Simplifying the Forehead Flap for Nasal Reconstruction: A Review of 420 Consecutive Cases

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Background: The forehead flap is an important tool in nasal reconstruction. The authors present objective data and recommendations based on over a decade of consecutive forehead flap nasal reconstructions performed by the senior author (J.F.T.). In addition, the authors separate the technique into its individual steps and provide details of the senior author's approach to each.
Methods: The authors performed a retrospective analysis of patients who underwent nasal reconstruction with the forehead flap over a 10-year period performed by the senior author (J.F.T.). Each case was evaluated for defect location, pedicle design, time of division, number of stages, use of cartilage grafts, lining reconstruction, donor-site closure, and complications.
Results: Four hundred twenty patients underwent forehead flap nasal reconstruction. Average time to pedicle division was 32 days. Three-fourths of patients completed reconstruction in two stages. Defects most commonly involved the nasal ala and tip. Approximately half of patients received cartilage grafts and half underwent lining reconstruction. There were 16 complications, ranging from partial flap loss to postoperative death ($n = 1$).
Conclusions: Confidently grasping the nuances of forehead flap nasal reconstruction arms the reconstructive surgeon with a reliable tool that can effectively treat a variety of defects. It is safe to use in an outpatient setting even in elderly patients. Recommendations include ipsilateral flap design and turn-in component as the first choice for lining replacement. (*Plast. Reconstr. Surg.* 140: 371, 2017.)
CLINICAL QUESTION/LEVEL OF EVIDENCE: Therapeutic, IV.

Significant composite nasal defects are most commonly encountered following oncologic resection, and reconstruction often requires the use of local and regional flaps.[1] One of the workhorses for significant nasal defects is the paramedian forehead flap. Its use in nasal reconstruction dates back to approximately 500 BC in India with the written description of the median flap to reconstruct an amputated nose in the *Sushruta Samhita*.[2] Our understanding of the forehead flap has been altered and improved on over time, from the initial pedicled forehead flap work by Carpue[3] to Millard,[4,5] Menick,[6] and Reece et al.[7] This flap remains an excellent option for a wide range of nasal defects.

The senior author (J.F.T.) has a robust experience in nasal reconstruction and the use of the forehead flap for management of nasal deformities. In addition to presenting data from over a decade of consecutive forehead flap nasal reconstructions, we divide the various components of the technique and present the details of his approach to each. This article provides the reconstructive surgeon with a comprehensive framework with which to confidently approach and efficiently execute nasal reconstruction with the forehead flap.

PATIENTS AND METHODS

This study was approved by the University of Texas Medial Center Southwestern Institutional

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Review Board. We performed a retrospective review of patients undergoing nasal reconstruction performed by the senior author from 2004 to 2014. Patients were included in the study if they underwent forehead flap reconstruction. If patients underwent another type of nasal reconstruction or if they had forehead flap reconstruction but lacked sufficient documentation regarding number/timing of procedures (i.e., those lost to follow-up), they were excluded from the study. Data collected for analysis included patient age, defect location (by subunit involvement), flap design (axial design based on ipsilateral pedicle versus "Parkland design" based on contralateral pedicle), use/type of cartilage grafts, use/type of lining reconstruction, number of stages, time to pedicle division, and technique used to manage the donor site. Cases were also evaluated for complications including but not limited to partial/total flap loss, wound dehiscence, hematoma, infection, poor result, and/or donor-site complications.

Technique

The senior author has modified his technique over the past decade based on this extensive experience. The most important evolutions/revelations include the following: (1) designing an ipsilateral flap ("axial design") when able; (2) the first choice for lining defect is a turn-in forehead flap; (3) advanced age (older than 80 to 90 years) by itself should not negatively influence decision to perform forehead flap nasal reconstruction; and (4) anticoagulation can be safely continued, with the exception of clopidogrel. Detailed below is the senior author's current approach to each aspect of forehead flap nasal reconstruction.

Patient Selection

The vast majority of patients are met on the day of surgery (in this series, only 4 percent of patients were evaluated before the day of reconstruction). This underscores the value of being able to quickly evaluate defects and develop a detailed reconstructive plan that can be discussed with the patient and family immediately before surgery. A brief but thorough educational process is undertaken with representative photographs and a discussion of immediate postoperative care requirements.

Candidates for forehead flap reconstruction should be willing to undergo reconstruction after attaining an understanding of all that the procedure entails. Forehead flap reconstruction is not appropriate in patients who are unable to care for the flap until division/inset or when life expectancy is not amenable to a prolonged reconstructive course. Anticoagulation, with one exception, is not an issue. The senior author routinely instructs patients to continue their anticoagulation, unless they take clopidogrel.

Before Incision

The initial stage (and the second stage in a three-stage reconstruction) is performed under general anesthesia. Division and inset are performed under intravenous sedation alone. The entire face, anterior scalp, and bilateral ears (front and back) are prepared in standard sterile fashion. If costal cartilage may be required, a separate sterile field is created over one anterior hemithorax.

Lining

Mucosal defects are classified as small or large. Small lining defects are amenable to primary closure. If primary closure of the defect would narrow the nasal airway and/or distort the shape of the nose, it is classified as large. Large mucosal defects should always be reconstructed with well-vascularized tissue. This is important to (1) prevent contracture and (2) support underlying cartilage grafts, which are often required in reconstructions with large lining defects.

Well-described local flap options for large mucosal defects include the bipedicle mucosal advancement flap, the ipsilateral septal mucoperichondrial flap, and the folded forehead flap.[8–10] The folded forehead "turn-in" flap has become the senior author's first choice for any lining defect requiring a flap. It is readily available, minimal additional donor-site morbidity is added, and, most importantly, it provides well-vascularized tissue for the reconstructed lining. In this technique, the forehead flap is designed with a distal component for lining. Before elevating the flap, a beaver blade is used to score the flap along the junction of the alar rim and lining portions of the flap. The incision is made no deeper than dermis, thereby preserving the subdermal blood supply. When insetting the flap, this transdermal alar rim incision facilitates folding of the lining component over the alar rim cartilage graft (Fig. 1, *above, left*). When placed properly, the scar is imperceptible (Fig. 1). Whether a two-stage or three-stage flap, the senior author maximally trims the lining portion to several millimeters of subcutaneous tissue under the skin so that it does not require reelevation for thinning. Very large defects involving both ala/soft triangles and the entire tip (i.e., bilateral defects) are managed with either a free radial forearm flap[11,12] or a three-stage forehead flap with late cartilage placement.

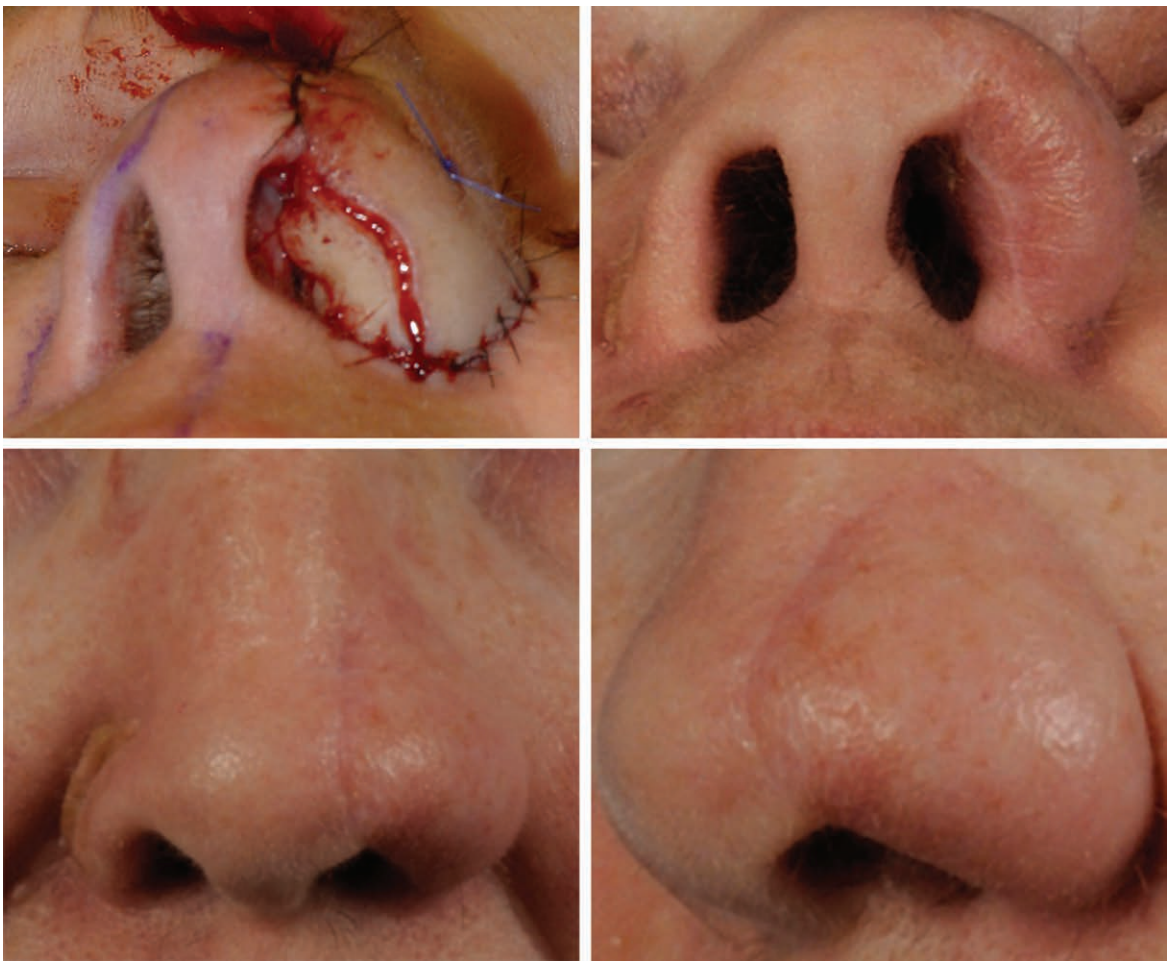

Fig. 1. (*Above, left*) Intraoperative photograph of alar rim incision after inset. (*Below, left*) Frontal and (*below, right*) lateral views, 1-year follow-up postoperative result. (*Above, right*) Basal view, 1-year follow-up postoperative result.

Framework

If cartilage is required in the reconstruction, the preferred donor site is ipsilateral conchal bowl cartilage. If additional cartilage is needed, costal cartilage is harvested.

Concomitant Defects of the Cheek

In cases that involve combined cheek and nasal defects, the cheek defect is repaired first to provide the stable platform needed before undertaking nasal repair. Cheek defects can almost always be addressed with a local advancement flap. The senior author developed an algorithm[13] based on the size and location of the defect, which he uses for all defects with cheek involvement.

Pedicle and Flap Design

Ipsilateral (axial) flap design (Figs. 2 through 4) is preferred. The Parkland design (Figs. 5 through 8) is selected if one is unable to avoid the hairline or a scar with an ipsilateral design. The supratrochlear artery is identified at the superior orbital rim (the pivot point) using an external Doppler device, and the flap is designed with its width centered on the pedicle. Although a narrower pedicle design allows a greater arc of rotation, we do not narrow the flap more than 13 to 14 mm, to minimize flap congestion. Superior pull from a short pedicle creates deformities that are difficult to correct and compromise final aesthetic outcome (e.g., alar retraction, alar notching, inadequate projection, overrotation); therefore, pedicle length is just long enough for tension-free inset.

Flap shape is designed by using suture package tin foil to make a template of the defect[14] (Fig. 5, *right*). The template is made using normal contralateral nose subunits when available. The template is first cut large enough to cover all involved subunits on the normal side of the nose. The template is then reflected across the midline onto the defect side and cut down until it covers the defect

Fig. 2. Preoperative photograph of right nasal defect and ipsilateral forehead flap design.

Fig. 3. Intraoperative photograph of ipsilateral (right) flap after inset and primary closure of the donor site (same patient as in Figure 2).

perfectly. The template is temporarily sutured into place to perfectly cover the defect to ensure proper dimensions. The flap is traced from the foil template. Great care is taken to avoid including scalp hair in the flap, as this will inevitably lead to some degree of dissatisfaction with the reconstruction. Dog-ear excision for the distal donor site is

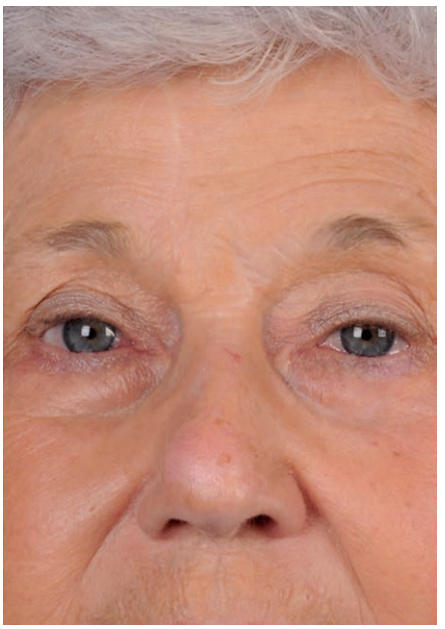

Fig. 4. One-year postoperative follow-up for the patient in Figures 2 and 3.

designed as a small triangle at the distal edge of the flap and serves as a "handle" during flap elevation. This minimizes trauma related to direct handling of flap skin. If the distal flap is needed as a turn-in component for lining, the dog-ear excision is designed with adequate dimensions so the turn-in flap can come from this portion of the flap. If a turn-in component will be used, the transdermal alar rim incision between this portion of the flap and the lobule portion should be made before elevation (Fig. 5, *right*). Cartilage graft, if needed, is then sewn in place before flap elevation.

Elevation and Inset

The flap is raised distal to proximal. The "handle" is elevated first and used to hold countertension. Subgaleal dissection then proceeds until we have raised the flap within 3 cm of the supraorbital rim. At this point, a transition to subperiosteal elevation to incorporate the periosteal branch of the supratrochlear artery in the pedicle is performed.

If two stages are planned, the distal flap is maximally thinned because this portion of the flap will never be reelevated. In the second stage of a two-stage flap (pedicle division and final inset), the flap is elevated up to 80 percent from proximal to distal (leaving the distal/inferiormost portion of the flap attached) and the remainder of flap thinning is performed.

If a three-stage flap is planned, the distal flap is not thinned before inset. Rather, this is performed

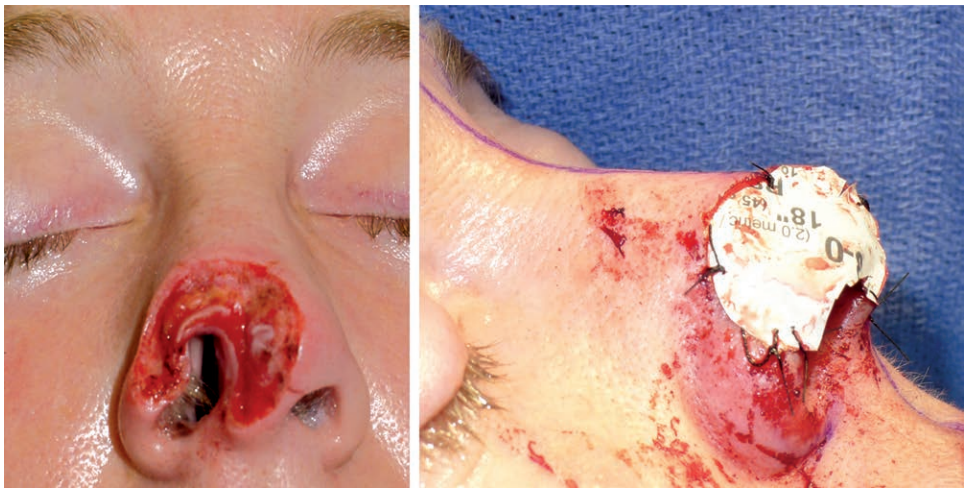

Fig. 5. (*Left*) Full-thickness defect involving multiple right nasal subunits. In this case, it is especially important to center the nose and mark the midline and bilateral nasal subunits accurately. (*Right*) Tin foil template made from the contralateral alar lobule/tip (sewn in place for the purpose of the photograph).

in the second operation. If there is a lining component in a three-stage flap, only the lining component is maximally thinned, and the remainder of the flap is left thick. In the second stage, the flap will be reelevated at the "transdermal alar rim incision" (dividing it from its lining component). Pedicle division and thinning of the proximal flap is performed in the third operation. Planning three stages and deferring distal flap thinning at the time of the first operation ensures maximum vascularity in the distal flap, which is beneficial in patients with questionable distal flap vascularity (because of smoking history and/or medical comorbidities) and large defects that would benefit from minimum contracture during healing.

Fig. 6. Forehead flap designed from the template in Figure 5. The *asteris*k marks the triangular portion of the flap, which functions as a handle during elevation and/or is trimmed and inset to replace the lining defect. If to be used for lining, a beaver blade is used to make a transdermal incision along the alar rim line (*arrow*) before flap elevation.

Donor-Site Closure

Primary closure is undertaken only if it can be done without causing (1) flap congestion, (2) brow distortion, or (3) more than moderate tension on the forehead closure. Sometimes, only a portion of the defect can be comfortably closed. In these instances, the remaining forehead defect is simply allowed to heal by secondary intention, which, in our experience, yields as fine a result as any other procedure (Fig. 8).

Postoperative Care

Postoperative bleeding from the raw (open) surface of the pedicle can be a significant source of discomfort and anxiety at the patient's home. In the operating room, we apply a microfibrillar collagen hemostatic agent (Avitene; C. R. Bard, Inc., Warwick, R.I.) to the raw surface and wrap the pedicle with Surgicel (Ethicon, Inc., Somerville, N.J.). High-functioning, reliable patients can be instructed to gently wash the dressing off in the shower with baby shampoo on the third postoperative day. More commonly, patients have the dressing removed by a nurse in our clinic or at home. A similar dressing can be reapplied for 2

Fig. 7. (*Left*) Intraoperative and (*right*) early postoperative views of the donor site after forehead flap harvest (same patient as in Figure 5).

Fig. 8. One-year postoperative result after allowing the donor site to heal by secondary intention (same patient as in Figures 5 and 6).

more days if needed. Patients that are dependent on eyewear are allowed to wear their glasses after the third postoperative day (reminding them to avoid pressure over the pedicle). By postoperative day 5, wound care is simplified to topical ointment twice daily along the incision lines. The donor site is managed with twice-daily ointment to incisions and wet-to-dry dressings for any open areas. Sutures are removed on postoperative day 6 or 7. Flap division is scheduled for 4 weeks after the initial procedure.

RESULTS

A total of 420 patients underwent forehead flap nasal reconstruction from 2004 to 2014 (Table 1).

Table 1. Patient Characteristics

Characteristic	Value (%)
Average age, yr	67.8
Two-stage flaps	317 (75)
Three-stage flaps	103 (25)
Days from flap to division/inset	32
Average no. of procedures	2.23
Pedicle location	
Contralateral	80 (19)
Ipsilateral	322 (77)
Central	15 (4)
Defect location by subunit	
Sidewall	250 (60)
Ala	287 (68)
Soft triangle	122 (29)
Columella	40 (10)
Dorsum	198 (47)
Tip	255 (61)
Nasal lining	
ATT mucosa	40 (10)
Fold-in/turn-in	28 (7)
Acellular	22 (5)
Graft	148 (35)
Cartilage	239 (57)
Rib graft	5 (1)
Skin graft over pedicle	
FTSG	115 (28)
STSG	4 (1)
Complications	
Total	16 (3.8)
Tip necrosis	6
Donor site	2
Complete flap loss	2
Poor cosmetic result	2
Hematoma	1
Partial flap loss	1
Mortality	1
Cancer recurrence	1

FTSG, full-thickness skin graft; STSG, split-thickness skin graft.

The average age of the patients was 67.8 years (range, 28 to 98 years). Patients had a wide range of defects, with nasal ala (68 percent of patients) and tip (61 percent of patients) being the most commonly involved subunits. Most flaps (77 percent) had ipsilateral (axial) flap design (versus the Parkland design). Cartilage grafts were used in 57 percent of reconstructions (only 1 percent of all reconstructions used costal cartilage grafts). The same proportion (57 percent) of patients underwent some form of lining reconstruction. Donor sites were closed primarily in 72 percent cases. The majority of patients (75 percent) completed reconstruction in two stages (overall average, 2.23 stages per patient). Average time to pedicle division was 32 days.

There were 16 complications (3.8 percent), with five complications (7 percent) in patients older than 80 years. The most common complication was tip necrosis, defined as necrosis to the tip that was not full thickness, which occurred in six patients (1.4 percent). There were two patients that had complete flap loss, and there was one postoperative death. There was no statistically significant difference in complication rate in patients aged 80 years and older versus patients younger than 80 years ($p = 0.1494$).

DISCUSSION

Our patient characteristics are similar to those of other large series in the literature when evaluating defect location and average number of procedures performed.[7,15,16] The patient selection for forehead flap nasal reconstruction must consider the nasal defect and the patient's ability to undergo the procedures and care required to complete reconstruction.

Our series has the largest subset of patients aged 80 years and older who underwent forehead flaps, with a total of 74 patients. Anesthesia selection is a strong consideration for these patients, particularly given the risk of complications related to type and frequency of anesthesia application in the elderly population.[17–19] However, although this population benefits from conservative anesthesia techniques, we have found that forehead flap reconstruction is well tolerated in elderly patients, with no statistically significant difference in complication rate compared with younger patients.

The reliance on the normal contralateral nose cannot be overstated, as it is very difficult to design a flap for adequate reconstruction based on the defect only. Considerations given regarding defect-only reconstruction versus subunit reconstruction have been discussed elsewhere. Briefly, we practice both techniques and feel that it is up to the operating surgeon to develop his or her own personal algorithm regarding this, as both techniques have validity.

The pedicle is routinely found by means of Doppler signal. The senior surgeon understands that even though the anatomical location of the artery is quite reliable, we still feel there is an added degree of safety with the Doppler signal, which allows for a much narrower flap design. As stated previously, one must strike a balance between narrowing the pedicle to increase arc of rotation and designing a pedicle of adequate width to safely capture the axial supply and minimize congestion.

Although good flap design and inset are critical for optimal aesthetic outcome, framework support and lining reconstruction are equally important for restoring form and function. More than half of our patients required lining and cartilage for reconstruction, whereas the

Fig. 9. (*Left*) Patient referred for complex deformity after full-thickness skin graft reconstruction. (*Right*) Intraoperative photograph of the same patient after scar excision and conchal cartilage graft placement. Marking the midline and nasal subunits on both sides of the nose (seen here in purple marker) can be helpful in defining the defect and designing an accurate template in complex defects crossing multiple subunits.

Fig. 10. (*Left*) Early postoperative appearance of the patient in Figure 9. Ipsilateral design was used. (*Right*) One-year postoperative result of the patient in Figure 9.

aforementioned studies required lining or cartilage in only a minority of their patients.[6,15,16] The management of mucosal defects has changed throughout the senior author's (J.F.T) practice. Local mucosal flaps[20] have been largely abandoned by the senior author, as they have been

unreliable, and his first choice is now to use the forehead flap skin for turn-in lining.

Ipsilateral flap design (Figs. 2 through 4) is preferred because the distal flap maintains an axial blood supply and the contralateral donor site is not violated. The main disadvantage of an ipsilateral design is that it can be more challenging to design a flap of sufficient length without going into the hairline, especially in patients with short foreheads. The benefits of the traditional Parkland flap design (Figs. 5 through 8) (i.e., it requires less pedicle rotation and avoids the hairline) do not outweigh the risk of disrupting the viability of the contralateral donor site as a future reconstructive option. Moreover, the working portion of the contralateral flap is based on a random blood supply. These disadvantages have led the senior author away from using the Parkland design such that he now reserves it for patients with very short foreheads and when forehead scar precludes use of an ipsilateral (axial) design. Ipsilateral design is often possible without significantly violating the hairline even with complex distal defects (Figs. 9 and 10).

The single postoperative death in our series was an elderly gentleman who had a forehead flap performed on an outpatient basis and whose antiplatelet therapy was discontinued. He returned to the emergency room, without communication with the operating surgeons, days later with active bleeding and, through a therapeutic misadventure, was given anticoagulation that resulted in a cardiac event and subsequent death. We now have patients continue their anticoagulation throughout the nasal reconstruction. We have not experienced any compromise to final reconstructive outcome as a result of this practice. Our experience has shown that patients may be operated on while on therapeutic doses of anticoagulation without any additional complications, provided that the surgeon is meticulous in achieving hemostasis intraoperatively. The one caveat to this is patients who are on clopidogrel. In our experience, clopidogrel leads to excessive bleeding, which increases operative difficulty and, more importantly, decreases patient safety.

There have been a number of soft-tissue epidermis/dermis adjuncts[21–26] that have been used to facilitate forehead wound healing; however, our clinical series has shown no great improvement in wound healing compared to traditional wound care, and each of these topical agents carries significant cost. The one exception is that, occasionally, in an elderly patient, there will be exposed calvaria from a poor harvest, and these patients

CODING PERSPECTIVE

Coding perspective provided by Dr. Raymond Janevicius is intended to provide coding guidance.

15731	Forehead flap with preservation of vascular pedicle (e.g., axial pattern flap, paramedian forehead flap)
15600	Delay of flap or sectioning of flap (division and inset); at eyelids, nose, ears, or lips

- A forehead flap is reported with code 15731.
- Code 15731 is global and includes the following:
  - Elevation of the flap
  - Dissection and preservation of the vascular pedicle
  - Transfer of the flap to the recipient site
  - Trimming, thinning, or other adjustments to the flap to allow for inset
  - Inset of the flap
  - Direct closure of the donor site
- Lesion excision (1164X) and recipient-site wound preparation (15004) are reported separately, as these are not included in forehead flap code. Thus, the excision of a 2-cm basal cell carcinoma of the nasal tip, with forehead flap reconstruction, is reported as follows:

15731	Forehead flap
11642-51	Excision of basal cell

- Division and inset of the flap are reported with code 15600.
- Since division and inset occur during the global postoperative period of code 15731, modifier 58 is appended: 15600-58.

CODING PRINCIPLE: Although the forehead flap is an axial pattern flap, and contains fascia, it is not considered a fasciocutaneous flap to be reported with code 15732. This would be upcoding. Code 15731 was specifically created to report forehead flap procedures.

Disclosure: Dr. Janevicius is the president of JCC, a firm specializing in coding consulting services for surgeons, government agencies, attorneys, and other entities.

are managed with initial placement of Integra (Integra LifeSciences, Plainsboro, N.J.) and late grafting, as exposed bony defects can provide significant morbidity in this patient population.

CONCLUSIONS

Forehead flap nasal reconstruction is safe and efficacious for a wide range of patients and nasal defects. Patient selection should focus on determining patient comprehension and willingness to undergo the multiple-stage reconstruction and ability to comply with postoperative care. We have found that elderly patients tolerate this form of reconstruction as well as young patients, provided that their anesthesia risks are minimized. It is common for reconstructions to require cartilage grafts for framework support and/or lining reconstruction to maximally restore form and function. We completely abandoned columellar mucosal soft-tissue flaps for lining because of unreliability. Donor-site closure should not be performed at the expense of flap perfusion or eyebrow distortion, as healing by secondary intention yields a solid final cosmetic result.

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PATIENT CONSENT

Patients provided written consent for the use of their images.

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