Local skin flaps are commonly used in reconstruction of facial defects by both otolaryngologists and plastic surgeons. Unfortunately, facial defects resulting from trauma and the excision of skin malignancies are relatively common. How this defect is treated is determined by a variety of factors including: the location and size of the defect, the projected functional morbidity, the underlying cause of the defect, the medical history of the patient, and the patient’s wishes. Many defects are amenable to or are more properly treated by allowing secondary healing to occur, with primary closure, or with the use of skin grafts. When the decision has been made to proceed with a local skin flap often excellent results can be obtained if the surgeon has planned appropriately. This discussion will be limited to the use of local skin flaps in the face and will not discuss treatment of defects by other modalities or the treatment of more complicated defects of the lip, eyelid, and auricle. Many excellent resources exist including past grand rounds regarding these defects.

**Vascular Anatomy**

Local flaps are classified by either its blood supply or its tissue movement. Its blood supply refers to the pattern of its feeding vessels and its tissue movement describes the basic movement that the flap exhibits (rotation, advancement, or transposition). The blood supply of the skin arises from segmental arteries which are direct named branches of the aorta. These vessels give off perforating branches that pass through and around muscle and continue toward the skin as either direct cutaneous vessels or into a rich subdermal plexus.

Random flaps are the type most commonly employed on the head and neck and are based on the rich perforating vascular plexus of the skin. The survival of random pattern flaps is unpredictable because of its blood supply. They are created by dissecting the free portion of the
flap at the level of the subcutaneous fat. It is thought that roughly a length to width ratio of 3:1 to 4:1 often provides a viable flap on the face.

Axial pattern flaps derive their blood supply from a direct cutaneous artery or named blood vessel. Axial flaps can be of greater length to width ratios than random flaps because of its more predictable blood supply. The use of axial pattern flaps is limited by the availability of direct cutaneous arteries. Examples include the nasolabial flap based on the angular artery and the midforehead flap based on the supratrochlear artery. The surviving length of an axial pattern flap is entirely related to the length of the included artery. Some additional length is obtainable in these flaps by including a distal tip of random nature based on the subdermal plexus.

**Physiology/Biomechanics**

It was long thought that the surviving length of a flap was entirely dependent upon the width of its base. This is now known to be untrue. The surviving length of a random portion of a flap depends on the physical properties of the supplying vessels and the perfusion pressure. When the perfusion pressure drops below the critical closing pressure of the arterioles in the subdermal plexus, perfusion of the flap stops. Contrary to popular belief, this cannot be improved by widening the base of the flap so that the length to width ratio decreases. A wider random flap will only include additional subdermal arterioles that have the same perfusion pressure since they are all based on the same feeding vessel. Adding additional vessels at the same perfusion pressure does allow for some increased collateral circulation which can be beneficial. It is now recognized that the length to width ratio is only a rough guideline and varies with different flaps. Generally, a 3 to 1 ratio is felt to be optimal.

The skin has a blood supply that far exceeds its nutritional requirements and is highly variable. Changes in response to temperature, autonomic system control, and trauma lead to markedly different amounts of blood flow. The regulation of this blood flow is controlled in the subdermal plexus via arteriovenous shunts. These shunts are often dependent upon the autonomic nervous system and circulating catecholamines. They are regulators of tissue blood flow. Through a variety of actions they can increase or decrease skin blood flow and therefore tissue nutrition by opening and closing in response to the sympathetic nervous system. It is speculated when opened fully they will allow blood to bypass the capillary beds despite increased skin blood flow.

It has been recognized that if a flap is incised and undermined but not transposed, it will survive to a greater length when transposed at a later date. The exact timing of the delay is not known but delays of 10 to 21 days are most common. After 3 weeks to 3 months the delay phenomenon is lost. The phenomenon is often explained by several theories but it is not fully understood. These theories include an improvement in blood flow, a conditioning to tissue ischemia, and a closure of the AV shunts.

Skin elasticity is a function of its elastin and collagen content. When applying tension to skin the initial stretch is obtained by a give in the elastin fibers and requires only minimal force. Continued stretch is obtained when the collagen fibers begin to reorient themselves in the plane of pull and requires an increasing amount of force. Eventually with increased force or
stretch, there is very little increase in length. Blood flow in a random flap will then decrease in an inverse manner with increased tension.

Creep occurs when skin exhibits an additional lengthening beyond its initial stretch when constant tension is placed for 5 to 15 minutes. This is explained by extrusion of fluid from the dermis and breakdown of the dermal framework.

Stress relaxation occurs over a longer period of time and is the principle of tissue expansion. It is thought to be explained by increased cellularity in the skin and a permanent stretching of the skin components.

Relaxed skin tension lines (RSTLs) run perpendicular to the direction of maximum skin extensibility. Placing incisions or lines of closure in these lines will allow for maximum skin mobilization and decreased tension. Additionally, wrinkles tend to fall in or parallel the RSTLs and scars can be hidden or camouflaged in natural skin creases. One must attempt to position final incision lines in relaxed skin tension lines or at the borders of aesthetic units. This may require excision of normal tissue to move the incisions into more aesthetically favorable positions. Unfortunately, it is difficult to design a flap that is 100% successful at accomplishing these tasks simultaneously. The best flap in any given situation is usually the best compromise.

Planning

Designing a local flap for a given facial defect is much like solving a puzzle. Each defect and patient is unique, and although there may be many ways to close a particular defect, generally one design will result in the best cosmetic and functional outcome and subject the patient to the least risk of complications. One must begin with an adequate history of the patient’s health and the etiology of the defect. The history should focus on the presence of comorbidities and current medications that might affect the planned reconstruction. The patient’s smoking history should be sought. Cigarette smoking is associated with a three times greater likelihood of necrosis following skin flap surgery. Smokers should be warned that they are at greater risk for wound complications, and a more conservative reconstruction should be planned. All salicylates and nonsteroidal anti-inflammatory agents should be discontinued prior to the planned procedure because these agents tend to increase bleeding complications. Salicylates exert their effects throughout the lifetime of the platelet and should not be taken within 7 to 10 days of the planned surgery. The effects of nonsteroidal anti-inflammatory agents are shorter, and these agents should be avoided for approximately a time equal to three drug half-lives—approximately 24 hours. The surgeon should identify health risks that affect the cutaneous vascular supply, such as atherosclerotic cardiovascular disease, collagen vascular disease, steroid-dependent disease, anticoagulation medications, and previous irradiation. The specific tumor biology may also have an impact on the decision, because patients at high risk for recurrent disease may be poor candidates for elaborate reconstructive efforts in the immediate setting.

Next, the defect must be inspected and important facial structures identified that are likely to be affected by alterations in skin tension. The surrounding skin must be inspected for laxity, secondary skin lesions, and color texture match. The skin should be palpated carefully to determine the amount of laxity and in what direction the RSTLs and the lines of maximal
extensibility run. The surgeon should check for eyelid laxity, nasal tip ptosis, scars from previous trauma or surgery, and additional lesions that are suspicious for malignancy. In many cases primary closure can be used on seemingly large defects. Because redundant tissue frequently must be excised, the best position for a Burow’s triangle excision should be sought.

Using a template of the defect can help the surgeon visualize the best tissue donor site. If there is laxity around the defect, the template can be drawn approximately 20% smaller in diameter, because secondary movement will occur at the time of flap closure. The surgeon should draw two or three flap options and review the pros and cons of each before selecting the best one. Before the flap is incised, the surgeon should undermine around the defect site and beneath the flap donor site. A check should be made as to whether the tissue behaves biomechanically as predicted. This may reveal that the tissue laxity is better than predicted and primary closure may look promising. On the other hand, tissue laxity may be less than predicted and another flap design warranted. This technique of undermining before incising keeps multiple flap options open.

The flap is incised and undermined, and rotated, advanced, or transposed into the defect. A few temporary key sutures are placed and the face is reinspected for distortion. The flap blood supply is inspected. Generally, the donor site is closed first so that less tension is left at the distal flap. If there is excessive tension or distortion, the key sutures are repositioned or a decision made to make a backcut or increase the amount of tissue undermining. The key sutures are also used to move standing cones and dog ears into favorable positions in RSTLs. The standing cones and dog ears are then excised as Burow’s triangles. It is much safer to remove the redundancies after the flap is set into its final position. Early excision of Burow’s triangles can be problematic, especially when the redundancy is overestimated and excessive amount of tissue is sacrificed prematurely. Once the flap position is satisfactory, the key sutures are sequentially removed, and the final closure is accomplished in a two-layer fashion.

Flaps

Three basic types of random soft-tissue flaps are used in the reconstruction of facial defects: the advancement flap, the rotation flap, and the transposition flap. Each of these flaps can be modified in an unlimited number of ways. Each design modification changes the angle of rotation, the amount of tissue moved, the distribution of tension, and the orientation of the final scar. It is helpful to analyze the fundamental concepts behind the three basic flap designs to understand the intent of the numerous design modifications.

Rotation

The basic rotation flap is a simple pivotal flap which is curvilinear in shape and which rotates around a pivotal point near the defect. It is designed immediately adjacent to the defect, and thus one side of the defect is the advancing edge of the flap. As with all pivotal flaps, a standing cutaneous deformity will develop at the base of the flap. A Burow’s triangle can be removed to facilitate repair to the donor site wound. The vector of greatest wound-closure tension after rotation of the flap is from the pivotal point to a point located on the peripheral circumference of the curvilinear incision. A back cut or excision of a Burow’s triangle at the base of the flap shifts
the position of the pivotal point and thus changes the wound-closure tension vector as well as the location of the standing cutaneous deformity. There are many advantages to the rotation flap. The flap has only two sides, thus it does lend itself very well to having both edges placed in borders of aesthetic units of the face or into one aesthetic border and one RSTL. The flap is broad based and therefore its vascularity tends to be reliable. This flap is most useful in defects of the cheek and upper forehead when the curvilinear incision can be placed along the inferior orbital rim or hairline.

Transposition

Transposition flaps are harvested at one site and transferred to a site immediately adjacent to the base of the flap. These differ from rotation flaps in that their final axis is linear, whereas the rotation flap has a curvilinear axis. This difference enables the final closure to have less wound tension and a scar in a more favorable axis. The most important element of design of a transposition flap is the location of the pivot point. The flap must be designed so that strangulation does not occur and the defect is repaired without excessive tension across the closure or distortion of surrounding tissue. These are extremely versatile flaps that can be used in almost any situation.

Rhomboid and Dufourmental

These are very popular flaps which can be used in a variety of locations in the face. Unlike other flaps, the geometry of the design is important and exacting here. It is important to measure the sides of the defect and the proposed flap to ensure that design is appropriate prior to making incisions. The rhombic or Limberg flap is based on four equal sides with corresponding 60 and 120 degree angles. After careful design there are four potential donor flaps from which to choose in order to appropriately align the final scar in an inconspicuous area and prevent surrounding tissue distortion. The dufourmental flap is slightly more complicated with angles varying from 60 to 90 degrees but there still exists the choice of four potential donor flaps.

Bilobed

These are double transposition flaps that share a single base. They move around a pivotal point and invariably develop a standing cone that is dependent upon the arc of rotation. The primary flap is to repair the surgical defect and the secondary flap is used to repair the flap donor site. The secondary flap defect is then closed primarily. It was originally described so that each flap was at a 90 degree angle of the next so that the final transposition would be over a 180 degree arc. It has been since recognized that increased arc leads to an increased size of the resulting standing cone deformity. Final arcs of transposition of 90 to 110 degrees is more optimal with less resulting deformity. The primary use is in closing defects of the lower third of the nose. A disadvantage of the flap is that the resulting scar is unable to follow skin tension lines in many cases.

Advancement

The term advancement flap is usually referring to a flap created by incisions, which allow for a “sliding” movement of incised tissue. The movement is in one direction, and the flap advances directly over the primary defect. The basic design of an advancement flap is to extend an incision along parallel sides of the defect and then directly advance the tissue over the
defect. Complete undermining of the advancement flap as well as the skin and soft tissue around the flap pedicle is very important.

Standing cutaneous deformities are created when advancement flaps are used and usually require excision accomplished by the removal of Burow’s triangles. Excision of these triangles may facilitate movement of the flap. Not all advancement flaps are pure advancement. The cheek advancement flap is primarily a sliding or advancement flap but also relies on rotation. The actual location of where to excise Burow’s triangles is best determined after the advancing edge of the flap is secured.

The classically designed advancement flap has a flap length to width ratio of around 1:2 and advances tissue a distance approximating the width of the flap. Advancement beyond this is possible, but the tension of the flap may increase dramatically, and the distal blood flow may become compromised and lead to distal flap necrosis. These flaps are particularly useful for defects of the forehead and brow because the RSTLS in this region are horizontal and parallel. Although the classic advancement flap has two parallel sides, modifications of this flap are easy to design based on the position of RSTLS and borders of aesthetic units. Burow’s triangle excisions should never be performed before the flap is advanced into position because redundancy may be minimal and resection may be unnecessary.

Monopedicle The single pedicle advancement flap is the most basic of the advancement flaps. It works well on the forehead by use of the horizontal skin crease lines and in the eyebrow by hiding a portion of the scar in the hair-bearing region. The typical ratio of defect length to flap length is 3:1. It is made by wide undermining prior to parallel incisions preferably in skin crease lines. The flap is inset with key stitches prior to removal of standing cones.

Bipedicle The bilateral advancement flap is typically made when a single-pedicle advancement flap does not allow sufficient tissue for closure of the defect. The basic principles and technique are the same as those for the monopedicle advancement flap. Again, it works well in the forehead and brow where incisions can be hidden by skin creases or hair. A disadvantage of this flap is the potentially long suture line.

V-Y flap This is a unique flap where a V shaped flap is moved into a defect with primary closure of the donor area leaving a final Y shaped suture line. It is pedicled from the underlying subcutaneous tissue rather than the surrounding skin.

A-T flap This flap represents a type of bilateral advancement flap where a triangular defect is closed by advancing tissue from either side of the defect. The advantage is that the defect can be divided in half by the use of the two flaps allowing placement of the incisions in natural creases, junctions of aesthetic units, or in the hairline. It works very well in the forehead and temple with the horizontal component placed in the hairline and along the lip with the horizontal limb at the vermillion.

Cheek advancement These flaps are optimally used in the cheek where the increased elasticity and mobility of the skin here allows for wide undermining and closure of medium to large defects along the medial cheek. For defects near the nasofacial sulcus the flap
can be tacked to periosteum of the nasal bones to relieve tension on the distal flap and prevent dehiscence. It is important to ensure that flaps elevated near the inferior lid are pulling laterally and not inferiorly to prevent ectropion.

**Nasolabial flap**

The nasolabial flap is an axial pattern flap based on the angular artery and is suitable for closure of defects involving the lower two thirds of the nose, perinasal area, and the nonvermillion upper lip. Because of its axial pattern blood supply they are very reliable flaps. They can be based either superiorly or inferiorly with good results. Potential disadvantages include pin cushioning in the superiorly based flap and blunting or obliteration of the nasofacial sulcus. It is important to prevent excessive wound tension when closing the donor site in the superiorly based flap to prevent ectropion of the lower lid.

**Midforehead flap**

The midforehead flaps, which include the median and paramedian forehead flaps, have withstood the test of time and are workhorse flaps used for midfacial reconstruction. It is classified as an axial pattern flap based on the supratrochlear artery and is extremely dependable. The location of the supratrochlear artery is consistently at a point 1 cm above the brow and travels in a subdermal-subcutaneous plane. Its pedicle can be narrowed to as little as 1.2 cm which reduces the donor site deformity in the glabellar area. Contouring and thinning of the flap is required for optimal aesthetic results. If used as an interpolation flap, a second procedure for division of the pedicle is required and is customarily performed at 3 weeks. Disadvantages include the forehead donor site scar, limited length in patients with low foreheads, and the need for a revision in some cases. It is the flap of choice for large nose or nasal tip defects but is also applicable in a variety of midfacial defects.

**Postoperative care**

Patients are sent home the day of the procedure and are prescribed a mild pain reliever and possibly a broad spectrum antibiotic. Surgical wounds are covered with antibiotic ointment and either covered with sterile gauze or left open. Wound care consists of twice-daily cleansing of the suture line with hydrogen peroxide to prevent crusting followed by application of an antibiotic ointment. Sutures are removed at 5 to 7 days and steri-strips can be applied if desired. Patients are instructed to avoid exposure to direct sunlight for 2 to 3 months to prevent changes in pigmentation. If scar revision is required, dermabrasion can be performed at 6-12 weeks. Further scar revision such as excision or irregularization should be delayed until at least 6 months to allow for full scar maturation.

**Complications**

Fortunately, complications are not common with local flaps in the face which accounts for their popularity. Infection is uncommon but is usually heralded by pain on days 4 to 8. They are managed by antibiotics and wound care. Hematomas and seromas can occur and will increase the likelihood of flap necrosis. If you suspect that a patient may be prone to developing
one of these it is prudent to place a drain temporarily. Flap cyanosis in the immediate postoperative period is often the result of venous congestion. If it is thought to be due to excessive wound tension, suspicious stitches can be removed in an attempt to optimize the outcome. Additionally, multiple punctures with a sterile needle, heparin soaked sponges, or even leeches may be beneficial. Flap failure or necrosis is often due to poor planning or design which underscores the need for careful preparation. Cigarette smoking can increase the risk of flap loss by up to three-fold. Failure in this situation is as much the responsibility of the surgeon as it is the patient because the surgeon should recognize this potential and opt for less risky procedures such as primary closure or skin grafting. When necrosis does occur it will usually involve the distal tip and should be managed expectantly. Unless there are signs of local infection, debridement should not be performed as the eschar will serve as a biologic dressing at worst.

Conclusion

Basic concepts in local flap reconstruction must be understood before treating soft-tissue defects of the face. Each defect is unique, and the surgeon often relies on variations of the rotation, advancement, and transposition flaps to close defects based on their specific location, size, and donor tissue. The better one understands these concepts, the more one is able to customize a local flap to suit the specific needs of the defect and avoid complications caused by miscalculations.

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