The Forehead Flap: The Gold Standard of Nasal Soft Tissue Reconstruction

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Abstract

Keywords

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- nasal lining

The forehead flap is one of the oldest recorded surgical techniques for nasal reconstruction. As the gold standard for nasal soft tissue reconstruction, the forehead flap provides a reconstructive surgeon with a robust pedicle and large amount of tissue to reconstruct almost any defect. Modifications provided by masters like Burget and Menick have only increased the utility of this exceptional flap. Maintaining an axial pattern, utilizing the pedicle ipsilateral to the defect, extending the flap at right angles with caution when extra length is needed, using a narrow pedicle, and early subperiosteal dissection are the guiding principles for forehead flap reconstruction of the nose. In addition, lining defects can be addressed simply and reliably with a folded forehead flap.

Just as rhinoplasty represents the most complex aesthetic operation, nasal reconstruction represents the most complex facial reconstruction. The nose is a complex three-dimensional structure and along with the eyes, represents a major aesthetic focus of the face. Although discussion of nasal reconstruction often focuses on the visible, aesthetic result, the functional outcome is also paramount to a successful operation. Nasal reconstruction can be conceptualized into three main components: lining, support, and coverage. Of the three, lining failure is most likely to lead to a total reconstructive failure.

There are several options for reconstructing the nasal lining, including mucosal flaps, skin grafting, local flaps, prefabricated forehead flap, three-stage forehead flap, forehead flap turnover, and free tissue transfer. In most cases requiring lining, there is only a focal full-thickness defect that is amenable to repair with a thinned folded forehead flap. If the area of lining is not local to the primary defect or extends beyond it, then one of the above-mentioned options may be needed.

The structural support of the nose is paramount for airway patency as well as aesthetic durability. Except in cases of total nasal reconstruction, as mentioned above,

most cases requiring support represent a focal defect with need for replacement of a segment of cartilage. Conchal cartilage represents an optimal choice given its location, size, and shape. The natural curvature and thickness of conchal cartilage makes it an ideal choice for structural support, especially when nonanatomic grafts are needed, such as alar rim grafts (►Fig. 1). The donor site is also favorable in that no significant aesthetic deformity results and complications are rare.

The approach to nasal coverage can be further categorized by the nasal subunits and subunit principle of reconstruction. Simply stated, there are nine nasal subunits based upon transitions in shadow between natural convexities and concavities where scars are most inconspicuous (►Fig. 2). Furthermore, if a significant portion of any given subunit is missing (e.g., > 50%) then completing excision and reconstructing the entire subunit will often lead to superior cosmetic results. Within these fundamental concepts are a multitude of unique defects with unique requirements, which necessitate the judgment of an experienced surgeon to lead to the optimal result. As is typical in plastic surgery, there are no hard and fast rules that apply for 100% of cases.

Fig. 1 Nasal subunits.

Nasal coverage can be accomplished in any number of ways, including secondary intention, skin grafting, local flaps, and interpolated flaps. This variety of options allows greater tailoring to specific patient characteristics. For example, although a staged forehead flap may lead to the best cosmetic result, a skin graft may be more optimal for a patient in whom cosmesis is not a priority, has comorbidities, or prefers a

Fig. 2 The conchal cartilage graft approximates the natural curvature of the ala.

single-stage operation. However, outside of these idiosyncrasies, when faced with a large and/or distal defect, often the choice is very clear: the paramedian forehead flap.

The Paramedian Forehead Flap

Use of the forehead for nasal reconstruction dates back to ancient India. In ~700 BC, nasal tip amputation was a common punishment for a variety of crimes. Its treatment was described in a medical treatise entitled the *Sushruta Samita*.¹⁻⁵ The technique was brought to Europe in the 1500s and finally to the United States in the 1830s by J.M. Warren.^{1,6} Once Kazanjian described the primary blood supply of the flap in the 1930s as the supratrochlear and supraorbital arteries, significant innovation in its design ensued. Millard, Gillies, and Converse, contributed significantly to this innovation, but it was Labat who was credited with designing the median forehead flap based upon a unilateral supratrochlear artery.^{7,8} Millard created the paramedian position, excluding the central glabellar skin, which reduced morbidity and maintained viability.⁷ Menick further improved upon Millard's design by making the pedicle narrower, thus affording greater versatility in movement and length.⁷

The anatomic studies of Shumrick and Smith demonstrated the position and course of the supratrochlear artery, running 1.7 to 2.2 cm lateral to the midline in a vertical vector. The artery runs in the submuscular plane to a more superficial, subcutaneous position beginning 1 cm above the brow.⁹ Knowledge of the anatomical course of the supratrochlear artery allows for more precise flap design, greater mobility, and increased pedicle length (→Fig. 3).

A well-executed forehead flap can result in the most natural-appearing, durable, and inconspicuous, if not unnoticeable, nasal reconstruction. In terms of color and texture, there is no other flap that approaches its suitability for skin matching. The only significant limitations of the flap are centered upon the investment of time and the morbidity involved in the necessary staging of the operation. Since its inception, the forehead flap has undergone a high level of innovation and change, making it the optimal choice for large nasal defects. It is traditionally limited to use for nasal defects that are too large to repair with other local flaps or full-thickness or composite grafts.^{1,3,10} A defect wider than 2 cm in the horizontal plane or those with exposed and denuded bone and/or cartilage are best repaired with the paramedian forehead flap. However, it should be considered the gold standard for all nasal reconstruction.

Patient Selection

Often, a forehead flap should not be considered a choice. It is almost uniformly the best selection and there are very few patient contraindications for its execution. One should remember that 3 to 4 weeks of flap inconvenience is a small price to pay for a lifetime of a correct nasal reconstruction.

Fig. 3 (A) Courses of the supratrochlear and supraorbital arteries. (B) Periosteal blood supply of the forehead flap. The arteries become more superficial as they travel away from the brow.

The appropriate preoperative evaluation is mandatory for its safe execution, but one should remember that if these are properly executed, they are short procedures (frequently < 1 hour) and patients do not sustain large fluid shifts or physiologic changes.

Age is not a contraindication for forehead flap reconstruction, as we have safely performed forehead flaps on numerous patients older than 90 with comorbid disease. Also, it is unnecessary to alter the patient's anticoagulation status prior to surgery. One can safely perform forehead flap reconstruction on all patients with one exception. Clopidogrel can lead to excessive bleeding, diminishing both the safety and final result of the procedure. In our experience, these flaps can be designed for safe reconstruction in active smokers.

Surgical Technique and Design Considerations

General Considerations

This operation can be performed under sedation or preferably with general anesthesia in either the inpatient or outpatient setting.

Prior to designing the forehead flap, the primary defect must be evaluated. In cases where a combined defect involving the nose and the cheek is present, evaluate and fix the cheek first, as this will reshape the nasal defect and define boundaries. The next step is to decide between performing a simple defect reconstruction versus a completion-excision and subunit reconstruction. In any given case, this represents a judgment call based upon the experience of the surgeon. If reconstructing a subunit then the contralateral "normal" subunit is used as a template.

Guiding principles for flap design and elevation include

1. Maintaining an axial pattern whenever possible
2. Utilizing the pedicle ipsilateral to the defect
3. Extending the flap at right angles across forehead with caution and only when extra length is necessary
4. Utilizing a reasonably narrow pedicle
5. Early subperiosteal dissection

Nasal Lining

The senior author has had a long history of standard combined septal mucosal and cartilage intranasal flaps for lining. He has largely abandoned these, and for the last 7 years no intranasal flaps have been used for lining. All lining needs should be met by either a two- or three-stage folded forehead flap or three-stage forehead flap combined with skin grafting on the posterior surface, as described by Menick.^{11,12} If designed properly, the distal portion of a forehead flap can provide the entire lining for heminasal reconstruction to a larger extent than previously described.⁵

For a folded forehead flap, the lining is designed with a full-pattern template with appropriate laxity to allow for folding of the distal flap to recreate the nasal lining. At the level of the alar rim, a 1-mm incision is made to "break" or speed up the rotation of the lining of flap. This cut allows a relaxed inset (► Fig. 4). The lining portion is thinned nearly maximally to the subcutaneous fat and inset with 5-0 chromic gut suture. This has proved to be markedly successful and reliable. We can return with an alar rim incision to thin it out to the appropriate nasal vestibular thickness. For larger lining requirements including columella or septum, rib is harvested to provide support as described by Gunter.¹³

For defects larger than heminasal, including both ala and tip, a folded forehead flap is not used for lining. Instead, the lining is recreated with a two-stage microvascular free radial forearm flap, again as described by Burgett and Menick.^{14,15}

Support

The majority of the cartilage or support requirements are supplied by conchal cartilage harvested from an anterior

Fig. 4 Folded forehead flap for repair of alar and nasal lining defects. (A) A cut is made at the distal portion of the flap at the alar rim. (B) The cut allows easy rotation and inset. (C) Final flap inset.

conchal bowl incision. The key to this is attaining a sufficient length of the cartilage as the entire bowl can be taken to reconstruct the ala. The donor site defect is closed with 5-0 continuous plain gut suture and through and through 4-0 Keith needles to tack the soft tissue down, minimizing the risk of a hematoma or seroma. For larger lining requirements including columella or septum, rib is harvested as described by Marin et al.¹³

Flap Elevation

The pedicle is located ~2 cm lateral to the midline near the medial eyebrow. The base of the flap is designed 1.5 cm wide to include the pedicle. The contralateral paramedian forehead flap, as discussed by Rees, is no longer advocated by the senior author.¹⁶ Recently, he has transitioned to a more traditional design, as championed by Dr. Menick, using an axial-patterned ipsilateral flap with a reasonably narrow pedicle (1.3–1.5 cm maximum width).⁷ Modifications include a narrower pedicle, axial pattern, ipsilateral rotation, subperiosteal dissection with periosteal scoring, and skin grafting at flap elevation (►Fig. 5). Avoidance of transferring hair at all times is best as postoperative hair growth on the intranasal portion of the flap leads to frequent complaints by the patient and can be difficult to deal with. In consideration of nasal reconstruction, obviously the support and lining issues need to be addressed first.

Great care and operative time is put into the correct flap dimensions for coverage. As described earlier, the flap is based on an ipsilateral 1.3- to 1.5-cm pedicle. It is Dopplered at the brow to capture the dominant arterial inflow. It is important to remember that the flap is always rotated medially. The template is based on the contralateral normal side if it is available, using either a foil pattern template or a construct of Dermabond (Ethicon, Somerville, NJ) and Steri-Strips (3M, St. Paul, MN) transferred to a foil template.

Careful consideration is made for correct orientation and a reverse Gilles test is made at the level of the brow to estimate the appropriate arch of rotation. The practitioner should remember that the flap can be pivoted at a point below the level of the eyebrow. The flap is designed with a “handle,” or essentially a dog-ear excision, adjacent to the template. The flap is handled only in that one area to avoid any trauma to the flap.

Widely infiltrating the surgical field will help define the surgical planes and minimize blood loss. Flap elevation begins distally. It is elevated thickly to the level of the galea, and then ~1 cm above the brow, the dissection is carried subperiosteally and continued over the orbital rim (►Fig. 6). We feel that this captures subperiosteal perforators and provides for a very safe flap.¹⁷ It should be remembered that if there is significant tethering or shortness of the flap, the periosteum can be scored, dissected free, or the flap can be raised above the periosteum.

The tip of the flap, for the initial 1.5 to 2 cm, is raised in the subcutaneous plane with removal of subcutaneous fat and underlying frontalis muscle. This technique creates a thin, pliable flap that will conform nicely to the underlying

Fig. 5 (A) Ipsilateral forehead flap with narrow pedicle. (B) Pivot point can be at or below the brow, always rotate medially, and graft the jelly side of flap to aid in hemostasis and wound care. (C) 7-months postop.

osseocartilaginous structure of the nose. This tissue can be safely thinned because the supratrochlear artery is in a subcutaneous plane at a level ~ 1 cm above the brow. If additional bulk or volume is needed, some of this tissue can be left attached to the flap.

Flap Inset

If properly designed, the inset should be the easiest part of the case. The amount of thinning performed at the first stage is case and patient dependent. Thinning flaps in smokers is risky and is not recommended. For the alar rim, the flap should be rolled up and in with the scar placed within the vestibule, ideally.

Great care is taken to thin the most distal, $\sim$ one-eighth of the flap as this portion will never be re-elevated. This portion should be maximally thinned to the level of thick dermis. The distal eighth is then inset and the remainder is thinned as much as the patient's condition and flap appearance allows. One must remember that if this is properly dissected and performed it is a robust flap and can tolerate a good degree of thinning (use caution in active smokers).

Donor-Site Closure

At this point, it is important to remember that properly executed, the nose will “take care of itself” and one should be able to deliver a superior nasal reconstruction. However, the forehead will not “take care of itself” and the quality of the forehead closure should not be taken lightly. It is not infrequent that if not properly done, the patient can have a near perfect nasal reconstruction with the overall result marred by a poor forehead result.

A single layer of permanent, monofilament suture is used to close the donor site. Deep sutures are used to help approximate the closure, but only as few as is necessary. It may not be possible to close the entirety of the donor site primarily. In this case, the open area can be left to heal by secondary intention or covered with a simple nonadhesive dressing, allograft, xenograft, equine products, or skin graft (**Fig. 7**). It is important not to attempt to close the donor site at the level of the rotation to prevent pinching and venous congestion of the flap. Nitropaste can be applied to aid venous drainage. The operative dressing is left in place for 2 to 3 days.

Fig. 6 The flap is elevated from thin to thick with early transition to subperiosteal.

Fig. 7 Donor site allowed to heal by secondary intention.

Fig. 8 Aggressive thinning of the flap at division and inset.

All of our forehead flaps are done as outpatient procedures, and it is incumbent upon the surgeon to leave the patient with a nonbleeding postoperative field. The posterior, raw side of the flap can represent a significant source of patient inconvenience. The importance of good hemostasis from raw edges is paramount at the end of the case. The liberal use of hemostatic agents such as Avitene (Davol, Inc., Warwick, RI) or Surgicel (Johnson & Johnson, New Brunswick, NJ) can help ensure good hemostasis. Despite these techniques and products, the best aesthetic results for the posterior side with the least patient inconvenience is achieved by simply grafting a full-thickness skin graft from the neck or the abdomen to the raw side of the flap.

Division and Inset

The second stage of the operation can be performed as early as 10 to 14 days later; however, the senior author prefers waiting a minimum of 3 weeks (preferably 4 weeks) to allow maximal vascularity and reduce edema. Once the decision is made to divide and inset, the flap can be aggressively thinned (► **Fig. 8**). For a two-stage flap, one can safely elevate over 50%

(and often up to 70–80%) of the flap at the time of division and inset.

Appropriate alar contour sutures are placed at this point to improve the shape; however, these are used with caution on maximally elevated flaps. Immediate dermabrasion can be performed in the operative setting after inset of the flap. Nitropaste is applied as a single application postoperatively, and all patients are offered both dermabrasion as needed at 6 weeks and a revision procedure at 3 months.

Postoperative Care

The majority of our forehead flaps are performed as outpatient procedures and if the above techniques have been followed then the patient is left with minimal postoperative care. If the raw side of the forehead flap has been packed with Avitene or Surgicel then the patient simply showers these off with baby shampoo and warm water on the third postoperative day. After removal, the patient resumes either Xeroform (Kendall Company, Mansfield, MA) only or ointment-only dressing changes. The inset sutures are removed at 5 to 6 postoperative days.

Results/Issues

The forehead flap is a robust tool in the arsenal of the reconstructive surgeon and overwhelmingly provides patients with excellent results (► **Figs. 9–11**). It should be considered the gold standard of nasal reconstruction and mastered by all facial reconstructive surgeons.

A patient's unique forehead anatomy greatly impacts the results. The ideal candidate for a forehead flap is bald and has significant tissue laxity and rhytides. In younger patients with low hairlines, issues relating to brow elevation, donor-site scarring, and recipient site hair growth can be significant problems.

When hair-bearing skin is included in the flap, some depilation can be performed from the underside of the flap at the initial flap elevation and inset. However, if densely populated, this can be difficult; in some patients fine vellus hair is exceedingly difficult to remove as the follicle is not

Fig. 9 (A) Ala and tip defect. (B) 2-weeks post initial operation. (C) 1-year postop.

Fig. 10 (A) Large tip and partial dorsum defect. (B) 2-weeks post initial operation. (C) 5-months postop.

Fig. 11 (A) Flap appearance after initial operation. (B) 7-months postop.

visible to the naked eye even with loupes. Subsequent laser depilation or chemical depilation may be necessary; in some cases, there still may be undesirable hair growth.

If additional length is needed and an oblique or right-angle course is taken for flap design, then significant brow elevation can occur. Tissue expansion preoperatively is

certainly an option to reduce this complication, but it represents a significant undertaking that adds length and complexity to the reconstruction, which a patient may or may not tolerate. Certainly, in lax patients, brow elevation may be desirable and a contralateral brow lift can be done for symmetry. However, in patients with good preoperative brow position, the elevation can be problematic and does not always settle.

Conclusions

The forehead flap represents the ideal reconstructive choice in many patients and can be safely and reliably performed in an outpatient or inpatient setting. Principles developed by masters, such as Burget and Menick, have guided innovation in this reconstruction. Additional principles that have improved outcomes include maintaining an axial pattern whenever possible, utilizing the pedicle ipsilateral to the defect, extending the flap at right angles across the forehead when extra length is necessary, utilizing a reasonably narrow pedicle, using early subperiosteal dissection and using the folded forehead flap for lining.

References

- 1 Converse JM. *Reconstructive Plastic Surgery*. Philadelphia, Pa: WB Saunders; 1964:797
- 2 Conley JJ, Price JC. The midline vertical forehead flap. *Otolaryngol Head Neck Surg* 1981;89(1):38–44
- 3 Converse JM. *Reconstructive Plastic Surgery*. 2nd ed. Philadelphia, PA: WB Saunders; 1977:694
- 4 Jackson IT. *Local Flaps in Head and Neck Reconstruction*. St. Louis, MO: Mosby; 1985
- 5 Burget GC, Menick FJ. Nasal support and lining: the marriage of beauty and blood supply. *Plast Reconstr Surg* 1989;84(2):189–202
- 6 Millard DR Jr. Total reconstructive rhinoplasty and a missing link. *Plast Reconstr Surg* 1966;37(3):167–183
- 7 Menick FJ. Aesthetic refinements in use of forehead for nasal reconstruction: the paramedian forehead flap. *Clin Plast Surg* 1990;17(4):607–622
- 8 Labat MDe la Rhinoplastie, *Art de Restaurer ou de Refaire Complètement la Nez* [Dissertation], Paris, France: Imprimerie de Ducessois; 1834
- 9 Shumrick KA, Smith TL. The anatomic basis for the design of forehead flaps in nasal reconstruction. *Arch Otolaryngol Head Neck Surg* 1992;118(4):373–379
- 10 Kazanjian VH. The repair of nasal defects with the median forehead flap; primary closure of forehead wound. *Surg Gynecol Obstet* 1946;83:37–49
- 11 Menick FJ. A 10-year experience in nasal reconstruction with the three-stage forehead flap. *Plast Reconstr Surg* 2002;109(6):1839–1855, discussion 1856–1861
- 12 Menick FJ. A new modified method for nasal lining: the Menick technique for folded lining. *J Surg Oncol* 2006;94(6):509–514
- 13 Marin VP, Landecker A, Gunter JP. Harvesting rib cartilage grafts for secondary rhinoplasty. *Plast Reconstr Surg* 2008;121(4):1442–1448
- 14 Menick FJ. Facial reconstruction with local and distant tissue: the interface of aesthetic and reconstructive surgery. *Plast Reconstr Surg* 1998;102(5):1424–1433

- 15 Burget GC, Menick FJ. The Aesthetic Use of a Free Flap. In: Aesthetic Reconstruction of the Nose. St. Louis, MO: Mosby; 1994:431–461
- 16 Rees TD. Aesthetic Plastic Surgery. Philadelphia, PA: WB Saunders; 1980
- 17 Reece EM, Schaverien M, Rohrich RJ. The paramedian forehead flap: a dynamic anatomical vascular study verifying safety and clinical implications. *Plast Reconstr Surg* 2008;121(6):1956–1963