Chapter 34

DELAYED SOFT-TISSUE INJURIES/REPAIR

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INTRODUCTION

Secondary soft-tissue reconstruction for facial wounds is one of the first reconstructive procedures ever reported. Nasal reconstruction in particular may be the very first reported use of flap reconstruction. Throughout history, in various parts of the world, nasal mutilation or nasal resection had been used as punishment for those accused of thievery and other crimes. As a result, some of these people sought reconstruction in an attempt to improve appearance and the stigma of punishment (ie, being identified as a criminal). Nasal reconstruction is believed to have been performed as early as 3,000 BCE. The first detailed description of surgical repair of an amputated nose using a cheek flap was described in the *Sushruta Samhita* (ca 600 BCE), an ancient Indian medical text originally written in Sanskrit.[1] This technique was then brought to Europe by Buddhist missionaries by way of Greece[1] and retained through the early Roman Empire.[1,2] However, with the decline of the Roman Empire, few medical advances, especially facial and flap reconstruction, were reported for a long period.[1,2]

Medical advances again developed during the Renaissance, paralleling advances in literature, art, and the sciences. Nasal reconstruction has traditionally been attributed to Gaspare Tagliacozzi in 1597, although it is now known that in the mid-15th century the Branca family of Sicily described the Indian method of nasal reconstruction and later Alessandro Benedetti described the same procedure in 1502.[3] This is also the first known example of distant pedicle flap reconstruction.[4] The origin of the word *flap* appears to have been derived from the 16th-century Dutch term *flappe*, which meant something broad, loose, and attached on one side.[5]

The spread of medical literature in the 19th century advanced facial flap reconstruction, and variations of local and pedicled flaps were reported by various authors, including Joseph Carpue (midline forehead flap) and Johann Dieffenbach (local cheek flaps). William E Homer described the Z-plasty principle in 1837, and Jacob A Estlander described lateral lip reconstruction in 1872.World War I and World War II time periods saw a dramatic expansion in the use of local and pedicled flaps. In 1917, Harold D Gillies described the tubed pedicled neck flap for head and neck reconstruction. In 1921, Vilray P Blair described the principle of surgical delay, which allowed further lengthening of fasciocutaneous flaps and reconstruction of larger and distant defects. In 1925, Blair[6] reviewed nasal reconstruction techniques and concluded that forehead flaps work best for most major nasal defects. From World War II through the Vietnam War, care of combat trauma generally involved wound care and secondary flap transfer (and bone grafting, if required) at a later date. External skeletal fixation was utilized extensively, which further complicated any immediate or early flap reconstruction due to physical problems with external devices and the delay for bony union to occur. The use of internal fixation has allowed early reconstruction, which may prevent soft-tissue envelope collapse and scar contracture.

In the 1950s, a novel concept of separation of tissue followed by reattachment using vessel-to-vessel approximation, similar to replant surgery, was developed; this technique is now described as microvascular free tissue transfer. Julius H Jacobson and Ernesto I Saurez adapted otological microscopes for vascular work, and later Carl Zeiss developed a double-opposing binocular microscope. The first microvascular free tissue transfer reconstruction (free flap jejunum for esophageal reconstruction) was successfully performed in 1957 by Max Som and Bernard Seidenburg. The following year, Harry Buncke developed swaged microsuture, another significant advancement in technique. At that point, microvascular surgery for head and neck reconstruction would have been expected to gain widespread acceptance, but it did not. This was because other head and neck reconstruction flaps created around the same time were reliable, simple to harvest, and required no special equipment.

Two significant *workhorse* flaps described included the deltopectoral flap in 1965 by Vahram Bakamjian[7] and the pectoralis major flap for head and neck reconstruction (reported by Ariyan[8] in 1979). Eventually, microvascular surgery became popularized because of the advances in technique, equipment, and literature. It is now an accepted option for secondary reconstruction and utilized extensively. Advances in personal protection also influenced the need for head and neck trauma reconstruction. Flak jackets were common for use by Marines in Vietnam, but only gained limited acceptance throughout the military. In the late 1980s and early 1990s, advances in body armor progressed to the point that Kevlar (DuPont, Wilmington, DE) and ceramic plates were used. The first use in combat of modern body armor was in October 1993, with the Rangers in Somalia. Since then, body armor has continued to improve and, as a result, usage has become widespread. Because of the common use of body armor, the demographics of war trauma has changed in that more people are surviving with significant facial wounds who would have otherwise had nonsurvivable injuries. Advancements in the last two decades with respect to tissue transfer and grafting have further refined outcomes, and there has been a gradual trend toward

- early flap reconstruction,
- increasing use of microvascular techniques,
- tissue substitutes,
- synthetic fillers,
- lasers, and
- other nonsurgical treatments.

Tissue engineering is also an active area of research. The most notable, recent advancement in secondary facial reconstruction is facial transplantation.

SECONDARY RECONSTRUCTION TECHNIQUES AND PROCEDURES

Secondary reconstruction of facial soft-tissue issues generally falls into three categories: (1) soft-tissue absence, (2) treatment of scarring, and (3) functional problems. Soft-tissue absence requires either filler or some type of flap to add volume back. Scar-related issues fall into two broad categories: (1) functional and (2) aesthetic. Functional scar revision involves release of scars due to tethering or transfer of adjacent tissue to improve pliability, function, and volume redistribution. Aesthetic scar revision commonly involves direct scar revision in an attempt to improve scar appearance. This may include procedures such as direct excision, local tissue rearrangement, dermabrasion, or even laser resurfacing. In select cases, scarring can be severe enough to warrant excision and skin grafting, tissue expansion, or major flap procedures. However, in most cases, there is some component of overlap in the indications for revision. Finally, functional problems, which include swallowing, chewing, and speaking, are the final indication for secondary repair of facial soft tissues.

This section provides supplementary guidance for second-stage or revision procedures of soft-tissue injuries, such as direct scar revision, local tissue transplantation, skin grafting, delayed use of tissue substitutes, composite grafting, autologous fat transfer, injectable fillers, tissue expansion, secondary flap release, and flap coverage. There is also additional focus on "bail-out" options, which includes a revision of problems due to prior procedures or techniques that would not be appropriate as first-stage procedures.

Direct Scar Revision

If the scar appears irregular and has evidence of hypertrophy and/or tattooing, it may be reasonable to perform simple scar excision. Chronic inflammation from prior wounding and debris with devitalized wound edges may be improved by simple excision of tissue and meticulous reapproximation. It has been reported that wounds treated within 24 hours of debris implantation do substantially better than those treated with delayed care.[9] It is common to excise these scars and find a palpable "grit" sensation during scalpel excision from the embedded debris. There should be an attempt to remove the minimal amount of tissue necessary to enter relatively normal tissue for reapproximation. It has been suggested that tattoo pigment may be removed by microexcision with good results.[10,11] When possible, avoid undermining these areas because they may have marginal vascularity, and there may also be a need for additional revision later. In some cases, this cannot be avoided, but use judgment regarding the degree of tension and limit undermining that may be unnecessary. Avoid "bridge burning" and think about future surgery that may be needed when planning the degree of excision and undermining.

Most simple scar revisions or tattooed debris removal can be performed under local anesthetic with sedation. Topical anesthetic can be applied for minimal procedures (eg, limited dermabrasion) or local blocks for regional anesthesia. If the duration of procedure is lengthy or there are extensive areas to revise, it may be reasonable to do select cases under general anesthetic. It is wise to be prepared to use an injectable steroid (Kenalog 10 or 40 with lidocaine) in the weeks following surgery, if hypertrophy manifests. Silicone sheeting, occlusive dressings, and in rare cases facial pressure garments may be useful. In select cases, there may be a role for laser resurfacing or dermabrasion at a later date.[12–15] If the scar is in a cosmetically undesirable orientation, it may be reasonable to do geometric broken line or W-plasty closure to reduce linearity of the scar. This does not lengthen the scar, but it may break up obvious scarring and partially orient some of the scar in a more favorable orientation. A secondary benefit is that the scar tends to stretch somewhat with tension because of the limited accordion effect rather than produce traction as a result of a straight-line scar.

Local Tissue Transposition

There are a variety of local tissue rearrangement options, including

- rotation advancement,
- advancement flaps,
- H-flaps (double advancement),
- rhomboid transposition flap,
- Z-plasty, and
- variations.

These local transposition flaps can be divided into two functional categories: (1) treatment of skin defects and (2) release/reorientation of existing scars or

tension lines. In general, the choice of flap in both cases should orient final scars into relaxed skin tension lines, if possible, and not result in unfavorable contracture (eg, ectropion). The base of the elevated flap should be oriented in an area that appears to have a reliable blood supply and pliability. The raised area of each flap is based off of the dermal-subdermal plexus, which is reliant on fasciocutaneous or musculocutaneous perforators. Thus, these flaps should be elevated deep to the dermal subdermal plexus, in the immediate subcutaneous fatty layer. In general, use the "cut as you go" technique, only undermining and back cutting the areas required to get release and rotation. On a practical note, it is technically difficult to rotate scarred or wounded skin, and angles greater than 45 degrees may be difficult to rotate. Rotation advancement, rhomboid, and H-flaps all rely on advancement, rotation, or transposition of adjacent skin and soft tissue into a wound. It is fairly unusual to do this in delayed trauma reconstruction because the problem is usually scar contracture or lack of tissue. The main reason to perform this in secondary surgery would be because of small defects created by scar excision.

Traditional Z-plasty is a common procedure in revision surgery of facial and neck scars. It is used to break up the outline of a linear scar, increase scar length, or reorient a portion of the scar into a more favorable orientation along relaxed skin tension lines. The planned Z-plasty should be carefully marked to ensure that the base of each transposition flap has an adequate blood supply. The scar should also be evaluated for best orientation of Z-plasty because there are different ways to Z-plasty the same scar. Theoretical lengthening of the scar is commonly described as 30-degree angles gain 25% length, 45-degree angles gain 50% length, 60-degree angles gain 75% length, and 75-degree angles gain 100% length. A series of smaller Z-plasties can be connected for long linear scars to avoid larger flaps that may have an obvious geometric appearance and cross-anatomical subunits (a running Z-plasty). The following case illustrates how z- plasty can significantly lengthen scars and improve scar contracture.

Case Details—*A 10-year-old Afghan girl was burned several years prior. She underwent wound care. As she grew older, she developed worsening scar contracture on the left side of her neck and face. Scar excision and local tissue rearrangement (running Z-plasty) were performed to lengthen the scar. The final result showed that improved contour and range of motion were dramatically improved. She also underwent scalp tissue expander placement in the same setting for later expansion and advancement. (See Figures 34-1 to 34-5.)*

Skin Grafting

In severe cases, the degree of scarring may be difficult to deal with, particularly if there is a component of the burn that is common in war wounds. A full-thickness skin graft harvests the entire thickness of skin to include the dermis whereas a split-thickness skin graft leaves some portion of the dermis and dermal appendages intact to allow reepithelialization. Full-thickness grafts require either direct wound closure or secondary grafting of the donor site with a split graft. Thus, a split graft donor site can usually just be dressed and allowed to heal secondarily. Full-thickness grafts generally do not contract to any significant degree. However, split grafts have some secondary graft contracture after "take." The degree of contracture is dependent on the percentage of retained dermis in the skin graft. Take rate is generally considered to be better in split-thickness grafts, and this is likely due to better nutrient diffusion and oxygen exchange because the graft is simply thinner. All skin grafts take in the same manner: initial nutrient and oxygen diffusion (plasmatic imbibition), inosculation (connection of existing donor and recipient blood vessels), and neovascular budding (new vessel ingrowth).

In general, full-thickness grafts have better pliability, two-point sensory discrimination, and the possible ability to sweat and secrete lubricants. In facial grafting, split grafts may cause later distortion because of lack of pliability and secondary contracture. Certain areas are particularly problematic with secondary distortion (eg, the eyelid). It is important to note that it is the percentage of dermis and not the graft thickness that results in contracture. A thick graft from the back may only contain 50% dermal thickness and still contract, whereas a thin upper eyelid graft (which is still full thickness) may not distort at all. In severe scarring—such as diffuse, severe shrapnel injury with secondary debris—it may be reasonable to completely excise the scarred skin similar to a burn debridement and sheet graft. Cosmetic results of isolated skin grafts may not be optimal, and one should attempt to resurface within the boundaries of anatomical subunits when possible.

Resurfacing an entire subunit (eg, mentum) tends to make the result more uniform and less obvious than the appearance of an isolated irregular patch of skin crossing boundaries. The down side of this technique is that it may have color match issues and is usually nonhair-bearing in males if the graft is applied to the beard area. Skin grafting can be done as split graft or full thickness, depending on the depth of wounding

Figure 34-1

Figure 34-2

Figure 34-4

Figure 34-3

Figure 34-5

Figures 34-1 to 34-5. Z-plasty for significant contracture.

and location. When the graft is applied to the face and neck, care should be taken to affix the graft either by direct approximation with suture or external fixation with bolster or negative pressure dressing. Fluid collection under graft and shear will both cause graft failure. Skin grafting is a common procedure in early secondary reconstruction and can be used as a temporizing procedure for wounds that will not completely close or for wounds in which closure will cause distortion. As a soft-tissue revision procedure, it can be useful for the resurfacing of severely scarred skin with poor local tissue transfer options. Skin grafts can be easily removed later and more elegant procedures performed in a delayed fashion. Eyelid asymmetry can be corrected by grafting from the opposite eyelid to produce symmetry and improve function of an eyelid with deficient or significantly scarred anterior lamella. Alternatively, a lateral-based upper eyelid flap can be used to correct ectropion or lower eyelid defects via transposition. Some scars may cause distortion from tension, and this can be particularly problematic for the lower eyelid. In select cases, lower eyelid skin grafting may be preferable to local tissue transposition because transposition may cause persistent tension. The following case shows eyelid malposition due to tension and the need for release and skin grafting. When possible, hair-bearing tissue should be used for eyebrow reconstruction. This can be done as a hair-bearing, full-thickness graft with hair growth oriented laterally or as micrografts.

Case Details—*A 58-year-old male presented with a large, left malar skin defect. He underwent a cervicofacial advancement flap procedure with delayed distortion of the lower eyelid after healing. The wound released to improve ectropion with a full-thickness graft from the opposite upper eyelid. (See Figures 34-6 to 34-9.)*

Delayed Use of Tissue Substitutes

A dermal regeneration template product, comprised of collagen/glycosaminoglycan with an overlying silicone barrier layer that retains moisture and acts as a barrier to infection, can be utilized. This is also described as a bilaminate tissue substitute, using the trade name Integra (Integra LifeSciences Corporation, Plainsboro, NJ). This product allows vascular ingrowth into the glycosaminoglycan layer, facilitating the creation of a vascularized neodermis

Figure 34-6

Figure 34-8

Figure 34-7

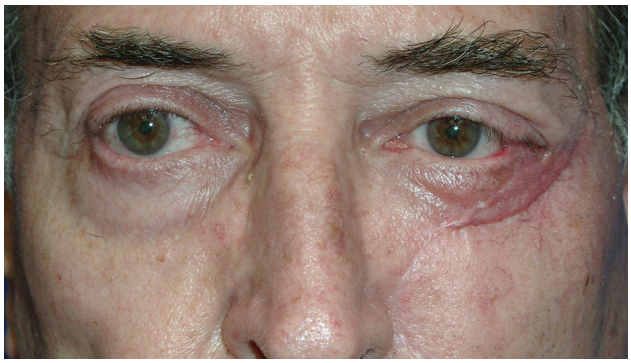

Figure 34-9

Figures 34-6 to 34-9. Early skin graft to improve distortion.

and coverage over structures. In some cases, this may allow coverage over tendon or bone. Integra requires a healthy, vascularized wound bed with minimal debris. It is applied directly on the wound, and a bolster or negative pressure device is applied to prevent shear. Vascular ingrowth occurs, and the inner layer becomes adherent to the deeper wound in approximately 2 to 3 weeks. When fully vascularized, the outer silicone layer is removed, which allows the use of split-thickness skin grafting instead of full-thickness grafting. This may be particularly helpful when the ability to harvest full-thickness grafts is limited, or even when donor areas in split grafts are limited and require thinner grafts with less proportion of the dermis in the graft. It is suggested that clinical outcomes may be improved compared with stand-alone split-thickness skin grafting to the face in burns[16] or forehead defects created from forehead flap harvesting.[17] In general, this product is reported to be favorable in contracture release. Frame et al[18] looked at a series of 127 contracture releases in 89 patients and reported no contracture recurrence in 75% of the sites (primarily extremity contractures). However, Hunt et al[19] looked at contracture and cosmesis with the use of Integra for neck contractures. Although they reported improvement in cosmesis and scarring, they also reported recurrence of contracture in more than 50% in all patients (a series of five patients). Hunt et al felt the contracture recurrence was because of difficulty in immobilizing Integra in a neck wound.

Acellular dermal matrix is also used in secondary head and neck reconstruction. This product is a cadaver harvest dermis that is reprocessed and implanted into wounds. It undergoes gradual vascular ingrowth and incorporation into the local tissue. Histological evaluation suggests that it is comparable with normal connective tissue once completely incorporated. It may be used for fascial replacement or barrier creation to prevent Frey's syndrome or for suspension of facial soft tissues in posttraumatic facial paralysis.[20,21] This product is known as AlloDerm Regenerative Tissue Matrix (LifeCell Corporation, Branchburg, NJ). Acellular dermal matrix can be directly implanted into a wound, or, in select cases, may be onlayed onto the wound and allowed to granulate secondarily. When used for facial suspension or correction of facial paralysis, it is generally used as an alternative to tensor fasciae latae or some other tissue used for suspension. There is a small degree of volume added to a wound with the incorporation of this product, but it is not primarily used as a filler for large-volume defects. There are other tissue replacement substitute products as well. However, cadaveric dermis is the most well-known.

Composite Grafting

Selected areas of the nose may do well with composite auricular grafting. Specifically, the alar margin is a common area to graft.[22] The graft is typically harvested from either the superior helical rim with an advancement closure, or the anterior helical insertion at the concha cavum and cymba junction. The maximal survivable width of a graft is reported to be up to 10 mm and, in some cases, 15 mm.[23] However, in trauma cases, the base of the wound is an established scar and may not support a graft that large. The graft can be inserted with a larger cartilaginous component extending into a surrounding pocket similar to an alar batten graft. Composite grafts can also be used for localized defects of the columella.

When affixing the graft, there should be a meticulous soft-tissue closure. Care must be taken to ensure that there is no fluid collection that may interfere with incorporation. It is important not to apply a pressure dressing to the graft, but to protect the wound and avoid manipulation for at least 5 days. A generous coating of Bacitracin ointment or something similar will keep bacterial colonization down and provide a moisture barrier dressing. The donor site can usually be closed primarily with absorbable sutures. The graft will initially look pale and will then turn pink by approximately day 5. There may be some epidermolysis and partial graft loss. Early debridement is to be avoided because this appearance can sometimes be misleading, and the ultimate graft take may be better than expected. Suture removal can be performed after obvious graft viability (usually within 7 days). An example of free tissue graft use is shown in the following case.

Case Details—*A 63-year-old female presented with a composite graft to the left nasal ala for staged upper lip and nasal reconstruction. (See Figures 34-10 to 34-12.)*

Autologous Fat Transfer

The technique of small-volume, widely dispersed fat grafting was described as "structural fat grafting" by Clauser et al[24] and Coleman.[25–27] All aspects of this technique will not be covered in this chapter (but see references for additional points). Structural fat grafting uses a minimally invasive fat harvest technique utilizing a standardized harvest cannula and processing fat to optimize graft viability. Very small volumes of fat are injected by microcannula to fill in small depressions or to make a diffuse cross-hatch pattern in multiple depths to allow generalized volume addition. The take rate is variable, but it is generally suggested that it may

Figure 34-10

Figure 34-12

Figure 34-11

Figures 34-10 to 34-12. Composite graft to nasal alia.

be higher than larger volume injections. In most cases, injections are performed as a series of three or four procedures until the desired volume and contours are achieved. It has also been suggested that autologous fat transfer may be more than a volume-adding procedure. Moseley et al[28] suggested a component of what occurs may also be the incorporation of adipose-derived stem cells resulting in tissue repair and regeneration, not just filling. Sultan et al[29] reported that reversal of tissue damage in significantly injured, radiated tissue occurs with fat injection. This may be comparable with the significantly wounded or scarred facial tissue, although there is no literature on that exact topic as this chapter was being written. Remarkable improvements in volume and symmetry have been reported, and this may be an alternative to a buried flap (eg, omentum) for volume addition. The procedure is relatively benign and is usually performed in an outpatient setting. The down side of the procedure is that it takes multiple grafting sessions in most cases.

Injectable Fillers

Local filler injections may be an option for small soft-tissue defects (depressions). There are a variety of injectable substances that are approved by the US Food and Drug Administration (FDA) and used primarily for treatment of facial aging. The most common product is hyaluronic acid, but there are variations of this product and duration of persistence is based on the degree of cross-linking. Hasson et al[30] suggests that this may be a reasonable treatment for small atrophic or depressed scars. Eventually, these products degrade and are resorbed, but they may be a reasonable choice for limited soft-tissue contour irregularities in a patient who may wish to have a minimal procedure and understands it will be temporary. Hyaluronic acid is the normal interstitial ground substance in tissue, and the likelihood of a reaction or complication is low. However, in rare cases, foreign-body granuloma response has been reported.[31] It is injected in small volumes directly into the depressed area into the deep dermis or subcutaneous tissue. Injection training videos for Juvéderm (Allergan, Inc, Irvine, CA) or similar products can be found online for more specifics on exact injection techniques.

There are also some longer lasting (possibly permanent) fillers that include micronized decellularized dermis (Cymetra, LifeCell Corporation, Bridgewater, NJ), micronized hydroxyapatite, and micronized polymethyl methacrylate. These substances are injected in a similar fashion, but in a deeper plane. The main risk of decellularized dermis is that a delayed immune response can present and result in erythema to the injected area. This should eventually resolve itself as

the graft is remodeled into normal connective tissue. Micronized hydroxyapatite or polymethyl methacrylate can also develop a delayed encapsulation response resulting in some palpable nodularity.[32] It has also been suggested that micronized hydroxyapatite can migrate.[33]

Poly-L-lactic acid (PLA) is an injectable micronized substance that is similar to VICRYL suture (Ethicon, Somerville, NJ). This substance elicited an immune response and subsequent deposition of connective tissue weeks to months after injection. Injections of this material are substantially deeper than traditional dermal fillers and spaced out for 6 weeks or more between serial injections. VICRYL suture is marketed as Sculptra Aesthetic (Valeant Pharmaceuticals International, Inc, Bridgewater, NJ) and requires specific training by the company prior to use. The product became FDA approved for use in August 2004 for HIV (human immunodeficiency virus)-associated lipoatrophy, but it is currently used as a large-volume filler in cosmetic patients who desire restoration of malar, cheek, or jawline volume. In select cases, it may be useful as an alternative to other volume correction procedures. However, immune response and subsequent volume increase are directly related to the volume and distribution of injected PLA. It is important to be cautious during injection in complex scar areas because the volume may be contained within select scar boundaries and later lead to irregular volume gain. Fillers and PLA in particular may be a good minimally invasive method of addressing posttraumatic or postsurgical temporal hollowing following bicoronal flap elevation. The author had previously placed implants for volume correction in this area, but is currently using fillers in select cases. If fillers are used, however, extend caution in craniotomy patients during injection because skull defects exist. In general, PLA is injected immediately periosteally and deep into the temporalis in the temporal fossae for this particular volume correction.

Tissue Expansion

Tissue expansion for head and neck reconstruction is a useful technique. By expanding surrounding tissue, the tissue used in closure will cover a greater area, have good color match, and can result in a closure with minimal tension (and thinner scars as a result). Neck skin can be easily expanded and transposed onto the face with good results so that the expansion can also be done remotely.[34] The ability to expand native tissue also reduces the need for a donor site. The need for scalp tissue expander is common because there is limited tissue laxity in the scalp, and local flap usage can be difficult. Tissue expansion also works particularly well in the scalp because it allows expansion of hair-bearing tissue to cover areas of the scar or alopecia. Also, a tissue expander can be utilized in the forehead prior to harvest of a forehead flap for nasal reconstruction.[35,36] When a tissue expander is placed, care should be taken to use an access scar or entry incision that will not create problems after expansion. In general, utilize existing scars at the wound margin that will be removed after expansion. The smaller the entry incision, the lower the complication rate (extrusion). Consequently, these implants can be placed using endoscopic assistance to reduce skin incision length.[37] The expander will likely need to remain in situ for approximately 4 to 6 weeks prior to initiation of expansion to allow wound closure. Expansion is then done on an approximate weekly basis by adding volume to the point of patient discomfort or reduced perfusion to the overlying tissue (decreased capillary refill). Aggressive expansion is avoided because this will likely cause complications. Smaller volumes injected more frequently are usually a wise choice. The amount of expansion is a judgment call, but, in general, it is essential to try and exceed the amount of tissue required by approximately 30% of the estimate. The expanded tissue will recoil fairly quickly, and temporary redundancy is generally not a problem. However, underexpansion and an inability to close or advance tissue as far as desired can be problematic. Secondary expansion of a previously transferred musculocutaneous flap in order to reinset and release neck scar contracture has also been reported.[38] Tissue expansion may also be required prior to secondary cranioplasty or cranial reconstruction. The following case shows use of a tissue expander in the scalp.

Case Details—*A 23-year-old active duty male sustained a significant scalp degloving injury. He was treated with wound care and skin grafting, and is 1-year postinjury at presentation. He had diffuse scarring and lack of mobility of the area surrounding the skin graft, as well as scar alopecia. He underwent tissue expander placement and generous excision of the skin graft and surrounding scar alopecia area. (See Figures 34-13 to 34-16.)*

Secondary Flap Release

It is common that the first major surgical procedure in the acute care of ballistic facial injuries with soft-tissue loss will be some type of tissue transfer to improve lost volume and skin or oral surface lining. Select patients will require pedicled flaps for reconstruction to include pectoralis and latissimus myocutaneous or myofascial flaps. In some cases, there may be distortion of the inset skin/soft-tissue paddle from traction or gravity along the pedicle. Pedicled flaps also have some limitations in the orientation of skin paddle positioning because of the requirement for an intact

Figure 34-13

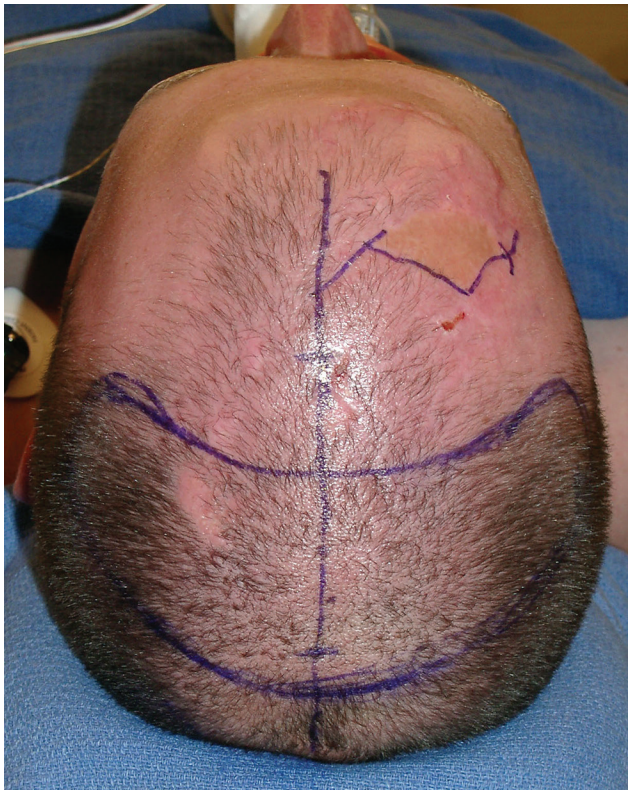

Figure 34-14

Figure 34-15

Figure 34-16

Figures 34-13 to 34-16. Tissue expansion.

pedicle (which may impair rotation or aligning). The pedicle itself may cause traction or distortion as scar maturation or settling occurs along the tunnel of the pedicle. Before proceeding with fine detail scar revision and further refinement of the direct wound, it is imperative that any traction or distortion of the distal flap be addressed prior to secondary scar revision of the actual flap. This may require direct excision of the pedicle or possibly revision of the prior inset to fully release. It may be possible to perform partial pedicle release without fully transecting the vasculature. An inspection of the pedicle is necessary to confirm that it has been denervated as well because this can cause delayed problems. A limited surgical exploration near the proximal pedicle may result in significant release and relaxation of the distal flap with just nerve transection. In some cases, the release may be generous, but skin release along the pedicle tunnel will also be required. It is important to attempt to perform this as far away from the primary wound as possible (near the proximal pedicle). Most likely, a skin graft will then be required to back graft this area. Remember that split-thickness grafts may again secondarily contract, so use thick split-thickness or full-thickness grafts, if possible. Confirm that tissue healing and scar contracture are again stable prior to final revision of the inset area because tissue may still migrate because of scarring or gravity even months later. The following case illustrates problems that can occur due to soft tissue contracture and correction that may be required.

Figure 34-17

Figure 34-18

Figure 34-19

Figures 34-17 to 34-19. Pedicle release.

Case Details—*A 23-year-old Afghan male underwent a gunshot wound to his right face with extensive soft-tissue loss. A pectoralis flap was used for immediate reconstruction. The patient returned approximately 3 months later with soft-tissue contracture and distortion, partially due to the flap pedicle. The pedicle released, and the skin graft was placed in a resulting defect to improve soft-tissue positioning. (See Figures 34-17 to 34-19.)*

Flap Coverage

There is an extensive body of literature with regard to flap classification that is beyond the scope of this chapter. A condensed version of this classification includes fasciocutaneous and musculocutaneous flaps. Axial pattern fasciocutaneous skin flaps have a defined vascular basis beneath the subdermal plexus in axial orientation (commonly incorporating a defined angiosome). This is generally described using the Cormack and Lamberty classification.[5]

- Type A has multiple fasciocutaneous perforators entering the base that extends longitudinally.
- Type B has a single perforator that continues through the flap.
- Type C has multiple septal perforators with a single supplying vessel.

Musculocutaneous flaps are commonly described using the Mathes and Nahai[39] classification.

- Type I: single vascular pedicle (eg, temporoparietal fascia flap).
- Type II: single dominant and lesser segmental vessels (eg, gracilis).
- Type III: dual dominant pedicle (eg, rectus, Abbe flap).
- Type IV: segmental perforator (eg, sartorius).
- Type V: single dominant with reliable secondary segmental pedicles (eg, pectoralis, latissimus).

Select flaps that may have utility in secondary head and neck reconstruction are described in the upcoming sections.

Lip Reconstruction

Lip transfer procedures, such as Abbe or Estlander flaps for lip defects greater than one third of the lip width, are common for injury with partial lip loss and in most cases performed as the first major reconstructive procedure. In select cases, it may be reasonable to perform lip advancement or switch procedure as a secondary revision to equalize the amount of soft tissue distributed between the upper and lower lips, and to improve oral function and appearance. Other more advanced reconstructive techniques (eg, Karapandzic flaps or similar) can also be performed as secondary procedures, in extreme cases during revision surgery. With severe avulsive oral defects, it is not uncommon to require major flap reconstruction (ie, a fibular free flap with skin paddle) and then need secondary lip reconstruction. A decision should be made at the first major surgery as to whether a closure procedure will result in a functional problem (eg, microstomia) and if soft tissue must be transferred into the wound instead of closure procedures. Oral and perioral revision procedures are commonly required as a result of a flap inset or closure procedure. Specific problems to be addressed are usually incomplete oral sphincter or functional issues (eg, scarring or microstomia). Secondary closure for oral incompetence commonly involves lip advancement procedures based off of the labial artery on the contralateral side. Goldstein[40,41] described the arterialized vermillion musculomucocutaneous advancement technique wherein a flap containing the labial artery can be advanced to correct vermillion loss. If there is a question as to whether the labial artery is intact proximally, gentle pressure with the fingers or a vascular clamp can be performed at the area of planned division, and a Doppler scan can be used to check the persistence of a pulse in the distal pedicle preoperatively. This is a useful technique to advance vermillion across a previously placed soft-tissue flap and restore oral competence. A modification of the Goldstein method has been described to reconstruct the commissure.[42]

Commissuroplasty is a procedure that is helpful for microstomia management and cosmesis.[43] It may also be required in the care of burn patients.[44] Ensure that no additional major soft-tissue revisions are required prior to definitive commissuroplasty. Multiple variations of commissuroplasty have been described and include techniques by Fairbanks and Dingman, Converse, Gilles and Millard, Kazanjian, and Roopenian/Anderson and Kurtay. Do not perform commissuroplasty during the initial repair to ensure that no additional lip revisions are required because it commonly transects the labial artery. Intraoral vermillion advancement can also be used to correct scarring and lack of pliability at the commissure. Severe oral injuries with massive soft-tissue loss may require an advanced procedure, such as a palmaris sling and a soft-tissue augmentation flap.[45] It has been suggested that oral competence is improved with an innervated dynamic free flap (eg, gracilis).[46] There may be a role for touch-up revisions or commissuroplasty in these cases as well.

Figure 34-20

Figure 34-21

Figure 34-22

Figures 34-20 to 34-22. Small lower lip defect closed with the Goldstein method of lip advancement.

Case Details—*A 58-year-old female presented with a cancer defect involving the upper lateral lip, commissure, and nasal ala. Photographs show planning of the lateral nasal flap and the Estlander flap. Rounding of the commissure is addressed with commissuroplasty. (See Figures 34-20 to 34-27.)*

Bakamjian/Deltopectoral Flap

Described in 1965 by Bakamjian and initially devised as a method of pharyngeal and cervical esophageal reconstruction, it became the premier reconstruction flap for complex head and neck defects until the late 1970s. Andrews et al[47] suggest there is still a role for this relatively simple flap, and it should be considered as a backup if needed for situations that do not allow modern reconstruction techniques. This flap is good for transferring skin and subcutaneous soft tissue to the lower and midface regions as a tubed pedicle that is later divided. The flap is based off of the 2nd and 3rd intercostal perforators as they arise off of the upper internal mammary vessels. They come directly out at the depression between the costosternal junction and the lateral sternal border. The angiosome supporting this flap runs axially and is very reliable up to the deltopectoral groove. At that point, the flap has a random dermal-subdermal plexus blood supply, but is reliable to approximate the anterior deltoid region. If a pectoralis major flap is elevated, care must be taken to preserve the blood supply along the sternal border because this flap can be used in addition to a previously harvested pectoralis flap. If needed, a delay procedure can be used to further extend the distal aspect of the flap and allow it to reach the midface or higher.

This flap is commonly transferred as a tubed pedicle with a second-stage release. However, it can be deepithelialized and transferred under a skin envelope with a distal skin paddle. If tubed, the flap is usually left in situ for 3 weeks prior to flap division and pedicle reinset. The donor site is usually covered with a split-thickness skin graft. When pedicle division occurs, the residual

Figure 34-23

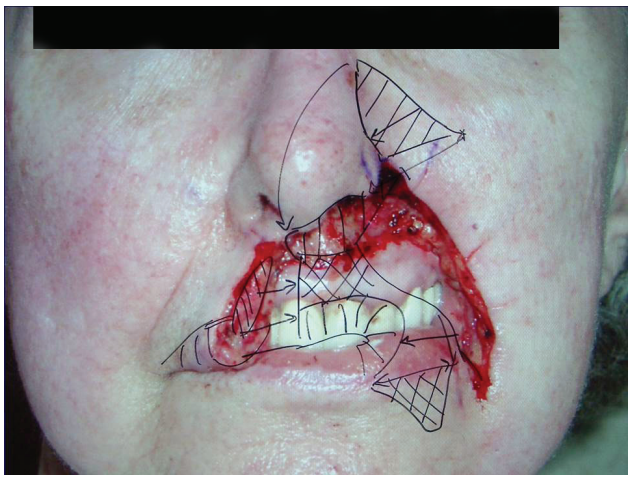

Figure 34-24

Figure 34-25

Figure 34-26

Figure 34-27

Figures 34-23 to 34-27. Planning of lateral nasal flap and Estlander flap.

Figure 34-28

Figure 34-29

Figure 34-30

Figures 34-28 to 34-30. Deltopectoral flap markings.

unused pedicle is reinset into the chest after deepithelializing the skin grafted area. Cervical tubed pedicle flaps are similar to deltopectoral flaps in design and can be transferred as a *walking flap* in unusual circumstances. It is fairly uncommon to use these flaps today, but they should not be forgotten as bail-out options.[48]

Case Details—*Deltopectoral flap markings, inset, and release (different patients). (See Figures 34-28 to 34-30.)*

Cervicofacial Advancement Flap

The cervicofacial advancement flap is an anteriorly based "facelift" flap that is extended down onto the neck. It can extend as far laterally as the lateral deltoid and incorporate the 2nd and 3rd intercostal perforators similar to a deltopectoral flap. Based anteriorly like a facelift flap, it can dramatically advance soft tissue to fill midface and preauricular soft-tissue defects.[49] This flap is particularly helpful for upper midface problems, such as skin loss or severe scarring. It can also be preexpanded with a tissue expander prior to rotation advancement. Significant skin defects or tissue tension can be addressed because this flap can be advanced with good color match and cosmesis. In cases of significant tissue malposition, it can add additional fascial support or elevation (eg, tensor fascia latae) prior to flap advancement and inset.[50] An example of a cervical facial flap follows in the case detail.

Case Detail—*Right facial defect amenable to a cervicofacial advancement flap from skin cancer resection is presented.* (*See Figures 34-31 to 34-34.)*

Paramedian Forehead Flap

This is the workhorse flap for nasal external reconstruction. Originally, it was described as a two-stage procedure with pedicle elevation and inset followed by division of the pedicle at approximately 2 to 3 weeks. However, this flap has evolved into a three-stage procedure as described by Menick.[51] The intermediate stage is a thinning and contouring procedure with reinset, thus resulting in better contours

Figure 34-31

Figure 34-33

Figures 34-31 to 34-34. Right facial defect with cervicofacial advancement flap.

and appearance. Delay of reconstruction or staging reconstruction over several operations may also be advantageous and have better outcomes than one single flap elevation, although this is generally not necessary. Tissue expansion of forehead flap donor sites has also been described.[35,36] The flap is generally elevated in a supratrochlear linear pedicle, transitioning to a subcutaneous plane distally. It is rotated onto the nasal defect, and the pedicle is loosely dressed. This flap may require deinsetting if congested or require application of topical nitropaste. The donor site is partially closed, and the superior aspect is allowed to heal secondarily. The subunit principle is utilized when designing and insetting the flap. The proximal pedicle is usually reinset after division, and eyebrow symmetry is improved. The following case details paramedian forehead flap.

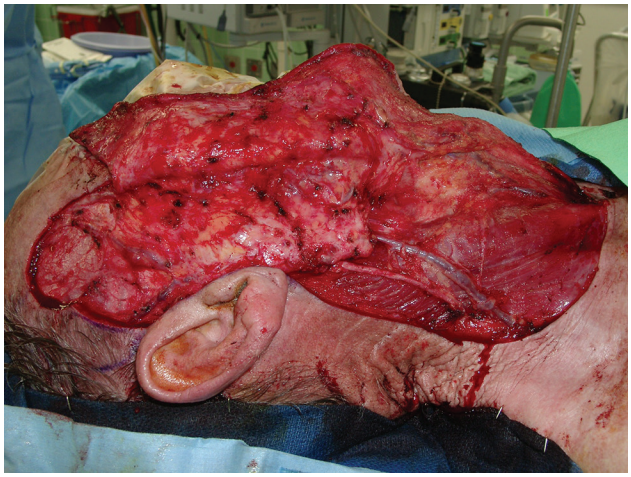

Figure 34-32

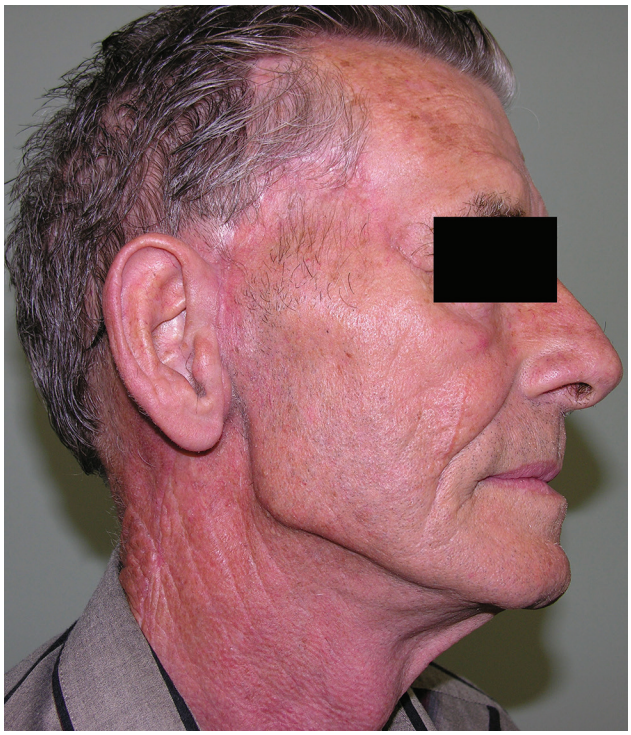

Figure 34-34

Case Details—*Paramedian forehead flap inset and second-stage thinning are presented. (See Figures 34-35 to 34-37.)*

Temporoparietal Fascial Flap

This is a fascial flap only, lying deep in the scalp but superficial to the temporalis fascia. It has a reliable blood supply based off of the superficial temporal vessels, but occipital vasculature can also be incorporated. It is a common flap to use for ear reconstruction in avulsion or burns to cover cartilage or to construct a

Figure 34-35

Figure 34-36

Figure 34-37

Figures 34-35 to 34-37. Paramedian forehead flap.

framework. It will require skin grafting to the surface of the flap that has not been buried. The flap is also a reasonable choice for revision orbital surgery or midface coverage. Inset into the orbit will generally require a lateral orbitotomy and a window for the pedicle to pass through. The biggest drawback to this flap is a generous scalp incision that may be prone to alopecia. A zigzag incision on the temporal scalp may break up the linear scar. Endoscopic harvest has also been described and is reported to significantly decrease donor site issues, surgical time, and blood loss.[52] The following case illustrates temporoparietal flap harvest.

Case Detail—*Temporoparietal fascial flap harvested for total auricular reconstruction is presented. (See Figure 34-38.)*

Temporalis Flap

This is a versatile flap for skull base and orbital reconstruction.[53] One of the more common uses in secondary soft-tissue surgery may be for the treatment of posttraumatic facial paralysis. This flap will provide both static support and dynamic function to the midface. Its blood supply is the anterior and posterior deep temporal arteries, which are terminal branches of the internal maxillary artery. When harvesting for facial paralysis, a central slip can be harvested and stretched to insert on the oral commissure through a facelift

Figure 34-38. Temporoparietal fascial flap.

approach. An extension of the galea can be taken with the flap, if necessary, and may assist with insertion into the oral commissure.[54] A second slip of muscle can be inserted at the lateral ocular commissure to assist with eye closure.[55] Outcomes are generally considered good from a functional standpoint.[55,56]

Pectoralis Major Flap

Described by Ariyan[8] in 1979 for head and neck reconstruction, this is a myocutaneous or myofascial muscle flap based off of the thoracoacromial vessels. The upper limit of flap coverage is generally considered the zygomatic arch, but patient body habitus may decrease this. It requires release of a generous neck skin envelope to pass the flap, and prevent compression and secondary vascular compromise. Care should also be taken in rotation to prevent kinking of the pedicle. The flap offers one-stage reconstruction, but the pedicle is relatively bulky and the skin paddle inset orientation may be limited because of pedicle orientation. Loss of pectoralis muscle may cause functional issues with arm use, but this is generally well-tolerated. The donor site can usually be closed primarily. There is the possibility of transferring some breast tissue, as well as distortion of the breast and nipple in women. This flap has generally been considered a workhorse flap for lower and midfacial reconstruction, and is one of the more common reconstructive flaps.[57]

Microvascular Flap Transfer

More recently, there has been a growing body of literature supporting the use of microvascular tissue transfer. Microvascular surgery is becoming more popular in general, and the equipment and training for it are becoming commonplace. Free flaps allow substantial freedom in orientation and inset without the problems of a pedicle. Donor site morbidity is generally low. There are a variety of flaps that provide coverage in acute and delayed reconstruction. Useful soft-tissue free flaps for the head and neck include radial forearm, anterolateral thigh, latissimus, and transverse rectus myocutaneous flaps. The difficulty with this technique is that it requires specialized instrumentation, training, and postoperative care. Treatment of complicated soft-tissue loss currently favors free flap reconstruction. Futran et al[58] described a series of patients with facial trauma, some of whom required multiple free flaps. The majority of recent facial reconstruction literature for soft-tissue defects has been focused on advances in microvascular techniques.

The first "self-donor" facial transplant occurred in 1994 with a 9-year-old Indian child whose face and scalp were traumatically ripped off in a thresher accident. The facial skin was successfully reattached using microvascular technique. In 2005, in Amiens, France, Devauchelle and Dubernard performed the first successful partial facial transplant on a woman who had her face mauled. Cadaveric studies have subsequently been performed to determine the optimal method of harvest and to refine technical requirements for reanastomosis.[59] A US Department of Defense grant was provided to both the University of Maryland (College Park, MD) and Brigham and Women's Hospital (Boston, MA) for evaluation of facial transplantation in wounded soldiers. Carla Nash, who was mauled by a chimpanzee, underwent full facial transplantation in May 2011 at Brigham and Women's Hospital. Ultimately, the physicians reported that a series of screened patients and four transplants were performed from April 2009 to May 2011.[60,61] In March 2012, Richard Norris underwent the first ballistic injury wounding facial transplantation that was performed at the University of Maryland by a team led by Dr. Eduardo Rodriguez.[62]

DISCUSSION

Personal Experience in a Deployed and Role 4 Setting

Nature of Wounding and Wound Healing

The nature of war wounds to the head and neck has shifted gradually over the last two decades. Previously, the injuries were more likely to be from ballistic projectile trauma or fragmentation blast devices. More recently, however, the wounds are most commonly caused by improvised explosive devices (IEDs). These IEDs tend to cause diffuse soft-tissue damage and a "peppering" pattern of wounding. An IED or similar device (eg, landmine, etc) has an explosive and fragmentary casing that causes blast, burn, and fragment injury, but secondary projectiles (eg, dirt, clothing, vegetation, and even body parts) can also become part of the wound. The inflammatory response from these types of wounds can be progressive if complete washout and debridement of all embedded debris are not performed thoroughly at initial presentation. The complex wounding pattern also produces irregular wounds with areas of decreased viability. As a result, there may be significant soft-tissue scarring in surrounding areas, and it may be more difficult than usual to elevate or rotate a local flap such as that performed for an excisional wound closure. The surrounding vascularity may also be somewhat compromised compared with a simple wound from a cancer resection. Judgment should be used as to whether soft-tissue flap elevation is reasonable, and elasticity and perfusion will be adequate. There may also be some "die back" of wound edges in serious ballistic trauma, and conservative management in the first few days while avoiding early flap elevation or advancement may be prudent. Fortunately, the face and neck have a remarkable blood supply and a dense dermal-subdermal plexus. As a result, tissue that would seem to have a remarkably limited pedicle may in fact survive when the same injury in other areas of the body would result in soft-tissue necrosis. At the time of revision surgery, consider surgical delay procedures if the surrounding tissue is significantly damaged. Tissue expansion may also be required to bring in noninjured and expanded soft tissue to completely cover a defect. A distant flap (pedicled) can also be used to bring in tissue for significant soft-tissue loss. The following case illustrates a complex wound that may not be amenable to early flap or soft tissue reconstruction.

Case Details—*Afghan National Army soldier presented with a gunshot wound to the lip and jaw. Note stellate soft-tissue wounding pattern. Wound is conservatively closed to preserve as much tissue as possible. A secondary revision will be possible in 6 to 12 weeks that will likely retain more tissue and result in better function than if aggressive debridement and primary closure were performed up front. (See Figures 34-39 and 34-40.)*

Figure 34-39

Figure 34-40

Figures 34-39 and 34-40. Complex wounding.

Timing of Reconstruction

Long-term facial reconstruction and rehabilitation from war wounds can be a slow, multistage process. If possible, a single surgeon or surgical team should attempt to maintain continuity with the patient to have a well thought-out reconstruction plan because it will be an evolving process. In general, the procedures begin large and then become smaller, with the results becoming more subtle as the number of procedures progress. There are optimal times to make an intervention and, if needed, the surgery can be delayed or staged to allow best scar maturation and positioning. Initial clinical evaluation should take into account the following:

- the nature of wounding,
- how long ago it happened,
- functional problems a patient is having, and
- whether there are other medical issues (ie, amputee issues may rule out use of latissimus as a reasonable reconstruction option).

Some soft-tissue injuries require early intervention (eg, eyelid defects) whereas other injuries may actually turn out better with secondary intent healing (forehead). Allowing scar contracture and normal skin elasticity to "creep" adjacent healthy tissue into the wounded area can sometimes make secondary corrections easier. Waiting 6 to 12 weeks (or longer) for the wound to mature will be inconvenient for the patient, but may ultimately result in a better outcome. Later, distortion from progressive scar contracture may not be appreciated with an earlier flap elevation. Larger structural issues (eg, bony defects and major soft-tissue defects) should also be addressed first. Restoring bony skeletal projection is advantageous early on to prevent soft-tissue envelope collapse, and this will be covered elsewhere in this book.

Complications

A well-meaning, but less than optimal, sequence of care may occur by starting a soft-tissue reconstruction plan before completion of a fundamental prior step (eg, ensuring no malunion or nonunion of deeper skeletal

Figure 34-41

Figure 34-42

Figures 34-41 and 34-42. Variation of cervicofacial advancement.

structure before moving on to finesse soft-tissue work). The revision rate for soft-tissue flap surgery may be high. Motamedi and Behnia[63] reported a revision rate of 48% in a series of 33 patients who underwent local and regional facial soft-tissue flaps as a consequence of war trauma. It is also tempting to push the reconstruction plan forward as fast as possible. This may be because of impatience on the surgeon's part, but is also a common concern patient concern. However, this temptation should be avoided. Scar density and lack of pliability peak at approximately 6 weeks postwounding and may extend far beyond this because of longstanding inflammatory response. In general, procedures generally become easier with time.

Treatment

The first decision is usually whether the scars themselves require early repeat surgical excision and closure. There is no definite indication for this but, in general, if the scars are hypertrophic and obviously tattooed, this may be reasonable. Embedded debris leads to a chronic inflammatory response, hypertrophic scarring, and difficulty with tissue elasticity. Simple meticulous surgical excision or lancing of embedded debris and tattooing with an 18-gauge needle and vigorous scrubbing may reduce ongoing inflammatory response and secondary scarring. It is not uncommon to excise a blast-related wound that has hypertrophic scarring and find the subsequent revision to heal unremarkably with minimal postoperative care. If skin quality and tattooing are generally minimal, the focus should then be on correction of volume loss and positioning or functional scar-related problems. Residual, limited embedded debris can then be addressed again with limited surgical excision, dermabrasion, and, in select cases, laser resurfacing after completion of major care.

When possible, wait a minimum of 3 months between sequential procedures (other than staged flap transfer, such as forehead flap). This allows laxity and settling of scars, and final outcome of tissue repositioning becomes more apparent. What may have

Figure 34-43

Figure 34-44

Figures 34-43 and 34-44. Variation of cervicofacial advancement.

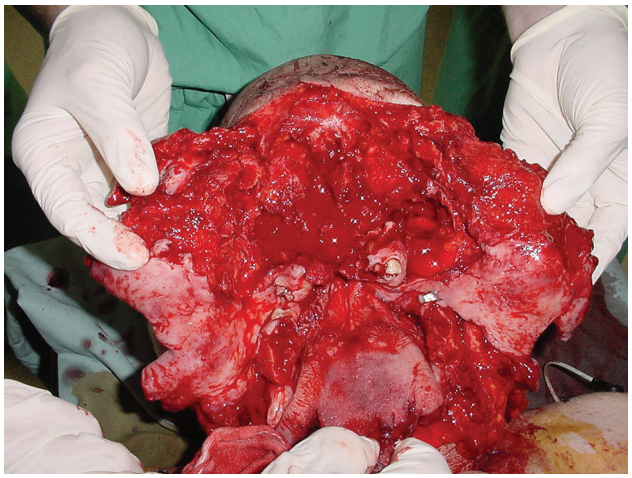

Figure 34-45

Figure 34-46

Figure 34-47

Figure 34-48

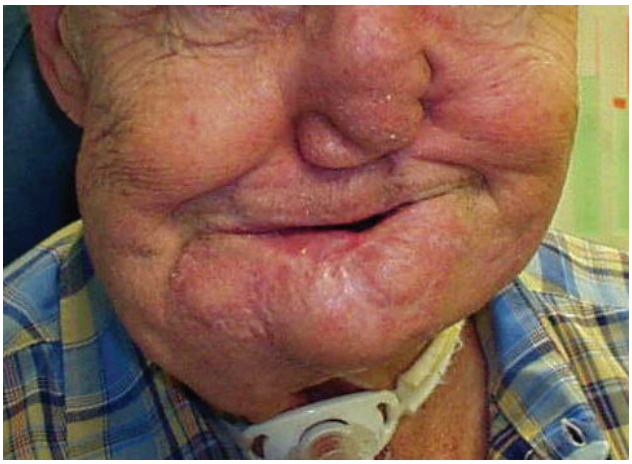

Figure 34-49

Figures 34-45 to 34-49. Lower lip reconstruction.

looked good on the initial major flap reconstruction may now have contracted or settled. Do not remove any soft-tissue laxity or redundancy until certain that all wound maturation has occurred. After all facial skeletal, volume correction, and functional surgery have been accomplished, it is now appropriate to remove laxity and address posttraumatic or postsurgical facial scars. It is common to debulk or reinset flaps with surgical resection, but liposuction may also be a useful tool for localized volume asymmetry. After soft-tissue scarring, volume, and position adjustments have been addressed, there should be a wait of several more months to observe scars. In some cases, silicone sheeting or local steroid injections may be required for return of hypertrophic scarring.

During revision surgery, note that blood supply to soft tissue has likely been altered because of prior trauma. This can be both a positive and a negative as far as soft-tissue elevation is concerned. After wounds have matured, the blood supply to previously marginal "tongues" of tissue may become quite robust from delay phenomena and neovascularization along the base of the flap. As a result, what may previously have been borderline tissue for local tissue rearrangement may now actually be quite robust and tolerate extensive elevation. However, it is likely that that same tissue still has its vascularity primarily based off of the uninjured flap base. If the tip of the flap is transected or if the tissue is raised in discontinuity with the uninjured base, there is a good chance that the tissue will die. This has been known to occur greater than 1 year out from wounding because surrounding neovascularization through extensive prior tissue damage can be reduced. Limited flap elevation (eg, for Z-plasty) may still survive if based off of a scar bed, but it may be more like a full-thickness skin graft than a true dermal-subdermal plexus flap. When surrounding tissue is significantly damaged, there may be no practical way to elevate a fasciocutaneous flap and may require either tissue expansion, pedicled flap (with or without tubed pedicle), or even free flap transfer.

Remember to maximize use of nonsurgical adjuncts, such as acrylic splints, compression or facial support garments, physiotherapy ("therabite" device, etc), and scar massage. This can take a good result to a very good result both functionally and aesthetically.[64–66]

SUMMARY

Secondary reconstruction of head and neck soft-tissue injuries can be challenging and rewarding. These problems need to be approached in a logical and stepwise fashion. There are certain issues that require immediate attention (eg, soft-tissue loss with eye exposure or severe tattooing and embedded debris) or issues that may be pursued after scar maturation and in a graduated fashion. Consider backup plans to avoid "bridge burning" should additional procedures or revision surgeries, which are common, be required. It is essential to encourage the injured individuals to be patient and understand that the best outcomes happen slowly. Results and outcomes become more subtle with subsequent procedures. It is common to follow these patients for months or years, and these relationships can be very satisfying.

CASE PRESENTATIONS

These final cases are included to show how soft-tissue reconstruction is frequently staged care and may require revisions. The principles outlined in the chapter can also vary from an anatomical site. Tolerating an open wound of the forehead or jawline may be acceptable as a treatment option, whereas other areas (eg, periocular or severe perioral soft-tissue loss) may require aggressive early reconstruction.

Case Study 34-1: Variation of Cervicofacial Advancement

A 25-year-old active duty male sustained trauma to the right jawline as a result of being dragged in a motor vehicle accident. He underwent negative pressure therapy and wound care elsewhere for approximately 1 month. He then underwent a modified cervicofacial advancement type procedure to advance facial and neck soft tissue. The soft-tissue envelope was elevated inferior to the clavicle through the periauricular incision and an extended facelift approach. The scar was left in situ and deepithelialized to retain volume and avoid facial nerve injury. (See Figures 34-41 to 34-44.)

Case 34-2: Complex Lower Lip Reconstruction

An elderly male presented with a self-inflicted gunshot wound with substantial loss of the mandible, lower lip, and the mentum area. He underwent initial wound care and temporary closure, then early bone grafting to the midface and a fibular free flap with a large skin paddle. Lower lip closure was released for flap soft-tissue inset. After bony union was confirmed and soft tissue allowed to mature for greater than 3 months, a lip advancement procedure for completion of oral closure was performed. (See Figures 34-45 to 34-49.)

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