

## Doppler-Guided Planning of Narrow Temporal Skin Flap Based on The Superficial Temporal Artery for Large Eye Lid Defects

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### Abstract

**Background:** The temporal area is a useful donor for flaps owing its robust blood supply from the superficial temporal artery. The anterior branch of the frontal division is one of the two terminal branches that runs antero-superiorly supplying the muscles, pericranium and skin of the lateral frontal area. Localizing the branch using Doppler enables the design of a narrow flap for eyelid reconstruction.

**Objective:** Evaluation of narrow temporal skin flap for large eye defects.

**Patients and Methods:** Eight patients with upper or lower eyelid defects were enrolled in the study. Doppler tracing of the anterior branch of the frontal division of the superficial temporal artery STA was done. A narrow and long flap was raised and used to reconstruct eyelid defects.

**Results:** Three upper and five lower eyelid defects were reconstructed. Four cases were post traumatic, 2 cases were post burn and two cases were post-infection with skin loss. Seven patients had only anterior lamella defect while one female patient had full thickness lower eyelid defect which reconstructed by Hughes' flap in addition to the forehead flap. Seven flaps healed well without any complications and one patient suffered ectropion after one month which was corrected by canthopexy.

**Conclusion:** Doppler-guided localization of the anterior branch of frontal division of STA was beneficial in harvesting a narrow reliable flap for reconstruction of thin eyelid defects, decreased operative time and minimized donor site morbidity.

**Key Words:** Eyelid reconstruction – Forehead narrow flap – Temple flaps.

**Ethical Committee Approval in March 2022:** Statement of human and animal rights, or ethical approval ethical review board of our institution approved the study. Informed Consent: Each patient signed a written informed consent document.

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### Introduction

It is appealingly essential to match the transferred tissue-whether in thickness or color to reconstruct the eyelids due to their unique anatomy. Hence, it needs thin and pliable skin that matches the eyelid and helps in eye closure and protection. More aesthetically pleasant results are obtained when flaps are designed from tissues, in vicinity to the defects, leaving less scarring.

The temple is an excellent donor site owing to its rich blood supply and different availability of different tissue. That's why lots of flaps are designed in the temporal area including skin only, muscle or combined flaps, based on the STA according to the deficient area and missed components [2]. Anatomically, the STA gives two divisions: The frontal and the parietal ones [3]. The frontal division runs in the axis of the STA that further divides into anterior and posterior branches. It continues exceeding eyebrow to supply forehead skin, frontalis, and frontal bone. The frontal division shares a rich anastomosis with the supraorbital and supratrochlear arteries [4].

The frontal division course is less variable when compared to the other division of the STA in cadaveric dissections [5]. In eighty five percent of cases, it starts above the level of the zygomatic arch [6]. The relatively consistent position of the frontal division allows harvesting of trustworthy flaps. Moreover, lots of dissection studies revealed the close relation of this division of the superficial temporal artery and the facial nerve temporal branch [13]. Hence, careful dissection and care should be implemented during flap harvest [6].

The forehead flap is a well-known flap that can be harvested on the STA or on one of its branches [7-12]. Guerrerosantos [7] reconstructed frontal defects utilizing frontalis myo-cutaneous flap based on the

frontal division of the STA. Later on, Ozdemir et al. [8] highlighted use of pedicled skin flaps, based on the frontal or parietal divisions of STA in facial soft tissue defect. In this study, we located the anterior branch of the frontal division of the STA using Doppler ultrasound and a narrow long flap was designed on this branch. We used this flap in reconstruction of different defects in upper and lower eyelid defects.

### Patients and Methods

In the period from Jan 2022 till December 2023, eight patients (8 eyelid defects) were operated upon by narrow forehead skin flap based on the anterior branch of the frontal division of the STA. The study was conducted in Ain Shams University Hospitals after obtaining the necessary consents. The study followed the Declaration of Helsinki on medical protocols and ethics, and the ethical review board of our institution. All patients have had upper or lower eyelid defects due to different etiology. One patient had full thickness defect of the lower eyelid involving the anterior and posterior lamella while the other 7 patients had only anterior lamellar defects. All defects were larger than half the width of the eyelid.

The procedure was done while the patient was under general anesthesia. To design the suitable length and width of the flap, the defect in the upper or lower eyelid was measured in centimeters. Hand-held Doppler ultrasound 8 MHZ probe (Huntleigh Multi Duplex II Bi-Directional Doppler, HNE Diagnostics, Cardiff-United Kingdom) was used to detect and localize the superficial temporal vessels then tracing the anterior branch of the frontal division of the STA. A line was drawn on the forehead corresponding to the branch. A skin flap was designed and marked centered over the traced branch (Fig. 1). We tried as much as possible to design the flap in a hairless area, but sometimes it did not work for all of patients, so we harvested a hairy part within the flap and we did laser hair removal after 5 months. The skin flap centered on the anterior branch of the frontal division was raised from distal to proximal. Width of the flap, usually 1cm, is usually sufficient to allow venous drainage, that is supplied by peri-arterial venous plexus.

The defect in the eye lid was meticulously prepared through refreshing the edges and floor. The flap was rotated and suturing to the edges of the skin defect. The proximal base of the flap was left exposed with regular application of antibiotic

ointment. The viability of the flap was regularly monitored. All flaps were taken with skin bridge, therefore, division of the forehead flap was done after three weeks. In case of severe posterior lamella defect, a tarso-conjunctival advancement flap (Hughes' flap) was transferred from the upper eyelid, then a narrow frontal flap was applied. In this case, the division of the forehead flap was done at three weeks then division of the Hughes' flap was done three months later. Follow-up of the patients was done up to six months post operatively to detect any ectropion or eye exposure.



Fig. (1): Marking of the course of the anterior branch of the frontal division of the STA using Doppler ultrasound and marking the flap.

### Results

Eight patients having different types of upper or lower eyelid defects have been operated using a skin flap based on the anterior branch of the frontal division of the STA. The study included 5 male and 3 female patients with an age ranged from 23 to 47 years with an average of (34.75). The demographic data of the operated patients, the etiology of defect, the procedure performed, the results and complications is shown in Table (1). The size of defects ranged from 3 to 7cm in length and 2 to 5cm in width. However, a detailed presentation of case 1 and 2 is as follow.

Table (1): Shows patients' characteristics, the defect, etiology, the procedure done and result.

Case	Age	Gender	Defect	Etiology	Procedure	Results and complications
1	23	Female	Lower eyelid	Post fungal infection	Forehead flap+ Hughes' transconjunctival flap + skin grafts	Uneventful
2	37	Male	Lower eyelid	Post traumatic	Forehead flap	Uneventful
3	33	Male	Lower eyelid	Post traumatic	Forehead flap +skin grafts	Uneventful
4	25	Female	Upper eyelid	Post infection	Forehead flap	Uneventful
5	41	Male	Lower eyelid	Post burn	Forehead flap +skin grafts	Uneventful
6	47	Male	Upper eyelid	Post traumatic	Forehead flap +skin grafts	Uneventful
7	34	Female	Lower eyelid	Post burn	Forehead flap	Uneventful
8	38	Male	Upper eyelid	Post traumatic	Forehead flap	Uneventful

**Case 1:**

23-year-old girl suffered from severe fungal infection "Mucor mycosis" in her nose and central face. The patient was not diabetic. The infection led to skin loss over the nose, full thickness skin loss of the lower eyelid on right side and partial thickness skin loss over the left lower eyelid. The patient received antifungal medications while she underwent three times of surgical debridement. The flap was designed as mentioned; near the hairline to get

more inconspicuous scar. A tarso-conjunctival advancement flap (Hughes' flap) was harvested from the upper eyelid to reconstruct the posterior lamella. Then Doppler-guided frontal division-based flap was raised and transferred over the Hughes' flap. Three weeks later the forehead flap was divided while Hughes' flap was divided three months later. However, the patient suffered corneal opacity from the former long exposure before coverage (Fig. 2).



Fig. (2): (A): A three lamellar defect of the right lower eyelid. (B): Harvesting of forehead flap and coverage of the anterior lamella in addition to Hughes' flap to reconstruct the lower lamella. (C): Division of the forehead flap. (D): 6 months postoperative.



**Case 2:**

A 38-year old man had a post-traumatic anterior lamellar defect involving more than a half of the right upper eyelid with adhesions and marked ever-

sion of the conjunctiva. He underwent release of the posterior lamellar adhesions and reconstruction of the defect by the frontal division-based flap which was divided after three weeks with excellent result (Fig. 3).



Fig. (3): (A): Anterior lamellar defect of the right upper eyelid with adhesions and eversion of the conjunctiva. (B): Design of the flap with the aid of Doppler. (C): Inset of the flap. (D): 3 months after division.

**Discussion**

Reconstruction of eyelid defect is one of the challenging procedures especially in large and/or composite defects. Many options are available for reconstruction of anterior lamellar defect as full thickness skin graft [13,14], local flaps [15,16] or even free flaps [17,18]. However, local flaps may be bulky and heavy for the eyelid or may leave bad scar at the donor site. Furthermore, local tissue may not be available as in cases of facial burn. The temporal area has rich vascularity and in close vicinity to the eye, so it is an excellent donor site for upper or lower eyelid reconstruction [19]. The pitfall in using such flaps is the obvious scar at the donor site [20]. A narrow flap that may have a more hidden scar is preferable. The tracing and localization of the vicinity of the anterior branch of the frontal division of the STA enabled us to design a relatively narrow and long skin flap adjacent to the hairline. Therefore, the flap was suitable to reconstruct the different defects

in lower and upper eyelids without donor site morbidity [21,22].

Full thickness skin graft (FTSG) is an easy and fast option to reconstruct defects of eyelids. Its harvesting from the contralateral eyelid or the postauricular areas provides similar color, thickness and texture that matching the original eyelid and considered an ideal replacement option [14]. However, it can only be used for modest skin defects with intact orbicularis muscle to allow its take, or in multiple lamellar defects in conjunction with other flap choices for posterior lamella reconstruction [14]. Hypertrophic scarring is the most common complication of FTSG that may require further treatment by steroid and silicone gel application [23].

Several local flaps were described to reconstruct the eyelid either random pattern flaps like V-Y advancement flap [24,25], Mustarde cheek rotational flap [26,27], Fricke forehead flap [28] and rhomboid

rotational flap [29]. Axial flaps named after definite arteries are more reliable than mere random flaps. Thus, they are more suitable for reconstruction of large narrow eyelid defects. Wu et al., in 2018 [30] have been advocated the axial pattern flap based on the frontal division of STA and combined it with hard palate mucosal transplant and used them in reconstruction of mid face defect after excision of huge tumours. Identification of the frontal division of STA and its perforators allows the harvesting of a safe narrow and long cutaneous flap for either the upper or lower eyelid defects. Furthermore, perforator-based flaps allow raising of slim flap for reconstruction of the eyelid. Excellent results were obtained with good aesthetic and functional outcomes, in two studies with modification allowing even splitting of the flaps [21,22]. Doppler-guided identification of the anterior branch of the frontal division of the STA allows to design a narrow flap centred on the artery and as well a thin long flap that can reach to the lower eyelid and reconstruct large defects. The donor area harvested is closed primarily, forms a hidden scar within the anterior hair line. This flap is versatile and easy to execute providing a good option for reconstruction of large defects of eyelids. The results were comparable to former studies (Elbanoby et al., 2016 and Rafaat et al., 2018) that utilized the same flaps with no statistical significance between results.

Designing the flap considering, the doppler signals for the vascular tree allows easier and safer elevation of the flap in addition to, narrowing the width of the flap to match the eyelid and decrease donor site morbidity.

#### Conclusion:

Doppler-guided frontal division-based flap is a versatile flap that can be used in reconstruction of anterior lamellar defect of upper or lower eyelids. The use of Doppler help to trace and localize the anterior branch of the frontal division and enables the surgeon to raise a long and narrow skin flap suitable very eyelid reconstruction.

*Conflict of interest:* The authors declare that they have no conflicts of interest to disclose or any financial ties.

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