Nasal Reconstruction: Forehead Flap

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Learning Objectives: After studying this article, the participant should be able to: 1. Understand the history of nasal reconstruction and its implications to modern nasal repair. 2. Understand current developments in the use of intranasal lining flaps and primary cartilage grafts. 3. Understand the use of the two-stage and, specifically, the three-stage paramedian forehead flap with an intermediate operation. 4. Understand methods that allow the use of skin grafts and a modified folded forehead flap for lining. 5. Understand the use of regional unit reconstruction as it applies to repair of nasal defects.

Nasal reconstruction remains the historic centerpiece of plastic surgery, and the forehead flap, the workhorse of repair. All anatomic layers—cover, lining, and support—must be replaced to reestablish the aesthetic quality of the nose and a patent airway. This article addresses the objectives and principles of aesthetic nasal reconstruction, emphasizing the use of the two- and three-stage forehead flap, intranasal flaps, skin grafts and the folded flap for lining, and primary and delayed primary cartilage grafts for support. (Plast. Reconstr. Surg. 113: 100e, 2004.)

“The tint of forehead skin so exactly matches that of the face and nose that it must be first choice. Is not the forehead the crowning feature of the face and important in expression? Why then should we jeopardize its beauty to make a nose? First, because in many instances, the forehead makes far and away the best nose. Second, with some plastic juggling, the forehead defect can be camouflaged effectively.”

—Sir Harold Gillies and D. Ralph Millard

A HISTORY OF NASAL RECONSTRUCTION

The origins of plastic surgery are rooted in the relief of facial deformity. Even though cartilage, bone, and mucous membrane are often missing in larger defects, when the nose has been injured the most obvious deficiency is skin. The forehead has been acknowledged as the best match for nasal skin because of its superb color and texture. Well vascularized and lying adjacent to the nose, it is the ideal donor material. However, many surgeons will not use a forehead flap because of a fear of forehead deformity and scarring, or believe that they cannot use the forehead because it is of inadequate size.

The origins of forehead rhinoplasty (the Indian method) are obscure, but it has been performed in India since 1440 A.D. and probably long before the birth of Christ. Sicily was the center of Arabian, Greek, and Occidental learning at the time, which probably made knowledge of Arabic translations of the Indian operations accessible to the Branca family in Italy during the fifteenth century. The first written account in English of the Indian midline forehead rhinoplasty appeared in the Madras Gazette in 1793. One year later, it was published in the Gentleman’s Magazine of London. Carpue, an English surgeon, published his account of two successful operations in 1816. The classic median forehead flap, which took a vertical flap from the midline of the forehead, was popularized in the United States by Kazanjian in 1946. It received its blood supply from paired supratrochlear vessels. The base of the flap twisted 180 degrees, with an arc of rotation at or above the eyebrows. The forehead donor sites in the early operations were allowed to heal by secondary intention.

Between 1940 and World War I, it became apparent that the results of repair using unlined flaps were poor. The external shape of the nose and its airways became distorted by contracting scar on the underlying raw surface of the covering flap. Residual intranasal mu-
cous membranes seemed inadequate. Around 1842, Petralli folded the distal end of the flap onto itself, so that it created its own inside and outside and, in a manner of speaking, formed the tip, ala, and columella while eliminating raw surfaces in the lower part of the reconstructed nose.\(^2\) However, normal hairline position limited the length of a vertical median forehead flap, unless hair was transferred. Midline forehead tissues seemed unable to provide enough tissue to create a long columella that could, at the same time, maintain projection, allow infolding of the covering flap for lining, and avoid unnecessary tension that might diminish flap vascularity. To obtain a longer flap, Auvert, in 1850, slanted it across the forehead at an oblique angle of 45 degrees.\(^5,6\) German surgeons of the same period positioned forehead flaps horizontally; the flaps were supplied by the supraorbital vessels on one side. In 1935, Gillies\(^7\) described an up-and-down flap that was centered over one supraorbital pedicle, passed into the hair-bearing scalp, and then descended into the forehead. In 1942, Converse modified the up-and-down flap by creating a long pedicle that was camouflaged within the hear-bearing skin and that included the major vascular supply of the scalp.\(^2,5\) All these flaps were designed solely to provide additional length, and each created a forehead defect that was harder to close. Surgeons were caught in a difficult predicament. On the one hand, they worried about forehead scarring. On the other hand, they bemoaned insufficient tissue to make a nose. To add insult to injury, they often used forehead tissue not only for nasal reconstruction but also for adjacent defects. Neighboring cheeks, lips, and nose losses in the midface were filled with one even larger flap, creating a single plump lump that replaced the subtle three-dimensional contours of these multiple contiguous facial units. The forehead was scarred beyond repair. Despite its limitations, the folding of covering skin for lining, and specifically the Converse scalping flap, came to be the most commonly used method of nasal reconstruction during most of the twentieth century. The median forehead flap was recommended only to replace small nasal losses, unless the patient was bald or had an unusually high hairline that might allow a longer vertical flap.

Rather than folding the forehead flap, others sought to eliminate the raw area on the deep surface of the covering flap in other ways.\(^5\) In 1873, Volkmann turned down portions of residual nasal skin adjacent to the defect, hinged down on scar to provide lining. Thiersch transferred flaps from other facial areas in 1879. More recently, Millard\(^8,9\) advocated rolling over bilateral nasolabial flaps to line both the ala and the columella.

In 1898, Lossen first described skin grafts for lining. Most often, grafts of split- or full-thickness skin were placed under the covering flap during a preliminary operation. Weeks later, once the viability of the grafts was assured, these prelaminated flaps were transferred to the nose. Although described much earlier by Konig, in 1943 Gillies\(^10\) popularized the placement of composite chondrocutaneous grafts to supply both lining and support. In 1956, Converse\(^11\) suggested a septomucoperichondrial graft as an alternative.

During the same period, it became obvious that without a skeletal framework, the soft tissue of cover and lining would collapse in major reconstructions, impairing the airway and limiting projection. A rigid skeleton was needed to provide support, projection, and contour. However, folded flaps were thick and often ischemic, and precluded the accurate placement of primary columellar, alar, and tip support. When residual nasal skin or adjacent cheek skin was turned over to line the nose, the tissues were thicker than normal intranasal lining and distorted the external nasal shape and clogged the airway. Only after the soft tissue had healed could large bone and cartilage pieces be placed as cantilever grafts to lift the dorsum and tip. Because of their bulk and risk of extrusion, they were not used primarily but were added much later in final touch-up operations. Unfortunately, once gravity and the contractual effects of the healing process had distorted nasal contour, it could rarely be regained. Covering skin became contracted and stiff. Multiple revisions were required to sculpt subcutaneous tissue into the semblance of a nasal shape. When lining and cartilage support were supplied as a composite graft under a prelaminated forehead flap, one or more preliminary stages were required before the nose could be put together. Their shape was fixed both by their natural configuration and by the scar that surrounded them as they sat in the forehead awaiting transfer to the nose.
MORE RECENT ADVANCES

The classic Indian forehead flap carried midline tissue on paired supraorbital and supratrochlear vessels. Its base lay at or above the eyebrows. When so designed, its length was quickly limited by the hairline; it is reached by the pedicle’s high arc of rotation. A 180-degree twist could lead to kinking at the nasal root and could impair blood supply. Early on, changes in flap design were made to overcome these limitations.\textsuperscript{5} If the height of the forehead could not be changed, the flap could be effectively lengthened by modifying incisions at the base of the pedicle and by lowering the point of rotation. Lisfranc, in 1827, extended one incision lower than the other. Dieffenbach lengthened one incision until it reached the defect. Labat curved his incisions proximally, centering the flap over the medial brow and canthus on one side. This reduced the twist of the pedicle base and brought the flap closer to the recipient site. Central forehead tissue could be transferred on a \textit{unilateral paramedian} blood supply. Strangely, except for the use of the paramedian forehead flap by Millard,\textsuperscript{12–14} this modification has received little attention. He clearly demonstrated that bilateral pedicles were not essential for flap viability. More recently, the anatomic studies of McCarthy and colleagues\textsuperscript{15} demonstrated that the forehead is perfused by an arcade of vessels supplied by the supraorbital, supratrochlear, infratrochlear, dorsonasal, and angular branches of the facial artery and the superficial temporal artery. A rich anastomotic plexus centered on the medial canthus can supply a unilaterally based flap, even after division of the supraorbital, supratrochlear, and infratrochlear vessels. The paramedian forehead flap is perfused by a vertically oriented axial blood supply. Its arc of rotation is centered near the medial canthus.

Refinements in design of transferred tissue also serve to minimize donor deformity.\textsuperscript{5} The outlines of the earliest forehead flaps were made from wax patterns, shaped to fill a defect, and then flattened on the forehead as a guide. In 1828, Veltech drew his flap as a reversed ace of spades, its stem forming the columella and its tapering tip remaining attached as a pedicle. In 1834, Labat diagramed a similar tripod-shaped flap, with limbs extending obliquely across the forehead. More recently, Millard\textsuperscript{12–14} has used a seagull-shaped flap with a central vertical component and lateral wings. The wings extend horizontally and lie in the natural transverse wrinkle lines of the forehead. The vertical component resurfaces the dorsum, tip, and columella, and the lateral extensions are wrapped around the ala and carried into the nostril flare as alar bases. The flap takes excess forehead tissue in both horizontal and vertical dimensions. This facilitates primary closure of the forehead wound as an inconspicuous midline T-shaped scar. It became apparent that simple undermining of adjacent wound margins was satisfactory for near-complete primary closure. It was not necessary to make additional parallel incisions along the brow or hairline, to rotate large scalp flaps, or to skin graft the forehead for closure, as some have recommended.

Because midline forehead tissue can be transferred successfully as a paramedian flap, it is not necessary to use distant tissue to reconstruct the nose or to expand available forehead. Skin expansion delays reconstruction for months and is associated with some degree of discomfort and social isolation. Such expanded skin may be subject to uncontrollable shrinkage and contracture. Forehead expansion may be appropriate to lengthen the reach of the flap when the forehead is inordinately short, or if flaps have been harvested previously, but is unnecessary in almost all cases. The results of nasal reconstruction using expanded forehead skin or other distant flaps rarely meet critical analysis. In most cases, the motivation for their use is an ill-conceived wish to take inordinately large amounts of forehead tissue to cover non-nasal units or to line the covering flap by folding its distal end.

More recently, Burget and Menick\textsuperscript{16,17} showed that a broad expanse of residual and well-vascularized intranasal mucosa lies available within most nasal defects and can provide lining for lateral, heminasal, and total nasal defects. These lining flaps are thin and reliably viable. Loss of lining, the chief enemy of nasal reconstruction, seldom occurs. The septal branch of the superior labial artery allows the elevation of the entire ipsilateral septomucoperichondrium on a narrow pedicle. If both right and left septal branches are included, the entire septum can be shifted as a composite flap containing a sandwich of cartilage between the two leaves of mucous membrane. Such flaps of septomucoperichondrium, cartilage, and bone extend from the nasal floor below to the level of the medial canthus above and posteriorly.
beyond the ethmoid perpendicular plate. They also noted that a bipedicle flap of residual vestibular skin based medially on the septal and laterally on the nostril floor could be advanced inferiorly to line the ala and nostril margin, creating a dry, thin lining for the alar rim.

Realizing that the forehead is a multilaminar structure of skin, subcutaneous tissue, and frontalis muscle, Burget and Menick revisited the use of full-thickness skin grafts for lining with a forehead flap. Because a skin graft will survive on such a highly vascular bed, they proposed that a skin graft could be used for lining if late contraction could be prevented. They buried a cartilage graft in the subcutaneous layer between the skin and the frontalis muscle at the time of flap transfer. However, such an alar margin remains somewhat thick. More recently, Menick noted that skin grafts (and folded forehead flaps) integrate into adjacent normal lining and can be completely separated from the overlying cover from which they were initially vascularized. So, a skin graft can be placed on the raw surface of a full-thickness flap without any primary support. Three weeks later, once the skin graft is revascularized from its peripheral inset, the covering flap can be re-elevated. Alternatively, a folded flap can be incised free along the rim and the covering flap can be lifted off the distal aspect used for lining, completely separating the proximal cover flap from the distal lining extension. The underlying subcutaneous tissue and frontalis muscle which covers a skin graft or folded flap is now widely exposed and can be excised to normal lining thickness. Delayed primary cartilage grafts are placed to support lining created from a skin graft or a folded flap during an intermediate operation before division. These modified uses of skin grafts for lining and the folded forehead flap are especially advantageous in the elderly or medically frail patient who demands a nasal reconstruction, or when the septal blood supply or the septum itself precludes the use of intranasal lining flaps. Because significantly less intranasal manipulation is required as compared with intranasal lining flaps, these new methods contribute significantly to lesser morbidity in patients.

Because they are thin and highly vascular, new lining flaps of vestibular skin and nasal mucosa allowed the use of primary cartilage grafts from the septum, ear, or rib to be cut, carved, bent, and fastened together to form a delicate hard-tissue construction that nearly resembles the normal cartilaginous framework of the nose. When covering skin is supplied by a very thin forehead flap, the shape of this cartilage construction shows through the skin and the contour of the nose is correct from the onset. Cartilage grafts provide support and projection, recreate a three-dimensional contour, and brace the repair against the contractile effects of wound healing. It has also become apparent that when a full-thickness forehead flap is used to cover intranasal lining flaps, a skin graft, or a folded forehead flap, it becomes physiologically delayed. Such a flap can be completely re-elevated, creating a smooth, supple, thin, and even skin envelope of ideal skin quality at an intermediate operation. The previously undissected subcutaneous plane separates easily. Subcutaneous tissue, frontalis muscle, and previously positioned primarily cartilage graft (if placed) are exposed. This underlying excess soft tissue (conglomerate of fat, cartilage, and scar) heals into a rigid, living structure that bleeds readily and can be excised and carved into an ideal subunit subsurface architecture. Previously positioned primary cartilage grafts are visible and can be remodeled. Just as importantly, delayed primary cartilage grafts can be placed over revascularized lining, skin grafts, or forehead skin that has been folded. An ideal subsurface architecture is created by soft-tissue excision and cartilage grafting. The forehead skin (now of ideal nasal skin thickness) is replaced on the underlying rigid, recontoured, three-dimensional recipient bed at the completion of this intermediate operation. Three weeks later (6 weeks after the transfer), the pedicle is transected. Nasal shape is imparted to the reconstruction by resupplying thin skin cover and lining, primary and delayed cartilage grafts, and a sculpted soft- and hard-tissue framework, recreating an ideal three-dimensional subcutaneous architecture.

A Modern Approach to Nasal Reconstruction with a Forehead Flap

Planning

Nasal reconstruction requires that the surgeon analyze the defect, both anatomically and aesthetically. Most importantly, the surgeon must visualize the end result. Anatomically, the nose is covered by a thin, conforming envelope
of skin that matches the face in color and texture. It overlies a sculpted soft- and hard-tissue middle layer framework that supports, shapes, and braces the repair against gravity and wound contraction. The underlying lining must be thin, supple, and vascular, neither distorting the external shape outward nor bulging inward and causing obstruction. Aesthetically, the nose can be described in terms of regional units17,19,20: adjacent topographic areas are of characteristic skin quality, border outline, and three-dimensional contour. The “normal” nose is created by the reestablishment of aesthetic contour, highlights, and landmarks. The surgeon must take bits and pieces of expendable tissue to create a facsimile of the lost nose that gives the appearance of a normal nose. The presence or absence of scars is much less important.

Assume that patients wish to look normal. Rarely do patients really want less. It is unusual for an associated medical illness to require healing by secondary intention, a simple closure of cover to lining, or a nonaesthetic skin graft or flap. Almost always, the goal should be an aesthetic result.

It follows, then, that if restoration of nasal subunits is the goal, certain principles20 follow. Because flaps often trap-door due to fibrotic contraction in the underlying bed between the recipient and the donor bed, flaps rise above the adjacent normal nose (unlike skin grafts, which may become atrophic or unpredictably pigmented but do not become “pincushioned”). It is often better to resurface an entire convex subunit rather than part of a subunit so that the expected wound contraction will augment, rather than distort, the contour of the final result. Frequently, the wound should be altered in size, site, or depth to improve the final result. The subunit principle then follows: If a defect occupies greater than 50 percent of a subunit, consider discarding adjacent normal tissue within the subunit so that the entire subunit is resurfaced with the flap, rather than the defect being simply patched. This approach (which is not applicable to skin grafts or to flat or concave subunits) also positions scars in the contoured depressions between subunits, where they are better camouflaged.

Missing tissue must be replaced exactly, neither underfilling or overfilling the defect. Flap dimensions are not taken from a fresh, gaping wound or old, contracted defect but from the contralateral normal or the ideal.

In repairing composite defects that encompass multiple facial units, anticipate late tissue settling and scar distortion before proceeding with subsequent stages. If a facial landmark must be built upon another (nose on lip and cheek), reconstruct the lip and cheek at the first operation and build the nose only after a stable platform is assured. Stage the repair. For massive facial wounds, by necessity, distant free flaps have become a first choice for large, complicated defects. Although the wound can be healed or closed, distant tissue does not match facial skin in color, texture, or thickness, or have a facial shape. Massive facial defects should be approached in two stages. Initially, distant tissue is supplied to provide bulk, protect vital structures, revascularize the wound, and reconstruct a stable platform. At later stages, a subunit approach is emphasized to restore facial skin quality, border outlines, and three-dimensional contour. Local tissues and traditional methods of transfer are utilized to establish aesthetic cover and three-dimensional shape, whereas distant tissues are used for the “invisible” requirements of lining and support.

Reconstruction of the nose is an artistic endeavor. Technology is not the answer. Dermabrasers or lasers to improve scars, or expanders and free flaps to provide more tissue, are, at best, limited tools in restoring the normal nose, although they may be useful.

**Technique**

The forehead is multilaminar, consisting of skin, subcutaneous tissue, frontalis muscle, and a thin areolar layer. Elevated as a full-thickness flap18 based on a paramedian pedicle, its supratrochlear vessels pass deeply over the peristeum and the supraorbital rim and travel vertically upward in the muscle to lie in an almost subdermal position under the skin at the hairline. It is both a myofascial and an axial flap, and it is highly vascular.

Forehead skin can be transferred as an island flap in one stage. However, the excessive bulk of the pedicle passing under intact galeal skin jeopardizes the blood supply and distorts nasal contour.

Traditionally, the forehead is transferred in two stages. At the first stage, frontalis muscle and subcutaneous tissue are excised distally, and the partially thinned flap is inset into the recipient site. At a second stage 3 weeks later, the pedicle is divided. However, excision of the frontalis muscle and subcutaneous fat at the
time of initial transfer removes the myocutaneous component of its blood supply, exposes a wounded, raw, bleeding subdermal surface prone to fibrosis and contraction, and creates a flap less able to tolerate the tension of closure. Such soft-tissue “thinning” is limited, incomplete, and piecemeal. Fat necrosis and contour irregularities are especially common in smokers and patient undergoing major nasal reconstructions. Flap transfer, followed 3 weeks later by division, is best limited to small defects that do not require complicated support or lining replacement.

To overcome these problems, the technique of forehead flap transfer has recently been modified. An extra operation has been added between transfer and division. This three-stage technique ensures a maximum blood supply, a thin covering flap, unimpeded surgical exposure, controlled shaping, and the maximum use of all lining options. The aesthetic results are improved, and the need for later revision is minimized (Figs. 1 through 5).

Stage 1

In stage 1, a full-thickness, multilaminar, nonexpanded forehead flap (skin, subcutaneous tissue, fat, and frontalis muscle) is elevated. Subcutaneous fat and frontalis muscle are trimmed only at the columella and a few millimeters along the nostril rim. An exception might be the isolated alar or tip defect requiring minimal support or lining repair, when the surgeon thinks that adequate distal and then proximal thinning is possible in two stages without the intermediate operation. The cover defect is replaced exactly using a template derived from the contralateral normal side or from an ideal. It is inset without tension or blanching with a single layer of fine silk sutures. If altering and enlarging the defect will improve the final aesthetic result, adjacent normal tissue within the nasal subunit is excised, and the entire subunit is resurfaced rather than only the defect.

Primary support grafts are a first choice, but they can be positioned in a delayed primary fashion at the second-stage intermediate operation, if necessary. Primary cartilage grafts are placed if lining is present, or if it can be restored with vascularized intranasal lining flaps. Although not apparent, significant amounts of lining normally remain within the residual nose and the piriform aperture.

Lining flaps from intranasal donor sites (the vestibule, the middle vault, and the septum) are thin. They are vascular enough to nourish primary cartilage grafts without the risk of ne-

![Fig. 1. Preoperative views of a 14-year-old girl with an involuted nasal hemangioma involving the tip, columella, dorsum, and both alae. Anterior and inferior septal cartilage at the septal angle and both alar cartilages were destroyed. The columella had previously been reconstructed with local flaps of scar tissue.](image-url)
crosis and soft enough to conform to the shape of a cartilage framework. Branches of the anterior ethmoid artery supply the dorsum dorsally, while septal branches of the superior labial artery supply it inferiorly. Laterally, the nasal base is supplied by branches of the angular artery. So, when lining of the ala or lateral sidewall is missing, frequently vestibular skin and mucosa remain above the upper border of the defect. A bipedicle flap of vestibular skin, 7 to 10 mm wide, can be designed just superior to the defect. It is based medially on the nasal septum and laterally on the nasal floor. This flimsy, ribbon-like strip of tissue can be brought down to the level of the nostril margin. The secondary lining defect which persists

Fig. 2. (Above, left) Atrophic telangiectatic skin of the dorsum, tip, both alae, and part of the right sidewall is marked for excision. (Above, right) Skin and residual hemangioma were excised. The distal septum and alar cartilages are absent. (Below, left) Through a dorsal approach, septal cartilage is harvested from the residual septum, as in a submucosal resection, and used to replace missing sepal cartilage to recreate the distal dorsum and caudal septum. This septal graft is fixed with figure-8 sutures and bilateral lateral spreader grafts. (Below, center) After reconstruction of the central dorsal and caudal support of the septum is achieved, septal cartilage anatomic tip grafts are positioned to replace the medial, middle, and lateral crura, and conchal cartilage alar battens are positioned to support the alar rims. (Below, right) A full-thickness forehead flap is transferred to resurface the nose. A 3.5-cm gap in the superior forehead is allowed to heal secondarily.
above the nostril margin can be filled with an ipsilateral septomucoperichondrial flap based on the septal branches of the superior labial artery, or by a dorsally based contralateral septal flap based on the ethmoid vessels. If the nose has been totally amputated, the entire

**Fig. 3.** (Left) At 3 weeks, the forehead flap has healed uneventfully. The outlines of the normal ideal nasal subunits are drawn on the surface of a bulky reconstruction. (Right) Forehead skin with 2 to 3 mm of subcutaneous fat is elevated over the entire inset except for the columella, exposing a conglomerate of subcutaneous fat, frontalis, scar, and primary cartilage grafts.

**Fig. 4.** (Left) After the forehead skin with a layer of subcutaneous fat has been elevated, the tip, dorsal lines, and alar creases are marked with ink. (Center) Excess soft tissue is excised until an ideal subcutaneous framework is formed from hard and soft tissue, exposing the now rigidly healed primarily cartilage grafts. (Right) Thinned to ideal nasal skin thinness, forehead skin is returned to the recipient site and held in place by percutaneous quilting sutures and fine silk sutures at the periphery. Three weeks later, the forehead pedicle will be divided and the residual proximal aspect inset as a small inverted V between the brows.
lining of the anterior vault is missing. If the septum is present, even if it has been trimmed off flush with the piriform aperture, it can supply a broad, bilateral expansive mucoperichondrium sufficient to line both nasal vestibules. A large septal composite flap is incised based on both septal branches of the superior labial artery and pivoted out of the nasal cavity and onto the front of the face. It is fixed with sutures or wire to the residual nasal bones. In most instances, such a complex lining replacement is performed at an initial operation, allowing the composite lining flap to lie perched in space for about 4 weeks. At a second operation, the cartilaginous framework and cover flaps are restored.

Fortunately, the reliable vascularity of a full-thickness forehead flap also ensures the “take” of a skin graft applied to its raw areolar surface at the time of flap surface, and also permits the folding of a forehead flap to provide both cover and lining. These lining replacements are especially useful in the elderly or debilitated patient, when the risk of temporary nasal obstruction caused by crusting edema or intranasal bleeding should be minimized, or when previous injury or rhinoplasty has interfered with the septal blood supply, making the use of intranasal lining flaps based on the superior labial artery branches or the anterior ethmoid vessels unreliable. In a smaller unilateral lining defect, the full-thickness skin graft can be sutured to fill the deficiency and fixed to the undersurface of the forehead flap with quilting sutures. With moderate defects, in which residual normal vestibular skin remains intact above the defect, a bipedicled flap of remnant vestibular skin based medially on the septum and laterally on the alar base is incised in the vicinity of the intercartilaginous line. Once advanced inferiorly to the level of the proposed alar margin, the defect (which remains above the vestibular flap) is filled with a full-thickness skin graft, lining the superior ala and nasal sidewall region. A primary alar rim cartilage graft can be sutured to the raw surface of the vascularized pedicle as a first stage but cannot be placed over the skin graft. A skin graft, raw surface outward, will revascularize from the overlying raw surface of the forehead flap. Contact between the skin graft and the forehead flap is enhanced by the placement of loosely tied, absorbable quilting sutures that pass intranasally through the skin graft and into the soft tissues of the overlying cover flap, and by a small sponge placed within the airway for 48 hours.

In the past, forehead flaps have been folded to provide both cover and lining for the alar rim. However, it is difficult to fold a thick flap
into a nasal shape, and the technique precluded accurate placement of primary columellar tip, and alar support grafts. The nose remains thick and shapeless, and the unsupported soft tissues along the alar margin may collapse, obstructing the airway. More recently, it has become apparent that just as the skin graft lining is well vascularized from the periphery and becomes indistinguishable from residual normal lining to which it was sewn, so too a full-thickness forehead flap can be designed to replace missing skin cover. At the same time, the lining deficit is determined and the second template is positioned distally on the forehead (in continuity with the cover flap) after adding 2 to 3 mm of extra length to allow for rolling in the lining hinge. The flap, designed to provide both cover and lining, is elevated with all layers. The distal extension is turned in to provide the lining and is sutured to the residual mucous membrane with absorbable sutures. The more proximal flap, which will be used for cover, is folded back and inset with a single layer of fine suture, opposing the two raw, deep areolar surfaces of the folded flap. The flap is not thinned; no cartilage support grafts are placed.

The forehead donor site is closed in layers after wide undermining in the subgaleal plane. Any gap that cannot be approximated is allowed to heal secondarily.

**Stage 2**

Three weeks later, the full-thickness forehead flap, now healed to the recipient bed, is, in effect, physiologically delayed. At an intermediate operation, forehead skin with 3 to 4 mm of subcutaneous fat (nasal skin thickness) is easily elevated in the unscarred subcutaneous tissue plane over the entire nasal inset, except for the columella. The extent of flap elevation varies depending on the exposure required for soft-tissue excision and additional delayed primary cartilage grafting. In fact, forehead skin (without any frontalis muscle) can be completely re-elevated off the nose, maintaining no distal inset without significant risk if such exposure is needed to allow more complete subcutaneous excision or cartilage graft replacement. This intermediate operation is performed under general anesthesia, avoiding the distortion created by local anesthesia or the chemical blanching of epinephrine. The underlying subcutaneous tissue, frontalis muscle, and previously positioned primary cartilage grafts are exposed. The underlying excess soft tissue is a conglomerate of cartilage, fat, and scar healed into a rigid, living stricture that bleeds readily. This is excised and carved into an ideal subunit subsurface architecture. Previously positioned primary cartilage grafts can be remodeled by sculpting, augmentation, or repositioning. Delayed primary cartilage grafts can also be placed over vascularized lining, skin grafts, or the forehead skin that has been folded for lining. No significant wound contraction occurs between the skin graft or the folded flap and the overlying covering flap. The skin graft lining becomes indistinguishable from the residual normal lining to which it is sewn. It is thin, supple, and bleeds readily. The folded forehead flap is incised along the proposed alar margin, completely separating the proximal cover flap from the distal lining extension along the alar rim. The proximal flap is then elevated off its inset with a few millimeters of subcutaneous fat. Just as in the skin graft lining technique, this folded lining becomes vascularized from the adjacent normal mucous membrane and remains well vascularized. Both the skin graft lining technique and the folded forehead flap restore a thin, vascular, and supple lining to replace that missing from a defect.

Support must be supplied during the construction of the soft-tissue lining and cover, because once soft-tissue collapse occurs, it becomes fixed by constricting scar. Late secondary placement of nasal support cannot fully regain what has been lost. If missing, the normal cartilaginous framework of the dorsum, tip, and sidewall should be replaced as it was before. In addition, a strip of cartilage should be placed along the new nostril margin, even though the alar lobule normally contains no cartilage. This braces the alar rim and prevents contraction inward, contracture upward, and collapse during the healing phase. Four different hard-tissue grafts are required for a major nasal restoration—a dorsal buttress, a sidewall brace, an alar margin batten, and alar cartilage tip replacements. Primary cartilage grafts are a first choice, but they can be positioned in a delayed primary fashion at the second-stage intermediate operation. An ideal rigid subsurface architecture can be created from soft and hard tissues before pedicle division, al-
most regardless of lining technique. Good support can be supplied in stages and is coordinated with the replacement of other anatomic layers. When the intermediate operation is delayed even months after forehead flap transfer, significant subcutaneous scarring does not occur. The intermediate sculpting operation can be completed with reliably supple cover and lining layers, easily molded by primary and delayed primary support grafts.

After creation of an ideal subsurface architecture by soft-tissue excision and cartilage grafting, the forehead skin (now of nasal skin thickness) is replaced on the underlying rigid, recontoured, three-dimensional recipient bed with quilting sutures to close the dead space and reapproximate the flap to the recipient site.

Stage 3

Three weeks later (6 weeks after transfer), the pedicle is transected. The inferior forehead scar is reopened, and the proximal pedicle is unfurled and inset as a small, inverted V at the medial brow. The distal flap is elevated with 3 to 4 mm of subcutaneous fat, and the proximal recipient bed inset is sculpted as needed by further excision of excess subcutaneous fat, frontalis muscle, and scar to define the dorsal lines, alar creases, and sidewall junction. The flap inset is completed over a stable, sculptured, rigid platform whose nasal shape shows through the thin, conforming nasal skin.

Revisions

Because the forehead flap is thinned in its entirety and an ideal subsurface architecture is completed before pedicle division, late revisions may not be required or will be minor in partial-thickness defects. Once wound maturation is complete in 4 to 6 months, the alar crease can be defined by direct soft-tissue excision, the nostril margin can be trimmed by rim excision, or the nasal aperture can be enlarged by local excision, local lining redistribution, or a composite skin graft if needed. The forehead scar can be revised by excision and readvancement, and any area of hypertrophy associated with secondary healing can be discarded.

Discussion

It is widely believed that plastic surgery offers the promise that a facial feature cut off, burned off, necrosed away, or lost to cancer can be returned to its condition before it was damaged. A healed wound can be achieved by secondary intention, a skin graft, or any number of flaps, but such a repair does not necessarily reestablish the subtle form that distinguishes a facial feature from a facial blob. In postoperative clinics, the surgeon’s efforts often initiate the unsettling patient query, “But when do we start the plastic surgery?” Or, the plastic surgeon’s hollow apologia, “It sure looks better than it did before.”

Remember, most patients wish to look as they did before injury. In reality, however, it is impossible to recreate a normal nose. The surgeon’s task can only be to take pieces of other expendable tissues and create a facsimile that appears to be a nose, although it is not. First, the surgeon must know the “normal.” The nasal subunits (adjacent topographic areas of characteristic skin quality, border outline, and three-dimensional contour) allow us to visualize the ideal end result. Aristotle said, “Art is the conception of the result to be produced before its realization in the material.” Aesthetic appreciation of the normal and the ability to visualize are prerequisites to achieving such results. Certainly, the paramount quality of a plastic surgeon should be a sense of form. Such an intellectual and visual approach provides principles that are useful in planning the reconstruction.

Frequently, the repair should be staged to ensure a stable platform, viability of tissues, and the absence of infection. The surgeon must conceptualize the various tissue options available to close the wound or fill the hole. The regional unit theory is important because, although we cannot control wound healing or prevent scars, we can select the color, texture, and thickness of donor tissue, control the size, shape, and directions of incisions and excisions, and judiciously choose and modify recipient and donor tissues to provide for the exact replacement of defects to recreate and maintain the expected contours and landmarks of a successful result.

As a first priority, a surgeon must use good materials. Each missing layer of tissue must be restored with raw materials that most exactly match lost tissue in color, texture, thickness, hair distribution, bulk, and function. The forehead is acknowledged as the preferred donor site for resurfacing the nose. Small defects less than 1.5 cm can be repaired...
with local flaps. Superficial defects consisting of skin and minimal subcutaneous fat can be repaired with skin grafts. Limited alar defects can be successfully repaired with a nasolabial flap. The forehead flap, however, remains the premier donor site for a nasal reconstruction because of its size, vascularity, and excellent color, texture, and skin thinness.

A paramedian forehead flap allows the transfer of forehead tissue in an efficient and reliable manner with minimal donor deformity and creates the most aesthetically pleasing reconstruction, both to the recipient nose and the donor forehead. Although there has been a shift away from midline forehead tissues toward more extensive or less satisfactory methods such as the scalping flap, skin expansion, or the use of distant or free flaps in nasal reconstruction, the paramedian forehead flap remains the best choice. It allows the surgeon to restore thin, supple, and conforming cover from thick forehead tissue in two or, preferably, three stages. Reflecting through the overlying skin, an ideal rigid subcutaneous subsurface architecture of hard and soft tissue is created by primary and delayed primary cartilage and bone grafts and by subcutaneous excision. Thin, supple, and vascularized lining is most often recreated with intranasal lining flaps, the skin graft technique, or the modified folded forehead flap method.

The three-stage forehead flap is useful for partial- or full-thickness defects, regardless of size or depth. It is especially helpful in smokers who are at risk of forehead flap necrosis, in patients with large nasal defects that require wide thinning of the covering flap, especially when the flap design requires alar and columnar extension, and when intranasal lining flaps are precluded or unnecessary and lining will be provided with the skin graft or modified folded flap technique.

REFERENCES


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