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Reconstructive

Optimizing Reconstruction with Periorbital Transplantation: Clinical Indications and Anatomic Considerations

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Background: Complex periorbital subunit reconstruction is challenging because the goals of effective reconstruction vary from one individual to another. The purpose of this article is to explore the indications and anatomic feasibility of periorbital transplantation by reviewing our institutional repository of facial injury.

Methods: Institutional review board approval was obtained at the R Adams Cowley Shock Trauma Center for a retrospective chart review conducted on patients with periorbital defects. Patient history, facial defects, visual acuity, and periorbital function were critically reviewed to identify indications for periorbital or total face (incorporating the periorbital subunit) vascularized composite allotransplantation. Cadaveric allograft harvest was then designed and performed for specific patient defects to determine anatomic feasibility. Disease conditions not captured by our patient population warranting consideration were reviewed.

Results: A total of 7 facial or periorbital transplant candidates representing 6 different etiologies were selected as suitable indications for periorbital transplantation. Etiologies included trauma, burn, animal attack, and tumor, whereas proposed transplants included isolated periorbital and total face transplants. Allograft recovery was successfully completed in 4 periorbital subunits and 1 full face. Dual vascular supply was achieved in 5 of 6 periorbital subunits (superficial temporal and facial vessels).

Conclusions: Transplantation of isolated periorbital structures or full face transplantation including periorbital structures is technically feasible. The goal of periorbital transplantation is to re-establish protective mechanisms of the eye, to prevent deterioration of visual acuity, and to optimize aesthetic outcomes. Criteria necessary for candidate selection and allograft design are identified by periorbital defect, periorbital function, ophthalmologic evaluation, and defect etiology. *(Plast Reconstr Surg Glob Open 2016;4:e628; doi: 10.1097/GOX.0000000000000545; Published online 26 February 2016.)*

Reconstruction of composite tissue defects of the periorbital subunit is challenging because the goals of effective reconstruction may vary from

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one individual to another. In the absence of a functional globe, microvascular tissue transfer with or without a prosthesis is an effective method of reconstruction. Appropriate positioning of the prosthesis within the orbit fosters optimal aesthetic results.[1] However, for individuals with a functional globe, preservation of vision is the ultimate goal. The eyelids and associated neuromuscular structures regulate multiple protective and mechanical functions of the periorbital tissue including voluntary blink and reflexive blink. The detrimental effects of severe facial deformity may lead to corneal exposure with sequelae of pain, keratopathy, and epiphora.[2] Prolonged duration of symptoms leads to visual impairment and ultimately blindness. Additional considerations include improving malar projection and correcting enophthalmos, vertical dystopia, lagophthalmos, and ectropion.

Facial vascularized composite allotransplantation (VCA) provides a sophisticated and comprehensive approach to prevent deterioration of visual acuity after devastating periorbital injury.[2] Multiple facial transplants involving the transfer of periorbital contents as a part of a larger (total) facial allograft have yielded encouraging results.[2–4] Restoration of normal skeletal anatomic relationships after full facial transplantation re-establishes a 3-dimensional framework in which periorbital soft tissue and ligamentous structures are anchored to maximize function.[2,3] Consequently, a paradigm shift in the attitudes toward facial VCA[5] has prompted reconstructive surgeons to consider transplanting isolated periorbital tissues.[6,7]

The current indications for facial VCA include trauma, burns, congenital deformity, and neoplastic conditions.[4,8] However, it remains unclear which type of injury is suitable for the application of periorbital subunit allotransplantation or what isolated periorbital tissues can be reliably transplanted. The purpose of this article is to explore the indications and anatomic feasibility of periorbital transplantation, emphasizing the importance of evaluating patient's preoperative vision and mechanical eyelid function.[2] Indications for isolated periorbital VCA and (total) facial VCA incorporating the periorbital subunit are discussed with case examples of varying degrees of injury.

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METHODS

Institutional review board approval was obtained at the R Adams Cowley Shock Trauma Center for a retrospective chart review conducted on patients with periorbital defects, including candidates for facial allotransplantation. Patient photographs, facial defects, visual acuity, and periorbital function were critically evaluated to assess potential candidacy for an isolated periorbital or total face (incorporating the periorbital subunit) VCA, to identify indications for periorbital transplantation, and to design an anatomically feasible allograft tailored for specific patient defects. Other disease conditions not captured by our patient population warranting consideration were reviewed. Periorbital allograft harvest dissections were performed at the Maryland State Anatomy Board (Baltimore, Md.).

RESULTS

A total of 7 facial or periorbital transplant candidates representing 6 different etiological disease conditions were selected as suitable indications for periorbital transplantation. Indications included ballistic trauma, animal attack, thermal burn, chemical (acid or alkali) burn, and neoplasm. Anatomic indications were selected from a modification of the Rodriguez classification system and algorithm for reconstruction of aesthetic and functional facial transplantation.[8] According to this defect-dependent algorithm, patients with any defect involving the periorbital region would require total facial transplantation. We have modified this algorithmic approach to tailoring periorbital allografts for patient-specific defects, ophthalmologic evaluation, and patient preferences (Tables 1 and 2). Autoimmune disorders including Sjogren's syndrome, graft-

Table 1. Modification of the Rodriguez Soft-Tissue Algorithm for Facial Transplantation[8]

Soft Tissue Defect Type	Anatomic Defects	Subunit to be Transplanted
1	Septum, nasal cartilage, and nasal soft tissues, with or without defects in type 0	Oral–nasal
2	Lower eyelids and malar soft tissues, with or without defects in type 1	Oral–nasal–orbital
3	*Palpebral and frontal regions only*	*Isolated periorbital subunit*
4	*Palpebral and frontal can include any other soft tissues of the face*	*Full face or isolated periorbital subunit*

The modifications include categories 3 and 4, their respective defects, and subunits to be transplanted. Modifications to the original Rodriguez classification are in italics.

Table 2. Allografts Options Based on Defect, Vision, and Patient Goals

Periorbital Defect	Visual Examination	Allograft Based on Patient Goals: Preserving Vision	Allograft Based on Patient Goals: Preserving Vision and Aesthetics
Unilateral isolated subunit	High risk for deterioration or actively deteriorating	Ipsilateral isolated subunit	Ipsilateral isolated subunit
	Blind in 1 eye	Do not transplant	Do not transplant
Unilateral contiguous (multiple) subunits	High risk for deterioration or actively deteriorating	Ipsilateral isolated subunit	Partial face
	Blind in one eye	Do not transplant	Do not transplant*
Bilateral periorbital subunits	One eye: high risk for deterioration or actively deteriorating	Ipsilateral isolated subunit	Partial (inclusion of bilateral periorbital tissue) or total face transplant
	Both eyes: high risk for deterioration or actively deteriorating	Ipsilateral isolated subunit or partial face (inclusion of bilateral periorbital tissue)	Partial (inclusion of bilateral periorbital tissue) or total face transplant
	Blind in 1 eye	Contralateral isolated subunit	Partial (inclusion of bilateral periorbital tissue) or total face transplant
	Blind in both eyes	Do not transplant	Do not transplant
Bilateral multiple subunits	1 eye: high risk for deterioration or actively deteriorating	Ipsilateral isolated subunit	Partial (inclusion of bilateral periorbital tissue) or total face transplant
	Both eyes: high risk for deterioration or actively deteriorating	Ipsilateral isolated subunit or partial face (inclusion of bilateral periorbital tissue)	Partial (inclusion of bilateral periorbital tissue) or total face transplant
	Blind in 1 eye	Contralateral isolated subunit	Partial (inclusion of bilateral periorbital tissue) or total face transplant
	Blind in both eyes	Do not transplant	Do not transplant†

The complexity of injury fosters a more complex process for selection of an allograft between the patient and the surgeon.
*Although this scenario does not meet criteria based on periorbital transplantation alone, other indications for face transplantation for aesthetic or restoration of maxillary, mandibular, or oral function may make the patient a good candidate for partial face transplant. Incorporating functioning periorbital tissue within the allograft may improve aesthetic results but is not expected to reverse blindness.
†Not all active vascularized composite transplant institutions unanimously agree on transplanting blind patients. Although blind patients have undergone face transplantation, some groups consider this a contraindication for a face transplant. This remains a controversial topic and is outside the scope of this article. Because the purpose of periorbital transplantation is to prevent deterioration of vision, blindness in both eyes is a contraindication for transplantation.

versus-host disease, and Graves' disease warranted consideration but were ultimately excluded from the indications for periorbital transplantation.

Anatomical Dissection

Cadaveric allograft harvest for proposed periorbital transplants was successfully completed in 4 hemifaces and 1 full face. There was no failed allograft harvest, and the approximate donor procurement time was 1 hour and 45 minutes. None of the dissected cadavers had a history of head or neck trauma, facial surgery, facial deformity, or congenital malformation. Periorbital subunit harvest, as previously described,[3,6,7,9,10] was based on a bipedicle vascular supply via the facial vessels and superficial temporal vessels.

Anatomical dissections demonstrated minor inconsistency among vascular structures. As described by Vasilic et al,[6] tortuosity of facial vessels was present in all hemifaces, and 1 superficial temporal vein was unable to be identified in 1 hemiface. Two hemifaces had no angular vessels. Facial nerve branches were dissected from their origin to the orbicularis oculi or their termination en route to the orbicularis oris. The lacrimal sac and puncta were able to be preserved in 100% of periorbital subunits. The zygomatic and buccal branches of the facial nerve were similarly preserved in 100% of hemifaces (Fig. 1). Preservation of the total eyelid (tarsal plate, levator, and septum) was achieved via a circumorbital transconjunctival dissection. All isolated periorbital allografts were devoid of bone, but the total face transplant allograft harvest incorporated a nasoorbitoethmoidal bony segment.

Case Reports and Indications for Periorbital Transplantation

Patient 1, High Impact Ballistic Injury

A 37-year-old man sustained a ballistic facial injury, requiring more than 20 major reconstructive procedures. Reconstructive efforts ultimately led to a previously reported total face, double jaw, and tongue transplant.[3] Although the patient had minimal periorbital defects with near-normal eyelid function bilaterally and uncompromised visual acuity, the periorbital and eyelid structures were incorporated within the allograft (Figs. 2, 3). Due to the extent of the defect resection, the patient was at high risk for damage to

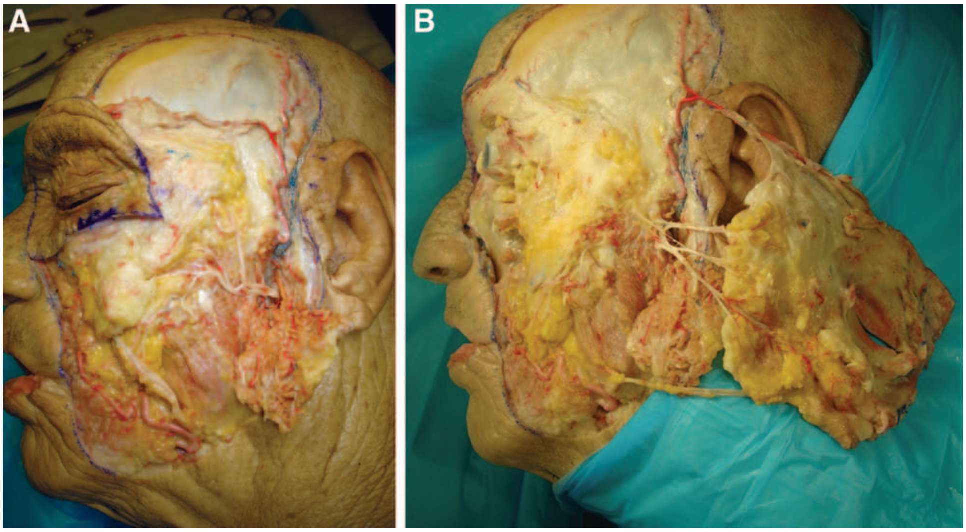

Fig. 1. A, Before harvesting the periorbital subunit, the facial nerve is identified. B, Buccal and zygomatic branches are identified as the isolated periorbital allograft is elevated. Dual vascular inflow and outflow is preserved.

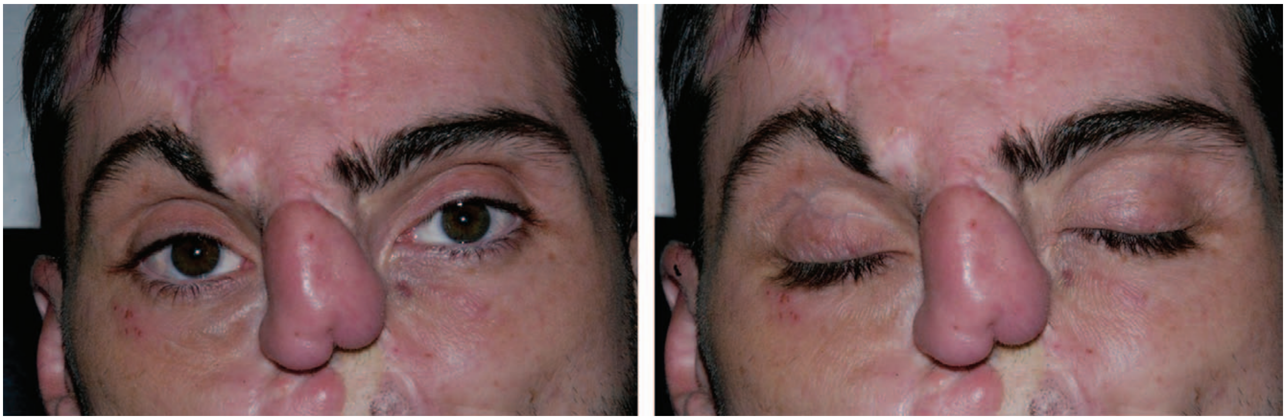

Fig. 2. Patient 1 before transplantation with minimal periorbital defect and preserved volitional blink. Partial impairment of reflexive blink was present.[2] Content reprinted with permission from Sosin M, Mundinger GS, Dorafshar AH, et al. Eyelid transplantation: Lessons from a total face transplant and the importance of blink. Plast Reconstr Surg. 2015;135:167e–175e.

the innervation to the eyelid. To maintain his reflexive and volitional blink and to optimize the aesthetic result of the face transplant, the principles of isolated periorbital transplantation were implemented in the total face transplant. The facial VCA demonstrated preservation of long-term periorbital function.[2]

Patient 2, Animal Attack

A 23-month-old boy sustained an extensive soft-tissue injury from a dog bite. Injury included avulsion of the mid-upper portion of the nose, bilateral ala extending to the mid-scalp, avulsion of all 4 eyelids with bilateral conjunctival involvement, and concomitant lacrimal duct destruction. He was initially treated at an outside institution with amniotic membrane transplants covered with split-thickness skin grafts to both eyes.

Reconstruction focused on repairing the protective lubrication mechanism of the cornea. Six weeks after the initial attack, he underwent a bilateral eyelid reconstruction with extensive scar release and buccal mucous membrane grafting to form the inferior conjunctival fornices bilaterally. The patient's parotid glands were then transpositioned bilaterally to the inferior cul-de-sac of each eye recreating the lacrimal irrigation complex. Finally, a full-thickness skin graft was used for lower eyelid reconstruction to provide coverage of exposed cornea ultimately leaving an 8-mm aperture in each eye. Unfortunately, the patient developed a left corneal ulcer. Despite multiple scar revisions, protective lubricating ophthalmic drops, and skin grafting procedures, the patient's vision progressively declined to bilateral blindness.

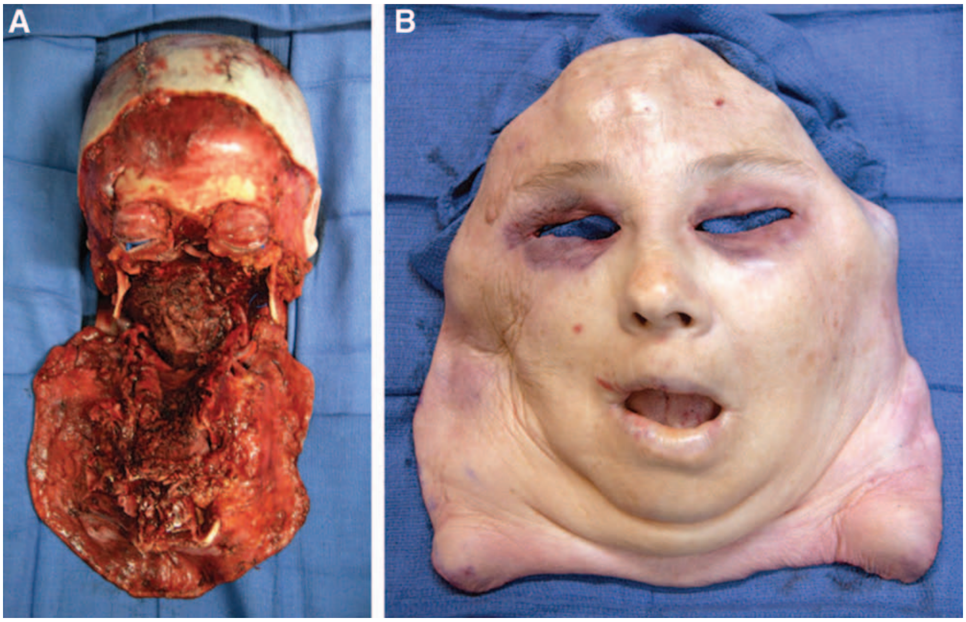

Fig. 3. Allograft preparation (A) and the full facial allograft with preserved periorbital subunits (B).[10] Image reprinted with permission from Bojovic B, Dorafshar AH, Brown EN, et al. Total face, double jaw, and tongue transplant research procurement: an educational model. Plast Reconstr Surg. 2012;130:824–834.

Allotransplantation planning for the patient was designed at the time point when the patient had unilateral visual deterioration. The proposed periorbital allotransplantation was an isolated periorbital subunit. Recipient preparation proceeded with a sub-superficial muscular aponeurotic system dissection with preservation of remaining recipient tarsus and levator muscle fibers (Fig. 4). The patient's hard tissue was not compromised; therefore, the allograft harvest was devoid of osteotomies (Fig. 5).

Patient 3, Thermal Burn

A 27-year-old military veteran returned from the first Persian Gulf conflict in 1990 with extensive total body and facial thermal injury and scarring. Severe left eyelid contractures resulted in enophthalmos and lagophthalmos leading to corneal injury. Split-thickness skin grafts were used to cover and protect the left eye in an attempt to mitigate ongoing deterioration of the corneal surface (Fig. 6). Visual acuity was normal in the right eye. For aesthetic reasons, the patient requested reopening the limited aperture of the left eye (Fig. 7). His lagophthalmos persisted and vision deteriorated. Because of the nature of a full facial burn, a total face allograft was considered for allograft procurement. However, the patient did not suffer from oral dysfunction, lip incompetence, sialorrhea, dysarthria, and impaired smile and did not desire a total face transplant. His primary concern was preserving vision in his left eye, and he was, therefore, a candidate for isolated periorbital transplantation. Similar allograft harvest as patient 2 ensued. De-epithelialization of donor skin was completed throughout most of the allograft, besides the upper and lower eyelid in an effort to cam-

Fig. 4. Recipient preparation depicting the superior and inferior tarsal plates maximally preserved.

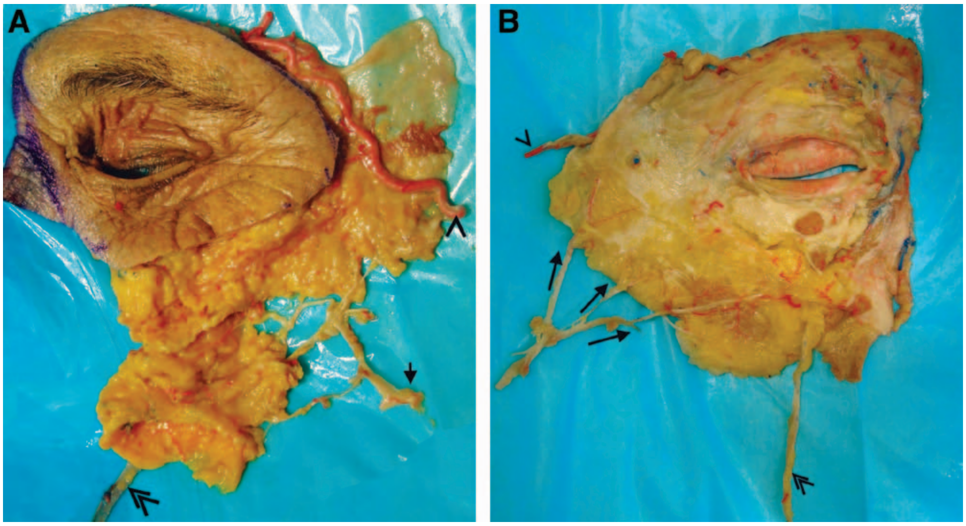

Fig. 5. Preserving orbicularis oculi with neuronal communication will minimize disruption of eyelid function and involuntary blink. This requires tailoring the allograft to include the superior and inferior eyelids. A, Anterior view of the allograft. B, A posterior view of the allograft. Solid arrows with tails depict the facial nerve and respective branches, V arrow depicts the superficial temporal artery, and double V arrow identifies the facial vein.

Fig. 6. Patient 3 with extensive thermal injury with diffuse contractures to bilateral periorbital subunits. Inability of volitional closure of the left eye pinhole aperture.

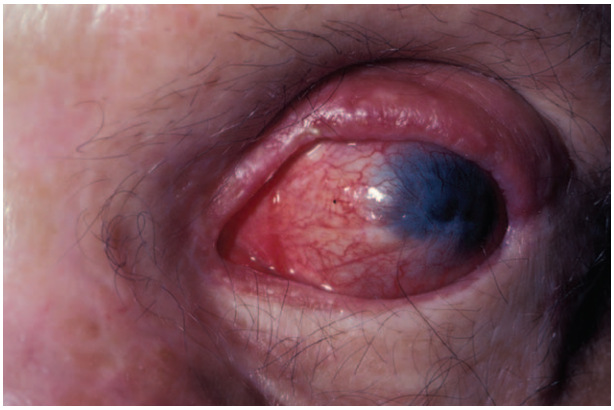

Fig. 7. Postoperative result of patient 3 after left-sided skin graft release revealing corneal opacification likely a reflection of prior corneal injury and severe scleral injection a result of ongoing ocular injury. The left eye demonstrates a diffuse inflammatory reaction with conjunctival injection.

ouflage the allograft. It should be noted that this strategy is ideally applied to patients with impaired skin and adequate periorbital projection (Fig. 8).

Patient 4, Chemical Burn

A 32-year-old woman was assaulted in Sudan with a liquid chemical injuring her face, scalp, ears, neck, chest, upper back, and limbs (Fig. 9). The patient reported preservation of vision after the assault with rapid progression to loss of vision throughout the ensuing months after her injury. At presentation, she suffered bilateral lower eyelid ectropion, scarring of bilateral upper and lower eyelids with 5 mm of lagophthalmos in the left eye, right corneal opacification, scarring, and vascularization. Additional injuries included left-sided neck contracture and complete absence of the left ear. She had total absence of vision in the right eye and only light perception in the left eye. She underwent multiple scar release procedures and skin grafting procedures in an effort to restore potential upper and lower eyelid mobility. Despite reconstructive efforts, her left lagophthalmos remained, but her right eye was able to achieve 100% eyelid closure. The patient's defects were more suited for a total face allograft, which is briefly described with emphasis defined at the eyelids and periorbital region.

Full face allograft harvest with periorbital contents is described in Supplemental Digital Content 1, which describes full face allograft harvest with periorbital contents (http://links.lww.com/PRSGO/A167).

Fig. 8. Deepithelialization of allograft and dissection in the submuscular plane will minimize the nerve damage and allow the skin of the eyelids to be transplanted. This approach allows for concealing the incision in the creases of the eyelids.

Fig. 9. Patient 4 with long-term visual deterioration after chemical injury to the bilateral periorbital tissue.

Patient 5, Neoplasm

A 69-year-old woman presented to our clinic with a hyperpigmented, raised, and fungating biopsy-proven basal cell carcinoma over her left supratrochlear region involving the left upper eyelid, supraorbital soft tissue, and forehead (Fig. 10). Her left eye examination demonstrated limited extraocular movement, severe exposure keratopathy with corneal ulceration and opacification, and conjunc-

Fig. 10. Patient 5 with an eroding basal cell tumor (oblique bird's eye view) extending from the superior lid to the forehead. (Photograph courtesy of and copyrights retained by Kofe Boahene, MD.)

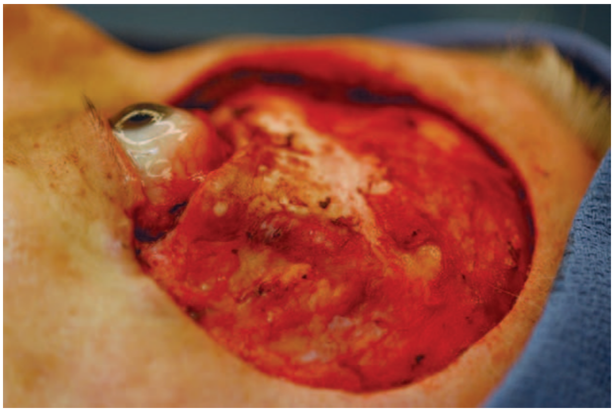

Fig. 11. Intraoperative image (profile) of patient 5 showing the extent of resection. (Photograph courtesy of and copyrights retained by Kofe Boahene, MD.)

tival injection. Visual examination in the right eye was 20 of 25 and only light perception in the left eye. Preoperative imaging did not show tumor invasion into the orbit. After excision (Fig. 11), the patient underwent reconstruction with a cartilage graft and full-thickness skin graft to the supraorbital defect with a conjunctival flap for corneal protection (Fig. 12).

The proposed allograft included the inferior eyelid as part of the isolated periorbital allograft. This facilitates a more aesthetically uniform periorbital subunit and preserves the inferomedial branches of the facial nerve to facilitate restoration of the motor input of the reflexive blink.

DISCUSSION

Complex midface and periorbital defects portend a poor prognosis in long-term visual acuity when defects are accompanied by periorbital

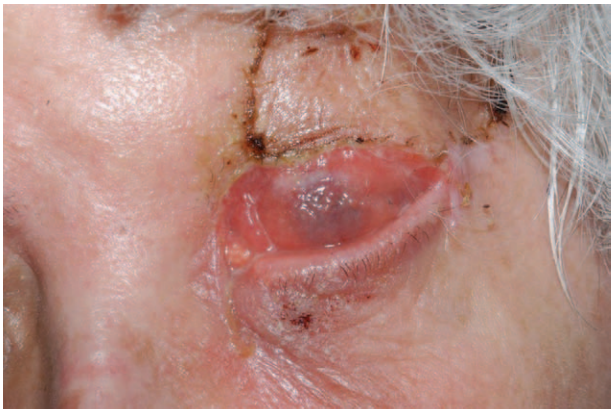

Fig. 12. Patient 5, 1 week after reconstruction of the upper eyelid and supraorbital rim using full-thickness skin graft (FTSG) and conjunctival flap to the left eye. (Photograph courtesy of and copyrights retained by Kofe Boahene, MD.)

dysfunction. Repair of maxillary and orbital floor subunits has involved vascularized and nonvascularized bone grafting, rotational flaps and free tissue transfer.[11,12] Despite rigid bony fixation, ample tissue replacement, protection of the cranial base, and restoration of oronasal function, orbital sequelae may persist resulting in visual dysfunction from impaired protective mechanisms of the eye.[2,12–14] Periorbital defects recalcitrant to autologous and prosthetic reconstructions may potentiate the need for isolated periorbital VCA or total face allotransplantation as encouraging results after prior face transplants continue to support the potential for functional and aesthetic restoration. Transplantation offers the patient sensorimotor functionality, correction of cephalometrics, preservation of vision, and avoids creating a donor site defect.[15] Although VCA commits the patient to lifelong immunosuppression, the benefits of restored vision with a transplant must be weighed against the inevitable progression to blindness when periorbital tissue is rendered nonfunctional. The task of identifying the optimal candidate for isolated periorbital or total face VCA remains complex. This critical evaluation of patients with periorbital defects can aid in selecting an ideal candidate.

The patients identified in this study exhibit the spectrum and gradation of unpredictable visual deterioration as a result of periorbital injury. Those patients with retained orbits, orbital nerve function, and early vision changes should be considered optimal candidates for allotransplantation in an effort to reverse the progression to blindness. Blindness is associated with disability, dependency, and decreased household income.[16] In a study examining utility values associated with blindness, patients with no light perception in at least 1 eye reported a time trade-off utility value for the return of vision to the impaired eye(s) to be 0.26, emphasizing the impact of blindness on the quality of life.[17] A trade-off utility value ranges from 0 to 1, and a lower score implies more years of life patients are willing to sacrifice for fewer years of life with improved vision. The respondents would trade almost 3 out of every 4 years of remaining life in return for perfect vision in both eyes.[17] Patients with severe facial disfigurement enough to qualify for transplantation exhibit a utility score of 0.46. This value compares with a utility score of 0.62 and 0.33 for monocular and binocular blindness, respectively, exemplifying the devastating effect of blindness.[18]

This study sought to define the indications for periorbital transplantation. Currently, the indications for facial transplantation remain a source of debate. There is general agreement that a defect inadequately reconstructed using conventional means may warrant evaluation for a VCA, but defining a specific set of indications has proven to be difficult. One group has chosen recipients based on loss of important facial subunits (at least 25% of the surface of the face), which are specialized, difficult, or impossible to repair using other techniques,[19] whereas another group has considered patients with loss of orbicularis oculi or orbicularis oris, without a specific criterion for defect size.[20] Our study identifies various periorbital defects that may be treated with isolated periorbital transplantation or total face transplantation (while incorporating periorbital structures) and defines indications for identifying patients who are eligible for periorbital allografts. Treatment is determined based on extent of injury (Fig. 13), type of injury, recipient's vision, eyelid mechanics, aesthetic goal, preservation of vision, and ultimately patient preference. Defect alone should not dictate the type of allograft (isolated or total face) a patient will receive. An ophthalmologic assessment with ocular mechanical assessment aids the surgeon in tailoring a suitable allograft (Table 2). This is well depicted in the thermal injury patient, with healthy right-sided periorbital function with unimpaired vision in the right eye and has visual impairment, conjunctival injection, and periorbital dysfunction of the left eye. Consequently, this patient (Fig. 6) is a good candidate for a full face transplantation or isolated periorbital. The decision can further be vetted with patient preferences and a multidisciplinary team during evaluation.

However, in the setting of a full face transplant, there may be more complex considerations, such as harvesting the nasoorbitoethmoid bony segment to preserve medial canthal attachments and the canalicular drainage system. Incorporating the nasoorbitoethmoid bony segment preserves the medial

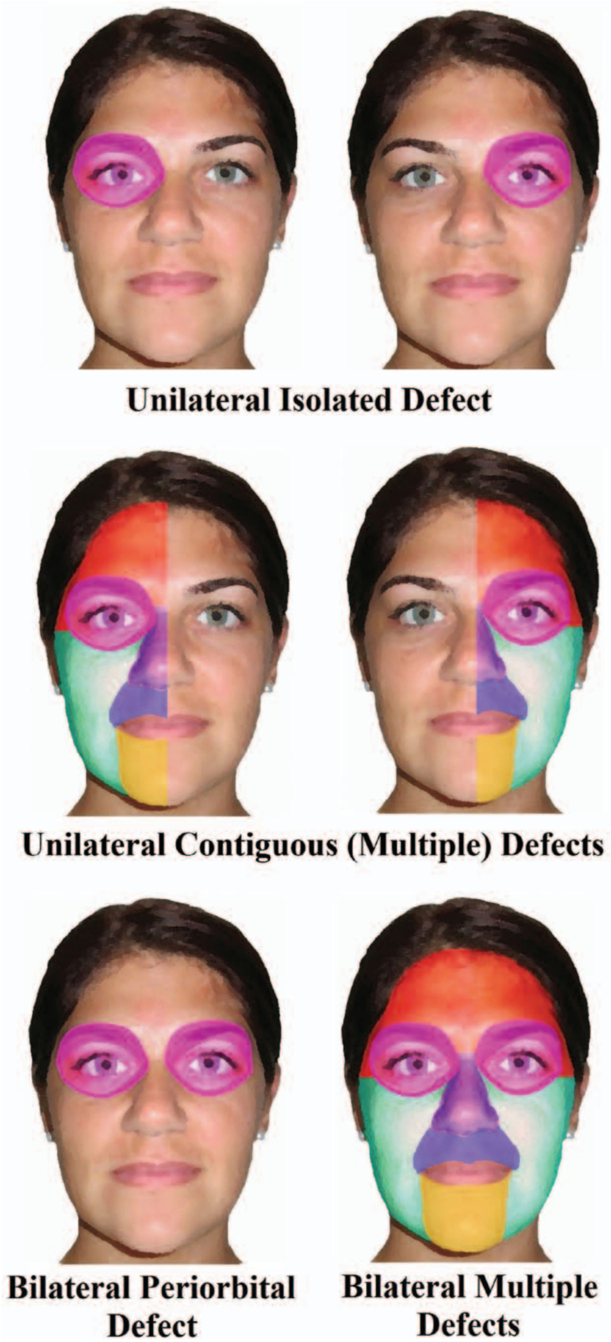

Fig. 13. The periorbital zone (pink) of injury can be isolated or associated with other subunits of the face. Determining whether eyelids or the entire periorbital subunit is transplanted is dependent on the components of the periorbital injury (2 different tones of pink demarcates these periorbital zones).

canthal attachments bilaterally and allows for the distal canalicular system to remain intact. However, the true value of preserving lacrimal drainage is unclear and should not affect vision outcomes. Therefore, little weight is given to this aspect of transplantation. Our group does not use lacrimal tubes, but they may be implemented in the recipient when allograft inset is performed. This endeavor may be futile due to a scarred or obliterated drainage system. Avoiding osteotomies is an option, especially in isolated periorbital transplants, as depicted in our study. Allografts devoid of bone require extreme precision in canthal fixation, but aesthetic revisions can always be completed after convalescence from transplantation.

Another important anatomic consideration is the levator palpebrae superioris and the tarsal plates of the upper and lower eyelids. Patients will have varying injury to these structures, and predicting the extent of preservation is challenging until the actual dissection is performed in the operative room. Any remnants of the levator palpebrae superioris should be maximally preserved in the recipient. Similarly, the donor harvest should preserve the levator palpebrae superioris and its insertion into the eyelid skin and the upper eyelid tarsus. This allows the allograft to be tailored to an optimal length during allograft inset. Similarly, the inferior tarsus should be preserved in the recipient and maximal length be preserved during donor allograft harvest. Not only is this approach ideal for achieving adequate tissue coverage of the eyelid defects but it also preserves the peripheral, marginal, and inferior eyelid arcades to enhance perfusion to the distalmost tissue of the allograft.

The etiology of periorbital defects in our series parallels the causes of facial defects of patients who have undergone facial transplantation.[4,21–29] These include ballistic trauma, animal attack, thermal burn, chemical (acid or alkali) burn, and neoplasm, which may vary in the mechanism of injury. Although autoimmune diseases manifest orbital complications and dysfunction of protective mechanisms of the eye, our study did not identify such a patient to meet inclusion criteria. Therefore, we sought to identify the potential autoimmune disorders to consider for transplantation. All 3 autoimmune disorders evaluated (Sjogren's syndrome, graft-versus-host disease, and Graves' disease) have adequate preservation of mechanical function of periorbital tissue, and resecting a fully functioning periorbital subunit is not recommended.[30–32] As such, transplantation of periorbital tissue is not expected to slow or reverse the pathological process of each disorder. Currently, these autoimmune diseases do not meet indications for periorbital transplantation, but future investigations are necessary to justify the potential for periorbital transplantation in autoimmune disease.

It is unclear whether a dual vascular arcade is necessary for transplantation, but our experience suggests that it may be prudent in the event of aberrant anatomy. Vasilic et al[6] performed dissections of

24 cadaveric hemifaces and found that such a transplant would be anatomically and technically feasible, with reliable vascular supply by the frontal branch of the superficial temporal artery, the facial-to-angular artery continuation, or both in all hemifaces. Angiographic assessment of the filling of the eyelid arcades after harvest confirmed perfusion variability (60–80%) after injection of the periorbital subunit with only a facial artery pedicle or only the superficial temporal artery.[6] Mathes et al[7] showed that the superficial temporal artery perfused the entire periorbital allograft in 100% of cadaveric specimens and the facial artery perfused the entire allograft in only 66% of specimens revealing inconsistency of facial artery perfusion territory. Importance of dual arterial inflow may not always be necessary but is highly recommended to ensure complete perfusion due to anatomic variability.[33] Our cadaveric allograft harvest reaffirmed the value of utilizing a dual arcade because the superficial temporal vein in 1 hemifacial dissection could not be identified. As a routine in facial transplantation, an angiographic work-up for clinical isolated periorbital transplantation is crucial to evaluate vascular anatomy during preoperative planning.

Two scenarios should be considered for innervation of the periorbital tissue. If there is suspicion that the recipient neuronal mechanism of blink is preserved, but the extent of adhesions from facial injury prevents an adequately functioning blink mechanism, then a nerve stimulator can be used in the recipient surgery to confirm periorbital function. If function is confirmed, then the patient would not require nerve coaptation. However, if the neuromuscular blink mechanism is impaired, then targeted nerve coaptation of the zygomatic and buccal branches of the facial nerve should be performed. Our study shows that the anatomical course of the facial nerve was consistent in the intraparotid and proximal extraparotid regions, with minor variability of the distal course. For the donor harvest, a distal dissection of the facial nerve to identify the zygomatic and buccal branches was able to be performed without overt entry into the orbicularis oculi. An extremely distal dissection of each branch may denervate the orbicularis oculi and should be avoided. After identification of the proximal branches of the facial nerve, a deep muscular dissection provides adequate length of the inferior zygomatic and buccal branches for coaptation, which is paramount to the preservation of eyelid squeezing and reflexive blink, respectively.[2,34–36] Preservation of the supraorbital and supratrochlear nerves may be challenging in this cohort of patients. Clinical face transplantation has demonstrated that sensation returns to the allograft even in the absence of sensory nerve coaptation, which allows for preservation of the reflex arc.[2,4]

This study identifies 3 major considerations for periorbital transplantation, including the etiology of the defect, extent of the defect, and ophthalmologic and periorbital function. The limitation to this study is its single institutional experience, as other institutions evaluating similar defects may capture patients we have not encountered with additional indications for transplantation. Candidates considered for transplantation should have an etiological indication deemed to be one of the following: trauma, animal attack, burn, or tumor because the mechanisms of injury commonly target the biomechanical protective function of the eyelid. The goals of periorbital transplantation are to re-establish the protective mechanisms of the eye, prevent deterioration of visual acuity, and optimize aesthetic outcomes. We advocate the use of dual vascular inflow and outflow, although it may not be mandatory in all cases.

CONCLUSIONS

Periorbital transplantation (isolated or total face) is technically feasible. The goal is to re-establish the protective mechanisms of the eye, to prevent deterioration of vision, and to optimize aesthetic outcomes. Indications include ballistic trauma, animal attack, thermal burn, chemical burn, and neoplasm. Careful scrutiny and selection of patients based on defect and vision should guide the surgeon in tailoring the allograft.

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