3 Cutaneous Considerations in Lateral Craniofacial Reconstruction

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Introduction

Regions and Subunits of Face

The face consists of seven principal aesthetic regions, which are the forehead, eyelids, cheeks, nose, lips, chin, and auricles. These areas are covered by skin that shares common characteristics, such as color, thickness, texture, fascial adherence, and hair growth. These regions can be divided into smaller subunits. For example, the forehead is divided into central and temporal units. The cheek is divided into zygomatic, infraorbital, and mandibular subunits. The concept of regions and subunits is critical for facial reconstruction in that a flap is often designed from within the same region or subunit, and incision lines are also often placed along the borders of the subunits.

Relaxed Skin Tension Lines

The extensibility of skin determines the tension for wound closures. This extensibility can vary depending on which direction strain is applied. This is how the lines of maximum extensibility (LMEs) are defined. Relaxed skin tension lines (RSTLs) correspond to the natural direction of collagen and elastin fibers in the dermis. Relaxed skin tension lines are generally perpendicular to the direction of the lines of maximum extensibility and the fibers of the mimetic muscles of the face. Therefore, orienting of wound repair parallel to relaxed skin tension lines puts the tension of wound closure to a minimum level.

Skin Grafts

Skin grafting is a useful tool for superficial facial defects especially when a local flap cannot be utilized for the reconstruction. Skin grafts can be harvested either as full thickness or split thickness. The graft survival depends on several factors such as vascularity and contact between the graft and recipient site. When there is limited contact with a vascular source, a thin graft is more likely to survive compared to a thick one. One should avoid choosing skin grafting as a reconstruction option when the recipient site is previously irradiated or badly scarred, or if periosteum, perichondrium, or peritenon is not intact.

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S. J. Wang, K. Fung (eds.), *Principles of Lateral Craniofacial Reconstruction*,
https://doi.org/10.1007/978-3-030-50291-1_3

Full-Thickness Skin Grafts

Full-thickness skin grafts (FTSGs) include both epidermis and the entire thickness of dermis. Therefore, they have better pigmentation, texture, and contour match, but have a higher rate of graft failure compared to split-thickness skin grafts. The ideal surgical candidate is an individual with fair complexion and thin facial skin who acquires a superficial wound, which is confined to one facial subunit, without underlying muscle loss. Full-thickness skin grafts can also be a practical reconstruction choice for wounds involving concavities on the face (e.g., temple or medial canthus). Donor sites are chosen carefully to hide scars and to avoid hair-bearing areas. Commonly used donor sites are pre- and postauricular skin, concha, upper eyelid, neck, submental, and supraclavicular skin.

Split-Thickness Skin Grafts

Split-thickness skin grafts (STSGs) include epidermis and dermis of a variable thickness. They "take" better to the wound bed as they incorporate vascularity more expeditiously. Despite these advantages, split-thickness skin grafts are chosen more carefully for facial reconstruction because they tend to contract significantly and pigment unpredictably, thus producing aesthetically less favorable outcomes (Table 3.1).

Table 3.1 Differences between full-thickness skin graft versus split-thickness skin graft

	Full-thickness skin graft	Split-thickness skin graft
Structure	100% of epidermis and 100% of dermis	100% of epidermis and parts of dermis
Contracture	Minimal secondary contracture	Maximal secondary contracture
Cosmesis	Excellent	Moderate
Survival	More resistant to trauma and shearing Higher chance of survival	Less resistant to trauma and shearing Lower chance of survival
Donor site	Must be surgically closed	Does not require surgical closure

Lateral Forehead Reconstruction

Surgical Principles

The important goals of forehead reconstruction are to preserve motor and, possibly, sensory nerve functions; to protect the aesthetic borders of the forehead and hairline; to maintain position and symmetry of the eyebrows; and to hide the scars in or near hairline, eyebrow, and relaxed skin tension lines (RSTLs). The temporal branch of the facial nerve is at high risk for injury during flap elevation over the zygomatic arch and the temporal area because the nerve courses immediately deep to the temporoparietal fascia–superficial muscular aponeurotic system (SMAS) layer. The area most susceptible to injury (also known as the facial danger zone) is a triangle outlined by a line drawn 0.5 cm inferior to the tragus to a point 2 cm superior to the lateral eyebrow, a second line on the zygoma to the lateral orbital rim, and a third line connecting the previous two lines. The injury to this nerve will result in ipsilateral eyebrow ptosis and facial asymmetry by paralyzing the frontalis muscle.

Reconstruction Options

A variety of reconstruction options are available for lateral forehead and temporal region due to excellent skin elasticity and contour that is flat and/or concave. These characteristics often allow primary closure when the orientation of the repair lies parallel to the relaxed skin tension lines (RSTLs). In fact, the transverse wrinkles on the forehead provide an excellent space for hiding scars. When primary closure is not feasible, advancement, rotation, and transposition flaps can be utilized.

An advancement flap is the simplest local flap option. It is created by advancing tissue into a defect unidirectionally (Fig. 3.1). The skin is slid into the defect without rotation or lateral movement. A defect adjacent to eyebrow or lateral hairline can be reconstructed with bilateral advancement flaps, which conceal the incision along the hairline. Care must be taken to avoid hair follicle damage by making the incision

beveled to the surface and 1–3 mm posterior to the anterior border of hairline.

For a defect away from a hairline, a rhomboid flap is most commonly used for reconstruction. A classic rhomboid flap, a type of a transposition flap, is designed with two 60-degree and two 120-degree internal angles to fill a rhombic defect with similar internal angles (Fig. 3.2). Multiple modifications exist in the rhomboid flap designs. For example, a rhomboid flap can be designed to fill a circular defect (Fig. 3.3). The flap is transposed into the original defect with a couple of key stitches, which evenly distributes the tension. The secondary defect can be closed primarily with undermining if necessary. A standing cone deformity can occur at the base of the flap, which may be excised to achieve an aesthetically pleasing contour. This modified rhomboid flap is extremely useful because the flap can be placed anywhere along the circumference of the defect ultimately allowing a scar to be made as inconspicuous as possible (Fig. 3.4).

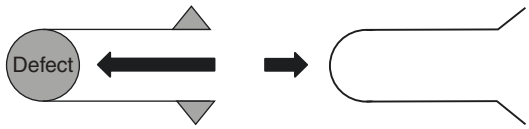

Fig. 3.1 Advancement flap

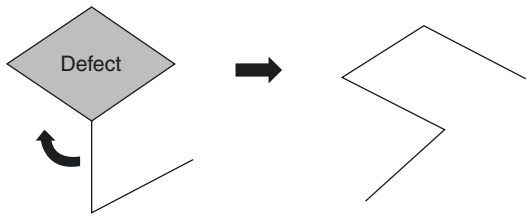

Fig. 3.2 Rhomboid flap

Lateral Cheek

Surgical Principles

The cheek plays a key role in mastication, facial manifestation of emotion, and the support of adjacent primary structures. Therefore, the goal of cheek reconstruction should be to preserve these functions while achieving adequate cosmesis. Extreme visibility and limited local tissue supply make the cheek reconstruction a challenging task. The cheek is divided into multiple subunits such as the medial, lateral, buccal, and

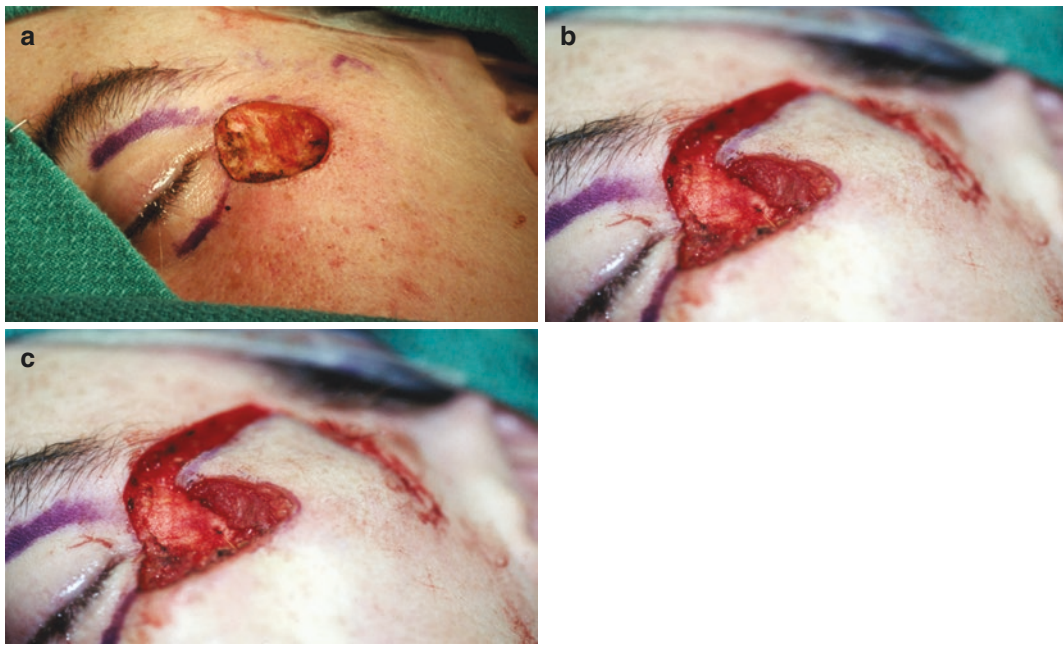

Fig. 3.3 Modified rhomboid flap. (**a**) Circular defect. (**b**) Flap raised. (**c**) After reconstruction

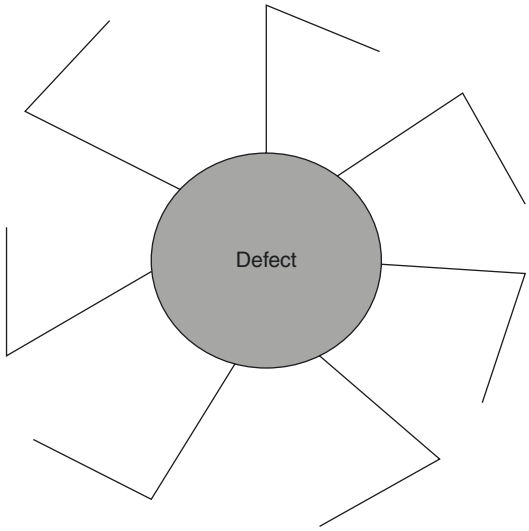

Fig. 3.4 Rhomboid flap allows incision to be placed in anywhere along the circumference of the defect

zygomatic units. This section, however, will focus on the lateral and zygomatic units of the cheek. It should be noted that the skin in these two regions adheres to the underlying fascia more strongly, making it less mobile and less redundant compared to the skin on the medial cheek. Potential radiation therapy and lymph node dissection should be taken into consideration when planning for major reconstruction.

Reconstruction Options

A small lateral cheek defect can be repaired with primary closure or with transposition flaps such as a rhomboid flap. One should plan to place the incision lines in the preauricular crease, or other preexisting folds, the resting skin tension lines, or along the beard edge in order to effectively hide the scars and to respect the borders of aesthetic subunits. Medium-sized defects can be repaired with transposition or advancement flaps. In this case, care should be taken to avoid distortion of the anatomy of the lower eyelid. For example, tissue movement should be based laterally rather than inferior in order to avoid development of lower eyelid ectropion. In fact, when it comes to the reconstruction that involves periorbital area, a thorough understanding of the complex anatomy

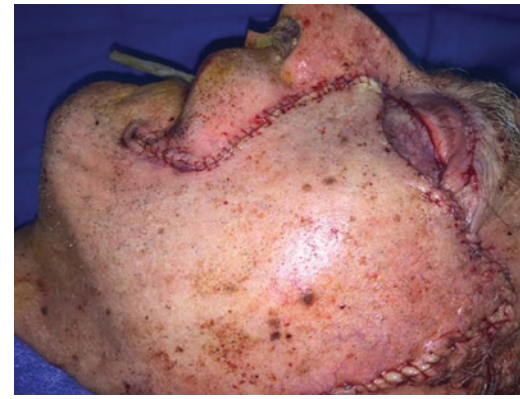

Fig. 3.5 The cervicofacial flap

is crucial to achieve optimal surgical outcome with the proper restoration of eyelid function. Periorbital relaxed skin tension lines (RSTLs) orient horizontally over both upper and lower eyelids. When tension is applied parallel to these lines, cicatricial scars or ectropion can occur. Therefore, it is preferred to create horizontal tension by orienting the long axis of the excision perpendicular to the eyelid margins. The tension can also be placed parallel to the relaxed skin tension lines over the medial and lateral canthi.

Large-sized defects can be repaired with cervicofacial, deltopectoral, or pectoralis major flaps. The cervicofacial flap is one of the most useful options for a large reconstruction for lateral cheek defects because it transposes submandibular skin, which provides excellent color and texture match (Fig. 3.5). The incision of the flap begins from the lateral border and extends along the preauricular crease. As stated above, the need for neck lymph node dissection should be taken into consideration while planning the surgery. If the neck dissection is necessary, it is recommended to raise the flap first and then to proceed with the dissection. The pectoralis major flap is another useful option for lower lateral cheek defects. This flap is based on the pectoral branches of the thoracoacromial vessels, and is reliable with low necrosis rate. This flap, however, can be bulky and, therefore, it is mainly used for complex reconstruction involving multiple structures such as skin, subcutaneous tissue, muscles, and parotid gland. The trapezius flap can also be used for complex lower lateral cheek

defects. This flap is based on the transverse cervical artery and vein, which are branches of the thyrocervical trunk. The trapezius system provides three different musculocutaneous flaps – superior, lateral, and lower. Because of their arc of rotation, the lower and lateral flaps are more useful for cheek reconstruction. It should be noted, however, that the trapezius flap often has poor blood supply and should be utilized with caution.

A large, complex defect may require free flap reconstruction such as the radial forearm, anterolateral thigh, and scapular flaps. The radial forearm free flap is a fasciocutaneous flap based on the perforators from the radial artery (Fig. 3.6). It is widely used as a workhorse flap in head and neck reconstruction due to its many advantages such as reliable vascularity, easy dissection, good aesthetic results, and low flap loss rate. The radial forearm free flap can be used not only for coverage of cheek defects but also for reconstruction of the mandible or oral lining.

The anterolateral thigh (ALT) flap is a fasciocutaneous flap based on perforators of the descending branch of the lateral circumflex femoral artery (Fig. 3.7). It has gained popularity for head and neck reconstruction because it can provide large areas of well-vascularized skin. The vastus lateralis muscle can also be taken when extra bulk is required.

The scapular flap, based on the circumflex scapular artery, is another popular choice due to its reliable anatomy and large pedicle, which makes harvesting relatively easy. Its large skin paddle makes it an ideal choice to cover big defects. Although it is most commonly described as a fasciocutaneous flap, it can be raised as an osteocutaneous flap based on the osseous branches of the circumflex scapular artery. This is a reliable alternative for mandibular or maxillary defect reconstruction when the free fibular flap is not available. Based on the multiple axes of the subscapular artery system, it can be designed as a chimeric flap with multiple independent soft tissue flaps.

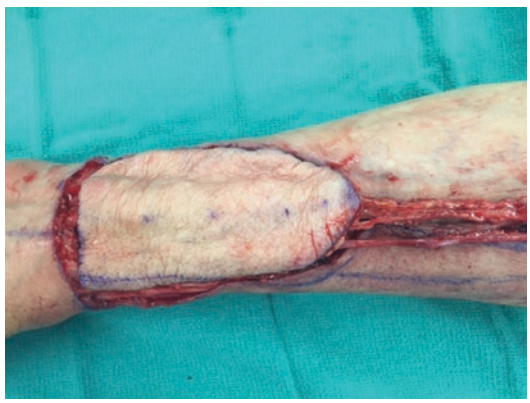

Fig. 3.6 Radial forearm free flap

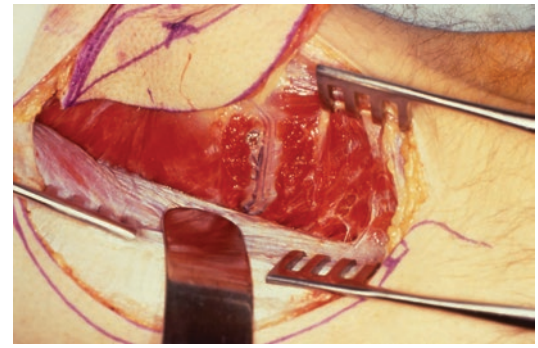

Fig. 3.7 Anterolateral thigh (ALT) flap

Lateral Skull Base Defect

Surgical Principles

Reconstruction of a lateral skull base defect can be a challenging task because it is often associated with exposure of vital structures and major vasculatures. A cancer ablative operation often encompasses lateral, subtotal, or total parotidectomy along with extensive soft tissue dissection. The pursuit of clear margins may lead to the exposure of the dura, often over the temporal lobe or posterior fossa. Extensive infratemporal fossa dissection may lead to pharyngotomy and/or the great vessels exposure. Therefore, the goal of reconstruction should be to (1) establish support for the CNS and facial skeletons, (2) protect the aerodigestive tract, (3) reconstruct the nasal and oropharyngeal cavities, (4) provide adequate volume for dead space, and (5) restore the three-dimensional appearance of the face and head.

The complete reconstruction is a multidisciplinary endeavor with involvement of the neurosurgical, head and neck, and plastic surgical teams. This section will focus mainly on cutaneous soft tissue restoration.

Reconstruction Options

Reconstructive options for lateral skull base defects are often limited to free tissue transfer. The skin in this region lacks laxity and mobility. Therefore, primary closure or small local flaps may not be always feasible even for a relative smaller defect. Free flaps cover the exposed bone and dura, eliminate dead space, and provide cutaneous coverage. For a relatively small defect, the radial forearm free flap is a great option because of its reliability and malleability (see the previous section for details). For a large defect, the anterolateral thigh (ALT) or the latissimus dorsi (LD) flaps are commonly used due to their excellent outcomes and minimal morbidity. The anterolateral thigh flap, based on the descending branch of lateral circumflex femoral artery, can be raised as a fasciocutaneous flap, musculocutaneous flap, or chimeric flap. This flexibility in flap design has made it a popular choice for head and neck reconstruction (see the previous section for details). The latissimus dorsi myocutaneous flap, based on the thoracodorsal artery, is equipped with a long pedicle and a large vessel diameter. The latissimus dorsi is the largest muscle in the body with less than 1 cm thickness, therefore making it a perfect option to drape defects with an irregular contour (Fig. 3.8).

The rectus abdominis flap is another workhorse flap for complex head and neck reconstruction that requires multiple layers of tissue. The pedicle vessels, the deep inferior epigastric artery and vein, are highly reliable. The flap may be bulky, particularly in obese patients, therefore, secondary revisions with liposuction or direct excision may be necessary in some cases. The rectus flap is often raised as a musculocutaneous flap, but it can also be designed as muscle flaps or fascial flaps.

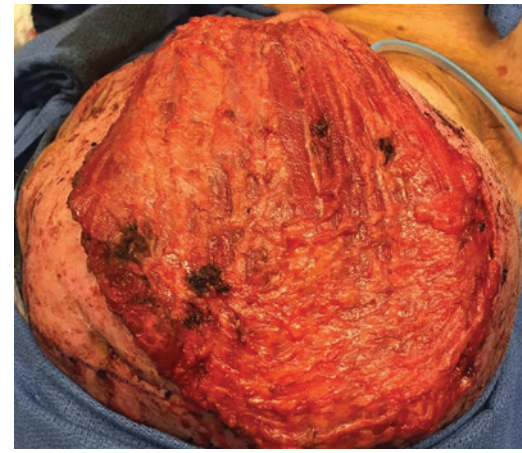

Fig. 3.8 Skull defect reconstructed with Latissimus dorsi flap

Burn Reconstruction

Almost half of burn injuries occur in the head and neck regions. Burn injury can not only severely affect the critical functions such as breathing, hearing, vision, speech, and eating, but also cause severe psychological distress such as social embarrassment, depression, anxiety, and/or posttraumatic stress disorder (PTSD). Therefore, the reconstruction of facial burns often requires multistaged operations, which aim to restore the vital functions with careful considerations for aesthetic results. As a general rule, the reconstruction should wait until scars mature, but early interventions can be necessary to release the scar around the neck, eyes, and mouth for functional reasons.

Scalp Burns

Cicatricial alopecia is a common sequela of head and neck burn injury. The reconstruction of the burn defect on scalp often depends on the size. In general, small areas can be excised and primarily closed by advancing adjacent hair-bearing scalp. On the other hand, serial excisions may be necessary for a moderately sized wound to achieve the best possible results. Care should be taken to avoid excessive tension in order to avoid second-

ary stretching over the scar. For a medium-sized defect, skin grafts or local flaps may be used. For up to 50% defect, the ideal method is to use a tissue expander. Using a tissue expander yields better color and texture match to the surrounding tissue while maintaining sensation with minimal donor site morbidity. However, it requires multistage procedures prolonging treatment duration, and is associated with temporary disfigurement and a higher complication rate. For a larger burn, free flaps are often chosen. Common free flaps for scalp reconstruction include the radial forearm free flap, parascapular flap, rectus abdominis flap, latissimus dorsi flap, and anterolateral thigh flap.

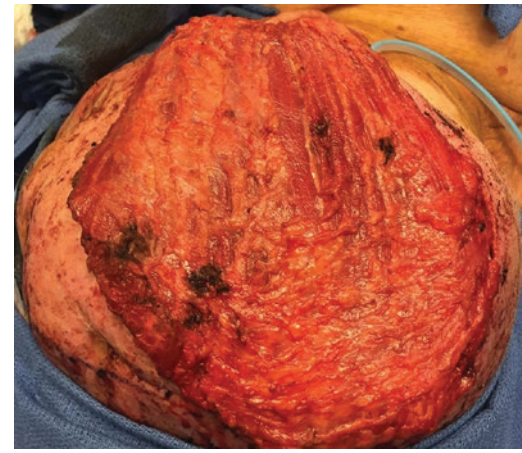

Fig. 3.9 Tripier flap. (Photo courtesy: Dr. Wendy K. Ng)

Forehead Burns

Small burn scars on the forehead can be excised and closed primarily. Similar to the scalp, skin grafts, tissue expansion, or flaps can be used. Forehead burns that involve skull exposure without intact periosteum require a flap for reconstruction. Care should be taken to preserve facial nerve when operating in the forehead region.

Eyelid Burns

A priority for eyelid reconstruction is to restore its function as much as possible. The upper eyelid reconstruction can be accomplished with skin graft from the opposite lid or distant donor sites such as the inner arm. A Fricke flap can also be useful for upper eyelid reconstruction. The lower eyelid is thicker than the upper lid, and therefore retroauricular skin grafts yield the best match. A Tripier flap, originating from the upper eyelid, can also be used for the lower lid reconstruction. If all local tissue was destroyed by a complex burn injury, a temporoparietal fascia pedicled flap or other free flaps may be necessary (Fig. 3.9).

Cheek Burns

In general, the burn defect in the cheek area is repaired with a full thickness skin graft or local flaps. Care should be taken to respect the aesthetic units of the cheek. If the cervical skin is intact, a cervical advancement flap may be used. If the beard area is affected, a submental flap can be used to bring the hair-bearing skin.

Conclusion

Craniofacial reconstruction is one of the most challenging fields in plastic surgery. It requires profound understanding of anatomy, careful planning, and meticulous execution. Effective reconstruction of this region is essential in achieving proper facial aesthetics. Color and texture match as well as contour are important factors that can affect the results. The goal of the reconstruction, however, should focus on maintaining and restoring of the functions and care must be taken to preserve the facial nerve functions.

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