In perusing the literature of this subject, one is struck chiefly with the lack of appreciation of the need for a lining for all mucous lined cavities... No nose, or portion of the nose, can be made without adequate skin for mucous lining, and the whole status of rhinoplasty, as practiced by the author and colleagues, has since that day undergone a change which is truly remarkable.” —H.G. Gillies, 1920.

Historically, external skin has been the most obvious tissue deficiency after nasal trauma and skin cancer excision. The loss of underlying support or lining was less apparent and, practically speaking, an afterthought. A surgeon interested in nasal reconstruction might assume that nasal repair has always been about external skin replacement and its transfer, rather than the restoration of a nasal appearance.

Gillies,1 after World War I, attributed the modern recognition of lining to the work of Keegan,2 in India, before the turn of the twentieth century. Gillies found, independently, that the addition of lining to the repairs of the injured soldier prevented late retraction and loss of nasal shape.

Because of its ideal surface quality, forehead skin has long been acknowledged as the ideal donor to resurface major skin deficiencies. Five hundred years before the birth of Christ, the Indian median flap first transferred the midline forehead on paired supratrochlear arteries to resurface the nose.3,4 Unfortunately, the underlying raw surface of the unlined flap contracted with late distortion, airway collapse, and stenosis. Slowly, surgeons addressed the problem.

Petralli (1842) folded the distal aspect of the flap to line itself. Volkman (1873) hinged over adjacent skin, bordering the defect, for lining. Both maneuvers increased the size of the defect and the size or length of the required forehead flap. The Indian flap, with a high pivot above the eyebrow, was too short to resurface the nose without carrying hairy scalp on its distal end.

To provide enough skin, the forehead flap was redesigned to increase its length and dimension. The oblique, horizontal, up and down, scalping, and sickle flaps are derivatives of this search for a bigger, longer flap. Each design increased the size or length of the flap. All also increased donor injury and scarring.

Millard,7,8 in the twentieth century, pivoted a “seagull” shaped flap, centered near the medial canthus, on a unilateral pedicle. This lowered the flap’s base and brought the flap closer to the defect, effectively lengthening the flap and the skin available for transfer. Its narrow proximal stalk resurfaced the dorsum and its wings covered the alae. The residual donor defect was less visible high, under the hairline.

This paramedian forehead flap can be elevated on either the right or left supratrochlear pedicle.9 The supratrochlear vessels exit the orbit over the periorbital muscles and then pass through the corrugator muscles and into the overlying frontalis. About 2 cm above the superior orbital rim, the vessels pass through the frontalis muscle to run vertically, within the subcutaneous fat, almost adherent to skin at the hairline and into the scalp. The flap is perfused randomly, through the frontalis muscle and, most importantly, through its vertical axial vessels. Because of its axial blood supply, the width of its pedicle need only be 1 to 1.2 cm wide or less. This paramedian flap has vascularity, size, reach, reliability, efficiency, and relatively minimal morbidity. It can resurface the entire nose.
FLAPS IN USE TODAY

Today the nose can be lined with various flaps.\textsuperscript{10,11}

Hingeover Flaps

Hingeover flaps of adjacent skin from the residual nose or within the medial cheek can be turned over to line a full-thickness defect. Healing of cover to lining, along the incised edges of the defect, must first occur to ensure survival through the scar along the margin of the defect.

Hingeover flaps are relatively poorly vascularized, although they usually survive if less than 1.5 cm in length. Unfortunately, contracture of the scar along the periphery of the defect narrows the airway. This stenosis persists after turning over the external skin for lining. Although the external nostril margin may seem satisfactory in size, the internal nose in the area of the hingeover flap base remains tight, limiting airflow. Later opening of the airway is difficult because of poor exposure deep within the nose, and unavailability of other tissues to fill the gap once the stricture is incised. A skin graft can be applied but recurrent contraction is frequent.

Such hingeover flaps are also stiff and thick. Their bulk occludes the airway and their rigidity prevents careful soft tissue contouring with support grafts. The unreliable vascularity of hingeover flaps contributed to the traditional hesitancy of surgeons to place primary support grafts. Lining necrosis often led to cartilage exposure and infection.

A Second Flap

Thiersch in 1879 used adjacent facial flaps. More recent choices are a second forehead flap, as suggested by Converse, or a nasolabial flap, championed by Millard. Both add additional scars to the face and are bulky.

Millard’s nasolabial flaps were usually elevated as unpredictable random flaps, based on scar along the periphery of the defect. They are stiff and may die if more than 1 to 1.5 cm in length. He also elevated nasolabial tissue as axial subcutaneously based flaps. Bilateral flaps were swung medially to line the ala and then sewn together in the midline to line the back of the reconstructed columella. Unfortunately, they are also stiff and stuff the airway.

Skin Graft

A skin graft can be applied, at the time of transfer, to the deep raw surface of the forehead flap, as first used by Lossen in 1898. A full-thickness skin graft is thin and pliable. It has no intrinsic blood supply, however, and must be placed against a highly vascular bed for survival. A skin graft may not take and contracts unless braced by support. Primary support is excluded, however, because a skin graft does not survive on an avascular cartilage graft.

Early in the history of nasal repair, surgeons voiced concerns about skin graft “take” and late postoperative contraction. Kazanjian and Converse\textsuperscript{12} noted “The septal composite (or a skin graft with separate buried cartilage graft), when placed under a scalping flap at the time of transfer, is associated with a disappointing distortion of the alar border.”

Rather than place skin grafts primarily, others attempted to “build the nose on the forehead” with the prelamination technique (prefabrication). At least 6 weeks before transfer, a full-thickness skin graft, with separate cartilage pieces buried within the subcutaneous layer of the flap, or a composite skin graft were placed on the deep surface of a forehead flap. This prelaminated flap is transferred only after take is ensured. Graft shrinkage still occurred, however, in these poorly supported noses.

A prelamination delays the formal repair but does provide time to ensure graft survival. It also permits the placement of a support graft along the future nostril rim. The cartilage graft is buried in a subcutaneous pocket between the skin and frontalis of the flap and does not interfere with the vascularity of the deeper bed on which the lining skin graft is positioned.

The skin graft usually survives on raw frontalis muscle. If not, the repair is not irretrievably destroyed because the skin graft can be reapplied. The cartilage graft must be limited in size, however, and provides minimal rim support. Such support replacement does not replicate a complete, shaped, subsurface architecture or recreate a delicate three-dimensional contour.

Composite Skin Grafts

Composite skin grafts alone can be applied along the nostril margin.\textsuperscript{13–15} They can restore limited cover and lining deficiencies along the nostril rim or within the columella.

Composite skin grafts, taken from the ear, are used to repair losses of the alar margin. Most often, a two-layered sandwich of skin containing cartilage or fat is taken from the helical root, helical rim, or lobule. They survive if placed on a well-vascularized recipient, sutured with care, and immobilized. They are most reliable if less that 1.5 cm in size.

Larger composite grafts have been recommended. Close examination reveals that they are, most often, large full-thickness skin grafts with a modest distal composite extension. The
composite component is positioned as an “add on” to the full-thickness graft. Frequently, the edges of the wound are first allowed to heal secondarily. Later, adjacent normal tissue is hinged over to line the superior aspect of the full-thickness defect. This increases the surface dimension of the external defect and expands the size of the vascularized bed for the full-thickness graft. It is hoped that the revascularization of the composite component is increased by the enlarged surface area of contact of the adjoining full-thickness skin graft.

The advantages and disadvantages of both methods are now combined: stiff, questionably viable hingeover flaps and avascular skin grafts. Although the results can be good, graft “take,” color and texture, and donor ear deformity are unpredictable.

Although championed by surgeons who have used them with great success, not all have been able to reduplicate these results. Nevertheless, small composite grafts can be useful if the defect is small and located along the alar rim. Their primary advantage is simplicity.

**CHOOSING AMONG TRADITIONAL TECHNIQUES**

Among these traditional choices, hingeover flaps remain useful to line small rim defects. Prefabricated flaps may be helpful in the elderly sick patient when a less aesthetic result is acceptable. They can be accomplished under very light monitored anesthesia.

Second flaps for lining are rarely used, although the facial artery musculomucosal flap, developed by Pribaz, which transfers intraoral mucosa based on the facial artery, is useful to line an isolated loss within the midvault in a nose injured by cocaine or Wegner’s disease.

**Traditional Folded Flap**

The traditional folded flap folded the forehead onto itself. The cover flap was folded inward to line the nostril rim or the columellar and both alar margins, simultaneously. The flap supplies both cover and lining. Poor exposure and stiff soft tissue, however, make it impossible to position sophisticated support to shape the rim, tip, and other parts of the nose. Also, the folded flap contains two layers of folded skin, fat, and frontalis, and makes a very thick nostril margin.

**Adding Support**

Support, in all traditional methods of repair, has been a secondary concern. Most often, the cover and lining were left without support leading to soft tissue collapse, scar fixation, and distortion. Alternatively, cartilage grafts were designed as limited bulky cantilevers to lift the bridge, or crude, poorly shaped “cement blocks” to hold up the nostril margin and prevent the rim from falling into the airway. Excessive soft tissue bulk and fear of tissue necrosis precluded the primary placement of delicate support during initial flap transfer. Unfortunately, it was difficult or impossible to insert them secondarily once the soft tissues healed. Scarred cover and lining were stiff and not easily molded by cartilage grafts placed secondarily.

To decrease bulk and improve contour, others tried to excise excess soft tissue months later, after the soft tissues had matured. The flap edges were elevated along the peripheral margins of the flap in stages after the division of the forehead flap. Fat, frontalis, and scar were excised from one area of the nose. Some months later, while maintaining an alternate area of inset, another area was debulked. Poor exposure, piecemeal thinning, and contracted, scarred skin prevented significant improvements in contour.

**Intranasal Lining Flaps**

The modern revolution in nasal repair was the development of intranasal lining flaps, in the 1980s. At first glance, there seems to be little excess residual lining within the remaining nose after a full-thickness loss. Burget realized, however, that residual intranasal lining could be elevated, based on named vessels. Equally importantly, because this lining was thin, supple, and highly vascular, primary cartilage grafts could be placed to support and shape these flimsy lining flaps at the time of their transfer. When combined with a regional unit approach to repair, the quality, border outline, and three-dimensional contour of a nose could be re-established.

A bipedicle flap of residual vestibular lining can be incised in the area of the intercartilaginous incision of cosmetic rhinoplasty. This flap is based on the septum, medially, and the alar base, laterally. Once released, it is swung inferiorly to replace the nostril margin. Its donor defect can be skin grafted or resurfaced with another lining flap (an ipsilateral or contralateral sepal flap).

The ipsilateral septal mucosa can be elevated and pivoted from the septal surface to line the lower nose, based on the septal branch of the superior labial artery. Originating from the facial artery, a branch of the superior labial artery passes from the lip, just lateral to the nasal spine, near the philtral column to the base of the septum.
The contralateral septal mucosa can be elevated from the septum and swung laterally to line the opposite midvault. This flap is based dorsally on the superior ethmoidal vessels and passes through a slit in the ipsilateral septum or through a fistula created by the simultaneous elevation of an ipsilateral septal flap. The contralateral mucosal flap can line the lateral midvault but does not extend inferiorly to reach the nostril margin.

More dramatically, the entire septum can be incised deeply into the piriform aperture and swung out, based on both the right and left superior labial artery branches. This is a composite flap of bilateral septal mucosa and cartilage. It is maintained on a 1.5-cm pedicle, based at the nasal spine. Pulled out of the depths of the nasal cavity, it can be positioned anteriorly to supply central bridge support. More importantly, the septal mucosa along its free edge can be turned laterally, on each side, to fill a central lining defect for a subtotal or total nasal defect. This composite lining flap can line the upper nose within the narrower upper or middle vault. It is not long enough, however, to reach along the nostril margin to the alar base more distally. It must be sutured to a residual alar remnant or a nasolabial flap, at the nasal base, to augment lining for a defect of the inferior nasal vault.

Intranasal lining flaps are thin and supple. Equally importantly, they permit the placement of individual shaped cartilage pieces, which shape the covering skin. These support grafts, when seen through a conforming forehead flap, recreate the appearance of a nose. They also shape and support the restored lining and the airway.

Fortunately, the raw surface left in the wake of an ipsilateral flap heals spontaneously. The septal fistula, which follows the use of the combined ipsilateral and contralateral flap or a composite flap, is largely asymptomatic. Nasal bleeding is a risk and temporary nasal crusting is inconvenient.

Intranasal flaps are relatively morbid, however, especially in the elderly, and are destructive to the residual intranasal anatomy even though they work. Practically speaking, the primary limitation of intranasal flaps is their dimension. Although dramatically useful in smaller defects, as the size of the defect increases, the capability of the technique is easily overreached. An intranasal flap may be inadequate in dimension. Its distal margin may necrose. The reconstructed nostril can be too small, leading to stenosis and malposition of the nostril margin.

Intranasal lining flaps remain an important technique; however, I use them infrequently. The exception is the heminasal or subtotal loss when the combinations of ipsilateral and contralateral flaps or a composite septal flap are effective.

### Three-Stage Full-Thickness Forehead Flap

More recently, forehead skin has been transferred as a three-stage full-thickness forehead flap.\(^1\) The forehead is multilaminar, consisting of external skin, subcutaneous fat, frontalis muscle, and a thin underlying areolar layer. It is thick and stiff. Practically speaking, the surgeon needs its “skin,” not the “forehead,” to resurface the nose. The three-stage approach elevates a flap without initial thinning and adds an intermediate stage between transfer and pedicle division. During the intermediate operation, the flap is re-elevated with 2 mm of subcutaneous fat to create thin supple cover. Primary and delayed primary cartilage grafts are combined with extensive excision of the underlying soft tissue excess to shape a subsurface framework before pedicle division. The “thin” skin flap is returned to the recipient site. The pedicle is divided later at a third stage.

The technique maximizes the flap’s vascularity and improves the final result. The need for late revisional surgery is minimized in major nasal defects, those with large skin losses, and those in which both skin and cartilage are missing. Just as importantly, it became apparent that the three-stage technique lent itself to a modification of the traditional folded method of nasal lining. This modified folded lining technique provides a simple, efficient, and widely applicable method for lining replacement that can be applied to most common nasal defects. The three-stage full-thickness flap with an intermediate operation permits the technique of the folded flap for lining to be reborn.

### Modified Menick Folded Flap

The modified Menick folded flap method has unique characteristics. A full-thickness flap is highly vascular and can tolerate being turned in to line a defect. Once healed, the folded lining becomes integrated into the residual normal lining and is no longer dependent on the vascular supply of the proximal forehead flap for survival.

Importantly, the reconstructed lining remains soft and supple. Unless the subcutaneous fat is injured or the frontalis excised, wound healing is not initiated in a forehead flap. The soft tissues within a folded three-stage full-thickness flap remain soft and are easily manipulated during the intermediate operation, between initial transfer and division.

At the first stage, primary support grafts are placed only in areas in which adjacent vascularized lining is intact. They are not placed within the folded aspect of the flap, which replaces both cover and lining. Although primary support cannot be effectively placed to support and shape the folded flap initially, it can be placed in a delayed
primary fashion, during the intermediate operation between transfer and flap division.

The flap, along the future nostril margin, is divided between its proximal cover and distal lining components 4 weeks after transfer. Proximal forehead skin is elevated completely off the nose with 2 to 3 mm of fat. This exposes excess soft tissue, composed of the doubled layers of frontalis, fat, and the underlying healed lining. The excess fat and frontalis are excised. The underlying soft and supple lining, healed to adjacent normal lining, is then shaped and supported with delayed primary support grafts in any area in which they were precluded at the time of initial transfer. Old primary cartilage grafts can be reshaped, carved, or augmented as needed during the intermediate stage, if they were imperfectly designed or had shifted.

Although forehead skin is used for cover and lining, the donor defect is minimally enlarged because the lining extension is harvested above distal edge of the traditional covering flap in an area normally discarded as a dogear on forehead closure. Even in a short forehead, if a few hairs are carried on the distal flap, they appear as inconsequential intranasal “vibrissae.”

Although an additional intermediate stage is required to thin the flap and place delayed primary support, the interior of the nose is not injured, bleeding and crusting are avoided, and the initial transfer is less complicated and time consuming. During the intermediate operation, old primary grafts can be reshaped, augmented, or repositioned if necessary; soft tissue sculpted into a nasal shape; and delayed primary grafts placed to shape any unsupported areas. Practically speaking, thin vascular cover, shaped support, and missing lining are integrated, to the surgeon’s advantage. The use of this modified technique of nasal lining has become the workhorse of my practice.

PRINCIPLES AND TECHNIQUE OF THE MENICK MODIFIED FOLDED FLAP FOR LINING
Stage 1: Flap Transfer

A full-thickness forehead flap is outlined to replace missing external skin (Figs. 1–4). The cover

Fig. 1. (A–D) Nasal deformity after traumatic injury. The patient is missing the full-thickness of the right ala and adjacent nostril sill.
template is positioned vertically over its supratrochlear artery base. At the same time, the lining deficit is defined and a second exact template is positioned distally on the forehead, in continuity with the cover flap. The lining replacement is added as an extension of a full-thickness forehead flap. Two to 3 mm of extra length is added between these two templates to permit easy folding.

Forehead height is not a limiting factor. The lining extension lies in the area normally discarded, as a dogear, on closure of the donor site. The donor site suffers minimal extra injury. If the lining template must extend into the hairline, any transferred follicles simulate intranasal vibrissae and can be trimmed postoperatively, if necessary.

The forehead flap, as a single cover and lining unit, is elevated, with all its layers, from its distal end to its proximal base. The distal lining extension of the full-thickness forehead flap is folded inward and sutured to the residual mucosal lining about the margin of the defect with fine absorbable sutures. The more proximal aspect of the flap is folded back onto itself to supply nasal cover. It is sutured to the external skin of the recipient site in one layer. This creates, in the area of folding, an external layer of skin, subcutaneous fat, frontalis, and areolar tissue resting against an inner layer of areolar tissue, frontalis muscle, subcutaneous fat, and skin, which replaces the missing lining.

No primary cartilage support is placed within the folded flap. Primary cartilage grafts can be placed in neighboring areas of superficial injury, however, if normal residual vascularized lining remains intact. For example, if the defect combines a partial-thickness defect of the tip with a full-thickness defect of the ala, primary cartilage grafts are positioned to repair the tip loss, where vascularized lining remains. In the adjacent area of full-thickness alar loss, the lining is replaced with the distal extension of the forehead flap. No cartilage is placed within the folded flap. The proximal flap is turned back on itself to resurface the entire external skin deficiency.

**Stage 2: The Intermediate Operation**

Three to 4 weeks later, during an intermediate operation, the forehead flap is physiologically delayed (Figs. 5–8). Its blood supply is significantly augmented. The proximal aspect of the forehead flap, which was designed for cover, can be widely re-elevated and thinned with impunity. Even more importantly, its folded distal extension, which was designed to line the repair, is now integrated into the residual normal lining and is no longer dependent on the proximal forehead flap and its supratrochlear pedicle for blood supply.

**Fig. 2.** (A–C) The nasal subunits are marked with ink. The scarred ala is released at its base. The defect is recreated. The defect includes cover and lining for the right ala and extends on to the nasal floor to the columella. The ala will be resurfaced as a subunit.
Because the frontalis muscle is not excised or the subcutaneous plane of the flap injured during transfer, its skin remains soft and supple. Wound contraction and scarring do not occur within the transposed flap. The forehead skin, which replaces both cover and lining, conforms to delayed primary cartilage grafts placed during the second stage. This shaped architectural framework shapes the soft tissues.

The proposed ideal nostril margin is marked with ink, based on templates of the contralateral normal alar rim or the ideal, a template of the opposite normal nostril, and by direct visualization. Incising along the proposed alar rim, the flap is completely divided, separating the proximal covering aspect from its distal lining extension. The proximal flap is completely re-elevated with 2 to 3 mm of subcutaneous fat. The forehead flap becomes covering skin of nasal thinness. The proximal flap is temporarily placed to the side of the operative field.

The underlying double layer of soft tissue, residual subcutaneous fat, frontalis, areolar tissue and a second layer of areolar tissue, frontalis muscle, and subcutaneous fat are exposed. This soft tissue overlies the underlying forehead skin, which was folded for lining. It is now integrated into the residual normal lining and dependent on adjacent intact lining, rather than the flap’s pedicle, for blood supply. This excess soft tissue is excised. As the excess is trimmed, the newly transferred folded forehead skin is visualized. It is thin, supple, highly vascular, and approximately equal in thickness to the normal. It is difficult to distinguish from normal nasal lining and bleeds freely.

Unscarred, the reconstructed lining is now shaped, supported and braced against the future contraction of wound healing with delayed primary support grafts. Individual cartilage grafts are placed to recreate subunit support and shape.

The thin, supple, unscarred skin of the proximal flap is returned to resurface the recipient site. It covers the underlying fabrication of primary and delayed primary cartilage grafts and lining.

**Stage 3: The Division**

Three to 4 weeks later (6–8 weeks after beginning the nasal repair) the pedicle is divided (Figs. 9 and 10).

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**Fig. 3.** (A–C) A template of the contralateral normal left ala is used to determine the correct dimension and outline of the required skin replacement for the right ala. Templates are also made of the missing alar lining and nasal floor. Subunit covering skin, nonsubunit lining, and adjacent nasal floor are replaced with the Menick modified folded flap technique. The three templates are combined. The lining template is positioned as a distal extension of the covering flap with a few millimeters of extra tissue between them as a hinge. The nasal floor template is designed as an extension of the lining template.
SKIN GRAFT INLAY METHOD

The use of skin grafts for lining\textsuperscript{10} has also been revisited. Gillies developed the skin graft inlay method. If lining and support were lost but the overlying skin remained intact, he released scar on the undersurface of the contracted and collapsed external skin envelope. He then applied...
Fig. 5. (A, B) Four weeks later, the tissues are thick and unsupported.

Fig. 6. (A–D) The nasal subunits are marked. The future nostril margin is outlined with ink. The folded lining is no longer dependent on the covering forehead flap pedicle or blood supply. The nostril margin is incised and the forehead covering skin is elevated with 2 mm of subcutaneous fat. The underlying excess double layer of subcutaneous fat, frontalis muscle, frontalis muscle, subcutaneous fat, and forehead skin lining are exposed.
a skin graft to the raw underlying surface. When a permanent internal prosthesis was placed to splint the graft, the airway remained patent and the nasal shape was maintained. The technique was used to treat the saddlenose deformity of syphilis and leprosy.

Burget, realizing that a paramedian forehead flap is bilaminar, tunneled a cartilage graft within the subcutaneous fat between the frontalis and external skin. Completely surrounded by well-vascularized soft tissue, the cartilage graft survived. It supported and contoured the nostril margin. Because the raw undersurface of the frontalis muscle remained well vascularized, it could be skin grafted to line the repair simultaneously. The buried cartilage graft “stented” the skin grafted lining, much like Gillies’ external splint. Four weeks later, the pedicle was divided. An additional cartilage graft could be placed to support the sidewall in the superior aspect of the repair, if needed, at division.

Alternatively, a skin graft might be combined with an intranasal lining flap. In smaller unilateral defects, significant residual skin remains above the defect. A bipedicule flap of remnant vestibular skin, based on the septum medially and laterally at the alar base, is incised and transposed inferiorly to the level of the proposed alar margin. Because the marginal bipedicule flap has its own blood supply, a primary cartilage graft can be sutured to its vascularized external surface. The rim support graft does not need to be buried within the layers of a forehead flap.

After its transfer inferiorly, a secondary lining defect appears above the vascularized vestibular flap. It is repaired with a full-thickness skin graft.

Fig. 7. (A–E) The excess soft tissue is excised leaving 1 to 2 mm of subcutaneous fat adherent to the underlying reconstructed lining. It is soft and supple and bleeds readily. Based on the contralateral normal alar template, a conchal cartilage graft is positioned to support, shape, and brace the right ala.
The skin graft is vascularized by the undersurface of a full-thickness forehead flap. This precludes the placement of a primary cartilage graft, under the more superior aspect of the covering flap, to support the superior aspect of the defect. But 3 weeks later, the forehead flap can be partially re-elevated. The skin graft lining is now vascularized through the adjacent residual lining. A delayed primary cartilage graft can be placed over the previously unsupported area to shape the superior ala and sidewall at pedicle division or during an intermediate operation.

In both methods, rim support is supplied during the first stage (within a marginal pocket between the skin and frontalis of a full-thickness forehead flap or over a bipedicle vestibular flap). The superior aspect of the defect remains initially unsupported. At a second stage 3 weeks later, once the skin graft is vascularized, the flap’s pedicle can be divided or an intermediate operation can be performed. Excess soft tissue and scar is excised in the superior aspect of the defect, and a shaped plate of cartilage or bone is inserted to support the nasal sidewall and middle vault. The delayed primary graft is placed above the previously tunneled rim support graft or above the primary graft positioned over the bipedicle flap. After two or three stages, a sheet of hard tissue lies within the defect to brace the entire repair against upward retraction or inward collapse.

These lining skin grafts retain most of their original dimensions, although the aesthetic result may be less precise. Some graft contracture does occur, causing minor distortion. Unfortunately, narrowing of the internal valve is not uncommon and difficult to fix.

Still, it is a simple technique and requires less intranasal dissection than intranasal septal lining flaps. It was recommended by Burget when the nasal mucosa has been injured or is unavailable (which precludes intranasal lining flaps); in the elderly or debilitated patient (when the risk of intranasal bleeding or crusting is best avoided); or for the less demanding patient who desires a simple, less elegant repair and accepts a lesser result.

**Fig. 8. (A–D)** The thin skin covering flap, equal in thinness to nasal skin, is resutured over the thin supported lining. Four weeks later (8 weeks after flap transfer) the pedicle is ready for division.
THE MENICK MODIFIED METHOD OF SKIN GRAFT FOR LINING

The development of the three-stage forehead flap, with an intermediate operation, has broadened the application of skin grafts for nasal lining. The Menick modified method of skin graft for lining was developed to permit placement of a complete and ideally shaped cartilage framework, before the completion of wound healing. Its principles are similar to those of the folded flap lining technique.

**Stage 1**

A full-thickness forehead flap is highly vascular. A full-thickness skin graft routinely takes on the deep areolar surface of a full-thickness forehead flap. Unlike the raw bleeding surface of a two-stage forehead flap in which the frontalis and subcutaneous fat have been excised, the areolar surface of a full-thickness forehead flap provides a reliable and dry bed onto which a skin graft can be applied with success.

An exact pattern of the lining defect is outlined and transferred from the postauricular area. The full-thickness skin graft is sutured with fine absorbable materials to the adjacent residual normal mucous membrane. The skin graft replaces missing lining in the area of full-thickness loss.

Because a primary cartilage graft placed between a skin graft and the undersurface of the flap interferes with revascularization, primary cartilage grafts are precluded in the area of skin graft lining replacement. Cartilage support can be placed over normal residual vascularized
lining, however, adjacent to the full-thickness defect.

Support grafts are not placed in soft tissue tunnels within the flap’s subcutaneous tissue. This avoids a thick nostril rim and soft tissue injury and scar. It is also difficult to design a tunneled cartilage graft with the correct size and shape or to position it correctly within a tunnel. Although useful, pocketed cartilage grafts provide only limited control over nasal form. They are no longer used.

After placing the lining graft, a full-thickness forehead flap is transferred to resurface the nose, based on an exact template of the recipient cover requirement. It provides a vascular bed for the lining skin graft. The flap is sutured to the recipient site with a single layer of fine absorbable sutures. The skin graft is quilted to the overlying vascular bed of the forehead flap. It is also splinted with a sponge bolus, placed within the nostril for 3 to 4 days to immobilize the repair and apply stabilizing pressure.

**Stage 2**

At 4 weeks, the skin graft is integrated into the adjacent normal residual lining and is no longer dependent on the covering flap for its blood supply.

Occasionally, the skin graft fails. Practically speaking, it often takes 1 to 2 weeks to be sure. Once identified, the granulating bed on the undersurface of the forehead flap is sharply debrided and a second graft applied (the forehead flap does not need to be re-elevated from the recipient site). Because the frontalis muscle is not excised during the initial procedure, the subcutaneous plane of the full-thickness forehead flap remains uninjured. Wound healing and fibrosis are not initiated. The flap remains soft and noncontracted, even if the skin graft fails to take and must be reapplied. A full-thickness forehead flap is thicker and stiffer than forehead skin alone. The intrinsic thickness of the flap acts as a brace and limits early distortion caused by scarring on its undersurface. Significant early scar contraction does not occur. Although

![Fig.10. (A–D) Postoperatively, overall quality, outline, and contour of the nose and nasal floor have been restored. The forehead scar is minimal. Subunit cover, non-subunit lining, and missing nasal floor had been restored with a folded forehead flap. No revision was performed.](image-url)
the final result is delayed and an additional stage required, the overall result is not impaired.

At the second stage (4 weeks after flap transfer), the covering skin with 2 to 3 mm of subcutaneous fat is incised along its periphery and completely re-elevated, creating thin supple cover of nasal thinness. It remains soft and supple. It is temporarily positioned to the side of the operative field.

Excess subcutaneous fat and frontalis, which lay over the skin graft, are exposed. This excess soft tissue is excised down to the newly reconstructed lining. The skin graft remains thin, relatively supple, and highly vascular. It is difficult to distinguish from normal lining and bleeds readily. Unscarred, it can now be shaped, supported, and braced against future wound contraction with delayed primary cartilage grafts. Individually designed subunit cartilage replacements are positioned to restore the aesthetics and function of the nose. An alar margin batten is fixed to support and shape the nostril margin and to support the airway against collapse. A sidewall brace is placed to support the middle vault and against upward retraction. A complex cartilage framework is restored in a single operation.

Once a complete cartilaginous framework has recreated a subsurface shape, the thin supple forehead skin flap is replaced over the delayed primary cartilage grafts, the sculpted soft tissue, and restored skin graft lining. It is sutured along its periphery and fixed with percutaneous quilting sutures to eliminate dead space and conform the flap to the recipient site bed.

**Stage 3**

Four weeks later (7–8 weeks after forehead flap transfer) the pedicle is divided. This modified skin graft technique for lining is reliable, efficient, and effective for the repair of small, full-thickness nasal defects. Most importantly, it permits the combination of skin graft lining and a complete, sculptured support framework.

Skin graft “take” is routine, although a second graft may be required in 20% to 30% of cases. All repeat grafts have taken. Even if the initial skin graft fails, the final result is not impaired, although an additional stage is required to replace the skin graft. An initial skin graft loss delays pedicle division for 12 weeks, however, rather than the routine 6 to 8 weeks normally required for an uncomplicated three-stage skin graft technique.

Scar contraction and secondary distortion are modest. A delicate alar rim can be created. The technique should be limited, however, to lining defects of 0.5 to 1.5 cm in size. The risk of poor skin graft take and subsequent contraction increases as the size of the lining defect increases. Moderation in the use of the method is recommended.

It is especially useful in the elderly or the 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 precludes the use of intranasal lining flaps. Overall morbidity, as in the folded flap technique for lining, is minimal. The occasional poor revascularization of skin graft lining and the requirement for another application, however, can make repair tedious. Equal or better results can be obtained with the folded forehead flap lining technique. The modified folded flap lining technique is the preferred option. The skin graft lining method is alluring, but not as attractive. I rarely use it anymore, but it should be in one’s armamentarium and it can be helpful, especially in a salvage situation.

The modified folded forehead flap and modified skin graft lining techniques are recommended for moderate-sized defects of the nose. They are excellent choices for most common full-thickness nasal defects. Both methods are reliable, less complex, require little intranasal manipulation, shorten the operating time, and are associated with minimal morbidity. Because of their simplicity, they are applicable to almost all patients. They are especially attractive in the smoker, the elderly, those with unassociated medical illness, or when intranasal lining flaps are unavailable.

I rarely use skin grafts for lining today. I use the folded flap method for all defects less than 3 cm in size. The folded forehead flap lining technique is my everyday solution to complex nasal problems. The ease of its use and its good results make it my first choice. Because of its reliability, it is preferred over the skin graft technique for even small defects. All available lining options should be considered for any specific defect but, in my practice, the modified folded technique is my first choice for all small and moderate defects.

**THE USE OF DISTANT MICROVASCULAR TISSUE**

Distant tissue can provide large amounts of vascularized tissue to repair a large, complicated wound caused by trauma or massive cancer excision, to protect exposed vital deep structures, and to control infected or radiated beds. Distant skin, however, does not match facial skin in quality. Microvascular transfer of distant tissue is used for “invisible” requirements. Distant skin on an exposed visual surface always looks like a patch.

Microvascular distant flaps are used to line the nose and oral cavities and supply soft tissue bulk...
and vascularity. Then, conventional techniques, using local grafts and regional flaps, are applied to resurface facial units and the nose. Free flaps \textsuperscript{20} can line the nose in complicated cases, but the external surface of the repair is restored with a forehead flap.

As long as the microvascular flap is thin enough to line the nose, without stuffing the airway, and has a long enough pedicle to pass from the defect to the available recipient vessels, the specific microvascular tissue or its exact design is of little importance. More critical is a careful preoperative analysis of the anatomic defect (the site, size, and position of missing tissues) and the aesthetic deficiencies that require replacement (the nose and lip-cheek platform).

A technique that permits modification of local and distant tissues to recreate conforming cover, shaped support, and thin lining is vital. Staged repairs are planned to recreate the defect; reposition the normal to its normal position; build a stable facial platform; and, sequentially, supply lining, support, and cover. The three stage full-thickness forehead method permits a timed integration of cover, lining, and support, which can restore the three-dimensional character of a normal nose. Success is determined by the surgeon’s ability accurately to define the tissue and aesthetic requirements, his or her ability to coordinate available local and distant tissue, and the effectiveness of shaping these tissues into a nose. The specific microvascular donor or the number of paddles is secondary. Each defect is different. Only a thoughtful approach, which meets the needs of the specific problem, and careful modification of all transferred tissues work.

**PRINCIPLES OF FREE FLAP LINING**

The normal nose is projected and positioned on the lip and cheek. If missing, the facial platform must be restored, often at a preliminary operation. \textsuperscript{10,21–23} Major defects are filled with the bulk of a truncal free flap (often a latissimus or scapular flap, which replaces soft tissue and bone) as needed. Then the nose is recreated on a stable facial base.

Identify the nasal needs (cover, support, and lining). Although visually enormous, the typical full-thickness defect is limited to a few centimeters of lining loss within the projecting aspect of the nose. Lining may be missing over the tip and dorsum, but the rest of the nose remains. The dorsal and caudal septum is largely intact. Such limited lining losses can be replaced with local tissue.

Massive, more complicated defects typically have lost lining for the nasal vault, columellar, and the nasal floor. The septum may be completely absent. The residual lining may be unavailable because of prior injury or irradiation. Such wounds require distant free-flap lining because simpler options are unavailable or less reliable.

The vault spans from alar base to alar base and projects anteriorly to the tip. Although easily underestimated, about 8 cm of skin is required to arc, transversely, from one alar base to the other, across the nasal tip. Vertically, 4 cm of skin is needed to span from nasal root to tip and an additional 3 cm is needed to line the back of the columella. Re-establishment of vault lining is straightforward. It must simply drape across a central support, which prevents its collapse into the pyriform aperture.

The columella, for practical purposes, requires only a soft tissue backing to envelope cartilage support and to line the posterior surface of a covering forehead flap. The columella must be long enough to project the nose and narrow enough to maintain patent nostrils and open airways without obstruction. If the internal septum is absent, the septal partition is not reconstructed. To avoid stuffing the airway with transferred tissue, a septal fistula is accepted.

The nostril floor (sill) is the skin platform onto which the nose is placed. In many cases, the floor remains intact. If it is absent, it is often restored before the nasal repair during a preliminary operation. It may also be reconstructed at the time of free-flap transfer with local tissue or part of the free flap.

A floor deficiency may be obvious after excision or trauma, especially if an open wound is present or, by history, if the lip has suffered extensive injury. The loss of the floor or sill is less apparent, however, when the injury is caused by cocaine or other intranasal processes. Clinically, the upper lip retrudes or retracts inward, creating a “monkey lip” deformity, because of the contraction, which follows intranasal lining injury. This is identified by displacement and posterior angulation of the upper lip. The lip is pulled inward and adheres to the pyriform aperture, across the lip and alar bases. This must be corrected by lip release and skin replacement under the future alar and columellar bases.

The reconstruction is planned in stages. The initial goal is to supply lining for the inner surface of the nose. A radial forearm flap is usually used as a skin-only flap. Its fasciocutaneous layer is excised, except for the fascia over the radial vessels. This soft tissue connection maintains its vascular connections to the overlying skin paddle.
Fig. 11. (A, B) Shotgun injury with total nasal loss, skin grafted cheek, and exenteration.

Fig. 12. (A–E) Skin excised from right cheek. Missing cheek soft tissue bulk and nasal lining supplied by a free radial forearm flap draped over a reconstruction plate and temporary cadaver rib grafts for dorsal support. The distal aspect of the radial flap is folded back on itself to provide its own covering skin. No columella lining is restored. A fasciocutaneous extension flap fills the nasal floor defect after the release of upper lip retraction. The raw cheek surface of the skin is grafted.
Survival of the free flap must be ensured. Swelling is allowed to resolve before going forward with cartilage grafts and cover. Later, during forehead flap transfer, the lining flap can be thinned more aggressively (and safely) and more extensive support placed.

Some months later, subcutaneous fat is excised under loupe magnification almost to forearm skin. The vascular leash is maintained. Then a complete, shaped support framework is placed. The lining and cartilage framework is resurfaced with forehead skin, which matches the face in color and texture.

The free flap is placed with its skin surface inward for lining. Its external surface is temporarily covered with a full-thickness skin graft or, more often, folded onto itself to provide vascularized skin for temporary external cover. Folding the flap on itself establishes a cleaner initial wound, initiates less scarring within the repair, and allows for greater flexibility at the time of forehead resurfacing.

If underlying support is completely absent, folding the lining flap on itself also allows a cantilevered dorsal graft to be placed initially. This prevents the lining from collapsing into the pyriform aperture and establishes a preliminary projecting dorsal nasal line.

If the height of the residual native septum is adequate, the flap is simply draped over the remaining septum. The skin of the radial flap is sutured to the periphery of the defect, positioning the raw soft tissue externally.

If the septum remains but has been partially resected, it can be swung out of the nasal cavity as an inferiorly based composite septal flap. The septal flap is transferred during a preliminary operation. This helps restore the dorsal line and provides support for the free flap lining and additional dorsal unit grafts.

If residual central septal partition is missing (eg, cancer excision, cocaine injury, or immune disease), it is not reconstructed. Local or distant tissue is too thick to rebuild the septum without creating an airway obstruction. A large septal fistula is largely asymptomatic. The surgeon only provides lining for the vault and backing for the columella.

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In smaller defects, the floor defect can be repaired with local tissue. If available, the cheek is advanced and the nasal floor defect repaired with a nasolabial skin.

Alternatively, external skin of the residual nose that will be discarded can be de-epithelialized on its deep surface and hinged on its lateral alar base. These bilateral local flaps are sutured in the midline of the lip to resurface the nasal floor.

A larger tissue loss within the floor is replaced with extensions of the nasal lining free flap. They can be designed in continuity, as an extension of the lining flap (a random or fasciocutaneous extension), or as a separate paddle with an axial pedicle of radial vessels.

Building a long thin columella and maintaining patent airways is the most difficult challenge. The goal is a lined soft tissue envelope that contains cartilage support, projects the tip, separates the airways, and provides a backing for the columellar extension of a forehead covering flap. The septal partition is not reconstructed.

Fig. 13. (A, B) Subsequently, the skin graft is excised and the cheek resurfaced with an advancing Schrudde cheek flap.
SEVERAL OPTIONS EXIST TO RESTORE COLUMELLAR LINING

The lining flap can be designed with an incontinuity columella extension. Although slightly smaller in size, it has the same outline as the forehead flap used for external cover. Its skin surface is positioned inward to line the nose. Its external raw surface of the flap is skin grafted. This is considered if the septum is intact and strong central support remains to maintain projection and nasal length. Unfortunately, it is very easy to short-change the defect and fail to re-establish a long columella and ample open nostril margins. Scar contraction and gravity are difficult to overcome, if dorsal support is not in place initially. In general, this approach is avoided.

At the time of vault replacement, the free flap can be draped under a cantilevered dorsal graft, placed for initial support. The radial flap is folded back on itself distally, in the general area of the future nostril margin, to cover its own outer surface and protect the dorsal graft. Lining for the columella is not initially provided (Figs. 11 and 12).

Some months later, the folded external skin is hinged inferiorly and trimmed along the proposed nostril margins, except for a central extension of skin, which is unfolded, turned inward and “tubed” (opened outward) to create internal lining for the columella partition, which envelopes a columellar...

Fig. 14. (A–E) Subsequently, the external radial skin is hinged downward, folded, and trimmed to recreate nostril margins and a posterior backing for the future columella. Autogenous rib grafts are placed as a dorsal strut, columellar strut, tip graft, and bilateral alar margin battens. The nose is covered with a full-thickness three-stage paramedian forehead flap.
support graft. The distal tip of the columellar flap is sutured into a de-epithelialized columellar inset site in the midline of the lip (Figs. 13–16).

If care is taken to design a long columella and ample nostril apertures, this works. The results are better than in the previous method because edema has resolved, more aggressive thinning is possible after maturation of the free flap, and a strong complete support framework can be placed simultaneously with lining and a forehead flap. The rims and columella must be rigidly but trussed by cartilage grafts. Secondary revisions are likely, however, to revise the airways and open the nostril margins.

Lining is most successfully designed by infolding the free flap on itself to create columella, vault lining, and nostril margins. This is similar to the old traditional technique of folding a distal forehead flap on itself to provide its own cover and lining. This method can produce a long columella, arching vestibules, and elegant nostril rims.

The radial forearm flap is transferred to the defect and its blood supply re-established. The external skin side of the flap is pinched centrally, between the surgeon’s fingers, along the planned distal nostril margin. This approximates the underlying raw flap surface to itself. The raw surfaces of the future columella are folded against each other.

Fig. 15. (A–E) During the later intermediate operation, forehead skin was elevated with 2 mm of subcutaneous fat and the underlying excess soft tissue and cartilage grafts sculpted into a nasal shape. The thin flap was returned to the donor site. The pedicle was later divided and a revision performed.
and sutured along their free margin to approximate the skin surfaces to one another. This creates a columella with an external skin surface and bilateral membranous septal epithelial surfaces. Its length is adjusted by altering the height of the pinch and infolding, more or less. This soft tissue columella is advanced upward under the more proximal aspect of the flap. As the flap is folded under, it lines itself, creating vault lining and nostril margins. The deepest, most superior aspect of the fold is fixed centrally with an absorbable suture to the raw undersurface of the overlying free flap surface to maintain its position. The length of the columella, the nostril margins, and the depth of the membranous septum are easily adjusted by manipulation of the design.

Two months later, after resolution of edema and wound healing, the proposed nostril margins are marked. Excess external forearm skin is excised. Folded skin along the rim is hinged over, as needed, and trimmed to design the ideal nostril rim. The external skin surface of the healed reconstructed columella is split to allow inset of the forehead flap. A complete cartilage support framework is placed to support, shape, and brace the repair.

This design is the first choice. It is simple, easily adjustable intraoperatively, and permits the creation of a long columella and capacious arching nostril margins. Smooth, arching, unscarred nostril margins and vestibular lining are established. The flap’s infolding adds a degree of soft tissue support, which is invaluable in the early postoperative period. The continuity of the columella and nostril margin maintains an open airway until permanent support is placed. Temporary cadaver grafts can also be used, until definitive support is placed during a later stage. This method does not attempt to recreate a deep septum partition, which may occlude the inner airway.

In some cases, a remnant of the native columella and adjoining scarred dorsal skin can be cut from residual nasal skin, which is otherwise discarded.

Fig. 16. (A–D) Postoperatively, overall facial and nasal form are restored. A microvascular flap provided lining. Success, however, is dependent on the exact replacement of missing tissues and their modification from “unlike” to “like” tissue. Forehead flaps, rib grafts, and forearm skin have nothing in common with a “nose.” The three-stage forehead flap technique with an intermediate operation permits the restoration of quality, two-dimensional border outline and three-dimensional contour. There is nothing magical about free flaps or their design. The surgeon only need identify and replace what is missing.
It is shifted and made available to line the columella and back the external columellar repair. Such excess can also be used to resurface a retracted nostril floor or nasal base after its release. If a stable platform is present or has been restored, a nose can be restored in four operations over 4 to 5 months. Lining is positioned with a free radial flap. Two months later, a complete support framework is established and the nose is resurfaced with a full-thickness three-stage forehead flap. One month later, the forehead flap is completely re-elevated and the soft tissues sculpted. One month later, the pedicle is divided. At this point, the overall result should be good. A revision, 4 to 6 months later, is needed to define the alar creases and nostril margins or debulk the airways. In general, if unexpected complications do not occur, the patient should be confident that his or her future is bright.

**SUMMARY**

The complexity of these reconstructions should not be minimized, but when carefully planned and executed, they progress with relatively few problems. Success is determined by the surgeon’s ability to diagnose the anatomic and aesthetic deficiencies and to integrate soft and hard tissues, rather than by the ability to perform microvascular surgery.

My practice includes a great deal of nasal reconstruction. I use the folded forehead lining technique as my routine technique. It can repair most common defects. A free flap is used in more complex cases. Other techniques are used infrequently.

**REFERENCES**