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Reconstructive Surgery of oral and maxillofacial region

A project Submitted to the Council of the Collage of Dentistry at the University of Misan, Department of Oral and maxillofacial surgery in Partial Fulfillment of the Requirement for B.D.S degree

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Dedication:

This research is dedicated to the countless individuals who have contributed to the field, from the pioneers who laid its foundation to the scholars who continue to push its boundaries. It is also dedicated to the participants who generously shared their time, experiences, and insights, without whom this study would not have been possible.

Lastly, We would like to dedicate this research to our families, friends, and loved ones who have supported us throughout this journey. Their encouragement, patience, and unwavering belief in us have been our pillars of strength.

ABSTRACT

Prosthetic replacements in the 19th and early 20th century were superseded by pedicled flaps and obturators. These have subsequently been superseded by free tissue transfer which currently is the mainstay of reconstructive jaw surgery. Although malignant and benign processes of the jaws are the predominant cause of segmental defects, a significant proportion still occurs due to trauma, or even iatrogenic causes such as radiotherapy. The varied aetiologies demand a nuanced approach to reconstruction and although the techniques remain similar the timing can be quite different. The maxilla and the mandible are both amenable to composite reconstruction with bone. The fibula, iliac crest, scapula, distal radius and medial femoral condyle are the most commonly utilised donor sites for vascularised reconstruction. Each has strengths and weaknesses and the requirements of the defect, and patient preference should outweigh surgeon preference. Osseointegrated implants allow reliable rehabilitation of the dentition by anchoring facial prostheses. Their integration into composite flaps is highly reliable although soft tissue management can be challenging. Virtual surgical planning and 3D printing have already impacted on the surgical workflow and improved the reliability and accuracy of results

INTRODUCTION

The human face is unique in its ability to express emotions, temper, and personality. The face is the most important means of communication-and not only in terms of verbal communication. For this reason, reconstructive measures in the oral and maxillofacial area are a uniquely difficult task in their attempt to restore the individual facial expression. Although this may not be feasible in every case, the principal aim of maxillofacial reconstruction still remains to avoid or to repair gross aesthetic disfigurement in cases of congenital malformations, tumor resections, and post traumatic deformities. In addition to restoration of facial aesthetics, maxillofacial reconstruction also has an important functional aspect in that reconstructive measures strive for the reinstitution of the complex functions of the upper aero digestive tract. Most reconstructions are performed primarily following tumor extirpation, but secondary reconstructions are also undertaken to treat problems such as fistulae or osteoradionecrosis. Modern techniques aim for one stage reconstruction utilizing vascularised tissues with a high success rate and good overall results.

Oral and maxillofacial functions such as facial expression, articulation of speech, chewing, and deglutition are based on a complex anatomy of soft tissues of the region and the underlying facial skeleton. Reconstruction in the maxillofacial area thus often has to deal with combined defects of hard and soft tissues. The different tissues involved in a defect have specific functions, and their replacement is often difficult because the repair or closure of a defect commonly is associated with the transfer of a tissue that may not fully restore the unique function of the lost part. The selection of the type of tissue to be transferred for replacement is subject to different criteria, which depend on the location of tissue loss and its previous function. If facial skin has to be replaced, aesthetic aspects such as the match of color, texture, and thick ness of the transferred skin are most important for the selection of the donor site, whereas the selection of donor areas for mucosal reconstructions is focused merely on mechanical aspects of graft performance such as ductility and pliability. If the reconstruction of facial bones is planned, the thickness, contour, and mechanical properties of the lost jaw segment deter mine the choice of the graft. Finally, the restoration of facial contour after extensive tumor resections may require the simultaneous transfer of more than one principal tissue in a composite flap, which contains skin, muscle, and bone[1,2].

Goals of Reconstruction

- ❖ Restoration of function
- ❖ Restoration of cervicofacial symmetry and form
- ❖ Facial reanimation
- ❖ Dental rehabilitation
- ❖ 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
- ❖ 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

When an osseous structure is defective in size, shape, position, or amount, reconstructive surgery can replace the defective structure. The tissue most commonly used to replace lost osseous tissue is bone.

BASIC ASPECTS OF TISSUE REPAIR

Although oral and maxillofacial reconstruction has to deal with the repair of any type of tissue in this area, management of surgical or traumatic soft tissue wounds is an important precondition for successful plastic reconstruction because adequate skin coverage of the reconstructed part is mandatory and access to deeply situated structures has to pass through the skin surface. Closure of a skin wound generally should be accomplished without tension. On the one hand, the texture and the tension of the skin changes with age and differs with gender, which may affect wound closure because of the variable composition of subcutaneous tissue. On the other hand, there are lines of minimal skin tension running across the face in a well-known pattern, which represent adaptation to two different types of functional mechanisms. The first type is represented by the lines of habitual expression in the face, such as the lines in the forehead, eyelids, and nasolabial folds, and other lines of expression around the mouth.

The second type، the lines of skin relaxation (such as the horizontal circular lines in the neck), result from movements of flexion and extension.

This pattern of lines has to be identified and obeyed during the skin incision by placing the incision line parallel to the lines of skin relaxation. A scar within or parallel to the lines of minimal tension is not subject to the intermittent pull of sub adjacent muscles and sub sequent widening of the scar from tension. This also holds true for lines of expression, which are produced by repeated and habitual contraction of the underlying muscles of facial expression and mostly coincide with the lines of minimal tension [3].

WOUND CLOSURE

Closure of the skin can be accomplished in various ways depending on the condition of the wound edges and the underlying tissue. Precise approximation of skin edges ensures primary healing with minimal scar ring. The interrupted suture is one of the most frequently used techniques of wound closure, with an inverting and everting modification by producing a wider loop either superficially or deep in the tissues. Mattress sutures may be used as horizontal and as vertical mattresses, both of which are used to adapt tissue edges in a broader and safer way than the single interrupted sutures in cases of increased wound tension or underlying void space. In the facial skin, however. these types of sutures are rarely necessary. Continuous running sutures may be quicker and provide as satisfactory wound closure if executed carefully. Each suture should be performed as a slightly everting suture to obtain satisfactory closure. Subcutaneous continuous sutures may be of particular value in children, whose skin is normally under greater tension than that of the adult. Tension during wound closure can be avoided by thorough undermining of the wound edges. Experimental assessment of forces required to advance wound edges have shown that this is the most effective way of gaining additional skin coverage [4].

BASIC ASPECTS OF TISSUE TRANSFER

With large tissue deficits resulting from trauma, resection of malignancies, or congenital malformations, transplantation of tissue may be become necessary to accomplish complete and satisfactory tissue repair. The term transplantation designates the removal of a colony of living cells from a donor area and its transfer to a recipient site, where it is capable of propagating a lineage of living cells.

The transferred tissue is categorized according to the relationship between donor and the recipient organism: Autogenous grafts are transferred within one individual, whereas allogenous grafts are transplanted from one individual to another of the same species. Xenogenous grafts indicate the transplantation of tissue between two individuals of different species. Finally, the term isograft designates allografts between genetically, highly identical individuals. The successful transfer of tissue for the closure of a defect or repair of a defect depends on the survival of the graft, which in turn, is based on an adequate vascular supply. The tissues of which the graft or flap is composed have different degrees of vascularity, varying patterns of vascular architecture, and a tissue-specific demand for oxygen. They react differently to the harvesting and transposition procedure and the systemic and local physiological response of the donor site and recipient site. The graft ultimately determines whether the transferred tissue will survive .Regarding vascular supply, the transfer procedures of tissues may be divided into non vascularized, pedicled , and vascularized flaps or grafts. At the same time, this classification describes the development taken by plastic and reconstructive surgery of the head and neck area until now [3].

Biologic Basis of Bone Reconstruction

A tissue that is transplanted and expected to become a part of the host to which it is transplanted is known as a graft. Several types of grafts are available to the surgeon. A basic understanding of how a bone heals when grafted from one place to another in the same individual (i.e., auto transplantation) is necessary to understand the benefits of the various types of bone grafts available. The healing of bone and bone grafts is unique among connective tissues because new bone formation arises from tissue regeneration rather than from simple tissue repair with scar formation.

This healing therefore requires the element of cellular proliferation (i.e., osteoblasts) and the element of collagen synthesis. When bone is transplanted from one area of the body to another, several processes become active during the incorporation of the graft[6].

Two-Phase Theory of Osteogenesis

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

The first process that leads to bone regeneration arises initially from transplanted cells in the graft that proliferate and form new osteoid. The amount of bone regeneration during this phase depends on the number of transplanted bone cells that survive during the grafting procedure. Obviously, when the graft is first removed from the body, the blood supply has been severed. Thus the cells in the bone graft depend on diffusion of nutrients from the surrounding graft bed (i.e., the area where the graft is placed) for survival. A considerable amount of cell death occurs during the grafting procedure, and this first phase of bone regeneration may not lead to an impressive amount of bone regeneration when considered alone. Still, this phase is responsible for the formation of most of the new bone. The more viable cells that can be successfully transplanted with the graft, the more bone that will form. The graft bed also undergoes changes that lead to a second phase of bone regeneration beginning in the second week. Intense angiogenesis and fibroblastic proliferation from the graft bed begin after grafting, and osteogenesis from host connective tissues soon begins. Fibroblasts and other mesenchymal cells differentiate into osteoblasts and begin to lay down new bone. Evidence shows that a protein (or proteins) found in the bone induce these reactions in the surrounding soft tissues of the graft bed. This second phase is also responsible for the orderly incorporation of the graft into the host bed with continued resorption, replacement, and remodeling [7].

Immune Response

When a tissue is transplanted from one site to another in the same individual, immunologic complications usually do not occur. The immune system is not triggered because the tissue is recognized as "self." However, when a tissue is transplanted from one individual to another or from one species to another, the immune system may present a formidable obstacle to the success of the grafting procedure. If the graft is recognized as a foreign substance by the host, it will mount an intense response in an attempt to destroy the graft. The type of response the immune system mounts against "foreign" grafts is primarily a cell-mediated response by T lymphocytes. The response may not occur immediately, however, and in the early period the incorporation of a bone graft into the host may appear to be progressing normally. The length of this latent period depends on the similarity between the host and the recipient. The more similar they are (antigenically), the longer an immunologic reaction may take to appear. This type of immunologic reaction is the most common reason for rejection of hearts, kidneys, and other organs transplanted to another individual. Tissue typing procedures, in which a donor and recipient are genetically compared for similarities before transplantation, are currently common place for organ transplantation but never for bone grafts.

Because of the immunologic rejection of transplants between individuals or between species, methods have been devised to improve the success of grafting procedures in these instances.

Two basic approaches are used clinically: The first is the suppression of the host individual's immune response. Immunosuppression with various medications is most commonly used in organ transplant patients. This approach is not used routinely in oral and maxillofacial surgical bone grafting procedures because of the potential complications from immunosuppression.

Another approach that has been used extensively in oral and maxillofacial surgical procedures is the alteration of the antigenicity of the graft so that the host's immune response will not be stimulated [8].

Donor sites

Bony reconstruction of the jaws with vascularized free flaps requires a donor site with acceptable morbidity and the absence of site specific contraindications (e.g peripheral vascular disease for the fibula free flap.(Patients and families frequently ask if they can donate the tissue required for the procedure however unless the donor is an exact genetic match (such as an identical twin) lifelong immunosuppression would be

required which is not appropriate, particularly in the cancer patient. All potential donor sites have some morbidity associated with them and these should be discussed with the patient considering their preferences, interests and occupation. Each of the potential donor sites has relative strengths and weaknesses and an ideal reconstructive team should be able to provide any one of many options. The fibula free flap provides a long straight segment of bone with associated skin if required with a pedicle length that is variable depending on how much bone is required. The scapula free flap (lateral border and tip) has the most versatile soft tissue components‹ however may have a short pedicle and the bone length is not as great as the fibula. It also requires alterations in patient positioning for harvest.

The iliac crest free flap has the greatest depth of bone and versatility from an osseous perspective although the length is not as long as the fibula. It is ideally suited to the benign jaw tumor which prioritises dental replacement. The composite radial free flap has a long pedicle and useful skin paddle though the bone is of poor volume and length. It is frequently used in compromised situations or to promote early patient mobility postoperatively. other donor sites have been proposed such as medial femoral condyle, the second metatarsal and rib. However, these sites tend to play a niche role in head and neck reconstruction. Some units have focused on one donor site over another although there is no evidence that one flap is more reliable than another and ideally, patient preferences can be matched with the defect requirements by a surgeon who has a diverse range of reconstructive options at their disposal[9-10].

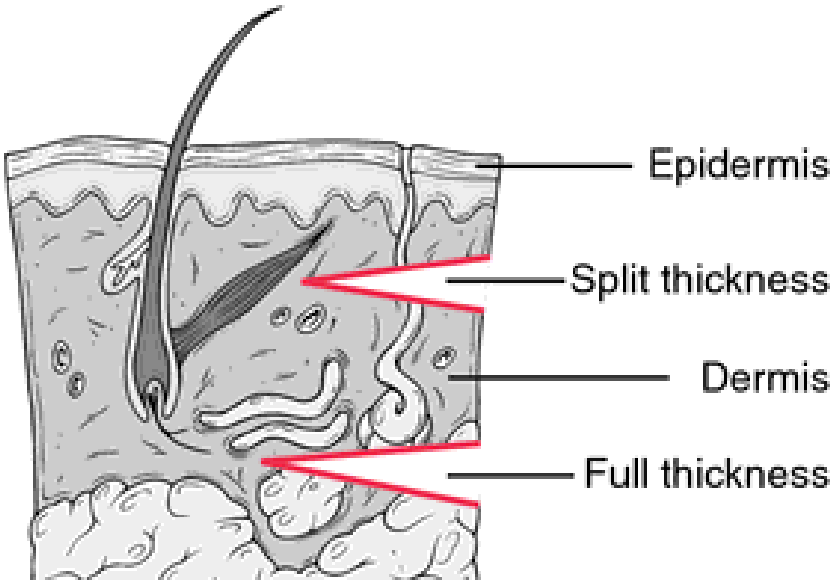
Flap

PRINCIPLES Over the past 50 years, the development and application of several different flaps has led to reliable reconstruction of facial defects. Most defects can be reconstructed immediately, leading to better restoration of form and function with early rehabilitation.

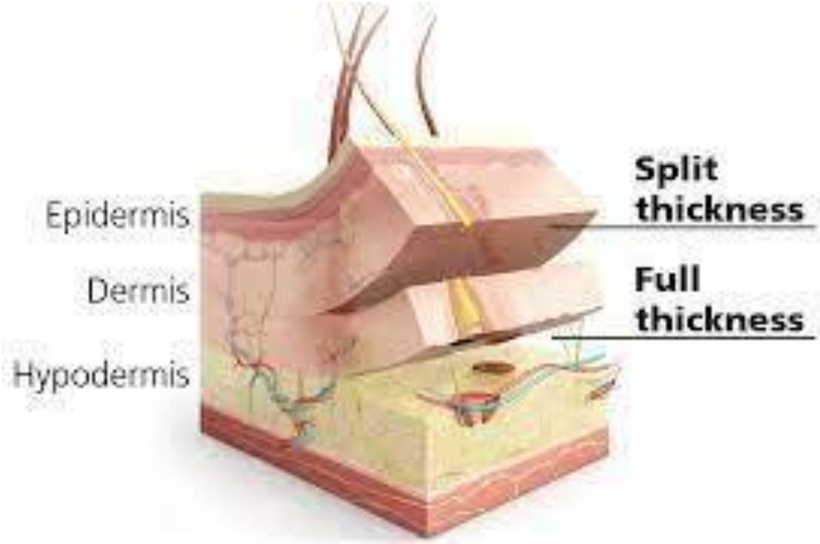
Flap surgery is a technique in plastic and reconstructive surgery where any type of tissue is lifted from a donor site and moved to a recipient site with an intact blood supply. This is similar to but different from a graft, which does not have an intact blood supply and therefore relies on growth of 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[11].

Choice for soft tissue reconstruction include

A-Full thickness skin 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.

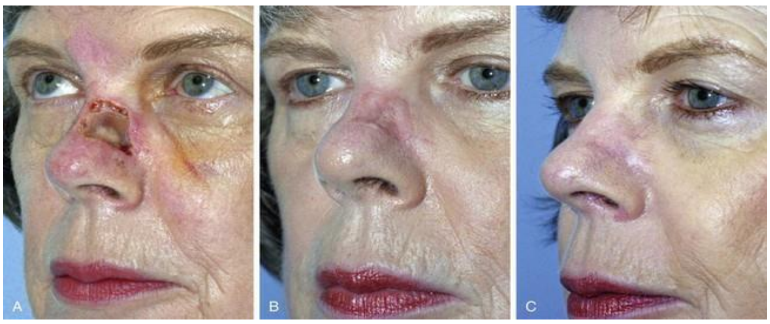


B-Split skin grafts: Contain all of epidermis and only part of dermis. Further subdivided in to thin , medium or thick according to amount of dermis contain . The graft is taken by either dermatome or a humby knife. It is most commonly used graft in head and neck cancer surgery. Resurfacing occur due to the remnant tissue in the donor area, so little care needed for donor area. It may be used to cover donor 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.

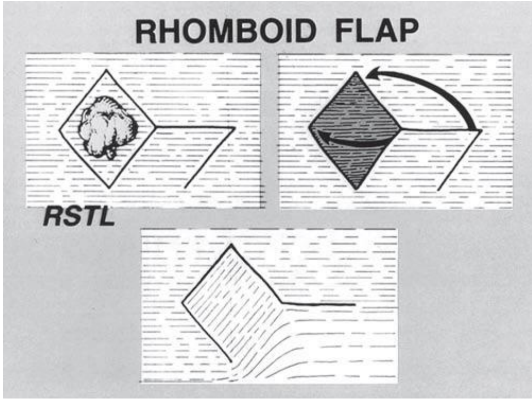
D-Full thickness skin and cartilage (composite) graft: consist of a full thickness skin graft with underlying cartilage may be taken from the auricular region used in reconstruction of small and moderate defects where tissue loss indicates that skin and underlying cartilage are required.

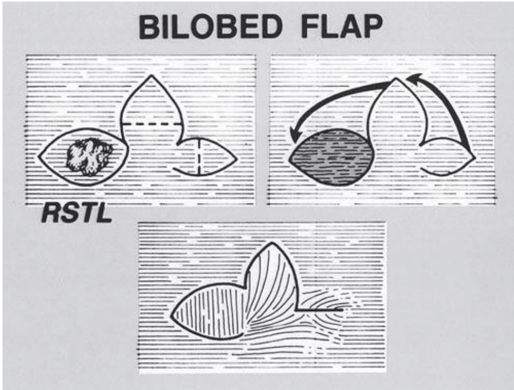


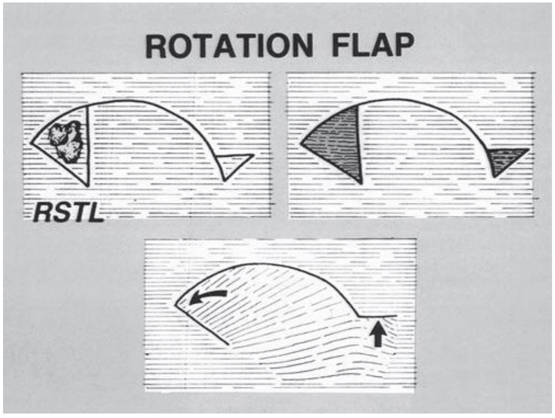
Classification of flaps

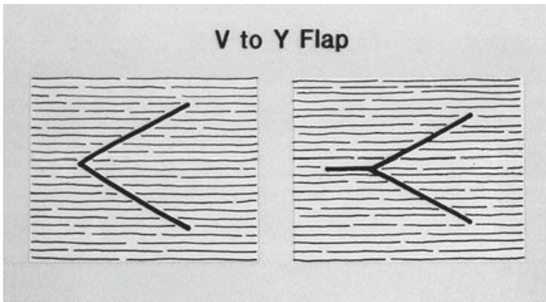
Flaps can also be classified according to tissue configuration

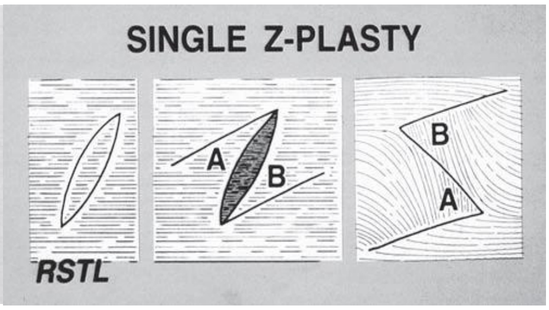
This describes the geometric shape of the flap. These flaps include rhomboid, bilobed, z-plasty, v-y, rotation, and others.





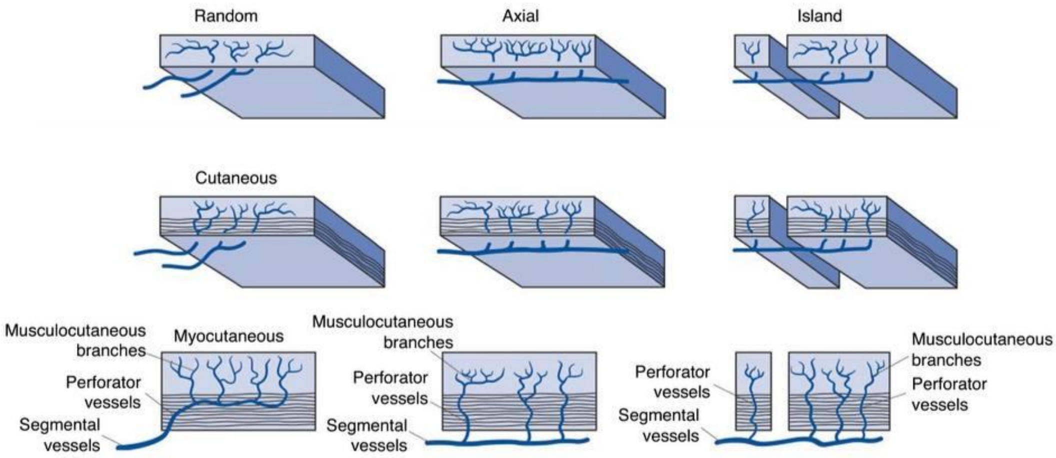






Flaps can also be classified by their tissue content.

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).

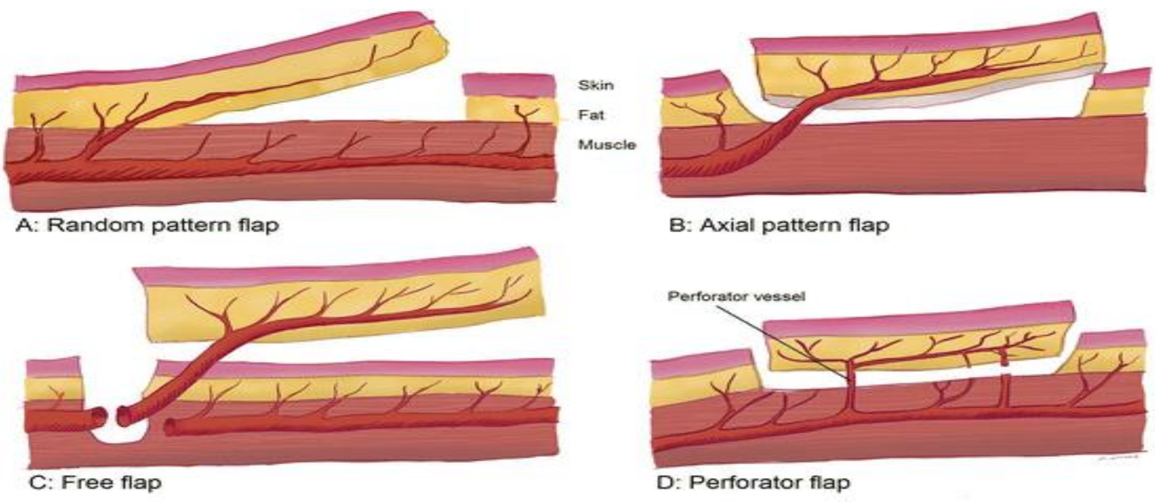


Flaps can also be classified according to arterial supply.

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.

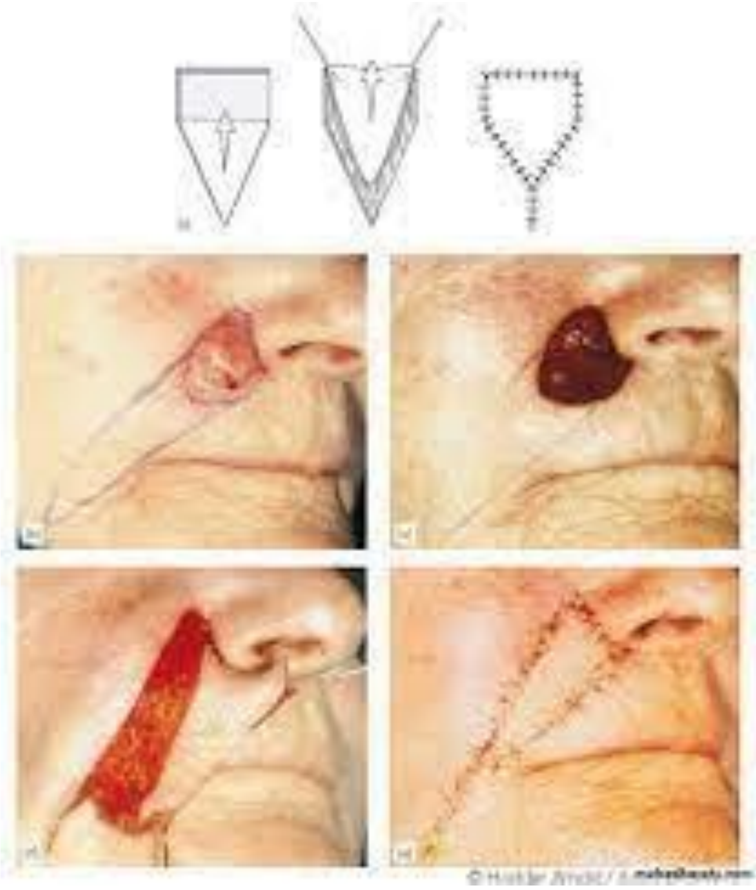
Pedicled flaps- remain attached to the donor site via a pedicle that contains the blood supply (in contrast to a free flap).

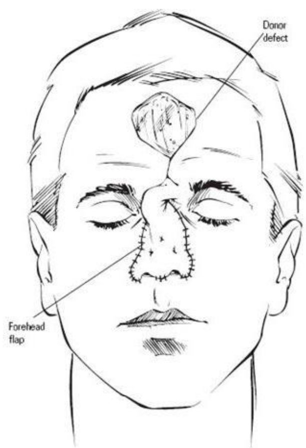


Classification can also be based on the relative location of the donor site.

Local flaps are considered adjacent to the primary defect.

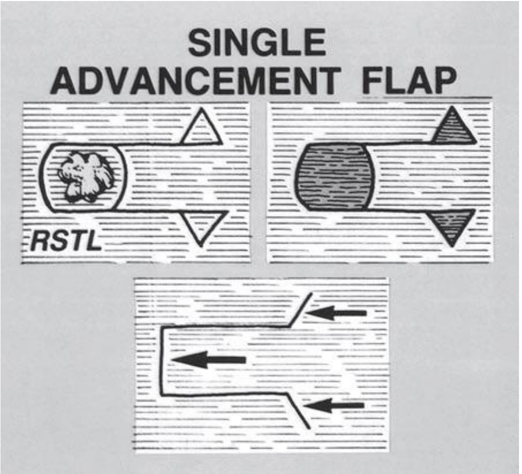
Regional flap donor sites are located on different areas of the same body part If different body parts are used as the donor site, the flap is termed a Distant flap.

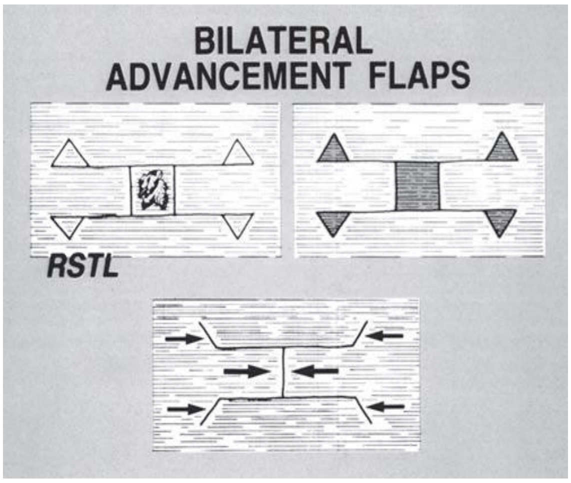




Classification can also be based on the flap movement.

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[12].

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- 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

1. Appearance and amount
2. The anatomy and physiology of the skin including colour , texture ‘
3. -Local muscle anatomy, vascular supply, nerve supply and lymphatic drain
4. -The esthetic of the area
5. Possible sites for incision placement.

6. -Area of local tissue available in relation to the area to be reconstructed.

Any one flap has advantages and disadvantages, Indications and contraindications

DESIGNING THE FLAP

Many options are available for reconstructing facial defects. Often, the optimal method is not readily apparent. A stepwise approach can be helpful in selecting and designing a flap. The characteristics of the defect and adjacent tissue must be analyzed. These include color, elasticity, and texture of the missing tissue. The defect size, depth, and location are evaluated as well as the availability and characteristics of adjacent or regional tissue. It is important to determine the mobility of adjacent structures and to identify those anatomic landmarks that must not be distorted. The orientation of the RSTLs and aesthetic units should by analyzed closely. Potential flap designs should be drawn on the skin surface, being careful to avoid those designs that obliterate or distort anatomic landmarks. The final location of the resultant scar should be anticipated by previsualizing suture lines and choosing flaps that place the lines in normal creases. The secondary defect created as the tissue is transferred into the primary defect must be able to be closed easily. When designing a flap, it is important to avoid secondary deformities that distort important facial landmarks or affect function. Avoid obliterating critical anatomic lines that are essential for normal function and appearance. Proper surgical technique involves gentle handling of the tissue by grasping the skin margins with skin hooks or

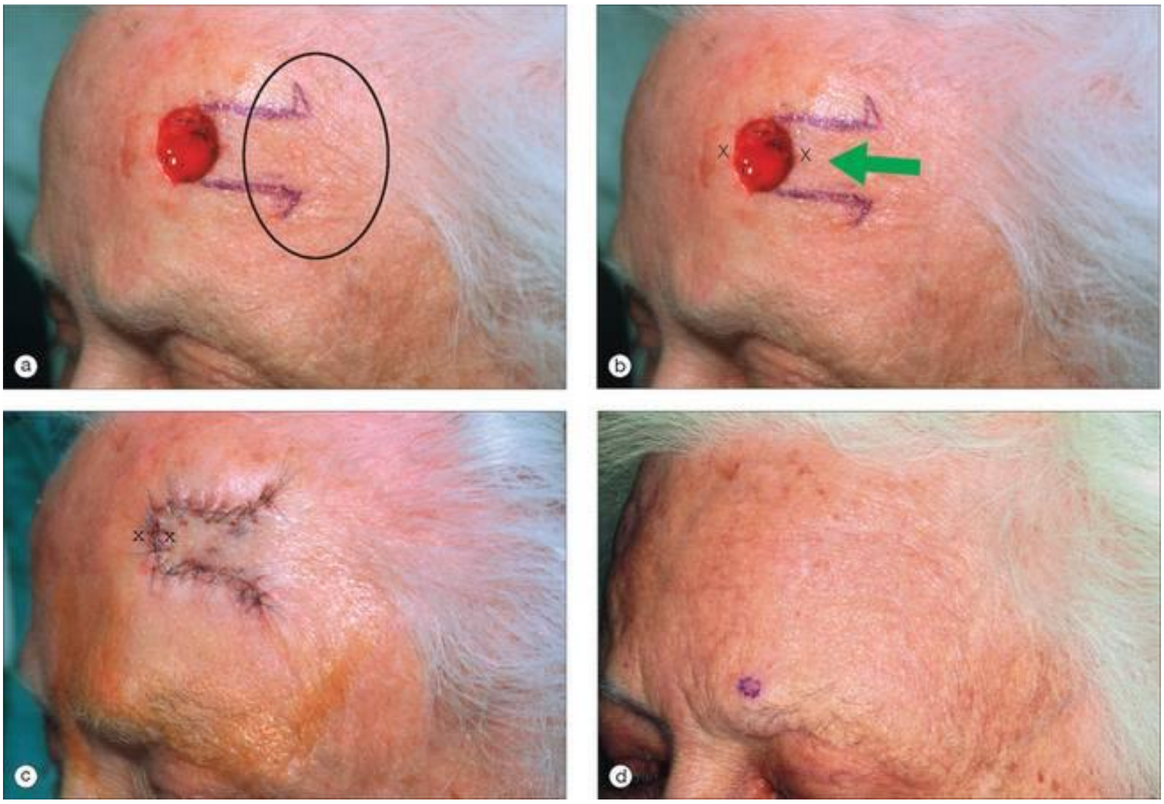
fine-toothed tissue forceps. Avoid traumatizing the vascular supply by twisting or kinking the base of the flap. Deep pexing sutures minimize tension on the flap and eliminate dead space. Excessive tension on the flap may decrease blood flow and cause flap necrosis. Meticulous hemostasis should be achieved before final suturing so that a hematoma does not develop beneath the flap. It is important to adequately mobilize and extend the flap, which should be of adequate size to remain in place without tension to minimize the chance of dehiscence, scarring, or ectropion[12].

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 donor 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[13].

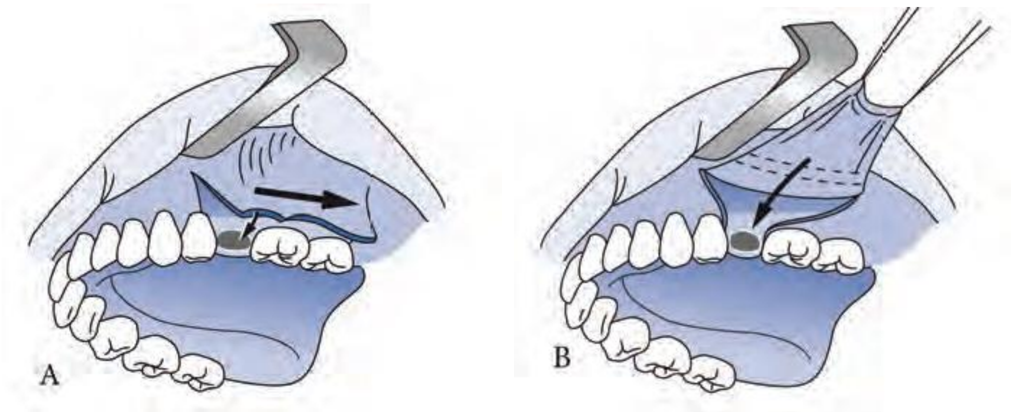
1-Advancement Flaps

Advancement flaps have a linear configuration and are advanced into the defect along a single vector. These flaps can be single or double. Advancement flaps are often chosen when the surrounding skin exhibits good tissue laxity and the resulting incision lines can be hidden in natural creases. Advancement flaps limit wound tension to a single vector with minimal perpendicular tension. They are often helpful in reconstructing defects involving the forehead, helical rim, lips, and cheek. In these areas, advancement flaps capitalize on the natural forehead furrows without causing vertical distortion of the hairline superiorly or the eyebrow inferiorly . Advancement flaps are created by parallel incisions approximately the width of the defect. Standing cutaneous deformities (“dog-ears”) are usually created and are managed with excision. A Z-plasty incision or Burow’s triangle may be performed at the base of the flap, reducing the standing cutaneous deformities.



V-Y flap A variation of the advancement flap. A triangular island of tissue adjacent to the defect is isolated and attached only to the subcutaneous tissue. It relies on a subcutaneous pedicle for blood supply. As it is advanced into the defect, the secondary defect is closed primarily in a simple V-Y manner. These flaps are especially amenable for cheek defects along the alar facial groove and are generally avoided where there are superficial nerves because of the depth of the incisions.

Intraoral uses of advancement flaps include covering oroantral fistulae and alveolar clefts. A disadvantage of buccal advancement flaps is the decrease in vestibular sulcus depth.



2-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 oroantral fistula (palatal flap).

3-Tranposition flap: These flaps are rotated and advanced over adjacent skin to close a defect. Examples of transposition flaps include rhombic flaps and bilobed flaps. These flaps are advantageous in areas where it is desired to transfer the tension away from closure of the primary defect and into the repair of the secondary defect. Transposition flaps have a straight linear axis and are usually designed so that one border of the flap is also a border of the defect. An advantage of this type of flap is that it can be developed at variable distances. Areas where these flaps are often used include the nasal tip and ala, the inferior eyelid, and the lips.

1-The rhombic flap is a precise geometric flap that is useful for many defects of the face. The traditional rhombic (Limberg) flap is designed with 60- and 120-degree angles and equal-length sides. The angle of the leading edge of the rhombic flap is approximately 120 degrees but may vary. The flap is begun by extending an incision along the short axis of the defect that is equal to the length of one side of the rhombic defect. Another incision is then made at 60 degrees to the first and of equal length . Disadvantages of the rhombic flap are the significant tension at the closure point as well as the amount of discarded tissue to transform a circular defect into a rhombus[14-15].

A, Nasal defect with missing skin and exposure of lower lateral cartilages. B, Inferior view of missing tissue. C, Use of Doppler to isolate the supratrochlear vessels to incorporate into the fl ap. D, The fl ap is secured in place with the blood supply intact. E, After the fl ap has been taken down and the incisions have healed

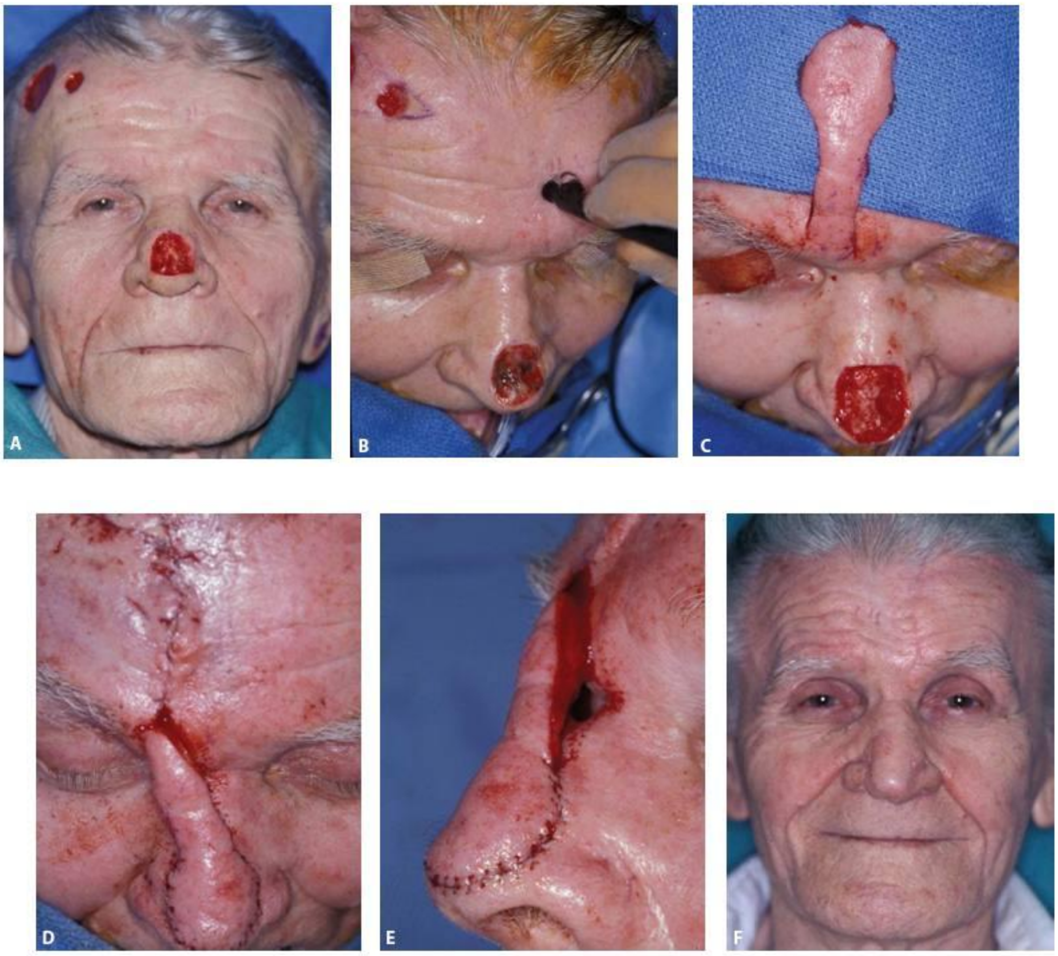
2-The bilobed flap is a transposition flap with two circular skin paddles Esser is credited with the design of the bilobed flap in 1918. It is useful for skin repairing of lateral nose and nasal tip defects up to 1.5 cm. The bilobed flap has a random pattern blood supply. The flap is primarily rotated around a pivot point and the paddles are transposed over an incomplete bridge of skin. The second lobe allows the transfer of tension further from the primary defect closure. The bilobed design rotates around an arc that is usually 90 to 100 degrees. In the bilobed flap, the first lobe closes the defect and the second closes the first lobe defect. The flap is designed with a pivot point approximately a radius of the defect away from the wound margin. The first lobe is usually the same size as the defect, and the second lobe is slightly smaller with a triangular apex to allow for primary closure. The axis of the second flap is roughly 90 to 100 degreees from the primary defect and undermined widely to distribute the tension. An advantage of the bilobed flap is that one can construct a flap at some distance from the defect with an axis that is independent of the linear axis of the defect. A disadvantage of this flap is that it leaves a circular scar that does not blend with the existing skin creases. During healing, the flap may become elevated ("pin cushioning") because of the narrow pedicle that is prone to congestion, scar tissue that impedes lymphatic drainage, and curvilinear scars that tend to bunch the flap up as they shorten[16-17].

Interpolation Flaps

Interpolation flaps contain a pedicle that must pass over or under intact intervening tissue. A disadvantage of these types of flaps is that for those passing over bridging skin, the pedicle must be detached during a second surgical procedure. Occasionally, it is possible to perform a single-stage procedure by deepithelializing the pedicle and passing it A under the intervening skin. Advantages of interpolation flaps include their excellent vascularity and their skin color and texture match.

1-**The forehead flap (median and paramedian)** is a commonly used interpolation flap and remains the workhorse flap for large nasal defects. It is a robust and dependable flap. The forehead flap is primarily based on the supratrochlear vessel, is relatively narrow, and uses a skin paddle from the forehead region. The flap is supplied by a rich anastomosis between the supratrochlear and the angular arteries. Because of the marked vascularity, it is possible to incorporate cartilage or tissue grafts for nasal reconstruction. The forehead flap has abundant tissue available, allowing resurfacing of the entire nasal unit with a single flap, and provides a good texture and color match to the native nose. The technique for elevating the forehead flap is straightforward[18-19].

The flap can be designed directly in the midline or in a paramidline location. A template of the defect is used to outline the flap. Elevation of the flap proceeds in either a subgaleal or a subcutaneous plane. The pedicle is always elevated in such a way as to incorporate the frontalis muscle. The width of the pedicle is usually 1.0 to 1.5 cm, which allows for easy rotation of the pedicle. Before inset, the skin paddle is selectively thinned to match the native skin thickness. The pedicle is divided approximately 3 weeks later, with the base of the pedicle inset into the glabellar area to reestablish brow symmetry. The incision, and resulting scar, is perpendicular to the RSTLs but tends to heal well [20-21].

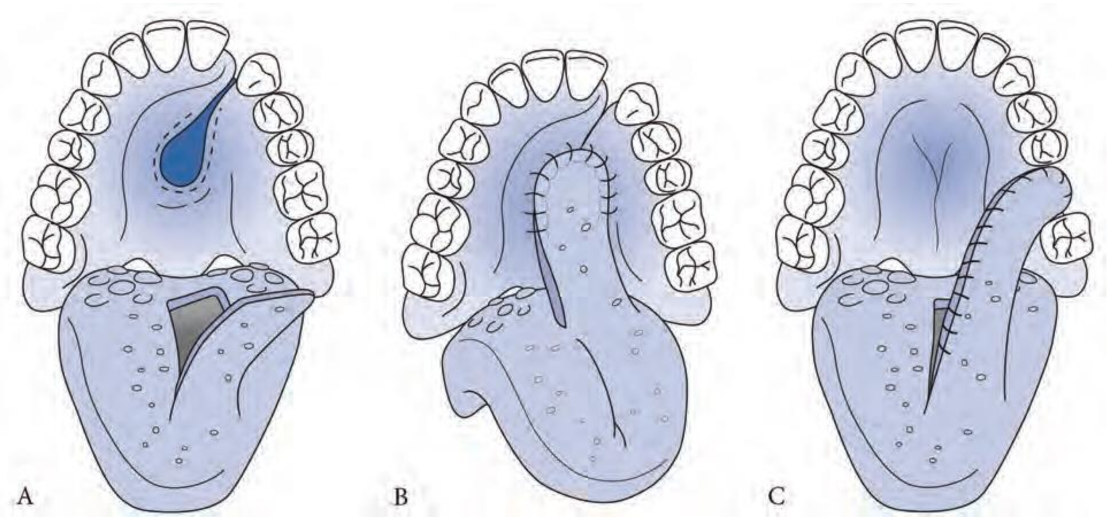


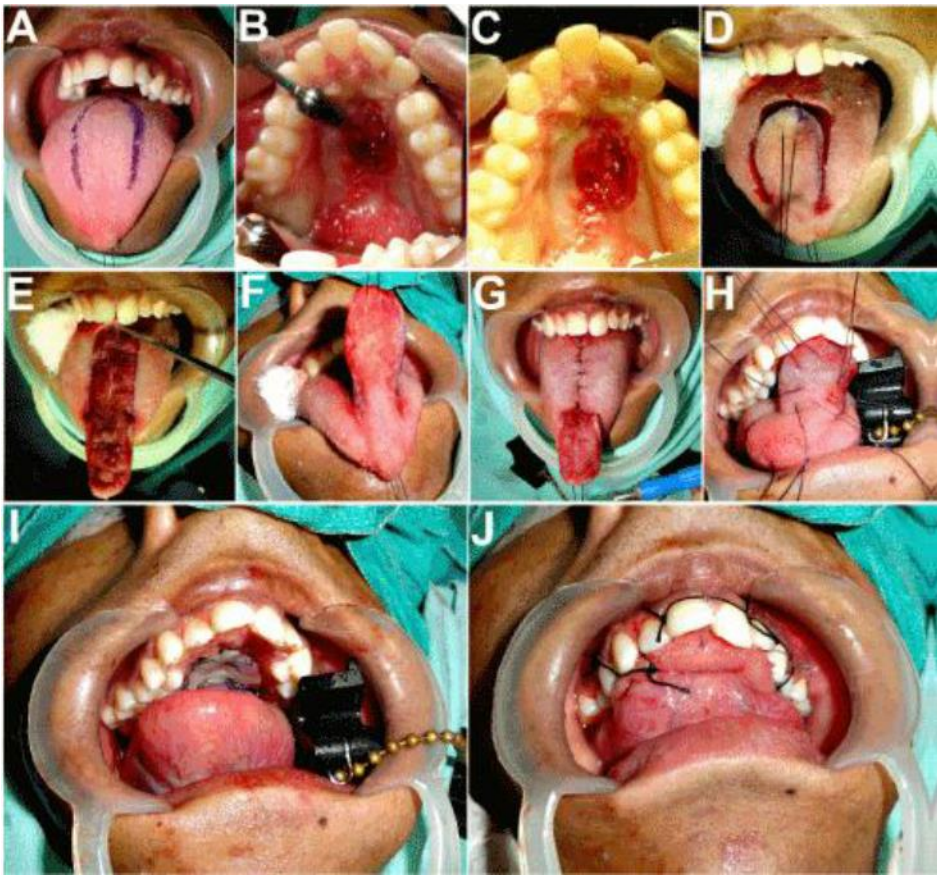
A, Nasal defect after excision of a squamous cell carcinoma lesion. B, Use of Doppler ultrasonography to locate the supratrochlear artery. C, The forehead fl ap has been elevated. D, The fl ap is turned 180 degrees and sutured into place. E, The pedicle is divided 2 to 3 weeks later. F, Postoperative result.

2-The nasolabial flap (melolabial) is useful for reconstructing defects involving the oral cavity and those involving the lower third of the nose . It can be used as an interpolation flap with either a single or a staged technique. The flap is supplied by the angular artery, intraorbital artery, and infratrochlear artery and can be based either superiorly or inferiorly. The area of recruitment for nasal reconstruction is in closer proximity to the primary defect than is the forehead flap. A disadvantage of the nasolabial flap is that there is a limited amount of tissue available, and asymmetry can occur along the nasolabial flap folds. When the pedicle is divided, the defect can be closed primarily by placing the scar in the nasal facial junction and the nasolabial flap fold [22,23,24,25].

A, Outline of a nasolabial flap in a patient with a defect in the anterior floor of the mouth. B, The pedicle is deepithelialized and tunneled into the mouth. C, The flap is sutured into place to restore the missing soft tissue. D, The incision has been hidden in the nasolabial fold.

3-Tongue flap : Tongue flaps are excellent flaps for intraoral reconstruction. They use adjacent tissue, have an excellent blood supply, and are associated with minimal morbidity. 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. ease of use make the tongue flap a reliable and predictable reconstructive technique for indicated defects. Some indications include repair of oral defects and fistula closure. These flaps are helpful for providing closure of large oroantral fistulae [26].

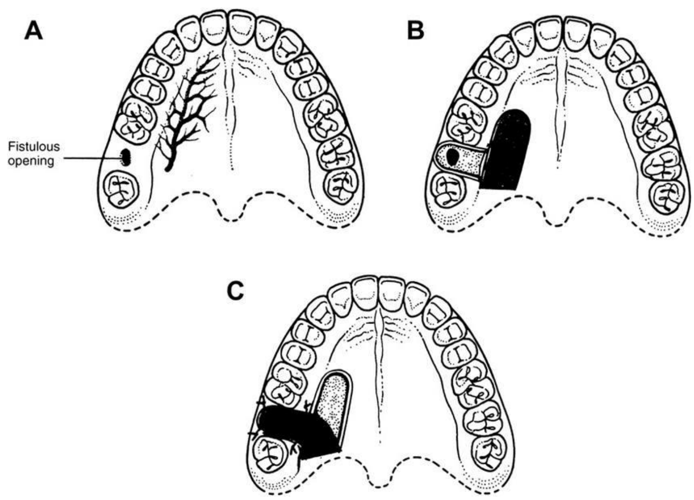




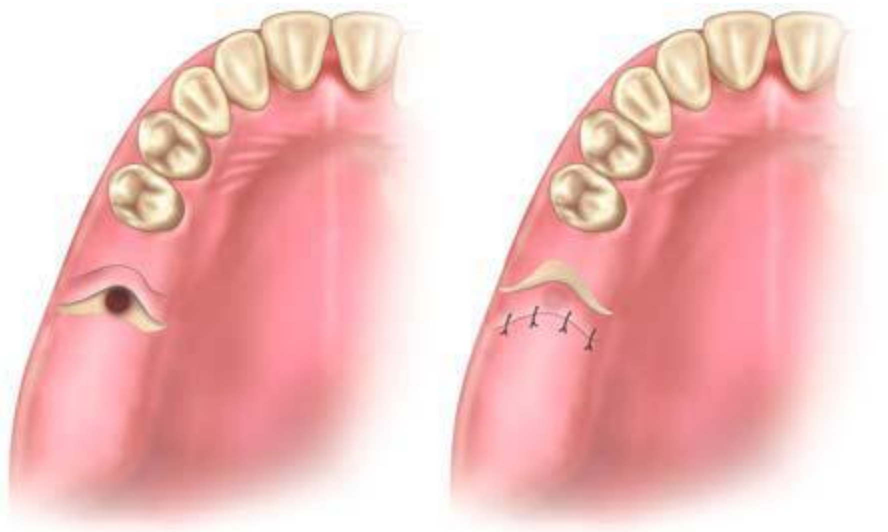
Pedicle Flaps: The three main types of pedicle flaps used for closure of an oroantral communication are: buccal, palatal, and bridge flaps.

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 wound margins 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.



Buccal Fat Pad

Buccal fat pad (BFD) is an encapsulated, specialized fatty tissue located between the buccinator muscle medially, the anterior margin of the masseter, and the mandibular ramus and zygomatic arch laterally. BFD was known as a surgical difficulty for many years because of its accidental encounter during various surgical procedures in the pterygomandibular area but later Egyedi4 has proven it as a boon for OMF surgeons. The flap is harvested through an incision in the posterosuperior vestibular sulcus opposing the second molar tooth. After incising the fascia, the fat pad is easily delivered into the oral cavity by blunt dissection. If the defect is not continuous with the donor site, the flap can be tunneled through mucosa. The flap is sutured into position and allowed to mucosalize, which occurs within 3 to 4 weeks. This is a pedicled flap with its blood supply derived from the buccal and deep temporal branches of the maxillary artery and from vessels from the transverse facial artery.

Because of its accessibility, available size, and mini mal donor site morbidity, it has been used reliably to reconstruct soft and hard palatal, retro molar fossa, buccal mucosa, and oropharyngeal defects. The flap is also used to help repair oral antral communications, in conjunction with an advancement flap, caused by dental extraction.

Buccal fat pad flap in management of oroantral fistula

Fig 1: Preoperative view of an established case of oroantral fistula in the upper right first molar region

Fig 2: A four cornered buccal mucoperiosteal flap is raised to expose the complete extent of the fistula

Fig 3: Excision of the fistula tract

Fig 4: BFP being transported into the defect site

Fig 5: Closure of OAF with BFP using polyglactin sutures

Fig 6: Double layered closure of the OAF with BFP and buccal advancement flap

Fig 7: 12 days postoperative view of double layered closure of the OAF. Note a slight dehiscence of the buccal advancement flap, and the start of mucosalization in the BFP

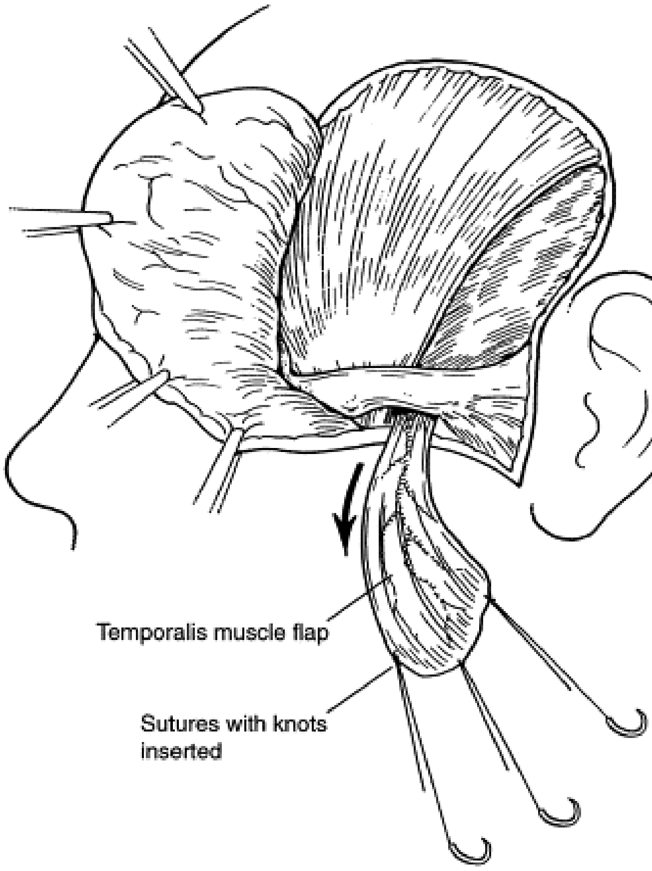
Fig 8: Complete healing of the surgical site at 6 weeks

Regional Flaps

For large facial defects, local flaps may not provide sufficient tissue to adequately restore the missing tissue. In these cases, consideration should be given to using a regional flap. Regional flaps are defined as those located near a defect but not in the immediate proximity. They are frequently harvested from the neck, chest, or axilla and can provide coverage of large surface areas on the face. Selection of a specific regional flap depends on the size and location of the defect and also on the intrinsic properties of the flap. Advantages of regional flaps include the large amount of soft tissue and skin available. Disadvantages of these types of flaps include poor color and texture match, excessive bulkiness of the flap, and donor site morbidity[27].

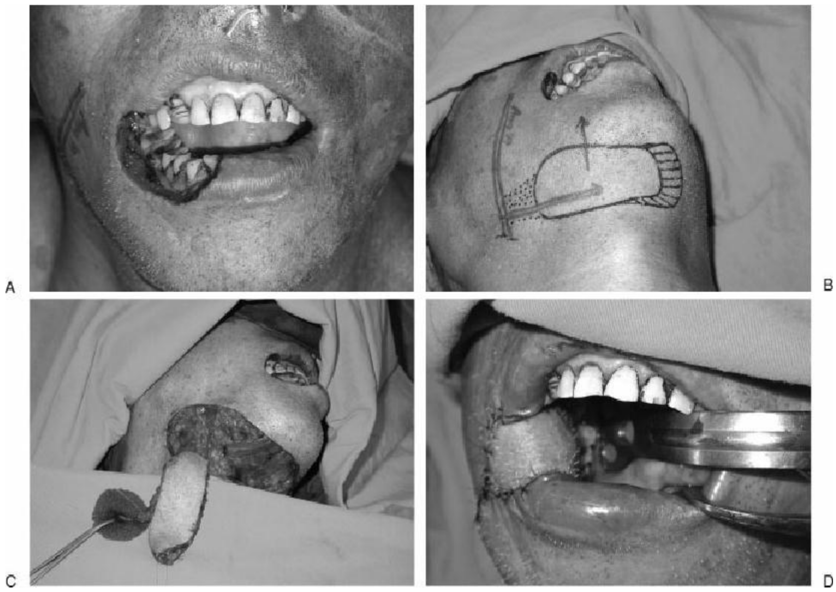
1-Temporalis muscle flap:

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.



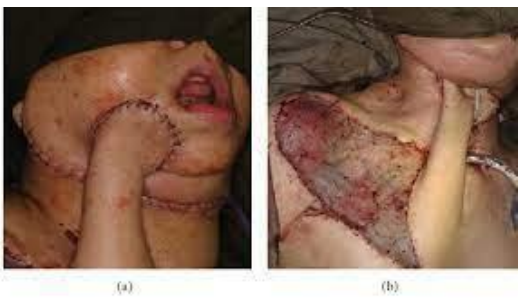
2-Submental Flap:

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.



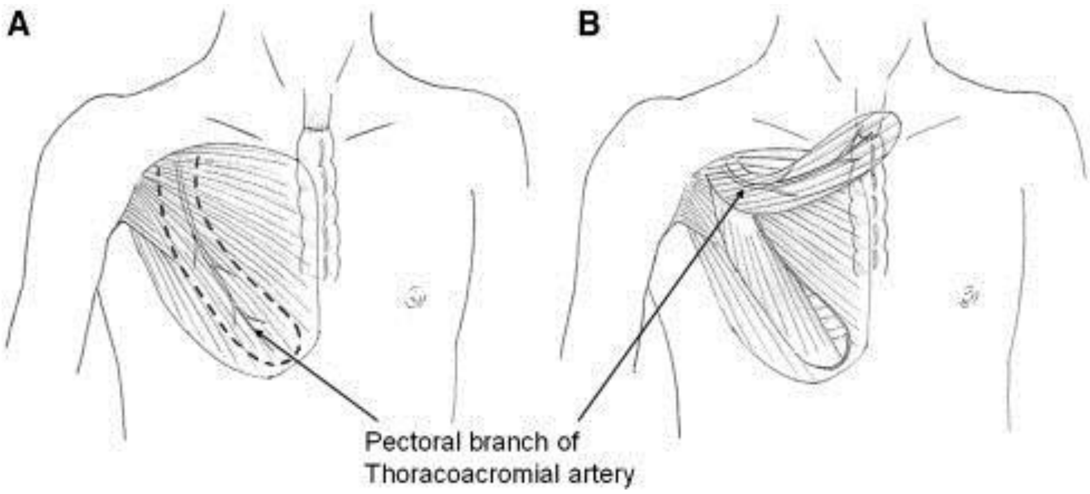
3-Deltopectoral flap :

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.



4-Pectoralis major flap:

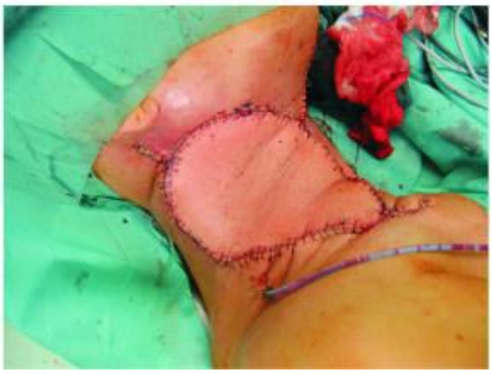
The pectoralis major myocutaneous (PMMC) flap has been used as a versatile and reliable flap since its first description by Ariyan in 1979. The flap receives its blood supply from the thoraco acromial artery and the secondary segmental perforators arising from the internal mammory artery. The lateral 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).



5-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.



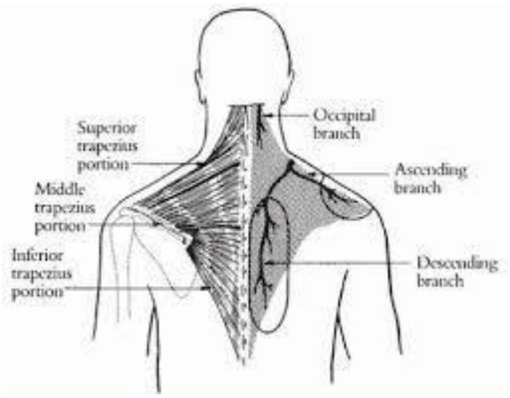
6-Sternomastoid flap:

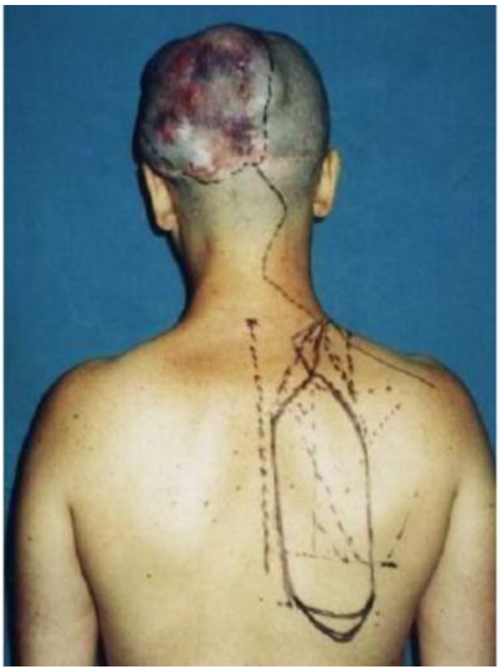
The sternocleidomastoid muscle has long been used for local reconstruction in the head and neck. It remains an incredibly versatile flap by providing bulk, an area of hairless skin with excellent color match for the face, and opportunity to transpose periosteum or bone for correcting head and neck defects. 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

7-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.





bone 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[8]

Osteoinduction, Osteoconduction and Osteogenesis

- **osteoconduction** (guiding the reparative growth of the natural bone),
- **osteoinduction** (encouraging undifferentiated cells to become active osteoblast)
- **osteogenesi**s (living bone cells in the graft material contribute to become remodeling). Osteogenesis only occurs with autografts.

Type of graft

- **Autogenous Grafts**
- **Allogeneic Grafts**
- **Xenogeneic Grafts**
- **Alloplastic grafts**

1-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 the number of living cells transplanted، the more will be the osseous tissue produced.

Autogenous bone is the type used most frequently in oral-maxillofacial surgery. The bone to be transplanted 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 (Fig.). 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.

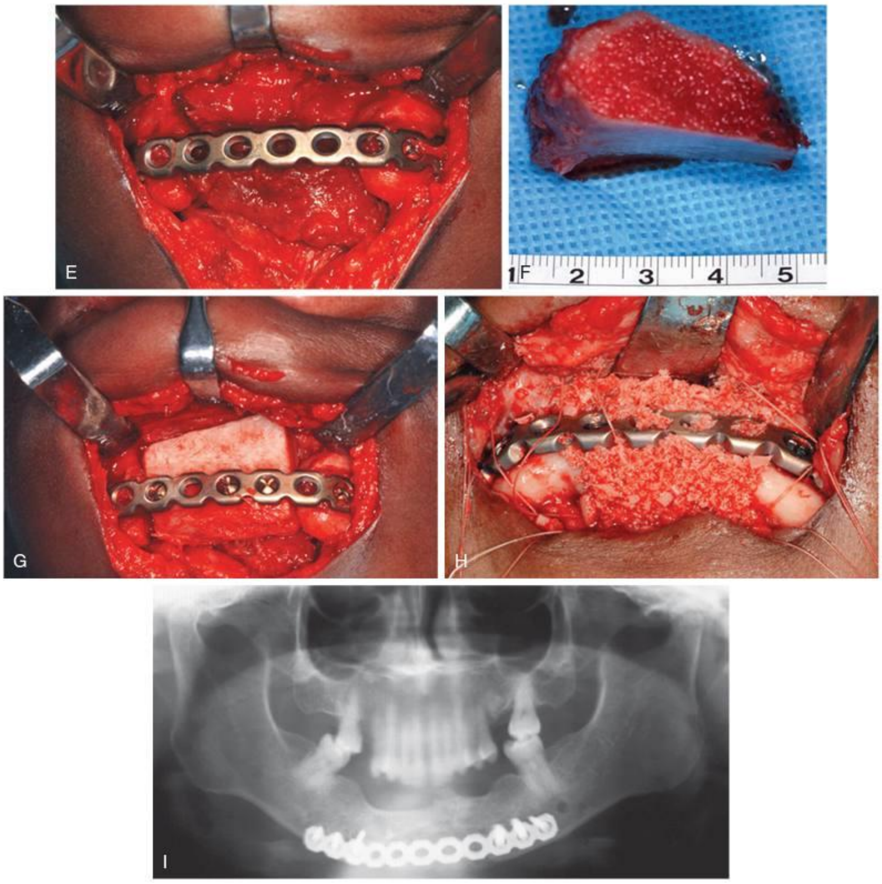


Fig. Use of autogenous corticocancellous block bone graft to replace a defect in the mandibular symphysis. This patient had an ameloblastoma of the anterior mandible.

The iliac crest can be entered, and large volumes of particulate marrow and cancellous bone grafts can be obtained with large curettes.

The diploic space of the cranial vault has recently been used as a site for obtaining this type of graft when small amounts of bone chips are needed (e.g., alveolar cleft grafts.(Autogenous bone may also be transplanted while maintaining the blood supply to the graft. Two methods can accomplish this: he 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 overlying soft tissue after dissecting free an artery and a vein that supply the tissue .

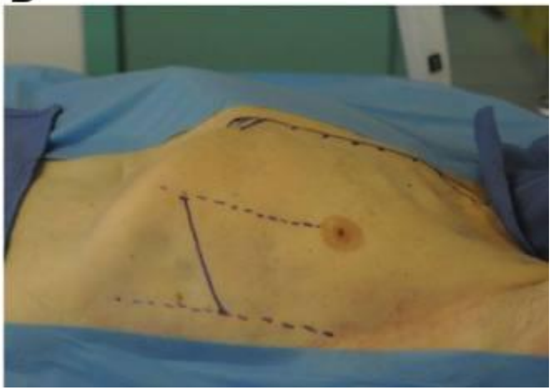
An artery and a vein are also prepared in the recipient bed. Once the bone graft is secured in place, the artery and veins are reconnected using microvascular anastomoses. In this way, the blood supply to the bone graft is restored.

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; that is, 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 soft tissues attached to the bone graft maintain the blood supply، minimal stripping of the soft tissue from the graft may occur 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 causes greater functional and cosmetic defects.

A

B



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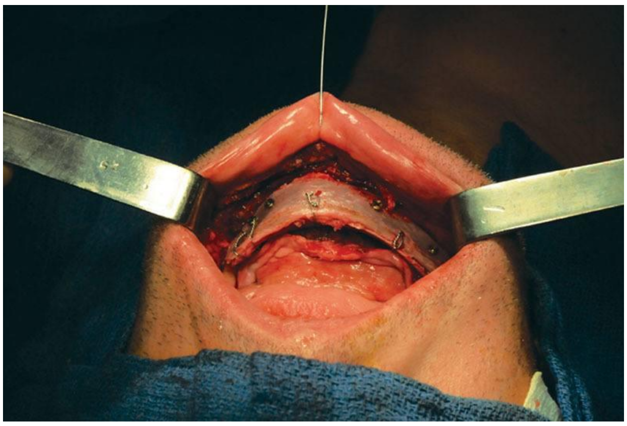
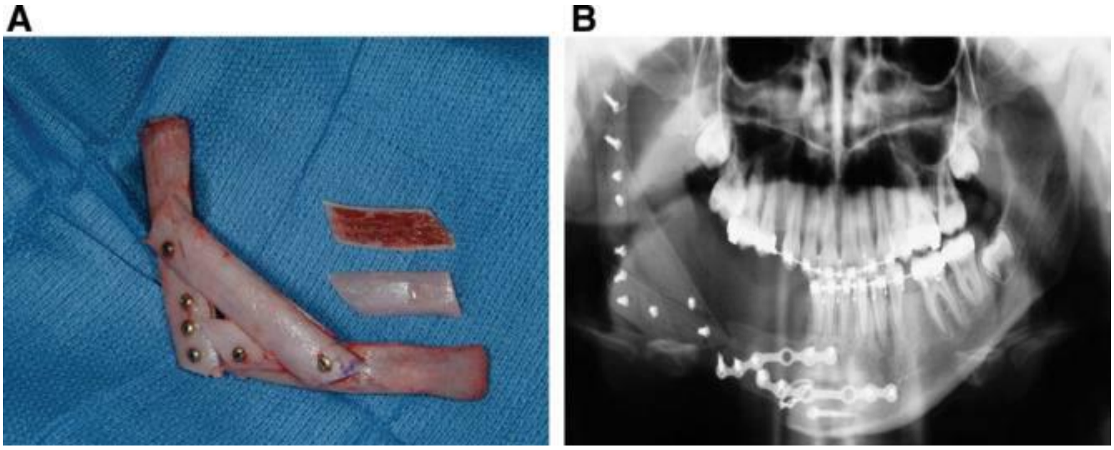




Advantages

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

Disadvantages

A disadvantage is that this procedure necessitates another site of

operation for procurement of the graft.

2-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 I 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

The 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.

Disadvantages

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

3-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-maxillofacial surgical procedures.

Advantages

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

Disadvantages

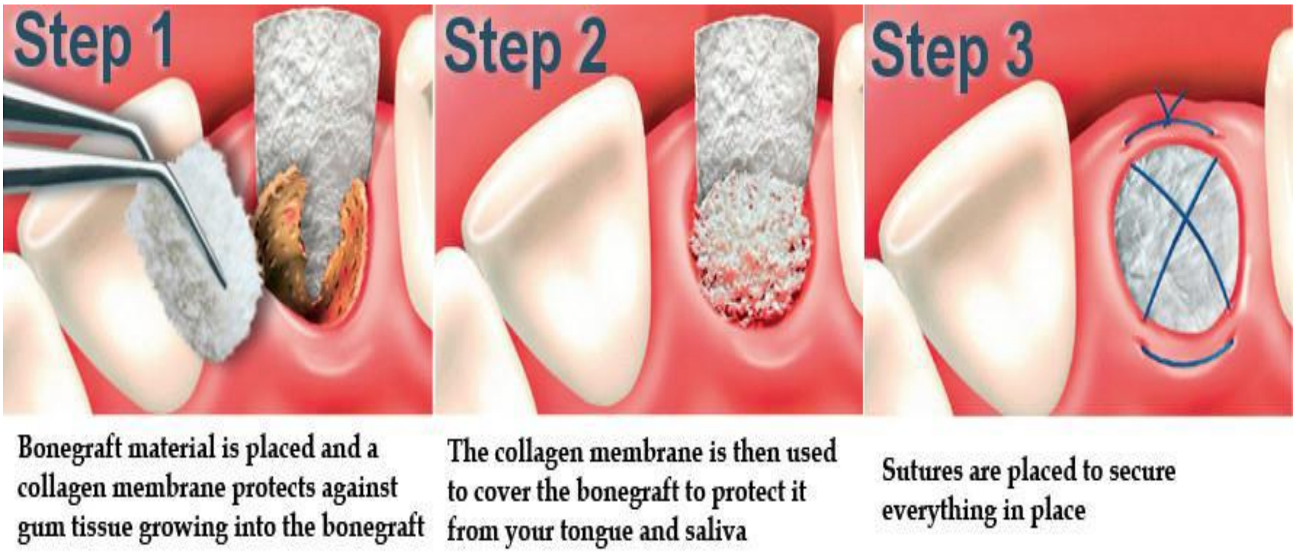
The disadvantages are that xenografts do not provide viable cells for phase I osteogenesis and must be rigorously treated to reduce antigenicity.

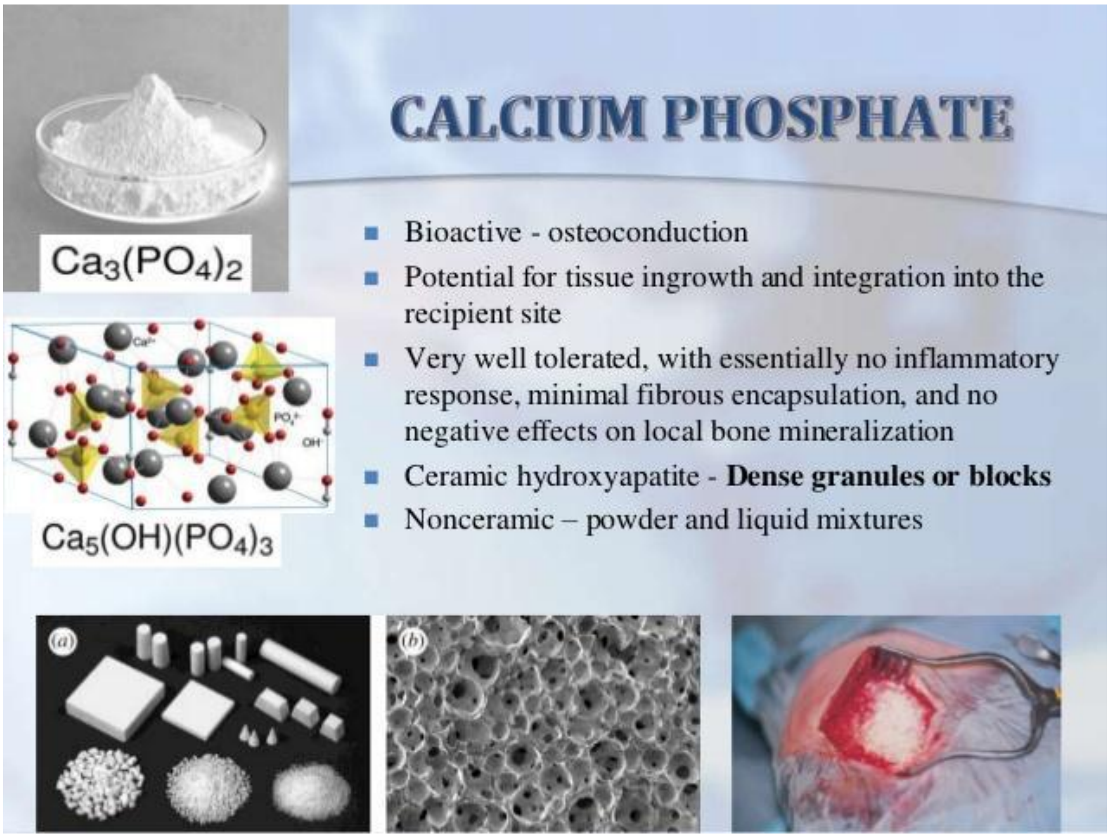
4-Alloplastic graft

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 [28].





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:

Prosthetic Reconstruction of the Midface

When the patient has lost a portion of the maxilla, the maxillary sinuses or nasal cavity may be continuous with the oral cavity, which presents great difficulties for the patient in speaking and eating. Defects of the maxilla can be managed by surgery or bone grafts. Defects that are not excessive may be closed with available soft tissues of the buccal mucosa and palate; bone grafts may also be used to provide the patient with a functional alveolar process. Very large defects or defects in patients who are poor surgical risks may require prosthetic obliteration in which a partial or complete denture extends into the maxillary sinus or the nasal cavities and effectively partitions the mouth from these structures (Fig.) [8].

Fig. Maxillofacial prosthetic reconstruction of patient who had the left eye and palate removed because of tumor.

FUTURE DEVELOPMENTS Computerised planning and 3D printing

Improvements in computer power and technology have been slow to show a benefit in surgical practice compared with other specialities such as radiology and radiation oncology. Recent advances however have seen computerised planning and three dimensional printing adopted as routine practice in many units. Dicom data (from CT Scans, MRI and even Ultrasound) is imported to modelling software. This generates a 3D image upon which the procedure can be virtually performed. Preoperative planning allows the fabrication of cutting guides for both the resection and the reconstruction (Fig). Proponents argue that it reduces surgical time and expense, improves accuracy and allows for less tissue to be harvested and thus lower donor site morbidity. A further extension of the technology allows for the fabrication of patient specific implants including reconstruction plates which match the cutting guides and fit exactly without bending or alteration. There is no doubt this technology will become routine in units performing a high volume of reconstructive surgery. The barriers to its widespread adoption at the moment include primarily, additional cost, time for fabrication of specific implants and a relatively poor integration between image acquisition, data importation and planning. Of course, none of these barriers are insurmountable and the benefits will improve with reduced cost as its use becomes more widespread[29].

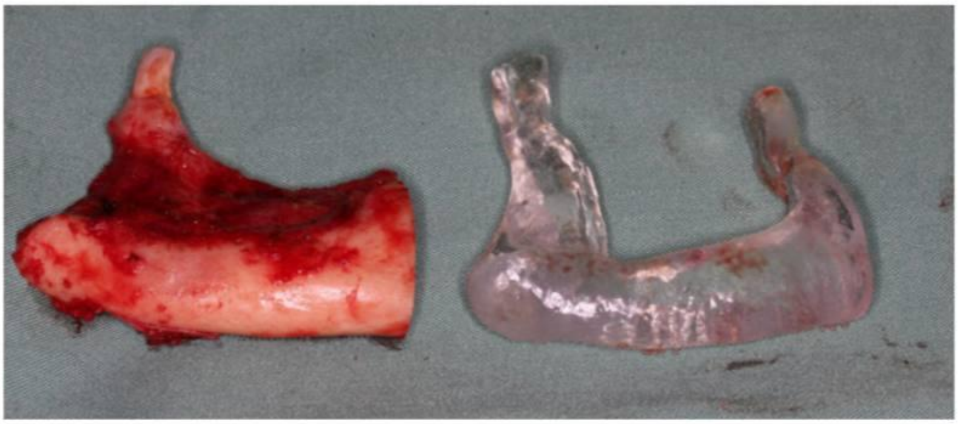


Fig. Mandibular resection 3D model and specimen.

SUMMARY

Major defects of the oral and maxillofacial region remain common due to a diverse group of aetiologies. Although their management is slightly different according to the cause the functional and aesthetic consequences for the patient are significant. Microvascular free tissue transfer has revolutionised the reconstruction of these defects and allowed single stage accurate and highly successful reconstructions to be performed. Dental rehabilitation has also increased exponentially with the widespread use of osseointegrated implants. Future research and development should focus on improving accuracy and the quality of reconstruction along with a reduction in donor site morbidity

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