Facial Reconstruction After Mohs Surgery

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Preface

The worldwide rise of skin cancer cases, both melanoma and nonmelanoma, has driven the development of effective treatment plans. Mohs surgical excision remains the gold standard of treatment and requires expedient, effective, and safe surgical treatment of the resultant Mohs defects. This book is a summary of 15 years and 12,000 cases in a surgical practice devoted to post-Mohs facial reconstruction. The practice is outpatient and involves daily resident education. The intended audience is both skilled and beginning surgeons. The cases presented were collected over the course of less than a year and by design are not “one-off best results,” but rather are daily working examples of common defects and standard repair techniques. Each presented case is based on hundreds of representative examples and is designed to provide efficacious, safe, aesthetically pleasing, and functionally complete repairs, while remaining respectful of the patient’s age, anesthesia commitments, and available resources. Although the textbook is based on a single surgeon’s practice, experts in the field were included for anesthesia, Mohs surgery, oculoplastic surgery, total ear reconstruction, and microsurgical reconstruction. The textbook is divided into three sections. The first covers the unique management of post-Mohs patients including evaluation for anesthesia and the thought process behind deciding the appropriate surgical repair. The second section discusses the management of defects based on specific anatomic locations. The final section discusses the management of complications and revisions. By book design, there is enough duplication between the first and second sections that experienced surgeons can jump to section two without content loss. The included algorithms should be considered for general guidance, which look to supplement the principles of the reconstructive decision process, as opposed to rigid pathways. Of note, there is extra emphasis on nasal reconstruction, which reflects the complexity and frequency of nasal repair. Also, a third of the book is devoted to management of complications and revisions, and this is a mere reflection that over 90% of current reconstructed patients would like some improvement of their operative scars. It also indicates the frequency of referrals for revision of suboptimal results from previous repairs and the importance of addressing the risk of even the rarest of complications. I hope that surgeons across all specialties will find what is written useful and beneficial to their practice.

References

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—James F. Thornton, MD

To my sister, Jade Carboy, who will always keep me grounded and endlessly inspires me with her strength and creativity. To my husband, Hansary Laforest, my stability, who shows me every day through his kindness and honesty that there is so much decency in the world. To my parents, Stephen and Natalia Carboy, who have encouraged me in everything that I have taken on, and shown me the kind of person that I will always strive to become.

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# Part 1

## Introduction

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1 Special Considerations for Mohs Patients

James F. Thornton and Jourdan A. Carboy

Summary
This chapter discusses the general management of Mohs patients, which includes identification of the defect, the thought process that goes in the surgical repair, and the planning for surgical repair. The considerations for the patient’s physical appearance, their physical condition, and identification of significant potential intraoperative issues including anticoagulation and social issues are also discussed. This chapter also discusses postoperative management techniques, surgical dressings for Mohs patients, as well as the issues that go into the development of a Mohs repair practice including specific surgical instruments useful for Mohs repair.

Keywords: Mohs repair, anticoagulation, local anesthetic, watchmaker’s forceps, Lalonde forceps, calipers

1.1 General Principles

In many ways, this is the “best of times” to practice medicine as a surgeon. We are at a time of unparalleled patient safety and at the cusp of remarkable advances in surgery including tissue engineering and tissue transplantation. We are also taking care of a patient population that is increasingly educated and inclined to take an active role in their health and health care. Conversely, it is also a time of great disappointment in medicine with frequent slipping standards of care and emphasis on the business aspects over the humanitarian aspects of medicine. The social contract between medicine and patients often appears broken with revenue-driven care models. This decline of professionalism roughly coincides with the advent of advertising in medicine.\(^1\) The advent of widespread internet advertising that can replace surgical skills by the optimization of internet search functions has become a huge burden and disappointment for all specialties. Despite all of the turmoil, the Mohs surgeon continues to offer the opportunity to restore patients to full function after devastating and life-changing excision of skin cancers on their face; this can in many ways be considered the ultimate privilege in surgical practice.

The advantages of a surgical practice dedicated to post-Mohs reconstruction are many, including the majority of daytime cases with very little to no after-hours calls. The cases are on the smaller side and by no means fatigue. The cases are almost all unique with different requirements and different expectations for “piecing the puzzle” together. Repaired properly, the patients are uniformly happy and pleased with their surgery and surgeon. The disadvantages are few and are manageable including the need for essentially year-round availability for patient care, as well as patient populations with significant comorbid diseases that require special attention and management.

In establishing a practice dedicated to post-Mohs surgical repair, one needs to fully understand the role that the surgeon will serve to the Mohs practitioner. Basically, the repair surgeon needs to fully and competently “take care of” the post-Mohs resection patients. This puts the onus on the repair surgeon to provide safe, effective repairs and render the patient uniformly happy with the repair, as well as the repair process. Full commitment to reconstruction patient care is required. The plastic surgeon that has no real interest in Mohs repair and is merely biding his time until he can either establish a cosmetic practice or is intending to convert Mohs patients to cosmetic patients or is using Mohs patients to “feed” a surgery center that is dedicated to cosmetic patients will have a short, bumpy career as an effective reconstructive surgeon. Additionally, post-Mohs patients are usually elderly and the repair surgeon who takes advantage of this lopsided patient-physician relationship with unreasonable surgical fees or co-pays or unreasonable schedule constraints or, worse, the surgeon who directs the patients to purchase overpriced wound or scar care products sold out of the surgeon’s office is no longer practicing medicine. He is rather engaged in extractionism and will have a short career as a Mohs repair surgeon.

Establishing a reconstructive practice to manage these patients entails the historical three As: Availability, Ability, and Affability. Availability or accessibility is paramount. The reconstructive surgeon must be readily available to the Mohs surgeon, as the requirements for a Mohs reconstruction are often not determined until the day of resection. The ability to rapidly provide scheduling for the surgical repair to avoid a patient waiting days or weeks is humane. The designated surgical facility should be in an easy geographic location and should be physically accessible to patients. The anesthesia team needs to understand the principles of anesthesia care for these patients, which is not always consistent with standard anesthesia practices, that is, these patients often will not require complex anesthesia workups for these small skin-only surgeries and in fact would be poorly served by standard “full preoperative anesthesia evaluation and workup” for minor surgical procedures. Also, current Medicare reimbursements for these types of cases are astonishingly low and a significantly large number of patients will need to be managed for a successful practice. Managing and effectively serving a large number of patients requires both the cooperation and the ability of the surgery center to accommodate last-minute scheduling, and schedule changes, as well as provide rapid turnover for these cases. As a rule, these patients are better served in an outpatient surgery center than in an inpatient hospital, as the majority are minor surgical procedures done in an hour or less and the patient should be able to return to their normal daily schedule afterward. Additional factors that go into making this work are standardized operating room sets, including prepackaged disposables, as well as standardized dedicated surgical instruments that can be rapidly “turned over” for reuse.

The operative planning for these patients first and foremost is predicated on the initial preoperative evaluation. It is not a requirement or even advantage that these patients are seen prior to their Mohs resection; however, accurate communication between the Mohs surgeon and repair surgeon is tantamount to ensure that complete excision has been performed prior to repair. The majority of decisions can be made regarding both the patient and the operative planning on the immediate
Introduction

visit prior to repair. That being said, it is incumbent upon the surgeon to understand that by the time the patient has had his or her Mohs resection and has found the surgeon for repair, he or she is at the end of a long day, is tired, usually has not eaten and is hungry, and often scared about the upcoming surgical process. The assessment of the patient’s expectations and comorbid disease and the assessment of the patient’s ability to comply with the planned repair process and postoperative requirements, especially if it is multistaged, all need to be determined with great accuracy. If a patient is woken early, not fed, placed in a dressing gown, he is in a vulnerable position and this can easily add 10 to 15 years of chronological age to his appearance, and reduce his functional status by many folds. The surgeon should very accurately assess the patient’s postoperative care requirements in order to provide a procedure that is appropriate. Understand that every patient does not need a multistaged surgical reconstruction (in many cases, this is a detriment), but this cannot become an excuse for the surgeon to develop a “good enough” or lazy approach to surgical repair. The caveat of restoring the patient’s appearance to normalcy and “one side matching the other side” should be the basis for every case in surgical planning and downsized from there based only on the patient’s condition and requirements. The beginner’s practice of removing the Mohs dressing, looking at the defect, and then searching through surgical textbooks until a similar defect is found and utilizing that described procedure for the repair is both lazy and will provide suboptimal results. Rather, the development of basic principles based on anatomic location and character of the defect will provide the surgeon both comfort encompassing all varieties of the defect and improved aesthetic outcomes for the patient.

During this initial preoperative visit, surgical planning, as well as the patient’s ability to withstand the postoperative issues, which may require surgeries or multiple postoperative visits, needs to be appreciated. Many patients seen at large medical centers have traveled significant distances and just having to travel further may encompass significant hardships on the patient. These include costs and time commitments. Appropriate operative planning needs to also take into consideration a patient’s means of transportation to and from facilities.

The issue of current anticoagulation and cessation of preoperative anticoagulation has been thoroughly examined by Mohs surgeons and current practice is not to stop anticoagulation in the perioperative period. This needs to be ascertained by the surgeon as to whether this will adversely impact the repair. Although it is prudent to see the patient as soon as appropriately possible after the Mohs excision, the definitive surgical repair does not need to be performed that day. Oftentimes, a patient with a poor or a nonexistent preoperative workup that does require preoperative evaluation, or a patient with anticoagulation that needs to be off anticoagulation, or a patient with external or home constraints that need to be optimized prior to surgery, can be managed with the simple placement of a cellular tissue-based product (either dermal regeneration template or acellular dermis) and the wound can then be temporized and managed for up to a month with very little wound care or dressing care until the patient’s social or medical condition is optimized; however, it remains poor practice to leave a patient with an open wound pending scheduling per the surgeon’s convenience.

After surgery, attentive postoperative care is critical. Effective communication in the initial perioperative is essential. It is useful to have clear postoperative instructions printed on colored paper to be given to the patients as they are often discharged home with a stack of surgery center papers and it is helpful to be able to say refer to the “pink” sheet or a designated color sheet. As a note, the author has given all his patients his personal cell phone number for the last decade with very favorable results. The patients appreciate it and, with few exceptions, have been respectful of its use. An office call the first postoperative day to answer questions, provide follow-up, scheduling, etc., is mandatory. Great care is taken to normalize the patient’s activities postsurgery. There are very few reasons to limit patient’s aerobic activities postsurgery as increased heart rate or exercise will in no way affect postoperative healing; however, with grafts or flaps, we do limit the patient’s active strength training and picking up heavy objects until either the flap is assured taken and we are far enough away from the postoperative period that there is not risk for late hematoma. We make great effort to make dressings with no requirements for tape: either Surgicel for suture lines at risk of actively bleeding wounds or Xeroform for other wounds that become just a simple requirement of ointment. Also, stocking caps for the majority of scalp, forehead, and cheek defects are preferable to tape. We allow the patients to shower within the first 48 hours with no restrictions. If the patient is not seen preoperatively, the first clinic visit is an ideal time to discuss the entire postoperative course including initial wound management, initial scar management, and final expectations for results. Postoperative photos of previous cases across all stages of wound healing are useful to set expectations.

The very nature of a Mohs repair practice is that fast efficient patient care needs to be practiced, but in a higher volume setting than in most plastic surgery practices. The physical location and the surgical facility need to be easily accessible by the patient and not overly cost prohibitive. An anesthesia staff that understands the special needs of these patients can safely execute a large number of cases and a dedicated nursing staff that can facilitate a rapid turnover are essential. The decision whether to undertake same-day repairs or next-day repairs is largely the surgeon’s and unfortunately the referring dermatologist’s preference. The advantages of next-day repairs are great. The patient is often already tired at the end of a long resection day and adding NPO (nil per os) status to their long day only makes it more difficult. Also, the ability of the Mohs surgeon to take postresection photographs and send them the night prior to the Mohs surgeon is exceedingly beneficial and prevents the removal of the Mohs postoperative dressing, which invariably results in bleeding in the immediate preoperative period. This allows the dressings to be removed in the operating room completely painlessly. The anesthetic choice for the vast majority of Mohs repairs is simple IV (intravenous) sedation with a brief period of propofol sedation, allowing the patient to wake up spontaneously after the painful local anesthetic injection. A fifty-fifty mix of 1% lidocaine with epinephrine and 0.25% Marcaine also with epinephrine is utilized in the majority of the cases with the advantage of Marcaine providing up to 4 hours of postoperative anesthesia. The surgical prep is a chlorhexidine prep, avoiding Betadine, and involves prepping the entire head with special attention paid to the ears and posterior
Special Considerations for Mohs Patients

Fig. 1.1 (a–e) Microforceps, watchmaker’s forceps, Penfield elevators, Lalonde forceps, calipers.
Introduction

Repair of Soft Tissue Facial Defects | 13.11.17 - 15:58

...cannula oxygen can be used safely in the conduct of Mohs requirements for oxygen use, and any patient allergies. Nasal...very valuable in stopping the bustle of OR progress, confirming and a timeout may seem unnecessary, timeouts are actually...Even though the laterality of a Mohs defect is rarely in question...1.2 Conduct of the Operation

Even though the laterality of a Mohs defect is rarely in question and a timeout may seem unnecessary, timeouts are actually very valuable in stopping the bustle of OR progress, confirming the patient’s identity, the location, the planned procedure, requirements for oxygen use, and any patient allergies. Nasal cannula oxygen can be used safely in the conduct of Mohs repair, but it often requires the removal of the Bovie electrocautery tip to prevent inadvertent electrocautery by the surgeon while oxygen is in flow and replacement of the cautery tip only for the short period of time the cautery is going to be utilized.

Postoperative pain management is paramount for these patients. Marcaine does provide a degree of coverage of roughly 4 hours, but judicious use of narcotics in the perioperative period is very beneficial. With the advent of obstacles to opioid use that includes the requirements for triplicate prescriptions and even obstruction from pharmacies, it falls on the physician to not resort to lower class pain medications simply for convenience that can adversely affects both the patient and the operative outcomes.

The initial postoperative care for these patients is very important as these patients often have not established a physician–doctor relationship prior to this surgery and early and frequent consultation with either the physician or the clinic nurse goes a long way toward alleviating their worries and managing initial problems. Sutures are uniformly removed on the face within 4 to 6 days to prevent subtle track marks and at this point, the patient is converted from antibiotic ointment to plain Vaseline to prevent the inevitable reaction to antibiotic ointment. The restrictions on the patient are minimal. While a graft is in place or a flap is in place, avoidance of lifting that requires Valsalva maneuver seems prudent, but the avoidance of aerobic exercise including walking, running, or stationary bicycle riding is of no real benefit to the patient. The patients are allowed to shower even with bolster dressing sewn in place across their face. They can purchase a clear shower cap that can be pulled over the scalp or nose and provide coverage as the patient is recovering. For patients that do not have a sewn-in bolster, the policy at UT Southwestern is to allow them to shower early in the first early perioperative period and just reapply the ointment after the shower. Scar care follows a fairly regimented process. The patients are begun on an over-the-counter scar therapy. Patients prone to hypertrophic scarring are offered silicone gel and sheeting early on and there is proven clinical benefit in this. They are seen at the initial 6-week postoperative period and the scar is at this point evaluated for color or contour irregularities, for which we can perform dermabrasion in the office with a motorized dermabrader wheel with only topical anesthetic. A pulsed-dye laser is utilized to hasten the resolution of pigmented or color changes. Scars that are prone to become hypertrophic are injected very carefully with intralesional steroids following the exact protocol as outlined in chapter 24.

References


1.2 Conduct of the Operation

The use of eye stretchers can reduce total daily operative transfer time by up to an hour a day. Understanding that having a patient move from a stretcher to an operating room (OR) bed and back again adds at least 4 to 6 minutes per case. The use of eye beds in a 10-case day can easily subtract an hour of wasted operative time and is actually more comfortable for the patient and rarely is an operative bed indicated.

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2 Anesthesia for Reconstruction of Facial Mohs Defects

Jayne Coleman and Javier Marull

Summary
Patients with Mohs defects present for closure of their facial wounds typically without any prior medical workup. Routine preoperative laboratory testing and echocardiograms (EKGs) have not been proven to change the outcome of anesthesia. These patients may require anesthesia ranging from straight local to general endotracheal anesthesia. Intraoperative considerations are the type of artificial airway required and management of intraoperative hemodynamic changes. In addition, during the recovery phase of care, postoperative pain and nausea and/or vomiting should be controlled. Special topics to be considered are obstructive sleep apnea, airway fires, and postoperative cognitive dysfunction in the elderly.

Keywords: preoperative evaluation, monitored anesthesia care, general anesthesia, postoperative nausea and vomiting, obstructive sleep apnea, malignant hyperthermia, operating room fires, postoperative cognitive dysfunction

2.1 General Principles
Patients typically present to an ambulatory surgical center for anesthesia and subsequent reconstruction the day of their Mohs procedure, usually without any prior medical screening. Often patients are added to the operating room (OR) schedule late in the day after the dermatologist has completed the procedure and decided that the patient would be best served by closure in the OR by a plastic surgeon, as opposed to immediate closure in the dermatology clinic. Anesthesia providers must then determine if the patient is an appropriate candidate for anesthesia, what type of anesthesia, such as general endotracheal anesthesia (GETA), monitored anesthesia care (MAC), or local anesthesia with or without conscious sedation, the type of operative facility (outpatient vs. hospital), and if the patient has an empty stomach (meets American Society of Anesthesiologists NPO [nihil per os] guidelines).1

Patients for repair of facial Mohs defects should receive a preoperative phone call prior to their Mohs procedure. This phone call is to identify any major medical issues that should delay the procedure if more medical workup will be necessary. Patients are not all sent for routine pre-op testing. Standard preoperative laboratory testing has proven to not be cost-effective and can lead to false-positive results and surgical delays. Additionally normal laboratory results have not been shown to have a correlation with perioperative complications.2 The exception to this is pregnancy testing in females younger than 50 years, and this should be standard on all female patients who have not had a hysterectomy. The prognostic value of preoperative electrocardiograms has also not been proven. These can be done at the discretion of the provider in most patients who pass the preprocedure phone call on the day of the procedure. Anesthesiologists also vary in their decisions on which electrocardiogram (EKG) abnormalities warrant further evaluation, therefore again bringing into question the benefit of pre-op EKGs in most patients.

On arrival to the surgical facility, the preoperative assessment includes NPO status, baseline cardiac rhythm, blood glucose level in diabetic patients, use of anticoagulants, regular medicines including the time of last B blocker dose, room air oxygen saturation, routine medicines, examination of the airway, BMI (body mass index), and any other coexisting medical issues. Often the morbidly obese are better served in the hospital setting if requiring anesthesia as narcotics will exacerbate sleep apnea issues and these patients may require longer postanesthesia recovery times. Patients having any IV (intravenous) anesthesia must be able to lay flat without supplemental oxygen.

2.2 Types of Anesthesia
The type of anesthesia used for each patient for the reconstruction of the Mohs defect will depend upon the type of defect to be repaired, the preference of the surgeon and patient, the patient’s current presenting issues and preexisting medical problems, and whether the procedure is elective versus emergent or urgent. Occasionally facial reconstructive patients will be added to the surgery schedule without confirmation of their ride home or NPO status. If the patient has driven himself and does not have another option for transport after procedure, or if the patient is not NPO, the surgeon will need to decide if this is a case that should be delayed or can be accomplished with straight local anesthesia. Likewise, if the patient has significant medical comorbidities making the prospect for safe anesthesia questionable, then the patient might proceed with straight local anesthesia, be transferred to an inpatient facility, and/or be delayed for medical workup and clearance. Assuming the surgery will proceed with anesthesia, the patient may be consented for either MAC or general anesthesia (GA).

2.2.1 Monitored Anesthesia Care
The ASA defines MAC as a specific anesthesia service in which an anesthesiologist has been requested to participate in the care of a patient undergoing a diagnostic or therapeutic procedure. The role is to monitor vital signs while administering anxiolytics or analgesics for patient comfort. Sometimes no anesthetics are given, but the anesthesia provider monitors patient’s vital signs and treats them as necessary. MAC can encompass differing depths of sedation and may be termed conscious sedation as the patient should be able to respond to verbal or tactile stimuli. Healthy patients should be able to maintain their own airway and are unlikely to have any cardiovascular compromise from the sedatives. A patient with significant comorbidities may have hemodynamic changes from minimal sedation. Once a patient is not responsive and/or is unable to maintain an unobstructed airway, the terminology changes to deep sedation and GA. GA is a drug-induced loss of consciousness during which patients are not arousable, even by
Introduction

Painful stimulation. These patients are likely to require airway support and may be subject to cardiovascular changes.

For patients with small facial defects, or in patients with significant comorbidities, minimal sedation may be all that is required. These patients are consented for MAC, told they will not be completely asleep, and are likely to have recall of the OR. All patients must have an IV when entering the OR, even if not being sedated, as injection of local anesthesia with epinephrine may cause significant changes in hemodynamics that may require rapid treatment. Most patients receive a benzodiazepine, namely midazolam, prior to leaving the preoperative area. Midazolam is a sedative and has rapid onset of anxiolysis with minimal side effects and causes anterograde amnesia, but no analgesia. At low doses (0.02 mg/kg), midazolam is an effective anxiolytic over a wide age range (20–80 years), with minimal respiratory depression in healthy patients. Larger doses (0.05 mg/kg) increase the likelihood of sedation but are not more effective at relieving anxiety.4 Because elderly patients may have increased postoperative sedation, especially those with preoperative cognitive deficits, midazolam is often withheld in this patient population.

Patients for sedation may also receive IV fentanyl. Fentanyl is ideal because it is a rapid-onset, short-acting opioid that produces analgesia. It has a shorter half-life than morphine sulfate, thus having the benefit of quicker arousal time. It can also decrease anxiety by decreasing pain, a common preoperative issue in patients with new facial defects who have arrived from dermatology. Fentanyl is easy to titrate and easily reversed by naloxone. Midazolam and fentanyl act synergistically. The anxiolytic and respiratory effects of fentanyl are pronounced in the presence of midazolam, it can depress the respiratory drive, and the anxiolytic and sedative effects of midazolam are pronounced in the presence of fentanyl.5

The anesthesia provider must be prepared to treat hemodynamic changes that may occur during a procedure in which the patient is only receiving sedation. He must also have a plan for respiratory depression as the depth of anesthesia may change resulting in an unexpected unconscious patient. Emergency airway equipment must therefore always be available.

MAC patients are brought into the operating suite on a stretcher with a separate head attachment, which cradles the head during the procedure (Fig. 2.1). They remain on this same stretcher from pre-op through the OR and recovery area until discharge. On entering the room, standard ASA monitors are placed: EKG, pulse oximeter, and blood pressure cuff. They are given oxygen through nasal cannula during the time of injection of local anesthesia by the surgeon. The oxygen cannula is usually removed prior to the prep solution being placed on the face. The prep solution is removed not only because the nasal cannula may possibly obstruct the operative field, but also because an open system of oxygen cannot be on the face due to the high risk of fire sparked from an electrocautery device in an oxygen-rich environment. These patients are continually monitored for changes in hemodynamics as well as level of sedation. More sedatives can be given if deemed necessary. These patients are generally awake on arrival to the postanesthesia care unit (PACU) and are ready for discharge in 30 minutes.

2.2.2 General Anesthesia

Patients requiring skin grafts, local flaps, and complex closures typically receive IV GA. These patients are consented for GA because loss of consciousness is anticipated. This is explained to the patient during the preoperative interview and that invasive airway devices are not anticipated. Premedicating for prophylaxis for gastric content aspiration should be considered. Metoclopramide is sometimes used both as a motility agent, to lessen the likelihood of aspiration, and as an antiemetic. Patients may experience agitation or anxiety when metoclopramide is used as a rapid IV bolus, and less commonly extrapyramidal reactions can occur. Other gastric acid reducing agents often considered are H2 blockers such as famotidine, proton pump inhibitors such as omeprazole, and sodium citrate, Bicitra. Aspiration of stomach contents can have such devastating consequences that patients having anesthesia without a secured airway should be carefully considered for prophylaxis.

All patients having Mohs reconstruction should receive IV antibiotics. For patients having IV GA, a benzodiazepine (midazolam) is administered en route to the OR. Most often, the facial reconstructive patients have been in a medical facility for hours by this point and are hungry and anxious for completion of surgical repair. Therefore, anxiolysis is appropriate for most patients and makes them more comfortable about entrance to the OR. Once in the operating suite, the patient remains on the transport stretcher that has the additional headrest and oxygen by nasal cannula is administered. ASA monitors—EKG, pulse oximetry, capnography via the oxygen cannula, and blood pressure cuffs—are placed on the patient and monitoring begins. When the surgeon is ready to inject local anesthesia IV lidocaine is given followed by a slow injection of propofol to maintain the respiratory drive and render the patient unconscious. By keeping the patient unconscious during injection of the local anesthesia, the patient’s blood pressure and heart rate should remain controlled, decreasing bleeding from the surgical site. Hemodynamic stability is important in any patient, but especially in patients with cardiac disease. The eyes are lubricated with ophthalmic ointment to protect them from irritation from the prep solution. After the patient can maintain an open airway, the supplemental oxygen is removed. This is always done prior to the facial prep as a reminder to keep the open flow of oxygen off the surgical field. If the patient is stable on room air and uncomfortable, or at surgeon preference, additional
sedation with propofol can be administered by small incremental boluses or by infusion during the procedure. As propofol is short acting, these patients are typically awake by the end of the procedure or shortly after arrival in the PACU and are discharged without incident within 30 minutes.

Patients having midline forehead flaps or other more complicated procedures are administered general inhalational anesthesia. GA helps ensure a calm operating environment without patient movement. This begins with IV midazolam and antibiotics on the way to the OR. Patients remain on the transport bed with the headrest (> Fig. 2.1), and standard ASA monitors are attached. Preoxygenation is initiated via face mask. The type of airway chosen is based on the surgical site and patient factors. If the facial defect is on the nose and therefore there is likelihood of blood in the airway, an endotracheal tube is chosen. If the defect is cheek, forehead, scalp, or any other area where blood in the mouth is unlikely, a laryngeal mask airway (LMA) can be used. Anesthesia is routinely induced with IV fentanyl and an induction agent. Propofol is most commonly used and is given with IV lidocaine first to decrease the venous irritation that is felt as propofol is started in the IV. The amount of lidocaine can vary, but the anesthesia practitioner should be cognizant of the fact that the plastic surgeon will be adding local anesthesia at the site and the amount of total local anesthesia should be considered to avoid local anesthetic toxicity. Etomidate can be used as an induction agent, particularly in patients with significant cardiovascular disease. Etomidate is a mild cardiovascular depressant and blood pressure is only minimally affected as compared with propofol. After the patient is unconscious, an LMA can be placed if appropriate, or a neuromuscular paralyzing agent can be given and the airway secured with an endotracheal tube. In most situations, an oral Ring–Adair–Elwyn (RAE) endotracheal tube is used to avoid being in the way of the surgeon. This tube also does not need to be secured as it should stay in place at the curve, making mobility of the tube possible for the surgeon. Lubrication is placed in the eyes prior to the prep and the eyes are covered or secured in the field. If the patient has an LMA, the goal is resumption of spontaneous ventilation of an inhalational agent. If paralyzed and with an endotracheal tube, the patient is put on the ventilator and given an inhaled anesthetic in conjunction with an oxygen and air combination. Sevoflurane and desflurane are the most commonly used volatile anesthetics. Their low blood and fat solubilities allow more rapid awakening compared to isoflurane. Additional narcotics and neuromuscular blockers are added as deemed necessary.

Patients who are maintained on a volatile anesthetic are given prophylaxis for prevention of postoperative nausea and vomiting (PONV). Corticosteroids, primarily dexamethasone, are given shortly after induction. These medicines have both the benefit of reducing facial and airway swelling, and also are an effective prophylactic against PONV. Ondansetron, a serotonegic receptor antagonist with minimal side effects, is widely used 30 minutes prior to arousal.

At the conclusion of the surgical procedure, the LMA is removed with the gas on to avoid the patient biting on the LMA and to ensure the patient does not move during removal of the artificial airway. After suctioning a patient with an endotracheal tube and little to no blood is in the airway, the endotracheal tube can also be removed with the gas on and the patient under deep anesthesia—a “deep extubation”—by an experienced anesthesia provider who is comfortable with deep extubations. The benefits to this are to avoid coughing and bucking during emergence causing hypertension in the face with added risks of additional bleeding or wound dehiscence.

Hemodynamic changes intraoperatively are common and the anesthesia provider needs to be prepared to intervene pharmacologically to correct any hemodynamic instability such as blood pressure changes and dysrhythmias. Severe intraoperative hypotension is an anesthetic emergency. Prompt recognition and treatment is vital to ensure organ blood flow, particularly to the brain, heart, and kidneys. Propofol produces vasodilation in both the arterial and venous circulation, producing a significant decrease in systemic blood pressure. Both sevoflurane and desflurane also reduce systemic vascular resistance and blood pressure, especially in the face of volume depletion due to fasting or bleeding. Hypotension intraoperatively can be lessened by decreasing the concentration of inhaled anesthetic and increasing the infusion rate of IV fluids. Boluses of epinephrine and phenylephrine are most commonly used to treat hypotension intraoperatively. Epinephrine is a sympathomimetic that has both alpha and beta activity and is used for treatment of vasodilatory hypotension. It generally raises the heart rate as well. Phenylephrine exhibits potent vasoconstriction via alpha 1 receptors, which causes a rise in blood pressure as well as a reflex bradycardia. Treatment of hypotension should be swift because if left uncorrected, it can lead to stroke, myocardial infarction, and acute tubular necrosis.

Severe intraoperative hypertension also requires immediate intervention to prevent CNS (central nervous system), cardiac, and renal adverse effects. In facial surgeries, even slightly elevated blood pressure will cause bleeding at the surgical site, making the success for the desired result less likely. The most commonly used medications to lower intraoperative blood pressure are hydralazine and labetalol. Hydralazine is given in bolus dosages to cause arteriolar vasodilation. It can cause a reflex tachycardia. Labetalol has a combined alpha and beta receptor antagonist effect and thus lowers blood pressure and heart rate. Changes in heart rate without significant blood pressure alterations can also occur. Glycopyrrolate or atropine can be bolused to raise heart rate. Metoprolol or esmolol, beta blockers, lead to rapid control of tachycardia.

The most commonly uses local anesthetics are the amides (lidocaine and bupivacaine). Local anesthetics act by blocking sodium channels and may be used with or without epinephrine. Bupivacaine (Marcaine) can last up to 8 hours and it is longer acting than lidocaine, which lasts 1 to 2 hours (> Table 2.1). The addition of epinephrine to all local anesthetics causes veins to constrict, helping with hemostasis, prolonging the anesthetic effect. Local anesthetic toxicity is a rare but serious potential intraoperative event. High plasma levels of local anesthetics affect organs that are dependent on sodium channels to function. Most cases of toxicity result from accidental intravascular injections. Less likely, but possible, is absorption of a significant amount of local anesthetic from the surgical site. The lidocaine injected intravenously prior to propofol should also be considered when figuring maximum dose of local anesthesia allowable in a patient. Toxicity can lead to serious CNS and cardiovascular complications. CNS toxicity manifests on a continuum starting with oral numbness and foul taste, to vertigo, tinnitus, and in severe cases...
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<sup>a</sup>Maximum is 7 mg/kg if administered with epinephrine.

Seizures should be treated with supplemental oxygen and a benzodiazepine. Refractory seizures may require induction of GA and invasive airway support. Cardiovascular repercussions from the blockade of sodium channels can progress from myocardial depression, heart block, ectopy, arrhythmias, and ventricular fibrillation. Bupivacaine is the most cardiotoxic of the local anesthetics because it binds the most tightly to the sodium channels. Treatment of cardiac symptoms is supportive with oxygen, vasopressors, inotropes, and antiarrhythmics. Additionally, lipid emulsion therapy should be instituted promptly when there are signs of hemodynamic instability impending cardiac collapse. Lipids are given by an initial bolus followed by an infusion until at least 10 minutes after the patient regains hemodynamic stability.

2.3 Recovery

Because of local infiltration by the surgeon, most patients in the PACU after Mohs reconstructive surgery have little to no pain. Patients with mild postoperative pain in whom postoperative bleeding is not a concern can be treated with oral or IV nonsteroidal anti-inflammatory drugs. Oral or IV acetaminophen is also often an appropriate choice. Patients receiving acetaminophen should be counseled about acetaminophen dosing after discharge so as not to exceed the Food and Drug Administration (FDA) recommended 4 g/d limit. For patients with more significant pain, for example, headache in a forehead flap patient, IV narcotics are reasonable. Oral narcotics on an empty stomach are less desirable at this time because of the increased risk of nausea after anesthesia, especially before transport home. In a patient who may have swelling or discomfort around the eyes, a cold gel mask is often applied. These masks are reusable and replaced with a fresh cold mask intermittently. The patient can take these home in a box set and keep them in the refrigerator to exchange periodically during the recovery period (▶ Fig. 2.2).

PONV remains the most common complaint following surgery and anesthesia. Not only is it highly unpleasant for the patient, but it can also lead to other ramifications. Pain can be intensified, dehydration can ensue, hematoma can form, and wound can dehisce. Uncontrollable PONV is a very common cause of hospital admission raising the cost of the procedure in an ambulatory patient. Older studies quote a 25 to 30% incidence of PONV. A more recent study claims the incidence is actually significantly less, with the overall incidence of postoperative nausea to be 13.4% and the incidence of vomiting to be 15.5%.<sup>6</sup> In this study, the risk factors seen were gender, duration of surgery, obesity, motion sickness, tracheal intubation, and use of certain drugs (see list in section “Predisposing Factors”). Interestingly, smoking seems to be a protective factor decreasing the risk of PONV. Patients with a significant history of PONV or motion sickness can be treated preoperatively as well as intraoperatively for prophylaxis. Transdermal scopolamine, an anticholinergic, is cost effective and has been widely used, particularly in patients with a history of motion sickness. However, it is associated with numerous side effects including drowsiness, double vision, urinary retention, and dry mouth. An overdose can lead to central anticholinergic syndrome. A newer drug used preoperatively is aprepitant. It is a NK<sub>1</sub> (neurokinin 1) antagonist and given orally has been found to be very effective in the prevention of PONV. It is recommended to be given within 3 hours of surgery start.

Predisposing factors (increasing the risk of PONV)<sup>6</sup>:

- Female gender.
- Longer surgeries (>60 minutes).
- Obesity.
- Motion sickness.
- Orotracheal intubation.
- Drugs used during anesthesia:
  - Nitrous oxide.
  - Naloxone.
  - Neostigmine.

Source: Adapted from Doubravska L, Dostalova K, Fritscherova S et al. Incidence of Postoperative nausea and vomiting in patients at a university hospital. Where are we today? Biomedical papers of the Medical Faculty of the University Palacký, Olomouc, Czech Republic.

Rescue medicine is used in the recovery area if a patient develops PONV upon awakening. Typically choices at this point are of the antihistamine class, such as promethazine and...
diphenhydramine. However, both can be quite sedating in an ambulatory patient. Studies have shown there is no increased benefit for a repeat dose of ondansetron. Often increasing IV fluids can make a nauseated patient feel better.

Hypertension in the PACU should be treated promptly as hematomas and/or increased bleeding from the site can be devastating. Ensuring the patient has taken their regular antihypertensives is important as well as making sure the patient is not in pain or needing to void. IV hydralazine or labetalol can be used for quick reduction in blood pressure.

2.3.1 Obstructive Sleep Apnea

Respiratory and airway issues in the PACU are common and patients may require management by a PACU nurse or an anesthesia provider until stable. This is more common in the immediate postoperative period and especially if the patient was extubated “deep.” Obstructive sleep apnea (OSA) is characterized by episodic periods of airway obstruction, which may be partial, complete, and periodic. Sleep apnea is very common and the majority of patients who undergo ambulatory surgery do so safely and without incident. The use of a positive airway pressure device (continuous positive airway pressure therapy [CPAP]) in the perioperative period is encouraged. As suggested by the Society of Ambulatory Anesthesia, patients with underlying comorbidities need to be optimized preoperatively.

Preoperative screening of OSA patients begins with a thorough preoperative evaluation. The STOP-Bang questionnaire categorizes patients with sleep apnea and will help in the decision of the type of anesthesia that is safe (see text box below (p.11) and ▶ Fig. 2.3). Patients with severe OSA, who will require longer stays postoperatively, are not appropriate candidates for GA in an ambulatory setting. Perioperatively watch for desaturation, respiratory depression, and apnea that can be exacerbated by opioid analgesics and residual volatile anesthesia. In severe respiratory depression or obstruction, the patient may need to be placed on CPAP or even intubated.

STOP-Bang Questionnaire

- Do you Snore loudly? Yes/No.
- Do you feel Tired, fatigued or sleep during the daytime? Yes/No.
- Has anyone Observed you stop breathing during your sleep? Yes/No.
- Have you been or are you now being treated for high blood Pressure? Yes/No.
- Is your Body mass index greater than 35 kg/m²? Yes/No.
- Are you over 50 years of Age? Yes/No.
- Is your Neck circumference greater than 40 cm? Yes/No.
- Gender (male)? Yes/No.
- High-risk OSA: STOP-BANG, yes to three or more questions.


Anesthetic techniques in the OSA patient:
- Use of nonopioid techniques whenever possible.
- Local or regional anesthesia is preferred if possible.
- If moderate sedation is used, then capnography should be used during surgery.
- If GA is used, then use a technique that allows early emergence.
- Use short-acting opioids if possible when opioids are needed.
- Consider multimodal anesthesia (local/regional anesthesia, NSAIDs [nonsteroidal anti-inflammatory drugs], and acetaminophen).

2.3.2 Malignant Hyperthermia

Malignant hyperthermia (MH) is a rare autosomal-dominant disease that causes hypermetabolism when administered triggering anesthetics agents. Triggering agents include succinylcholine and all inhalational agents. Propofol, etomidate, ketamine, nitrous oxide, all benzodiazepines, narcotics, and nondepolarizing neuromuscular blocking drugs are safe. MH can occur any time during anesthetic administration and has been reported to occur as long as 24 hours postoperatively. The mechanism of the hypermetabolism is from the release of free unbound calcium from storage sites. Clinical manifestations result from the state of highly increased metabolism. The initial signs of MH include increased end tidal CO₂ levels, tachycardia, unstable blood pressure, and tachypnea and skeletal muscle rigidity in an unparalyzed patient. Increased body temperature is a late clinical sign and treatment should not be delayed for hyperthermia to present. Late complications can include renal failure, coagulopathies, pulmonary, and cerebral edema. At first signs of an MH crisis, all triggering agents should be discontinued and the patient should be hyperventilated with 100% oxygen. The critical component of treatment is dantrolene, a skeletal muscle relaxant. It should be administered quickly by IV bolus and repeated every 5 minutes until effect is seen and then continued as repeated doses every 6 hours for 24 to 48 hours to prevent symptoms from reoccurring. A patient in an ambulatory setting should be transported to a hospital as soon as possible. MH is an anesthesia crisis and therefore patients with a
known history of MH, or even those with a high suspicion due to family members with MH, would be best served in a hospital setting for their procedures.

2.4 Operating Room Fires

Fires in the OR have injured 550 to 650 people per year according to the Emergency Care Research Institute. Three components are necessary to start and sustain a fire: a fuel (something to burn), an oxidizer (oxygen), and an ignition source (something to spark the flame). If a patient has an open delivery of oxygen on the face, for example, a nasal cannula, and the surgeon uses an electrocautery device, a fire could be ignited on the nasal cannula itself, the drapes, patient hair, dressings, gowns, and anything else combustible in the area. Because of this enormous risk, when a patient is having a facial procedure, the oxygen cannula is most frequently removed from the patient’s face prior to the prep and the surgical procedure. If a sedated patient continues to need supplemental oxygen via an open system, there must be continual communication between the anesthesia provider and the surgeon so that the oxygen can be turned off and allowed to clear the area before the surgeon uses electric cautery each time. Fire risk should now be discussed with everyone in the OR prior to the start of each case with the use of the now widely used Time Out procedure.

2.5 Postoperative Cognitive Dysfunction

Although postoperative cognitive dysfunction (POCD) can occur in any patient, it is more common in the elderly and it is for the most part transient. Studies have shown that cognitive dysfunction can occur in up to 40% of patients older than 60 years of age in the first week following surgery and even up to 12% 3 months postoperatively. POCD must not be confused with delirium. Delirium after surgery is defined as an acute alteration in mental status, which presents with reduced awareness, hallucinations, agitation, and mental confusion. POCD on the other hand is more difficult to assess. It is more subtle and affects the way the brain processes information such as memory, concentration, and reasoning. It can affect the patient’s quality of life by limiting patients in simple everyday tasks.

Risk factors for postoperative cognitive dysfunction:

- Age.
- Duration of surgery.
- Postoperative delirium.
- Cardiac surgery.
- Underlying cognitive dysfunction.
- Lower levels of education.
- Alcoholism.

The pathophysiology of cognitive dysfunction is thought to occur as an inflammatory response to surgery and not anesthesia, although this mechanism is not yet fully understood.

The type of anesthesia may play a role in preventing short-term postoperative cognitive dysfunction. For example, regional and local anesthesia is preferable in reducing the incidence cognitive dysfunction in the first 7 days postoperatively when compared to GA. However, there is no difference in the type of anesthetic used when POCD is prolonged.

To help prevent POCD, especially in the elderly, carefully plan an anesthetic that will reduce or minimize certain risks. For example, avoiding midazolam will help reduce amnesia postoperatively. The use of local anesthesia with minimal sedation for procedures that are of shorter duration may prove beneficial. In patients requiring a general anesthetic, one should target reducing the length of surgery, minimizing fluid shifts, and maintaining stable vital signs in addition to keeping the patient warm in the OR. Most recently, the American Society of Anesthesiologists sent out a report that, in essence, stated that neither surgery nor anesthesia is the cause of POCD. Clearly, more studies should be done to more fully understand POCD.

2.6 A Note on Office-Based Anesthesia

Over the last 20 years, more patient care has moved out of the hospital setting and into ambulatory care centers. More recently, there has been a shift to office-based procedures, especially in plastic surgery. Current estimates suggest 17 to 24% of all elective ambulatory surgeries occur in physician offices. Outcomes are difficult to compare as adverse events are voluntarily reported, and thus are likely underreported. Although ambulatory centers and physician offices both have less resources available than in a hospital setting, they are most likely not equal either. In some states, office-based practices are subject to less regulation (or no regulation) than ambulatory settings. There are less likely to be the same guidelines for the monitoring of patients in office-based practices both during the procedure and in the recovery phase, and nearly half of office-based claims are deemed preventable by better monitoring, such as pulse oximetry in the postoperative period. It is therefore imperative to have cardiac and respiratory monitoring throughout the procedure and until the patient is ready for discharge. Resuscitation equipment should always be immediately available, along with staff who understand how to operate such equipment, and plans should be in place for quick transfer of patients should emergency situations arise.

References


3 Mohs Micrographic Surgery

Sean Chen, Divya Srivastava, and Rajiv I. Nijhawan

Summary

Mohs micrographic surgery (MMS) is a specialized technique consisting of a standardized series of steps for the treatment of skin malignancies. MMS offers precise and comprehensive histologic margin control, superior cure rates, and maximum preservation of normal tissue, making it the ideal technique for histologically aggressive cutaneous tumors or tumors located in cosmetically and/or functionally sensitive areas such as the head and neck.

Keywords: Mohs micrographic surgery, tumor extirpation, basal cell carcinoma, squamous cell carcinoma, melanoma, surgical defect, frozen section histology, immunostaining, skin cancer

3.1 Introduction

Mohs micrographic surgery (MMS) allows for efficient evaluation of the entire margin in an outpatient setting under local anesthesia with the goal of confirming clear histologic margins prior to reconstruction. The advantages of MMS over standard surgical excisions are multiple: its precise and comprehensive histologic with 100% histologic margin evaluation, higher tumor clearance rates, and maximum preservation of normal tissue. The technique relies on the contiguous nature of most cutaneous tumors. Once serial excision has led to histologic clearance, one can feel confident that a negative margin has been achieved. Further, when Mohs surgery is the chosen method for appropriate indications, the average cost to the patient and the health care system is often less than traditional surgical excisions. MMS has demonstrated 5-year cure rates of basal cell carcinomas (BCCs) to be 99% and 94% for squamous cell carcinomas (SCCs), and offers the highest cure rates for nonmelanoma skin cancers (NMSC).

One of the unique aspects of Mohs surgery is that the Mohs surgeon acts as the surgeon as well as the pathologist throughout the entire procedure, allowing a single physician to maintain control and accuracy of tumor extirpation. MMS also offers the maximum amount of normal tissue preservation, therefore optimizing functional and cosmetic outcomes particularly in cosmetically sensitive, functionally important, and/or high-tension areas. Mohs also is the preferred method for recurrent or incompletely excised tumors or those that have a high risk of recurrence due to histologic features or due to size in the context of its anatomic location. Larger lesions in lesions in cosmetically sensitive locations that may require significant tissue rearrangement for reconstruction (e.g., flaps or multistaged repairs) should always have clear margins confirmed histologically prior to reconstruction, and MMS is ideal given its rapid and precise approach. While there are clear-cut advantages of MMS, there are also some disadvantages (Table 3.1).

Table 3.1 Advantages and disadvantages of Mohs surgery

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local anesthesia used and preferable in patients not amenable to general anesthesia</td>
<td>Requires contiguous tumors</td>
</tr>
<tr>
<td>Tissue preservation in cosmetically or functionally sensitive areas</td>
<td>Improper surgical removal can lead to specimens that are too thick, too thin, or misfolded, leading to decreased pathologic sensitivity</td>
</tr>
<tr>
<td>100% margin evaluation</td>
<td>Poor staining can affect tumor recognition</td>
</tr>
<tr>
<td>Real-time surgery with pathologic evaluation increasing convenience to the patient</td>
<td>Surgeon error in reading histopathology or the procedure itself</td>
</tr>
<tr>
<td></td>
<td>Unable to perform larger cases under local anesthesia</td>
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</tbody>
</table>
3.2 History

MMS was developed and pioneered by Dr. Frederic E. Mohs during his tenure at the University of Wisconsin-Madison. Dr. Mohs was studying the potential curative effects of injecting various substances into tumors. During one experiment, he injected 20% zinc chloride solution that inadvertently caused tissue necrosis. Microscopic analysis showed that the tissue retained its structure as if it had been excised and processed for standard histologic assessment. Dr. Mohs realized that this effect of tissue fixation could be paired with surgical excision to remove tumors in a serial manner. He first published his findings in 1941 in the Archives of Surgery where he described treating 440 consecutive patients over 4 years using this technique.7

His original technique involved the application of zinc chloride paste to the tumor 24 hours prior to surgical excision. For any areas where positive margins remained, zinc chloride paste was again applied to these margins for an additional 24 hours prior to additional tumor extirpation, and the process was repeated until tumor clearance was achieved. Dr. Mohs also conceived the idea of using horizontal frozen sections to evaluate 100% of the tumor margin rather than the traditional vertical sections, which comparatively only examine approximately <0.1% of the total margin.8 One of the major drawbacks of the zinc chloride was that it caused local tissue necrosis, and the resulting wounds were more challenging to reconstruct. This limitation also led Dr. Mohs to evaluate healing by secondary intention, which he observed was a cosmetically superior option in concave locations.

Today, tissue processing with MMS no longer relies on zinc chloride but rather using a fresh frozen tissue technique, which was also initially performed by Dr. Mohs in 1953. This fresh frozen technique does not cause local tissue destruction, allows for same-day reconstruction, and remains the standard today.

3.3 Preoperative Considerations

Initially, a thorough history and focused skin examination should be conducted along with clinical lymph node assessment. Important factors to evaluate for include the following: implantable cardiac pacemakers and defibrillators that may affect the use of cautery devices, use of blood thinning medications including warfarin, aspirin, clopidogrel, nonsteroidal anti-inflammatory drugs (NSAIDs), and newer anticoagulating agents (e.g., fondaparinux, argatroban, dabigatran, etc.), as well as herbal supplements including garlic, ginkgo, and fish oil.9 Allergy to local anesthetics, antibiotics, iodine, latex, and tape products should also be reviewed. True allergy to amide anesthetics is rare and most adverse reactions are likely secondary to sensitivity to epinephrine. If a history of lidocaine allergy is elicited, an ester anesthetic such as tetracaine may be substituted.10 A social history may elicit long-term alcohol consumption or smoking, which may increase intraoperative bleeding risk and poor wound healing respectively.11

The pathology report of the biopsy should also be reviewed to ensure that MMS is appropriate and indicated for the lesion. Given the uniqueness of skin pathology, ideally the initial biopsy would have been examined microscopically by a dermatopathologist. Patients with large tumors abutting sensitive structures such as the orbit or nose or invasive lesions that feel fixed to underlying structures clinically may benefit from preoperative imaging (e.g., computed tomography [CT], magnetic resonance imaging [MRI], or positron emission tomography [PET] scans) as well as a multidisciplinary approach with consultation of other specialties such as plastic surgery, otolaryngology, ophthalmology, surgical oncology, and radiation oncology.

Historically, antibiotics were routinely prescribed prophylactically for procedures on the lower extremities, groin, or large defects on the lip, ear, skin flaps on the nose, and skin grafts;12 however, given the overall low risk for infection, there has been a shift away from the routine administration of prophylactic antibiotics in dermatologic surgery. Currently, antibiotic prophylaxis is provided to patients with high-risk cardiac conditions or prosthetic joints at high risk for hematogenous total joint infection.13,14,15 Antibiotics are also prescribed when the surgical site is infected or when the oral mucosa is breached.13

3.4 Description of Technique

To ensure correct site surgery, the lesion is identified using photographs and landmarks provided by the referring physician as well as the patient. However, it is imperative not to solely rely on the patient’s perception of the lesion given that they often are unsure and/or incorrect.16 After the site has been confirmed, the tumor borders are examined, and the clinical margin is marked (Fig. 3.1a). The site is then prepped with alcohol and/or antiseptic solution prior to local infiltration of the anesthetic solution (most commonly a mixture of 1% lidocaine and 1:100,000 epinephrine). The anesthetic may be buffered with sodium bicarbonate in a ratio of 1:10 to increase the pH to decrease the pain of injection.17,18 Injecting the local anesthetic slowly also helps decrease the stinging sensation.

The site is then prepped using antiseptic solution, most commonly chlorhexidine or povidone-iodine. After a broad prep, the center of the tumor may be debulked using a curette (Fig. 3.1b), which helps delineate the subclinical boundaries and decrease the number of Mohs layers needed.19,20 Some surgeons prefer to perform a sharp debulk of the tumor with their surgical blade, especially for larger tumors. Debulking the tumor also helps for tissue processing to allow for the tissue to flatten appropriately.

After debulking the clinical tumor, the first Mohs “layer” is taken as a disc of tissue with a small margin of normal appearing tissue around the clinical lesion (Fig. 3.1c). While 1 to 2 mm is the traditional initial margin, the margin may range from 1 to 10 mm depending on the site and the histologic aggressiveness of the primary tumor. Shallow deep margins may be taken on mucosal sites or sites amenable to secondary intent healing.21 Deeper margins to subcutaneous fat should be taken on other sites. For recurrent tumors, all tissue involved in previous treatments including the entire scar should be surgically removed in the first layer. Infrequently, exceptions of this approach include lesions in anatomic sites where tissue sparing is critical and/or the recurrent tumor is clinically obvious.

For each Mohs layer, the scalpel is held at approximately a 45-degree angle (range of 30–60 degrees) to provide a beveled incision along the entire periphery, which is critical for proper tissue processing. Before removing the deep tissue, the layer as well as the patient’s adjacent normal tissue is marked with
superficial nicks (commonly at 3, 6, 9, and 12 o’clock positions) for orientation purposes and tissue mapping (▶ Fig. 3.1d). The deep tissue is then removed with either a scalpel blade or curved iris scissors (▶ Fig. 3.1e) and placed on a piece of blotting paper displaying orientation (▶ Fig. 3.1g). Hemostasis is then achieved with electrocautery (▶ Fig. 3.1f). A sterile pressure dressing is applied and the patient is asked to wait in the waiting room for approximately 1 to 2 hours for tissue processing and any special stains. The surgeon creates a diagram of the excised tissue with its markings to maintain correct orientation (▶ Fig. 3.1g).

To ensure complete histologic assessment of the margins, tissue processing must be executed meticulously. Depending on the size of the lesion, the specimen may need to be cut in multiple pieces to fit on a glass slide. Based on the initial nicks, the specimen’s margins are then inked with different colored dyes to provide accurate pathologic orientation. Consistency in the color coordination helps maintain the correct orientation each time. The goal of MMS is for the surgeon to microscopically assess both the peripheral and the deep margin in a single view. Thus, the tissue must lie perfectly flat so that the epidermis, dermis, and deeper tissues (e.g., subcutis, muscularis, fascia, cartilage, etc.) all lie in a single plane. Extra relaxing cuts may be needed to achieve this goal.22

The histotechnician subsequently freezes the tissue using a cryostat and embeds the tissue with the deep surface facing up with embedding medium.23 The frozen sections are then sectioned on a microtome and mounted onto glass slides and stained. The most common stains used for histologic examination are hematoxylin-eosin or toluidine blue, though other immunostains may also be utilized for unique or more aggressive tumors. These frozen sections are then examined by the Mohs surgeon, who assesses whether there is residual tumor at any margin. If tumor remains, the location of residual tumor is marked on the specimen map based on the inking and orientation (▶ Fig. 3.1h).
For additional Mohs layers, the patient is brought back to the operating suite, where the area is again infiltrated with local anesthesia and prepped. Residual tumor in the epidermis and dermis requires extending the periphery of the surgical defect, whereas residual tumor in the deep margin requires removal of the base of the surgical defect (Fig. 3.1i). The surgeon then removes additional tissue only in the area shown to have residual tumor based on the Mohs map while preserving areas that have already been “cleared.” The map, nicks, and inking help orient each layer throughout the procedure. Any tissue removed is again processed by fresh frozen tissue processing in the Mohs lab and examined microscopically by the Mohs surgeon. This process is repeated until a specimen free of tumor is obtained. Once the tumor is removed, the final defect is examined and repair options are explored. Many options exist for management of postsurgical Mohs defects to achieve the optimal functional and cosmetic outcome as will be discussed in subsequent chapters.

### 3.5 Postoperative Considerations

The postoperative period should take into account the anatomic location of the defect, patient comorbidities, and the severity and size of the defect. Secondary intention healing often offers cosmetically acceptable results for superficial defects on concave surfaces. Additionally, this approach or a split-thickness skin graft may allow for better tumor surveillance for tumors at high risk for recurrence, whereas flaps or full-thickness skin grafts may “hide” recurrent tumors. Reconstruction often has a shorter healing time compared to secondary intention healing.

Pain control should be addressed postoperatively. While over-the-counter analgesics are often adequate for pain control, oral narcotic agents may be required for opioid-tolerant patients, larger tumors, or wounds in high-tension areas such as the scalp. Patients with NMSC require routine long-term surveillance by their dermatologists as 30 to 50% of these patients will develop another unrelated NMSC during a 5-year follow-up period. These patients are also at an increased risk for developing cutaneous melanoma.

### 3.6 Complications

Patients should be counseled on pain, bleeding, nerve damage, allergic reactions, hematoma formation, infection, necrosis, dehiscence, and scarring during the consenting process.
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Hemorrhage is a risk both during and after surgery but can be minimized with meticulous hemostasis intraoperatively and pressure bandaging postoperatively. There is no evidence that patients on aspirin or warfarin experience increased risk of major hemorrhagic complications; however, there is an increased risk of bleeding in patients taking clopidogrel or ticlopidine, but these agents are normally continued due to greater risk of thrombotic complications.29,30

The most likely artery to be damaged during cutaneous surgery is the superficial temporal artery.

Equally, patients should be counseled on possible nerve injury. Transection of cutaneous sensory nerves are inevitable in skin surgery; however, transection of motor nerves particularly the temporal branch of the facial nerve, marginal mandibular nerve, buccal and zygomatic nerves, and mixed motor and sensory nerves in the posterior triangle of the neck regions may occur as well.31

Merritt et al in a study of complications after MMS of 1,550 patients showed no major complications including pacemaker or defibrillator malfunction during electrocoagulation. Minor complications were rare as well at 2.6% with active bleeding being most common, followed by infection, necrosis, and hema-
toma. Further, patients expressed low levels of postoperative pain (1.99 on a 0–10 scale), and 91% reported good control of their postoperative pain.32 Postoperative infections after Mohs surgery are incredibly low at 0.91%.33

3.6.1 Nonmelanoma Skin Cancers

NMSC include both BCCs and SCCs, which are the most common cutaneous malignancies, as well as more rare skin tumors. NMSC can be treated with a variety of modalities depending on the histologic diagnosis, size, and anatomic location. Superficial ablative techniques, including electrodessication and curettage (ED&C), and surgical excisions are acceptable techniques for low-risk tumors and produce acceptable cure rates and cosmetic outcomes. For higher risk lesions, more definitive treat-
ment is usually recommended. MMS can meticulously track the deep and superficial invasion of certain tumors, which is the primary benefit and the reason for higher cure rates and lower recurrence rates comparatively. MMS relies on a continuous tumor to fully evaluate the margins and appropriately determine margin negativity. Other incomplete therapies such as topical agents prior to Mohs surgery can create so-called “skip lesions” that can increase rates of recurrence by providing false-negative margins.34

3.6.2 Basal Cell Carcinoma

Currently, BCCs represent the most common skin cancer.35 Cure rates of 87 and 95% can be obtained with ED&C and excision, respectively, in low-risk locations such as the trunk and extremities.35 In a meta-analysis performed by Rowe et al, the 5-year cure rate for a primary BCC treated with Mohs surgery was 99% as compared to 90 to 92% using standard treatments.3 The 5-year cure rate for recurrent BCCs was 94.4% treated with Mohs surgery compared to 80% for standard treatments.30 MMS is also preferred for the treatment of large BCCs (defined as 6 mm or greater in high-risk areas/Area H, 10 mm or greater in intermediate-risk areas/Area M, and 20 mm or greater in any area/Area L) given they have a higher likelihood of recurrence and unpredictable margins37,38,39,40,41 (Table 3.2). Further, histologic features such as perineural invasion, squamous differentiation, and sclerosis present a high risk for local recurrence, and Mohs surgery is the preferred modality in these instances as well.42

Table 3.2 Risk based on anatomic location

<table>
<thead>
<tr>
<th>Area H (high risk)</th>
<th>&quot;Mask area&quot; of face (central face, eyelids, eyebrows, periorbital, nose, cutaneous and vermilion lips, chin, mandible, preauricular and postauricular skin/sulci, temple, ear), genitalia, hands, and feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area M (moderate risk)</td>
<td>Cheeks, forehead, scalp, neck, and pretibial</td>
</tr>
<tr>
<td>Area L (low risk)</td>
<td>Trunk and extremities (excluding nail units and ankles)</td>
</tr>
</tbody>
</table>

3.6.3 Squamous Cell Carcinoma

MMS is indicated in the management of SCCs with higher risk for recurrence or metastasis including larger size based on anatomic location (defined as 6 mm or greater in high-risk areas/Area H, 10 mm or greater in intermediate-risk areas/Area M, and 20 mm or greater in any area/Area L), recurrent tumors, positive margins from previous excisions, aggressive histologic type such as poor differentiation, as well as SCCs arising within scars. Multiple aggressive SCCs may arise in patients who are immunosuppressed such as solid organ transplant recipients or those with chronic lymphocytic leukemia, and Mohs surgery is preferred in these patients given the high tumor burden and the desire for tissue preservation.44,45,46

Certain anatomic locations represent high-risk sites for SCC recurrence and metastasis including the lips, penis, and ears, or are functionally important such as the hands, and Mohs surgery is preferable in these sites as well.45,46 SCC of the mucosal epithelium either on the foreskin, glans penis, or coronal sulcus occurring primarily in uncircumcised men or the labia minora or vestibule in women can also be amendable for Mohs surgery achieving a 5-year cure rate of greater than 90%.47 Collaboration with a urologist for these genital cases is often helpful.

3.6.4 Melanoma

While the role of Mohs surgery in the treatment of melanoma is becoming more accepted and commonplace, the ability to reliably detect malignant melanocytes in fresh frozen sections had previously been debated.50,51,52 Immunostains such as HMB-45, Mel-5, Melan-A/MART-1, and S-100 increase histologic sensitiv-
ity.53 Recent studies have shown that MMS achieves high cure rates with low risks of recurrence while providing patient convenience of same-day surgery and reconstruction.54

Proponents of Mohs surgery for melanoma argue that excision with standard margins, especially in head and neck melanomas with extensive surrounding actinic damage, are often inadequate given the extent of subclinical extension of the melanoma.56,57 Stigall et al reported 83% of melanoma in situ (MIS) were completely excised with a 6-mm margin, whereas 9-mm margins were necessary to excise 97% of cases, while Felton et al reported 15-mm margins required for a 97%
clearance rate. Advocates for using Mohs surgery for melanoma assert that margins needed to clear melanoma can be variable, thus leading to higher rates of incomplete removal of tumors using wide local excision alone. Five-year survival and metastatic rates for 535 patients were the same or better when treated with Mohs surgery than historical controls treated with wide local excision. Alternatively, melanomas may be treated with staged excisions with permanent sections (often dubbed “slow Mohs”) for comprehensive margin evaluation prior to reconstruction. Rapid preparation of permanent sections using microwave technology to create paraffin sections in a few hours rather than 1 day may become more widely used in the future for the treatment of melanomas using the Mohs surgical approach.

### 3.6.5 Other Tumors

<table>
<thead>
<tr>
<th>Tumors Amenable to Mohs Micrographic Surgery</th>
</tr>
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<tbody>
<tr>
<td>• BCC.</td>
</tr>
<tr>
<td>• SCC.</td>
</tr>
<tr>
<td>• MIS.</td>
</tr>
<tr>
<td>• Atypical fibroxanthomas (AFX).</td>
</tr>
<tr>
<td>• Dermatofibrosarcoma protuberon (DFSP).</td>
</tr>
<tr>
<td>• Merkel cell carcinoma (MCC).</td>
</tr>
<tr>
<td>• Microcystic adnexal carcinoma (MAC).</td>
</tr>
<tr>
<td>• Sebaceous carcinoma.</td>
</tr>
<tr>
<td>• Extramammary Paget’s disease (EMPD).</td>
</tr>
<tr>
<td>• Leiomyosarcoma.</td>
</tr>
</tbody>
</table>

### Atypical Fibroxanthomas

AFX is a rare tumor that often presents as an ulcerated nodule in an area of sun-damaged skin (e.g., ears, nose, cheeks, and scalp) in an elderly person. Because most AFXs occur on the head and neck, tissue preservation is another consideration for Mohs surgery in addition to strict margin control. AFX is now considered of intermediate malignant potential with a rare ability to metastasize. Therefore, surgical excision with histologic margin assessment is the standard of care. Deeper, more invasive tumors are now classified as undifferentiated pleomorphic sarcomas (UPS) that have a more aggressive clinical course with an increased risk for metastasis and recurrence.

Davis et al compared wide local excision versus MMS and found no recurrences in 19 patients with AFXs treated with Mohs surgery, whereas 4 of the 25 patients (16%) treated with wide local excision had recurrences in 27 months. Ang et al examined 91 patients with AFX and found no recurrences in 59 AFXs treated using Mohs surgery versus an 8.7% recurrence rate in 23 AFXs treated with wide local excision. Huether et al described 29 AFXs treated with Mohs surgery and cited a 6.9% rate of recurrence. Adjuvant radiation treatment may be considered for recurrent disease, and close follow-up monitoring for recurrence is imperative for this locally aggressive tumor.

### Dermatofibrosarcoma Protuberans

DFSP is a slow-growing, locally aggressive soft-tissue sarcoma that most often presents on the trunk of young to middle-aged adults. DFSPs have unpredictable deep and lateral margins making Mohs surgery ideally suited for treating these tumors. Recurrence rates with standard excision are 11 to 53%, while cure rates with MMS are cited at 98%.

### Merkel Cell Carcinoma

MCCs are aggressive skin cancers often presenting in the head and neck region with high rates of metastasis. For localized disease, wide local excision of the primary tumor has traditionally been used with a reported 32 to 50% rate of local persistence and recurrence. Several recent studies suggest that Mohs surgery offers better margin control compared to wide local excision. The management of MCC often requires a multidisciplinary approach with sentinel lymph node biopsy and adjuvant local and regional radiation.

### Microcystic Adnexal Carcinoma

MACs are also locally aggressive tumors with a propensity for perineural invasion often involving the face of older adults. Preoperative estimates of the clinical margins often underestimate the true size of the tumor. Chiller et al showed that defects following Mohs surgery were four times the size of preoperative predictions. Local recurrence rates approach 40% when using standard therapies. Recurrence rates with Mohs surgery range from 0 to 22% with a 5-year follow-up period.

### Sebaceous Carcinoma

Sebaceous carcinomas often occur in cosmetically and functionally sensitive anatomic locations including the eyelids, making Mohs surgery ideal. Overall, compared with wide local excision, MMS has lower recurrence rates for periorbital sebaceous carcinomas, though fewer studies have been published for extraocular cases.

### Miscellaneous Tumors

Other rare tumors that may also be amenable to MMS including mucinous eccrine carcinomas, eccrine porocarcinomas, adenoid cystic carcinomas, papillary eccrine carcinomas, EMPD, angiosarcomas, and leiomyosarcomas. Rarely, Mohs surgery has also been used in the treatment of deep fungal infections.

### 3.7 Conclusion

MMS is a specialized surgical technique that offers almost immediate 100% microscopic tissue margin examination allowing for the highest cure rates for both common and uncommon cutaneous malignancies. This approach relies on precise mapping to help preserve normal tissue while ensuring the entire cancer has been removed prior to reconstruction. For any aspect of the margin where tumor remains, Mohs surgery allows for precise and immediate re-excision while limiting...
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morbidity and ensuring that the defect is as small as possible. Once complete tumor extirpation has been confirmed histologically, reconstruction can be performed confidently given the high cure rates with MMS.

References


Mohs Micrographic Surgery


4 Cellular and Tissue-Based Wound Care

James F. Thornton and Jourdan A. Carboy

Summary

This chapter discusses the use of cellular and tissue-based wound care products in Mohs reconstruction. A broad overview of all available products is made, as well as a graphical representation of available products. Cellular tissue products, indication for use, especially with regard to Integra and ACell, cellular tissue product limitations, and operative techniques are also discussed.

Keywords: cellular and tissue-based products, dermoinductive, dermoconductive, extracellular matrix, acellular dermal matrix, dermal replacement, dermal regeneration template, split-thickness skin graft, full-thickness skin graft

4.1 Algorithm

4.1.1 General Considerations

Cellular and tissue-based wound products have been available for decades (> Fig. 4.1). Currently, hundreds of products are available all with different degrees of efficacy but more importantly all with different degrees of promised efficacy that often does not match reality. There are tremendous marketing forces that drive these often expensive products that the user has no recourse for failure and again the patient is the one who suffers.

However, in their current state, many, many products are very useful and can help restore patients to normalcy without donor site morbidity or extensive operative procedures. It is up to the practitioner to develop critical analytic skills on what products work and become proficient in product selection and use.

In very general terms, cellular and tissue-based products (CTPs) fall into two general categories: dermoinductive and dermoconductive.1 Dermoinductive CTPs include a wide range of products that include Apligraf, TheraSkin, Dermagraft, and Epicel.1 They are products that actually provide living cells into a wound and are designed to stimulate the activity of either new tissue growth or tissue granulation within a wound.2 These products are uniformly expensive and require distinctive handling skills for their successful use. For all practical purposes, given the robust vascularity of head and neck patients, dermoinductive wound healing products provide little utility and will not be described further. A much broader category are dermoconductive products. These include Integra, GRAFT-JACKET, Oasis, AlloDerm, and ACell. These products provide scaffolding within a healing wound that allows cells from surrounding tissue to migrate across the wound and create a neodermis.2,3 The advantage of this scaffolding is that it both promotes tissue and growth and is ultimately designed to provide tissue ingrowth without formation of a scar.3 Dermoconductive products can be further subdivided into three general categories and although they are not scientifically rigorous definitions, the divisions can help guide product selection. The general categories include acellular dermal matrix, which can result in progression to complete wound healing; extracellular dermal matrix, which can also result in complete wound healing; and dermal regeneration template, which requires an
additional skin grafting procedure to achieve full wound closure, the only one that will be described here—Integra.4,5,6

Integra has been in active use since the early 1980s when it was originally designed to facilitate wound healing in large open wounds particularly from burn excisions. It is a regenerating two-dimensional structure or a neodermis in which it is composed of a layer of bovine collagen crosslink with glycose glycans covered by a silastic membrane.5,6 So it is a bilaminar structure. The collagen is specifically shark cartilage and the vertical design provides for infiltration of host cells into the collagen matrix or scaffolding and then this forms a “neodermis” over the course of 3 to 6 weeks. The silicone outer layer lifts off and at this point a thin split-thickness skin graft is required for completion of wound healing. Integra has been described by multiple authors for use in head and neck reconstruction and has several unique roles, particularly in scalp reconstruction where it can provide coverage over exposed bone, whereas the acellular dermal matrix or extracellular dermal matrix cannot reliably provide the same.5,5,6

The use of Integra does involve a fairly steep practitioner-based learning curve and is expensive.

4.2 Integra

The first category of dermoconductive products are dermal regeneration templates, of which only Integra will be discussed. Integra is currently available as a mesh bilayer wound matrix in a large variety of sizes. It is placed over a wound bed that is often not suitable for grafting with exposed bone and cartilage. It is secured in place either as a simple bolster or with the use of negative pressure wound treatment (NPWT) sponge. After 5 to 7 days, the initial wound dressing, either matrix or NPWT wound sponge is removed and then the patient is allowed to shower and essentially resume normal activity and by design, the Integra has no requirements for further wound care at this point. Over the course of 3 to 8 weeks, depending on the wound bed, as well as ultimate patient factors, the Integra heals and the silicone sheeting is lifting off by the ingrowing underlying soft tissue, and the resulting wound bed is now suitable for grafting. Originally described for use with split-thickness grafting only (0.8-mm thickness), Integra has now been described by multiple authors as being useful in thicker split-thickness grafting and even full-thickness grafting.6 One distinct characteristic with Integra should be mentioned. As the soft-tissue ingrowth occurs around week 2 or 3, a creamy exudate will develop under the silicone sheeting and it can be easily confused with an infected process. It is incumbent upon the practitioner to understand that this is a normal occurrence and without additional signs of soft-tissue infection is likely not an infective process and can be simply monitored and then the exudate removed prior to grafting.

The advantages of Integra at this point are multifold. It can obviate the need for involved multistage local or free-flap procedures.5 It can serve as a viable placeholder in a patient undergoing staged surgical resection until the pathological results return. Authors have described Integra to be initially placed prior to reconstruction while waiting for pathological clearance for oncologic margins of resected specimen. At this point, final reconstruction can be pursued or further cancer resection can be completed if necessary (Fig. 4.2, Fig. 4.3, Fig. 4.4, Fig. 4.5, Fig. 4.6, Fig. 4.7, Fig. 4.8).

4.3 Cellular and Tissue-Based Products

The second category of dermoconductive CTPs can be broadly broken down into two categories: acellular dermal matrix and extracellular dermal matrix. Acellular dermal matrix is essentially human or animal dermis that has been both deepithelialized and decellularized with a process that maintains the basement membrane complex, as well as the extracellular matrix structure of the dermis.2,3 This material serves as tissue scaffolding that allows tissue ingrowth following the prearranged vascular pattern. The promise of this technique is that it allows tissue ingrowth while both speeding the process and maintaining the extracellular structure.2 These products can only be used in a wound bed suitable for wound healing and
will allow the progression to complete wound coverage in an appropriate patient with the promise of avoiding a donor site scar. There are limitations with both the size of the wound and the vascularity of the wound bed, but these can often be considered analogous to the use of a dermal graft without the patient's own tissue. The next broader definition of dermoconductive products is that of extracellular matrix. These are predominantly animal matrices that do not maintain the vascular ingrowth, but provide dermoconductive properties that also allow for progression of final wound healing with the avoidance of a donor site scar, that is, they will allow wound healing without the development of scar contractures, as well as facilitate wound healing in an otherwise unacceptable bed. The most widely used product is ACell, which is a urinary bladder matrix and is available in both sheet and powdered form. The sheet form requires hydrolysis by the donor host to begin the process of healing, while the powdered form can begin immediately. Both are often used in conjunction with each other and the powdered form may require reapplication. Ideal usage for these is in shallow well-vascularized wounds and can facilitate

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**Fig. 4.3** Meshed single-layer Integra sewn in place with 4-0 monocryl sutures.

**Fig. 4.4** Simple sponge bolster was placed and was removed on postoperative day 6. Integra allowed to heal over 1 month. Patient resumed daily activity including exercise and showering.

**Fig. 4.5** Note fibrinous yellowish exudate at week 4 prior to skin grafting. This is quite common and reflects ingrowth and spontaneous separation of the silicone laminate. This is rarely culture positive.
secondary healing.9 We have had extensive use and it is our primary goal to go for healing of mucosal surfaces and poor wound beds in patients who are not suitable operative candidates for involved surgical procedures. The clinical use of these again has a significant learning curve and requires fairly attentive nursing care, while the use of the common dermal regeneration templates essentially requires no nursing care after the initial application. Dermal extracellular dermal matrices can be placed in a clinic or operative setting. They are sewn in place and treated initially exactly as a split-thickness skin graft with regard to bolstering and initial wound management with the exception that water-soluble ointment is required versus the petroleum-based antibiotic ointments that are used for full-thickness grafts. The product is applied and then the patient is followed in clinic. Unfortunately, it is well known that almost all extracellular dermal matrices will actually result in the wound looking “worse” before it gets better and progresses to healing. This can be expected at approximately 10 to 12 days where a fibrinous, even foul-smelling, exudate can develop around the wound, and this must be followed with a good degree of caution because it is often confused with an infectious process. If there are no secondary signs of infection, the wound can continue to healing. For wounds with exposed cartilage, poor vascularization, or exposed bone, extracellular dermal matrices can provide enough initial coverage to allow them to proceed to secondary healing, or they can provide enough granulation tissue in the base where a split- or full-thickness skin graft can be applied over it.4,6 The advantage of extracellular dermal matrices is with regard to both a lower cost of an application and possible progression to complete wound healing without the requirements for a secondary graft. In comparison to Integra, they have not proven to be as robust in allowing healing to completion on areas of exposed bone (Fig. 4.9, Fig. 4.10, Fig. 4.11, Fig. 4.12, Fig. 4.13, Fig. 4.14, Fig. 4.15, Fig. 4.16, Fig. 4.17).
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Fig. 4.9 A 75-year-old female status post-Mohs resections of basal cell carcinoma at left ala and tip. Defect presents with exposed cartilage.

Fig. 4.10 Initial placement of acellular powder and sheet.

Fig. 4.11 Results at 1 and 3 weeks postoperatively.

Fig. 4.12 Color-matched full-thickness skin graft placed 1 month status post-ACell placement.

Fig. 4.13 Postoperative results shown 2 months after full-thickness skin graft placement.
References


5 Full-Thickness Skin Grafts

James F. Thornton and Jourdan A. Carboy

Summary
This chapter will discuss applications of full-thickness skin grafts in Mohs repair. The indications as well as technical considerations and graft harvest bolstering in postoperative care are included. Special attention is made regarding full-thickness skin graft donor sites for specific applications. This includes both color-matched and non-color-matched grafts.

Keywords: donor site, full-thickness skin graft, supraclavicular, conchal bowl, preauricular, postauricular, bolster

Summary
- Full-thickness skin grafting constitutes a large percentage of procedures for head and neck reconstruction.
- For color-matched grafts, skin must be harvested from above the clavicles; there are few indications to not use color-matched full-thickness skin grafts in head and neck reconstruction.
- Full-thickness skin grafting can be used in both upper two-thirds and lower one-third nasal reconstruction, provided careful selection guidelines are followed.

5.1 Algorithm

5.1.1 General Considerations
In many ways, color-matched full-thickness skin grafting is an ideal reconstructive modality for head and neck soft-tissue defects (Fig. 5.1). For suitable patients, it is simple and reliable, and the majority can be performed under local or IV (intravenous) sedation anesthesia. From an oncologic standpoint skin grafting does not disturb venous or lymphatic outflow and allows easy postoperative surveillance for cancer recurrence. The absolute contraindications are few including exposed bone and an unsuitable recipient bed. Commonly mentioned contraindications of active smoking, current anticoagulation, and the requirement for postoperative radiation are in fact not true contraindications. For over a decade, University of Texas Southwestern Medical Center (UTSWMC) has been treating active smokers, fully anticoagulated patients, and patients requiring postoperative radiation with little difference in clinical outcomes.

Fig. 5.1 Algorithm for appropriate donor site decision.
5.2 Selection of Donor Site

The selection of donor site for full-thickness grafting from the head and neck is mandated by the need or indications of color-matched result given there can be no color match on skin grafts harvested below the clavicle. The other considerations regarding donor site include surgeon preference, as well as the size and thickness of the graft.

Color-matched skin grafting is harvested only above the clavicle and in the rare instance that the surgeon is performing skin grafting for head and neck defects where color-matched skin is not required it involves such large defects where a supraclavicular incision is not allowable or in patients where large posterior scalp defects or postauricular defects can be full-thickness grafting without consideration of color match. However, for large defects on the visible portions of the head and neck that are too large for full-thickness grafting, these can be treated initially with extracellular matrix (ECM) followed by split-thickness grafts harvested from the posterior scalp to achieve equivalence of full-thickness skin graft (FTSG) coverage.

For color-matched requirements, the decision regarding donor site is often surgeon preference. Although the most often cited, the postauricular donor site is not always an ideal donor site. Postauricular skin color match is not ideal or in patients where the skin is not required it involves such large defects where a supraclavicular incision is not allowable or in patients where large posterior scalp defects or postauricular defects can be full-thickness grafting without consideration of color match. However, for large defects on the visible portions of the head and neck that are too large for full-thickness grafting, these can be treated initially with extracellular matrix (ECM) followed by split-thickness grafts harvested from the posterior scalp to achieve equivalence of full-thickness skin graft (FTSG) coverage.

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5.3 Graft Elevation and Inset

Proper skin graft inset starts prior to graft harvest with careful attention to measuring accurate graft size. The size of the graft based on subunit or defect is largely based on a foil pattern template that is transposed from the defect to the donor site. The planned dog-ear incisions are marked out on the neck and then a no. 69 beaver blade is utilized to score the outline of the graft only. It should be understood that the neck donor site, as well as the preauricular cheek donor site, needs to be placed on stretch prior to graft design and graft harvest. If this is not done, the harvested graft will be greatly oversized and can impair graft take. Additionally, time spent now with appropriate graft sizing will result in a much faster inset procedure because no decision needs to be made during inset given there is assurance that the graft is of the correct size.

As the graft is elevated, no attempt is made to thin the graft; rather after the graft has been sharply elevated, it is left attached on one limb and then can be thinned with sharp face-lift scissors to the deep dermal layer safely. When the graft is separated, it is still handled only by the soon-to-be-discarded dog-ears and these are excised and the graft is placed in the prepared wound bed. At this point, it is understood that it is unnecessary to place tacking sutures to determine the graft dimensions. The graft is the correct size because the appropriate size template was used prior to graft harvest. For smaller grafts (less than 1 cm), tacking sutures of 5-0 fast-absorbing gut are utilized in a clock face pattern to secure the graft; if the graft is larger than 1 cm, then two opposing sutures of 5-0 plain gut or fast-absorbing gut are utilized to sequentially inset it and then at the end they are both tied to each other 180 degrees opposite to the start. This results in the fastest inset possible without unnecessary “fussing” and manipulation of the graft during the inset.

5.3.1 Bolstering the Graft

Great attention needs to be paid after graft inset to bolster preparation. Although there are many descriptions of bolsters, the most commonly cited is a cotton ball wrapped in Xeroform. In many ways, this is an unsatisfactory bolster. It requires the opening of multiple surgical products and has no inherent stretch or give. If not properly cared for postoperatively, it will dry and can stick to and dislodge the graft on bolster removal. A much-improved bolster is a simple dry surgical sponge that is included in the prep set. It is easily cut to size and vigorously coated on one side only with antibiotic ointment, and this can be simply sewn in with through-and-through 3-0 prolene bolster suture, as well as with interrupted 4-0 Nurolon pop off suture for the scalp or 5-0 silk for lesions on the face.
No attempt is made to tie over sutures as the sponge itself has adequate resilience to hold the centripetally placed stitches.

**5.3.2 Postoperative Care**

The patient is allowed to shower the second postoperative day with a sponge in place provided he or she liberally coats it with ointment prior. The only activity restriction put on the patient at this point is against heavy lifting. From day 1, we allow them to cycle, run, sweat, and resume their daily activities; we, however, prefer that they do not swim or lift heavy objects. The sutures are removed on the fifth or sixth postoperative day and the patient is changed from antibiotic ointment to plain Vaseline for the duration of healing. On bolster removal at day 5 or 6, even a properly healing FTSG will go through a number of color changes that can be disconcerting to a beginning surgeon, as well as most patients. Even early discolored skin grafts can pink up and go on to near-normal healing. No matter the graft appearance, great care is put into postoperative care until the final determination of the graft outcome is made (Fig. 5.2, Fig. 5.3, Fig. 5.4, Fig. 5.5, Fig. 5.6, Fig. 5.7, Fig. 5.8, Fig. 5.9).
Fig. 5.5 Neck skin placed on stretch and foil pattern template outline traced with planned standing cone excisions.

Fig. 5.6 After borders incised with scalpel graft is quickly elevated with facelift scissors and all subcutaneous fat is sharply removed with scissors.

Fig. 5.7 Graft placed at site and sewn in with running 5–0 plain gut sutures started at opposing sides.
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References


Fig. 5.8 A through and through 3-0 prolene suture is placed centrally within the graft to secure the midportion of the bolster.

Fig. 5.9 Bolster is sewn into place with peripheral interrupted 5-0 silk sutures that go through the bolster, the graft, and the underlying tissue.
6 Split-Thickness Skin Grafting

James F. Thornton and Jourdan A. Carboy

Summary
This chapter discusses split-thickness skin grafting for post Mohs reconstruction. Indications, including detailed intraoperative use of the dermatome in skin graft harvest, as well as considerations for donor-site care are discussed. Particular attention is directed to the selection of appropriate donor sites for split-thickness skin grafts.

Keywords: split-thickness skin grafting, dermal regeneration template, Zimmer dermatome, skin graft harvest site, bolster

6.1 General Considerations
The usefulness of split-thickness skin grafting (STSG) in head and neck reconstruction may well be more than generally appreciated and is greatly expanded by STSG in conjunction with dermal regeneration templates.1 The ease and reliability of split-thickness grafting and the ability to provide large volumes of thin color-matched skin that will reliably heal to an excellent cosmetic result with very acceptable donor-site appearance makes it a very valuable technique for head and neck reconstruction.2 The decision to use either a split-thickness color-matched skin graft or a full-thickness color-matched skin graft for head and neck reconstruction depends on the quality of the skin, the size requirements of the skin, as well as considerations regarding both harvest and donor-site management.

Historically, many surgeons feel that general anesthetic is required for safe harvest of STSG; however, in our practice at the UTWSMC, we have comfortably and easily performed STSG under both local and intravenous sedation. Limiting the use of anesthesia is safer for elderly patients who may not be suitable candidates for general anesthesia.

6.2 Donor-Site Selection
The selection of donor site begins with the determination of whether color-matched skin is required and following the same principles as for full-thickness skin grafting, if color-matched skin is required then the graft must be harvested above the clavicles. In many ways, the scalp is an ideal donor site for STSG.3,4 It is very thick, very vascular, and provides a robust graft and if harvested appropriately on shaved hair-bearing scalp, the donor site heals very rapidly and can heal with a nearly imperceptible scar.3,4 Contrast this versus the very notable scar that is left following harvest of STSG from the traditional site on the leg.

For defects that do not require color-matched skin, the lateral or proximal thigh donor site is very accessible, very easy to harvest from, and is able to provide large volumes of smooth, non-color-matched skin; however, it can leave an unsightly scar, particularly on young females, that is difficult to cover.5 It is preferable to have the patient wear an appropriate underwear or swimsuit bottom and then mark out the borders of the clothing and then take the graft within the borders. For current fashions, this usually results in a graft that is harvested medially from a single buttock. Although this will result in painful donor-site sitting for 5 to 10 days, it does result ultimately in a scar that can be completely hidden by clothing.6

6.3 Harvest Technique
After selection of the skin graft harvest site, careful measurement of the required graft dimensions and careful infiltration of the donor site are performed with local anesthetic to provide hemostasis, pain control, and some degree of turgor to the skin that will aid in the graft harvest. The selection of the Zimmer dermatome blade guard is also important, given that oftentimes the 3-in. guard is the only template that will harvest the entire dimensions of the guard. A 4-in. guard, although it will harvest larger than 3 in., will result in the harvested skin not fitting on the standard meshing carriers. This is also true of the 2-in. guard that will also oftentimes harvest less than the 2-in. guard dimensions. The decision on harvested skin graft thickness involves three factors: (1) the thicker the harvested graft, the longer the donor-site healing—and with elderly thin skinned patients, it is possible to inadvertently harvest skin thick enough to result in a full-thickness donor-site defect; (2) the thicker the graft, the more prolonged the graft healing; and (3) thicker grafts heal with less primary and secondary skin contracture. Additionally, even though the manufacturer recommends for Integra graft of 0.008” thickness, our clinical experience with Integra is that a robust Integra base is able to heal much thicker skin grafts, even up to 0.012” thick, which is more easily harvested and easier to handle during inset.

Several considerations are to be made in setting up a dermatome for graft harvest. This includes the selection of the blade guard and ensuring the blade has not been inadvertently placed upside down. Even though there are safeguards in place on the dermatome itself to prevent incorrect blade placement, it is still a possible mistake and will result in the blade guard being ineffective, resulting in an instantaneous full-thickness skin defect when graft harvest is attempted. Care must be taken that a Padgett blade is also not placed into a Zimmer dermatome, because this will result in no protection by the guard and a full-thickness injury to the donor site. In setting up the donor site after infiltration of local anesthetic, care must be taken that the
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Drapes do not interfere with the full path of the harvest and is useful to perform a practice pass without power on the dermatome to ensure there are no obstructions to harvesting. A very common practice of using a no. 15 blade as a “feeler gauge” to measure the blade thickness is infeasible, is not accurate, and is not recommended by the Zimmer dermatome manuals. This is a habit that is easily discarded with no ill effect for the patient. Mineral oil is routinely used on the guard, as well as on the donor site. After the graft is harvested, initial attention is to be focused on the donor site. There is literature in support of an inclusive dressing of either Tegaderm or BioDerm to be placed directly over the donor site and great care is taken for the accurate placement of this dressing with wide borders and use of a tissue adhesive on the normal skin borders to maintain this dressing in place.\(^8\) The patient is given postoperative instructions to leave the adhesive in place for 5 to 7 days and healing can occur underneath. If the patient develops a large area of ballotable fluid unexpectedly, we encourage them to make a small piercing on the Tegaderm with nail scissors and drain it and make every attempt to leave the occlusive Tegaderm dressing in place until the donor site heals underneath. For surgeons who are interested in the final aesthetic outcome, some degree of insight needs to go into the decision-making process of actually meshing the graft. Although meshing does increase the volume of usable skin, and also likely increases the graft take, it will result in an irretrievably abnormal aesthetic result that is impossible to correct. The common pebble-stoning or screen door appearance of a meshed skin graft is unmistakable and is caused by the healing of the meshed interstices by scarring and not actual primary healing and results with a far inferior result than a unmeshed sheet graft. Additionally, the practice of meshing, but not expanding, also results in wound healing that is inferior to an appropriately inset unmeshed sheet graft.

6.4 Graft Inset

The inset process for large sheet graft relies on continuous fast or plain gut sutures (never chromic gut) along the border of the graft and then dependent on the size, as well as the eventual contours, small areas of the graft, where it is not adhered or where there are clear air bubbles underneath which are then sharply incised with a no. 69 Beaver blade and a 5-0 gut suture is utilized to secure one limb of the interstices to keep this open and allow the easy egress of any potential seroma fluid. The graft is then carefully bolstered with a surgical sponge bolster with ointment on one side and no intervening nonstick gauze. For large areas of graft, central 3-0 double-armed Prolene sutures are utilized to improve uniform compression of the sponge and the remainder of the sponge is sewn in place with 4-0 pop-off Nurolon sutures with no attempts to do a tie-over bolster, rather utilizing just peripherally placed sutures. The advantage of peripherally placed suture is the speed of the bolster inset and also that it prevents the peripheral upturning that can occur with tie-over bolsters. Postoperatively, the sponge is kept dry and removed in 5 to 7 days. On bolster removal and if there is any accumulation of seroma fluid, then this is carefully expressed on the initial phase and the graft recompressed and given a chance to continue healing (Fig. 6.1, Fig. 6.2, Fig. 6.3, Fig. 6.4, Fig. 6.5, Fig. 6.6, Fig. 6.7, Fig. 6.8, Fig. 6.9, Fig. 6.10, Fig. 6.11, Fig. 6.12, Fig. 6.13, Fig. 6.14, Fig. 6.15, Fig. 6.16, Fig. 6.17, Fig. 6.18, Fig. 6.19, Fig. 6.20).

**Fig. 6.1** A 32-year-old male patient with very large dermatofibrosarcoma protuberans tumor of left scalp.

**Fig. 6.2** Tumor was resected and wound temporized with Integra until clear margins were verified.
Fig. 6.3 Decision was made to proceed with existing Integra as final wound coverage with required split-thickness skin graft.

Fig. 6.4 Decisions regarding donor site involve ease of harvest and final color match. For this patient, even though proximal thigh donor site would provide easier harvest, the split-thickness graft was harvested from shaved posterior scalp in order to provide final color match.

Fig. 6.5 Although the graft is not meshed, it is handled with a carrier to facilitate accurate placement on the scalp.

Fig. 6.6 Tegaderm and Mastisol dressings are utilized for the donor site with stockinette cap for final wound coverage. This dressing is left in place until postoperative day 5.

Fig. 6.7 Split-thickness graft inset.
Fig. 6.8 Sponge bolster applied to graft site with topical antibiotic ointment. Bolster may be stapled in place with cosmetic staples or sewn into place with 4-0 Nurolon pop-offs. Bolster is removed on postoperative day 5.

Fig. 6.9 Stockinette cap is placed and may be removed on postoperative day 5.

Fig. 6.10 Final postoperative results shown at 4 months.

Fig. 6.11 Wound site measured and appropriate dimensions drawn onto thigh donor site prior to local anesthetic infiltration of donor site.
Fig. 6.12 Sponge bolsters measured for final wound coverage.

Fig. 6.13 Mineral oil placed on both the Zimmer dermatome and graft donor site to facilitate harvest.

Fig. 6.14 Skin placed under manual tension and graft harvested at 0.012 inches thickness.
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Fig. 6.15 Tegaderm and Mastisol dressing placed on donor site.

Fig. 6.16 Harvested graft spread out on carrier and tacked down with antibiotic ointment.

Fig. 6.17 Graft meshed at 1:1.5.
References


7 Cartilage Grafts

James F. Thornton and Jourdan A. Carboy

Summary
This chapter discusses the use of cartilage grafts in soft-tissue facial reconstruction. Donor sites and grafts include conchal bowl, septal cartilage, rib, and radiated cartilage (MTF banked cartilage). This includes the discussion of donor sites, technique for each donor site, cartilage graft harvest, and cartilage graft inset.

Keywords: cartilage graft, conchal cartilage graft, conchal bowl, donor site, septal cartilage, rib cartilage, banked frozen allograft

7.1 General Considerations
The use of cartilage grafting in nasal reconstruction is liberal and is used to both replace resected cartilage and reinforce areas that anatomically lack cartilage but will require support to prevent deformity in healing. This is most applicable in partial or total alar reconstruction where both anatomic and nonanatomic cartilage grafting can prevent irreversible alar retraction and deformity.1

The requirements for a successful cartilage graft include a robust vascular bed and firm suture fixation to support its ingrowth and prevent extrusion and subsequent infection. The selection of donor site for cartilage grafts is based on the needed graft size and shape, consideration of the donor-site surgical access and postoperative morbidity, as well as the shape and size of the cartilage. The majority of isolated lower third nasal defects can be managed with conchal cartilage grafting or MTF cartilage. Defects larger than isolated heminasal will require rib cartilage grafting or multiple MTF cartilage grafting.

7.2 Donor-Site Selection

7.2.1 Conchal Bowl Donor Site
The conchal bowl is an excellent donor site and provides robust flexible cartilage that, if harvested contralateral to the defect, approximates the shape of the native alar cartilage. Provided the antihelical fold is not violated, the entire cymba and cavum conchae can be harvested with minimal donor-site morbidity and no change in the final appearance of the ear.2 Preoperatively, the patient should be asked about any hearing aid requirements, given this requirement can be a contraindication. For patients who do require hearing aids, the conchal bowl donor site is not suitable, given the long-term pain and difficulty in fitting the expensive prosthetic hearing devices. When the side that the patient prefers to sleep on has been determined, then the contralateral side is chosen for harvest as long as the alar shape requirement is not required. During the surgical preparation, the external auditory meatus, as well as the front and back of the external ear, is carefully prepped. The patient is placed on a sterile towel and great attention is directed at maintaining sterility throughout the process, which includes avoiding contact of the patient’s hairnet or nonsterile head dressing with the ear.

Lidocaine mixed with epinephrine and 0.25% Marcaine is injected subcutaneously with a 27-gauge needle both anteriorly and posteriorly on the conchal bowl, and the local anesthetic injection is used to hydrodissect the skin from the cartilage. Either an anterior or posterior incision can be made. The advantages of an anterior incision rely on a significantly easier harvest, as well as an easier access to the incision for postoperative care with no sacrifice in donor-site scar appearance. The entire conchal bowl is sharply dissected with an assistant holding the dissected skin flap up out of position and then the entire conchal bowl is carefully managed with Adson-Brown forceps versus regular Adson forceps and then sharply dissected free of the donor site. At this point, careful hemostasis is achieved and then the donor site is simply closed with a running horizontal mattress, 5–0 plain gut suture taking care to ensure eversion approximation of the wound edges. No external bolster dressing is required; however, the dead space must be obliterated to prevent formation of late hematoma, and multiple through-and-through 4–0 gut sutures are placed from the front to the back of the ear with a straight Keith needle and the suture is tied on the anterior aspect of the ear. The ear is liberally coated with antibiotic ointment and followed carefully during the postoperative period to ensure healing without hematoma or infection. No postoperative antibiotic coverage is provided; however, if the patient does develop a postoperative infection at the donor site, wound cultures must be taken and prescribed antibiotics must include pseudomonas coverage, given this can be a frequent pathogen.3 In elderly patients, the gradual increasing in stiffness of the cartilage must be considered and significant care taken in the graft harvest, given that it is increasingly brittle and prone to fracture.

The cartilage is harvested with perichondrium intact on both sides and carefully thinned and contoured and sewn in place with 4–0 Vicryl sutures to a carefully designed and approximated cartilage pocket. Even small toothpick-sized segments of conchal cartilage can be utilized and these can prevent late alar retraction if placed in a properly designed subcutaneous pocket in a nonanatomic location along the alar rim.

The difficulty in harvesting conchal cartilage grafts lies only in harvesting adequate length and this must be ensured prior...
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to incision and rarely is the vertical height or width of the graft a limiting factor (Fig. 7.1, Fig. 7.2, Fig. 7.3, Fig. 7.4, Fig. 7.5, Fig. 7.6).

7.2.2 Rib Cartilage Donor Site

For larger cartilage requirements that include complete nasal defects or heminasal defects with columellar loss, the rib cartilage is the next choice. Through either a horizontal infra-mammary incision in females or a horizontal medial incision as described by Nagata, large segments of up to 4 cm of costal cartilage can be utilized. Advantages of the rib harvest are both in the size of the graft and the ability to harvest grafts of such thickness so that balance cross-sectional carving can be performed to prevent later warping. Additionally, both bone and rib can be harvested simultaneously.

The choice of rib varies from the fifth to the ninth ribs as has been described by Gibson et al. The postoperative pain associated with costal cartilage grafting is not insignificant and wide Marcaine blocks should be placed intraoperatively with careful attention to detection and treatment of inadvertent pneumothorax, particularly in the outpatient setting.

7.2.3 Septal Cartilage Donor Site

Septal cartilage harvest is advantageous as it leaves no postoperative scar, the donor site is already within the surgical field, and large volumes of cartilage are available. However, the
Fig. 7.3 The graft is inset as a nonanatomic alar rim graft secured in place with 5–0 Vicryl through-and-through sutures. This must be apposed with underlying tissue at host site.

Fig. 7.4 Final flap appearance with underlying conchal cartilage graft.

Fig. 7.5 Donor site is closed with 5–0 continuous plain gut with through-and-through 4–0 Keith needles on plain gut to tack down any space between skin and cartilage and avoid hematoma.
septal cartilage itself is flat and is difficult to contour for alar reconstruction.

### 7.2.4 Banked Frozen Allograft Cartilage

Banked frozen allograft is widely available with the advantage of no donor-site morbidity and the ability to obtain large pieces of cartilage. The product is easily obtainable and available as follows (Fig. 7.7, Fig. 7.8, Fig. 7.9, Fig. 7.10).

Costal cartilage grafts:
- Sheets W/L/T
  - 1–2 cm, 3.5–4 cm, 1.8–2.2 mm #258223
  - 1–2 cm, 4.1–5 cm, 1.8–2.2 mm #258224
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Summary
This chapter discusses the use of two pedicle flaps in soft-tissue facial reconstruction: the paramidline forehead flap and the nasolabial flap. The design, surgical harvest, surgical inset, and postoperative care of these flaps are discussed, as well as indications and postoperative management.

Keywords: paramidline forehead flap, nasolabial flap, pedicle flap, division and inset, postoperative care, anticoagulation

8.1 General Considerations
Two distinct pedicle flaps for nasal reconstruction are described: the interpolated nasolabial flap and the paramedian forehead flap. The flap selection between nasolabial flap and paramedian forehead flap is dictated primarily by surgeon’s preference, but the flaps should not be considered interchangeable. Nasolabial flaps are suitable for patients with a distinct nasolabial fold and cheek redundancy and who have either ala, tip, or soft triangle defects with intact lining. Advantages of the nasolabial flap include technically simpler flap harvest, the ability to harvest under local or intravenous sedation only, and much easier postoperative wound care.

The disadvantages include a tendency toward pincushioning and the inability to provide large areas of robust soft-tissue coverage in comparison to the paramidline forehead flap.

The paramidline forehead flap is exceedingly reliable and predictable and should be the first choice for nasal defects of any significance. The contraindications to forehead flaps are few and include current anticoagulation with clopigel and the inability of the patient to understand or comply with the postoperative course, including follow-up visits, surgery, and dressing changes. Forehead flaps can be performed with some difficulty under local or sedation anesthesia, but greater precision and greater patient comfort result if the initial procedure is performed under general anesthesia.

8.1.1 Nasolabial Flap (▶ Fig. 8.1a–f)

Flap Design
For the nasolabial flap design, the only sizing decision is the height of the defect. The vertical height of the defect is transposed to the cheek after placing the cheek under stretch and marking the vertical height of the flap with calipers and ink. A reverse Gilles test will confirm sufficient flap length, and remembering that the majority of the nasolabial flap laxity is obtained from the perioral cheek, the distal extent of the flap can be positioned lateral to the commissure. The absence of a nasolabial fold is an absolute contraindication to elevation of a nasolabial flap as the scarring will be unacceptable. After the vertical and horizontal dimension of the flap is determined, the flap is designed again with the cheek placed under mild stretch to avoid oversizing. The flap dimensions include a planned dogear excision and this excess skin is utilized as a handle before being discarded (▶ Fig. 8.2, ▶ Fig. 8.3, ▶ Fig. 8.4, ▶ Fig. 8.5, ▶ Fig. 8.6, ▶ Fig. 8.7, ▶ Fig. 8.8).
Fig. 8.1 (a,b) The vertical height of the defect is transferred to the cheek with the inferior margin being the nasolabial fold. General traction is placed to prevent oversizing the flap. (c) The flap is sharply elevated to the level of the ala. (d) Bovie cautery is utilized at the flap corners and proximal defect. (e,f) The cheek is meticulously closed, but care is taken to avoid compression of the pedicle. (g) The flap is sharply divided at 3 to 5 weeks. (h) The flap is elevated up to 80% of its volume and aggressively thinned prior to final inset. (i,j) The flap is inset under slight tension. (k,l) No attempt is made to keep any of the pedicle remnants; it is excised and discarded and the resulting incision closed. No attempt is made to keep any of the pedicle remnants; it is excised and discarded and the resulting incision closed.
Fig. 8.2 A 72-year-old female patient status post Mohs excision for basal cell carcinoma at right ala.

Fig. 8.3 Alar rim cartilage graft is harvested from anterior conchal bowl incision.

Fig. 8.4 The anterior portion of the graft is placed within a previously dissected subcutaneous tunnel and then the remainder of the graft is meticulously inset to the lining soft tissue.
Fig. 8.5 Graft is inset with 5–0 Vicryl.

Fig. 8.6 The vertical height of the nasal defect is transposed to the cheek.

Fig. 8.7 Measurements verified by repeat measurement of flap design following transposition to cheek while cheek is under slight tension.
Elevation and Inset

Elevated sharply in the deep subcutaneous plane and then approaching medially, it is elevated with either scissors or bluntly with cotton-tipped applicators, taking care to identify the angular perforating vessels and maintain them as the medial extent of the incision is approached. The most medial corners of the inset flap will then undergo electrocautery, as these frequently bleed postoperatively. The flap is always rotated medially, trimmed on inset, and inset under slight tension with 6–0 black nylon sutures. The donor site is meticulously closed with 3–0 Vicryl deep sutures followed by 4–0 subcuticular Monocryl followed by 6–0 black nylon sutures. The flap is trimmed on inset (▶ Fig. 8.9, ▶ Fig. 8.10, ▶ Fig. 8.11, ▶ Fig. 8.12, ▶ Fig. 8.13, ▶ Fig. 8.14).

Postoperative Care

The flap is dressed with fibrillar collagen immediately postoperatively and the pedicle donor site deliberately packed with either fibrillar collagen or sterile cotton for hemostasis and the patient is instructed to simply shower away the dressings on the third postoperative day and then the flap is treated with just petroleum ointment until it is divided between the third and fourth weeks. The patient is allowed to return to full activity and as long as the pedicle is not compressed, the patient can wear a CPAP mask (▶ Fig. 8.15).
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Fig. 8.10 Hemostasis is achieved at the base of the flap.

Fig. 8.11 Flap is accurately marked for inset.

Fig. 8.12 Flap is inset with 6–0 nylon.
Fig. 8.13 Cheek is meticulously closed with 3–0 Vicryl and care is taken to avoid compression of the flap pedicle.

Fig. 8.14 Final cheek closure achieved with 5–0 nylon.

Fig. 8.15 The flap is coated in nitropaste and wrapped in oxidized cellulose, with care taken to avoid compression of the pedicle.
Division and Inset

At the time of division and inset, the pedicle is excised and discarded and the cheek is closed as a linear incision with no attempt to reinsert the pedicle. The cheek scar undergoes initial dermabrasion and the flap is re-elevated over 70 to 80% of its maximal length and is inset under slight tension with 5 and 6-0 black nylon suture (▶ Fig. 8.16, ▶ Fig. 8.17, ▶ Fig. 8.18, ▶ Fig. 8.19, ▶ Fig. 8.20, ▶ Fig. 8.21, ▶ Fig. 8.22, ▶ Fig. 8.23, ▶ Fig. 8.24).

8.1.2 Paramidline Forehead Flap

The contraindications to paramidline forehead flaps are few and include widespread forehead scars, severe patient comorbidity, and the inability of the patient to meet the postoperative wound care requirements. Ongoing anticoagulation is only a relative contraindication.

Unquestionably, a patient fully anticoagulated on any agent, even as simple as aspirin, makes the very vascular forehead flap more difficult to harvest, inset, and manage postoperatively. However, we do not consider either aspirin or Coumadin as absolute contraindications against paramidline forehead flaps. Clopigel is considered a contraindication given its irreversibility without transfusion. In all cases, it is preferred if the surgeon is able to place an initial temporizing wound dressing and the patient is able to safely hold anticoagulation for the flap elevation as well as the inset.
Fig. 8.18 Pedicle on cheek is completely excised and resulting wound closed with 3-0 Vicryl and 6-0 nylon.

Fig. 8.19 Flap is elevated up to 80% of its maximal volume and inset under slight tension.

Fig. 8.20 The border of the defect is marked to determine flap outline for inset and flap is then sharply cut to size and shape.
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Fig. 8.21 Flap is then inset with 5-0 nylon.

Fig. 8.22 Flap is coated in nitropaste. Following dermabrasion with Bovie scratch pad of cheek scar, it is coated in bacitracin ointment.

Fig. 8.23 Xeroform is placed over stitches as final dressing.
The remaining contraindications including forehead scars require decisions made on a case-by-case basis. Often times forehead scars will be superficial and the arterial pedicle beneath will be intact by Doppler examination. However, elevated flaps with scars across the majority of the pedicle can develop significant venous stasis despite adequate inflow. The “Dallas” design with a medial right angle extension at the hairline is felt to provide adequate soft tissue for the reconstruction but with a reduced arc of pedicle rotation. Although the flap design does provide sufficient soft tissue, the reduced pedicle arc of rotation provides no practical benefit and the medial flap design destroys the contralateral side for possible revision or a second flap.

Great care is taken to remain out of the hairline. The flap pedicle width is dependent on the venous requirements of the flap. Very large flaps will require a pedicle width beyond 1.5 cm to maintain venous outflow. For thin, single subunit (ala or isolated tip), the width of the flap can be narrowed to as small as 1.2 cm wide. The forehead donor-site scar is improved with a thinner, narrower flap and the narrower pedicle provides an easier arc of rotation. With proper flap design, which includes the Doppler identification of the pedicle, and centering the pedicle on the identified artery, the flap can be safely narrowed. The actual sizing of the flap, whether it be subunit or defect only, takes a significant amount of the operative time. Multiple techniques have been described, but the easiest is a foil suture pack that is placed with printed side down over outlines of the contralateral nose and then simply reversed which can provide the most expedient and accurate detail. The foil is allowed to be cratered in the concavities and very accurately contoured along the convexities. Oftentimes 5–0 silk is utilized to suture tack it along the defect site borders as the flap template is being designed. If there is significant three-dimensional tissue loss, then bone wax with overlying constructs of Steri-Strips and Dermabond to create a three-dimensional moulage has also been utilized and these are transposed to suture foil to provide the correct volume requirements. The malleable tin foil wrappers of traditional wine bottles also contour very nicely to the convexities of ala and tip and if sterilized ahead of time are useful for flap design. In all cases when an accurate sized foil pattern template is designed, it can be saved, labeled, and re-sterilized for use during any subsequent inset and revision procedure.

The flap dimensions are designed with very accurate templating as either a defect or a subunit with no regard to final closure of the forehead. The length of the flap is determined by a reverse Gilles test, understanding that the arc of rotation is below the eyebrow, the takeoff of the vascular pedicles. Intraoperative pencil Doppler is utilized to identify the pedicle below the eyebrow and this provides safety in maintaining the vertical and axial design. For defects that have large lining requirements, such as isolated hemimalar and heminasal defects, it is allowable to develop a lateral transition of the flap maintaining axial flow as much as possible in patients with a sparse or thinning hairline, as illustrated in Fig. 8.26, Fig. 8.27, Fig. 8.28, Fig. 8.29, Fig. 8.30, Fig. 8.31.
Fig. 8.25 (a,b) Combined nasal tip, ala, and soft triangle defect. The remaining tip and ala are excised for subunit-based reconstruction. (c,d) Foil template is carefully made of nasal tip and contralateral ala to aid in symmetrical reconstruction of affected side. (e) Foil outline is transposed to forehead with planned medial rotation. Standing cone excision is planned superior to template. Great care is taken to maintain axial pattern of forehead pedicle. Avoid violating the hairline if at all possible and if additional length is required, a short cant can be made ipsilaterally. (f) The flap is initially sharply elevated subcutaneously and is grasped only at the soon-to-be discarded standing cone triangle. Dissection eventually transitions to the subfrontalis.
Proxi mally 1–2 cm above eyebrow the plane of dissection is developed underneat h the periosteum. To prevent postoperative bleeding, the medial and later al flap edges as well as the superior aspect of the defect are aggressively cauterized. For planned two-stage flaps, the distal 30% of the flap that will never be re-elevated is aggressively thinned. The flap is inset with simple 5–0 nylon sutures. The forehead is closed with 3–0 Vicryl and simple 4–0 and 5–0 nylon sutures. If the forehead cannot be fully closed due to tension, it may remain open and allowed to heal in secondarily. At 4 weeks following initial flap elevation and inset for a two-stage flap, the pedicle is sharply divided and dermabrasion on the forehead scar is done with a Bovie scratch pad. Great care must be taken to restore eyebrow symmetry. The forehead pedicle is either completely excised and closed in a linear or incision or a small remnant of pedicle is saved and inset as a small upside down V with 6–0 nylon sutures. Nasal pedicle is trimmed accurately for inset and is inset with simple 5–0 nylon sutures.
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Fig. 8.26 A 62-year-old male patient status post Mohs excision of basal cell carcinoma at right nasal tip and partial ala.

Fig. 8.27 Through an anterior conchal bowl incision, a nonanatomic cartilage graft is harvested. The graft is carefully inset with 5–0 Vicryl, ensuring close apposition of the cartilage to the intact lining.

Fig. 8.28 Following inset of cartilage graft to defect, a foil pattern template is designed based on the contralateral normal side.

Fig. 8.29 The vascular pedicle is identified with Doppler at a single point inferior to the eyebrow. The 1.5-cm flap pedicle is centered over the identified vascular pedicle.

Fig. 8.30 The flap remains axial pattern and template is transposed to the ipsilateral forehead with planned medial rotation.

Fig. 8.31 Adequate flap length is ensured with revers Gilles test.
Elevation and Inset

When the flap has been accurately templated and the volume requirements have been determined and drawn out on the forehead with surgical marker, a no. 69 beaver blade is utilized to score the flap borders, given surgical markings can be obscured and even erased by bleeding during elevation. The entire forehead is infiltrated with lidocaine containing epinephrine and then the flap is elevated with a small distal extension or “handle” where a dog-ear excision can be extended into the hairline and then the flap is elevated initially in the subcutaneous plane transitioning to the subfrontalis. Caution must be exercised particularly in elderly patients, as it is quite easy to inadvertently score the periosteum and expose the calvarium which can result in a full-thickness defect on the forehead that can be difficult to heal. If this occurs, Integra can be placed at the initial flap elevation and grafted during the inset. The flap continues to be elevated sharply without using Bovie cautery until 1.5 cm above level of the eyebrow and then the cautery is turned up significantly and both the lateral borders of the flap and the native forehead undergo electrocautery identifying all the bleeding vessels. For vigorous well-isolated bleeder, they can either be suture ligated or even clip ligated if required. After the flap is elevated to the level of the eyebrow and bleeding is controlled, the periosteum is scored approximately 1.5 cm above the eyebrow and the flap is elevated bluntly to below the eyebrow if required. There is significant clinical discussion of the utility of elevating the flap below the periosteum. Detractors feel it captures periosteal perforating vessels.1 Anatomic studies support the elevation below the periosteum with the perforating vessel supporting the vascularity of the flap, which can result in a safe rapid plane of dissection. If further flap length is required and it is tethered by the periosteum, under loop magnification, the periosteum itself can be scored to provide further lengthening. The flap vessel origin and the arc of rotation are below the eyebrow. After the flap is fully elevated, taking care not to over-elevate it and create a redundant pedicle, the flap is wrapped in warm moist lap pad and hemostasis is achieved on the forehead and attention is placed to forehead closure. The forehead is closed only to the point of no distortion on the hairline and then the flap is allowed to heal in secondarily. If required dermal regeneration templates can be utilized for very thick defects or acellular dermis can be utilized to facilitate healing.13 No attempts are made at color-matched full-thickness grafting on the forehead defects because ultimately the forehead that is allowed to heal in secondarily will have a better final outcome than full-thickness grafting. After forehead closure, attention is then returned to the nose. The flap inset portion is actually the easiest portion of the case, provided it has been accurately templated. Border sutures are placed at the alar border and if it is a defect that does not require lining, it is significantly thinned with great care taken to the distal 30% of the flap and it is thinned without plans for further re-elevation and very accurately inset with 5–0 black nylon simple sutures. If the lining portion is included in the reconstruction, a simple scoring of the alar rim is made, as this allows a more rapid turn in or decreases the tension on the skin and allows rapid turn in with no real loss of vascularity and then the lining portion itself can be significantly thinned. For axial pattern flaps, these can be thinned safely to skin only. As the flap is turned in on itself, 3–0 Prolene tacking sutures are utilized for the distal portion of the flap and these are placed on the designed alar groove to secure the lining portion over the cartilage construct. Chroic gut sutures are used internally to attach the recreated lining to the native nasal lining and these can often be placed externally with retraction on the inset flap. The remainder of the flap is carefully inset with 5–0 black nylon (▷ Fig. 8.32, ▷ Fig. 8.33, ▷ Fig. 8.34, ▷ Fig. 8.35, ▷ Fig. 8.36, ▷ Fig. 8.37).

Dressing and Management of Flap Pedicle

Management of the exposed flap pedicle is surgeon dependent. Numerous authors have described skin grafting of the back portion of the flap; unquestionably it does provide a great improvement in postoperative wound care and reduces perioperative bleeding. However, to raise a skin graft with an additional donor site with the plans to discard it within 3 to 6 weeks is often not well received by the patient. Alternatively, the back portion of the flap is carefully dressed with oxidized cellulose to stop bleeding and the entire flap is wrapped in sheet collagen (Surgical) (▷ Fig. 8.38 and ▷ Fig. 8.39).

Postoperative Care

The patient is allowed to shower off the dressing on the third postoperative day and Vaseline and nonstick gauze is then used as the wound dressing. The patient is returned to normal activity as much as possible. With care, they are allowed to wear eyeglasses taking care to avoid compression on the flap pedicle. With the understanding of paramidline forehead flaps, there is no real ability to camouflage it with a dressing and the patient is counseled on this preoperatively. The timing of flap division and inset is never made at less than 3 weeks and if the patient has significant flap fullness or edema at 3 weeks, the procedure is delayed. Any planned two-stage flaps can be converted to a three-stage flap if there is need to improve the contour, reduce the flap volume, or manipulate cartilage grafts.
Template outline is lightly scored with a beaver blade.

Flap is sharply dissected with care being taken to grasp only standing cone portion of flap that will be discarded during inset. The flap is initially elevated subcutaneously and this is later transitioned to the subfrontalis when it is assured that the donor site can be closed directly.

Corners of the flap are aggressively cauterized to prevent late postoperative bleeding. Approximately 1–2 cm above eyebrow, bluntly dissect to subperiosteal plane. This can be extended to well below the eyebrow if needed.

Distal portion of flap can be aggressively thinned.

Forehead is closed directly with 3–0 Vicryl with care being taken to avoid compression of the pedicle.

Forehead is then closed with simple 4–0 and 5–0 nylon sutures. Flap is trimmed and inset with simple 5–0 nylon sutures.
Conversion to Three-Stage Flap

If the decision is made to perform a three-stage flap, the pedicle is left intact and the flap is elevated from distally to proximally as thin as the final inset will be (▶ Fig. 8.40, ▶ Fig. 8.41, ▶ Fig. 8.42).

Division and Inset

At the time of division and inset, which usually occurs between the third and fourth weeks for two-staged flaps, a significant amount of elevation and thinning can safely be performed.

In nonsmoking patients, 80% of the flap can be routinely elevated and thinned safely. Immediately after the flap pedicle is divided, a good indication of the vascularity of the flap is the amount of back bleeding from the flap pedicle. With experience, this can be used to gauge the safety of the flap elevation and thinning. In a robustly vascular flap, tacking sutures can be placed at and superior to the alar groove to contour the inset flap along the new alar groove. Nitropaste is routinely
placed as a single application on inset flaps\textsuperscript{12} (Fig. 8.43 and Fig. 8.44).

**Forehead Scar Optimization**

After flap inset and contouring, attention is directed to optimizing the forehead donor-site closure.\textsuperscript{13}

The vertical forehead incision scar is released from periosteal and bony attachments by blunt elevation with the elevator in place and the scar is dermabraded with a Bovie scratch pad.

Autologous fat grafting is performed if needed to improve scar contour. The fat is harvested from the abdomen with a syringe and blunt tip cannula. The harvested fat is placed on Telfa to remove the effluent and then injected using 1-ml Luer Lock syringes and a 21-gauge needle or a 1-mm blunt cannula in a crosshatch pattern.

After the forehead incision scar is optimized, the eyebrow containing the flap pedicle is reoriented to match the contralateral normal side. After the eyebrow alignment, the pedicle remnant is either excised directly and closed with a linear incision or debulked aggressively and the remainder is carefully inset as a small inverted V at the medial eyebrow (Fig. 8.45, Fig. 8.46, Fig. 8.47).

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**8.2 Postoperative Care**

After suture removal at 5 days, the patient is changed from antibiotic ointment to scar management oil or silicone gel and sheeting for no less than 8 weeks.\textsuperscript{14} At 8 weeks, the patient is reexamined and offered a revision procedure to be done at about 3 months after the division and inset.
Fig. 8.41 (a,b) The tissue remaining on the nose is very carefully carved into the final desired contours to match contralateral side.

Fig. 8.42 The maximally thinned forehead flap is returned to the soft-tissue construct on the nose and carefully inset with 5-0 black nylon border sutures. Through-and-through contour tacking sutures are placed for the ala.
Fig. 8.43 Four weeks after the second stage inset, the pedicle is divided sharply.

Fig. 8.44 The flap is elevated over 60% of its volume and aggressively thinned and inset.

Fig. 8.45 The forehead scar is elevated off of the calvarium and undergoes dermabrasion with a folded Bovie scratch pad.

Fig. 8.46 Final inset with simple 6–0 black nylon sutures.
References

9 Local Flaps

James F. Thornton and Jourdan A. Carboy

9.1 General Considerations

The numerous classification systems for local flaps do not necessarily contribute to their clear understanding. Flaps may be classified by the native blood supply (random or axial pattern), the geometric configuration (i.e., rhombic, bilobed, trilobed), the location of either the defect or the pedicle (regional, pedicled), and by the method of transfer of the flap. The method of the transfer seems to provide the most clear representation of the flap and that will be utilized in this chapter. Three types of local flaps will be described: rotation, advancement, and transposition flaps. All of these flaps are confined to head and neck facial reconstruction.

The advantages of the local flaps are their ability to provide vascularized color- and texture-matched skin for reconstruction. The majority of the repairs can be done as a single stage. The disadvantages of local flaps are not trivial and include often extensive incisions distant from the site of the defect and the opportunity for wide and irreversible anatomic component distortion. The most obvious example of this is a poorly designed or executed bilobed flap that can irreversibly distort the nasal ala. Additionally, the consequences of a flap failure, all or partial, are not insignificant. The potential disaster for a complex local flap being performed in the case of an incompletely excised or recurrent skin cancer and the subsequent provisions that have to be made for cancer clearance after the formation and inset of a flap are tremendous. Appropriate planning for local flap reconstruction includes a very careful assessment of the defect, but more importantly the flap donor site. As an example, the limitations on use of a bilobed flap in nasal reconstruction are most dependent on the site of the secondary lobe and its subsequent closure and possible distortion of the lower eyelid versus the initial lobe placement. Appropriate reconstruction planning must always include alternatives to flap reconstruction and the placement of flap incisions, as they relate to any “lifeboat” provisions for a failed flap.

9.2 Linear Closure

Although not technically a local flap, simple linear closure constitutes the majority of nongraft repairs and merits discussion on proper execution.

The advantages include unmatched simplicity, reliability, and speed. Properly performed, it can yield the “best” result in all small and many large defects. Understand that ideal relaxed skin tension lines facilitate final incision placement. Metlious and complete standing cone or dog-ear excision is required, given that standing cone rarely “settle” completely. Skin undermining is rarely indicated and its benefit is overrated on inset, as it contributes to seroma or hematoma formation and devascularizes the inset.

For proper performance of linear closure, the surgeon will place a single silk tacking suture in the center, but 90 degrees from the estimated ideal closure orientation. The wound is tented closed and then the suture is now placed at the new best guess of the ideal closure orientation. Any retraction of anatomic features, especially eyelid, is evaluated. As a rule, any eyelid retraction or nasal alar retraction is a firm contraindication to linear closure, but mild lip retraction almost always resolves. The single central suture location is marked and the standing cones are marked for excision with surgical marker. The suture is removed and the standing cones meticulously excised. It is very important to conceptually understand that the standing cones must be excised to the depth of the central defect. This is not simply a skin-only excision, but rather a skin and soft-tissue debulking to result in a symmetric depth throughout the closure. The process is somewhat akin to “dug a ditch” with each end symmetric to the middle. Undermining is rarely required and meticulous linear closure to the level of the skin is performed. There really is no perceptible difference in final outcomes based on final skin closure techniques. As long as the skin is reached in closure with elimination of all deep dead space without any undue tension, any choice of skin closure can yield an equivalent result. Other issues regarding skin closure can be considered, including surgeon’s preference, need for patient follow-up, as well as the patient’s preference. It seems prudent for the beginning surgeon to try a number of different skin closure techniques to determine what works best for his practice and patients (Fig. 9.1, Fig. 9.2, Fig. 9.3).

9.3 Rotation Flaps

Rotation flaps are a type of pivotal flap where the flap is designed so that the leading edge of the flap is also bordering the defect. They are the most commonly utilized, the most...
anatomically correct, and easiest to visualize. A rotation flap relies on the conversion of any defect into a triangular defect, where the base of the triangle forms a portion of the circumference of the flap arc rotation circle.\textsuperscript{2,3} The base of the flap then becomes the radius of the flap rotation circle and these flaps are very easily designed and executed, particularly on large flat featureless areas such as the scalp or the cheek.\textsuperscript{2,3} Two provisions to provide safe inset are caution in the back cut that cuts into the base of the flap at the consequence of decreased flap vascularity and a meticulous Burrow’s triangle which is required to eliminate the standing cone that arises from the mismatched flap radius (\textsuperscript{2} Fig. 9.2, \textsuperscript{2} Fig. 9.3, \textsuperscript{2} Fig. 9.4, \textsuperscript{2} Fig. 9.5, \textsuperscript{2} Fig. 9.6, \textsuperscript{2} Fig. 9.7).

\textbf{9.4 Advancement Flaps}

Advancement flaps are useful on featureless and flat areas, such as the cheek and scalp. One detractor is the required long linear incisions which ideally are placed within natural soft-tissue borders. The most common and useful example of advancement flaps is the V-Y advancement flap, where planned incisions can usually be placed within soft-tissue borders and ideal contour as well as color-matched skin and soft tissue can be advanced into the wound. If a V-Y advancement flap design includes a single perforator vessel identified by Doppler, the entire flap can be safely elevated on that single vessel. This allows for significant dissection up to the identified pedicle and permits generous and safe flap advancement.
Fig. 9.4 The flap begins with conversion of defect to a triangular configuration so that base of triangle forms a portion of the flap circumference.

Fig. 9.5 As the flap rotates to fill the defect, a standing cone develops.

Fig. 9.6 A true Burow’s triangle excision of the standing cone is performed.
During flap design, a single tacking suture can be placed within the defect and the leading edge of the planned V-Y advancement flap. If this closes, even with significant distortion, one can be assured that after flap elevation, there will be enough laxity to affect closure without distortion (▶ Fig. 9.8, ▶ Fig. 9.9, ▶ Fig. 9.10).

9.5 Transposition Flaps
The last flap design is transposition flaps. Basically, a transposition flap is created where the donor site is remote from the defect and the flap is moved about the pedicle or transposed over intervening normal tissue and into the defect. It is a
commonly used flap for head and neck reconstruction. We will discuss three examples of it. It provides the advantage of immediate flap inset of color-matched and texture-matched tissue with often a direct linear closure of the donor site. The difficulties of transposition flaps also involve obscuring natural contours or providing distortions at site distant to the defect. Two examples of these would be a melolabial transposition flap that distorts the contour of the cheek–nose junction or a poorly designed bilobed flap, which distorts the medial eyelid\(^4,5,6,7\) (Fig. 9.11, Fig. 9.12, Fig. 9.13).
9.6 Bilobed Flap

The bilobed flap, classic transposition flap, was originally described by Esser in 1918 for nasal reconstruction and made more workable by Zitelli, who limited the arc of rotation to 45 degrees of each limb versus 180 degrees in the original design.6,8,9 Like most transposition flaps, the bilobed flap allows the ability to recruit tissue from a distant site and thus recruit from an area of relative tissue laxity to an area of relative tissue scarcity, which makes it theoretically ideal for transition of tissue from the more lax upper two-thirds of the nose to the less mobile lower third of the nose.

There are, however, significant disadvantages to bilobed flap reconstruction, including complex incision lines that are, by definition, impossible to be placed within relaxed skin tension lines.9 There is no opportunity to follow principles of subunit nasal reconstruction and an inadequate flap design or execution can result in irreversible nasal deformities of both contour and symmetry. For these reasons, even within the best hands, a bilobed flap reconstruction is never a "perfect" reconstruction, but may well be the most appropriate given the defect.

Modern bilobed flap design is based on the Zitelli modification that limits the arc of rotation of each limb.8 The first lobe is always designed exactly the same size as the defect and is rotated in position in a relaxed easy fit. The arc of rotation can either be geometrically drawn or free drawn and is a fixed constant based on the diameter of the defect. The donor site of the second lobe actually determines whether the flap design will be successful. Understand that the second lobe is not made 50% of the first lobe size, but is essentially made as large as can be closed without distortion of the second lobe donor site.6,8,10 This determines the suitability of the flap, that is, if the closure of the second lobe is going to result in medial lower eyelid distortion to recruit tissue on the nasal sidewall, the flap design is unsuitable for this location. Zitelli also described a planned dog-ear excision or a standing cone excision on the first lobe that is excised prior to flap elevation.6,8,10

Dermatologist Joel Cook has made multiple observations and provisions for successful flap design, including the preference for a submuscular flap dissection; however, this decision can mostly be left to surgeon preference, as a submuscular dissection provides only a theoretical decrease in pincushioning and is significantly more involved in flap elevation and inset.6,8,10

Principals of successful bilobed flap reconstruction include the initial marking of the arc of rotation for the entire flap and then very careful anatomic measurement of the initial lobe size, which is transposed along the previously drawn arc of rotation. The planned dog-ear excision is outlined and then excised prior to the remainder of the flap elevation. Then, decisions are made regarding the second lobe, which is designed as large as possible to permit primary closure. The second lobe is elevated and the defect is closed with the remaining lobe rotated into position on the inset and then tacking sutures can be utilized even along the pedicle of the flap to improve in particular alar contour. Initial flap sutures are removed at 5 days and dermabrasion offered at 5 weeks. Unfortunately, pincushioning is not an infrequent complication of this flap and is initially managed with sequential low-dose (10%) triamcinolone. If the pincushioning does not resolved after a reasonable period of intralabial management, flap re-elevation, thinning, and re-inset are indicated (Fig. 9.14, Fig. 9.15, Fig. 9.16, Fig. 9.17, Fig. 9.18, Fig. 9.19, Fig. 9.20, Fig. 9.21, Fig. 9.22, Fig. 9.23, Fig. 9.24, Fig. 9.25, Fig. 9.26, Fig. 9.27).

9.7 Dorsal Nasal Flap

The dorsonasal flap is a rotation flap that is very useful for defects of the distal half of the anatomic nasal dorsum. The flap...
itself has a transposition, as well as a rotation component, and may result in a degree of tip elevation, which is acceptable, in elderly patients. The flap was popularized and the design utilized based on Rieger and presented in 1967. Rohrich et al in 1999 very accurately defined limitation of the flap that includes only nasal tip defects that are above the tip-defining points, the defect at least 1 cm from the alar rim, and less than 2 cm wide. The flap is elevated in the deep submuscular plane and is a relatively bloodless dissection initially, with arterial inflow, based on the contralateral side. It is important that the dog-ear is marked out and elevated and excised so that there is a symmetrical flap inset. The study of Rohrich et al describes avoidance of the classic Rieger excision, which extends onto the forehead with a preference for a dorso-nasal incision; however, having experience based on over 100 sequential flaps, it is felt that the Rieger incision does provide a degree of additional soft tissue for inset and the dorsal incision.
is almost always unnoticeable if properly executed and closed. Great care on flap elevation and inset needs to be made with regard to hemostasis, as well as contouring the thick forehead skin as it is inset onto the thinner glabellar area and often vigorous direct thinning is required on proximal inset. The flap is robust with rarely any issues (Fig. 9.28 and Fig. 9.29).

9.8 Melolabial Flap

The melolabial transposition flap is, in its simplest form, a transposition flap of cheek skin crossing the cheek–nose junction to re-create nasal defects. Its advantages include ideal incision line placement along the cheek–nose junction and the
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Fig. 9.23 Second lobe is drawn at least 75% diameter of first lobe, standing cone excision included.

Fig. 9.24 Flap is elevated in deep subcutaneous plane and rotated for inset. Second lobe closed as first lobe is inset into the defect.

Fig. 9.25 Standing cone excised from second lobe as last step in inset.
transfer of color-matched skin from the cheek to the nose, often with sufficient volume to fill in significant contour defects.\textsuperscript{4,5,13,14,15,16} The disadvantages are extensive and they include partial or complete obliteration of the cheek–nose junction, as well effacement of the alar groove, which can be quite difficult to re-create.\textsuperscript{4,5,13,14,15,16} The flap is elevated in the deep subcutaneous plane and a single tacking suture is placed to facilitate incision line closure with deepithelialization of the normally turned-in or discarded portion of the nasolabial flap if additional bulk is required. A preoperative discussion is often had with the patient regarding the need for late “division and inset” with the understanding that this is not a true division and inset, but rather an attempt to re-create the cheek–nose junction, as well as the alar groove. This procedure performed at no less than 6 weeks after initial flap design requires significant re-elevation and thinning of the cheek–nose junction, as
well as the nasal sidewall superior to the ala with tacking sutures or even direct alar rim incision to re-create the alar groove (Fig. 9.30, Fig. 9.31, Fig. 9.32, Fig. 9.33, Fig. 9.34, Fig. 9.35, Fig. 9.36, Fig. 9.37, Fig. 9.38).

### 9.9 Note Flap

The note flap is a versatile flap for smaller defects. Ideally, it permits the closure of common circular defects with a triangu-
lar flap, given the donor site is able to be closed primarily. It was probably first described in early India around 300 BC and it was popularized and given significant geometric analysis by Walike and Larrabee in 1985. The note flap is a classic transposition flap and it would be useful in many areas where a surgeon would originally consider a rhombic flap, but with the advantage of not requiring conversion of a circular defect into an unnatural square or rhombic shape. Ideally, the note flap is placed within natural folds where the donor site is able to be placed in a natural crease. The advantage of the flap is by transposing a triangular flap to fill in a circular defect, and the donor tissue of the flap is maximally used. However, the disadvantage
Fig. 9.36 Flap is elevated in deep subcutaneous plane and advanced into position. As cheek is closed primarily, flap is inset along alar rim.

Fig. 9.37 Final flap inset shows unavoidable effacement of cheek–nose junction as well as flattening of the alar groove.

Fig. 9.38 Final results shown at 4 months.
is that the inset flap is actually smaller than the defect and a small amount of laxity is required of the surrounding defect to affect closure. The flap is designed as illustrated with the maximal limb approximately one and a half times the diameter of the circular defect with the “note” portion of the flap (this resembles a musical eighth note) placed at the exact diameter of the defect. The flaps are uniformly elevated in the deep subcutaneous, but not submuscular, plane and rotated into position. Some deepithelialization of the inset portion is sometimes required to minimize contour abnormalities and the donor site is closed directly and then the remainder of the flap is inset, again, taking advantage of some of the laxity from the surrounding tissue. The flap unfortunately does not have a trivial learning curve, but when mastered, it becomes a very useful adjunctive flap for circular defects (▶ Fig. 9.39, ▶ Fig. 9.40, ▶ Fig. 9.41, ▶ Fig. 9.42, ▶ Fig. 9.43).

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References


Fig. 9.43 A 59-year-old male status post Mohs resection with thick posterior left ala defect. Note flap design with flap limb placement along alar groove.
10 Scalp Reconstruction

James F. Thornton and Jourdan A. Carboy

Summary
This chapter discusses an algorithm for closure of scalp defects. Particular attention is paid to the identification of the defect, whether the periosteum of the scalp is intact or absent, as well as the final planned endpoint of the scalp reconstruction, that is, whether it is to be hair-bearing scalp or simple soft-tissue closure. The general approach to this special class of patients and their unique dangers is made. A wide variety of management techniques for scalp defects is discussed, including linear closure, local flap closure, rotation flap closure, simple split-thickness skin grafting, skin grafting after Integra placement, free flap coverage, and bone burring with split-thickness graft coverage.

Keywords: scalp, calvarium, alopecia, Integra, split-thickness skin grafts, free flaps

10.1 Algorithm For Closure

10.1.1 General Considerations
Although appropriate scalp reconstruction techniques will be rewarded with a healed aesthetically pleasing scalp, care and caution should be exercised in planning and execution. The scalp is exceedingly vascular, which lends itself to reliable reconstruction with low risk of infection. However, this vascularity can increase risk of significant bleeding during the Mohs resection, intraoperative repair, and postoperatively, and requires that diligent care and precautions be made. A patient may have suffered a significant amount of bleeding in the Mohs surgeon’s office prior to presentation for surgical repair and the possibility of a low hemoglobin in an elderly patient with cardiac compromise should always be considered. Diligent preoperative hemodynamic monitoring and hemoglobin measurement, if indicated, should be practiced. Also, understand during preoperative planning that there is very little scalp laxity in closure and decision making regarding techniques should both be planned with a good deal of precision, and that the next step, or lifeboat, needs to be considered and available. For this reason, it is prudent to treat even what would be considered the most trivial scalp defects in an operative setting. They do not often require general anesthesia; however, the safety and monitoring that is available in the operating room versus an office is preferable. The scalp itself can tolerate significant tension on closure and our general

Fig. 10.1 Algorithm for scalp reconstruction.
rule of thumb in a patient with no other morbidities is that if the closure can be maintained with skin staples, it will ultimately continue on to healing.

The general concept of scalp reconstruction and decision making can be greatly simplified by the consideration of both the defect starting point and the ultimate final endpoint for the patient. This consists simply of the defect starting point being with either periosteum intact or not and the defect endpoint being hair-bearing scalp or simple soft-tissue coverage. An example of this is if the periosteum is intact and the endpoint is not hair-bearing coverage, any scalp defect can be simply covered with a split-thickness skin graft (STSG) for final definitive coverage. If either the endpoint or the starting point is different from this, then multiple other factors go into the management decision. For hair-bearing scalp coverage, the options range from direct closure, local flap closure, or initial STSG with tissue expansion placement and alopecia excision on the way to final hair-bearing coverage or soft-tissue coverage followed by microfollicular hair transplantation (▶ Fig. 10.2).

10.2 Commonly Applied Methods of Closure

- Assistive wound healing agents (Integra or ACell) with or without bone burring and skin grafting.
- Primary closure.
- For larger defects, rotation flaps may be employed, particularly for hair-bearing scalp.
- Full- or split-thickness skin graft coverage either directly or proceeded by Integra placement.
- For large defects without intact periosteum or with exposed hardware, free tissue transfer remains the gold standard.

10.2.1 Bone Exposure and Calvarial Defects

The common perception that exposed bone and calvarial defects can be managed with simple bone burring and split-thickness graft coverage is not entirely correct. This technique rarely results in a permanently closed wound and often results in chronic wound breakdown, continued intermittent bone exposure, and risk for serious complications such as skull osteomyelitis.4 With the advent of bilaminar dermal matrices, management of these previously difficult defects has been made much safer and more predictable.5,6,7

10.2.2 Direct Closure

We manage most scalp wounds with direct closure. The preoperative “pinch test” is notoriously inaccurate for determining the ability to be closed directly. Usually, we limit this to 4-cm defects, again restricted by the patient’s laxity, but remember, simply pinching the inelastic scalp together while the patient is awake is not an accurate assessment.3,8 The thick remaining scalp tissue that comprises the dog-ear extent of the wound will restrict the final closure until excised in the operating room (▶ Fig. 10.3).

When it is uncertain whether or not the defect will be able to be closed directly, an algorithm to follow is to leave the option of local flap closure, in this case a hatchet flap closure—by simply incising one of the contralateral opposing limbs of the hatchet flap and attempting to close the scalp directly. If the scalp does not close and is left with a central defect, then simply rotate the V-Y hatchet flaps into position and this will serve as soft-tissue coverage, although the scar pattern will not be as ideal as it would if the wound is able to be closed directly. Other adjuncts available to facilitate a direct wound closure include wide undermining and galeal scoring. Galeal scoring is performed with a no. 15 blade or pinpoint cautery taking care to just incise the galea without damaging the more superficial vessels.9,10 This will provide a mathematical tissue advancement (see ▶ Fig. 10.4).9,11 With these three techniques, the majority of small (up to 4 cm) scalp defects can be closed directly. Remember, if the wound edges can be maintained in opposition with a standard skin stapler, the incision will likely proceed on to healing (▶ Fig. 10.4, ▶ Fig. 10.5, ▶ Fig. 10.6).
**Fig. 10.4** (a) Removal of lesion in wedge shape to facilitate rotational closure; (b) galeal scoring and undermining of rotation flap (undermining indicated by arrows) to maximize advancement; (c) final postoperative closure.

**Fig. 10.5** (a) Preoperative pinch test, often inaccurate to determine whether or not a wound can be closed directly on the scalp; (b) partial excision of standing cones to evaluate whether or not wound may be closed linearly; (c) final appearance with linear closure.

**Fig. 10.6** (a) When intraoperative attempts at primary closure prove unsuccessful, standing cones can be converted to a “hatchet flap” design after partial incision and demonstration that linear closer is not an option; (b) the standing cones are then rotated inward to cover defect; (c) final postoperative appearance.
Rotation Flaps

Larger on the scale, and this should be determined preoperatively, are scalp defects with exposed cranium or scalp defects where hair-bearing scalp is the final endpoint. To address these defects, design and perform a large rotation flap based on the ipsilateral vascularity with provision allowing for rerotation.\(^3,11,12\) Proper flap design is made more complicated by the numerous flap descriptions, such as the Orticochea banana peel flap, multiple Limberg flaps, triple rhomboid flaps, pinwheel flaps, and the VYS scalp plasty. However, three simple rules can address the majority of rotation flap design: (1) previous incisions need to be respected and not crossed, (2) the four paired vessels providing vascular supply to the scalp need to be considered in the flap design (supratrochlear, supraorbital, superficial temporal, and occipital arteries), and (3) a large ultimate flap design needs to be drawn with an "elevate and cut as you go" design. Remember that, as a rule, even larger rotation advancement will be required than is more frequently expected. These can be quite vascular and bloody procedures and intraoperative management with general endotracheal anesthetic and the use of hemostatic techniques such as Raney clamps and wide infiltration of local anesthetic with epinephrine are often required.

Finally, if the flap design is off and periosteal or dural coverage is required, simple split-thickness back grafting can be utilized as a lifeboat (\(\Rightarrow\) Fig. 10.7 and \(\Rightarrow\) Fig. 10.8).

Alternatively, with the periosteum intact and final hair-bearing coverage desired, non-color-matched split-thickness skin can be initially performed and allowed to heal with subsequent tissue expansion placement, serial expansion, and then non–hair-bearing scar excision and tissue expanded non–hair-bearing skin flap advancement\(^{13,14,15}\) (\(\Rightarrow\) Fig. 10.9).

Full-Thickness Skin Grafts

With the periosteum intact and no requirements for hair-bearing coverage, either full-thickness skin grafts for small sized defects can be harvested with color-matched skin from above the clavicle or split-thickness grafts can be harvested. If color match is not required, any donor site is amenable. For full-thickness skin grafts, the ultimate graft size limitations are usually donor-site closure which can be extended by splitting the graft and performing an apron neck incision to take advantage of symmetric neck laxity (\(\Rightarrow\) Fig. 10.10a,b).

Split-Thickness Skin Graft

With intact periostium, split-thickness skin grafts alone will provide durable, albeit non–hair-bearing, coverage.

If color match is required, remember that the scalp itself is an ideal donor site. Hair-bearing scalp can be shaved and harvested with a Zimmer-type dermatome. The donor site heals very quickly and will provide an ideal color match. For an aesthetic outcome, there is no role in meshing the STSG—it does not improve take rate over a properly bolstered unmeshed graft and the likelihood of improving the poor appearance of a healed meshed graft is zero.\(^{16}\)
The final instance is with large defects with sparse or intermittent periosteal coverage. These defects were previously quite difficult to manage and required either very large rotation flaps or often free flap coverage. The use of Integra has completely changed the management of these wounds, given that we are now able to cover even rather large (12–18 cm) defects with factory meshed Integra bilaminar wound matrix. For intermittent periosteal coverage, the Integra can be placed directly without bone preparation, but for sparse or no periosteal coverage, bone burring is performed. The technique for safe bone burring is the use of a high speed round cutting bur with continuous water irrigation. A small area of skull is burred to deep punctate bleeding (often called the "Paprika sign" as if the spice were scattered on the bare bone, as shown in Fig. 10.12). When the depth is established, the remaining defect is burred to that depth. Care must be taken with elderly patients, because the cancellous bone can be quite thin and a beginner's quest for more vigorous bleeding can lead the surgeon through the outer and inner table into the dura and beyond (see Fig. 10.12). The Integra is then simply stapled in place with a surgical sponge bolster over it and left exactly as an STSG would be for a period of 5 to 6 days. The bolster is then removed and the silicone sheeting of the Integra is left intact, and the patient is allowed to shower while the remainder of it is allowed to heal in over 3 to 5 weeks. The patient should be followed up in clinic weekly, as oftentimes an exudate will develop underneath the Integra and will be confused with an infectious process, but it rarely is. This can be removed as the Integra silicone overlay sheet lifts off and the patient is prepared for split-thickness grafting. The secondary procedure is done at 3 to 5 weeks after initial placement and is a simple STSG from anywhere on the body if color...
match is not required. If color match is required, harvest it from the adjacent scalp. This provides ideal durable wound coverage and often times, if the defect is small enough and it has robust hair on the remaining scalp, the patient can be referred for microfollicular hair transplants to restore hair-bearing coverage (▶ Fig. 10.11, ▶ Fig. 10.12, ▶ Fig. 10.13, ▶ Fig. 10.14, ▶ Fig. 10.15).  

**Free Tissue Transfer**

For larger defects without intact periosteum or exposed hardware, the gold standard remains free tissue transfer. The choice of flap involves surgeon’s experience, pedicle length required, and coverage requirements, with anterolateral thigh (ALT) or latissimus dorsi being most common. Flap donor site and harvest considerations include pedicle length and patient positioning. Both the latissimus dorsi and the ALT flap provide ideal scalp coverage without the need to reposition the patient after flap harvest. Regarding donor site vessels, our institutional preference has been to perform a formal neck incision and obtain large size-matched inflow from a suitable branch from the external carotid artery. Secondary inflow choice is from the temporal vessels isolated from a pretragal location. Again, meshed STSG is never used on free flaps to the scalp (▶ Fig. 10.16).

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**Techniques for Specific Anatomic Location**

**Fig. 10.11** Outer and inner table of calvarium with bur depth to diploid layer.

**Fig. 10.12** Burring bone prior to placement of Integra. Final results pictured following split-thickness skin graft.

**Fig. 10.13** An 88-year-old male status post Mohs excision of squamous cell carcinoma of posterior scalp with bone exposure. Wound was initially treated with bone burring to the point of punctate bleeding of calvarium (“paprika sign”) which was followed by placement of Integra dermal matrix. One month later, patient was taken back to the operating room to have a split-thickness skin graft placed over wound. Postoperative results shown at 3 months.

**Fig. 10.14** A 32-year-old male status post wide local excision of 0.5-mm-thick cutaneous melanoma on vertex of scalp. Wound treated with Integra and subsequent split-thickness skin graft. Postoperative results shown at 4 months.
10.3 Postoperative Management

- All scalp reconstruction patients have a postoperative stockinette cap utilized for dressing. No tape is used.
- For linear closures and flaps with sutures or staples, patients are allowed to shampoo their hair on the second postoperative day.
- For Integra and skin grafts, the bolster dressing is kept dry and removed after 5 days.
- After bolster removal, patients with Integra are allowed to shower and return to full activity as the Integra integrates over 3 to 5 weeks.

References

Techniques for Specific Anatomic Location

11 Forehead Reconstruction

James F. Thornton and Jourdan A. Carboy

Summary
This chapter discusses the identification of forehead defects and their management. This requires recognizing the unique characteristics of the forehead, its ability to be closed in the vertical or horizontal direction, as well as the long-term deformity resulting from inappropriate closure. Several specific algorithms based on the presence of the periosteum, as well as the ability to be closed primarily, are presented. The management of both lateral forehead defects and lateral eyebrow and mid-eyebrow as special considerations is presented. The postoperative scar care of vertical and horizontal forehead closure is also discussed.

Keywords: forehead, vertical closure, horizontal closure, skin graft, lateral brow, eyebrow, O to T closure, dermabrasion

11.1 Algorithm for Closure

11.1.1 General Considerations

The forehead is a featureless, but prominent aesthetic unit (> Fig. 11.1). Its defining characteristics are its borders, the eyebrows, and hairline, and maintaining symmetry of these features is imperative.1 The forehead lends itself to successful reconstruction with its robust vascular supply and inherent ability to heal well secondarily.1,2 It is also able to tolerate a significant amount of tension on closure and will heal well even when closed perpendicular to traditional relaxed skin tension lines.1

Improper management resulting in distortion of the hairline and/or eyebrows causes significant cosmetic deformity that can be difficult or even impossible to secondarily revise. When approaching a patient with a forehead defect, it is wise to at least consider the result if no surgery is done because this may well provide the best cosmetic result. This is well demonstrated by the results of foreheads allowed to heal secondarily after paramidline forehead flap elevation.3

Fig. 11.1 Algorithm for forehead defect closure.
11.2 Commonly Applied Methods of Closure

- Delayed healing with or without assisted wound healing agents (i.e., ACell or Integra).
- Primary closure in either the vertical or the horizontal plane.
- Full- or split-thickness skin-graft coverage either directly or preceded by Integra placement.
- For defects that involve the eyebrow, use either direct closure or O to T closure.
- Lateral temporal defects are quite common and merit special management, namely either direct closure taking advantage of the cheek laxity or simple rotation advancement flap with the incision placed in the anterior hairline.

11.2.1 Delayed Healing/Acellular Adjuncts

In general, defects allowed to secondarily heal will do well. With appropriate scar management, including dermabrasion, pulsed-dye laser, or late secondary scar revision, if necessary, can have an optimal cosmetic outcome. The forehead is well supported by bone and allows secondary healing to take place with minimal scar contracture, the exceptions being the more mobile elements directly above the eyebrows. Secondary healing must be carefully monitored and interventions made if significant eyebrow distortion is inevitable. The use of acellular dermis products (ACell, Integra, etc.) have provided a useful adjunct in this area and will result in improved healing time and improved final outcome (Fig. 11.2 and Fig. 11.3).

Large areas of exposed bone deserve special management. Earlier, large rotation advancement flaps or even free tissue transfers were required; however, the final results were often disfiguring and under all circumstances, significant surgical intervention was required. Management and placement of Integra wound healing products, ideally with a mesh bilayer product, is a preferable alternative. It is placed as a skin graft with no significant burring of the bone for defects of 6 cm or less. No vacuum-assisted closure is required. It is simply bolstered as a full-thickness graft for a week, at which point the bolster is removed and the patient may shower. Integra is monitored as the vascular ingrowth occurs over 4 to 5 weeks, at which point it serves as a robust base for either a color-matched full-thickness skin graft from the supraclavicular region or a split-thickness color-matched skin graft to be placed for final closure. For an aesthetic result with split-thickness graft coverage, it is important to harvest color-matched skin, which can

Fig. 11.2 A 65-year-old male status post wide local excision of melanoma on right temple. Wound was allowed to heal secondarily. Final result pictured 4 months after Mohs resection.

Fig. 11.3 (a,b) A 59-year-old male status post wide local excision of melanoma. Wound was allowed to heal secondarily. Final results shown at 3 months. (b) Planned scar revision with rotation flap performed 3 months after initial melanoma resection.
only be provided above the clavicle. Current surgical preference is to shave a small area of posterior scalp and harvest skin with a Zimmer dermatome or equivalent and use this for final coverage. In many ways, a scalp donor site is ideal. It heals very rapidly and, for hair-bearing patients, will be completely covered with no noticeable final scars (▶ Fig. 11.4 and ▶ Fig. 11.5).

11.2.2 Direct Closure
For direct closure, careful attention must be made regarding scar placement to avoid distortion of either the eyebrow or the forehead.2,8,9 Forehead wounds can be closed under significant tension with successful healing in either the vertical or the horizontal direction.2,8,9 Sparse use of absorbable sutures is required given that these are prone to late extrusion and is preferable to use closely spaced simple skin sutures to approximate skin edges with sequential removal of the permanent sutures over 2 weeks’ time10 (▶ Fig. 11.4 and ▶ Fig. 11.5).

11.2.3 Defects Involving the Eyebrow
The eyebrow deserves special attention. Even if there is a significant 30 to 40% defect of the volume of the eyebrow, direct closure with careful attention to borders, similar to management of the vermilion border of the lip, is appropriate with a vertical closure with extension into the eyelid.1,5 This will maintain the natural appearance of the eyebrow.

Fig. 11.4 A 62-year-old white female patient with multifocal SCC (squamous cell carcinoma). Mohs excision left scattered exposed cranium. Wound was treated with Integra and subsequent color-matched full-thickness skin grafting to the forehead and split-thickness skin grafting to the scalp. Final postoperative results shown at 8 months.

Fig. 11.5 A 47-year-old female status post 3 × 3 cm Mohs excision of melanoma in situ. Wound was treated with full-thickness color-matched skin graft. Final postoperative results shown at 4 months.

Fig. 11.6 A 65-year-old male status post 3 × 2 cm Mohs excision of melanoma in situ. Wound was repaired with horizontal primary closure with dog-ear excision. Final postoperative results shown at 5 months.

Fig. 11.7 A 72-year-old male status post 4 × 4 cm Mohs excision for basal cell carcinoma at left upper forehead. Wound was treated with vertical primary closure and dog-ear excision. Final postoperative results shown at 4 months.
symmetry of the brow and ultimately will provide a superior cosmetic result. If the patient has significant loss of volume of the upper eyebrow, then microfollicular hair transplantation can be performed from the contralateral brow to increase both the volume and the length of the eyebrow on the affected side.\textsuperscript{11,12} Additionally and with no preference for either technique, an O to T type closure can be performed with the incision placed laterally to match the radius of the brow and forehead incision\textsuperscript{13} (Fig. 11.8, Fig. 11.9, Fig. 11.10, Fig. 11.11, Fig. 11.12).

11.3 Postoperative Management

For secondary healing with no exposed bone, consider ACell. For healing with exposed bone, consider Integra and split- or full-thickness skin grafting.\textsuperscript{2,6,14} Consider postoperative dermabrasion and pulsed-dye laser to improve scar appearance and hasten resolution of scar redness.\textsuperscript{4}
References

12 Introduction to Nose and Simple Nasal Defects

James F. Thornton and Jourdan A. Carboy

Summary

This chapter discusses the complexities involved in nasal reconstruction including defect identification and patient management. General considerations of the upper two-thirds and lower-thirds of the nose and the differences in management of these anatomic areas are made, as well as the concept of nasal subunits and their appropriate application and reconstruction. Three general techniques for closure of simple nasal defects are discussed: secondary intention healing, full-thickness skin grafting, and local flaps. Local flap coverages include bilobed flaps, note flaps, dorsonasal flaps, V-Y advancement flaps, melolabial flaps, as well as primary closure. Indications for each, as well as clinical examples, are presented.

Keywords: nasal reconstruction, subunit, nasal subunit, local flaps, note flap, bilobed flap, dorsonasal flap, V-Y advancement flap, melolabial flap, primary closure

12.1 General Principles of Nasal Reconstruction

The nose is the most prominent feature of the face with complex curvatures and contours. The intersecting concavities and convexities are distinct. Additionally, the overlying skin of the nose varies in thickness and composition with the upper two-thirds being thin and the lower third being thick and sebaceous. These external characteristics as well as tremendous functional requirements make reconstruction of the nose a significant operative challenge. Currently, the overwhelming majority of nasal soft-tissue defects result from nonmelanoma skin cancer excision. The presence of the nose as the most prominent feature on the face lends it most susceptible to sun exposure with resulting ultraviolet damage and subsequent skin cancer. Currently, the nose is the most common site of skin cancer of the head and neck with nearly a quarter million new cases of nasal nonmelanoma skin cancers diagnosed every year. The current standard of care for skin cancers on the nose involves Mohs histographic tumor excision and reconstruction by a surgeon. The obvious immediate advantages of a Mohs excision are a very low recurrence rate and preservation of the maximum amount of native tissue. As opposed to other areas of the face, successful nasal reconstruction requires reconstructive requirements that include unique coverage lining and framework. Dr. Burget and Menick, the current champions of nasal reconstruction, spent a lifetime dedicated to finessing nasal reconstruction and several points inherent to their practice are essential concepts for any surgeon interested in nasal reconstruction. The most important, and at times the most confusing, is the concept of subunit versus defect reconstruction. Understand that the nose has nine nasal subunits and these are based on transitions in the shadows between natural convexities and concavities of the nose. The arguments for either re-creating a partial subunit defect or reconstruction of the entire subunit are based both on the actual technical execution and the final result. The lower third subunits include the alar lobule, soft triangle, the paired soft triangles, and the single tip. The conversion of partial defects of the subunit that comprises 50% or less into total subunit defects will result in the surgeon’s incisions along natural crease lines, as well as the valid argument that a practitioner who repairs an entire ala or tip subunit repeatedly becomes adept at re-creation of the entire subunit every time. Simplicity, repeatability, execution, and improved final aesthetic results are expected from the practice of subunit reconstruction. The arguments against subunit reconstruction are varied and argue against resection of “normal tissue” with the resultant requirement of larger donor sites with subsequent morbidity. It is also important to understand that subunit reconstruction has never been advocated for the upper two-thirds of the nose, that is, the dorsum or sidewalls. Remember that these areas are fairly flat and featureless. There is no inherent advantage to placing scars within the borders of these areas and in fact the majority of these defects can be repaired with full-thickness, defect-only skin grafting. It is prudent to be aware and adept at subunit and defect reconstruction, and be able to practice both. Blind dogmatic approach of either technique without fully understanding the principles and basis behind it is poor surgical practice and will ultimately yield inferior final results versus accurate individual assessment and appropriate technique application. Additionally, the beginning practitioner can often be overwhelmed by the literally hundreds of descriptions of various surgical techniques for nasal reconstruction often involving geometric local flaps. Understand that the current masters of nasal reconstruction use collectively less than half a dozen surgical techniques and are able to demonstrate results that are essentially a normal anatomic reconstruction with very minimal donor-site morbidity. The lesson here is that a practitioner would be well served to truly understand the most basic techniques of nasal reconstruction and finesse a few individual techniques versus a partial familiarity with a large number of techniques. In fact, the overwhelming majority of nasal defects can be managed with either full-thickness grafting or the paramidline forehead flap.
12.1.1 Regional Considerations: Upper Two-Thirds versus Lower One-Third of the Nose

Reconstruction of isolated defects of the upper two-thirds of the nose is straightforward. The region is relatively featureless and the skin is thinner and can be lax in elderly patients and often simple techniques can be applied. Initially, primary closure either vertically, taking advantage of the cheek laxity, or horizontally, taking advantage of nasal tip descent, can be performed. Larger defects without exposed cartilage can be managed with color-matched full-thickness skin graft. A full-thickness skin graft can be used for defect-only reconstruction without regard to subunits, given there is no inherent advantage demonstrated in a formal subunit reconstruction, placing these scars on the upper two-thirds. With regard to local flap closure, bilobed flaps offer no improved aesthetic advantage over careful linear closure on upper two-thirds of defects. A well-designed banner flap can recruit lax cheek skin providing ideal scar placement. For thicker sidewall defects, a V-Y advancement flap with a vertical limb placement on the cheek–nose junction is useful. The circumstances of combined cheek nasal defects with exposed nasal cartilage or bone are common and can be well managed by simultaneous cheek advancement flap with subcutaneous turnover flap to provide nasal bone and cartilage coverage with subsequent full-thickness grafting.

Finally, larger defects of the nasal dorsum or sidewall with exposed bone or cartilage or significant potential contour deformity can be managed with forehead flaps. Lower third nasal reconstruction is considerably more difficult than upper two-thirds nasal reconstruction. Skin is thicker, sebaceous, and less mobile. The region is dominated by intersecting anatomic convexities and concavities. Additionally, the ala does not tolerate retraction of the alar rim. Alar retraction and asymmetry are common with poor local flap design and remarkably difficult to correct. For these reasons, very accurate planning, reconstructive method selection, and execution are required. Poorly executed full-thickness skin grafts, although simple in nature, can result in unmistakable long-term deformities.

Additionally, the single-staged melolabial flap is useful for small (1.2 cm or less) posterior ala defects. This is simply a transposition flap taking advantage of the cheek laxity with a planned dog-ear excision. The cheek skin is transposed, the dog-ear is excised, and then the flap is inset with great care to reapproximate the cheek–nose junction. Understanding that the flap disrupts the cheek–nose junction and diminishes the normal alar curve, and often requires a secondary revision procedure.

12.2 General Techniques for Closure of Simple Nasal Defects

- Allowing the defect to heal by secondary intention or heal with assisted wound-healing agents.
- Color-matched full-thickness skin grafting.
- The rearrangement of nasal skin by the use of local flaps.

12.2.1 Secondary Healing

The first category, secondary healing or healing by assisted wound healing agents usually an extracellular matrix (ECM) has a limited but expanding utility in nasal reconstruction. Although there is increasing reliance of wound healing agents to allow the body to heal in secondarily without surgical repair, often resulting in equivalent or superior aesthetic results, the usefulness of these agents for nasal reconstruction is currently limited. The requirements for a functional reconstruction with accurate airway flow patterns and the aesthetic intolerance of alar retraction do not permit a wide range of secondary healing. Secondary healing does work well for medial canthal and nasal sidewall defects where the deep buttress bone prevents late contraction; however, on the thickened skin of the lower third and in particular large nasal sidewall defects, more superior aesthetic results can currently almost always be reached with surgical repair (see Fig. 12.1).

12.2.2 Full-Thickness Skin Grafting

The second general technique is full-thickness skin grafting. It is useful to break down the nose into upper two-thirds and lower third anatomic regions. Invariably, the upper third can be treated by non-subunit, that is, defect-only full-thickness grafting, for the vast majority of defects. Understand that the full-thickness grafts need to be harvested from a supraclavicular location for final color match. Our selection of donor site is based almost entirely on the size of the defect, as well as the thickness of the defect. The smaller defects can be managed...
with forehead, preauricular or postauricular donor sites, whereas larger defects require full-thickness grafting from supraclavicular neck incisions. The exception to full-thickness grafting for upper two-thirds defects is only with exposed cartilage or defects of such thickness that a noticeable contour deformity will be incurred from simple full-thickness grafting. Additionally, a special category of a combined cheek and nasal defect with exposed nasal cartilage deserves special management. For full-thickness defects with exposed cartilage, the surgeon’s choice is to either allow it to heal in secondarily to allow granulation tissue to develop along the base, which can be successfully grafted, or inclusion of similar ECM to facilitate the incorporation of a soft-tissue bed that will support full-thickness grafting. Additionally, there are instances, particularly in young patients, that such large defects in the upper two-thirds require forehead flap reconstruction to adequately fill in or recreate soft-tissue contour defects, but these are relatively infrequent.

The use of full-thickness skin grafts on lower third defects has long been an issue in plastic surgery. Traditional plastic surgery teaching has often derided lower third skin grafting as an unacceptable operative choice with unacceptable aesthetic results. This dogma perpetuated despite the dermatologist’s wide successful use of full-thickness grafting for lower third defects. In fact, with meticulous and disciplined approach to patient selection and graft selection, full-thickness grafting for lower third soft-tissue defects can yield superior aesthetic results. Understand the characteristics of the lower third of the nose that is defined by the alar rims inferiorly, the nasolabial grooves laterally, and the alar groove, which forms a junction with the upper two-thirds of the nose, and is very intolerant of distortion of these margins. As discussed earlier, proper patient donor-site selection is essential to achieving optimal results. The criteria for selecting nasal defects that can be appropriately treated with full-thickness skin grafts include defect location and this would include 1.5 cm in diameter on the lower third, as well as the entire dorsum, the entire sidewall, with these defects remaining partial thickness with underlying dermis and subcutaneous tissue or perichondrium intact

12.3 Seven Local Flap Options

1. Primary closure when permitted without distortion of nasal tip or ala.
2. Banner flap, most useful for nasal dorsum taking advantage of adjacent cheek laxity.
3. Note flap, also most useful for defects of nasal dorsum and side walls to recruit adjacent tissue laxity.
4. Bilobed flap, which allows recruitment of tissue from an area of laxity to an area with less laxity (i.e., upper two-thirds to lower one-third).
5. Dorsal nasal flap.
6. V-Y advancement flap, useful for quite small combined distal ala tip defects and thick sidewall defects.
7. Melolabial flap for small posterior alar defects.

12.3.1 Primary Closure

Direct linear closure of the wound is often overlooked as a suitable option for nasal defect repair. The indications to direct linear closure on the nose are significantly more limited on the lower third than on the upper two-thirds due to the relative paucity of lower third skin laxity, as well as the risk of subunit distortion. Either vertical or horizontal closure can be performed. Horizontal closure is usually confined to the supratip break, taking advantage of age-associated tip descent. Small defects on the ala and tip can be closed with judicious restraint and careful alignment in the alar rim. Primary closure can be a useful tool for revision of alar notch defects.

12.3.2 Note Flap

The note flap, described by Walike and Larrabee in 1985, is another type of rotational flap. Appropriately named, the design of the flap looks like a musical eighth note with the defect being the note head. Using the note flap on the upper two-thirds of the nose is very well indicated, given there is inherent skin laxity. Care should be taken when using this on the lower third of the nose, given that any tension from closure and inset of the wound could cause unilateral distortion of the ala, which will invariably yield an unacceptable cosmetic result. Additionally, judgment needs to be used during the design and execution of this flap for a successful result. As the note flap requires contribution and laxity from the inset region, its use is limited in lower third defects.

12.3.3 Bilobed Flap

In comparison to both the banner and the note flaps that allow a single lobe to be transposed into the defect and relies on adjacent tissue laxity on final inset, the bilobed flap employs the rotation and inset of two distinct lobes. It is designed to recruit tissue laxity or color-matched tissue laxity from an area of paucity or from areas of excess laxity to an area of paucity of laxity while maintaining color-matched skin. The original flap design is attributed to Esser and the more modern version is...
considered the Zitelli design that was published in 1989.\textsuperscript{13} The Zitelli design modifications include limiting the arc of rotation for each individual flap and this subsequently eliminates the degree of ultimate skin tension and rotational torque across the entire flap.\textsuperscript{14} Dermatologist Joel Cook has probably written the most on the use, as well as the pitfalls of the bilobed flap and any serious practitioner would do well with understanding his techniques, criticisms, and concerns of the flap.\textsuperscript{15,16,17} Many upsides come from the use of the bilobed. The most obvious one is the use of adjacent color-matched and thickness-matched skin for defect repairs. The amount of flexibility in both the lobe sizes and placement of the defect created by the primary and secondary lobes allows the surgeon almost total control in distributing the tension of closure and secondary movement of the wound. However, with these benefits of design, there are drawbacks. The very core of the design violates otherwise untouched nasal subunit. Many surgeons feel that violation of multiple subunits is an unacceptable side effect. Also innate to the design of the bilobed flap is the necessity of perpendicular scars. No matter how the surgeon orients each lobe, there are always two
scars perpendicular to the relaxed skin tension lines. Additionally, the second lobe size is limited by donor site’s ability to close. The entire flap needs to be visualized and accurately drawn because the flap does not tolerate a “cut-as-you-go” execution. Preference to submuscular versus subcutaneous dissection has both proponents and detractors, but it is best made on an individual case basis (▶ Fig. 12.5 and ▶ Fig. 12.6).

12.3.4 Dorsal Nasal Flap

The dorsal nasal flap works well and can be the best choice in some lower third dorsal defects. It was described by Rieger in 1967. The most recent and thorough modification was done by Rohrich et al in 1988. The description given by Rohrich et al of the utility of the flap and its applications is very complete and includes the following four limitations on flap design: (1) defects on the distal half of the anatomic dorsum limited to 2 cm in diameter, and at least 1 cm from the alar rim and not below the tip defining points. The flap itself is designed following dorsal nasal lines. The Rohrich elimination of the Reiger incision into the forehead is not universally accepted, given that most authors feel the rotational advancement component comes entirely from the lax forehead skin. The execution of the flap includes a wide submuscular dissection, essentially a degloving of the nose, and recruitment of the somewhat thick glabellar skin onto the thinner nasal skin particularly around the medial canthal segment portion. This often requires thinning to thickness-matched skin. Great care must be taken to ensure symmetric upward retraction on flap inset because irreversible alar retraction can occur with an improperly designed dorsal nasal flap. The remaining consideration of dorsal nasal flap design is that patients must have adequate soft tissue and nasal volume on the nose itself to support both flap elevation and inset without external alar retraction. There are no available clinical parameters to define sufficient tissue and this must come with experience as to what is an appropriately sized nose and defect for a successful dorsal nasal flap (▶ Fig. 12.7a, b).

12.3.5 V-Y Advancement Flap

A very small subset of partial ala and combined distal ala tip defects can be managed with V-Y advancement flaps. One limb flap can be hidden in the alar groove and anterior advancement of the remaining subunit is performed. It is limited by use for small defects on patients with thick sebaceous skin. Moderate postoperative pincushioning usually occurs within the subunit and is not noticeable (▶ Fig. 12.8 and ▶ Fig. 12.9).

12.3.6 Melolabial Flap

The superiorly based nasolabial transposition flap or melolabial flap is used for small posterior alar defects. The flap is essentially a cheek transposition flap with a planned...
dog-ear excision superiorly. It is very reliable, easily executed, and provides superior donor-site defects. However, understand that this flap is inherently limited, as the repair crosses the alar crease and in addition to obliterating the alar groove, it will slightly diminish or efface the cheek–nose junction. These deformities, although they can be mitigated by careful attention to flap elevation and inset, can be unpredictable and the deformity can be difficult to correct. Fig. 12.4 shows an appropriate defect that is amenable to simple nasolabial transposition flap coverage. The flap is elevated and thinned and inset with closure of the planned dog-ear excision of the nasal sidewall. Great care is taken to appropriate inset and close the cheek donor site. Even with good postoperative healing, you can see there are alar groove effacement and blurring of the cheek–nose junction. Late revisions directed at both sharpening and redeveloping the alar groove and cheek–nose junction can be performed (Fig. 12.10).

12.3.7 Postoperative Management
- Nitropaste is routinely used in local flaps as a single application in the operating room to improve venous return.
- Xeroform or fibrillar collagen dressings without adhesive are used for the first 24 hours after surgery.
- Patient is allowed to shower on the second postoperative evening.
- Sutures are removed on postoperative day 5.
Fig. 12.7 (a) A 48-year-old male status post 2 x 1 cm Mohs excision at nasal dorsum for basal cell carcinoma. Defect-only reconstruction with dorsonasal flap. (b) Postoperative results shown at 3 months.
Fig. 12.8 A 50-year-old female status post 2 × 1 cm Mohs excision for squamous cell carcinoma in situ right nasal side wall. Defect-only reconstruction with V-Y advancement flap. Postoperative results shown at 1 week and 4 months.

Fig. 12.9 A 44-year-old female status post 1 × 1 cm Mohs excision for basal cell carcinoma at right nasal side wall. Defect-only reconstruction with V-Y advancement flap. Postoperative results shown at 1 week, 2 months, and 5 months.

Fig. 12.10 A 73-year-old female status post Mohs excision for basal cell carcinoma. The defect was closed with a single-stage melolabial transposition flap and nonanatomic conchal cartilage graft placement. Top row: from left to right—postoperative results shown immediately after flap placement and at 5 days. Bottom row: from left to right—postoperative results shown at 5 days, 2 months, and 9 months.
Techniques for Specific Anatomic Location

References


13 Complex Nasal Defects

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Summary

Complex nasal defects are discussed, including what comprises a complex nasal defect and management techniques. The discussion focuses on two interpolated flaps appropriate for nasal reconstruction, the nasolabial flap and the paramidline forehead flap. The management of simple lining defects is also discussed.

Keywords: complex nasal defects, nasolabial flap, paramidline forehead flap, forehead flap, division and inset, template

13.1 General Principles in Complex Nasal Defects and Reconstruction

Complex nasal repairs include larger coverage-only defects, defects involving multiple subunits, or defects with missing cartilage and lining.

The fourth category of general techniques in nasal reconstruction is the use of nasolabial and forehead flaps. Both techniques allow the predictable transfer of large volumes of well-vascularized color-matched tissue. Generally, both flaps are performed as two or more staged procedures. Despite proper execution of the nasolabial flap, it has inherent design flaws that include marginal vascularity and irreversible donor-site contour deformity that the forehead flap does not have. Additionally, the forehead flap is able to provide lining and any volume of coverage needed, while the nasolabial flap is limited in size and is unable to provide reliable lining.

13.1.1 Nasolabial Flaps

The nasolabial flap is based on the utilization of redundant skin over the nasolabial fold. This implies that the patient does in fact have a nasolabial fold with redundant skin and for this reason the flap is often not successful if utilized on patients without well-defined cheek laxity and a well-defined nasolabial fold. The nasolabial interpolation flap can be based inferiorly or superiorly with superior-based flap being the most useful. Superiorly based nasolabial flaps receive their blood supply via the angular artery, as it connects to the anterior facial artery and to the dorsal branch of the ophthalmic artery. The nasolabial interpolation flap has been classically described for alar-only defects, but has shown to be quite useful for alar, tip, nasal sidewall, as well as nasal dorsum defects.

There is no doubt that any clinical surgeon can find fault with the final aesthetic result of a nasolabial flap, namely, the effacement of the cheek contour and resulting cheek asymmetry that is not often corrected. That being said, it can be a useful adjunct for nasal reconstruction in patients who will not tolerate a forehead flap or the degree of the defect does not mandate the surgical intervention of a forehead flap. The nasolabial flap is most useful in smaller defects, posteriorly based alar defects, and defects in patients who medically, personally, or aesthetically will not tolerate a forehead flap. It is very important not to confuse the indications for the nasolabial flap with the forehead flap. The skin supply, volume of tissue provided, the skin type, the appropriate predictably, and final aesthetic results from a nasolabial flap are far less than the results provided with forehead flaps and they should not be considered interchangeable. Additionally, although described by other authors, our experience with nasolabial flaps is that they are not useful for defects that require lining reconstruction. Additionally, a subcutaneous island pedicle nasolabial flap has limited application in clinical practice, given the poor cheek appearance and sometimes the ultimately poor nasal appearance. Rather, the procedure is performed with an interpolation flap which allows the practicing surgeon to perform a final “fine tuning of the nasal defect repair” at the time of division and inset.

The described version of the nasolabial flap is simply a superiorly based interpolation flap based on the perforators from the angular artery. It is a random pattern, not axial pattern, and again requires redundant cheek skin. The flap is elevated with the inferior aspect of the incision based on the nasolabial fold with distal extension directly adjacent to the lateral commissure of the lip. Properly closed, the cheek scar will heal well. Although this is a random pattern flap, it is robust, able to be elevated, and can reach significant distances that greatly exceed the normal 3:1 ratio (length:width ratio) of random pattern flaps. With proper flap design, the flap can easily reach the nasal tip and for patients with nasal tip defects when paramidline forehead flap is contraindicated, a nasolabial flap can provide a robust reliable nasal tip reconstruction. Interpolated nasolabial flaps are routinely performed under intravenous sedation or local anesthetic only. The flap is elevated sharply with blunt medial dissection and rotated medially for inset. For all defects except the ala, the flap is inset under a slight amount of tension. The entire flap is covered with nitropaste and then is wrapped in fibrillar collagen for postoperative hemostasis. The dressing is simply washed off in the shower by the patient on the third postoperative day. At that point, no further dressings are required and the flap can be simply covered with antibiotic ointment only. The flap is divided at no less than 3 weeks and at the time of division, no attempt is made to save any of the flap pedicle remnants. It is excised directly and then closed as a straight incision. Primary dermabrasion is performed on the flap scar within the nasolabial crease as well as its location on the nose at the time of inset. The reconstructed nasal portion is elevated at least over 60% of its maximal volume.
contoured, and inset. The flap is useful for total alar defects, nasal sidewall defects, and nasal dorsum defects. For sidewall and dorsum defects, the flap is significantly thinned and inset under slight tension. For nasal tip defects, the flap is thinned only to match the volume of the existing nasal tip contour. No attempt is made to perform subunit reconstructions for nasal tip defects with the nasolabial flap and this will only contribute to the poor donor-site appearance and will not provide a significant improvement over a defect-only reconstruction of the nasal tip. Special mention is made of the use of cartilage grafting. It is routinely used in alar contour grafts which can often be small partial-thickness conchal bowl incision routinely used for nasal defects within 7 mm of the alar rim. Special note is made of the soft triangle defect. This is a common defect and it is critical that this area is reconstructed to maintain the alar nasal angle. Isolated soft triangle defects are preferentially repaired with a nasolabial flap with a nonanatomic alar contour graft. The graft can be significantly thinned in contour and sewn in place for the small and often difficult to reconstruct defects (Fig. 13.1).

**Fig. 13.1** (a) The vertical dimensions of the nasal defect are transposed to the nasolabial fold on the cheek. Adequate flap length is confirmed with the reverse Gilles test. The flap is elevated lateral to medial, initially sharply and then bluntly as the perforating vessels are approached. The flap is inset under slight tension. (b) The flap is divided at no less than 3 weeks and when soft-tissue edema has resolved. The donor pedicle on the cheek is sharply excised and discarded and the incision closed directly. The inset portion of the flap on the nose is elevated over at least 60% of its volume and inset under slight tension.

13.1.2 Forehead Flaps

The previous discussion in nasal reconstruction has covered techniques available for soft-tissue coverage only. There are three distinct requirements for successful nasal reconstruction, namely, coverage, lining, and support, and the previous descriptions all assumed adequate lining and intact cartilage framework. For defects that require reconstruction of all three—coverage, lining, and cartilaginous support—there is only one reliable option: the paramidline forehead flap, with cartilage grafting if required. Additionally, the usefulness of the paramidline forehead flap for coverage-only defects is unparalleled with its ability to bring in large volumes of well-vascularized soft tissue with ideal color match. Understandably, there are significant short-term morbidities. The postoperative care is extensive. It is not a popular flap for a patient to have and the difficulty in patients who require eyeglass wear is also understood.

As was briefly discussed at the beginning of this section on nasal reconstruction, it is understood that the few and real masters currently practicing nasal reconstruction rely on less than a handful of surgical techniques and all large nasal reconstructions are performed using a paramidline forehead flap. Any surgeon who is looking to develop world-class results would do well to utilize the forehead flap more.

There are numerous forehead flap pedicle designs. These include the up-down flap, the ipsilateral or contralateral axial pattern flap, the “Dallas design” or paramedian contralateral flap, the median forehead flap, as well as the transverse or oblique forehead flap. In recent review of over 400 forehead flap cases with utilization of a multitude of forehead flap designs, several principles of flap design are true and can serve as guiding principles for flap design.

1. Maintenance of an axial pattern arterial pedicle greatly increases the reliability and versatility of the flap.
2. By utilizing the flap design ipsilateral to the defect, the axial pattern vascularity is maintained, as well as the provision for a secondary flap harvest in the event that this is required.

The use of reasonably narrow pedicle based on Doppler identification of the artery will help in both minimizing the forehead flap donor-site scar and allowing for a lax easy rotation.
3. Early subperiosteal dissection will capture the periosteal blood supply to the flap and is easily performed at the level of the brow with acceptable postoperative donor site.

4. Meticulous attention to forehead flap closure prior to flap inset.

It is preferable to perform the initial forehead flap itself under a general anesthetic to assess the viability of the flap as well as for patient comfort. Patients who are candidates for safe general anesthesia are uniformly candidates for forehead flap reconstructions. Careful examination of the forehead with regard to previous surgical incisions or previous surgical scars is made, as well as assessment of the vertical height of the forehead and the volume of the forehead skin available in comparison to the volume requirement of the defect. Intraoperatively, the patient is placed supine and the bed rotated 180 degrees. The patient is placed in a slight reversed Trendelenburg position to decrease venous bleeding. The eyes are prepped into the field with lubricant and the neck is also prep into the field if a full-thickness graft is required. Although the vascular pedicle for paramedian forehead flap is reliably located based on anatomic landmarks (1.7 cm from the midline), it is preferable to actually Doppler the pedicle at the level of the eyebrow, mark it and then center with calipers the flap width directly over the identified axial pattern vessels. This allows for more safety and flap elevation and comfortable application of Bovie cautery during the flap elevation. The template for the surface markings of the flap is preferably made from the contralateral nose. Initially, all the subunits of the nose are marked on the normal side. The decision is made regarding whether a subunit (preferable) or defect-only reconstruction is to be made and then a very accurate foil pattern or Steri-Stripped pattern that accurately corresponds to the three-dimensional surface area of the defect is made and transposed to a foil template. The soft lead foil wrappers of wine bottle cork covers can also be used as a template, given that this conforms very accurately to the contralateral side. Additional items have been described, including heat soluble thermoplast and neurosurgical bone wax to recreate an accurate template. Once the template has been accurately outlined and made and transposed to the contralateral side or reversed to allow accurate size matching on the opposite side, then it is transposed to the forehead. As a rule, a 1.5-cm pedicle is utilized with the tendency for a wider pedicle in active smokers. Every attempt is made to avoid transposing the flap into the hairline.9 Carrying hair-bearing skin down to the flap is a significant postoperative morbidity for all patients and, no matter the counseling, is seen as a “surgeon’s mistake” by the patient. This requires very accurate flap development and template design and in patients with short foreheads and large volume requirements, preoperative tissue expansion may well be required.10 Once the flap is accurately designed and double- checked prior to flap elevation, the nose, including the defect, is thoroughly injected with lidocaine and epinephrine and the wound edges from the Mohs surgery are sharply excised back to clean healthy bleeding edges.11 At this point, the entire forehead, except for the portion of elevated flap, is also injected with dilute lidocaine with epinephrine. The flap outline is very carefully scored with a beaver blade and then a small distal incision is drawn on the flap and this is considered to be the handle, as well as the dog-ear excision and the handle is utilized for the entire flap elevation to minimize or eliminate handling of the reconstructive portion of the flap itself. Initially, the flap is elevated in the deep subcutaneous plane at the thickness of the requested inset at the point that the forehead flap can be determined to be closed, primarily if the flap elevation extends to the subfrontalis and then approximately 1.5 cm above the brow, the flap dissection is extended subperiosteally. Understand that this captures the perforators as described by Reece et al and contributes to flap vascularity.12 The flap axis of rotation is below the brow and, if required, the flap incision itself can be extended and elevated to below the eyebrow with sharp dissection. If further length is required and is restrained by the periosteum, the peristeum itself can be scored under loop magnification, taking care to avoid injuring the axial vessels. It is important to Bovie electrocautery both the corners of the flap incisions because these will have zero tension on them at the conclusion of the case and can often contribute significantly to postoperative bleeding. Once elevated and rotated into position taking care to avoid excessive flap redundancy, a fresh no. 10 blade is used to thin the flap to the appropriate flap inset thickness. Understand that the distal quarter of the flap will likely never be re-elevated again and this portion needs to be thinned to match the final inset. The thickness of the flap is determined by the final requirements and whether a two- or three-staged flap is planned, as well as some assessment of a patient’s vascularity and as a rule for forehead flaps performed on smokers, no attempt is made to thin the flap except for the distal quarter. With a properly designed forehead flap, the elevation and actual inset should be the easiest part of the procedure. Final inset sutures are placed at the given alar margins of the flap and then it is very efficiently inset with 5–0 black nylon suture. Before flap inset, great consideration must be given to accurate closure of the forehead. The forehead itself is often forgotten and hastily closed, without considering the final cosmetic result. Understand that with a properly executed and inset forehead flap, the final nasal deformity can often be near invisible and the sole remaining deformity will be an unsightly forehead scar. For this reason, great attention should be directed to meticulous closure of the forehead. Care is taken to not close the forehead and pinch the pedicle. 1.5cm of unclosed skin should be maintained above the pedicle base. The remainder of the forehead is closed with 3–0 Vicryl sutures and then closely spaced 5–0 nylon sutures for skin closure. Oftentimes, a forehead will not be able to be closed given the initial size of the flap and for this reason, the forehead is either left open or extracelluar matrix is applied to expedite healing. It is important to dismiss the idea of being able to close all of the forehead defects and the surgeon should not limit the size of the nasal flap based on amount of forehead skin available for a complete closure. The forehead does not require final closure and will heal with superb results if allowed to heal secondarily.

After the flap is inset, a significant amount of attention needs to be directed to postoperative dressings. Any active bleeders along the flap pedicle undergo either Bovie cautery or surgical clip application and all active bleeders are addressed prior to flap dressing. The most caudal portion of the Mohs surgical defect undergoes Bovie cautery, given this portion is not fully covered by the forehead flap and will often bleed, contributing to postoperative bleeding and possibly preventing the adherence of the flap to the defect. When all visible signs of bleeding...
have undergone cautery, the flap itself is wrapped, an H pattern of oxidized cellulose is designed to fit on the back of the flap without barber poling the flap itself because bleeding onto the oxidized cellulose can cause a postoperative blood cast and contribute to flap ischemia.7 Understand that forehead flaps are often blue on elevation and rotation and although these looks can be alarming, great faith has to be placed in the robustness of the flap given that they ever rarely fail. Nitropaste is routinely applied to the distal portion of the forehead flap and then antibiotic surgical ointment is placed across the flap incision, as well as the flap pedicle itself and then the surgical dressing is wrapped around it to cover every exposed suture line.13 The patient is followed up in the operating room for a period of 5 to 10 minutes to ensure that no bleeding persists because it is much easier to control bleeding in an operative setting than in the recovery room (▶ Fig. 13.2).

Fig. 13.2  (a) Foil pattern template is made with care taken to include convexity of nose. Supratrochlear artery is identified with Doppler at a single point below the medial eyebrow. Calipers are used to center pedicle design over identified arterial pedicle. (b) Flap is outlined, and marks are made to realign forehead on closure. Superior aspect of defect undergoes Bovie cautery to eliminate potential source of bleeding. (c) Perimeter of flap is scored and flap elevation begins with standing cone (to be excised later). Flap is elevated in deep subcutaneous plane, transitioning to subperiosteal 1–2 cm above the eyebrow. Periosteum is bluntly dissected to below the eyebrow if needed. Minimal undermining is performed only lateral to the pedicle. (d) If needed, conchal cartilage is elevated from an anterior incision. Nonanatomic cartilage graft is secured with 4–0 Vicryl suture.
Flap Division and Inset

The single most pressing question that patients have is when will the flap be divided and inset, restoring normalcy to their lives. It is incumbent upon the surgeon to divide the flap at the appropriate time and not too early. Forehead flaps can be divided and survive as early as 14 days after surgery; however, this rarely contributes to an ideal postoperative result. Even though the vasculature will be adequate to support flap survival, the flap will have existing edema that will only worsen with early division and inset. Our practice at UT Southwestern Medical Center is to divide the flap at no less than 4 weeks. The division and inset procedure can be performed under intravenous sedation. The flap pedicle is injected with lidocaine and epinephrine. The surrounding skin and forehead are also injected with lidocaine with epinephrine. The flap is divided and then prior to flap elevation, some assessment of the flap perfusion can be made by the back bleeding through the divided flap pedicle. If suitable, the flap is elevated to 60 to 80% of its maximal volume and contoured based on the contralateral normal aesthetic units. At this point, through-and-through tacking sutures can be utilized to define the curvatures, especially the alar curve.

After the nasal portion has been elevated and inset, attention is then directed to the forehead. The two most prevalent postoperative patient complaints are the thickness of the brow pedicle and any hair remaining on the nasal reconstruction. The latter can be obviated by adequate flap design and not transferring hair on the reconstructed nose. The avoidance of pedicle thickness is difficult. At the time of flap inset, if the pedicle is narrow enough and the patient has adequate laxity, then the pedicle can simply be excised completely and then the wound closed in the resultant linear incision. This should be done with caution because patients with a very thick brow skin can have an unnatural step-off and this will be visible. The second option is to close the brow in a small inverted V with care taken to minimize the vertical dimension of it, as this can also be a quite unsightly postoperative scar. After pedicle excision, a blunt periosteal elevator is placed underneath the incision and then the entire forehead skin is bluntly elevated free from any adhesions to the periosteum in an attempt to improve the final contour. Dermabrasion performed with electrocautery scratch pad is routinely performed on the forehead scar at this point (Fig. 13.3 and Fig. 13.4).
Fig. 13.3 (a) The flap is divided at no less than 1 month. During flap division, the flap remnant backbleeding is evaluated to obtain an estimate of relative flap vascularity. The forehead donor-site incision undergoes electrocautery scratch pad dermabrasion. (b) The flap is elevated from 50 to 80% of its maximum volume and thinned for inset. (c) The remaining donor-site pedicle is excised and inset as a tiny inverted V, (d) or the remaining pedicle is excised completely and a linear closure performed.

Fig. 13.4 A 52-year-old woman status post 2 × 2 cm Mohs excision of midline nasal tip and dorsum for melanoma in situ. Defect-only reconstruction with paramidline forehead flap. Top row: from left to right—Mohs defect, immediately and 1 month following forehead flap. Bottom row: from left to right—postoperative results at 1 week and 6 years following division and inset.
13.2 Special Considerations: Three-Stage Forehead Flap

For defects that include multiple subunits, that require cartilage grafting across multiple subunits, or in patients who are active smokers, a three-stage forehead flap is performed. The three-stage forehead flap, as described by Menick, elevates the flap on the first stage with the frontalis muscle intact and, accurately templated to required reconstructive dimensions, the frontalis muscle will prevent late contraction.11

At the second stage, the forehead flap is elevated at the thickness of the final inset, not divided, and then the remaining soft tissue is very carefully carved or contoured to match the final contour. The length of time between each stage is 3 to 4 weeks and the patient’s total commitment with the flap in place is 6 to 8 weeks. The safety, as well as reliability of a three-stage forehead flap, is superior to a traditional two-staged flap and is much more predictable for larger multi-subunit reconstructions.15

Additionally, if a patient presents for division and inset on a planned two-stage flap reconstruction with significant flap edema and the flap is divided and inset, the edema will only worsen. For this reason, the planned reconstructive procedure can be converted to a three-stage forehead flap reconstruction with elevation at the second stage, significant thinning and flap debulking to be followed by final inset.

13.2.1 Special Considerations: Lining and Cartilage Support

For defects that require reconstruction of the lining, the vast majority of these can be managed by a turn in paramedian forehead flap.11,16,17 The historic options for lining are multitude and reflect on the importance of lining, as well as the difficulty reproducing described results. Various modalities have been utilized. These include prefabricated forehead flap performing the majority of the nasal reconstruction on the forehead, prior to flap transfer. The second is various septal hinge flaps or mucoperichondrial hinge flaps.18 Third is the three-stage forehead flap with late flap inset. Fourth is free radial forearm initial surgical procedure for lining. Our current algorithm for lining reconstruction is the use of the folded paramidline forehead flap for the majority of lining defects and nasal reconstruction with bilateral ala and tip lining defects, and then we utilize free tissue transfer, namely, the free radial forearm flap which is completed prior to forehead flap elevation.11,16,17

With the majority of lining requirements only being 1.5 to 2.0 cm and the actual length of the lining, turn-in paramidline forehead flaps as described by Menick have proven to be the most successful lining reconstruction modality.11 The lining is designed with a foil pattern template similar to the surface and then the planned alar rim is carefully outlined and then scored with a beaver blade during the flap elevation. As the flap is elevated, the lining components are significantly thinned to allow successful turn in. As the flaps are turned in, they are either secured with 5–0 chromic gut sutures to the existing lining or double-armed 3–0 Prolene sutures are utilized to secure the turned-in lining. These flaps are performed as three-stage flaps and at the second stage, an incision is made on the previously scored alar rim and the flap elevated and the lining portion maximally thinned and the remainder of the flap is inset prior to the third stage being performed. The use of paramidline forehead flap for lining is proven to be very reliable and eliminated any reliance on septal mucosal flaps.

Cartilage Grafting

For isolated ala, as well as isolated tips, most of the cartilage grafting requirements can be met through conchal cartilage grafting. Understand that the entire conchal bowl can be harvested with no significant postoperative donor-site deformities. Conchal bowl cartilage can be elevated and thinned and contoured with caution taken in elderly patients because it is frequently stiff and more prone to breakage. Larger cartilage requirements including more than a single ala or dorsal strut or tip can be met with rib cartilage grafting which requires general anesthesia.

More recently, banked cadaver cartilage is available in a large variety of sizes and is suitable for nasal reconstruction with the advantage of avoiding any donor-site morbidity19 (+ Fig. 13.5).

Late Revisions

Postoperative management of significant hair growth on the nasal portion of the reconstruction is quite difficult. The premise of intraoperative electrocautery to the hair follicles rarely results in permanent hair loss. The utilization of postoperative laser hair reduction or use of Vaniqa cream also rarely result in permanent removal of the hair and is expensive for the patient.20 For this reason, every attempt is made to avoid transferring large (greater than five individual follicles) amounts of hair down onto the reconstructive nose.

After division and inset, all patients are offered a nasal flap revision as soon as 3 months after surgery. At this stage, contour deformities of both the nose and the forehead are addressed. The nose contour deformities are most often managed with direct alar rim incisions and superior soft-tissue debulking with resurfuring and bolster tacking sutures to match alar contour to the normal contralateral side. The forehead almost always requires dermabrasion, thinning of the flap pedicle, and frequently fat injection to improve the forehead scar contour.14,21,22 It is important to undertake the revision only when sufficient soft-tissue nasal edema has resolved and this may require 3 to 12 months of delay.

13.2.2 Postoperative Management

Forehead flaps can be reliably performed as outpatient surgery, provided meticulous intraoperative hemostasis and postoperative dressing management are maintained.

Early follow-up with initial dressing changes in the clinic is helpful for elderly patients, often the morning after the surgery or arrange for home nursing care to facilitate dressing changes by the third postoperative day.

Patient may shower with warm water running over surface of flap after initial dressing changes and only topical ointment is required from this point forward with no additional dressings. Sutures are removed on postoperative day 5 or 6.

The use of eyeglasses postoperatively is difficult and most patients requiring forehead flaps also require eyeglasses for activities of daily living. Flap patients can very carefully utilize
Fig. 13.5 A 78-year-old female status post Mohs excision of the majority of skin surface over bilateral nose, partial ala, complete tip, dorsum, and side walls for basal cell carcinoma. Mohs defect closed with paramidline forehead flap and initial cartilage grafting to bilateral ala. Planned three-stage flap. (a) Top row: initial Mohs defect, 1 week and 1 month following forehead flap. Bottom row: after 3 weeks, flap re-elevated and remained soft-tissue contoured. One month following second stage, flap divided and inset. (b) Postoperative results shown at 7 months following division and inset.
their normal spectacles, allowing them to rest on the flap as long as they take care to remove the glasses themselves without disrupting the flap.

Forehead flap division and inset is performed at no less than 4 weeks for planned two-stage flaps with the provision that any two-stage flap can be converted to a three-stage flap if required.

13.3 Free Tissue Transfer
13.3.1 Potential Approaches

*Nicholas T. Haddock*

1. Fasciocutaneous flaps (radial forearm flap).
2. Composite flaps (helical root flap).

13.3.2 Technique

Nasal reconstruction with free tissue is universally a staged reconstruction. In large full-thickness wounds, free tissue can provide abundant well-vascularized tissue that will have minimal secondary contracture. This is of great benefit in large full-thickness injuries and is primarily where these techniques are utilized.

**Radial Forearm Free Flap**

The primary flap used for nose reconstruction is the radial forearm flap (see Chapter 9). The radial forearm flap provides relatively thin skin and fascia. The fascia can be limited to reduce the bulk of the flap. The long pedicle can easily reach the superficial temporal vessels or the facial vessels. In small defects (large alar defects or hemi-nose), the donor site can potentially be closed primarily with a large back-cut on the forearm. There are ultimately two technical approaches to nasal reconstruction with a radial forearm flap (lining or exterior coverage).

**Radial Forearm Flap for Nasal Lining**

Lining is one of the most important aspects of a full-thickness nasal defect. Poorly vascularized options will result in secondary contracture and overtime can result in degradation of what initially appeared to be very good result. In patients with a large defect or vascular compromise to local flaps, a radial forearm is the ideal choice. This flap can be placed and a skin graft can temporarily be placed on top (Fig. 13.6 and Fig. 13.7). This is usually a first-stage procedure followed with a staged reconstruction that usually involves a debulking, the addition of cartilage, and a forehead flap for improved color.
match. The radial forearm prevents secondary contracture of the lining reconstruction.

**Radial Forearm Flap for Coverage**

Ideally the exterior coverage will come from skin above the clavicle, given that this typically matches the remaining nose. The most common technique utilized for large defects is the forehead flap. In a large defect with an unavailable forehead flap, the radial forearm can provide adequate coverage with a very good aesthetic result. In this technique, the flap can either be folded on itself for lining or skin grafted.23 Folding the flap allows easy placement of cartilage support but can increase the bulk of the reconstruction (Fig. 13.8, Fig. 13.9, Fig. 13.10).

**Helical Root Free Flap**

The helical root free flap can provide composite tissue with lining, structure, and coverage. Anatomically, the helical root is very similar to the nasal ala and works very well for a total subunit reconstruction.24,25 This flap is harvested on the superficial temporal vessels but typically requires a vein graft to reach acceptable recipient vessels.25 The inset is important and occurs in all layers. Bulk is allowed at the point of pedicle exit and if needed, this is temporarily skin grafted. This area is later debulked and the skin graft can be removed for final contour (Fig. 13.11, Fig. 13.12, Fig. 13.13, Fig. 13.14, Fig. 13.15, Fig. 13.16).

**13.4 Problems and Complications**

The biggest problem with free tissue transfer is the potential for total loss. These techniques should be employed by those who regularly perform microsurgery to optimize outcomes and avoid vascular technical issues.
Fig. 13.10 Radial forearm donor site following primary closure.

Fig. 13.11 Traumatic full-thickness loss of ala.

Fig. 13.12 Preoperative marking for helical root free flap based on the superficial temporal vessels.
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Fig. 13.13 Helical root free flap immediately following harvest.

Fig. 13.14 Helical root free flap immediately following inset into the nose. Anastomosis with vein grafts to the contralateral superficial temporal vessels.

Fig. 13.15 Nose reconstruction immediately following revision following helical root free flap (anterior view).
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References

14 Nasal Reconstruction Based on Subunits

Summary
This chapter discusses nasal reconstruction techniques based on the anatomic subunit location of the defect. A number of different surgical techniques for the nine paired subunits are included (Fig. 14.2).

Keywords: nasal defect, nasal subunit, nasal sidewall, full-thickness skin graft, nasolabial flap, nasal ala, complete defect

Summary
● Accurate determination of the nature of the defect is essential in anatomic-based reconstruction planning.
● In reality, a few basic techniques will manage a majority of defects.
● Complex defects most often require a paramidline forehead flap for reconstruction.

14.1 Algorithm for Closure (Fig. 14.1)

14.1.1 Sidewall
The sidewall is frequently involved with skin cancer and can often be simply closed as a linear incision. Larger defects may require a non-subunit, color-matched full-thickness skin graft or nasolabial flap (Fig. 14.3, Fig. 14.4, Fig. 14.5).

Dorsum
Cephalic dorsal defects can also be frequently managed with simple vertical closure, often with wide undermining. For patients with thin skin non-subunit, full-thickness skin grafting is ideal. For defects with exposed cartilage or significant contour deformity, a nasolabial flap or a paramidline forehead flap...
flap is predictable and ideal\(^1\) (Fig. 14.6, Fig. 14.7, Fig. 14.8, Fig. 14.9).

**Combined Cheek and Nasal Sidewall**

These are common defects and frequently mismanaged by simply “dragging” the cheek skin up to close the cheek and nasal defects; this completely disrupts the cheek–nose junction and is unsatisfactory. The correct approach is to manage the two individual anatomic defects; first the cheek is advanced and closed, often without undermining. When the cheek–nose junction is restored based on the normal contralateral side, the nasal sidewall defect is managed. For relatively shallow defects, simple color-matched full-thickness skin grafting is performed—often the skin can be obtained from the discarded standing cones on the cheek advancement flap. Thicker defects with exposed bone and cartilage are treated with either a turnover flap and full-thickness skin graft or a concurrent paramedian forehead flap\(^2\) (Fig. 14.10, Fig. 14.11, Fig. 14.12).
Fig. 14.5 A 63-year-old female status post Mohs excision for basal cell carcinoma as nasal side wall. Defect-only reconstruction with nasolabial flap. Postoperative results shown at 1 year.

Fig. 14.6 A 49-year-old male status post Mohs excision for basal cell carcinoma at nasal dorsum. Defect-only reconstruction with direct vertical closure. Postoperative results shown at 1 week and 1 month.

Fig. 14.7 A 45-year-old female status post 1 × 2 cm Mohs excision for basal cell carcinoma on medial dorsum of nose. Defect-only reconstruction with color-matched full-thickness skin graft from preauricular donor site. Postoperative results shown at 2 and 4 months from left to right.

Fig. 14.8 A 66-year-old female status post Mohs excision of basal cell carcinoma at nasal tip. Defect-only reconstruction with nasolabial flap. Final results shown at 7 months.
Fig. 14.9 A 77-year-old male status post 3 × 2 cm Mohs excision for squamous cell carcinoma at nasal dorsum. Defect-only reconstruction with paramidline forehead flap. Postoperative results shown in bottom row at 5 weeks, 5 months, and 2 years.

Fig. 14.10 (a) Combined cheek and nasal defect with exposed nasal bone and cartilage. Dog-ear excisions for plain cheek advancement flap drawn; (b) cheek advancement flap elevated with soft-tissue turnover for nasal side wall designed and dog-ear excision remnant saved; (c) soft-tissue flap rotated and inset to cover nasal bony defect; (d) cheek advanced and inset; (e) dog-ear excision remnant trimmed and inset as full-thickness nasal side wall graft.
Nasal Tip Defects

Nasal tip defects are common and although dozens of local flap options are described, substantial tip defects are better managed with interpolated two-stage nasolabial or forehead flaps. Although they will reach reliably, nasolabial flaps used for nasal tip repair require dissection down to the level of the oral commissure and often heal with substantial pincushioning that requires revision. Nasolabial flaps can be a useful choice for patients who absolutely refuse a forehead flap, or are unable to tolerate anesthesia required for a forehead flap require continuous positive airway pressure (CPAP) for sleep apnea as nasolabial flap can be designed to fit within a CPAP mask. The vertical orientation of the forehead flap lends itself to an easier flap inset than a nasolabial flap and ultimately provides more robust and predictable soft tissue for reconstruction (Fig. 14.13, Fig. 14.14, Fig. 14.15, Fig. 14.16).

Nasal Ala

Nasal ala defects lend themselves to a number of reconstruction modalities. Entire subunit defects can be reliably reconstructed with interpolated nasolabial flaps. Entire subunit defects with absent lining require paramidline forehead flaps. Partial subunit defects can be repaired with interpolated nasolabial flaps as a defect-only reconstruction or melolabial flaps as a defect-only reconstruction, or in selected cases and with limitations, it can be repaired with local flaps or full-thickness skin grafting.

The interpolated nasolabial flap is a defect-only reconstruction of an alar defect and reflects the near ideal contour and volume that can be achieved with a defect-only reconstruction (Fig. 14.17, Fig. 14.18, Fig. 14.19, Fig. 14.20, Fig. 14.21, Fig. 14.22).
Fig. 14.13 A 78-year-old female status post Mohs excision for basal cell carcinoma. Defect was 2 × 2 cm at the nasal tip and was reconstructed with nasolabial flap. Final results shown at 4 months.

Fig. 14.14 A 62-year-old male and active smoker status post 2 × 2 cm Mohs excision for basal cell carcinoma at nasal tip. Defect-only reconstruction with paramidline forehead flap. Postoperative results shown at 1 year.

Fig. 14.15 A 24-year-old female status post Mohs resection for squamous cell carcinoma. Defect repaired with “Parkland” forehead flap due to low hairline. Final results shown at 1 year.
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Fig. 14.16 A 50-year-old female status post 1 × 2 cm Mohs excision of basal cell carcinoma at right superior nasal tip. Defect-only reconstruction with paramidline forehead flap. From left to right: postoperative results shown immediately, and then at 1 week and 6 months following division and inset.

Fig. 14.17 A 36-year-old female status post 1 × 1 cm Mohs excision at right alar groove for basal cell carcinoma. Defect-only reconstruction with single-stage melolabial flap. Postoperative results shown at 4 years.

Fig. 14.18 A 73-year-old female status post Mohs excision for basal cell carcinoma. The defect was closed with a single-stage melolabial transposition flap and nonanatomic conchal cartilage graft placement. Top row: from left to right—postoperative results shown immediately after flap placement and at 5 days. Bottom row: from left to right—postoperative results shown at 5 days, 2 months, and 9 months.
Soft Triangle

Soft triangle defects are common and often underestimated. If poorly repaired, they can lead to a disfiguring collapse of the alar tip angle. The soft triangle is a “busy” anatomic area and cannot be repaired with local flaps that do not violate multiple subunits. A reliable algorithmic approach that includes full-thickness grafts, composite grafts, nasolabial, and forehead flaps is available4 (Fig. 14.23 and Fig. 14.24).

Complete Defect

These are the most challenging nasal defects. The establishment of reliable lining reconstruction is the single most important and difficult aspect of these cases.5 If the lining construct is inadequate, the entire flap, including cartilage grafts, is put at risk. Paramidline forehead flap is invariably required as a reconstructive element for these cases. Isolated complete ala or combined complete ala and tip defects can usually be managed safely with cartilage grafting and folded forehead flap for lining. Bilateral complete ala and tip defects are more safely reconstructed with lining established by a microsurgical free radial forearm flap6,7 (Fig. 14.25, Fig. 14.26, Fig. 14.27).
Fig. 14.21 (a) A 44-year-old male status post Mohs excision of left nasal side wall, partial nasal tip, and ala for melanoma in situ. Defect closed with paramidline forehead flap with conchal cartilage graft. From left to right: preoperative defect, planned forehead flap with nasal subunit markings, immediately following and at 2 weeks following forehead flap. (b) From left to right: postoperative results shown at 1 week, 10 months, and a front and three quarters view at 2 years following division and inset.
Fig. 14.22 (a) A 59-year-old female status post Mohs excision for basal cell carcinoma at left ala. Defect was repaired with subunit reconstruction with paramidline forehead flap. (b) Final results shown after division and inset at 1 week.

Fig. 14.23 (a) A 40-year-old female status post 1 × 1 cm Mohs excision of basal cell carcinoma at left nasal ala. Defect-only reconstruction with composite graft of skin and cartilage from left helical rim. (b) Postoperative results shown at 3 months.
Fig. 14.24 A 62-year-old female status post Mohs excision of basal cell carcinoma at left ala. Defect-only reconstruction with nasolabial flap. Final results shown at 5 months.

Fig. 14.25 (a) A 42-year-old female status post 2 × 2 cm Mohs excision for basosquamous cell carcinoma at right nasal tip, dorsum, and partial ala. Defect-only reconstruction with conchal cartilage graft and paramidline forehead flap with turn-in for lining in two stages. Forehead allowed to heal spontaneously. From left to right: preoperative defect, markings for flap, and 1 week following forehead. (b) From left to right: postoperative results shown immediately after, at 1 week, and at 1 year following division and inset.
Fig. 14.26 (a) An 81-year-old male status post 8 × 6 cm near-complete Mohs defect for multiple recurrent basal cell carcinoma. Mohs defect involves left nasal side wall, ala, and extends through alar cartilage, nasal dorsum, and partial right nasal sidewall as well as left malar cheek. Mohs defect closed with paramidline forehead flap and conchal cartilage graft and 16-cm cervicofacial advancement flap. From left to right: Mohs defect frontal and lateral view, 1 week and 1 month post flap elevation and placement and cervicofacial advancement.
(b) From left to right: postoperative results shown immediately, at 1 week and 3 months following flap division and inset.

Fig. 14.27 (a) A 76-year-old male status post Mohs resection for squamous cell carcinoma on nasal dorsum, bilateral sidewalls, tip, and bilateral ala. Subunit-based reconstruction of nose done with paramidline forehead flap. Forehead allowed to heal secondarily. (b) Final results shown at 1 year.
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References


15 Eyelid Reconstruction

Ronald Mancini

Abstract
This chapter discusses a variety of techniques utilized for periocular reconstruction after Mohs excision. Anatomical considerations of this highly specialized area and an algorithm for closure depending on defect size, location, and thickness are discussed in depth.

Keywords: eyelid reconstruction, medial canthus, lateral canthus, canthal tendon, lateral tarsal strip, anterior lamella, posterior lamella, lacrimal outflow system, canaliculus, Hughes tarsocconjunctival flap

Summary
- Normal eyelid structure and function is critical for ocular protection.
- Multiple aesthetic subunits coalesce in the periocular region.
- Complex anatomy can be broken down into two basic subunits: the anterior and posterior lamellae, each of which must be individually addressed during reconstruction.
- Defects in the medial canthal region often involve the lacrimal outflow system which must be assessed and reconstructed if present.

15.1 Anatomical Considerations
The complex anatomy of the upper and lower eyelids can be simplified for reconstructive purposes into the anterior and posterior lamellae. The anterior lamella consists of the skin and orbicularis oculi muscle and the posterior lamella consists of the tarsus and conjunctiva. The two lamellae have very specialized roles and, when full-thickness defects are present, must be considered and reconstructed individually (Fig. 15.1). Partial-thickness defects often involve only the anterior lamella, leaving the critical posterior lamella tissues intact. The medial canthus houses the lacrimal outflow apparatus and includes the lacrimal punctum and the canaliculi of the upper and lower eyelids (Fig. 15.2). Integrity of these structures is critical for normal lacrimal outflow and absence of epiphora. The medial and lateral canthi are the horizontal stabilizing structures of the upper and lower eyelids and when their integrity is violated, eyelid function is compromised and lack of a proper eyelid–globe interface ensues (Fig. 15.3).

15.2 Algorithm for Closure
Approaches to eyelid defect closure can be separated into subgroups, which take into account special considerations based...
on anatomic localization (▶ Fig. 15.4). Defects involving the canthi can involve specialized structures in these regions. Defects in the medial canthus may or may not involve the lacrimal outflow system, particularly the puncta and canaliculi, and defects in both the medial and lateral canthal regions can affect the canthal tendons which provide anchoring and horizontal support to both the upper and lower eyelids. Defects of both the upper and lower eyelids not involving the canthi can be broadly grouped into partial thickness (involving the anterior lamellar structures) or full thickness (affecting both anterior and posterior lamellar structures).

15.3 Defects Involving the Canthus (▶ Fig. 15.5)

15.3.1 Medial Canthal Defects

Defects involving the medial canthus have a high likelihood of affecting the lacrimal outflow system. Any suspicious defect close to the medial aspect of the upper or lower eyelids, or deep defects of the medial canthus, should be inspected for injury to the lacrimal outflow system and repaired primarily if possible (▶ Fig. 15.6a). Probing of the upper and lower puncta and canaliculi with a Bowman lacrimal probe can reveal occult injury to the lacrimal canaliculus (▶ Fig. 15.6b) and can often be primarily repaired with a silicone monocanalicular stent (▶ Fig. 15.6c,d). The canaliculi run through the medial canthal tendon which provides an anchor for, and horizontal support to, the eyelids. Concurrent injury is diagnosed as an easily distractable eyelid and repair is necessary to allow proper eyelid function. Pericanalicular sutures ensure re-approximation of the medial canthal tendon (▶ Fig. 15.7).

After lacrimal system involvement is either ruled out or corrected as above, the surgeon has several options for the repair of medial canthal defect.

The medial canthus heals very well by secondary intention, and often times this approach is favored for small defects (typically 5 mm or less in diameter) in the natural depth of the medial canthal concavity. Advancement flaps and thick full-thickness skin grafts can partially obliterate this natural concavity and lead to a poor aesthetic result. Larger defects in this area...
are amenable to a variety of reconstruction options. One must bear in mind that the medial canthus is a site where multiple aesthetic units coalesce. The thicker skin of the lateral nasal wall should be reconstructed with like thicker tissue and involvement of eyelid skin in this area is best addressed with thin eyelid skin or an appropriate substitute such as retroauricular skin.

Defects involving the medial canthal lateral nasal wall tissues are nicely reconstructed with local advancement flaps of like tissue. The bilobed flap is a versatile tool for reconstructing moderate-size defects in this area and allows advancement of similar thick tissue from the glabella and nasal dorsum (> Fig. 15.8). The first lobe is sized according to the defect being addressed, and when oriented 90 degrees to the defect will allow this closure scar to fall in the corresponding vertical glabellar furrow. This lobe can be conservatively thinned if needed to improve thickness match without sacrificing integrity (> Fig. 15.8b). The second lobe is sized 50% smaller than the
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Defects Involving the Canthus

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<td>- Full Thickness Flap</td>
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<td>- Full Thickness Skin Graft</td>
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Fig. 15.5 Algorithm for closure of defects involving the canthi.

Fig. 15.6 (a) Large medial canthal defect in the region of concern for lacrimal outflow apparatus injury. (b) Lacrimal probing confirms injury of the lower lacrimal canaliculus. (c,d) Placement of a silicone monocanalicular stent to bridge the compromised canalicular segment.

Fig. 15.7 5–0 Vicryl pericanalicular sutures (anterior and posterior to the canaliculus) ensure reapproximation and repair of the medial canthal tendon, as the canaliculi run through the middle of the medial canthal tendon \(^2\) (Used with permission from Chen WP. Oculoplastic Surgery: the Essentials. Thieme, New York, 2001.)

First lobe in width and situated 90 degrees away from the first lobe. This allows the closure scar to fall within, or in close proximity to, the horizontal glabellar fold. Dissection of the flaps is in the subcutaneous fat plane to prevent excessively thin flaps which can be lost, and also to avoid injury to the deeper structures, particularly the corrugator and procerus muscles in this region.

Larger and more inferiorly positioned medial canthal defects can be addressed with cheek advancement flaps, utilizing a lateral rhinotomy incision coupled with an incision hidden in the orbital rim ligament depression which can recruit significant thick skin for medial canthal reconstruction (▶ Fig. 15.9a). Dissection once again is in the subcutaneous fat plane to maintain a thick viable flap, yet avoid damage to the underlying facial mimetic muscles (▶ Fig. 15.10b). The depth of the medial canthus is often best left to heal by secondary intention which, as noted earlier, often results in an excellent final aesthetic result (▶ Fig. 15.9c–e).

Full-thickness skin grafting or dermal matrix substitutes (e.g., Integra) followed by partial- or full-thickness grafting after integration are good options when very large defects less amenable to advancement flaps are present or in patients in whom large flaps are less desirable, such as smokers (▶ Fig. 15.10).
15.3.2 Lateral Canthal Defects

The lateral canthus houses the lateral canthal tendon which stabilizes the upper and lower eyelids (▶ Fig. 15.3). Defects in the lateral canthus can involve the lateral canthal tendon and destabilize the eyelids. Small defects that involve the upper or lower eyelid canthal tendons can be repaired by creating a lateral tarsal strip from the remaining eyelid if adequate mobility is present for the tarsal strip to be attached to the periosteum of the inner aspect of the lateral orbital rim; typically this can be achieved for defects less than or equal to one-fourth of the horizontal eyelid length (▶ Fig. 15.11). ▶ Fig. 15.12 demonstrates use of the technique in a patient with approximately one-fourth of the eyelid defect involving the tarsus and lateral canthus.

Defects involving the lateral canthal tendon and full-thickness eyelid greater than one-fourth of the eyelid length are not amenable to the tarsal strip procedure due to the inability to adequately mobilize the eyelid laterally to allow attachment in the lateral canthus. A periosteal flap of varying length (typically for defects up to half of the eyelid horizontal length) can be developed from the lateral orbital rim to reconstruct an upper and/or lower lateral canthal tendon and serves as an adequate posterior lamella substitute in this region as well (▶ Fig. 15.13). Local advancement flaps or even full-thickness skin grafts can then be used to reconstruct the anterior lamellar deficiency.

15.4 Defects Not Involving the Canthus (▶ Fig. 15.14)

15.4.1 Upper and Lower Eyelid: Partial-Thickness Defects

Partial-thickness defects, those involving the anterior lamella (skin +/- orbicularis), of the upper and lower eyelids can be closed in a variety of ways including full-thickness skin grafting or local advancement flaps.

Full-thickness skin grafts of the upper and lower eyelids heal well with good care and cosmesis if appropriate grafting sources are utilized to provide like tissue. The ideal source of full-thickness skin graft tissue to the eyelids is eyelid donor itself. Older patients with redundant dermatochalasis of the upper eyelids provide an excellent source of tissue for grafting. If eyelid skin is unavailable or insufficient for reconstruction, retroauricular skin grafts thinned appropriately provide an excellent donor site. Supraclavicular, preauricular, or other non–hair-bearing donor sites provide an adequate, though less favorable, donor site if eyelid or retroauricular sources are unavailable. It is important to adequately thin this thicker donor skin and ensure the harvest site is truly non–hair-bearing.

Graft size can often be minimized, particularly in lower eyelid defects with preexisting horizontal laxity and a high likelihood for development of ectropion, by converting a portion of the defect to full thickness. This is particularly useful in defects which partially violate the integrity of the tarsus (▶ Fig. 15.15).

Bolstering of full-thickness skin grafts can be very difficult and uncomfortable for the patient in the periocular region. Use of a “cyanoacrylate cast” can be very helpful in this area to stabilize, immobilize, and prevent graft corrugation during the first week of healing, often obviating the need for a bolster for small grafts in this area (▶ Fig. 15.16).

A variety of flaps are useful in the periocular region for partial-thickness defect reconstruction (▶ Fig. 15.17). The single most important tenet which must be obeyed in this region regardless of the choice of advancement flap is that defect closure tension must be directed parallel to the eyelid margin which is most readily achieved with defect closure oriented 90 degrees perpendicular to the eyelid margin. Closure in this manner disobeys relaxed skin tension lines in this area; more importantly, however, closure in this manner does not place vertical tension on the eyelid that can result in ectropion and or eyelid retraction. O-T plasty is particularly useful in this area and allows for closure with tension directed parallel to the eyelid margin (▶ Fig. 15.18).
Full-thickness defects of the upper and lower eyelids require reconstruction of both the anterior and posterior lamellae. The underlying degree of preexisting eyelid laxity determines the method of closure that can be used. In general, approximation in younger patients with minimal eyelid and canthal tendon laxity defects up to one-fourth of the eyelid margin can be closed directly; defects up to one-third of the eyelid margin can be closed directly after release of the lateral canthal tendon with or without a semicircular advancement flap; and defects more than one-third of the eyelid margin typically require a lid-sharing-type procedure to allow adequate closure. In older patients with significant eyelid and canthal tendon laxity defects up to one-third of the eyelid margin can be closed directly; defects up to half of the eyelid margin can be closed directly after release of the lateral canthal tendon with or without a semicircular advancement flap; and defects more than half of the eyelid margin typically require a lid-sharing-type procedure to allow adequate closure. The use of two forceps to attempt tissue reapproximation without undue tension can confirm or contradict the above approximations on an individual basis (▶Fig. 15.21c). When direct closure is an option, with or without canthal manipulation, closure involves stepwise lamella reapproximation (▶Fig. 15.19, ▶Fig. 15.20, ▶Fig. 15.21).

When direct closure is not an option for large full-thickness defects, lid-sharing procedures can be utilized. For large lower eyelid defects, posterior lamellar reconstruction can be achieved with a Hughes tarsalconjunctival flap (▶Fig. 15.22).
Fig. 15.11 Lateral tarsal strip procedure. (a) The procedure involves conservative exposure of a small strip of tarsus (2–3 mm is sufficient) of the remaining eyelid by denuding the eyelid margin epithelium and recessing the anterior lamella to expose a strip of tarsus. (b) The tarsal strip is then secured to the inner aspect of the arcus marginalis with a horizontal mattress suture to provide horizontal stability to the eyelid and recreate the lateral canthus.

Fig. 15.12 (a,b) A 58-year-old woman with approximately one-fourth of eyelid margin defect involving the lateral canthus and partially violating the tarsus. The violated region of lateral canthus and tarsus was excised and a lateral tarsal strip fashioned for reconstruction. (c,d) Six months post-op.
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Fig. 15.14 Algorithm for closure of defects not involving the canthi.

Fig. 15.13 (a) A large lateral canthal defect which involves the upper and lower eyelid lateral canthal tendon and approximately 50% of full-thickness lower eyelid and 25% of full-thickness upper eyelid. (b,c) A peristeal flap is developed from the lateral orbital rim periosteum for lower eyelid posterior lamellar and lateral canthal tendon reconstruction at which point anterior lamellar reconstruction can commence with either local adjacent tissue flaps or full-thickness skin grafting. (d) A 52-year-old patient with a large upper and lower eyelid and canthal defect. A peristeal flap was used for both upper and lower eyelid posterior lamellar and canthal reconstruction at which point a modified Mustarde flap was used for anterior lamellar reconstruction. (e) Post-op 2 years.

Defects Not Involving the Canthus

Upper
- Partial thickness
  - Advancement flap
  - Full-thickness skin graft
- Full thickness
  - Direct closure +/- semicircular advancement flap
  - Cutler-Beard

Lower
- Partial thickness
  - Advancement flap
  - Full-thickness skin graft
- Full thickness
  - Direct closure +/- semicircular advancement flap
  - Hughes Tarsal conjunctival flap w/ FTSG
Fig. 15.15 (a) A 70-year-old patient with a large partial-thickness defect of the right lower eyelid. There is partial violation of the tarsus in one area and the patient has underlying lower eyelid involutional laxity predisposing to ectropion. (b-d) A full-thickness wedge removed from the area of tarsal violation achieves several goals in addition to the simple removal of this relatively weakened area: horizontal tightening in an eyelid at risk of developing ectropion and minimizing the size of the full-thickness graft needed for reconstruction. (e, f) The patient 3 months after reconstruction.

Fig. 15.16 Cyanoacrylate glue with or without pressure patching can be used for stabilizing and immobilizing small skin grafts in the periocular region often obviating the need for suturing in a formal bolster. (a,b) Glue is placed at the periphery of the graft on normal tissue with the goal of immobilizing the surrounding normal eyelid tissue to prevent graft corrugation during healing. (c) The glue can be removed along with sutures at 1 week post-op.1

Fig. 15.17 (a) In the periocular region, bilobed flaps are particularly useful in the medial canthus (see ▶ Fig. 15.8). (b) O-T plasty is particularly useful when the defect is situated close to the eyelid margin (▶ Fig. 15.18). (c) Conversion to an elliptical shape can be utilized in the periocular region; however, as noted above, orientation should be perpendicular to the eyelid margin to prevent tension perpendicular to the eyelid margin and possible ectropion. (d) Defects too close to the eyelid margin to be closed with a simple ellipse can be closed by converting to an M-plasty for the portion close to the eyelid margin which in effect will reduce by 50% of half of the ellipse. (e) O-Z plasty provides another useful tool for partial-thickness closure in the periocular region.
Fig. 15.18 (a) A 65-year-old female with a partial-thickness defect close to the eyelid margin. O-T plasty allows closure with tension directed parallel to the eyelid margin. (b, c) Post-op 6 months.

Fig. 15.19 Full-thickness defect closure. The tarsus is closed with partial-thickness lamellar bites followed by skin closure. A vertical mattress suture through the eyelid margin allows for wound eversion and minimizes the risk of eyelid notch formation with healing.² (Reused with permission from Chen WP. Oculoplastic Surgery: the Essentials. Thieme, New York, 2001.)

Fig. 15.20 (a) A 48-year-old female with minimal eyelid laxity and one-third full-thickness eyelid margin defect. (b) A canthotomy and inferior cantholysis without semicircular flap allow adequate mobilization to allow full-thickness closure without undue tension. (c, d) Post-op 2 years.
Fig. 15.21 (a) A 65-year-old male with moderate involutional eyelid laxity and approximately one-third full-thickness lower eyelid margin defect. Canthotomy and inferior cantholysis with a (b) small semicircular advancement flap allow adequate mobilization for direct closure, (c) demonstrate adequate mobilization without undue tension confirmed with forceps prior to closure. (d) Post-op 30 months.

Fig. 15.22 (a) A 70-year-old male with approximately 60% full-thickness lower eyelid defect. The defect is reconstructed with a tarsoconjunctival flap from the upper eyelid to reconstruct the posterior lamella and an advancement skin flap to reconstruct the anterior lamella. (b) Surgery commences with measurement of the defect to be repaired. (c) The planned tarsoconjunctival flap is drawn on the posterior upper eyelid donor tissues. It is important to leave adequate upper eyelid tarsus in situ to prevent upper eyelid destabilization, typically 4–5 mm left in situ throughout the length of the eyelid is adequate. (d, e) After tarsal dissection, a conjunctival flap is then dissected to the superior fornix to allow mobilization of the tarsoconjunctival flap which is sutured in place to reconstitute the posterior lamella. The anterior lamella is then reconstructed with an advancement flap in this case from the (f) upper eyelid; however, the tarsoconjunctival flap provides a vascularized bed which can allow full-thickness skin grafting as well. The flap is transected typically at 2–4 weeks. (g) Post-op 1 year.
The anterior lamella is then reconstructed typically with a full-thickness skin graft or local advancement flap.

Large upper eyelid defects pose a particular challenge, given the strict requirement of a structurally functional upper eyelid for ocular surface health. Large upper eyelid defects can be repaired with a Cutler-Beard procedure to allow simultaneous anterior and posterior lamellar reconstruction (▶Fig. 15.23).

References

16 Cheek Reconstruction

James F. Thornton and Jourdan A. Carboy

Summary
This chapter discusses cheek reconstruction including the identification of the three anatomic zones of the cheek, as well as a number of surgical techniques for closure corresponding to the three anatomic zones. The avoidance of lower eyelid and lip complications as well as closure techniques ranging from simple linear closure to cervicofacial advancement flaps are covered.

Keywords: cheek, suborbital, preauricular, buccomandibular, primary closure, advancement flap, malar, perialar crescentic advancement flap, cervicofacial advancement flap

Summary
- There are three anatomic zones, the suborbital, preauricular, and buccomandibular (zones 1, 2 and 3, respectively), to consider when reconstructing the cheek.
- Direct closure, even for large defects, often provides the most ideal result.
- Cervicofacial advancement flaps can be performed under intravenous sedation with very low complication rate.
- Lower eyelid complications can be avoided by appropriate flap design that includes the cheek–lid junction incision and lateral placement of vertical flap tension vector.
- Full-thickness grafting can be preferable for medial cheek defects but should be used with caution for larger central defects.

16.1 Algorithm for Closure (▶ Fig. 16.1 and ▶ Fig. 16.2)

16.1.1 General Considerations
In evaluating the cheek, there are important functional considerations and it is useful to consider the anatomic zones defined as follows: zone 1—the suborbital and premolar medial cheek from eyelid to below malar eminence; zone 2—the temporal/preauricular; and zone 3—the buccomandibular from below malar eminence to mandibular rim (▶ Fig. 16.1 and ▶ Fig. 16.2). The primary factor of zone 1 is the functional integrity of the lower lid and a successful cheek reconstruction is a failure if there is extrinsic ectropion, which is the most common complication of these procedures and is entirely avoidable with appropriate techniques. Also, zone 1 contains the malar eminence, or the malar prominence, and this is often quite a difficult area to reconstruct due to convexity with limited tissue laxity from anterior to posterior plane. Additionally, it is the most prominent anatomic location on the cheek.

Zone 2 is reasonably featureless. It is limited posteriorly by the ear and therefore there is functional significance to maintain the patency and configuration of the external auditory canal. What is most challenging on zone 2 is that it is a zone of adhesion and, despite being relatively flat and featureless, has relatively little laxity in the anteroposterior plane and this must be a consideration for reconstructive planning. Importantly, zone 2 is somewhat posterior and hidden from frontal viewing.
and more liberty can be taken with incision placement and secondary healing.

Zone 3 has functional importance with regard to the lower lip, and it must remain in its anatomical position to maintain oral competence. Additionally, zone 3 includes the convexity of the chin and it has little inherent laxity to recruit for reconstruction.

16.1.2 Commonly Applied Methods of Closure

- Primary closure utilizing the laxity of the cheek and oriented in the vertical plane to reduce risk of lower eyelid ectropion.
- Combined chin and cheek defects (zone 3) may tolerate primary closure with avoidance of lower vermilion ectropion; however, in the elderly patients with significant lower face laxity, a bilobed flap advanced from the neck may be a preferable postoperative result.
- V-Y advancement flap is often an excellent choice for either lateral or medial chin defects as well as defects found on the upper cutaneous lip. These may be especially useful for small defects in males restoring hair bearing coverage.
- Defects of the upper cutaneous lip may ideally be managed with a perialar crescentic advancement flap; care must be taken to avoid eversion of the upper lip.
- For patients that may not tolerate a cervicofacial advancement flap, color-matched full-thickness skin grafting is a safe and viable option.

16.2 Primary Closure

The algorithm for cheek reconstruction begins with attempts at primary closure. A single tacking suture is placed sequentially in two orientations at 180 degrees from each other and the wound is tailor tack closed. Even large linear scars on the cheek heal tremendously well and this is considered a first choice reconstruction. Linear closures on the midportion in zones 1 and 2 of the cheek are vertically oriented to prevent ectropion. The resulting dog-ear or standing cone can be extended into the cheek–lid junction. This often involves the lower eyelid and as long as meticulous attention is paid to elimination of redundant skin on the final inset, excellent results can be obtained. Rarely any attempt is made at undermining given there is more than sufficient laxity for the vast majority of defects to affect a
mild tension closure. Vigorous postoperative scar management, including early use of silicone sheeting, adjunctive laser treatment, and dermabrasion as required are critical to obtain ideal postoperative results. The clinical examples illustrated show both short- and long-term results for linear closures. These were female patients without ideal skin tone or type for optimal linear closure; however, with closure even under moderate tension, the final results with minimal postoperative adjunctive methods are superior to any other technique. The consideration or institutional avoidance of transposition flaps for the cheek is based on the fact that even the most properly done transposition flap will, by definition, have surgical incisions placed counter to ideal relaxed skin tension lines. The very premise of a transposition flap is to recruit laxity from an area of relative laxity to an area of a paucity of laxity and on the cheek we consider the entire anatomical subunit to have essentially equal laxity. Therefore, there is simply no surgical advantage of transposition flaps on the cheek and additionally they lead to suboptimal scarring patterns. Clinical example 3 shows the poor postoperative result from an adequately designed and executed rhomboid transposition flap for cheek reconstruction (Fig. 16.3, Fig. 16.4, Fig. 16.5).

16.3 V-Y Advancement Flap

A V-Y advancement flap has been defined for both central and lateral cheek defects and is effective for very large and complete defects. Several technical points on this is that once a single
perforator vessel is identified with Doppler, generous soft-tissue advancement can be performed if this single vessel is maintained.8 Very wide dissection is then possible. When these have been performed and appropriately inset, the final results on these flaps are quite good, with provision for re-advancement if needed (▶ Fig. 16.6).

16.4 Perialar Crescentic Advancement Flap

For defects that abut the upper lip, a perialar crescentic advancement flap is an effective option. These are essentially “reversed facelift flap” with a planned standing cone excision along the nasolabial fold both superior and inferior to the defect.1,9 Moderate amount of tension can be placed on the upper lip at inset with the expectation that this will resolve secondary to the action of the orbicularis oris muscle.1 These flaps provide a very nice color-matched soft-tissue inset and easy postoperative management. Great care must be taken on inset, however, to ensure there is no vermillion effacement as it will rarely resolve spontaneously (▶ Fig. 16.7).

16.5 Cervicofacial Advancement Flaps

For defects larger than 3 cm that are not amenable to primary closure, a cervicofacial advancement flap is designed. Cervicofacial flaps are actually very simple procedures and can be done safely under intravenous (IV) sedation. Part of the confusion lies in the multiple descriptions of flap design (▶ Fig. 16.8). These include the Esser, the Mustarde, Blascowicz, Ferris Smith, Converse, Stark and Kaplan, and Juri and Juri, as illustrated in ▶ Fig. 16.9.

This can create significant confusion as to correct flap selection and execution. A better approach is to look at a cervicofacial flap on a continuum, a “cut-as-you-go” type flap with identical incision planning but with varied extent of the incisions. Another point of confusion is the plane of dissection. Subcutaneous, sub-SMAS (submuscular aponeurotic system), and submuscular flap dissection are all championed as the ideal option; however, at the University of Texas Southwestern Medical Center’s clinical practice of over 500 sequential cheek reconstructions, subcutaneous-only flap elevation resulted in only a 3% partial flap loss.1 There are several principles that should be practiced in regard to cervicofacial flaps: (1) IV sedation anesthesia is appropriate for the majority; (2) wide infiltration of local anesthetic containing epinephrine on flap dissection can be used; (3) subcutaneous dissection can be performed, even for large flaps; (4) the understanding that the laxity from the flap is negligible in the anteroposterior direction and the majority of the flap laxity comes from the lax neck with a superior advancement; (5) subciliary incision is not used, but rather an incision made at the cheek-lid junction is preferable; and (6) no attempt is made to secure the flap along the orbital rim, rather the vector is posterior to the lateral canthus where tension of the flap is supported entirely on the lateral brow, allowing redundant skin to fall along the lower eyelid and support the lower eyelid with prevention of late ectropion.10 These flaps are performed as follows. The maximal extent of the incision is designed and drawn with no postauricular component, only a component that extends down to the neck. The incision starts medially and follows the cheek-lid junction, extending into the temporal brow hairline and then to an immediate preauricular
Fig. 16.8 (a) Blascowicz. (b) Converse. (c) Esser. (d) Ferris-Smith. (e) Juri and Juri. (f) Mustarde. (g) Stark and Kaplan.

Fig. 16.9 (a–e) Schematic showing importance of lateral tacking sutures to the periosteum to allow redundant free infraorbital cheek flap inset.
location that stays preauricular with extension onto the neck. At this point, the flap is dissected sharply without electrocautery to the level of the maximal extent, and a planned standing cone excision is outlined on the cheek. The flap is then released from its tailor tacking sutures and hemostasis is achieved on the cheek portion with electrocautery. Any actively bleeding vessels are cauterized again with electrocautery on the flap itself and then fibrillar collagen is placed along the flap elevation junction and on any areas of previous active bleeding. The flap is then re-inset and great care is taken to provide deep periosteal tacking sutures posterior to the lateral canthus even to the point of an exaggerated upward vector with redundant flap skin. The redundant skin is then very carefully inset on the cheek–lid junction with excision of any nonviable skin that resulted from handling during the flap elevation. At this point, the incision extending onto the anterior cheek is closed (▶ Fig. 16.9b) and the remaining flap inset is performed. Vicryl 3–0 pop-off sutures are utilized for the majority of the flap inset, Monocryl for superficial wound closure, and then 5–0 fast-absorbing gut is placed underneath the eye with 5–0 or 6–0 nylon for the remainder. The patient is cautioned postoperatively that there will be significant postoperative swelling even to the point of complete eyelid swelling. Sutures are removed at 5 days, and early postoperative scar care is utilized. Nitropaste is applied to the majority of these flaps intraoperatively as a single application to increase venous return. Illustrations shown here demonstrate that excellent final aesthetic results can be maintained by placement of the surgical incision in the cheek–lid junction, both early and late in the postoperative period. No lid tightening procedure is required providing that laxity is maintained in the superior direction, posterior to the lateral canthus (▶ Fig. 16.9, ▶ Fig. 16.10, ▶ Fig. 16.11, ▶ Fig. 16.12, ▶ Fig. 16.13, ▶ Fig. 16.14).

16.6 Full-Thickness Skin Grafts

Full-thickness skin grafting is ideal for zone 1 medial canthal and lower lid defects. There is relatively little laxity in this area to allow linear closure and on patients, particularly in male patients with thick sun-damaged skin that does not lend itself
Fig. 16.13 A 68-year-old female status post 4 × 2 cm Mohs excision for basal cell carcinoma on the right malar cheek. Wound was closed with cervicofacial advancement flap. Incision was placed at the cheek–lid junction. Postoperative results shown intraoperatively at 1 and 2 months.

Fig. 16.14 A 65-year-old male status post-Mohs excision of right ear lobule and preauricular region of cheek. Lobule was reconstructed with small advancement flap of remaining soft tissue and a small color-matched full-thickness skin graft to maintain external auditory canal patency. Cheek defect was repaired with a cervicofacial advancement flap in the deep subcutaneous plane and elevated to the level of mid-neck. Postoperative results shown intraoperatively at 1 week and 2 months, from left to right.

Fig. 16.15 A 42-year-old male status post 3 × 2 cm Mohs defect for basal cell carcinoma at right medial canthus. Wound was treated with color-matched full-thickness skin graft. Postoperative results shown intraoperatively at 3 and at 6 months.

Fig. 16.16 A 52-year-old female status post 1 × 1 cm Mohs excision of basal cell carcinoma at left nasomalar region. Wound was treated with color-matched full-thickness skin graft. Postoperative results shown at 5 months.
to easy transposition, a full-thickness graft placed here with appropriate bolstering provides a final wound appearance that is superior to any other technique11 (▶ Fig. 16.15, ▶ Fig. 16.16, ▶ Fig. 16.17, ▶ Fig. 16.18).

Final considerations are given to large cheek defects in patients that are not able to tolerate formal cervicofacial advancement flap. These can be reconstructed with full-thickness grafting and, despite common dismissal of full-thickness grafting as a poor reconstructive modality for the cheek and although it is not our primary modality, oftentimes it offers the best surgical result. The use of color-matched skin is preferable, but non-color-matched skin can provide adequate soft-tissue coverage at the expense of final wound appearance.11

16.7 Postoperative Management

Full-thickness skin grafting often requires initial dermabrasion and may benefit from late (3 months) fat grafting to improve contour deformities.12

Cervicofacial advancement flaps done under IV sedation can be managed without drain placement with a predictably low postoperative hematoma rate.1

V-Y advancement flaps require early enthusiastic scar management with silicone sheeting and often adjunctive pulsed-dye laser to provide satisfactory incisional scars.5

References


Fig. 16.17 A 31-year-old male status post 4 × 5 cm Mohs excision for melanoma in situ. Mohs defects were closed with color-matched full-thickness skin graft. Skin graft was chosen over a flap closure due to patient’s hemophilia. Postoperative results shown at 2 years.

Fig. 16.18 A 66-year-old male status post-Mohs resection for basal cell carcinoma. Wound was treated with non-color-matched full-thickness skin graft, which provided suboptimal cosmetic results, as shown postoperatively at 6 months.
17 Chin Reconstruction

James F. Thoroton and Jourdan A. Carboy

Summary
This chapter discusses soft-tissue reconstruction of the chin including the complexities involved in the anatomic location and functional importance of the chin. A number of different techniques including primary closure, bilobed flap, V-Y advancement flap, as well as full-thickness skin grafts utilizing cheek reconstruction are covered.

Keywords: chin, primary closure, bilobed flap, V-Y advancement flap, skin graft

Summary
- The chin is a prominent aesthetic subunit.
- Its reconstruction is complicated by the fact that it is a prominent convexity with little inherent laxity and little surrounding laxity.
- It has functional significance supporting the lower lip, meaning poor reconstruction will result in oral incompetence.

17.1 Algorithm for Closure

The chin is quite frequently involved with Mohs resection for skin cancer (Fig. 17.1). It is a prominent aesthetic unit with somewhat thick and oily skin that does not lend itself to grafting. Additionally, the convexity acts much like the vertex of the scalp with little surrounding laxity. The soft-tissue components of the chin are deeply adherent to the underlying mandible and there is little inherent tissue laxity for closure. The natural reservoir of laxity unfortunately comes from the lower lip and any excessive recruitment of lower lip tissue to reconstruct the chin will provide both a jarring postoperative appearance and external ectropion and subsequent oral incompetence. Fortunately, the chin tolerates tension on closure very well and the vast majority of chin defects can be managed appropriately by primary closure.

17.2 Commonly Applied Methods of Closure

- Primary closure with meticulous care for standing cones to avoid contour deformity and to avoid lower lip ectropion.
- Bilobed flap reconstruction with recruitment from laxity of the neck and avoidance of excessive tension on the lower lip.
- V-Y advancement flap.
- Full-thickness skin grafts.

17.2.1 Primary Closure

Primary closure involving the chin can be determined intraoperatively with a 2–0 Vicryl tacking suture placed vertically with planned dog-ear excisions superiorly and inferiorly. Even with significant tension on closure, with a sequential layered closure of 2–0 and 3–0 nylon sutures, the final aesthetic result is nearly always uniformly good to excellent. There is little need for undermining as simple advancement and closure under slight tension is more than adequate. At the time of closure, dog-ears need to be meticulously managed so that there is no contour deformity as this will rarely settle.

Fig. 17.1 Algorithm for chin defect closure.
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17.2 Early postoperative management including silicone sheeting and dermabrasion at 6-week intervals helps optimize the final scar1,2 (▶ Fig. 17.2 and ▶ Fig. 17.3).

17.2.2 Bilobed Flaps
In elderly patients, there is often limited laxity of the chin and little resting tone of lower lip. This can complicate reconstruction of larger chin defects due to enhanced risk of lower lip eversion. Therefore, a bilobed flap can be recruited from submental laxity. A large two-limbed bilobed flap with a generous second limb that is essentially as large as can be closed, that is, 65 to 70% of the initial limb, can be easily rotated into position. With simple and meticulous dog-ear excision and contour inset, adequate closure can be achieved. The only difficulty in this is the dissection is performed in the deep subcutaneous layer, remaining above the platysma.3 In patients with platysmal banding, it is difficult to maintain a symmetric bilateral contour.4 However, revisionary procedures, which in fact are rarely indicated given this patient population, can restore neck contour to near normal (▶ Fig. 17.4).

Fig. 17.2 A 45-year-old female status post Mohs excision for basal cell carcinoma. Wound was closed with primary closure. Postoperative results shown at 4 months.

Fig. 17.3 A 52-year-old female status post 4 × 2 cm Mohs excision of recurrent melanoma in situ at left chin. Wound was closed with vertical primary adjacent tissue transfer with dog-ear excision. Postoperative results shown at 6 months.

Fig. 17.4 An 86-year-old female status post Mohs excision of squamous cell carcinoma on the left chin. Wound was treated with bilobed flap that recruited the patient’s skin redundancy on her neck to avoid recruitment of lower lip laxity and avoid lower lip ectropion. Postoperative results shown at 6 months.

17.3 V-Y Advancement Flap
A V-Y advancement flap has been well described for both central and lateral chin defects.5 Although the technique is described here, it should be considered inferior to both direct closure and bilobed flap reconstruction. A submental pediced V-Y advancement flap is quite difficult to raise and essentially an entire V-Y perforator needs to be developed with removal from the submental attachments and despite wide mobilization, there is often little minimal soft tissue available to advance.5 However, the supplied clinical photographs do support their use in large central cases with good final results given the initial size of the soft-tissue deficit (▶ Fig. 17.5 and ▶ Fig. 17.6).

17.4 Full-Thickness Skin Grafts
For patients whose comorbid disease would not support the intraoperative requirements of either a bilobed or submental flap, color-matched full-thickness grafting from the clavicle can be performed with the understanding that ultimately this is an...
inferior aesthetic result. With that in mind, there is no attempt made to perform subunit-only grafting reconstruction.

17.5 Postoperative Management

For direct closure, early postoperative silicone sheeting for all patients and steroid injection of hypertrophic scars are often required. For bilobed flap reconstruction, revision of asymmetrical neck donor site is often required.

References

Techniques for Specific Anatomic Location

18 Lip Reconstruction

James F. Thornton and Jourdan A. Carboy

Summary
This chapter will discuss the functional and aesthetic differences, as well as differences in reconstructive approaches to the upper and lower lips. A wide variety of reconstruction techniques based on the anatomic deformity including skin, mucosal-only, and combined defects are covered. The closure techniques include delayed healing, acellular dermal products, buccal advancement flap, direct closure, ergotrid, V-Y advancement flaps, and full-thickness skin grafts. Larger defects requiring Abbe and Karapandzic flaps are also discussed.

Keywords: lip, vermilion, microstomia, buccal advancement, direct closure, ergotrid, V-Y advancement, Abbe flaps, rotation flaps

18.1 Algorithm for Closure

18.1.1 Anatomy
There are significant functional and aesthetic issues in lip reconstruction (Fig. 18.1 and Fig. 18.2). It is important to understand the functional significance of the upper and lower lips. It is also necessary to realize that the upper and lower lips have very different functional and aesthetic requirements. The lower lip is most important in maintaining a “dam” effect to maintain oral competence, and reconstruction techniques that maintain the muscle integrity of the lower lip are more useful than simply reconstruction with atonic tissue (e.g., free radial forearm flap). The lower lip is actually easier to reconstruct as it is somewhat featureless and tension on closure results in less deformity than tension on closure in the upper lip. Conversely, the upper lip has significant anatomic features that must be maintained or re-created for a successful reconstructive outcome. These anatomic features include the white roll, the philtral columns, and Cupid’s bow.

Generally, reconstruction of the lips should allow for retention of oral competence, preservation of oral commissures, maintenance of vermilion alignment, and prevention of microstomia. These considerations are critical to a functional aesthetic reconstruction. Wounds of the lip are classified into three separate types of defects that include mucosal-only defects, skin-only defects, and then combined skin and mucosal defects. These are each managed quite differently.

18.2 Commonly Applied Methods of Closure

• Mucosa-only defects: Delayed healing/secondary intention with or without wound healing agents (i.e., acellular dermal products) and buccal advancement flaps.
• Skin-only defects: Direct closure, ergotrid, and V-Y advancement flaps, perialar crescentic advancement flap, and full-thickness skin grafts.
• Combined skin and mucosa defects: Direct closure with or without wedge resection, Abbe and rotation flaps, advancement closure, the innervated mucosal advancement flaps, and Karapandzic flap.

18.2.1 Mucosal-Only Defects

Delayed Healing/Acellular Adjuncts
For mucosal-only defects, if primary closure for small-sized defects without lip distortion is a possibility, this should be the wound is treated; however, the vast majority of these are now managed with secondary intention healing, either with or without acellular matrix or simple porcine acellular dermal matrix (ADM) coverage. There are textbook chapters written on vermilion-only lower lip reconstruction that really ignore the tremendous ability of the lower lip to spontaneously heal without scarring and it is very rare for a vermilion-only defect to heal with a contracture that will distort the lip. Primary management for even large defects of the lower lip are to place ACell matrix powder and then sew in an overlying acellular dermis sheet and then send the patient home with instructions to just keep the surface wet with three to four times daily applications of Surgilube water-based surgical ointment. Gratifyingly, these will uniformly heal well with no late contracture.

Buccal Advancement Flap
There is a role for buccal advancement flaps in cases when patients are unable to provide local wound care or endure the 3 to 5 weeks required for secondary healing. A buccal advancement flap is particularly useful on the lower lip and takes advantage of the laxity present in this region. Great caution must be utilized that the buccal space is not shortened to the point that oral incompetence results. It is also important to understand that a buccal advancement flap that advances the wet mucosa to replace the dry mucosa will never result in a “perfect” lip reconstruction. Secondary intention healing for these cases is preferable (Fig. 18.4 and Fig. 18.5).
Lip Reconstruction

Fig. 18.1 Algorithm for lip reconstruction.

Fig. 18.2 Side lip anatomy.
18.3 Skin-Only Defects

18.3.1 Direct Closure

When approaching skin-only defects, the option of primary closure should strongly be considered first. This approach has significantly changed over the course of the author’s practice, when previously every vermillion-only defect or combined vermillion- and skin-only defect was treated as a wedge excision with excision including the buccal mucosa and then oriented and re-closed. These uniformly resulted in very fine postoperative results as seen in Fig. 18.5; however, the healing time could often be significant, secondary to the time it takes for the divided orbicularis oris musculature to reapproximate and reinnervate. A much more graded approach with simple linear closure following relaxed skin tension lines is much less invasive and has equal, if not superior, cosmetic results, as seen in Fig. 18.6. If closure without a significant superior/inferior dog-ear or bunching of the soft tissue is not possible, perform partial debulking of the resultant orbicularis oris muscle to the point of complete excision; however, every effort should be made to maintain the oral mucosa. By providing a watertight seal, it reduces late infection risk and allows for quicker recovery with similar ideal aesthetic appearances (Fig. 18.6 and Fig. 18.7).

Fig. 18.3 A 73-year-old white male status post-Mohs excision for basal cell carcinoma at lower lip. Wound was allowed to heal secondarily. Results shown at 2 months.

Fig. 18.4 (a) Flap is designed with the leading edge slightly larger than the defect. (b) Flap is elevated and the current wet mucosa is advanced to cover the vermillion defect. (c) Final inset with 4–0 and 5–0 chromic gut sutures.

Fig. 18.5 An 86-year-old female status post complete vermilion excision for multifocal squamous cell carcinoma. Mohs defect closed buccal advancement flap. Postoperative results shown at 4 months.
Ergotrid and V-Y Advancement Flaps (a Continuum)

Ergotrid flaps, described by Becker, are essentially a rotation advancement flap that takes advantage of the ability to hide the longer advancement limb incision within the nasolabial fold. These can be extended quite far provided patients do have visible nasolabial folds. Their utility in younger patients without well-defined nasolabial folds is significantly less. Every effort should be made to orient the flap to avoid crossing the vermilion border. The ergotrid flap should be considered on a continuum with a V-Y advancement flap for larger, skin-only defects of the upper or lower lip. The incision for the lower limb of the V-Y advancement is outlined and a Doppler is utilized to capture a single perforator, which is sufficient to keep the entire flap alive. First, the ergotrid portion of the superior limb is designed and performed. If there is insufficient advancement, then the lower limb along the white roll is performed and the flap advanced into position for final wound closure, as depicted in Fig. 18.7. By considering the V-Y advancement flap as a continuum of the ergotrid flap, the surgeon should never be “caught short” on a unilateral upper lip defect as the V-Y advancement flap can repair the entire subunit (Fig. 18.8, Fig. 18.9, Fig. 18.10, Fig. 18.11).

Perialar Crescentic Advancement Flap

The remaining flap choice for upper lip skin-only defects is the perialar crescentic advancement flap, which is simply an advancement flap taking advantage of the laxity of the superior cheek with planned dog-ear excisions along the perialar and nasolabial fold. These flaps are useful, but great caution should be utilized to prevent telltale effacement of the upper lip, eversion, and a long-term deformity (Fig. 18.12 and Fig. 18.13).

Full-Thickness Skin Grafts

The use of full-thickness graft on the upper lip is with caution only. For whatever reason, even color-matched full-thickness skin grafts performed as a defect-only reconstruction yield uniformly poor results, as shown in Fig. 18.10. The caveat to this is reconstruction of the entire subunit can yield uniformly excellent results. With extensive skin-only defects of the upper lip, satisfactory full-thickness grafting results can be performed as a subunit with color-matched supraclavicular skin. Successful graft take requires meticulous bolstering. A surgical sponge with through-and-through 3-0 Prolene sutures tied on the exterior bolster yields consistently good results (Fig. 18.14, Fig. 18.15, Fig. 18.16).
Fig. 18.8 (a) Initial surgical plan is ergotrid flap. Note standing cone excision planned along white roll of lip. (b) Ergotrid flap will not fully cover defect. (c) Incision planned along lower portion of ergotrid to complete V-Y advancement. (d) Ergotrid is converted to V-Y advancement flap. (e) Final postoperative appearance.

Fig. 18.9 A 62-year-old female status post 2 × 1 cm Mohs excision of left upper cutaneous lip for basal cell carcinoma. Wound was closed with small ergotrid flap. Postoperative results shown at 1 week, 2 months, and 9 months, from left to right.

Fig. 18.10 A 70-year-old white male status post 3 × 2 cm Mohs excision of melanoma in situ of left upper cutaneous lip. Wound was closed with V-Y advancement flap. Postoperative results shown intraoperatively at 1 and 5 months, from left to right.
Fig. 18.11  A 60-year-old white female status post 2 × 1 cm Mohs excision at right nasolabial crease for basal cell carcinoma. Wound was closed with V-Y advancement flap. Postoperative results shown intraoperatively at 1 and 18 months, from left to right.

Fig. 18.12  A 63-year-old female status post 2 × 2 cm Mohs excision of basal cell carcinoma at right upper cutaneous lip. Wound was closed with perialar cervicofacial advancement flap. Postoperative results shown intraoperatively at 1 and 2 months, from left to right.

Fig. 18.13  A 66-year-old male status post wide local excision of malignant melanoma at left mouth. Wound was closed with combined rotation and advancement flaps. Postoperative results shown at 3 months.

Fig. 18.14  A 16-year-old female, (active smoker) status post-Mohs excision for basal cell carcinoma. Mohs defect was closed with color-matched full-thickness skin graft as a defect-only reconstruction with expected unacceptable postoperative results despite vigorous scar management.
18.4 Combined Skin and Mucosal Defects

For combined skin and vermillion defects, our reconstructive algorithm essentially centers on wedge excision and primary closure. Essentially, every effort is made to close the lip accurately in approximation. Accurate identification of the vermillion border is paramount and understanding patients seen on single-day Mohs resection and repair may present with compromised anatomy due to infiltration of local anesthetic and subsequent smudging of the anatomic border. If it is not clearly identified, patients should be rescheduled for the next day to allow the epinephrine to wear off prior to closure. Conversely, adequate preoperative communication with the referring Mohs surgeon to allow him or her to mark the vermillion border prior to infiltration will also suffice. Preoperative markings of the vermillion border, as well as a white roll, used to be a somewhat involved affair with methylene blue and a 27-gauge needle used to temporarily tattoo both adjuncts to the border. This has been replaced by what is a more accurate, and certainly easier, placement of a single 5–0 silk both at the vermillion border and at the wet-dry junction in the mucosa prior to infiltration of local anesthetic. The suture is left in place during the surgical preparation. Vermillion alignment cannot be overemphasized as its importance in successful reconstruction of the upper or lower lip. Even a small step-off is visible and will require postoperative correction (> Fig. 18.17 and > Fig. 18.18).

18.4.1 Direct Closure with or without Wedge Resection

The differential ability to close the upper and lower lips is essentially based on their laxity. In elderly patients with significant laxity, defects greater than 60% of the lower lip can be closed primarily with maintenance of the oral competence. Even if initial microstomia is encountered with closure of the lower lip, this can be managed with postoperative physical therapy including manual physician-directed lip stretching to restore the normal architecture of the lip. The previous descriptions of free tissue reconstruction, particularly free radial forearm coverage of the lower lip, have not been demonstrated institutionally at the University of Texas Southwestern to provide reliable long-term postoperative results because an active muscular structure is essentially being replaced with an atonic wedge of soft tissue that has no solid anchoring and will relax over time, losing the dam effect for the lower lip. With large 50 to 60% excision and advancements of the lower lip, it is often necessary to perform transverse wedge incision in the mucosa to accurately match the mucosal sides on inset. The technical details of the lower lip closure include closing the

Fig. 18.15 A 28-year-old female with severe facial burns following aviation accident. Burn scars were excised and grafted with color-matched skin as full subunits. Final postoperative results shown at 9 months. This illustrates the need to skin graft lips in subunits. Additionally, the philtrum is preferentially reconstructed as a subunit with full-thickness skin grafting rather than attempts at local flaps.

Fig. 18.16 A 56-year-old female status post-Mohs excision of basal cell carcinoma at the philtrum. Defect was treated by subunit reconstruction with color-matched full-thickness skin graft from postauricular donor site. Postoperative results shown at 1 month.
mucosa first to the level of the white roll, and this is performed with running as well as supplementary simple sutures of 4-0 or 5-0 chromic gut to provide a watertight seat and then the orbicularis oris muscle is reapproximated with Vicryl or PDS suture. When this has been performed, the skin is closed over it. At this point, the vermillion is precisely reapproximated using the pre-placed suture and the remainder of the lip is closed. Upper lip defects are not able to tolerate as tight or as significant closure because the lateral retraction on the philtral columns will result in a telltale long-term deformity. The size is limited on these to 40% or less. Understand that there is a moderate amount of retraction that is allowed and the philtral columns will often return to their normal anatomic position even with moderate retraction; however, overestimating the ability to return to position will result in a long-term deformity that is very difficult to correct (▶ Fig. 18.19 and ▶ Fig. 18.20).

### 18.4.2 Central Defects of the Upper Lip: Abbe and Rotation Flaps

Abbe or rotation flap closures are restricted to significant defects of the upper lip and in the author’s 10 years of practice, no instance of an Abbe flap from the upper to the lower lip has been performed. The Abbe flap is done under intravenous (IV) sedation or general anesthetic depending on the patient’s preference with provisions for extubation with a limited mouth opening. The flap is designed undersized to the defect and works best on central lip defects. It is rotated into position and inset with permanent and nonpermanent suture. No suture is placed between the upper and lower lip. These patients are admitted and kept overnight for observation. The flap is then divided between the late second or the third week. These have uniformly provided very safe and reliable reconstructive results. Under very rare circumstances should an Estlander flap be considered for lip reconstruction as when the commissure is violated, there is very little opportunity to reconstruct it (▶ Fig. 18.21 and ▶ Fig. 18.22).
18.4.3 Lateral Commissure Defects: Advancement Closure

Lateral commissure defects are important to recreate, understanding that the anatomic location of the commissure is the midpoint of the patient’s pupils bilaterally and compared to the contralateral side. Many combined cheek and lip defects can be successfully reconstructed with simple advancement closure taking great care to reapproximate the damaged commissure at the anatomic location determined by the contralateral side (▶ Fig. 18.23 and ▶ Fig. 18.24).

18.4.4 Large Defects of the Upper or Lower Lip: Karapandzic Flap

For large defects of the upper or lower lip, where the lower lip is not able to be approximated primarily, a Karapandzic flap is our last option. This can be utilized for even 90% nearly commissure-to-commissure defects of the lower lip, and it is essentially a circumoral innervated myocutaneous flap maintaining both the intact nerves and mucosa with advances bilaterally. Microstomia is expected primarily; however, using the same principles as postoperative physical therapy and stretching on the primary closures of large lip defects, this can eventually be resolved (▶ Fig. 18.25).
18.4.5 Upper and Lower Lip Mismatch: AlloDerm Placement

For repairs that result in a significant vermillion volume mismatch between the upper and lower lip, AlloDerm can be used as a volumizer for the under volume lip. This is performed as an operative procedure. Rolled thick AlloDerm is placed in the mucosa lip with a tendon passer and this has been well described for aesthetic volume reconstruction of the upper or lower lip21 (▶ Fig. 18.26).

18.5 Postoperative Management

- Postoperatively, these patients are allowed to eat and speak the day of surgery with no limitations.
- Patients are just given intraoperative antibiotics and routinely do not continue postoperative antibiotics.
- Patients are then instructed to utilize either a non-alcohol-based mouthwash or to brush their teeth four to five times a day. Anecdotally, this reduces the bacteria flora count and infection risk.
Fig. 18.24  A 78-year-old female status post Mohs excision of squamous cell carcinoma of upper and lower right lips including commissure. Mohs defect closed with layered closure and anatomic alignment of the commissure to the mid-pupillary line. Postoperative results shown at 3 months.

Fig. 18.25  (a) Karapandzic flap design. (b) Final postoperative appearance.

Fig. 18.26  A 78-year-old male with central lip defect status post Mohs defect closure of 40% lower lip defect resulting in lower lip incompetence. Surgical correction with AlloDerm placement restored lower lip volume and corrected central incompetence.


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Lip Reconstruction
19 Ear Reconstruction

James F. Thornton, Jourdan A. Carboy, and Christopher A. Derderian

Summary
This chapter discusses the issues regarding soft-tissue reconstruction of the ear including the functional and anatomic considerations in ear reconstruction, the management of ear defects, as well as a spectrum of surgical repair options for ear defects including secondary healing, full-thickness skin grafting, wedge excision and closure, a two-stage folded postauricular flap (Dieffenbach flap), as well as the management of near-total auricular defects including prosthetic ears.

Keywords: ear, auricle, cartilage, full-thickness skin graft, Antia–Buch flap, Dieffenbach flap, Medpor, total ear reconstruction

Summary
- Do not let exposed cartilage become an issue, almost all cartilage defects with intact perichondrium will heal well secondarily.
- The majority of ear reconstruction cases can be done with simple full-thickness skin grafting.
- Use caution with primary closure or Antia–Buch flaps to not distort the repaired ear compared to the contralateral side.
- Leave the normal contralateral ear alone.
- For large defects in elderly patients, consider a prosthetic ear reconstruction.

19.1 Algorithm for Ear Reconstruction

19.1.1 Anatomical Considerations

Anatomical considerations of ear reconstruction encompass both aesthetic as well as functional issues (Fig. 19.1 and Fig. 19.2). Functionally, it is important to maintain the vertical height of the ear in relation to the normal contralateral side as this is the platform for eyeglass wearing and maintenance of symmetry is important. Also, the accompanying effect of the ear to wide binaural localization, and therefore prevention of external auditory canal stenosis, is important.1,2 From an aesthetic standpoint, it is quite important to maintain the continuity of the helical rim as any step-off, even small, will draw the viewer’s attention much as a vermillion border step-off on the lip. Additionally, the ear has limited laxity and does not tolerate significant soft-tissue closure, and any attempt at this without cartilage resection often results in forward buckling of the ear. Conversely, the presence of cartilage throughout the ear provides an excellent framework for full-thickness grafting and with successful full-thickness grafting, the antihelix and helix shape and contour can be successfully re-created.

Fig. 19.1 Algorithm for ear reconstruction.
19.2 Commonly Applied Methods of Closure

- Allow wound to heal in secondarily.
- Full-thickness skin grafting.
- Local wedge or flap closure.
- Folded postauricular flap two-stage reconstruction.
- Prosthetic ear.

19.2.1 Secondary Closure

Large areas of the ear can heal secondarily with no secondary contraction as long as the perichondrium is intact. Careful monitoring and wound care is required for uneventful wound healing. Traditionally, we provide just a simple topical antibiotic ointment that is converted to Vaseline ointment after approximately 10 days. We allow the patient to shower on the second postoperative day and then a nonstick dressing (Xeroform) is applied at night. We will dress the ear with a simple stockinette dressing if the patient desires. Tape is avoided at all times. The presence of exposed cartilage with absent perichondrium is not a contraindication to secondary healing, given this can be simply resected and the remaining area be allowed to heal. The use of assistive wound healing devices including acellular dermis can provide faster healing with reduced requirements for dressing changes by the patient (Fig. 19.3).

19.2.2 Full-Thickness Skin Grafting

Full-thickness grafting constitutes the majority of our ear reconstruction cases. It is a very safe and highly reliable technique. The full-thickness skin is harvested from the ipsilateral neck and significantly thinned to match the thickness of the skin native to the host site on the ear. The key to ensure complete graft take is careful bolster placement on the graft, which frequently requires the majority of operative time. The graft itself is sewn in place with 5–0 plain gut suture and then multiple mattress sutures of through-and-through 4–0 plain gut with a straight Keith needle are utilized to adhere the full-thickness graft to the underlying graft contours. If the graft area is large (> 20% of the ear), we will use a surgical foam bolster that is secured with through-and-through 3–0 double-armed Prolene suture. This is kept dry and removed on the fifth postoperative day. Postoperative or oral antibiotics are not given; however, ciprofloxacin otic solution is given and the patient is instructed to liberally coat the sponge and healing graft for the first 3 postoperative days (Fig. 19.4 and Fig. 19.5).

19.2.3 Local Flap Wedge or Local Flap Closure

We consider a simple wedge closure to a Antia–Buch type closure as techniques on a continuum that are performed from simple closure and alignment of the auricular rim to near-complete undermining, degloving of the ear, and advancement of bilateral chondrocutaneous flaps. These can provide ideal postoperative results when executed for appropriately sized defects; however, it is important to proceed with caution. It is not uncommon to be able to get the two edges of the auricular...
rim approximated, but the resulting ear will have a significantly different shape and height than the unaffected ear on the contralateral side (▶ Fig. 19.6 and ▶ Fig. 19.7).

### 19.2.4 Folded Postauricular Two-Stage Ear Flap Reconstruction (Dieffenbach Flap)

For large segmental defects of usually the middle ear—although it can be applied to upper third defects also—the folded postauricular flap is exceedingly useful.\textsuperscript{11,12} This flap utilizes the non-hair-bearing postauricular skin that is elevated to the insertion of the ear into the scalp. It is also thickly elevated into the hair-bearing scalp in a slight wedge pattern to allow tucking of the ear and then the ear is simply tethered to the scalp with the skin overlying it. Vicryl 3–0 pop-off sutures are utilized to tether the cartilage portion of the ear to the scalp and then the remaining flap is simply inset with 5–0 either gut, or this is one
instance where we will use chromic sutures on the ear. Non-stick dressings and antibiotic ointment are placed on the ear, which are removed on the second postoperative day. After 4 days, the patient may be allowed to shower and continue their daily activities, the only care required being a simple antibiotic dressing placed over the ear by the patient. Understand that there have been numerous descriptions of complicated dressing techniques requiring nonstick dressings or red rubber catheters to maintain the separation on the ear, but in our experience with over 40 of these flaps, there have been no postoperative infections with simple antibiotic ointment and showering.

Since these are so well tolerated by the patient, and there is not that significant of an aesthetic deformity, the flaps are able to be left at a minimum of 3 and oftentimes up to 6 to 7 weeks for development of maximum vascularity. Understand that on division and inset, the skin can be simply folded on itself and sutured with through-and-through 4–0 double-armed Prolene sutures to restore the normal contour of the helical rim. No cartilage is required (Fig. 19.8, Fig. 19.9, Fig. 19.10).

Fig. 19.8 Folded postauricular two-stage flap during initial flap elevation and inset.

Fig. 19.9 A 62-year-old male with middle third auricular rim skin and cartilage defect after Mohs resection. The third picture in the series shows flap after division and inset. Flap is folded on itself to recreate auricular rim with no additional cartilage support required. Scalp donor site is repaired with color-matched full-thickness skin graft.

Fig. 19.10 A 73-year-old male status post 4 × 3 cm Mohs excision of melanoma in situ at left antihelical rim. The lobe was then reconstructed with an anteriorly based transposition flap. Postoperative results shown at 10 months.
Techniques for Specific Anatomic Location

19.2.5 Postoperative Care

- The patient is placed in a stockinette cap with bulky cotton ear dressing over the first.
- Postoperative night, no surgical tape is used. The surgical stockinette cap is removed on day 1.
- If the patient does not have a bolster in place, the patient may be allowed to shower.
- Postoperative enteric antibiotics are not given. Topical ofloxacin is applied to full thinness.
- Skin grafts and local flaps for 3 days and the graft bolsters are removed on day 5 or 6.
- No special care is given to the postauricular flap wound care; just simple antibiotic ointment is placed over the flap portion of the ear, as well as the donor site. The flap is divided from 4 to 7 weeks postoperatively.

19.3 Total Ear Reconstruction

Christopher A. Derderian

The primary surgical means of reconstructing a total or subtotal loss of the ear rely upon techniques used for treating microtia. For those patients who are not good surgical candidates, an osseointegrated implant-based prosthesis is an excellent option.\textsuperscript{14,15}

The two main treatment options for ear reconstruction utilize either a costochondral or a porous polyethylene (Medpor) construct (\textsuperscript{14,15,16,17} Fig. 19.11).\textsuperscript{14,16,17} The traditional approach to ear reconstruction uses a costochondral construct.\textsuperscript{15} In the first stage, the rib cartilage is harvested and the construct is fashioned and placed in a skin pocket at the desired location. In a second procedure, the ear is elevated, projected, and the posterior surface is skin grafted. The lobule and tragus are typically created during the first stage or in a third stage. The primary advantage of this approach is the use of autologous tissue.

Given that most patients requiring Mohs reconstruction of the ear are in the middle-age years or older, there is a high likelihood of calcifications being present in their costal cartilage. These calcifications and decreasing pliability of the costal cartilage with increasing age complicate the carving and assembly of a costal cartilage construct.\textsuperscript{14} The morbidity of harvesting the cartilage is also a drawback.\textsuperscript{14}

Use of a Medpor construct requires coverage with a temporoparietal fascia (TPF) flap even if there is skin of good quality in the recipient site.\textsuperscript{14,16,17} This approach provides a well-projected ear framework with lobule transposition in a single stage. Using porous polyethylene constructs avoids dealing with donor site morbidity in the chest, and calcifications and/or fracture of costal cartilage during construct fabrication.\textsuperscript{14,16,17} The Medpor approach also has drawbacks. Medpor is a foreign body predisposing it to infection and it can fracture with trauma.\textsuperscript{18} The procedure for harvesting a large enough TPF flap to provide a well-projected ear is a lengthier single-stage procedure of 6- to 8-hour duration in experienced hands. This may be prohibitive in patients with significant comorbidities. Careful patient selection with regard to patient health, expected patient compliance in the perioperative period, duration of recovery, and preparation of the patient for possible short- and long-term complications are all important considerations when deciding between autologous cartilage, implant, and prosthetic options for ear reconstruction.\textsuperscript{19}

19.3.1 Medpor Technique

I employ the Medpor and TPF flap approach to ear reconstruction pioneered by Dr. John Reinisch.\textsuperscript{17} I learned this approach by observing him operate on multiple occasions and continued correspondence with him. It is the many small technical points that make the difference between achieving a good and a poor result. Anyone considering this approach to ear reconstruction

Fig. 19.11 (a) Typical costochondral framework in the method of Nagata. (b) Assembled Medpor framework.
Ear Reconstruction

would be well served by watching Dr. Reinisch or another surgeon experienced with this technique execute the procedure before attempting it.

Reinisch uses a clear plastic eye shield from a surgical mask to create a template of the dimensions, features, and location of the patient’s normal ear. Landmarks including the sideburn, lateral eyebrow, the lateral canthus, palpbral fissure, and ala are marked to triangulate the position and axis of the ear (▶ Fig. 19.12a, b). The distance from the lateral canthus to the helical root is also measured to aid in verifying appropriate anteroposterior (AP) positioning of the construct during inset. The plastic sheet is flipped over and the position of the new ear is transposed onto the affected side. The construct will predictably have some inferior descent during the healing process, so it is best to place the ear 5 to 8 mm more superior with a slightly more vertical axis than the mirror image position of the unaffected ear (▶ Fig. 19.12c).

The location of the superficial temporal artery (STA) can be palpated and/or traced using Doppler as necessary. The TPF flap is outlined on the scalp (▶ Fig. 19.12d). The typical dimensions are 11 to 12 cm vertical by 10 to 11 cm AP attempting to include both the anterior and posterior branches of the STA (the most common branching pattern) when possible. The vertical dimension of the flap is proportionate to the size of the desired ear. The standard flap dimensions cross the line of temporal fusion (marked LTF in ▶ Fig. 19.12d); therefore, the distal portion of the flap is comprised of the galea aponeurotica, which is contiguous with the TPF. The vascularity to this portion of the flap is reliable. In addition to the incision in the mastoid skin, I employ a transverse counter incision, typically located midway along the vertical axis of the flap, to facilitate dissection and elevation of the flap. The counter-incision is oriented perpendicular to the direction of the temporal hair growth to hide the scar.

19.3.2 General Operative Setup

For males, the entire surgical site is shaved. For females, the 2 to 3 cm of the hairline abutting the new ear position and a 1-cm strip of hair at the transverse counter-incision are shaved. The entire head and face are prepped into the field. Isolating the eyes and the oral and nasal cavities is achieved using occlusive dressings (Tegaderm).

19.3.3 Procedure Details

An anteriorly based skin flap is raised in the subcutaneous plane using scissors. If present, any residual ear cartilage and soft-tissue bulk posterior to the STA pedicle that may interfere with the positioning of the construct or that adds excess bulk to the conchal bowl should be removed.

The scalp is elevated in the subcutaneous plane using electrocautery. The cut function is set at 20 on blend and the coagulation is set at 15. There should be a thin layer of fat covering the hair follicles. Exposing the hair follicles increases the chance of temporary or permanent alopecia. Even when the fat on the hair follicles is preserved, it is common to have some temporary alopecia in the area of the dissection.

The anterior limit of dissection should be the anterior border of the temporal and frontal hairline to avoid injury to the temporal branch of the facial nerve. If the anterior branch of the STA crosses anterior to the hairline, it should be ligated where it crosses the hairline. The collaterals between the anterior and posterior branches are typically sufficient to perfuse the anterior portion of the flap.

When the entire superficial surface of the flap is exposed, the anterior, posterior, and superior limits of the flap are incised with cautery and the flap is raised from superior to inferior using a gauze peanut. The loose areolar tissue between the flap and the periosteum and deep temporal fascia should be included on the flap by sweeping it up with the peanut. The skin grafts will sit on this loose areolar tissue, which will function as a glide plane akin to the normal thin layer of subcutaneous fat along the posterior edge of the helical rim. Once the flap is elevated, it is placed back into the donor site to allow any vasoconstriction from manipulation to resolve.

Skin grafts are harvested from the groin and the posterior surface of the contralateral ear (if available). The groin graft size is typically 8- to 9-cm long and 4-cm wide to resurface the posterior surface of the ear. The skin graft from the contralateral ear is one-third postauricular skin and two-thirds mastoid skin (▶ Fig. 19.13). This skin is used to line the anterior surface of the ear. The grafts are thoroughly defatted down to the dermis.

Preparation of the Medpor Implant

The Medpor implant comes in two pieces: a helical rim piece and a base piece, each specific for the right or left ear, as appropriate. Open both pieces and soak in antibiotics with saline. The package insert indicates suturing the construct together is the recommended technique. Reinisch uses a high-temperature ophthalmic cautery to solder together the base and helical rim pieces. A smoke evacuator is necessary for this approach because the smoke emitted is unsafe to inhale.

Remove the tragus and lobule extension from the construct using a no. 15 blade and retain for soldering. The helical rim segment is manipulated to produce an ear with the desired size. The contribution of the lobule to the total ear height should be subtracted from the construct height. Failure to account for the lobule contribution will result in too large an ear. While determining how much of the helical rim component is needed to create the desired dimensions, a nonpenetrating towel clamp can be used to hold the helical rim piece to the inferior aspect of the base piece (▶ Fig. 19.14). Once the ear is sized, the helical rim and base pieces are soldered together at all points of contact on the anterior and posterior surfaces of the construct. The tragus, lobule, and excess helical rim pieces of the construct are used to solder. When the construct assembly is complete, the implant is placed in a bowl and soaked with antibiotic-containing saline.

Insertion of the Implant

Two 4-mm flat drains are inserted under the mastoid fascia through the occipital hairline. One drain sits in the expected position of the construct and the other is placed in the flap donor site. The implant is positioned in the footprint and axis as marked preoperatively with the suction deep to the construct. The flap is transposed to cover the implant (▶ Fig. 19.15a, b) and suction is applied to the drain. Digital manipulation of the flap edges creates a seal that allows the flap to essentially shrink-wrap the flap around the implant. The
Fig. 19.12 (a) Normal landmarks are placed to triangulate the appropriate position of the on the affected side. (b,c) Vertical overcorrection is marked in anticipation of slight downward migration of the construct with healing. (d) The flap dimensions are marked in blue. The red marking indicates the course of the superficial temporal artery (STA). The line of temporal fusion is estimated with LTF to demonstrate that the distal portion of the flap consists of galea. Mastoid skin to be used as full-thickness skin graft and scalp to be excised to accommodate implant placement are marked in black.
position and axis of the ear are confirmed. Once the ear position and flap distribution are confirmed to be in the desired position, the flap and implant are hinged upward onto a sterile towel on the surface of the scalp and the TPF flap is wrapped around the inferior pole of the construct and sutured to itself with 5–0 PDS. Only two to three sutures should be required.

The flap and implant are then hinged back down to the final position. The drain is placed to continuous suction. Digital manipulation of the flap edges creates a seal due to the suction and adherence of the TPF to the implant. It is critical at this point to ensure that the construct is well projected. The flap surface area should be distributed to ensure that the construct sits well projected before committing to the inset. The posterior TPF flap is sutured to the mastoid fascia with a 5–0 PDS suture to maintain the suction and adherence of the flap to the construct.

The anteriorly based skin flap is defatted to allow the skin to drape over the TPF flap and reveal the contour of the construct. The scalp posterior to the construct is undermined and advanced to minimize the postauricular skin defect by anchoring the skin to the mastoid fascia with a 4–0 PDS suture. If present, the lobule is split at the margin of the incised surface to allow it to be draped at the inferior pole of the construct and sutured to the anterior and posterior skin flaps and grafts, respectively.

When insetting the skin grafts and anterior skin flap, no sutures are placed from the skin to the TPF flap. Once the skin distribution is determined, the skin grafts are sutured together with interrupted 5–0 and 6–0 chromic to create an airtight as the skin grafts adhere to the flap and construct through the forces of cohesion only (Fig. 19.16a). It is critical to ensure the projection is adequate before applying the dressing (Fig. 19.16b).
19.3.4 Dressings

Bacitracin is applied to all suture lines. Any areas of concavity including the concha and posterior surface of the construct are gently packed with Kaltostat. A silicone splint is made from orthodontic impression material (A-ZOFT). The purpose of the splint is to maintain the position and projection of the ear and bolster the skin grafts in place. The splint is sutured to the scalp with 2-0 Prolene horizontal mattress sutures with care to avoid the drains and pedicle of the flap. Once the splint is secured, the drains are placed on bulb suction. The drains are removed postoperative day 1. One week of oral antibiotic prophylaxis is prescribed. At 2 weeks, the patient returns for splint removal (▶ Fig. 19.17).
References


Part 3
Management of Complications and Revisions

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20 Intraoperative Complications and Initial Management

James F. Thornton and Jourdan A. Carboy

Summary
This chapter discusses philosophical as well as surgical approaches to the management of complications in soft-tissue facial reconstruction. Techniques of “extreme ownership” with regard to patient care are discussed. The identification and management of intraoperative complications including fire, bronchospasm, anaphylaxis, corneal injuries, and nerve injuries are discussed with regard to both management and prevention.

Keywords: Jocko Willink, extreme ownership, complication, intraoperative fire, Bovie cautery, bronchospasm, bronchoconstriction, anaphylaxis, corneal injuries, nerve injuries

20.1 General Principles
Avoidance and management of complications begins prior to making the first incision. “Extreme ownership,” initially coined by Navy SEAL Jocko Willink, is a concept in leadership that defines a true leader as an individual who takes responsibility of not just their own actions and behaviors, but also the people and the environment around them. A successful surgeon must embody this notion of leadership, taking ownership of both the positive outcomes of the procedure and the negative outcomes and possible complications. A true surgeon understands that the negative outcomes of a surgical procedure cannot be attributed to a patient’s level of compliance or shortcomings, anesthesia care, or factors “outside their control.” But instead, he or she takes responsibility as the surgeon and accepts negative outcomes with self critique, such as being due to a lack of maturity and/or attention to detail. Success is dependent on the surgeon’s ability to be self-aware and cognizant of all the variables influencing his patients care, all the while evaluating his own standards of care for quality improvement. He must practice “extreme ownership” in order to ensure patient-centered care throughout the entirety of the clinician–patient interaction from preoperative assessment to postoperative care. Although seemingly impossible, maintaining this mindset and developing a practice around these principles will, without question, improve the doctor–patient relationship, improve outcomes, and ultimately lead to a reduction in complication rates. It entirely becomes the surgeon’s responsibility to reduce rates of complications and substandard results, and in doing this, there are no longer factors outside the surgeon’s control given these factors will have been foreseen and optimized for surgery from the beginning.

Effective conduct of the operation begins with very accurate patient assessment in conjunction with the anesthesia provider and accurate assessment of what the patient is able to contribute to his own care. This includes not just the patient’s health, but also their ability to understand the operative process and to comply with postoperative instructions including even simple social issues such as transportation or home nursing issues.

Optimizing the next steps in the operative process, including anesthesia and supplies, comes with repetition and attention to detail. Dedicated anesthesia staff, dedicated surgical instruments, and disposables eliminate variability and distractions. Properly done, the only variables become the patient and their Mohs defects, and operating can become a seamless “flow state” that is both safe and enjoyable for all involved.

20.1.1 A Note on Patient Consent
Undertaking a complex multistage Mohs repair is somewhat similar to accompanying the patient on a journey through a hostile land. The surgeon can serve as the experienced guide and prevent pitfalls along the journey to a successful repair.

The consent process should not be an opportunity to discuss every possible outcome and it is foolish of a surgeon to discuss fatalities from an operative procedure for Mohs repair. Yes, fatalities can result, but one does not sign an equivalent consent on fatalities from a domestic airline flight when the safety rate for both are very similar. It is unnerving for the patient and legally unnecessary. It is incumbent upon the surgeon to discuss possible adverse outcomes and briefly consider all options including doing nothing. The first or second postoperative visit is also an ideal time to discuss long-term outcomes with regard to finer results and to discuss in much greater detail the need for possible revisions. At this time, it is also an opportunity to review the procedure performed in depth and with the use of postoperative photos, discuss the initial appearance, that is, where we are now and what the expected outcome is, as well as the time course of this surgery. Patients will find this very reassuring and in many cases they can make travel and work plans based on the physician’s illustration. Understand that the patient, on the initial postoperative visit, is looking up to the doctor for “how they are supposed to look” and oftentimes they consider the physician as a guide on an extended journey or travel toward their final outcome.

20.2 Intraoperative Complications

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<td>- Intraoperative complications experienced in Mohs repair have included fire, bronchospasm, preoperative anaphylaxis, eye injuries, and nerve injuries.</td>
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20.2.1 Fire
Unfortunately, the incidence of intraoperative fire is not zero. It is an entirely avoidable event. The use of awake intravenous (IV) sedation, which provides multiple benefits to the patient, is often accompanied by the concurrent use of oxygen by nasal cannula and if inappropriately managed, it can lead to flash fires on the table. The current standards on oxygen administration—during the use of Bovie cautery—is to simply not use oxygen at no greater than 30% FiO2 at all during the case.34 If patient conditions mandate higher oxygen concentrations, then
very accurate communication between the surgeon and the anesthesiologist allows for its safe effective use. Consistent draping with four towel drapes where the entire head is left exposed and no tenting for possible oxygen containment is mandatory, and the removal of the Bovie tip while the oxygen is in use will prevent the inadvertent ignition source. The removal of all surgical prep solution is mandatory as well as ensuring availability of damp surgical laps on the surgical field (▶ Fig. 20.1 and ▶ Fig. 20.2).

### 20.2.2 Bronchospasm

Bronchospasm or bronchial hypersensitivity describes intense bronchoconstriction following a low level of airway stimulus. This presents a challenge to the anesthetist to maintain airway control and oxygenation during awake IV sedation. Most common presenting etiology can almost always be determined on the preoperative evaluation and include bronchial asthma, chronic bronchitis, emphysema, and upper/lower respiratory tract infections. Proceeding with awake IV sedation on a patient with poorly controlled asthma or active respiratory tract infections is inadvisable and the procedure is best postponed until respiratory mechanics are optimized.

### 20.2.3 Perioperative Anaphylaxis

Perioperative anaphylaxis occurs in 1 out of 5,000 to 10,000 anesthesias and involves a 3 to 9% mortality rate. The most common etiologic agents in decreasing order are neuromuscular blocking agents, latex, antibiotics, rarely local anesthetics, chlorhexidine, and heparin. The initial treatment is essentially circulatory support, which includes oxygen, crystalloid IV fluids, and epinephrine. Identification of the likely agent often requires referral to an allergist and is essential to prevent repeated exposures.

### 20.2.4 Corneal Injuries

Corneal injuries are prevented with protection throughout the operative course. The routine use of ophthalmic ointment on all cases prior to surgical prep and then the covering of the eyes with a sterile “Swiss Therapy” eye mask that the patient is allowed to take home postoperatively provides some degree of protection, but will not protect against dropping of sharp instruments. Additionally, many corneal injuries occur in the postoperative recovery if the semiconscious patient tries to rub his or her eyes with the tape and/or pulse oximetry probe on his or her hands.

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Fig. 20.1 A 62-year-old male with nasal sidewall defect repaired by single-stage island nasolabial flap. Repair complicated with intraoperative fire from electrocautery igniting oxygen delivered by nasal cannula. Wounds healed without long-term sequelae. Incident resulted in policy change of discontinuing oxygen delivery by nasal cannula during intravenous anesthetic sedation.
20.2.5 Nerve Injury

Nerve injury, particularly facial nerve injury, is avoided with meticulous knowledge of anatomy and surgical technique, but if it occurs the decision to immediately repair the nerve is based on the surgeon’s expertise as well as identification of the injury. A pessimistic approach to full recovery is unfortunately realistic in an elderly patient population, and there is little justification for intraoperative nerve repair for injuries medial to the canthus. Additionally, with the injection of local anesthetic during the Mohs procedure and repair, it is difficult to determine the functional defect at the time of surgery. The most common facial motor nerve injury in Mohs surgery that results in long-term disability is injury of the frontal nerve. Little actual functional return is expected from cross-innervation and the functional deficit includes ptosis from the overhanging eyebrow. Direct functional eyebrow-pexy done as a secondary procedure provides the most reliable surgical correction.

References

Management of Complications and Revisions

21 Management of Complications in the Acute Healing Stage

James F. Thornton and Jourdan A. Carboy

Summary
This chapter discusses complications in the acute healing stage, including hematoma, soft-tissue infection, dermatitis, chondritis, wound disruption, and flap failure. Techniques for both prevention and management are covered.

Keywords: postoperative complications, dermatitis, hematoma, infection, corneal injuries, chondritis, flap failure, wound disruption

21.1 General Principles

Management of complications in the early healing stage requires a degree of diligence and enthusiasm than the initial procedure requires. So often, early wound complications that can put the entire procedure at risk are attempted to be managed in a clinic setting when they require an operating room or are not approached with appropriate diligence in what could have been an easy return to the operating room and process to final healing turns into a late complication requiring revision and reoperation anyway.

21.1.1 Hematoma

Currently, the standard of care is for dermatologists to not alter the coagulation status of patients undergoing Mohs resection. In this patient population, hematomas can be a frequent complication. The reconstructive surgeon needs to be adept at identifying which patients and procedures can be managed with anticoagulation. Additionally, the surgeon should be well versed with the use of a wide range of intraoperative techniques for safe hemostasis during awake anesthesia, including wide infiltration with epinephrine containing local anesthetics, and the use of topical oxidized cellulose.

Again, most hematomas can be prevented by attention to intraoperative hemostasis and awake anesthesia. If a hematoma occurs in the initial postoperative period, there can be little downside to immediately returning to the operating room, identifying the bleeding source, and evacuating the hematoma. If a hematoma occurs in the immediate perioperative period but after patient discharge, the criteria for returning to the operating room for evacuation is similar but not as urgent. Few hematomas will resolve completely and spontaneously. There is almost always some negative impact on the final repair appearance whether it is a color mismatch or contour irregularity, but it always carries with it an increased risk of postoperative infection if left undrained.

The routine use of compressive dressings are surgeon dependent and in a series of over 200 cheek reconstructions, no compressive dressings were used with no increase in bleeding complications. It seems prudent to place a drain routinely on take backs for bleeding. This can be removed in the initial postoperative period.

21.1.2 Infection

Fortunately due to the favorable vascularity of the face, soft-tissue infections in facial reconstruction are gratifyingly rare even in the patient population with frequent comorbid disease including diabetes and steroid dependence. Soft-tissue infections require wound debridement and washout with concurrent culture for appropriate antibiotic selection. For purulent skin soft-tissue infections, wound culture is mandatory for appropriate antibiotics selection and therapy. Antibiotic therapy for mild to moderate cases can be initiated with trimethoprim/sulfamethoxazole or doxycycline pending culture results, while severe purulent and moderate to severe nonpurulent cellulitis requires admission with intravenous antibiotics. All cases of purulent skin soft-tissue infections require wound debridement and washout with concurrent culture for appropriate antibiotic selection. Severe purulent and moderate to severe nonpurulent cellulitis requires admission with intravenous antibiotics. In all cases, outpatient management requires careful and frequent postoperative visits to ascertain the effectiveness of the chosen antibiotic therapy. There should be no hesitation regarding repeated surgical debridement until clear signs of improvement are seen.

21.1.3 Dermatitis

Dermatitis in soft-tissue facial reconstruction is frequent and can be easily confused with infection and can result from the surgical prep, the postoperative antibiotic ointment, or simply from the trauma of surgery. Prompt identification and...
differentiation between soft-tissue infections, as well as the identification of the offending agent, is mandatory, but the offending source needs to be identified, particularly for the patient’s benefit, to prevent future events. Dermatitis with the use of Neosporin ointment over an extended period of time is almost always universal and resolves with cessation (▶ Fig. 21.4).

### 21.1.4 Chondritis

Auricular chondritis is a potentially significant complication, is difficult to treat, and can cause long-term disfigurement.\textsuperscript{15,16} Occurring even late in the postoperative course, it requires identification and appropriate treatment, often inpatient intravenous antibiotic therapy.\textsuperscript{15,16} The avascular involved cartilage is more susceptible to bacterial infection and antibiotic therapy is less effective. Involved organisms are commonly \textit{Pseudomonas aeruginosa} and \textit{Staphylococcus aureus}.\textsuperscript{17} Effective antimicrobial management includes accurate identification of the organism and antibiotic selection that provides appropriate antimicrobial coverage and adequate tissue penetration (▶ Fig. 21.5).
Management of Complications and Revisions

Fig. 21.4 A 78-year-old male with classic dermatitis from topical antibiotic ointment use with previous sensitivity. Rash rapidly resolved with cessation of topical ointment with no long-term sequelae.

Fig. 21.5 A 58-year-old male patient with ear chondritis after Mohs resection and attempted secondary healing. Treatment required intravenous antibiotics with multidrug coverage for *Pseudomonas aeruginosa*. Results shown at 2 months with no sequelae.
21.1.5 Flap Failure

The absolute flap failure is gratifyingly rare, but when it does occur the reason for its loss needs to be accurately determined. For a surgeon, losing one flap is devastating, but losing a second “rescue” flap is an order of magnitude more devastating for the patient as it is frequently the last chance at a reasonable reconstruction that is lost. Evaluation of a flap in jeopardy during the immediate postoperative period should include patient assessment and removal of any flap dressings that may contribute to venous or arterial compression. Additionally, evaluation of the flap pedicle to ensure no compression and removal of a portion of the inset sutures may promote flap survival.

For flaps with venous congestion, the use of topical nitroglycerin ointment is beneficial, as is the use of leech therapy, but the utilization of hyperbaric oxygen or intravenous anticoagulants is of questionable benefit and of significant expense.\(^\text{14,18}\)

With flap failure, if it occurs, the decision on secondary reconstruction needs to be made with careful identification of the reason for the initial failure.

Many pedicled flaps that show distal flap tip loss can be converted to a successful reconstruction by simple debridement and flap re-advancement (\(\triangleright\) Fig. 21.6 and \(\triangleright\) Fig. 21.7).

Wound Disruption

Something that occurs infrequently, but is devastating when it does, is complete wound disruption or flap disruption from inset pedicled flaps or local flaps. If it is from a traumatic injury, a fall, or actual disruption, the best results will be obtained from returning the patient to the operating room, thoroughly cleaning and debriding the wound to clean healthy bleeding tissue, and then re-inserting it as it was done initially (\(\triangleright\) Fig. 21.8).
Management of Complications and Revisions

Fig. 21.7 A 77-year-old female status post with poorly designed and executed cervical facial flap reconstruction of large cheek Mohs defect. Inevitable flap failure with partial loss. Reconstruction salvaged with color-matched full-thickness skin graft. Final results shown at 4 months.

Fig. 21.8 A 63-year-old male patient with hemiagnosia due to brain tumor. He presented with posterior alar defect caused by nasogastric tube-induced necrosis. He initially underwent posterior alar repair with nasolabial flap. The flap was subsequently disrupted by the patient. Nasolabial flap was debrided and re-attached and ultimately failed. An ill-advised forehead flap was then performed and was also disrupted twice by the patient. Flap ultimately failed.
References


Management of Complications in the Late Healing Stage

James F. Thornton and Jourdan A. Carboy

Summary

The management of complications in the late healing stage including hyper- and hypopigmentation as well as contour abnormalities is discussed. Treatment modalities including dermabrasion, laser therapy, steroid injection, and surgical revision are outlined. The identification of cancer recurrence after Mohs resection is also described.

Keywords: hypertrophic, hypopigmentation, hyperpigmentation, dermabrasion, cancer recurrence, contour abnormalities, laser therapy, steroid injection

Summary

● Hyperpigmentation can be common with full-thickness skin grafts that have prolonged healing. Dermabrasion and/or laser therapy is very efficacious in improving final appearance.
● Hypopigmentation is often unpredictable in occurrence and difficult to correct.
● The treatment of contour abnormalities begins with effective scar management including massage, silicone sheeting, and intralesional triamcinolone. If contour abnormalities are not resolved with final scar maturation, then revision surgery is indicated.
● Although rare in postoperative Mohs patients, practitioners must remain vigilant about the possibility of cancer recurrence.

22.1 General Considerations

The management of complications in the late healing stage involves poor color match of the flap or graft, poor contour of the flap or graft, unexpected hypertrophic or keloid scarring of the flap or graft, as well as functional issues such as nasal airway obstruction or lip ectropion and then finally cancer recurrence after the initial resection. Unfortunately, the management of late complications also encompasses the management of suboptimal results from the patient’s perspective. These can either be true suboptimal surgical results or failure of the patient’s expectations matching expected surgical results. Patient education can obviate and minimize many of the expected results. A perfectly fine and acceptable, even very good, surgical result can be viewed by the patient as an abject disaster if their expectations do not match the surgical reality. It is foolish of the surgeon and of low yield to continue to point out “how good” the results are if the patient remains unhappy. Education with time spent discussing the procedure, as well as the patient’s perception of the results that include representative postoperative photographs, is time well spent. Additionally, a second opinion can also help temper this often difficult clinical situation.

22.1.1 Hypo- and Hyperpigmentation

The management of color complications can be hypo- or hyperpigmentation. More commonly, hyperpigmentation with healed full-thickness skin grafts or flaps is often the result of continued surface desquamation despite adequate graft take, and this will require multiple episodes of dermabrasion to improve the final color. Laser has some proven benefit and pulsed-dye laser can commence as early as 6 weeks after graft inset, often in conjunction with dermabrasion. The management of hypopigmentation is more difficult and its occurrence is somewhat unpredictable even with good graft take. Well-vascularized healthy grafts may have a period of transient hypopigmentation that corresponds to the absent vasomotor function, but this will be restored as the vasomotor function returns. Unfortunately, some hypopigmentation will never resolve and long-term management of can be difficult (Fig. 22.1 and Fig. 22.2).

22.1.2 Contour Abnormalities

Unacceptable contour abnormalities are initially managed with rigorous postoperative scar therapy including silicone sheeting and massage. If there is a hypertrophic scar component to this, then intralesional triamcinolone on a scheduled injection series is added to the treatment protocol. No attempt is made to revise contour abnormalities until the graft or flap repair has entered the supple healing stage and the skin is pliable. Depressed contour abnormalities in the late healing stage are fairly easily managed by flap re-elevation and placement of a...
dermal fat graft, cartilage graft, or fat grafting. The management of hypertrophic or keloid scars depends on the accurate identification of either. Keloid scars can be tremendously difficult to manage and with simple excision alone or simple steroid injection alone show an unacceptable (as high as 90%) recurrence rate. Multimodal therapy, including surgical excision and intralesional steroids with or without mitomycin, is the only acceptable management for keloid therapy. Recurrent keloids are best managed by multimodality therapy that includes surgical excision and immediate short-term radiation therapy. Simpler to manage are hypertrophic scars and the management should include a patient discussion that everyone heals along a continuum and hypertrophic scars are a normal portion of this continuum. Aggressive management should include silicone sheeting, scar massage, as well as scheduled intralesional steroid therapy (Fig. 22.3).

22.1.3 Cancer Recurrence

Cancer recurrence is gratifyingly rare in post-Mohs patients; however, it should always be kept in mind as an etiology for poor contour abnormalities or recurrent skin lesions surrounding the repair. Remember that cancer recurrence is always at the forefront of the patient’s mind and there is no greater perceived catastrophe in treating cancer recurrence as a hypertrophic scar over a period of 3 to 6 months. Understand that in a high-volume Mohs repair practice, even though the actual rate of recurrence is very low, the surgical practitioner will see several episodes yearly of cancer recurrence. The simplest solution is a punch biopsy of any suspected lesions, or, if a patient returns to the operating room for a revision procedure, then biopsy and submission of pathologic specimens at the time (Fig. 22.4a, b).
Management of Complications and Revisions

Fig. 22.4 (a) An 81-year-old male presented 1 to 2 years status post Mohs excision of basal cell carcinoma at dorsal nose that was allowed to heal secondarily. He returned with a present lesion that measured 1.2 cm × 1.3 cm. Biopsy of the lesion revealed basal cell carcinoma. The working diagnosis was recurrent basal cell carcinoma. Two stages of Mohs surgery required to achieve clear margins (defect = 2.0 × 2.3 cm). Final repair was done with dorsal nasal rotation flap. (b) A 78-year-old male presented 1 year status post Mohs excision for squamous cell carcinoma. Current lesion present for approximately 8 months with crusting, itching, and rapid growth. The lesion measured 0.5 cm × 0.7 cm (not counting linear scar that was also excised with Mohs stage). Biopsy of the lesion revealed squamous cell carcinoma. The working diagnosis is squamous cell carcinoma. One stage of Mohs surgery required resulting in defect measuring 2.5 × 2.5 cm.

References

Management of Complications in the Late Healing Stage


23 Skin Graft Revisions
James F. Thornton and Jourdan A. Carboy

Summary
The management of skin graft complications in both the acute and late healing stages is discussed. The management of contour abnormalities, both concavities and convexities, is outlined.

Keywords: skin graft, full-thickness skin graft, fat grafting, cartilage graft, dermabrasion

Summary
- Even though on initial postoperative visits skin grafts are often marginal in appearance, they very rarely need complete revision once healed.
- Skin graft contour abnormalities are most commonly concavity and can be relatively easily corrected with dermal fat, cartilage grafting, or fat grafting.
- Skin grafts can be safely re-elevated and undermined within 6 weeks of initial surgery.

23.1 General Principles
The disappointment with skin grafts is their unpredictability regarding take rate with multiple, sometimes uncontrollable, factors affecting their successful take. It should be understood that unquestionably thicker grafts will oftentimes have a rockier course to final healing, but even dusky poor-appearing grafts can most frequently go on to heal completely. The incidence of partial graft loss is great, but the incidence of total graft loss or partial graft loss that requires reoperation is actually very low.

23.1.1 Initial Postoperative Visit
During the initial postoperative visit, if the graft is dusky or has poor wound appearance, particularly thicker-appearing grafts, and if there is a hematoma or seroma, certainly attempt to re-evacuate it on the initial visit, which is between days 5 and 7. This will allow thicker grafts to incorporate and if there is some superficial slough, it is appropriate to change the antibiotic ointment to plain Vaseline and allow the patient to shower and continue simple local wound care. Plan to re-evaluate on a weekly basis until the graft has declared itself, which may be several weeks. Even on larger areas of superficial slough, weekly debridement back to clean healthy bleeding tissue with local wound care will convert many partial failures on to successful healing (▶ Fig. 23.1).

23.1.2 Unacceptable Color Match or Scar Contour
If the graft heals with unacceptable color and scar formation, then simple scar management techniques that include dermabrasion at 6-week intervals or even injection with Kenalog are appropriate for management. For full-thickness grafts that heal with significant depression, it is realized that these can be re-elevated, even over 100% of their perimeter, and then at 6-week intervals, the contour deformity can be addressed with either a dermal fat graft or fat injection to improve the final contour. Understand that slight overcorrection with dermal fat will be required and significant overcorrection with fat grafting may also be required. For full-thickness skin grafts that heal thickly with fuller contour, silicone sheeting begun at 6 weeks and then periodic fairly low-dose Kenalog injection with multiple episodes over a period of 3 months can provide adequate final contour. Alternatively, after 3 months, grafts can be re-elevated, thinned, and contoured, and inset to improve the final contour. Mismatched color on full-thickness grafts can best be managed with both initial dermabrasion and laser therapy as illustrated.

23.1.3 Dermabrasion
Dermabrasion is an exceedingly useful adjunct for improving the appearance of scars, full-thickness grafts, and flaps. Most patients are offered dermabrasion beginning at no less than 6 weeks postoperatively. The procedure is done in the clinic utilizing a cylindrical diamond bur and a dedicated dermabrasion hand power tool. Topical anesthetic is utilized with no infiltration of local anesthetic. The dermabrasion is performed to deep punctate bleeding, often called paprika bleeding, and after dermabrasion, the resulting wound is given a single application of triple antibiotic ointment and then the patient is instructed to stay out of the shower for 1 day and then follow up with 3 to 5 days of petroleum-based ointment until healing. The patient is cautioned to avoid significant sun exposure 3 to 6 months postoperatively after dermabrasion. Dermabrasion is offered at 6-week intervals, usually for no more than three times. Understand that dermabrasion has no effect on significant contour
Skin Graft Revisions

Fig. 23.2 A 49-year-old male 6 months status post color-matched full-thickness skin graft from scalp donor site for 2-cm Mohs resection at nasal tip. He complained of poor graft contour. He had graft re-elevated over 60% of its maximal volume and dermal fat graft placed underneath the original full-thickness skin graft. Final postoperative results shown at 2 months.

Fig. 23.3 A 72-year-old male status post inappropriate skin graft done outside of UTSW to repair left alar defect. He complained of poor graft site contour and nasal airway collapse. Alar rim was reconstructed with conchal cartilage graft and scar excision. Final postoperative results shown at 2 weeks.

Fig. 23.4 A 59-year-old female status post skin graft to left nasal tip. She complained of contour deformity. She was treated with scar excision and re-elevation and inset of graft. Final postoperative results shown at 4 months.
abnormalities. It is particularly efficacious in improving small incision line roughness or contour abnormalities and is particularly effective at improving final color on hyperpigmented full-thickness skin grafts.8,9,10,11,12

Dermabrasion is also routinely performed in the operating room. It is performed on most forehead flap donor sites, as well as routinely performed on inset of all nasolabial flaps. This occurs at approximately 3 to 4 weeks postoperatively and the same procedure is performed with the exception that local injection is injected along the incision line to be dermabraded. The majority of dermabrasion performed in the operating room is performed with a sterile Bovie scratch pad folded in half and again is performed to deep punctate bleeding. It is actually our preference to use a Bovie scratch pad over a hand-powered tool for dermabrasion given that we feel it is safer and delivers more predictable results. Unfortunately, patients are uniformly underwhelmed to have Bovie scratch pad dermabrasion as an awake clinic procedure.

Great care and caution should be utilized when using the power dermabrasion device because it can be associated with significant soft-tissue trauma if it abrades an eyelid or lip, for example. Also, it is incumbent upon the assistant to not place any gauze within the proximity of the dermabrader because if it becomes entangled in the cylindrical tip, it is a significant hazard that can lead to corneal abrasion (▷ Fig. 23.2, ▷ Fig. 23.3, ▷ Fig. 23.4, ▷ Fig. 23.5).

References


Fig. 23.5 A 77-year-old male status post skin graft at left nasal side wall. He complained of contour deformity, which was subsequently excised and replaced by bilobed flap. Final postoperative results shown at 10 months.
Local Flap Revisions

James F. Thornton and Jourdan A. Carboy

Summary

The identification, timing, and management of local flap contour abnormalities are discussed. Revision techniques, including dermabrasion, steroid injection, silicone sheeting, and direct surgical revision are covered.

Keywords: scar massage, steroid injection, dermabrasion, silicone sheeting, contour abnormalities

Summary

- The most frequently indicated revision for local flaps is correction of contour abnormalities. The final result is best if maximal scar maturation is achieved prior to revision.
- Alar contour abnormalities often require direct alar rim incision and significant soft-tissue debulking along nasal sidewall.
- Incisions across the very vascular face can be made with little regard to previous incisions.

24.1 Complications and Their Management

24.1.1 Noninvasive Management

The issues with local flaps involve early healing with contour abnormalities, as well as color. Most color issues including poor border scar appearance can be addressed with judicious scar management like any other Mohs procedure. This includes early (6 weeks) dermabrasion and pulsed-dye laser if indicated for color.1,2 The management of contour abnormalities, particularly with interpolated bilobed flaps or posterior labial flaps, entails early scar care with massage, which has proven to be remarkably efficacious, as well as a light dose of steroid injection.2,3,4 Understand that straight volume requirement or disruptions of natural creases are rarely improved to the point of not requiring later revision surgery and the role of scar massage and Kenalog should be viewed as optimizing the appearance prior to definitive surgery. For this reason, the use of multiple rounds of laser therapy might best be saved until after the final revision when the contour is right to improve the final color for the patient’s lifetime result (Fig. 24.1, Fig. 24.2, Fig. 24.3).

24.1.2 Revision Surgery

When the decision to proceed with revision surgery is made, very careful assessment of the patient’s perception of the defect is paramount to ensure that it matches the surgeon’s. Other factors important to consider in this decision making are the multiple variables that contribute to final scar appearance, including the patient’s persistence, the wound healing phase or the stage of wound healing, and the severity of the defect. Understand that left entirely with no other factors and left entirely to the plastic surgeon, the majority of plastic surgeons would elect to perform scar revisions somewhere in between 18 to 24 months when maximal healing is allowed.2 However, when there is an untoward scar on somebody’s face, now is not the time to either be dogmatic or academic and it is best to weigh all the factors regarding management of revisions. If one is able to achieve a reasonable facial result with an early initial revision, then “time is on the surgeon’s side” and one is able to wait a great deal longer prior to planning of the next or often final stage of surgery. Simple flap contour deformities will worsen the border scar appearance just from the shadowing and highlighting and the would-be flap is able to be re-elevated. A significant amount of thinning can be performed safely even to the point of re-elevating the flap 100% and base the circulation on the deep soft tissue, and one is able to provide an improvement in contour across the entire border (Fig. 24.4, Fig. 24.5, Fig. 24.6, Fig. 24.7).

Fig. 24.1 (a) It is extremely easy to inject underneath lesion, which will only lead to long-term and often irreversible fat atrophy. (b) To avoid this, the scar tissue itself must be injected with a Luer Lock needle and syringe.
24.1.3 Z-Plasty

Z-plasty, which is mathematically defined by Limberg, is an extraordinarily useful plastic surgery technique.\(^5\) The Z-plasty is able to lengthen a contracted scar, break up a straight line scar, and shift soft-tissue contour all through soft-tissue rotation. The tenet of appropriate Z-plasty design depends on precise symmetry.\(^5\) The length of each lateral limb and the central limb must all be identical. The most common prescribed angle between the lateral and central limbs is 60 degrees.\(^5\) Appropriately designed and executed, the elevation and rotation of the resultant triangular flaps reorients the forces of scar contracture and allows nearby tissue recruitment to lengthen a contracted scar.

For scars that cross natural concavities, that is, the medial and/or lateral canthus, a Z-plasty is invaluable to provide predictable scar revision (\(\Rightarrow\) Fig. 24.8, \(\Rightarrow\) Fig. 24.9, \(\Rightarrow\) Fig. 24.10).
Local Flap Revisions

Fig. 24.5  A 56-year-old female status post poorly executed left upper lip repair with cheek advancement that healed with significant tethering and distortion of the upper lip. Revision involved excision of the scar and re-elevation of the flap with proper inset to return the lip to its normal anatomic location. Final postoperative results shown at 5 months.

Fig. 24.6  A 51-year-old female status post single-stage melolabial interpolation flap that subsequently pincushioned with obliteration of the alar groove and cheek–nose junction. Flap was almost completely re-elevated and thinned out. It was then re-inset with internal tacking sutures along the alar groove. Final postoperative results shown at 2 months.

Fig. 24.7  A 61-year-old female status post single-stage interpolated melolabial flap that resulted in diminished alar groove. Revision involved direct excision of alar groove based on the normal contralateral side. Postoperative results shown at 2 months.
Fig. 24.8 (a) Classic Z-plasty application. A thickened and tethered scar that crosses the natural concavity of the lateral canthus. A Z-plasty is designed with two lateral limbs that are of identical length to the central limb placed on the scar and are designed at 60-degree angles. (b) The flap is elevated in the deep subcutaneous place and properly designed will inset with no tension. (c) Final corrected scar with resultant relaxed tension at lateral canthus.

Fig. 24.9 A 63-year-old male status post cervicofacial advancement flap for Mohs resection repair. He had tethering of scar at lateral brow and lateral canthus. The scar was excised and tethering reversed with small Z-plasty. Final postoperative results shown at 8 months. Hooding, or tenting, of either the lateral or the medial eyelid with or without canthal involvement can rarely be corrected with scar massage and/or steroid injection. Surgical revision with Z-plasty is almost invariably required.

Fig. 24.10 A 74-year-old female patient’s linear closure that resulted in a short upper lip. Revision involved a simple Z-plasty. Final postoperative results shown at 4 months.
References


Management of Complications and Revisions

25 Pedicled Flap Revisions
James F. Thornton and Jourdan A. Carboy

Summary
In this chapter, management of contour abnormalities in nasolabial and forehead flap reconstruction is discussed. Both acute- and late-stage revisions utilizing steroid injection, dermabrasion, and surgical excision are discussed.

Keywords: nasolabial flap, paramidline forehead flap, contour abnormalities, pincushioning, three-stage forehead flap

Summary
- Contour abnormalities in pedicle flap reconstruction are common and easily managed with appropriate revision.
- Edema and soft-tissue contour abnormalities present at the time of flap division and inset will not resolve predictably. It is safer to wait until it resolves spontaneously or the flap is converted to a three-stage flap.
- After 6 weeks, most pedicle flaps can be aggressively re-elevated and defatted over 80% of their volume.

25.1 Introduction
Over 90% of reconstruction patients would like some improvement of their operative scars and it is incumbent on the treating surgeon to help the patient set expectations and select efficacious and appropriate treatment modalities.5

Scar massage, silicone sheeting, dermabrasion, pulsed-dye laser treatment, and fat injection have all shown benefit in improving final scar appearance.

25.2 General Principles
Of the two pedicled flaps covered—the nasolabial and the forehead flap—the nasolabial flap is much more likely to suffer partial loss due to its random arterial inflow. Fortunately, even the more tenuous nasolabial flap rarely suffers a complete loss requiring a repeat flap procedure. Usually, the nasolabial flap will suffer only a partial loss that allows sufficient deep soft tissue to develop in the base and allow full-thickness skin grafting as a conversion to a completed reconstruction. Given the geometry of the nasolabial flap design, there is rarely enough length available to salvage the flap-by-flap elevation and re-advancement.

25.2.1 Early Healing Stage
The majority of forehead flap complications in the early healing stage are due to improper flap design, usually as conversion to a random-pattern flap versus remaining axial pattern. Remaining as an axial pattern flap, the forehead flap is very robust and will tolerate significant thinning on inset without distal tip loss. A significant number of well-designed and robust forehead flaps will show early venous stasis reflected in a dusky appearance. This worrisome initial appearance will usually resolve within 24 hours and topical application of nitropaste does speed resolution.1 For forehead flaps that do in fact progress to partial necrosis, usually manifested by distal tip loss, the reconstruction can be salvaged by simple flap revelation and advancement.2,3,4

25.2.2 Contour Abnormalities and Late Healing Stage Revisions
For nasolabial flaps that heal with significant pincushioning almost all can be managed with significant (>60%) flap re-elevation, aggressive thinning, and re-inset as early as 6 weeks after division and inset. The volume and geometry of nasolabial flaps do not usually tolerate internal or external tacking sutures on inset.

For forehead flaps that present with significant pincushioning or contour abnormalities prior to division and inset, any forehead flap can be converted to a three-stage flap by leaving the flap pedicle intact and flap revelation and inset, including tacking sutures to improve contour.2,3,4 The likelihood of a flap that is significantly thickened or pincushioned before division and inset correctly recontouring after division and inset is very low. The safest and the most time-effective route to achieving acceptable contour is conversion to a three-stage flap with aggressive thinking, tacking suture placement, and re-contouring done at the second stage. The third and final stage, which includes pedicle division and inset, occurs 4 to 6 weeks after the second stage, provided acceptable contour is reached.4

For forehead flaps that pincushion after division and inset most frequently with disruption or effacement of the alar groove, revision involves direct incision of the alar groove based on the normal contralateral side with careful debulking above the groove and tacking sutures placed during re-inset to maintain the shape. If there is a combined cheek and alar defect, then the same principles can be applied to the cheek–nose junction with direct linear incision along the junction, debulking of the cheek and nasal sidewall, and inset.

Often, patient issues after a successful nasal reconstruction with a forehead flap involve the donor site and not the nasal reconstruction. Frequently, the inset flap pedicle itself can become thickened and distort the eyebrow and if a widened (>1.5 cm) pedicle was required, then forehead scar depression may result.

To address these issues, maximal improvement with nonoperative management, including silicone sheeting, triamcinolone injection, laser therapy, and dermabrasion, is performed.5,6,7 At 4 to 9 months after division and inset, the patient can be returned to the operating room for final revision of the forehead flap donor site scar.

The flap pedicle is re-elevated and maximally thinned before re-insetting or if the geometry of the eyebrow permits is simply excised and the remaining defect closed as a linear incision.

Careful attention is paid to maintaining eyebrow symmetry and position.
If the forehead scar is significantly depressed, the scar itself is bluntly freed from the often adherent skull by elevation from the eyebrow incision with a Penfield no. 4 elevator.

At this point, autologous fat is often injected in a crosshatch pattern with a 21-gauge needle (Fig. 25.1, ▶ Fig. 25.2, ▶ Fig. 25.3, ▶ Fig. 25.4, ▶ Fig. 25.5, ▶ Fig. 25.6).

### 25.2.3 Autologous Fat Grafting

The benefits of autologous fat grafting and final graft appearance are well supported by current literature and the technique becomes a useful adjunctive therapy to improve final scar result. Fat grafting can be performed under general anesthesia, intravenous (IV) sedation or local anesthetic and requires very limited specialized equipment. The ideal fat source with regard to patient draping and comfort is from a fat roll from the lateral abdomen. The area is widely infiltrated with 1% lidocaine and 0.25% Marcaine for both hemostasis and a wetting solution. The fat is harvested with a short blunt-tip cannula and affixed to a Luer Lock 10-mL syringe. Fat is harvested from a single lateral stab wound incision and the fat roll is elevated off the patient's abdomen and great care is taken to maintain the

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**Fig. 25.1** A 66-year-old female status post forehead flap reconstruction of a nasal tip defect. She complained of "bottle-cap" appearance and would have benefited from a subunit as opposed to defect-only reconstruction. Revision performed at 2 months illustrates the ability to fully re-elevate the flap 360 degrees across the perimeter, leaving only a central portion unelevated. Re-inset in this fashion greatly improves flap contour. Final postoperative results shown at 3 months.

**Fig. 25.2** An 84-year-old male 5 months status post forehead flap and conchal cartilage graft reconstruction of complete heminasal defect. Initial results shows poor inset, bulky flap, and obliterated alar groove. Revision includes 50% flap revelation, direct excision of the alar groove based on the contralateral side, debulking superior to the alar groove, and flap re-inset. Results shown at 3 months.
direction of travel of the lipoaspiration probe parallel to the patient’s body. After harvest, the fat is squirted onto a sterile Telfa pad and then rolled back and forth until the wetting solution and supernatant are absorbed by the Telfa pad. The remaining dry fat at this point is manually placed into 1-mL Luer Lock syringes. The fat is then injected in the deep dermal plane with 21-gauge needles affixed to the 1-mL Luer Lock syringes in a crosshatch pattern. Slight overcorrection is achieved on the initial fat injection. The patient is placed in a stockinette dressing with an ABD pad overlying it and then instructed to avoid manual compression for 5 to 7 days. The difficulty with fat injection lies in the unpredictability of the absorption, and expectations are best managed preoperatively with the patient and significant contour abnormalities may well require a secondary grafting procedure. If the patient requires a secondary fat grafting procedure, then an estimate of the amount of fat that needs to be overcorrected performed on the secondary procedure can be based on the patient’s rate of absorption seen during the first procedure (▶ Fig. 25.7, ▶ Fig. 25.8, ▶ Fig. 25.9).
Fig. 25.5 (a) A 75-year-old female status post poorly designed and executed nasolabial flap for right ala and sidewall reconstruction. She sought a second opinion after flap revision performed showed no improvement. The poorly designed flap has significant pincushioning and blunts both the alar groove and the cheek–nose junction. 

(b) Revision involved elevating the flap over 80% of its perimeter and significant flap thinning and size reduction. Internal tacking sutures were placed, to better define both the alar groove and the cheek–nose junction. 

(c) The donor site scar on the cheek was improved with Bovie scratch pad dermabrasion, scar subcision with a 14-gauge IV (intravenous) needle and fat grafting. 

(d) Final results shown at 1 month.
Fig. 25.6  (a) A 72-year-old male status post left heminasal reconstruction with paramidline forehead flap. Initial results show poorly defined alar groove and tissue redundancy on nasal side wall. (b) Alar crease is drawn based on template made from normal contralateral side. Direct alar crease incision is made and superior flap skin is significantly elevated and debulked. Flap re-inset with internal tacking sutures and 5–0 nylon sutures spanning alar crease. Forehead donor site is also dermabraded. (c) Initial results shown at 5 days and final results shown at 1 month.
Fig. 25.7 A 71-year-old female status post right heminasal reconstruction for alar loss due to inadvertent intravascular injection of soft-tissue filler. Patient shown 2 years after nasal reconstruction with slightly depressed and discolored forehead sight scar. About 2 mL of fat is harvested from the abdomen and injected in a crisscross pattern with a 14-gauge IV (intravenous) needle. Results shown at 6 months.

Fig. 25.8 A 76-year-old female status 6 months status post linear cheek closure. She complained of contour abnormality, which was treated with 4 mL of fat injected in a crisscross pattern with a 21-gauge needle. Results shown at 3 months.

Fig. 25.9 A 46-year-old female status post multiple Mohs repairs at left cheek referred from outside provider for scar management. Scars were treated with 4 mL of fat injected in a crisscross pattern with a 21-gauge needle. Results shown at 3 years.
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