

Single-staged Tunneled Forehead Flap for Medial Canthal and Eyelid Reconstruction

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Purpose: The paramedian forehead flap, while initially used for reconstruction of nasal defects, has been adapted for repair of anatomical subunits in the medial canthal and eyelid area. A significant obstacle for utilizing the flap has been the bulky, unsightly vascular pedicle that is maintained between surgical stages. We describe our surgical experience using the tunneled variation in a single stage procedure.

Methods: A retrospective chart review was performed of three surgeons' charts over a 5-year period. All patients who underwent the tunneled paramedian forehead flap variation were selected. Outcomes measured included underlying pathology, Mohs defect area and depth, and canalicular involvement.

Results: A total of 20 tunneled flaps were performed after successful Mohs excision of cutaneous malignancies. The average Mohs defect surface area was 13.57 cm² with depth down to periosteum (n = 13), bone (n = 5), or orbital fat (n = 2). Five patients had full-thickness eyelid defects (25%), and nine (45%) had canalicular defects. The overall complication rate for this study was low with no flap failure. Two patients (10%) desired thinning of the subcutaneous flap for improved cosmesis, and one patient (5%) required further eyelid revision due to the complexity of the initial Mohs defect. The remaining 17 patients required no further surgical procedures.

Conclusion: The tunneled paramedian forehead flap is a useful technique for medial canthal and eyelid reconstruction. This technique allows reconstruction of a challenging area. Complication rates are low, and this tunneled variation provides a single stage variation to the traditional multistage forehead pedicle flap. (*Plast Reconstr Surg Glob Open* 2022;10:e4223; doi: 10.1097/GOX.0000000000004223; Published online 22 April 2022.)

INTRODUCTION

The medial canthal region is a common site for malignant skin tumors.¹ These tumors generally have a low risk for metastasis, but considerable invasive potential causing risk of eyelid, canalicular, and globe malformation with possible orbital invasion. Complete surgical excision with negative histological margins is the gold standard

for treatment.¹ Reconstruction of the resultant medial canthal defect provides a unique challenge to the plastic surgeon. The medial canthal region has minimal skin laxity, thin subcutaneous tissue, and has a characteristic concave curvature (umbra). In addition, the region includes many other structural components including the canthal tendons and lacrimal drainage system. Violation to any of these structures after Mohs excision can leave the patient with significant functional deficits.¹⁻³

Medial canthal defects can be managed in several ways ranging from healing by secondary intention to a combination of flaps and or skin grafting.⁴ The surface area, location, and depth of the defect ultimately determine the optimal reconstructive technique. Defects down to periosteum or bone are often associated with inadequate vascularity. This makes free skin grafting unpredictable, and risks graft failure, lower eyelid retraction, cicatricial ectropion and inadequate correction due to graft contracture.^{4,5} Myocutaneous flaps including advancement, rotation, and transposition flaps are often used for larger defects with significant depth. The paramedian forehead flap is a useful transposition technique as it provides

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adequate tissue volume, surface area, and a robust blood supply.⁵ The paramedian forehead flap, while initially used for reconstruction of nasal defects, has been adapted for repair of other anatomical subunits of the face, including the medial canthus and eyelids.^{6–10}

The paramedian forehead flap is an axial pattern, interpolated flap based on the supratrochlear artery and vein. It has aesthetic and functional advantages due to its location, axial design, narrower pedicle, and effective length.^{11,12} The paramedian flap is traditionally managed as two or more staged procedures. Multiple staged flaps are ideal for larger defects with significant volume loss, and in patients with concern for the vascular supply such as smokers or those with healing issues.^{13,14} The second stage of flap division and inset is usually done at 3–4 weeks. The pedicle is transected, and the forehead defect is closed primarily in the glabellar crease.^{9,12}

When performing a two or more staged procedure, a common patient complaint is the bulky, unsightly vascular pedicle that is maintained several weeks between surgical stages. In addition, the fullness of the pedicle flap may obscure the natural concavity of the medial canthal area creating functional issues such as spectacle wear. Thus, there is potential for multiple surgeries to achieve acceptable functional and aesthetic outcomes.^{15,16} In addition, many patients cannot afford the time or cost of additional operative procedures, or have significant pre-existing medical conditions where the risks for return to the operating room outweigh the benefits which may preclude multiple operative procedures.

For medial canthal and eyelid reconstruction, single stage modifications of the paramedian flap have been described in dermatologic and plastic surgery literature.^{8,9,16–18} We review our experience over a 60-month period using surgical variations to previously described techniques for medial canthal and eyelid reconstruction. This study presents the technique and results in 20 patients with medial canthal and eyelid defects. In addition, we include two case examples where the single stage tunneled flap proved to be the optimal surgical solution.

METHODS

A retrospective chart review was performed of three surgeons' charts (the senior authors) over a 5-year period. Using the CPT code 15731, a search was conducted through the electronic medical records. The charts of all patients who underwent the tunneled paramedian forehead flap were reviewed. Outcomes measured were underlying pathology, Mohs defect area and depth, canalicular involvement, and amount of follow-ups. All patients except one were followed through postoperative month (POM) 6 with an average follow-up time of 8.2 months. This one patient was seen through POM 3, and then lost to follow-up despite multiple attempts to contact the patient. Statistical calculations were performed using Excel functions from the data set.

All procedures performed in studies involving human participants were in accordance with the ethical standards of the office of the institutional review board, Department

Takeaways

Question: Can the paramedian forehead flap be used in a single stage to repair medial canthal and eyelid reconstruction?

Findings: This study retrospectively looked at 20 cases over a 5-year period where the tunneled single stage flap was used. Many of the cases were complex and included canalicular and/or full-thickness eyelid involvement. There was no flap failure, and only two patients desired thinning of the flap for improved cosmesis.

Meaning: This study showed that the tunneled single stage variation of the paramedian forehead flap allows for reconstruction of a challenging area with low complication rates.

of Clinical Investigations at the 59th Medical Wing, and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. The study was granted a waiver of informed consent by the institutional review board at the 59th Medical Wing as it involved no more than minimal risk to the individuals and their privacy. The data are Health Insurance Portability and Accountability Act compliant. Demographic and clinical data from the initial examination, surgical charts, and follow-up visits were recorded in a de-identified database. Signed patient photograph consent was obtained for all identifiable clinical photographs.

SURGICAL TECHNIQUE

The medial canthal/eyelid defect for each patient is measured for surface area (cm²) depth, and structures involved (Fig. 1A). A custom template is then created in the superior 1/3 of the forehead based on the contralateral supratrochlear artery (Fig. 1B). The supratrochlear artery can be identified using a handheld Doppler probe, or demonstrated anatomically. The skin flap is marked on the forehead, and an incision is made down to the subgaleal plane around the template previously created down to the frontalis muscle (Fig. 1C). Dissection is then carried down to the brow and orbits and transitions to a subperiosteal plane to protect the supratrochlear vessels. An incision is then made on either side of the fashioned pedicle based on the supratrochlear artery down to the orbital rim. (Fig. 1D). To secure the blood supply to the flap, care is taken to leave the pedicle attached at its pivot point while creating the tunnel. To ensure venous drainage of the flap, the base does not extend below the medial canthal horizontal line. In addition, to facilitate the rotation at the pivot point, pedicle dissection in the subdermal plane is extended beyond the skin incision on both sides.^{15,18}

Undermining is then performed toward the defect in the subcutaneous plane. The cranial portion of the skin flap was defatted and thinned to correspond to the thickness required for the surgical defect, taking care not to overly thin the flap. Subcutaneous dissection from the base of the flap across the glabella into the medial canthal/eyelid defect is created with facelift scissors.

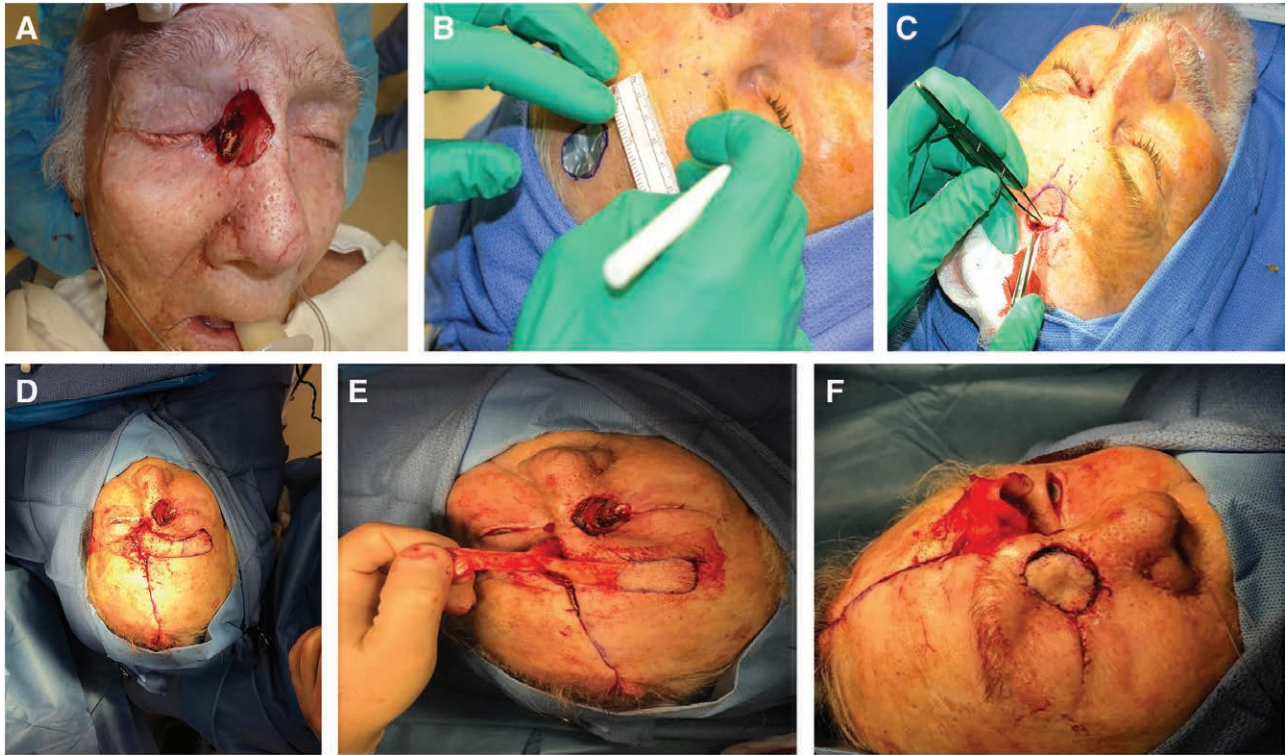


Fig. 1. Patient with BCC in right medial canthal area (A) with defect down to periosteum. B, Template transfer to forehead. C, Initial incision around template down to subgaleal plane. D, Dissection in subgaleal plane down to brow and orbits. E, The superficial epidermis and dermis are dissected from the substance of the flap on the central 1/3 of the flap. F, The flap is delivered through the dissection site with minimal tension and placed into the defect.

Adequate size of the tunnel is created to avoid potential flap strangulation or puckering. The flap is then pulled through the tunnel and into the defect. The distal portion addressing the defect is marked, as is the area of the flap to be de-epithelialized. The flap is then brought out of the tunnel, and the marked tunnel portion of the flap is carefully de-epithelialized. Care is taken to avoid the supratrochlear artery (Fig. 1E). The flap is then delivered through the tunnel again with minimal tension on the flap, and the skin flap is then sutured into the defect (Fig. 1F). The primary cutaneous defect is modified in each case to conform to the principle of aesthetic subunits. After extensive subgaleal dissection to provide forehead mobilization, the donor site is closed in a layered fashion. The flap inset site was covered with Xeroform gauze and dressed with a rolled eye pad fixated over the flap with steri-strips and paper tape. A light head wrap can also be applied to the forehead and left in place for 24–48 hours.

RESULTS

A total of 20 tunneled paramedian forehead flaps were performed. Eleven (55%) patients were female, nine (45%) were male, and the average age was 74.9 years with a range of 55–91 years. Seventeen (85%) patients had a diagnosis of basal cell carcinoma (BCC), and the other three (15%) had squamous cell carcinoma (SCC). Six (30%) patients had a previous history of prior skin cancer involving the periocular region, and another patient had

a previous lesion excision that was not sent for pathology. All patients had tumors that involved the medial canthal region, medial upper eyelid, or medial lower eyelid. The defect area ranged from 3.75 to 56.0 cm² with an average of 13.57 cm². The depth was either down to periosteum or noted to have no orbicularis oculi muscle to provide vascular support for free grafting in 18 patients (90%) In five patients (25%), the defect involved full-thickness (FT) eyelids with exposed orbital fat, and required posterior lamella repair. For the posterior lamella repair, three were repaired primarily with residual tarsus, and two were repaired with a mucous membrane graft (MMG) harvested from the lower lip. Nine (45%) of the patients had canalicular system involvement. Of these, six (30%) were able to be repaired primarily, and three (15%) had complete loss of the canalicular system from Mohs surgery. Of the three patients with complete loss of the canalicular system, only one patient progressed to having Jones tube placement at a later date. The average length of follow-up was 8.2 months with a range of 3–24 months during the postoperative course.

Complication review demonstrated no flap failures. One patient (5%) developed a hematoma in subcutaneous tunnel after resuming anticoagulation in the early postoperative period. This was evacuated via aspiration in clinic without further sequelae. Three patients (15%) developed partial distal flap epithelial breakdown without necrosis. These granulated in well with topical antibiotic use and required no further intervention. Two (10%)

patients complained of cosmetic bulkiness at the flap. The bulkiness did not affect their ability to wear glasses. These two patients ultimately desired thinning of the subcutaneous flap at 6 months postoperatively for improved cosmesis. We present two of our cases that detail specific reasons why we performed the single stage tunneled flap.

CASE 1: PATIENT 4

An 86-year-old man with biopsy-proven BCC to the right lower lid (RLL; Table 1). The patient had a history of multiple periocular skin cancers that required Mohs excision and repair. He waited over a year after his biopsy for further intervention due to Mohs fatigue. The tumor

was cleared via Mohs surgery which resulted in an FT RLL, right upper lid (RUL), and medial canthal defect (7.2cm²) down to periosteum with complete loss of the canalicular system down to the lacrimal sac (Fig. 2A). A repeat Hughes flap with skin grafting was not possible for the lower eyelid repair due to inadequate tissue on the right and left due to prior Mohs surgeries. In addition, he had severe actinic changes, so a large rotational flap was not an option either. The decision was then made to use a tunneled paramedian forehead flap along with a modified Tenzel flap to help rotate the anterior lamella medially on the lower eyelid. An MMG was used to help create the posterior lamella on the lower eyelid (Fig. 2B). He

Table 1. Patient Details

Patient	Age	Sex	Diagnosis	Location	Area and Depth	Posterior Lamellar Repair	Complications	Canalicular Involvement	Follow-up, mo
1	55	M	BCC	Medial RLL, nasal base	18.9 cm ² , down to bone medial	None	None	None	6
2	59	F	BCC	Medial RUL, medial canthus, anterior orbit	10.85 cm ² down to anterior orbital fat medial	None	None	None	6
3	81	M	SCC	Medial RUL, RLL, bridge of nose	18.9 cm ² , down to periosteum medial	None	None	Yes, repaired primarily	6
4	86	M	BCC	RLL, RUL, medial canthus	7.2 cm ² , FT RLL, down to periosteum medial	MMG due to previous bilateral Hughes flaps	None	Complete loss, no Jones tube	6
5	74	F	BCC	Medial RUL, brow, forehead	5 cm ² , down to anterior orbital fat medially	None	Thickened flap, debulked in office	No	10
6	84	M	BCC	LUL, medial canthus	10.5 cm ² , down to periosteum medial	None	Hematoma drained in office, no further procedures	Yes, repaired primarily	6
7	86	F	BCC	LUL, Glabella, nasal root	3.75 cm ² , down to periosteum along nasal root	None	None	No	6
8	76	F	BCC	RLL, medial canthus	5.0 cm ² , FT RLL and canaliculus, exposed orbital fat, bone	Primary repair with lateral tarsus	None	Yes, repaired primarily	6
9	69	F	SCC	LLL, medial canthus	16 cm ² , down to periosteum	None	None	Yes, repaired primarily	6
10	70	M	BCC	LLL, medial canthus	21.7 cm ² , down to periosteum, heavy smoker	None	Thickened flap, debulked twice	None	8
11	69	M	BCC	LUL, LLL, medial canthus	16.5 cm ² , down to bone medial, required bone debridement	None	None	Yes, repaired primarily	8
12	56	F	BCC	Right medial canthus	8.96 cm ² , down to periosteum	None	None	No	6
13	91	F	BCC	LUL, LLL, medial canthus	16 cm ² , FT LUL and LLL, down to periosteum medial	Primary repair with lateral tarsus	None, scheduled for Jones tube	Complete loss, Jones tube at POM 6	6
14	70	F	BCC	Right medial canthus	5.75 cm ² , down to periosteum	None	None	No	4
15	75	M	BCC	LUL, brow	8.64 cm ² , down to periosteum medial	None	None	No	3
16	80	F	BCC	Right medial canthus	10.92 cm ² , down to periosteum	None	None	No	6
17	78	M	BCC	RUL, medial canthus	13.33 cm ² , FT RUL, and canaliculus, periosteum medial	Primary repair with lateral tarsus	None	Yes, repaired primarily	6
18	82	F	SCC	RLL, medial canthus	8.75 cm ² , down to bone medial	None	None	No	6
19	87	F	BCC	LLL, medial canthus	8.75 cm ² , down to bone medial	None	None	No	7
20	83	M	BCC	RUL, RLL, medial canthus	60 cm ² , FT RUL and RLL, down to periosteum medial	Periosteal flap, MMG to RLL, AMG from MMG to superior conjunctiva	Complex case, RUL and RLL revision at 6 mo	Complete loss, no Jones tube	8

Patient details with further procedures in red. LLL, left lower lid; LUL, left upper lid.

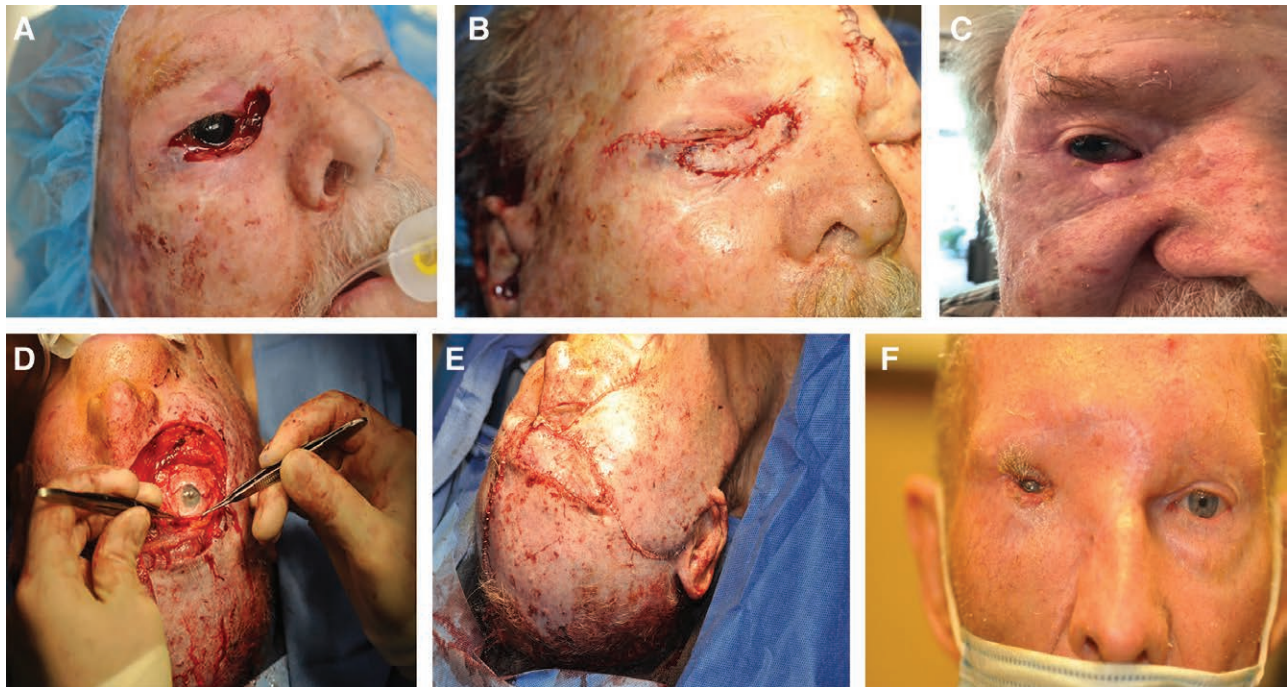


Fig. 2. A, Defect involving medial canthus, FT upper and lower eyelid, canalicular system, down to periosteum. B, Repair with tunneled paramedian forehead flap, modified tenzel flap, mucous membrane graft. C, POM 6 results. D, Large periorbital defect with complete, FT loss of eyelids and canalicular system. E, Repair with tunneled paramedian forehead flap, Mustardé flap, mucous membrane graft, periosteal flap, amniotic membrane graft, and FT skin graft. F, POM 8 from initial surgery, POM 2 from further eyelid revision.

was seen through POM 2 in clinic without complications, and no complaints. He was unable to follow up again in clinic due to quarantine restrictions from the coronavirus. He was contacted via phone and postoperative photographs he sent in were reviewed over the phone at POM 6 (Fig. 2C). He had no complaints, and was very pleased with the results of the operation both functionally and aesthetically.

CASE 2: PATIENT 20

An 83-year-old man with biopsy-proven BCC to the RUL and RLL (Table 1). The patient had a history of previous removal of BCC to the RUL 5 years prior. The patient presented when he could no longer open his right eye to see clearly. An orbital MRI showed a preseptal mass without globe invasion. The tumor was cleared via Mohs surgery which resulted in a large defect involving the nasal sidewall, cheek, medial canthus, and complete, FT RUL and RLL eyelid loss with complete loss of the canalicular system (56 cm²). Periosteal flaps were created for the upper and lower eyelids laterally. An MMG from the lower lip was used to help create the posterior lamella on the lower eyelid. An amniotic membrane graft (AMG) was sutured to the RLL MMG and to the superior edge of the RUL palpebral conjunctiva. A tunneled paramedian forehead flap was used to repair the RUL and fixated laterally to the skin and superior periosteal flap. A Mustardé flap was used to correct the cheek and anterior lamellar RLL defect, and the remaining nasal sidewall defect was closed with a left supraclavicular FT skin graft (Fig. 2D and E). The reconstructed eyelids fused together at POM 4 due to the narrow

palpebral fissure. The patient returned to the operating room at POM 6 for RUL and RLL revision. An MMG was again used to repair the RLL posterior lamella, and AMG was fixated to the recessed RUL mucous membrane to help reconstruct the superior fornix. At his last visit, he had no complaints, and was very pleased with the results of the operation both functionally and aesthetically (Fig. 2F).

DISCUSSION

Forehead flaps are an excellent choice for reconstruction of larger, deep defects of the medial canthal area that extend into the eyelid. They are useful in conjunction with other local and regional flaps and grafts in the reconstruction of larger periorbital defects.^{10,16} The paramedian forehead flap is richly vascularized, primarily by the supra-trochlear artery. The blood supply is so adequate that a comparatively narrow pedicle can support a relatively large or long flap.^{19,20} Complications are uncommon and when treated promptly have a high propensity to resolve. The most common complications include distal flap necrosis, hematoma, and poor aesthetic outcome.^{13,14} The key to minimizing these complications are to create the appropriate flap size (no less than 1.0–1.2 cm at the base), create no tension at closure, avoid excessive thinning, and maintain meticulous hemostasis during the procedure.^{13,14}

Several modifications based on the paramedian forehead flap have been proposed in the reconstruction of medial canthal and eyelid defects. The myofascial, galeal, and pericranial flaps harvested from the median or paramedian forehead have been used to reconstruct deep defects of the medial canthal and eyelid area.^{21–24} However,

these flaps do not transpose skin, and thus require the use of free or local skin flaps.

In 1963, Converse and Wood-Smith²⁵ described the first single-staged median forehead flap using a subcutaneous pedicle in the reconstruction of defects of the nasal dorsum. The flap design was later abandoned due to complications related to the median variant of the forehead flap. In 2002, Park presented the single-staged midline forehead flap with a subcutaneous pedicle. In this study, 10 patients with defects of the upper two-thirds of the nose successfully underwent a single-staged forehead flap.¹⁵ Since 2002, the flap has been described multiple times with slight variations for the repair defects involving nasal and periorbital subunits.^{8,9,16-18} This study is the largest review of the tunneled forehead flap cases with canalicular defects.^{8,16} In addition, this is only the second study to review the tunneled forehead flap for the repair of FT eyelid defects,¹⁶ and this is the first study to document both the size in cm² and depth of the eyelid defects. In the previous reviews, the case numbers ranged from three to 15, and this case review represents the largest review to date with 20 cases that involved medial canthal/eyelid defect repair.

The overall complication rate for this study was low with no flap failure, and only three patients (15%) required more than a single surgical procedure. Two of these patients complained of bulkiness at the distal flap which is also a common aesthetic complaint when performing the traditional paramedian flap as well. The third patient required eyelid revision due to the complexity of his case, and complete loss of eyelids with the initial defect. This review had three patients (15%) with distal epithelial breakdown without necrosis. However, each patient had a specific reason for developing epithelial breakdown. One patient developed a hematoma after restarting anticoagulation, another had poorly controlled diabetes, and the third was using a topical homeopathic medication to the distal flap. All three of these patients healed well with a good cosmetic result without further procedures.

The tunneled paramedian forehead flap offers several advantages in a single procedure. First, there are many patients in whom performing the procedure in a single stage is much safer due to pre-existing health conditions and comorbidities where a return to the operating room would be risky. Second, this can be a technique used in patients with severe eyelid/periorbital scarring from previous surgical procedures, radiation therapy, actinic damage, or recurrent malignancies with inadequate tissue (case 1). Additionally, this can be used as an option for patients who might not be able to follow up for multiple procedures due to work or financial concerns. Finally, this technique is useful for large, deep defects with multiple subunits (case 2).

Possibly, the biggest advantage of the tunneled flap is the lack of the unsightly vascular pedicle that is maintained several weeks between surgical stages. This allows patients to continue to wear spectacles, and not have functional issues associated with the pedicle. In addition, the tunneling buries the pedicle and helps to maintain the natural depression of the medial canthal area. Furthermore, we noticed that by tunneling the flap there

is an added cosmetic benefit that glabellar rhytids were actually smoothed out in a majority of patients due to the tunneled tissue.

CONCLUSIONS

The single-staged tunneled paramedian forehead flap is a useful variation of an established reconstructive technique for the medial canthal area and eyelids. This flap is particularly useful for complex Mohs defects with a large surface area that have a poor vascular supply. This technique may also avoid medial lower eyelid retraction and ectropion seen with other standard techniques. As with the traditional paramedian forehead flap, complication rates are low, and this tunneled variation provides a single stage alternative to the traditional forehead pedicle flap. This technique avoids several weeks of disfigurement while awaiting the takedown and/or thinning of the vascular pedicle.

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