**Paparella: Volume IV: Plastic and Reconstructive Surgery
and Interrelated Disciplines**

Section 1: Plastic and Reconstructive Surgery

Chapter 16: The Management of Soft Tissue Trauma to the Face and Neck

Paul J. Donald

Trauma to the face produces injuries of varying severity and complexity whose ultimate functional and cosmetic outcome largely depends on the skillful execution of soft tissue repair. Wide, raised, or depressed scars are obvious on the face, whereas fine flat scars are less conspicuous and may be easily camouflaged by cosmetics.

In the management of facial wounds, the principles that should lead to minimal scarring include (1) a knowledge of the anatomy of the area, (2 thorough examination of the wound and precise assessment of the injury, (3) meticulous cleansing and conservative debridement, (4) careful approximation of the lacerated tissues in a layered fashion, and (5) attentive postoperative care.

An understanding of the precise configurations and features of the significant anatomic structures of the face facilitates accurate approximation of these areas and produces the best results. Accurate alignment of the eyebrows, eyelids, nasal alae, nasal columella, and lips is absolutely essential. Nothing is more apparent even at a great distance than a malaligned labial vermilion-cutaneous edge. Even 1 mm of misalignment is patently obvious.

The direction of a laceration relative to the facial crease lines determines the prognosis of the subsequent scar. In 1861 Langer mapped out a series of lines on the body that were created by connecting slits produced when multiple puncture wounds were made in the skin of a cadaver with an awl. These lines result from the alignment of collagen bundles deep in the reticular dermis. For many years, these lines were thought to indicate the most favorable direction in which to make a surgical incision.

In 1951 Kraissl pointed out that in the face, the most inconspicuous scars are those that fall in the natural crease or wrinkle lines. When facial muscles contract, they produce a series of parallel wrinkles that run at right angles to the long axes of these muscles and give expression to the face. These crease lines do not all coincide with Langer's lines and in some areas such as the upper lip, run at right angles to them.

Wound Assessment

Lacerations may be linear, slicing, stellate, or avulsed. They may be clean or contaminated, fresh or old. They may or may not involve injury to underlying viscera or skeletal elements.

Linear lacerations are usually made by a sharp object such as a knife or broken glass. There is a minimal amount of contusion, or tissue damage, peripheral to the cut edge, and the wound is usually relatively clean. A slicing laceration may be linear as viewed in its course

along the skin surface, but when closely inspected from the superficial epithelial surface to the deep dermal aspect it is seen to be obliquely angled or skivied. The epidermis on the sliced side of the cut is thin, like a split-thickness skin graft, and tends to form a wide scar on healing. Stellate wounds are usually the result of blunt trauma, and have an exploded appearance with ragged and irregular margins. There is usually much contusion at the edges.

Avulsion lacerations involve injuries in which portions of epithelium and occasionally underlying soft tissue and bone have been ripped out or blown away. These severe injuries may result from animal bites, motor vehicle accidents, or gunshot wounds. However, it is important to remember that in many extensive lacerations, the gaping of the wound caused by the elastic recoil of the dermis may give the illusion of tissue loss. This is especially true in lacerations that lift up a flap of tissue, particularly in children and young adults.

The degree of contamination and the age of the wound must be carefully assessed. Contamination, in the sense used here, implies gross soilage with substances such as road dirt or barnyard soil. The depth of the wound must be explored for foreign bodies. Pieces of glass, gravel, and organic material may be found and must be meticulously removed to prevent wound infection or later extrusion, with subsequent scarring and disfigurement. The age of the wound is important from the standpoint of bacterial infestation and timing of the surgical repair. Because of the rich blood supply to the face, most lacerations may be closed primarily up to 4 days after the injury. However, if active suppuration has supervened, delayed closure is the best form of treatment.

Injuries to underlying structures must be assessed and remedied before closure whenever possible. However, in certain cases of a laceration overlying a fracture, it is permissible to close the laceration and delay the reduction and fixation of the fracture until the patient's sensorium is clearer, the facial swelling has diminished somewhat, or operating room time becomes available. Diplopia or malocclusion raises a strong suspicion of a facial fracture. Careful palpation in the depths of the wound may confirm this.

A flow of saliva from a wound that does not penetrate the oral cavity usually indicates that the parotid gland or Stensen's duct has been lacerated. Insertion of a lacrimal probe through the ductal papilla, followed by examination of the wound, helps to reveal the site of the ductal dehiscence. The cut surface of the parotid gland is distinctive, owing to its slightly grayish color and lobular appearance. Frequently, saliva in the wound is due to a lacerated gland alone with the duct escaping injury.

When the parotid is cut or when a laceration is present in the vertical axis of the face, examination of facial nerve function is mandatory. Diagnosis of facial nerve severance is facilitated by familiarity with the extratemporal course of the nerve and its branches.

Treatment

General Considerations

Patients presenting with facial lacerations have often sustained multiple injuries involving other organ systems. Therefore, their general condition should be assessed first, and any respiratory embarrassment or signs of shock must be treated immediately. The mouth

should be cleared of broken teeth, dentures, blood clots, and other debris. Fractures of the maxilla or mandible may cause upper airway compromise, and emergency tracheostomy may be required. Any obvious bleeders should be clamped with a hemostat or stemmed with a pressure pack.

In any facial injury involving a large amount of force, a central nervous system injury must be suspected. Radiography of the cervical spine and of the skull is essential, and should be done prior to manipulation of the head.

Tetanus prophylaxis should be instituted by the administration of either toxoid or, in the unimmunized, toxoid and human antitoxin.

When assessing a trauma victim, it is important to remember that although dramatic in appearance, facial lacerations have a low therapeutic priority. While the patient's other problems are being investigated and care for, a sponge soaked in antiseptic solution such as povidone-iodide (Betadine) should be placed in the wounds until definitive closure can be performed. This will keep the wound moist and help to prevent infection. Prophylactic antibiotics are not recommended routinely in most lacerations. In any laceration close to the orbit, trauma to the globe must be suspected. An accurate assessment of vision and extraocular motion, retinoscopy, and even slit lamp examination may be required. An ophthalmologic consultation may be advised.

Wound Preparation

Initial assessment is usually performed in the emergency room. Although uncomplicated facial lacerations may be treated adequately there, the same care should be administered as would prevail in the operating room. Thorough cleansing of the wound is the just first step in definitive treatment. Shaving of a beard or mustache may not be as important for cleanliness as for clear visibility. However, the eyebrows should never be shaved because they sometimes fail to regrow. The area is scrubbed with a germicidal soap and flushed with copious amounts of sterile saline or half-strength hydrogen peroxide until all foreign material is washed away. The use of a pulsatile irrigator is of immense help in the cleansing of wounds containing tenacious contaminants. Any road tar must be meticulously removed with a brush, because any vestige will invariably result in the formation of an unsightly tattoo. Occasionally, a shave excision of parts of the wound is necessary to remove this tar.

It may be impossible to cleanse the wound adequately without some form of anesthesia. Local anesthesia is the preferred method, unless the patient is under general anesthesia for repair of other injuries. A field block is obtained by injecting the wound edges with 1 per cent lidocaine with epinephrine 1:100.000. It is well to remember that the toxic dose of lidocaine with epinephrine is 500 mg, or 7 mg/kg body weight. In patients with extensive lacerations, multiple nerve blocks are usually safer because the total dose of lidocaine administered with this method is much less than that with a field block.

It is extremely important not only to cleanse the wound thoroughly but also to simulate as closely as possible the conditions found in a regular surgical suite. An appropriate surgical preparation of the wound and adjacent skin, draping, and the use of a cap, mask, and gloves by the surgeon are of paramount importance. The greatest enemy of a satisfactory

aesthetic result is wound infection. Correct wound care and appropriate surgical conduct in the operating room may preclude this complication.

Conservatism is the rule in debridement. It should be limited to devitalized tissue and tissue that is either stained by road or contains dirt that cannot be scrubbed out. A No. 11 or 15 scalpel blade is used to shave away these areas. Lacerations consisting of a beveled cut should have the thin portion excised and this edge countersunk into the opposing side to avoid the scarring previously alluded to. It is unwise to excise the tips of jagged, irregular-shaped lacerations if they are viable. These should be treated as small flaps that fit into opposing small defects. When approximated, they impart an irregular configuration to the resulting scar that actually tends to camouflage it. A straight-line scar, even when very thin, may easily be noticed by the observer because of the predictable nature of a straight line. This is especially true when the scar does not lie in lines of minimal tension. On the other hand, the eye finds it difficult to follow an irregularly shaped scar owing to its unpredictable course, so the changing pattern of the scar helps to make it invisible.

Suture Technique

There is nothing magical about the plastic surgical repair of facial lacerations. Over the years, this appellation has conjured up an undeserved mystique that has dissuaded many fine surgeons from repairing facial wounds. These lesions are easily amenable to treatment if a few basic principles are followed. The main rules are: (1) use delicate instruments, small needles, and fine sutures; (2) take time to make careful stitches; (3) use a layered closure; (4) place the cutaneous sutures so that the edges will evert; and (5) instruct the patient in meticulous postoperative care.

Delicate instruments and fine sutures complement accurate surgical technique. Needle holders designed by Webster, Castroviejo, or Gillies are designed for small needles. Small skin hooks and tissue forceps hold the tissues atraumatically while the stitches are being taken. Iris scissors are ideal for trimming contused or macerated skin.

Skin edges on the face should be approximated with 6-0 nonabsorbable suture material. The various polymers, such as nylon, polypropylene, and Dacron, are inert, and although they do not tie as readily as silk, they are eminently more suitable as skin suture materials. Silk sutures tend to irritate the skin and thus require removal at around 4 days, whereas the synthetics may remain in place for 2 to 3 weeks if necessary. Four or more knots are necessary to prevent spontaneous untying of the suture. In oral mucosa, 3-0 or 4-0 chromic catgut is ideal, although it tends to unravel or dissolve prematurely. Many surgeons prefer silk because it tends to do well in the oral secretions, lies limp and flat, and is nonirritating. Dexon and Vicryl are important catgut substitutes and work well, although knots made with the former occasionally unravel. Subcutaneous sutures may be absorbable or nonabsorbable. Catgut, 4-0 or 5-0, is commonly used for these sutures, as are the above-mentioned synthetics. While 5-0 nylon is popular as a subcutaneous suture, it is important to tie it with the knot facing into the depths of the wound to prevent the tail ends of the suture from protruding toward the skin surface.

Small cutting needles are fairly atraumatic, especially when the sutures are swaged on. The oral mucosa is best handled with 3-0 chromic catgut sutures on a round-point

gastrointestinal needle. In the cramped confines of the nasal cavity, lacerations are best sutured with 4-0 chromic catgut on a micropoint needle. This half-circle cutting needle is small but stout and is generally used in dacryocystorhinostomy.

A dry field must be ensured before suturing. Ligature with 4-0 chromic catgut or cauterization with ophthalmic or bipolar cautery are the methods usually employed. Lack of adequate hemostasis may result in the formation of the hematoma, which may become infected and later form an ugly scar.

A layered closure involves placing sutures in each anatomic plane that has been incised. If a muscular or fascial layer has been violated, it must be sutured, as must the dermal layer, the subcuticular layer, and the epidermal layer. These sutures serve not only to coapt accurately each anatomic layer involved in the wound, but also to eliminate dead space where blood or tissue fluid may collect. They also assist in placing the skin edges in precise edge-to-edge contact.

Careful suturing entails taking an equal bite of tissue on both sides of the wound. This means that the suture must be at the same distance from the wound edge and at the same depth from the cutaneous surface on both sides of the laceration. Subcutaneous sutures should be placed approximately every 5 mm. They should hold the wound surfaces together so that the external skin sutures serve merely to coapt epithelial edges. The skin stitches should be placed about every 1.5 to 2.0 mm, about the same distance from the wound edge and not tied too tightly. This is a time-consuming enterprise that should not be attempted unless the surgeon is willing to spend the necessary time to do it correctly.

The skin sutures must be placed so that the skin edges are everted. If eversion is not effected and the wound edges are level, a depressed scar will result as healing proceeds and the wound contracts. Such a scar will cast a shadow, making it conspicuous. This eversion is produced by taking a wider bite of tissue in the depth of the needle's excursion than at the surface. The use of a skin hook greatly facilitates the placement of this suture. The hook puts traction on the dermis toward the wound and spares the epithelium the crushing trauma of tissue forceps. The suture needle is then driven into the tissue at an angle of 90 degrees to the epithelial surface. When the hook is relaxed, it is apparent that the skin suture runs a course that is wider in the depths than at the surface. When the suture is tied, this wider bite of the deeper tissue pushes the wound edges higher than the skin surface. Care is taken to ensure that the suture is symmetrically placed on each side of the wound. The laying down of a loose loop on top of the first throw of a surgeon's knot will allow the suture to slip during the postoperative period when edema causes tightening of the suture. This loop prevents the formation of a track mark from pressure of the suture against the skin.

Missing Tissue

There rarely is actual tissue loss in a facial wound. However, when tissue is missing and simple undermining of the skin locally will not effect adequate tension-free closure, the raw surface should be covered by a flap or a graft.

Skin Grafts

Skin grafts may be of partial or full thickness. The partial-thickness grafts may be classified as thin (8/1000 to 12/1000 inch), medium (12/1000 to 18/1000 inch), or thick (18/1000 to 28/1000 inch). Full-thickness grafts include both the epidermis and the dermis.

Partial-thickness grafts have the advantages of ready availability and good "take" on the recipient site. The principal disadvantages are contracture and poor color match. Because of this, the use of split-thickness grafts on the face after trauma is usually limited to those instances in which a tissue dressing is needed until a flap may be mobilized to reconstruct the defect. The thicker a split-thickness graft, the more closely it will resemble the qualities of a full-thickness graft.

Full-thickness grafts are superior to partial-thickness grafts in color and texture, and undergo less contracture. The major disadvantage is their relatively inferior "take" rate. These grafts are frequently used instead of flaps when skin has been avulsed in such areas as the lip or nose, eyelid, or eyebrow. Full-thickness grafts for use in the head and neck should be taken from an area that will provide a good color match. The postauricular and supraclavicular areas provide skin of excellent color and texture for resurfacing facial skin loss.

Thorough excision of fat from the undersurface of a full-thickness graft is essential to ensure adequate contact between the dermis of the graft and the recipient surface. Both partial- and full-thickness grafts should be kept in place with a tie-over bolster of cotton, gauze, or sponge rubber to facilitate the establishment of circulation and prevent the formation of hematoma. The bolster is removed at 10 days. The discolored appearance of the graft when the bolster is removed should not discourage the surgeon. Even grafts that are very dark often have a 100 per cent "take" rate.

Flaps

A much more satisfactory method of restoring avulsion defects is the use of local or regional flaps. The major disadvantage of flaps is the addition of incisions that increase the amount of scarring. There are three basic types of flaps: advancement, rotation, and transposition.

The simplest is the advancement flap. Two parallel incisions are made from each limit of the defect, and the underlying tissue is elevated until gentle traction will approximate the flap edge to the opposite edge of the defect. Dog ears created at the base of the flap may be eliminated by the excision of Burow's triangles. If the defect is too large to be accommodated by a single advancement flap, two flaps may be used from opposing sides of the wound.

The rotation flap is one of the best methods of closing a triangular defect. A semicircular flap, the diameter of which is roughly twice the width of the defect, is cut. This rule dictates a rather large flap and its geometry necessitates careful planning, so that the incision does not fall across too many natural crease lines in obvious areas. A back cut to enhance closure may be made at the base of the flap either toward or away from the defect. It is important to remember that a back cut made toward the defect narrows the flap's pedicle.

A Burow's triangle excised from the flap's base and away from the defect facilitates closure and eliminates any dog ear that may form there. This is an excellent flap in the scalp, or for moving tissue from under the chin or from the neck onto the face.

The transposition flap involves the swinging of a flap into a defect across healthy tissue. The donor site is closed primarily by undermining the edges or by skin grafting. The donor site is usually selected in a relatively camouflaged area in the neck or in an area where the suture line of primary closure will be in a natural crease. Major defects resulting from a gun blast or other severe mechanical trauma may be restored by a large transposition flap from the nape of the neck, supraclavicular area, or chest.

The bilobed flap applies the principle of two transposition flaps in tandem, arising from a common base. The larger flap fills in the primary defect, while the smaller flap resurfaces the defect left by the larger flap. The defect left by the lesser flap is closed by approximating its edges.

An ingenious application of the principle of the transposition flap is the Z-plasty, which is composed of two triangular flaps disposed around a common axis. This common central axis may be a scar, a small avulsion defect, a web, or a contracture. When the flaps are transposed, the defect is obliterated. The gain achieved by the transposition of the Z-plasty flaps is at the expense of tissue lateral to the original defect. The three limbs of the Z-plasty must be of equal length, but the angle of the two outside limbs to the central axis need not be the same. The ideal angle is 60 degrees; this will lengthen the original central limb by a factor of 0.73. As the angles are made smaller, the resultant lengthening diminishes and the amount of blood supply to the flap tips is less. When the angles are increased, the resultant lengthening increases, but the ease of transposing the flaps is diminished. In practice, these angles range from 20 to 75 degrees.

A popular type of combination transposition and advancement flap is the rhomboid flap. It may be used when the defect is in the shape of a rhombus. The flap is constructed by a line extended from any corner of the rhombus that is the same length as the short diagonal of the figure. A second line is drawn from the end of this first line that runs parallel to, and is the same length as, one side of the rhombus. This flap is transposed into the defect and the donor site is closed primarily. Once the flap is turned, careful attention must be made to the points of maximal tension so that their pull does not exert traction on vital areas, causing distortion. This flap is especially useful for defects near the eyelids.

Flaps are rarely used in primary facial laceration repair. For avulsive injuries, advancement of local tissue and skin grafts are usually employed. The reason for this is that contusive trauma to the tissues that will provide the donor material for the flap promote subsequent scarring. In any event, scar revision in traumatic lacerations is not uncommonly required. It is probably more appropriate to use flaps at the revisional stage. Other than massive avulsive wounds, the exception to this rule might be the management of the trapdoor laceration. The judicious deployment of multiple small Z-plasties at the most dependent portions of the skin flap may be used to break up the scar contracture and possibly preclude the subsequent formation of the trapdoor deformity.

Postoperative Care

Since absolute hemostasis must be secured before wound closure, no drains are usually required. The only dressing used is a layer of antibiotic ointment over the suture line. If a large flap has been elevated, and especially if there has been gross contamination of the wound, a 1/4-inch Penrose drain is placed and removed at about 24 to 48 hours. Gunshot wounds, and those in which there has been tissue loss with the potential development of a dead space, should also be drained. A light pressure dressing is applied to any wound that is drained or whenever it is necessary to help seat a flap. Tacking sutures from the flap to the deep surface of the wound also help fix it to its bed.

The patient should be instructed to keep the wound edges free of crusts, using cotton-tipped applicators in hydrogen peroxide. Antibiotic ointment applied three or four times daily will keep the wound free of infection and the skin soft and supple. It is wise to avoid immersion of the injured area in water until primary healing has taken place, because of the danger of infection. Alternate sutures are removed on the third or fourth postoperative day, and the remainder 1 or 2 days later. Once the sutures are removed, the skin is painted with tincture of benzoin, and Steri-Strips are placed across the wound edges for a period of several weeks. These are replaced every 48 to 72 hours. The purpose of this maneuver is to minimize tension on the maturing scar in those lacerations that cross natural crease lines.

The patient should be advised that the final appearance of the scar should not be judged for about 1 year. The scar for the initial 2 to 3 weeks is usually narrow and pink, but becomes somewhat wider and red over the ensuing 3 to 6 months. It gradually blanches as it matures, at around 12 to 18 months. Scar revision should be delayed for 12 months or longer, when maturation will finally have taken place.

Follow-Up

The repair of facial lacerations usually involves few complications. Most of these are the direct result of poor technique. The most common early complication is infection. It is important to reemphasize the importance of tetanus prophylaxis. Most infections that follow closure of facial lacerations are minor and easily treated by judicious removal of a few sutures to release any entrapped pus, followed by repeated cleansing and the local application of antibiotic ointment. A drain or packing is rarely required. Because of the rich vascular supply to the face, these infection tend to stay localized and should clear easily with vigorous local therapy. A systemic antibiotic is indicated only occasionally. One should not be lulled into a state of complacency, however, because disastrous progression can occur in neglected facial wounds.

Recalcitrant infections should raise the suspicion of a foreign body in the depths of the wound.

Slough of the wound edges or of small flaps involved in the repair may occur as the result of infection, trauma, or maceration of the skin or because of excessive tension in wound closure.

Poor blood supply to the area, especially in diabetic patients or in those with skin damaged by irradiation, may be the cause of major necrosis at the wound site. The slough should be treated by careful attention to the metabolic status of the patient, control of diabetes or restoration of a depressed hemoglobin level, and local therapy to control any existing infection. Any debridement should be avoided until a clean line of demarcation between dead and viable tissue ensues. Infection is usually easily controlled in these patients by the application of saline or acetic acid soaks. Once the sloughed area is debrided, the granulating wound, if small, can be left to heal by secondary intention; if large, it may be covered by a flap or skin graft.

Tattooing of the wound will occur if road tar or gunpowder is not adequately removed at the time of closure. This usually requires treatment by excision of the affected areas.

During the time the scar is maturing, it may be softened by gentle daily massage with cocoa butter or vitamin E cream.