Extended Hair-bearing Lateral Orbital Flap for Simultaneous Reconstruction of Eyebrow and Eyelid

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Background: When a tumor in the lateral eyebrow region is resected, reconstruction of the eyebrow and upper eyelid defects is necessary. We perform simultaneous reconstruction of such defects; sideburn hair is included on an extended lateral orbital flap. We describe our method and results of a retrospective evaluation.

Methods: We treated 6 patients with partial eyebrow and upper eyelid defects. An extended lateral orbital flap was designed on the lateral region of the lateral canthus including sideburn hair and was elevated with a pedicle of the orbicularis oculi muscle. Flap size, surgical outcomes, and reconstructed eyebrow morphology were evaluated.

Results: Mean flap size was 2.7 × 4.1 cm, with a maximum width and length of 3.5 and 5.1 cm, respectively. The mean hair-bearing region was 1.4 × 0.9 cm, with a maximum width and length of 1.8 and 1.3 cm, respectively. Total flap survival and hair growth were confirmed in all patients. The reconstructed eyebrow and eyelid were aesthetically satisfactory. The new eyebrow hair grew long and was directed upward but considered acceptable. No additional surgery was performed for any patient. The donor site scar was acceptable because it followed the wrinkles of the lateral eyelid. No paralysis of the temporal branch of the facial nerve resulted.

Conclusions: The procedure for raising an extended hair-bearing lateral orbital flap is relatively easy, although attention must be paid to the temporal facial nerve. This flap is useful for simultaneously reconstructing defects of the upper eyelid and lateral eyebrow. (Plast Reconstr Surg Glob Open 2014;2:e111; doi: 10.1097/GOX.0000000000000053; Published online 18 February 2014.)

The eyebrow is so aesthetically important that many methods of eyebrow reconstruction have been reported.1–6 However, to the best of our knowledge, no 1-stage reconstruction method that uses a single flap has been found for defects of both the eyebrow and upper eyelid. The lateral orbital flap and orbicularis oculi musculocutaneous flap are the reported flaps elevated from the lateral region of the lateral canthus.7–15 These flaps are designed from the lateral side of the frontal process of the zygoma to the anterior border of the sideburn and are elevated without any sideburn hair for reconstruction of an eye.
socket or upper or lower eyelid. We have extended the flap to include the sideburn hair and used it for simultaneous reconstruction of lateral eyebrow and upper eyelid defects. We retrospectively reviewed the cases in which we applied the extended hair-bearing lateral orbital flap to determine its reliability and usefulness.

**PATIENTS AND METHODS**

Our study included 6 patients in whom the extended flap was applied: 5 patients who had undergone resection of a malignant tumor (basal cell carcinoma, $n = 2$; squamous cell carcinoma, $n = 1$; skin metastasis of breast cancer, $n = 1$; adenocarcinoma, $n = 1$) and 1 patient who had undergone resection of a benign tumor (melanocytic nevus). The tumor resections and immediate reconstructions were performed at Tokushima University Hospital between June 2000 and December 2012 (Table 1). Mean age of these patients at the time of surgery was 66 years (37–86 y). The tumors in all of these patients were in the lateral area of the eyebrow; thus, the postresection defects spanned the lateral area of the eyebrow and upper eyelid. Patients were followed up for 4–120 months (mean, 32 mo).

**Vascular Anatomy for the Flap**

The region between the lateral canthus and auricle on which the flap is designed is nourished by the zygomatic orbital artery from the auricular side and the zygomatic facial artery from the orbital side. The zygomatic orbital artery branches from the superficial temporal artery and runs along the zygomatic arch up to 1 cm above the lateral canthus. The zygomatic facial artery arises from the zygomaticofacial foramen and sends branches to the lower eyelid and zygoma (Fig. 1). The zygomatic orbital artery anastomoses directly with the zygomatic facial artery. These arteries link to the infraorbital artery, forming a vascular network. To ensure stable blood supply in the flap, the base of the extended hair-bearing lateral orbital flap is designed on the orbicularis oculi muscle, which contains the branches of the zygomatic facial artery (Fig. 1).

**Surgical Technique**

A hand-held Doppler is used presurgically to locate sounds of the zygomatic facial artery and thus confirm its location at the zygomaticofacial foramen. The extended flap is designed on the lateral side of the frontal process of the zygoma and includes sideburn hair (Figs. 1, 2). The long axis of the flap should match the horizontal line of the face to avoid an upward or downward shift in the external canthus. The flap is elevated carefully to avoid injury to the temporal branch of the facial nerve. The distribution of the temporal branch is predicted from anatomical landmarks and is marked on the skin. Flap elevation is started from the lateral area and proceeds into the superficial layer of subcutaneous fatty tissue to within 5–10 mm of the predicted course of the nerve branch. The dissection is gradually continued to the deeper layer of the subcutaneous fatty tissue. A nerve stimulator is used around the predicted course of the temporal branch to avoid damage to the nerve because the actual facial nerve distribution can differ from the predicted distribution. The orbicularis oculi muscle is then identified and is contained in the pedicle of the flap. Further dissection is performed above and below the orbicularis oculi muscle to rotate the flap to the defect. The link between the orbicularis oculi muscle and the zygomatic facial artery is preserved (Fig. 3). The flap is transplanted to the defect and sutured so as to position the hair-bearing region on the lateral side of the eyebrow. The donor site is closed by primary suture.

**Evaluation of Flap Reliability and Usefulness**

Patients’ records were searched for the following outcome variables: width and length of the flap, width and length of the hair-bearing region, occurrence of any circulatory problems, flap survival, growth pattern of the transplanted hair, patient satisfaction with the cosmetic outcome, and occurrence of any complications. In 1 patient, we observed blood circulation of the flap during the surgery by intravenously injecting 1 mL (1.7 mg/mL) of indocyanine green (ICG).

**RESULTS**

Flaps were 1.7–3.5 cm (mean, 2.7 cm) in width and 3.0–5.1 cm (mean, 4.1 cm) in length. The hair regions within the flaps were 1.2–1.8 cm (mean, 1.4 cm) in width and 0.5–1.3 cm (mean, 0.9 cm) in length (Table 1). No circulatory problems were encountered in the flaps, and all flaps survived completely. Hair growth was confirmed in the flap apex in all patients (Figs. 4–6). The hair on the flap was directed slightly upward 1 or 2 months after the surgery. However, it turned downward as time went by. Furthermore, the hair grew long, and all patients cut it about once a month. All patients were satisfied with the results of the flap transplantation, and no revision was necessary for any patient. The scar at the donor site was not noticeable because it followed the wrinkles of the lateral eyelid, and no postoperative complication, such as facial paralysis, hematoma, and infection, occurred. In the case in which we performed the ICG test, blood reached the distal side...
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Table 1. Patient Data

| Patient | Age (y) | Sex | Resection/Flap Indication          | Flap Size (cm)* | Hair-Bearing Region Size (cm) |
|---------|---------|-----|-----------------------------------|-----------------|-----------------------------|
| 1       | 67      | Male| Squamous cell carcinoma           | 3.0 × 4.0       | 1.2 × 0.8                   |
| 2       | 81      | Male| Basal cell carcinoma              | 2.5 × 3.0       | 1.2 × 0.5                   |
| 3       | 37      | Male| Melanocytic nevus                 | 1.7 × 3.7       | 1.4 × 0.9                   |
| 4       | 46      | Female| Skin metastasis of breast cancer | 2.5 × 3.5       | 1.5 × 0.8                   |
| 5       | 86      | Male| Basal cell carcinoma              | 3.5 × 5.1       | 1.7 × 1.1                   |
| 6       | 79      | Female| Sebaceous carcinoma              | 3.0 × 5.0       | 1.8 × 1.3                   |

*All flaps survived in total.

Fig. 1. A schematic diagram of reconstruction with an extended hair-bearing lateral orbital flap. The flap is designed to include the sideburn hair. X: site of the zygomatic facial artery (ZFA) arising from the zygomatic foramen. Broken line: distribution of the temporal branch of the facial nerve.

Fig. 2. Photograph of a 79-year-old woman (patient 6) with sebaceous carcinoma involving the right lateral eyebrow. The tumor has been resected on the periosteum with a 1-cm margin. A 3.0 × 5.0-cm flap is designed on the lateral side of the lateral canthus.

Fig. 3. Intraoperative photograph of patient 6. The extended hair-bearing lateral orbital flap was elevated based on the orbicularis oculi muscle. Note the sideburn hair on the tip of the flap and the pedicle muscle under the flap base.

Fig. 4. Pre- and postoperative photographs of patient 6. A, Preoperative view. A 1.0 × 1.0-cm sebaceous gland carcinoma is present on the lateral eyebrow. B, Six months after surgery, hair growth from the apex of the flap is noted.

of the flap, though not immediately; the entire flap stained with ICG (See Video 1, Supplemental Digital Content 1, which displays circulatory dynamics of the flap observed with a near infrared camera. The video shows the condition before and after ICG administration, http://links.lww.com/PRSGO/A23).
The lateral orbital flap contains a thick vascular network. Although Ogawa et al stated that the orbicularis oculi muscle is not always necessary for the lateral orbital flap, some authors have elevated such flaps based on the orbicularis oculi muscle. We think that attachment of the orbicularis oculi muscle containing the zygomatic facial artery ensures blood supply to the extended hair-bearing lateral orbital flap. When the flap is elevated solely on the muscle, the pedicle can be made narrow, facilitating rotation of the flap. We think that the use of the muscle does not endanger the temporal branch because the branch exists on the lateral side of the muscle. Survival of our flap, hair growth on the distal part, and the ICG confirmation suggest that blood flow to the hair-bearing region of this flap is stable. The length-to-width ratio of the flaps in our patient series was in the range of 1.2–2.2:1. Ogawa et al note that the usual lateral orbital flap is designed at a ratio of approximately 2:1. In our patient series, this flap was limited in terms of its width because the donor site required closure. Generally, the width of the flap is no more than 3–3.5 cm.

Attention should be paid to the deep layer of the flap because the temporal branch of the facial nerve is present there. This nerve exists under a reference line drawn from about 0.5 cm below the tragus to the upper part of lateral end of the eyebrow and passes through the region approximately 3–4 cm lateral to the lateral orbital rim at the level of the upper margin of the zygoma. We marked the distribution of the temporal branch on the skin and avoided deep dissection of the subcutaneous fat layer in the marked region. Use of the nerve stimulator was also helpful.

Eyebrow reconstruction methods fall roughly into 3 categories: free hair graft transfer, free skin graft with hair transfer, and flap transfer. For the free hair graft, there are 2 methods: transplantation of a single hair and transplantation of a bundle of 3–4 hairs. Tunnel

Fig. 5. Pre- and postoperative photographs of a 67-year-old man with squamous cell carcinoma involving the right lateral eyebrow (patient 1). A, A 1.0 × 1.0-cm squamous cell carcinoma is present on the lateral side of the right eyebrow. The tumor was resected with a 1-cm margin. B, Six months after surgery, symmetry of the eyebrows is noted.

Fig. 6. Photographs of an 86-year-old man (patient 5) with basal cell carcinoma involving the right lateral eyebrow and upper eyelid. A, Appearance of the tumor on a preoperative frontal photograph. The tumor was resected from the perios- teum with a 1-cm margin. Because the defect on the eyelid was of full thickness, oral mucosa was transplanted for the conjunctival defect. B and C, Six months after reconstruction, symmetry of the eyebrows is noted.

Video 1. Circulatory dynamics of the flap. See video, Supplemental Digital Content 1, which displays circulatory dynamics of the flap observed with a near infrared camera. The video shows the condition before and after ICG administration, http://links.lww.com/PRSGO/A23.
sculpt grafting and use of the postauricular hairline have been reported for the free skin graft. For flap transfer, hair transplantation with a superficial temporal artery-pedicle flap, a subcutaneous pedicle flap from the affected eyebrow, and an orbicularis oculi myocutaneous flap have been reported. The main characteristic of our procedure is the simultaneous reconstruction of a part of the eyebrow and the upper eyelid. Because the hair-bearing region of this flap is the sideburn with sparse hair, it fits well with the lateral eyebrow. In the reconstructed eyebrow, new hairs grow upward at the root but after some growth hang downward due to gravity. This is aesthetically pleasing. It is difficult to design the flap so that it precisely fits the defect in terms of the amount of hair needed and the direction of hair growth. The flap is oriented in the horizontal direction on the face, and this cannot be changed. We do our best to adjust the length and width of harvested sideburn on the flap to match those of the eyebrow defect. However, the direction of hair growth cannot be corrected.

The extended hair-bearing lateral orbital flap has 4 main advantages: The eyebrow and upper eyelid can be reconstructed in 1 stage with a single flap, the flap is thin and does not require revision, the flap elevation is relatively safe and easy, and the donor site scar is acceptable. Disadvantages are that the direction of hair growth in the reconstructed eyebrow can be upward and the hair grows long. However, the 1-stage simultaneous reconstruction of the upper eyelid and eyebrow reduces the number of surgeries required, which is sensible for elderly patients with skin cancer.

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PATIENT CONSENT
Patients provided written consent for the use of their images.

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