The Function-Preserving Frontalis Orbicularis Oculi Muscle Flap for the Correction of Severe Blepharoptosis With Poor Levator Function

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Abstract

Background: Severe blepharoptosis with poor levator function (LF) has traditionally been managed with exogenous frontalis suspension but complications such as lagophthalmos, infection, and rejection are often reported.

Objectives: The aim of this study was to design a function-preserving frontalis orbicularis oculi muscle (FOOM) flap to correct severe blepharoptosis with poor LF. The long-term surgical outcome of the technique was assessed.

Methods: This retrospective study included only adult patients with severe blepharoptosis and poor LF, all of whom had their surgery performed by the senior surgeon over a 6-year period. Clinical assessment of LF, palpebral fissure height (PFH), marginal reflex distance 1 (MRD_1), duration of follow-up, and postoperative complications were recorded.

Results: A total of 34 patients and 59 eyelids were recorded during a mean follow-up period of 17.7 months. Postoperative evaluation yielded mean [standard deviation] improvements of PFH gain of 5.62 [1.61] mm ($P < 0.001$), and MRD_1 and PFH increases of 4.03 [0.82] mm ($P < 0.001$) and 8.94 [0.81] mm ($P < 0.001$), respectively. All patients demonstrated normalization of orbicularis function: no lagophthalmos was observed at the 8-month postoperative follow-up. Recurrence of ptosis was recorded in 4 eyelids (6.78%). Revisions were performed in 2 eyelids (3.39%). No infection or granuloma was noted.

Conclusions: The function-preserving FOOM flap is a useful vector for frontalis suspension. Not only does it effectively address lagophthalmos as well as other complications, but it provides aesthetically pleasing outcomes in patients with severe blepharoptosis and poor LF.

Level of Evidence: 4

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Severe blepharoptosis may result in impaired visual acuity, amblyopia, or astigmatism if left untreated. Traditional frontalis suspension has been used to treat patients with severe blepharoptosis and poor levator function (LF) (<5 mm).[1-4] However, postoperative lagophthalmos remains a common complication that not only causes pain, dry eye syndrome, and blurry vision, but potentially leads to keratopathy (corneal ulceration). The use of autologous materials, such as tensor fascia lata, has been reported to result in lower infection, granuloma formation, and recurrence rates than encountered with alloplastic materials.[5-10]

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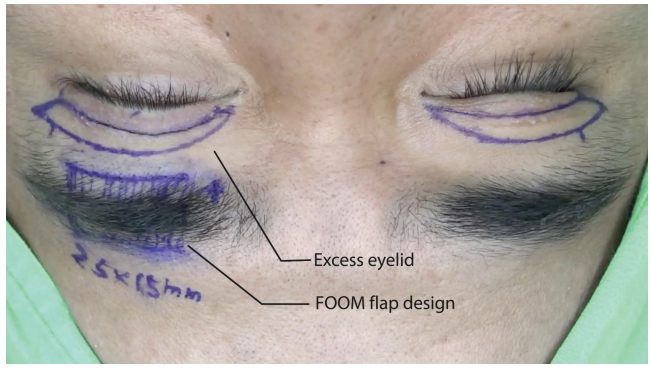
The pliability of the autologous local muscular flaps of the eyelids makes these a suitable option for upper blepharoplasty and spares a second surgical donor site.[11-13]

In 1996, Knize first described the interdigitation of frontalis muscle and the orbital portion of the orbicularis oculi muscle (OOM).[14] Lai et al[15-17] established the concept of the "frontal orbicularis oculi muscle (FOOM) flap" to denote the cross-linkage of the longitudinally oriented frontalis muscle and the horizontally oriented OOM of the orbital portion. The distinct anatomic continuation of the frontalis muscle and orbital OOM exerts a dynamic action on the muscles involved, which is the concept that was applied to the inception of the FOOM flap-shortening technique to address upper lid blepharoptosis.[16,17] The frontalis muscle transfer technique, on the other hand, involves advancement of the muscular flap that connects directly to the tarsus without disturbing the OOM.[18-20] However, the direct transfer of pure frontalis muscle may cause overcorrection of ptosis. Therefore the concept of utilizing the OOM flap as a vector in situ was developed to mitigate the effects of overcorrection caused by a direct frontalis muscle transfer.[21-25] Previous FOOM flap-shortening procedures inevitably required sacrifice of a variable portion of the OOM during upper eyelid adjustment, which potentially affected its function.[16,17,23-25] As a result, the function-preserving FOOM flap was developed by the senior author to correct severe blepharoptosis with poor LF while preserving the anatomic and functional integrity of the OOM. This study aimed to assess the surgical outcomes of this innovative technique, particularly with respect to postoperative lagophthalmos.

METHODS

Data Collection

A total of 34 adults and 59 eyelids treated with function-preserving FOOM flap-advancement surgery in our medical institution between February 2013 and December 2018 were included in this review; children were excluded from this study due to the lack of standardization in clinical assessment of LF in this cohort. The retrospective study protocol was approved by the institutional review board of Kaohsiung Medical University Hospital. Data including patient demographics, family and medical history, laboratory studies, perioperative eyelid examination results, and ptotic etiologies were reviewed in detail. Postoperative complications including infection, granuloma formation, overcorrection, ptosis recurrence, and lagophthalmos were recorded. For the clinical measurement of lagophthalmos, we asked the patients, in a sitting position, to close their eyes gently without squinting, and measured the space between the upper and lower eyelid margins with a ruler. The presence of lagophthalmos is defined by 2 consecutive measurements of the space >0.5 mm. The chi-square test was used to compare changes in marginal reflex distance 1 (MRD_1), LF, and palpebral fissure height (PFH) perioperatively. The perioperative evaluations and operations were performed by the senior surgeon (C.S.L.).



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Perioperative Evaluation and Clinical Presentations

Clinical measurement of LF, PFH, MRD_1, and ptosis severity were evaluated in each patient. MRD_1 is a standardized measurement for upper eyelid ptosis to determine the distance from the corneal light reflex on the patient to the central portion of the upper eyelid in primary gazing.[26] Bell's phenomenon, tear secretion, and Herring's phenomenon were carefully examined. Ophthalmic and neurologic tests were performed if indicated. The anti-acetylcholine receptor antibody test was conducted for diagnostic workup of myasthenia gravis (MG) or ocular myasthenia gravis (OMG). A preoperative eye-closing power test was performed. The patients were asked to close their eyes and hold them firmly shut. If the examiner's finger could open the eyelid easily, insufficient eye-closing power was present, and the surgery was not indicated for this condition.

Surgical Technique of Function-Preserving FOOM Flap Advancement

A video is provided to demonstrate the surgical technique (Video). The supraorbital foramen must be localized by palpation and marked to avoid nerve injury during the flap dissection. The operation was performed under local anesthesia except for patients who were pain-intolerant and required general anesthesia. Nerve block of the supraorbital, supratrochlear, and lacrimal nerves was completed first, followed by injection of local anesthetic mixture of 2% lidocaine containing 1:200,000 adrenaline to the eyelids. The desired muscular flap, measuring between 20 mm × 10 mm and 25 mm × 15 mm in size, was marked on the upper lid skin along the superior orbital rim. After excising redundant skin of the upper eyelid, a submuscular blunt

dissection beneath the OOM was performed beyond the superior orbital rim to the sub-eyebrow area with meticulous hemostasis by bipolar electrocauterization. The orbital septum was left intact unless fat bag removal was indicated. The rectangular-shaped FOOM flap corresponding to the skin marking was then harvested and freed by subcutaneous dissection. Any tethered fiber was released until the FOOM flap was free for downward traction. The entire preseptal and orbital OOM was preserved and kept intact. The upper eyelid margin was adjusted and positioned at the upper border of the corneal limbus to determine the appropriate advancement of the FOOM flap when the patient was supine. The upper lid margin was adjusted to rest at 1 mm below the limbus when the patient was in a sitting position.[13,22] The muscular flap was then anchored to the central and upper one-third of the tarsus with 6-0 nylon sutures. The excised excess muscle was diced into several pieces and used to fill in the gap above the FOOM flap to generate a smoother contour of the upper eyelid. A final evaluation of the upper eyelid margin position with the patient in a sitting position was performed for patients under local anesthesia before wound closure. Double-eyelid blepharoplasty was created at the last step. Five interrupted stitches were implanted for the double-eyelid creation. Three of these stitches were placed at the level of the midpupil and on either side, corresponding to medial and lateral corneal limbus. These key stitches included partial thickness of the upper third of the tarsus, a portion of the muscle flap, and the dermis of the eyelid skin edge. Two further stitches were placed in the pretarsal aponeurosis and the subdermal layer on the medial and lateral side of the upper eyelid. Securing the sutures between the tarsus and the FOOM flap is the key to avoiding dehiscence of the double-eyelid crease (Figure 1).

Postoperative Care

Temporary lagophthalmos may occur in all cases after surgery. Hence, immediate postoperative eye protection in the operating room is important. Moisture wrap dressing was used to cover the eyes with an ice pack during sleep. Application of artificial tear solutions during the day and eye lubricants at night were recommended to prevent exposure keratopathy and chemosis. Active eyeball movement was encouraged with the use of TobraDex eye suspension (dexamethasone and tobramycin; Alcon, Fort Worth, TX) to help prevent chemosis.[27]

RESULTS

A synopsis of the pertinent perioperative features of the 34 patients (12 males and 22 females) is given in Table 1. The mean [standard deviation] age was 45.3 [16.4] years (range, 18-74 years). The major etiology of blepharoptosis was myogenic type as presented in 54 eyelids of 31 cases (91.53%), followed by aponeurotic type in 4 eyelids of 2 cases (6.78%), and neurogenic type in a unilateral eyelid of 1 case (1.69%). Among the myogenic blepharoptosis group, intractable MG and OMG were diagnosed in 10 eyelids of 5 patients (16.95%). Oculopharyngeal muscular disorder (OPMD) was reported in 4 eyelids of 2 patients (6.78%). The follow-up period ranged from 6 months to 2 years and 7 months (average, 17.7 months). In Table 2, among all ptotic eyelids on which the function-preserving FOOM flap advancement was performed, improvements in MRD_1 and PFH by 4.03 [0.82] mm ($P < 0.001$) and 8.94 [0.81] mm ($P < 0.001$) compared with their preoperative measurements of –2.51 [1.93] mm and 3.02 [1.67] mm, respectively, were recorded. A mean PFH gain of 5.62 [1.61] mm was achieved after surgery. All patients (100%) demonstrated lagophthalmos at 1 month follow-up due to temporary eyelid swelling. The number of lagophthalmos cases continued to decrease to 31 cases (52.54%) at 2 months, 8 cases (13.56%) at 4 months, and only 2 cases of minimal lagophthalmos (3.39%) at 6 months follow-up. Follow-up investigation of these 2 cases revealed no residual lagophthalmos (0%) at 8 months after surgery. Recurrence of mild ptosis was recorded in 4 eyelids (6.78%). Two patients (3.39%) underwent second revision with an eventual desirable outcome. The other 2 patients declined revision because they were satisfied with the results. No infection or granuloma formation was reported.

CASE REPORTS

Case 1

This 18-year-old female had the history of MG diagnosed at the age of 2 years with thymus hyperplasia. She was referred from the neurologic department of another hospital due to refractory blepharoptosis despite medical treatment. She had been taking pyridostigmine 60 mg 4 times a day and presented with severe bilateral myogenic blepharoptosis. Her anti-acetylcholine receptor antibody level was 11.8 nmol/L. The PFH, MRD_1, ptosis severity, and LF of her right/left eyelid were 3/3 mm, –2/–2 mm, 7/7 mm, and 5/5 mm, respectively. The extraocular muscle test showed voluntary movement; her eye-closing power was normal. Function-preserving FOOM flaps measuring 15 mm × 20 mm were designed for each eyelid. The eye-closing strength remained good without lagophthalmos postoperatively. Significant improvement of the bilateral ptosis was recorded with normalization of PFH 2 years and 7 months after surgery. Postoperative PFH, MRD1, ptosis severity, and LF of the eyelids were 9/9 mm, 4/4 mm, 1/1 mm, and 5/5 mm, respectively (Supplemental Figure 1).

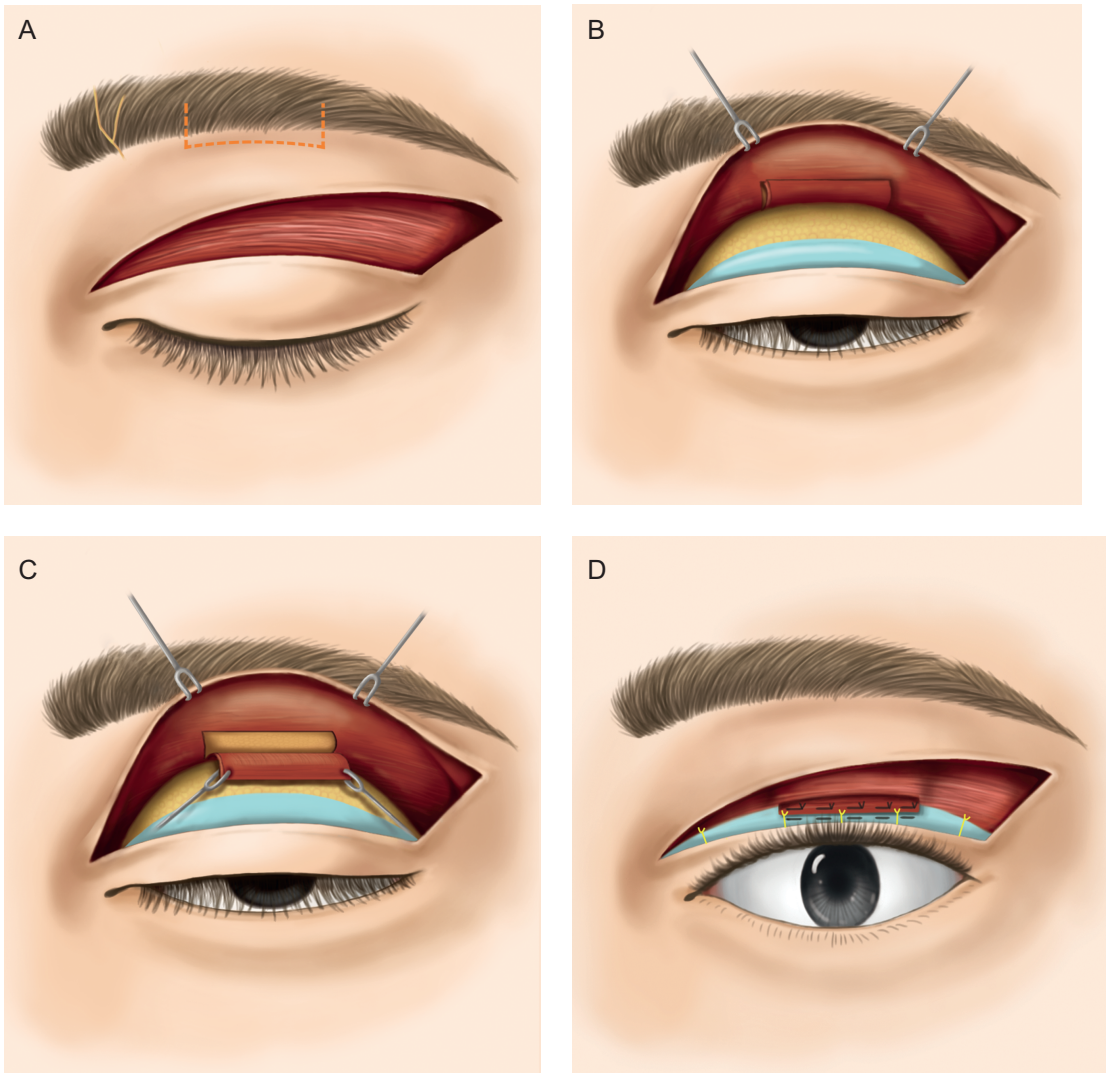

Figure 1. The function-preserving FOOM flap advancement. (A) The rectangular flap is designed and marked on the upper eyelid skin. (B) The submuscular dissection proceeds superiorly beyond the superior orbital rim while the septum is maintained intact. (C) All tethered fibers are dissected until the FOOM flap is free for downward traction. (D) The flap is anchored to the central and upper third of the tarsus followed by the double-eyelid blepharoplasty (shown in yellow sutures). Excess muscle is diced into several pieces and placed in the flap base to generate a smoother contour of the upper eyelid. FOOM, frontalis orbicularis oculi muscle.

Case 2

This 59-year-old female, referred from the ophthalmologic office, had a 10-year history of progressive bilateral blepharoptosis that had obscured her visual field. She had associated symptoms of progressive dysphagia, dysphonia, and slurred speech. The patient had the family history of OPMD that was diagnosed by genetic testing. She presented with long-term backward thrusting of the head, which enabled her to maintain a limited visual field through the narrow palpebral fissures. Preoperative PFH, MRD_1, ptosis severity, and LF of her right/left eyelids were 1/1 mm, –4/–4 mm, 9/9 mm, and 4/4 mm, respectively. A function-preserving FOOM flap 20 mm × 25 mm was designed for frontalis suspension. At 18-month follow-up, the patient displayed normalized PFH, eye-closing function, and satisfactory upper eyelid contours. Postoperative PFH, MRD_1, ptosis severity, and LF of the right/left eyelid were 8/8 mm, 3/3 mm, 2/2 mm, and 4/4 mm, respectively. The patient's head and neck posture had returned to a normal position (Supplemental Figure 2).

DISCUSSION

The choice of frontalis suspensory material may determine the surgical outcome in the treatment of patients

with severe blepharoptosis and poor LF. Autologous materials such as tensor fascia lata, palmaris longus, and temporal fascia have the advantages of reducing postoperative extrusion (0%–8.3%) and recurrence rate (4%–22%) compared with synthetic materials.[28] Nevertheless, autologous tendon or fascia transfer has the disadvantage of creating a second surgical site that may cause donor-site morbidity. Banked allogenic fascia lata also poses the risks of premature absorption, cross-infection, and subsequent fibrous tissue formation that in turn will affect the long-term success rate. Easy accessibility of synthetic grafts (eg, silicone implants, nylon monofilament sutures and polytetrafluoroethylene sheets) and avoidance of donor-site morbidity are the main reasons for their widespread use.[5-10] However, the complication rates with synthetic materials, including postoperative lagophthalmos, graft breakage, granuloma formation, and infection, continue to remain high (7%–45%).[9,29-31]

Local muscle flaps are a good alternative because they mitigate the need for a second donor site and the complications associated with implantation of foreign bodies. However, direct transfer of frontalis muscle to the tarsus, in spite of its comparatively shorter operative time, may cause prolonged postoperative lagophthalmos and loss of normal forehead wrinkles in cases of overcorrection.[18,19] During the evolution of the FOOM flap surgery from our previous studies, the superiorly based OOM flap improved postoperative upper eyelid movement, but the resulting dynamic imbalance and antagonistic equilibrium during eyelid closure remained unresolved postoperatively. Wide dissection of the OOM for harvesting the double-breasted FOOM flap required longer operative time and yielded longer downtime.[13,22] The function-preserving FOOM flap addresses lagophthalmos by performing submuscular dissection from the lower part of the orbital OOM, thereby leaving most OOM in situ without disturbing the integrity of the muscle.

The function-preserving FOOM flap has the following key properties: (1) it is an autologous muscular flap which is readily available in the same operative field of upper blepharoplasty, hence donor-site incision is not required; (2) the preservation of the orbital OOM allows near-normal eye-closing power; (3) the interlocking strength created by the horizontal fibers of OOM and the longitudinal fibers of frontalis muscle reinforces the durability of the FOOM flap and prevents it from attenuating. The frontalis muscle flap has demonstrated long-term elasticity and contractility, which is consistent with the histologic findings in our previous reports.[16,17,32] Unlike the interdigital OOM flap

Table 1. Clinical Summary of the Patients Receiving the Function-Preserving Frontalis Orbicularis Oculi Muscle Flap

Patient information	
Number of cases	34
Age (years)	45.3 ± 16.4
Gender	Male: 12; female: 22
Etiology of ptosis	
Myogenic	54 (94.7%)
Aponeurotic	4 (6.8%)
Neurogenic	1 (1.8%)
Clinical evaluation	
Bilateral lids	25
Unilateral lids	9 (left: 5; right: 4)
Follow-up (months)	17.7 [9.5]
Postoperative complications after 8 months	
Lagophthalmos	0% (0/59)
Recurrence	6.8% (4/59)
Second revision	3.4% (2/59)

Table 2. The Preoperative and Postoperative Ocular Measurements

Clinical measurements	Preoperative	Postoperative			*P* value
		1 month	3 months	5 months	
Lf (mm)	3.5 [1.3]	3.5 [1.7]	3.6 [1.2]	3.7 [0.6]	$P = 0.63$
Mrd_1 (mm)	-2.5 [1.9]	3.1 [1.5]	3.8 [0.9]	4.0 [0.8]	$P < 0.001$
Pfh (mm)	3.4 [1.6]	8.0 [1.4]	8.7 [1.0]	8.9 [0.8]	$P < 0.001$
Mrd_1 gain[a] (mm)	4.0 [0.8]				
Pfh gain[a] (mm)	5.6 [1.6]				

Values are numbers with percentages or mean [standard deviation]. Lf, levator function; mrd1, marginal reflex distance; pfh, palpebral fissure height.
[a]Comparison between preoperative and postoperative results ≥6 months.

suspension described by Wang et al,[32] who successfully treated moderate to severe blepharoptosis, the rectangular function-preserving FOOM flap with minimal involvement of the lower part of the orbital OOM creates an evenly distributed force in the frontalis movement. Additionally, in order to keep the orbital septum intact, submuscular dissection was performed at the upper margin of the eyebrow, thereby minimizing surgical interruption of the anatomic integrity of the upper eyelid.

The 2 patients with aponeurotic blepharoptosis who demonstrated poor LF were the oldest patients (aged 71 and 74 years, respectively) in this study group. In fact, in our previous study of 126 patients and 231 eyelids, 4.3% of the severe ptotic eyelids displayed fair LF (6-9 mm). Kim and Lee[33] reported 30% of their patients having fair even poor LF (<10 mm) in their involutional ptosis series. Poor LF was identified in about 1% of these patients with aponeurotic ptosis. LF was inversely proportional to the degree of fat tissue infiltration in patients of advanced age with aponeurotic ptosis.[33,34]

To achieve the ideal upper eyelid position and bilateral eyelid margin symmetry, the FOOM flap should be carefully anchored to the central and upper third of the tarsus with nonabsorbable sutures in at least partial thickness of the tarsus. We recommend placing the ptotic upper lid margin 1 mm below the limbus with the patient in a sitting position, and placing the upper limbus margin intraoperatively with the patient supine.[13,22]

The function-preserving FOOM flap significantly improves PPH and MRD_1, and eliminates lagophthalmos 8 months postoperatively with a revision rate of 3.39%, and hence offers a functional and aesthetic outcome.

CONCLUSIONS

Functional preservation of the OOM is the key point in the correction of severe blepharoptosis with poor LF. In function-preserving FOOM flap advancement, we utilized the autologous muscle flap in the same operative field via a minimally invasive approach. The technique preserves the maximal anatomic integrity of the OOM, thereby maintaining its pliability during dynamic movements of the eyelids. The surgical technique not only corrects severe blepharoptosis effectively but also eliminates postoperative lagophthalmos and other complications better than traditional frontalis suspension.

Supplemental Material

This article contains supplemental material located online at www.aestheticsurgeryjournal.com.

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Shu-Hung Huang and Chia-Chen Lee made an equal contribution to this work as co-first authors.

Disclosures

The authors declared no potential conflicts of interest with respect to the research, authorship, and publication of this article.

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