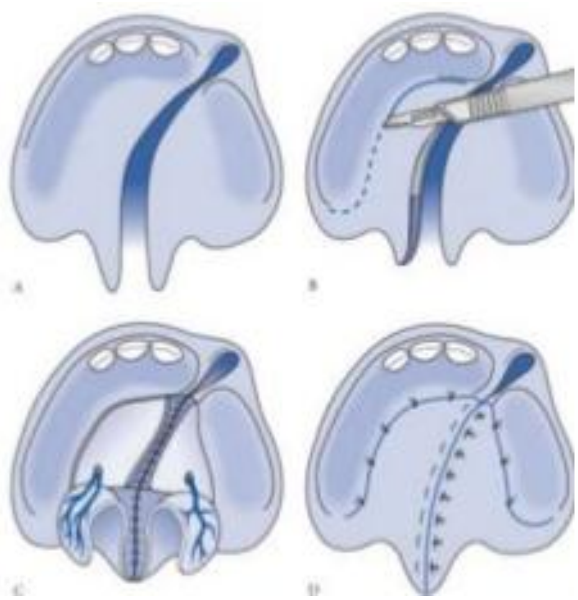
V-Y pushback technique

Many authors believed that the von Langenbeck procedure resulted in insufficient length of the soft palate and advocated the V-Y pushback technique. It has the advantage of lengthening the palate and repositioning the levator muscle in a more favorable position. However, this technique involves extensive dissection and the denuded palatal bone from which the mucoperiosteal flaps are raised adversely affects midfacial growth in cleft palate patients.



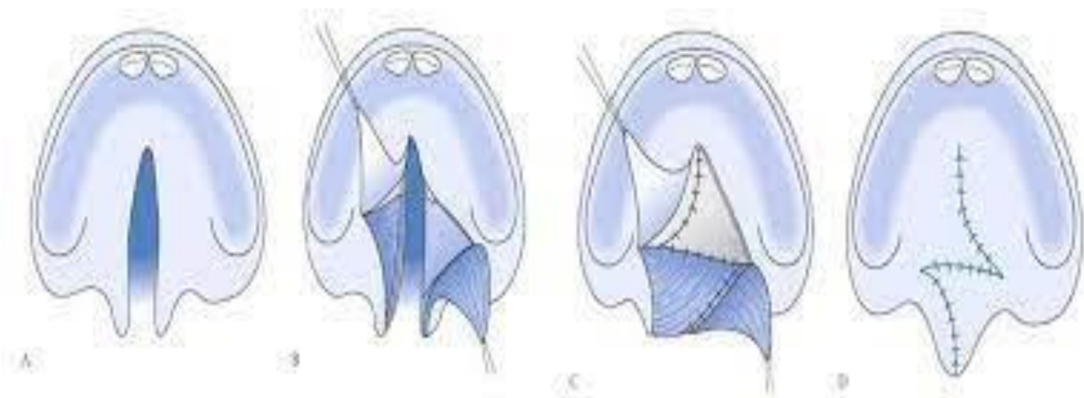
Two-flap technique

In this procedure a full-thickness mucoperiosteal flap is elevated on each side of the cleft, which preserves the palatal neurovascular bundle.



The Furlow technique

It essentially consists of repairing palatal clefts using Z-plasties of the oral and nasal mucosa. The theoretical advantage is that the soft palate may be lengthened while preventing longitudinal scar contracture and palatal shortening.



Secondary operative management *(Alveolar bone grafting)*

Goals of alveolar bone reconstruction

- To provide bone support and adequate attached gingival width for teeth adjacent to the cleft.
- To close the remaining oronasal fistula.
- To improve support of the nasal alar base and lip on the affected side(s).
- To allow normal eruption of the permanent teeth in the cleft area and providing sufficient bone for the placement of dental implants, where needed.
- To create an appropriate ridge form to allow for optimization of orthodontic care and dental alignment.
- To allow for stabilization of the premaxillary segment and to provide continuity of the maxilla as a whole.
- To improve nasal symmetry.
- To provide support for the upper lip.

Timing of the alveolar bone reconstruction was one of the most controversial issues. Generally it can be grouped according to timing into:

Primary (early) grafting; which was defined as that performed simultaneously with lip repair or as grafting performed before the palate is repaired at age younger than 2 years.

Secondary (delayed) grafting; which can also be divided into:

- Early secondary; before the eruption of the permanent incisor teeth (3-6 years).
- Secondary; before the eruption of the maxillary canine, (6-12 years).
- *Late grafting*; after 12 or 13 years of age, after the eruption of the permanent canine.

Sources of bone graft materials

- Iliac crest;
- Cranium;
- Tibia
- Mandibular symphysis.
- Bone graft substitutes

Complications

- Wound dehiscence which is managed by debridement and antimicrobial mouth washes with or without systemic antibiotics.
- Infection which is managed by conservative debridement, daily irrigation and packing with oral antibiotics.
- Persistent fistula which may require subsequent procedures.

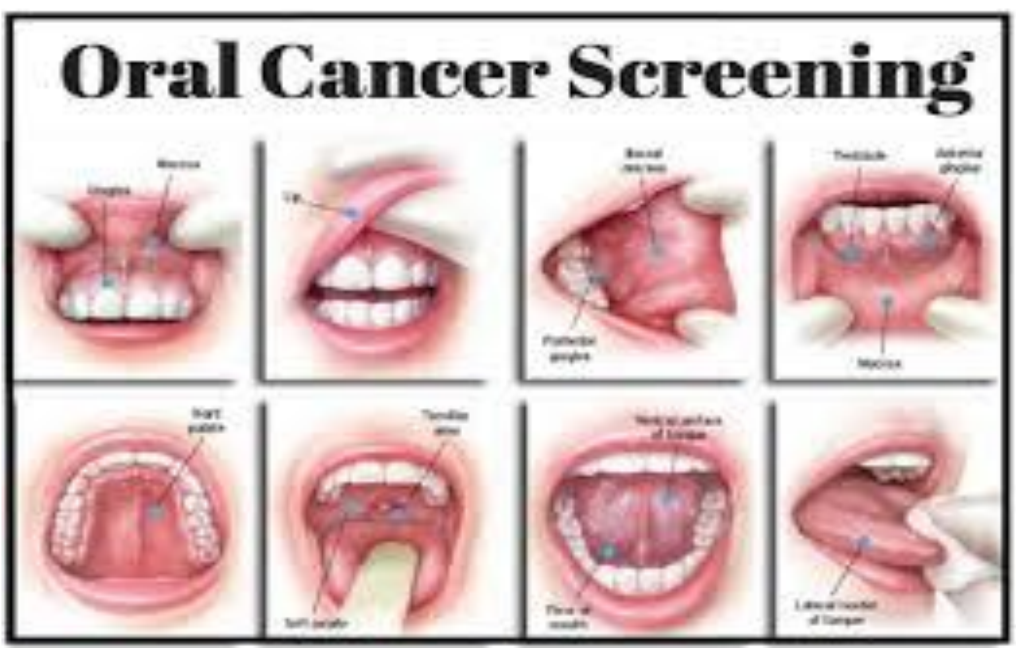
Suggested Reading

Peter Ward Booth, Maxillofacial Surgery: Churchill Livingstone, 2006

ORAL CANCER

Oral cancer is a term used for general description of malignant tumors of the oral cavity .Over 94% of oral cancers are squamous cell carcinoma (SCC). Oral squamous cell carcinoma (OSCC) is defined as a malignant neoplasm in the oral cavity which is derived from squamous epithelial cells. The term oral include all intra- oral structures such as tongue, gingiva, buccal mucosa, floor of mouth, palate, vestibules, oropharynx as well as lip. Oral cancer accounts for 4% of all cancers in the world but it is the sixth most common cancer in males and the twelfth most common in females. It is uncommon before the age of 40 years and the highest incidence of oral cancer is in the 5^{th} - 6^{th} decades of life with sex incidence being a 3:1 male predominance. Geographically, the oral cancer is found world wide, but there is significant variation in incidence in African and Asian countries.

In some countries, such as India and Sri Lanka (however, exceptional) cancer of the mouth accounts for approximately 40% or more of all cancer. In Iraq cancer of the mouth accounts for approximately 4.5% and most of this percentage are SCC (91.5%) according to the Iraqi Cancer Registry. Oral cancer is an age-related disease, 98% of patients are over the age of 40 years. The risk of intra-oral cancer development increases with increasing age, especially for males. In the United States, white men have a higher risk of intra-oral cancer after 65 years, while, the highest annual incidence rate in middle age is seen in American males of African ancestry. Advanced age is probably the most important factor in the mortality associated with the development of any cancer. With all respect of molecular carcinogenesis of cancer development, the age of the patients have a great effect in the proper function of immune system which tends to become less efficient at recognizing and eliminating aberrant cellular growths which arise from time to time in people of all ages.



Females, whether white or non-white, have a much lower annual incidence rate than males at all age levels. The lower lip is the most frequent site of oral cancer, while the tongue is the most affected site within the mouth. Cancer of the tongue is accounted about 40% of all cases in the oral cavity proper, 70% of oral cancer are concentrated in the lateral borders of tongue, the adjacent floor of mouth and lingual aspect of the alveolar margin, forming U-shape area extending back to oro-pharynx. About 40% of OSCC begin on the floor of mouth or on the lateral or ventral surfaces of the tongue. About 38% of all OSCC occur within lower lip due to chronic sun exposure and presence of solar-related cancers on the external surface.Lip cancer is in some countries mainly Neozeland the most frequent malignant neoplasm of the oral cavity, reaching 25% of all cases. Lip cancer has a variable incidence around the world, with the highest rates being reported in the south of Australia and in some regions of Canada and Spain.

Squamous cell carcinoma :Represent 90 % or more of all oral malignant neoplasm.Male : female ratio of intra oral carcinoma is 2:1 or 3:1 in most country while lip cancer is 6-8 time more common in men .SCC occur mostly in old who have been aware of alteration in oral cancer site for 4-8 month before seeking professional help .

Etiology and risk factors:

The causes of OSCC are multifactorial, no single causative agent or factor (carcinogenic) has been clearly defined or accepted, it is likely that more than a single factor is needed to produce such a malignancy (carcinogenesis). In general term it can be defined into Extrinsic and Intrinsic factors.

1. Tobacco smoking:

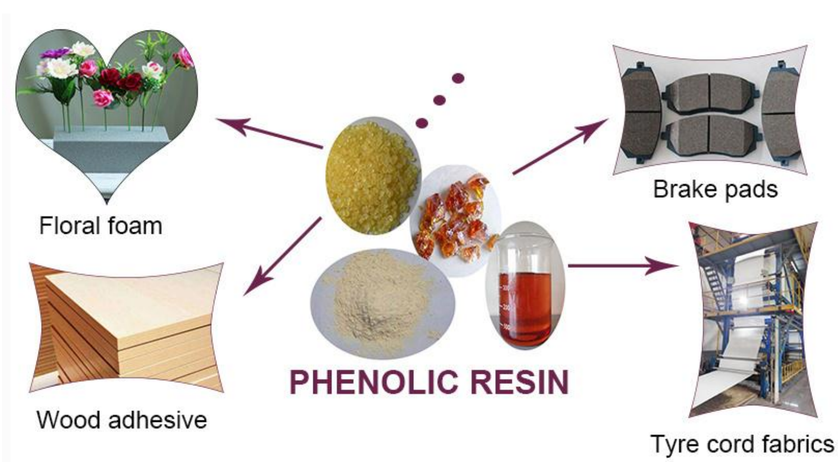
Tobacco smoking (pipes, cigars, cigarettes, reverse smoking) is thought to be implicated in well over 80% of cases of OSCC, particularly of cigarettes. Chronic exposure of the epithelial surfaces of head and neck to this irritation is thought to result in a "field cancerization" sequence of hyperplasia, dysplasia and carcinoma. Tobacco is a known carcinogen, which means that it is known to damage cellular DNA and causes the cellular reproductive machinery to malfunction, which is the first step in the growth of malignant cellular masses (cancer). Thus tobacco causes malignant mutations in the cellular DNA.There is a dose-relationship between exposure to tobacco smoke and the development of oral cancer. Smokers are up to 25 times more likely to develop head and neck cancer than their non-smoking counterparts. Tobacco chewing ,snuff-dipping, betel chewing and tobacco sachets (smokeless tobacco) where it's particularly noticeable in India and Sweden, cause extensive hyperkeratosis plaques which may lead to development of verrucous carcinoma as well as SCC. Pipe- smoking is also associated with oral cancer development but this habit has steadily declined in most westernized countries and has never become popular with women.

2. Alcohol:

Alcohol is known to inhibit a gene that functions in response to DNA damage. This gene is responsible for initiating cell death in cells with DNA damage (apoptosis gene), plus alcohol inhibits the body's natural defense against malignancy. Some studies show a dose-response relationship with heavy drinkers being at a greater risk. In addition, drinkers of spirits may be at a greater risk than those who drink wine.Moreover, there is a fairly convincing evidence that alcohol is carcinogen when acts synergistically with tobacco, hence it has been known for more than 30 years that tobacco and alcohol have the major role in the etiology of OSCC. This is perhaps because alcohols act as solvents and facilitate penetration of the oral mucosa by other carcinogens that may be present in the mouth e.g. tobacco.

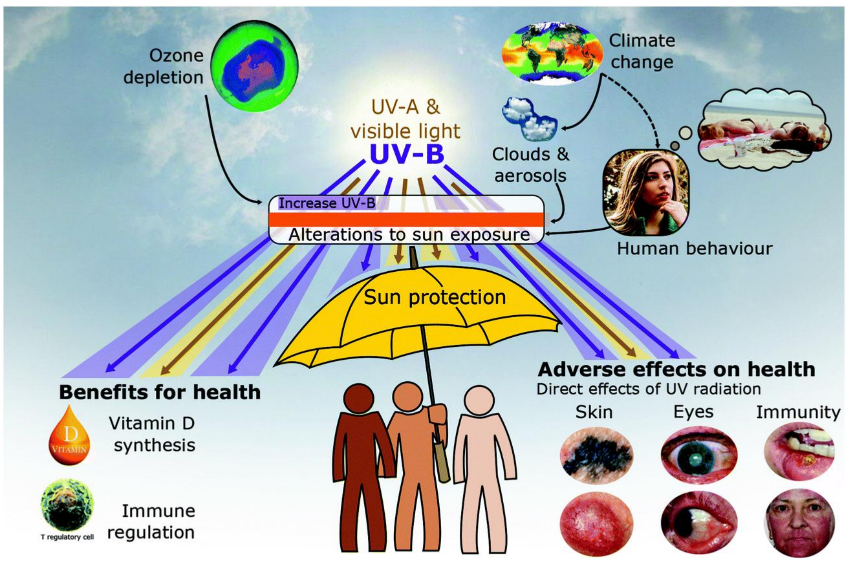
3. Phenols:

Recent evidence has pointed to an increased oral cancer risk for workers in the wood products industry chronically exposed to certain chemicals, such as phenoxyacetic acids. Moreover, it has long been known that these workers are at increased risk for nasal and nasopharyngeal carcinoma.



4. Radiation:

Whatever its source (ultra-violet rays (UVR) of sun light, x-rays, nuclear fission and radio nuclides) is a carcinogen. Ionizing radiation causes chromosome breakage, translocations and less frequently point mutations leading to genetic damage and carcinogenesis. UVR induces the formation of pyrimidine dimmers within DNA, leading to mutations. Therefore U.V.R. can give rise to S.C.C. and melanomas of the skin. The incidence is increased between farmers and fishermen and it is considered as a disease of outdoor workers.



5. Malnutrition:

It can be considered as an extrinsic factor. In India, malnutrition is widespread and may contribute together with betel quid chewing, to the high incidence of SCC. This factor can be subdivided into many deficiencies:

- *Iron deficiency;*

The increased risk of oral cancer associated with primary sideropenic anemia (Plummer –Vinson or Patterson- Kellsy) has been recognized for many years. Irons is essential for maintenance of oral epithelium, thus in deficiency states these epithelium cells turnovers more rapidly and produce an atrophic or immature mucosa, and it is possible that atrophic changes in iron deficiency anemia render the mucosa more susceptible to chemical carcinogens).

- *Vitamin deficiency:*

Vitamin A important in the maintenance of stratified squamous epithelium; vitamin A deficiency produces excessive keratinization of mucous membrane. Several epidemiological studies have shown that individual whose diet are high in the antioxidant vitamin A,C and E have a protective effect and decreased risk of oral cancer**.**

6. Oncogenes viruses

Viruses may play a major role in a wide variety of cancers. Viral agents capable of integration into the host's genetic material may be particularly dangerous and potentially could commander the host's ability to regulate normal growth and proliferation of the infected cells. The oncogenic viruses that facilitating malignancy transformation are:

- Human papilloma viruses (HPV).
- Herpes simplex viruses (HSV).
- Epstein-Bar viruses (EBV).
- Human immunodeficiency viruses (HIV).

7. Immunosupression

Reports have been published of an increased risk of carcinoma of the lip in patients with AIDS, renal and organ transplantation especially when tobacco smoking and alcohol abuse are present .

8. Chronic infection

- *Chronic candidal infection*

White plaque candidal leukoplakia is cited as an oral precancerous condition, because this lesion appear as a white plaque that can't be rubbed off and superimposed candidiasis. Some studies improved that; some strains of Candida albicans produce nitrosamines which are chemicals that have been implicated in carcinogenesis.The role of candidal infection in malignant lesions must be regarded as uncertain.

•Syphilis

Tertiary stage of syphilis has a strong association with the development of dorsal tongue carcinoma. However, syphilis-associated oral malignancies are rare today because the infection is typically diagnosed and treated before the onset of the tertiary stage.

9. Occupation

High incidence of oral cancer has been reported in:

- Textile workers, particularly in those exposed to dust from raw cotton and wool .
- Air pollution and environmental exposure to the burning of fossil fuels, which is considered as one of contributing factors of oral cancer etiology.

10. Pre-existing oral lesion

There is general agreement that pre-malignant oral lesion is defined as "a morphological altered tissue in which cancer is more likely to occur than in its apparently normal counterpart".The most important pre-malignant oral lesions are:

- Proliferative verrucous leukoplakia.
- Nicotinic palatines in reverse smokers.
- Erythroplakia.
- Oral sub mucous fibrosis.
- Erythro leukoplakia.
- Granular leukoplakia.
- Laryngeal keratosis.
- Actinic cheilosis.

- Smooth, thick leukoplakia.
- Smooth red tongue of Plummer-Vinson syndrome.
- Smokeless tobacco keratosis.
- Lichen planus.
- Smooth, thin leukoplakia.

11. Familial factors

There are a few genetic disorders that contribute with cancer development but such disorders are rare so they received less attention. Multiple primary tumors are often seen in hereditary cancer syndromes includes Xeroderma pigmentosum and Dyskeratosis congenital.

12. Socio-economical factors

The biological behavior of oral cancer

After transformation of cells and cancer development, cancer grows by progressive infiltration, invasion, destruction and penetration of the surrounding tissue. Most OSCCs are extremely locally destructive. Malignant neoplasm disseminate by one of 3 pathways:

- **Seeding:**

Spread by seeding within body cavities.

- **Lymphatic spread:**

It is the favored route for dissemination of OSCC into the surrounding lymph node. "A sentinel lymph node SLN" is defined as the first lymph node in a regional lymphatic basin that receives lymph flow from a primary tumor. A SLN is very important in determination the spread of tumor, and can be used to plan treatment by surgeons, determine most important lymph nodes in head and neck region are: parotid, buccal, sub mental, submandibular, deep cervical and superficial cervical. However; because of delayed diagnosis approximately 21% of patients have cervical metastasis at diagnosis

- **Hematological spread:**

It is favored pathway for dissemination of sarcomas. In OSCC the hematological dissemination occur late in the clinical course of the disease.. The most common sites are: lung, liver and bones, but any part of the body may be affected.

Clinical presentation of OSCC

OC has a varied clinical presentation including:

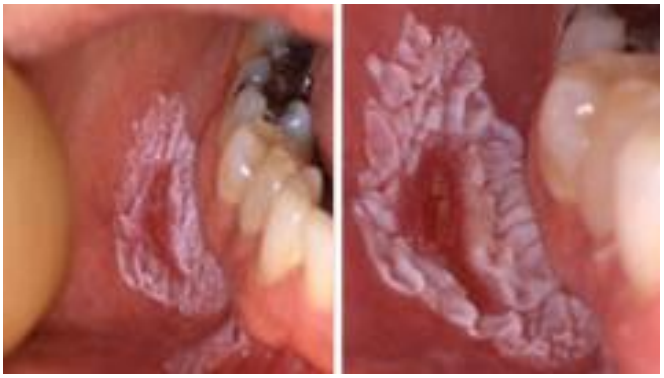
- *Exophytic (mass forming, fungating, papillary and verruciform).*

- *Endophytic (invasive, burrowing and ulcerated).*

- *Leukoplakia (white patch).*

- *Erythroplakia (red patch).*

- *Erythro-leukoplakia (combined red and white patch)*



Pain is not a reliable indicator as to whether a particular lesion may be malignant. Larger; advanced carcinoma will often be painful, but many early oral cancers will be totally asymptomatic or may be associated with only minor discomfort.The symptoms which the patient may complain can be summarized as follows:

Early symptoms:

- Any white or red speckled patch.
- A non-healing ulcer or sore.
- Any lump or thickening.
- Persistent soreness or discomfort.

Later symptoms:

- Ulceration of the oral mucosa.
- Difficulty in the tongue or jaw movement.
- Difficulty in the chewing or swallowing.
- Numbness of the tongue or other parts of the mouth.
- A lump under the lower ridge or in the neck.

Clinical Staging of Cancer

The clinical characteristics of the tumor can be staged using TNM system (Tumor – Node –Metastasis), which serves as a therapeutic guide. It allows the definition of prognosis and comparison of results, given that they have a common language. The TNM system depended on three basic clinical features; where;

T= Size of primary tumor in centimeters.

N =Involvement of local lymph nodes.

M=the presence or absence of distant metastasis.

TNM system for Oral Cancer

Primary Tumor (T) size	
Tx	No available information on Primary tumor
T0	No evidence of primary tumor
Tis	Carcinoma in situ at primary site
T1	Tumor 2 cm or less in greatest diameter
T2	Tumor more than 2 cm but not more than 4cm in greatest diameter
T3	Tumor more than 4cm in greatest diameter
T4a	(Lip) Tumor invades through cortical bone, inferior alveolar nerve floor of mouth or skin of face (i.e. chin, nose). Tumor is respectable.
T4a	(Oral cavity) Tumor invades through cortical bone into deep extrinsic tongue muscles (genioglossus, hyoglossus, palatoglossus & styloglossus) ,maxillary sinus or skin of face.Tumor is resectable
T4b	Tumor involve masticator space, pteyrgoid plates or skull base and/or encases internal carotid artery. Tumor is unresectable.

Regional lymph nodes (N) involvement	
Nx	Regional lymph node can not be assessed
N0	No regional lymph node metastasis
N1	Metastasis in single ipsilateral lymph node, <3 cm
N2a	Metastasis in single ipsilateral lymph node, >3 cm but <6 cm
N2b	Metastasis in multiple ipsilateral lymph node, <6 cm
N2c	Metastasis in bilateral or contra-lateral lymph nodes, non >6 cm
N3	Metastasis in a lymph nodes >6 cm in greatest diameter.
Distant metastasis (M)	
Mx	Metastasis can not be assessed
M0	No distance metastasis
M1	Distance metastasis

TNM Clinical staging

Stage		**TNM classification**	**Oral cavity (5year survival rate)**	**Lip (5 year survival rate)**
Stage I		T1 N0 M0	68%	83%
Stage II		T2 N0 M0	53%	73%
Stage III		T3 N0 M0 or T1,T2 or T3 N1 M0	41%	62%
Stage IV	IVA	T4a N0 or N1 M0 or T1,T2,T3 or T4a N2 M0	27%	47%
	IVB	Any T N3 M0 or T4b any N M0		
	IVC	Any M1 lesion		

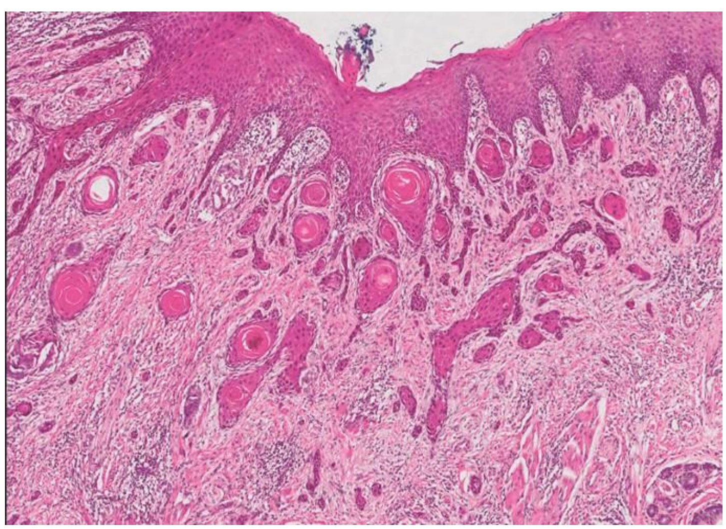
Histopathological grading

According to the method originally described and adopted by the WHO, 2003 which takes into account a subjective assessment of the degree of keratinization, cellular and nuclear pleomorphism, and mitotic activity, the histological variations showed in OSCC is related to the degree of differentiation (grade) exhibiting by the tumor cells and how closely the tissue architecture resembles normal stratified squamous epithelium.

The WHO, 2003 grading system recommends three categories:

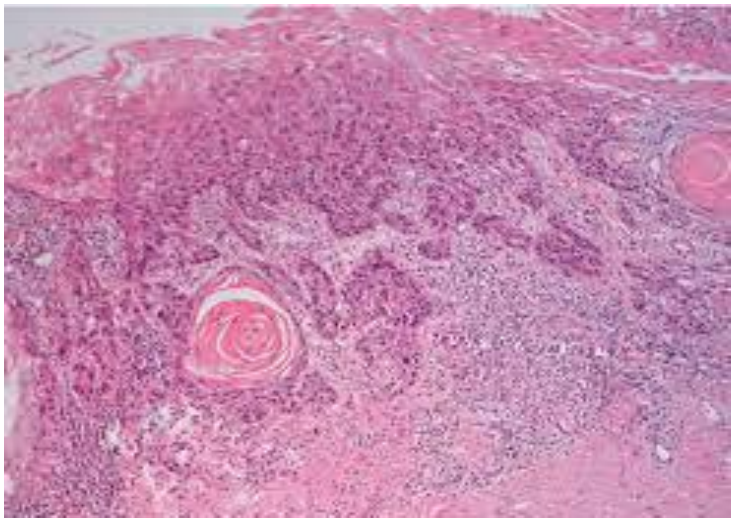
Grad 1: Well differentiated

These are tumors that produce significant amounts of keratin and exhibits some features of maturation from the basal cells to the keratinized surface layer and it seems to grow at a slightly slower pause and metastasis later in its course so called low-grade tumor.



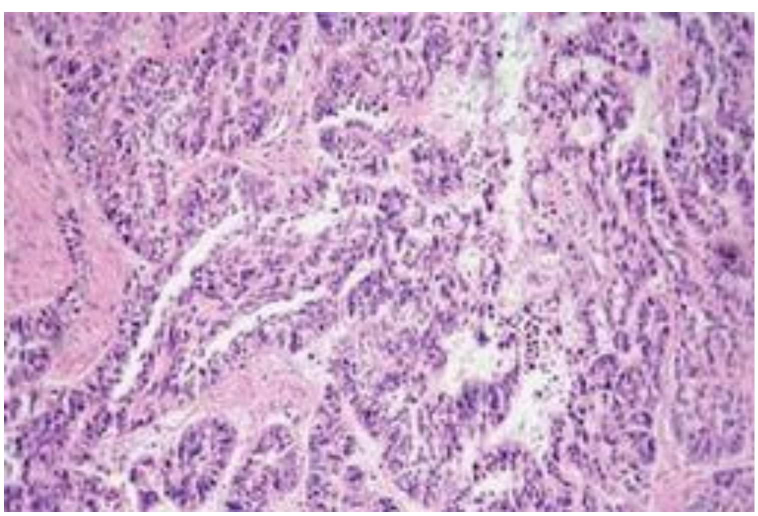
Grad 2: Moderately differentiated

The biological behavior of tumor cell somewhere between these two extremes. It produces no or little keratin but tumor cells are still recognizable as stratified squamous epithelium despite its significant deviation from normal.



Grad 3: Poorly differentiated

High –grade tumors or anaplastic carcinomas which have a biological behavior with extremely cellular and nuclear pleomorphism with little or no keratin production and rapidly metastasis in its course.



Biological Behavior, Oncogenes And Tumors-Suppressor Genes

Oral cancer has a multifactorial aetiology and is the result of genetic damage allowing uncontrolled proliferation of cells. It is a multistep process involving multiple sequential mutations which accumulate within the cell. Mutations in the genes which regulate cell growth and proliferation are particularly important. These genes are the growth-promoting proto-oncogenes found in normal cells, and the tumour-suppressor genes that encode for growth inhibitory proteins.Under normal circumstances cellular proliferation is controlled by the balance between these growth-promoting and growth-inhibiting genes. During carcinogenesis a proto-oncogene may undergo mutation and become an activated oncogene, resulting in enhanced activity, and/or tumour-suppressor genes may be mutated or their products inactivated.There sultan both cases leads to deregulation of cell proliferation and tumour formation. Oncogenes (for example, the c-myc and ras families) encode for a range of growth-promoting proteins such as growth factor receptors, signal-transmitting proteins, and stimulatory cell-cycle regulating proteins. In contrast, tumour-suppressor genes encode for growth-inhibitory proteins, such as p53 which plays a vital role in inhibiting the cell cycle and, if necessary, arresting the cycle and switching cells into apoptosis. The most important oncogenes and tumorsuppressor genes so far identified appear to influence pathways controlling the first stages of the cell cycle, i.e. the progression through the G1 phase (the phase before DNA synthesis) into S phase (the phase of DNA synthesis). Most oncogenic agents probably exert significant effects during the G1 phase of the cell cycle and the G1 to S transition is carefully regulated by inhibitory proteins, particulary p53. Thus, cells with damaged DNA are normally blocked at this G1 checkpoint. This allows time for repair of the damaged DNA, or, if that fails, to switch the cell into apoptosis, so preserving the integrity of the genome. Mutations of the p53 gene can therefore result in loss of regulation of the checkpoint, allowing cells with damaged DNA to undergo replication. Mutation of the p53 gene is a common and significant event in many cancers throughout the body.

The cervical lymph nodes are usually divided into five groups. Tumours tend to metastasize initially to the nodes in the superior drainage groups (levels 1 and II), with progressive involvement of the more inferior groups in the chain as metastatic disease spreads. As the metastatic carcinoma destroys and replaces the nodal lymphoid tissue it may also invade through the capsule of the node into the surrounding tissues, resulting in fixation of the node on clinical examination. Extracapsular spread is an important feature which has an adverse affect on prognosis. Blood-borne metastases occur later in the clinical course of the disease. Previously, many patients died before distant metastases became apparent, but their incidence is now increasing as a result of better local and regional control of the primary tumour. The risk of distant metastases increases with increasing involvement of nodal metastases in the neck.

Main lymph node groups in the neck

Level I: nodes of the submandibular and submental triangles.

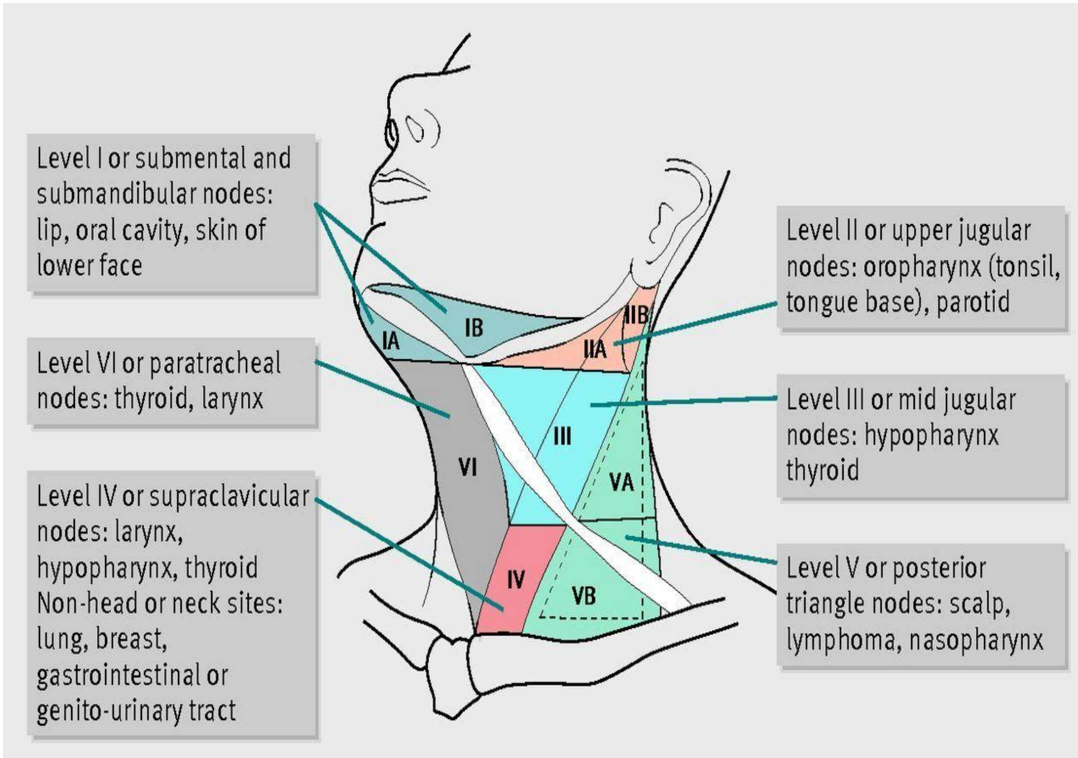
Level II: nodes of the upper cervical (jugular) chain.

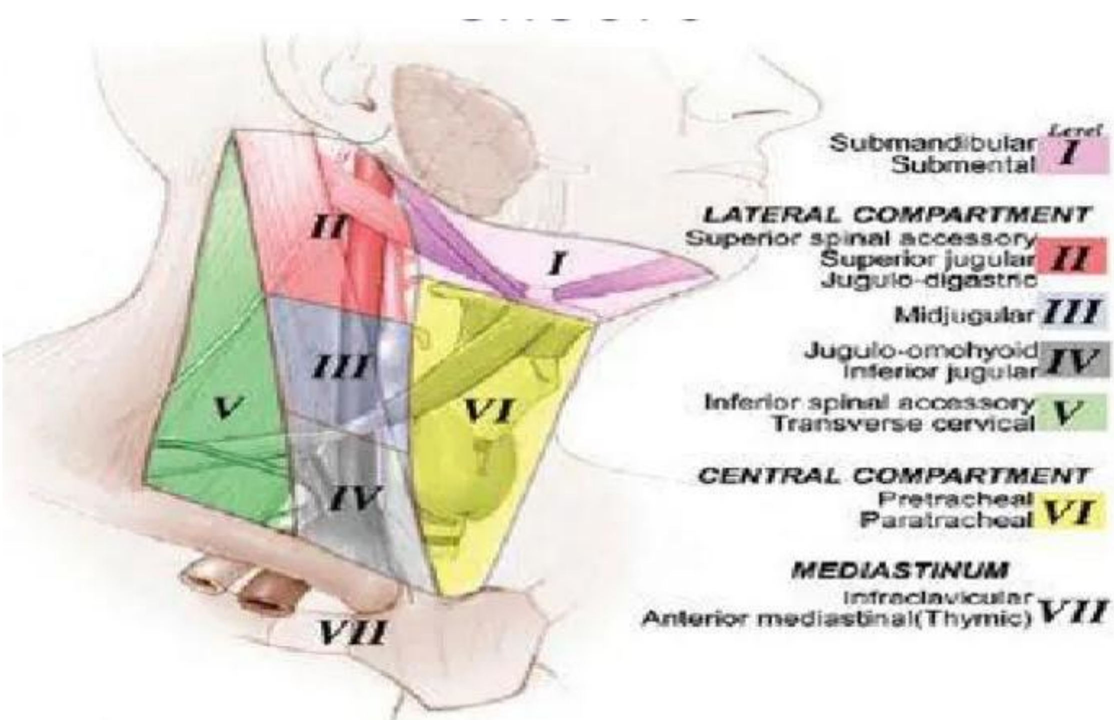
Level III: nodes of the mid-cervical (jugular) chain.

Level IV: nodes of the lower cervical (jugular) chain.

Level V: nodes of the posterior triangle of the neck.

Level I is bounded by the digastric muscle. Levels II, III, and IV nodes lie deep to the upper, mid, and lower thirds of the sternocleidomastoid muscle and are related to the internal jugular vein. The omohyoid muscle separates levels III and IV.


Level I or submental and submandibular nodes: lip, oral cavity, skin of lower face
Level VI or paratracheal nodes: thyroid, larynx
Level IV or supraclavicular nodes: larynx, hypopharynx, thyroid
Non-head or neck sites: lung, breast, gastrointestinal or genito-urinary tract
Level II or upper jugular nodes: oropharynx (tonsil, tongue base), parotid
Level III or mid jugular nodes: hypopharynx thyroid
Level V or posterior triangle nodes: scalp, lymphoma, nasopharynx
IA
IB
IIA
IIB
III
VI
VA
VB
IV


Submandibular
Submental
I
LATERAL COMPARTMENT
Superior spinal accessory
Superior jugular
Jugulo-digastric
II
Midjugular
III
Jugulo-omohyoid
Inferior jugular
IV
Inferior spinal accessory
Transverse cervical
V
CENTRAL COMPARTMENT
Pretracheal
Paratracheal
VI
MEDIASTINUM
Infraclavicular
Anterior mediastinal(Thymic)
VII

Diagnostic Aids

- Lab. Investigations (Hb., ESR….etc)
- Biopsy (incisional, excisional, FNAC, SLN, Drill Biopsy…..etc)
- Conventional radiograph (PA, occipitomental, true & oblique lateral, OPG)
- UlS examination
- CT and MRI
- Immunohistochemistry
- In situ hybridizations

Treatments

- **Surgery:** complete excisions of the tumour with safe margin, guided by frozen sections(surgical pathologist)

- **Chemotherapy:** cytotoxic drugs in general interfere with division and proliferation of cells, the ultimate target is the DNA of the cell nuclei. Chemotherapy (chemo) is the use of anti-cancer drugs that are given into a vein or taken by mouth. These drugs enter the bloodstream and can reach cancer that has spread to organs beyond the head and neck. It may be used in several different situations: Chemotherapy combined with radiation therapy may be used instead of surgery to control larger cancers that are confined to the head and neck region. Chemotherapy (sometimes given with radiation) is sometimes given to shrink the cancer before surgery. This is called neoadjuvantorinduction chemotherapy. Chemotherapy (often together with radiation) has also been used to reduce the severity of symptoms of cancers of the head and neck that are too large to be completely removed and which radiation treatment alone has not been able to control

The uses of chemotherapy in head and neck cancer as follows

1. as adjuvant to other modalities in three patterns

i. Before surgery or radiotherapy to reduce bulk of tumor and control micrometastesis.

ii. During(concurrent)with radiotherapy (act as radiosensitizing agents)

iii. Following surgery or radiotherapy, to eradicate micrometastesis.

2. Palliative: patients with significant symptoms caused by advanced or recurrent tumor stage.

3. Alone as radical (therapeutic) chemotherapy, it is unreliable agent, some patient may respond dramatically but for short period of live, recurrence is high after 3-6 months.

4. combination chemotherapy allow a high antitumor response rate but it is more toxic

Types of chemotherapy

- *alkylating agents e.g cyclophosphmide, chlorambucil, nitrosurea.*
- *antimetabolite e.g methotrexate, 5-fluorouracil.*
- *plant derivative e.g vincrestine.*
- *antitumors antibiotics e.g Bleomycin, doxorubicin.*
- *miscellaneous e.g cis-platinum*

- **Radiotherapy**: it is the use of ionization radiation to treat disease.

1. radical radiotherapy which aims to cure the patient.

2. palliative radiotherapy which aims to relief symptoms of diseas with out attempting to cure the patient.

3. adjuvant radiotherapy

Types of radiotherapy

1. Teletherapy (external beam radiation) which use a machione to deliver a beams of radiation directed to the tumor from out side of patient.
2. Plesiotherapy(Brachytherapy, interstitial radiotherapy), the source of radiation is placed within or in close proximity to the tumour.

So that tissues either radio sensitive or radio resistant depending on type of tissues, size of tissues, oxygenation of tumour cells.

- **Immunotherapy**: method of therapy directed to augmenting the immune response against cancer, it is divided into

1. passive immunotherapy which is administration of externally stimulated immunological component that are initially obtained from patients being treated. E.g. thymic factors such as thymosin
2. active immunotherapy which is administration of agents to tumor – bearing host that are able to elicit an immune reaction designed to control or eradicate malignant diease. E.g. BCG, cytokines (IL1,IL2, interferon…etc)

- **Thermal Applications**

1. cryosurgery and Cryotherapy (liquid nitrogen and liquid nitrouoxide)
2. heat application. E.g cautry

- **Laser Application**
- **Gene Therapy**
- **Chromosomal Therapy**
- **Monoclonal Therapy**
- **Gamma Knife**
- **Apoptosis**

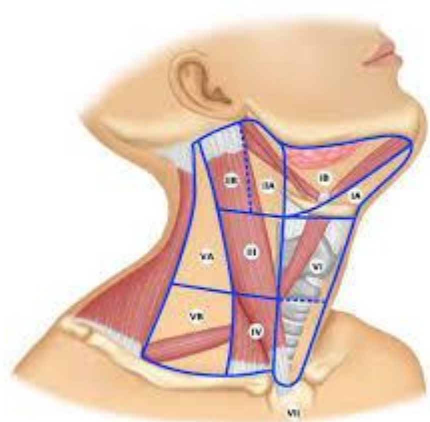
Prognosis

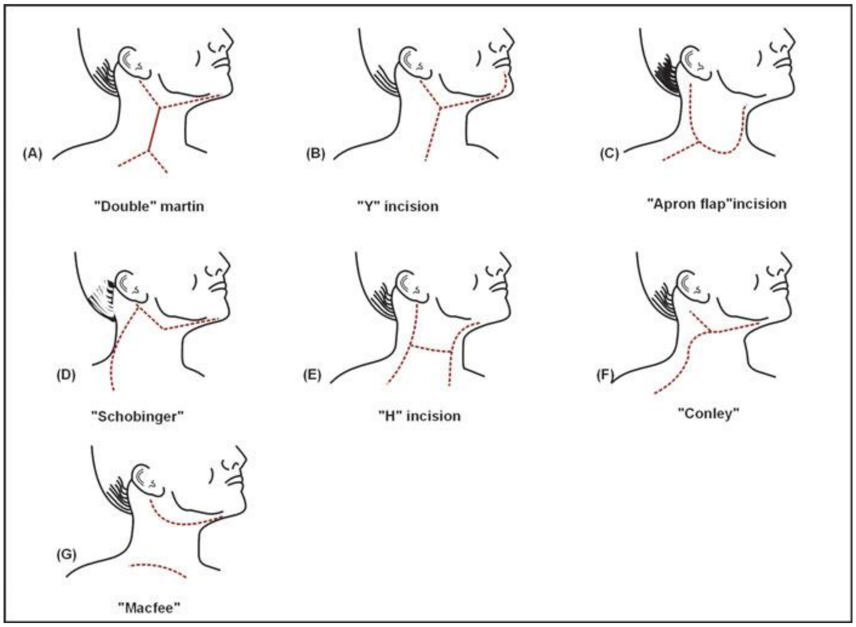
The survival rate of patients with oral carcinoma depends on a number of factors, but early diagnosis is by far the most important. It is influenced by the site of the lesion, and generally the further back in the mouth the tumour, then the worse the prognosis. This is probably because tumours at the back of the mouth tend not to be diagnosed at an early stage, but the rich lymphatic drainage around the base of the tongue may also favour early metastatic spread. Carcinomas in females have a better prognosis than carcinomas in males, possibly because they tend to be diagnosed and treated at an earlier stage. This probably reflects the fact that more females are regular dental attenders than males. Age affects prognosis, partly because with increasing age the patient becomes less well able to withstand extensive surgery or radiotherapy. Reduction in the effectiveness of cell-mediated immune responses may also be involved. Although the past few decades have seen major advances in the methods used to treat oral cancer, the overall 5-year mortality rates have not changed significantly. Local recurrence at the primary site, or within the neck in patients with metastatic disease, is the major cause of death. A few patients also develop new primary tumours. The major factors thought to influence prognosis have been incorporated into clinical staging systems which assess the extent of disease in the patient. The reduction in survival rates related to metastatic spread is well established. Several studies have shown 5-year survival rates of about 80 per cent for patients without lymph node metastases compared to between 45 per cent and 65 per cent for those with metastases, depending on their extent. In particular, the presence of extracapsular spread is an important indicator of poor prognosis.

Carcinoma in situ

This term is used to describe severe epithelial dysplasia in which the whole, or almost the whole, thickness of the epithelium is involved but the basement membrane is intact and there is no invasion of the lamina propria. Oral carcinoma in situ usually presents clinically as leukoplakia or erythroplakia. It is a precancerous (premalignant) lesion (see below) but its natural history is not well understood. In some patients the lesion may progress to invasive carcinoma but in others it remains static for long periods and, in some, the degree of dysplasia may regress or fluctuate with time. It is common to find histological changes of dysplasia, including carcinoma in situ, in the epithelium surrounding an invasive carcinoma, even though this may appear clinically healthy. This suggests that in some patients there may be a field of potentially precancerous change involving a wide area of mucosa. It is probable that some carcinomas thought to be recurrent tumours represent new primary lesions arising in such a field change.

Neck dissection





Radical (classical) neck dissection (RND): means removing all lymph nodes containing levels I-V with all three non-lymphatic structures (IJV, SCCM & AN)

Indications

1. significant operable palpable LN with primary (in continuity resection)
2. significant operable palpable LN with occult primary
3. significant operable palpable LN with primary well control

Contraindications

1. Distant metastesis
2. unfit for surgery
3. inoperable primary
4. inoperable neck
5. significant bilateral neck LN enlargement

Modified neck dissection (MND): preserving one or more of non lymphatic structures.

- Type I (preserve accessory nerve)
- Type II (preserve accessory nerve + IJV)
- Type III (preserve three non lymphatic structures)

Selective neck dissection (SND): preservation of one or more lymph node group + all three non lymphatic structures.

- Supra-omohyoid SND: remove I, II, III
- Extended (Anteriolateral) SND: remove (I, II, III, IV)
- Lateral SND: remove (II, III, IV)
- Posteriolateral SND: remove (II, III, IV, V)

Management of Neck

1. **N_0** : manage by

- Surgery by performing selective neck dissection (SND)
- Radiotherapy (DXT=deep x-ray therapy)

2. **N_1**: Modified neck dissection (MND).

Note: some use DXT only when primary in nasopharynx.

3. **N_2** : manage as follow

- N_{2a} : Modified or Radical neck dissection.
- N_{2b}: Modified or Radical neck dissection.
- N_{2c}: Radical neck dissection.

4. **N_3** : often they are incurable, mostly treated by DXT and / or Chemotherapy (palliative therapy)

Suggested Reading

- Peter Ward Booth, Maxillofacial Surgery: Churchill Livingstone, 2006