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Extended Bilaminar Forehead Flap With Cantilevered Bone Grafts for Reconstruction of Full-Thickness Nasal Defects

Jason K. Potter, DDS, MD, Yadranko Ducic, MD, FRCS(C), FACS,† and Edward Ellis III, DDS, MS‡*

The nose forms a prominent esthetic highlight of the face, as well as having significant functional importance. Acquired nasal defects of the nose may arise as sequelae of trauma, inflammatory processes, or, most commonly, cutaneous neoplasms. Nasal reconstruction has remained a challenge to the reconstructive surgeon despite advancements in surgical technique. As the size of the defect increases, so do the technical demands of the repair. Subtotal and total nasal reconstruction (replacement of cover skin, structural framework, and lining) and other large full-thickness nasal defects present significant difficulties in terms of adequate restoration of form and function. Regardless of the etiology of the defect, primary objectives of the repair include restoration of acceptable nasal appearance with maintenance of proper nasal function. Full-thickness nasal defects require replacement of all 3 nasal lamellae—external skin, structural framework, and lining—to achieve these goals.

It has been demonstrated that primary reconstruction of the structural framework with cartilage and/or bone grafts at the time of replacement of cover skin leads to improved anatomic nasal form and aesthetic outcome.[1-3] Providing support to the soft tissues during healing prevents unwanted soft tissue contraction and collapse. It is generally desirable to graft more structural material in a reconstructed nose than that found in nonoperated individuals. Regions such as the ala, which normally harbor no cartilage, require grafting to give the final nasal reconstruction form and to prevent collapse.

The placement of structural components requires the presence of vascularized tissue on both the lining and cover surfaces of the grafted supporting material. Commonly, a pedicled paramedian forehead flap provides vascularized cover skin. Vestibular mucosa and septal mucosa flaps are ideally suited to provide vascularized lining tissue. However, soft tissue defects that include both the nasal septum and large portions of the vestibular mucosa create a challenge to providing adequate vascularized lining and cover tissue simultaneously. Previous reports have described staged procedures, the use of a second local flap, or free tissue transfer to provide lining to circumvent this problem.[4-6]

We describe a modification of the paramedian forehead flap with a distal pericranial extension to provide vascularized lining tissue to support primary placement of structural grafts at the time of initial repair. The tissues are elevated as a single flap with the pericranial tissues folded into the nasal vestibule to form septal and vestibular lining tissue. The pericranial flap subsequently undergoes mucosalization. We have used this technique in 9 patients with a variety of nasal deficiencies (Table 1). This technique has allowed primary placement of both cartilage alar grafts and dorsal nasal bone grafts simultaneously at the initial repair of full-thickness defects without resorting to microvascular lining flaps.

Technique

The supratrochlear vessels are located with a Doppler probe, and their path is marked on the overlying skin. The pivot point for the flap is medial and slightly inferior to the brow. A standard paramedian forehead flap[7] is designed following the course of the supratrochlear vessels based on this pivot point. The distal end of the flap should in general remain within

*Formerly, Resident, Oral and Maxillofacial Surgery, University of Texas Southwestern Medical Center, Dallas, TX.

†Associate Professor, Otolaryngology/Head and Neck Surgery, University of Texas Southwestern Medical Center, Dallas, TX; and Director, Otolaryngology and Facial Plastic Surgery, John Peter Smith Hospital, Fort Worth, TX.

‡Professor, Oral and Maxillofacial Surgery, University of Texas Southwestern Medical Center, Dallas, TX.

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Address correspondence to Dr Ellis: Division of Oral and Maxillofacial Surgery, University of Texas Southwestern Medical Center, 5323 Harry Hines Blvd, Dallas, TX 75390-9109; e-mail: Edward.Ellis@UTSouthwestern.edu

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FIGURE 1. Photograph showing outline of the forehead flap (ink) to reconstruct the entire tip and columella of the nose. The path of the supratrochlear vessels is also shown in ink within the flap's pedicle. The dashed white lines outline where the pericranium will be incised.

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FIGURE 2. Photograph showing the forehead flap after its dissection from the pericranium (*white arrows*) and elevation to the level of the brow.

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the hairless portion of the forehead skin. A template based either on the normal side (reversed) or on the patient's preexcision nasal form is used to transfer the exact shape of the acquired defect to the distal end of the flap. A No. 15 blade is used to perform the incision along the outline of the flap. The incision is made through the subcutaneous tissue layer. Sharp and blunt dissection is used to carry the dissection through the galea at the distal aspect of the flap. It is important to stay within the subgaleal layer and to not incise into the pericranium at this time. The scalp adjacent and superior to the forehead flap is widely undermined in the subgaleal plane. A sagittal incision extending from the superior aspect of the forehead flap into the hairline may be necessary to improve access to the pericranium superiorly. Later, modification of this incision will also aid in primary closure of the donor wound without a standing cutaneous cone deformity. The proposed incision through the pericranium is outlined with a marking pen, ensuring that the pattern is slightly larger than the dimensions of the previously designed template. The pericranium is then incised and carefully elevated in a distal-to-proximal direction with periosteal elevators, taking care to maintain its attachment to the distal end of the forehead flap (Fig 1). The distal skin portion of the forehead flap may be elevated for a distance of 3 to 4 cm from the underlying pericranial flap and thinned as deemed necessary (Fig 2). We have found it is easier to create the pocket for graft material between the skin flap and pericranium before elevation of the pericranium from the frontal bone. The remainder of the forehead flap is then elevated full thickness to the level of the brow.

A moist sponge is placed into the donor site and the flap is transposed into position. If cantilevered bone grafts are necessary, they should be positioned and secured into position, preferably before elevation of the forehead flap (Fig 3). A stab incision may be placed in the pericranium parallel to the long axis of the flap to allow passage of bone grafts. This allows bone grafts attached to the nasal dorsum to assume a position between the vascularized lamellae (Fig 4). Alternatively, the pericranial flap can be divided into

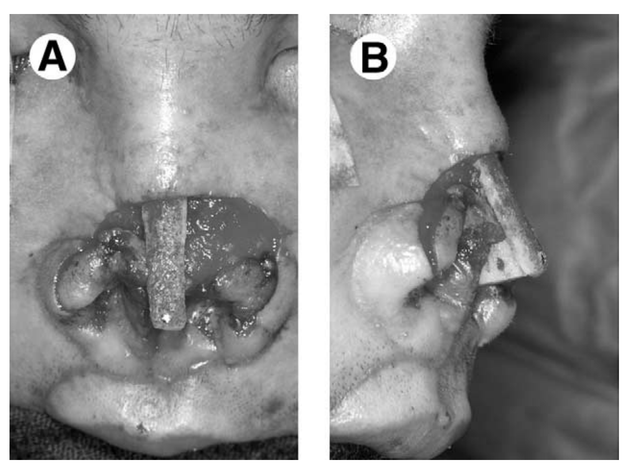

FIGURE 3. Frontal (*A*) and lateral (*B*) photographs showing reconstruction of the nasal skeleton using bone grafts. One graft is secured to the dorsum and the other to a groove cut in the maxilla above the anterior nasal spine. A microscrew is used to join them at the tip.

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FIGURE 4. Photograph showing pericranial flap pierced by the bone grafts. Arrow indicates the microscrew used to secure 2 grafts together. The pericranial flap can then be used to line internal nasal defects.

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2 and each used to provide internal lining (Fig 5). The pericranium is then draped around the bone grafts and fashioned to line the vestibular surface of the nasal cavity (Fig 6). The pericranium is sutured into position with 4-0 chromic gut or Vicryl suture. This separation of the extended forehead flap into a bilaminar structure also allows for placement of this flap into through-and-through midnasal defects. Nonanatomic alar grafts are fashioned as indicated and placed into a pocket between the covering skin and the pericranium. Final inset of the forehead flap then

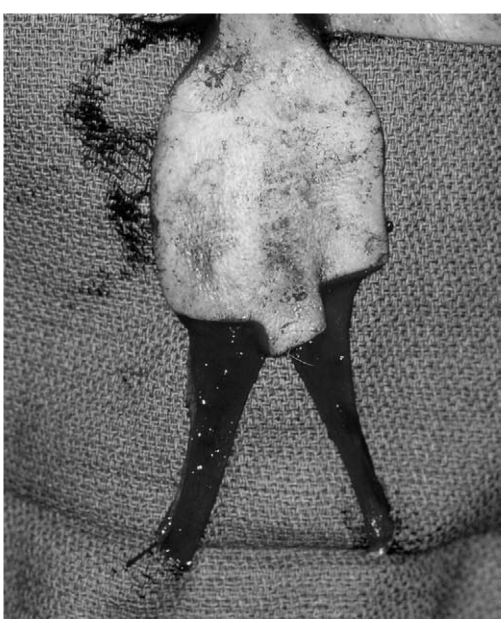

FIGURE 5. Photograph of a different patient showing how the pericranial flap can be divided if necessary, providing 2 separate pericranial flaps.

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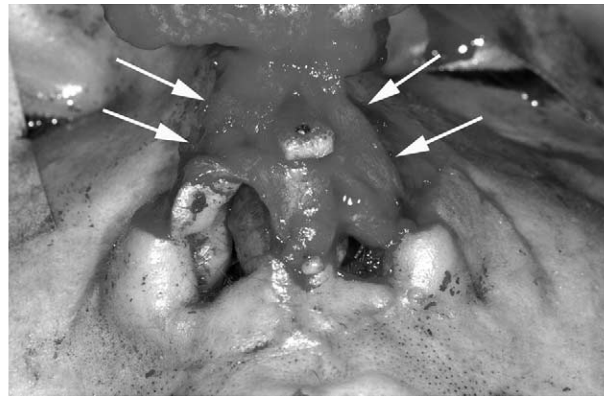

FIGURE 6. Photograph showing pericranial flap lining the internal nasal defects (*white arrows*) before providing any additional skeletal support to the tip (ie, cartilage) and before insetting the skin portion of the forehead flap.

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proceeds in a layered fashion. The initial inset is performed with 5-0 Vicryl in the dermal plane, and the skin edges are approximated with 6-0 nonabsorbable interrupted sutures (Fig 7). The donor site is closed primarily with 2-0 Vicryl dermal sutures. As much of the cutaneous donor defect as possible is closed without tension with interrupted nonabsorbable sutures. Any remaining defect is then treated with Xeroform (Kendall-LTP, Chicopee, MA), Adaptic (Johnson & Johnson, New Brunswick, NJ), or similar material until complete wound closure has been achieved. Figure 8 shows the patient several months later.

Discussion

Nasal reconstruction using the paramedian forehead flap dates back to the Ayur Veda of Sushruta in

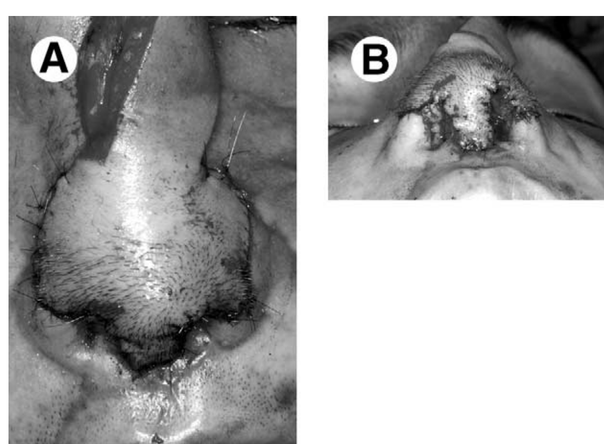

FIGURE 7. Frontal (*A*) and inferior (*B*) views of nose after closure of the forehead flap.

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FIGURE 8. Frontal (*A*), profile (*B*), and inferior (*C*) views of patient several months after take-down of the flap and one debulking procedure. The patient has undergone several laser treatments to remove the hair from the flap.

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800BC India, who used a pedicled forehead flap to reconstruct the external nose following punitive amputation.[2,8] Western acceptance of the technique did not occur until much later. The first English-language written account of the technique appeared in the *Madras Gazette* in 1793 and was reproduced in the *Gentleman's Magazine* of London in 1794. Carpue, an English surgeon, was the first to perform and report the technique in the Western world. He reported 2 successful cases of pedicled forehead flap nasal reconstruction in 1816 and stimulated a new era of reconstructive surgery in Europe.[2,8]

The importance of replacing lining tissue was not appreciated until the mid to late 1800s. Surgeons began to recognize that cicatricial contracture of unlined flaps had deleterious effects on the external morphology and airway function.[2] Reports of folding the distal end of pedicled forehead flaps in onto themselves to provide lining soon followed. The technique successfully created lining tissues but exposed other shortcomings. In-folding of the skin flap produced thick, shapeless alar margins, and the bulk of tissue transferred did not allow creation of nasal tip definition. Accurate placement of primary structural elements was mostly ineffective. Techniques to turn over adjacent cheek or nasal skin were reported, but they involved similar difficulties.[2]

The interdependence of nasal support and lining has been described in detail by Menick.[4] Skin grafting and vestibular/septal mucosal flaps are simple and effective methods to recreate lining tissue. Assuming the septum is intact to maintain central nasal support, small full-thickness nasal defects may be adequately treated combining a forehead flap, simultaneous placement of a full-thickness skin graft, and delayed placement of support grafts. In the case of total or subtotal loss of nasal tissues, these techniques are inadequate for several reasons. Large nasal defects with resultant loss of the septum and destruction of the cartilage skeleton require placement of vascularized lining tissue to sustain primary placement of support struts and grafts. Frequently, with significant through-and-through nasal defects, there is insufficient vestibular and septal mucosa to replace the missing lining tissue.

Options for vascularized tissue include cheek or nasal skin turn-in flaps, free tissue transfer, and pericranial flaps. The disadvantages of turn-in flaps have been mentioned. Free tissue transfer significantly increases the difficulty, operating time, cost, and potentially the bulk of the tissue transferred. Both free tissue transfer and use of additional local flaps increase the number of donor sites and therefore patient morbidity. Pericranial flaps offer the advantage of being within the same donor site.

Pericranial flaps have been widely used for various reconstructive procedures about the face. These flaps consist of the periosteum of the skull and the overlying connective tissue. Pericranial flaps are reported to have excellent vascularity and blood supply. When these flaps were based anteriorly, Argenta et al[9] reported the flaps to be supplied by deep divisions of the supraorbital and supratrochlear vessels running in an axial fashion. Perforating vessels from the galea and calvarium complement these. Argenta et al suggest creating wide-based flaps and dissecting the pericranium free of the galea only enough to allow rotation, to preserve as many supplemental perforators as possible. No study to date has assessed the in vivo viability and perfusion of pericranial flaps.

Brackley and Jones[10] reported the use of a pericranial flap for replacement of lining tissue for reconstruction of a full-thickness defect of the nasal dorsum. The forehead flap and pericranium were elevated as separate flaps based on the same-side vessels. This combination of flaps allowed primary placement of cartilage grafts for nasal side wall support. The authors also reported epithelialization of the flap at longest follow-up.

We have reported the modification of the paramedian forehead flap for full-thickness defects of the nasal lobule. The flap is bilaminar, providing a distal pericranial extension for creation of lining tissue when vestibular and septal mucosa are lacking. This flap design has several advantages. Elevation of the forehead flap and pericranium as a single entity preserves galeal perforators into much of the pericranium, maximizing flap vascularity. The scalp can be undermined superiorly through the same donor defect to allow harvest of the pericranium without need for additional incisions and without increasing the size of the forehead defect. The pericranium can be draped around bone grafts and/or a pocket can be created between the pericranium and skin flap for placement of cartilage grafts. The pericranium undergoes epithelialization. Disadvantages include the need to debulk and revise the thickness and definition of the soft tissues over the nasal lobule as described by Menick.[1]

In summary, this technique has proved to be successful for the reconstruction of complicated through-and-through nasal defects of the nasal lobule, even those associated with loss of the nasal septum. Inclusion of a pericranial extension provides a source of vascularized lining tissue that will support primary placement of structural elements, without increasing the difficulty of the procedure or morbidity to the patient.

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