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A Combination of Three-Step Lower Blepharoplasty to Correct Four Types of Lower Eyelid Deformities in Asian People

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Abstract
Background This study aimed to propose a novel four-type deformity and treatment-oriented classification of the lower eyelids that directs the therapeutic combination of three-step lower blepharoplasty for Asian populations.
Methods We reviewed 183 patients who underwent a therapeutic combination of three steps of lower blepharoplasty after being diagnosed with four types of lower eyelid deformities between July 2018 and April 2021. The three-step lower blepharoplasty includes: (1) mid-face and lower eyelid augmentation, (2) transconjunctival eye bag removal, and (3) skin pinch removal. Consecutive digital images, detailed fat graft volume, fat removal amount, skin pinch removal amount, complications, and patient's satisfaction and aesthetic improvement score were recorded.
Results The overall patient's satisfy score is 91. Aesthetic improvement score is 80.2 and 83.3 among lay persons and experts, respectively. The volume of the fat graft ranges from 2 to 3 mL per orbit according to the severity of the deformity. The amount of fat removed was 0.53 ± 0.36 and 0.61 ± 0.40 mL per orbit in types II and III patients, respectively. There is no lower lid malposition. Eleven patients had over-correction of fat grafting, and they need steroid injection; 20 patients had under-correction of fat grafting, and they need secondary fat grafting. Ten patients need secondary skin pinch excision due to post-op skin redundancy. Two patients had conjunctiva wound granuloma.
Conclusions The combination of three-step lower blepharoplasty according to the novel classification is a straightforward and effective method to correct lower eyelid deformities. The complication rate was low with high patient satisfaction.
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Keywords Lower blepharoplasty · 4 classifications · Tear trough · Eye bag

Introduction

Lower blepharoplasty is a common aesthetic procedure; however, achieving optimal outcomes remains challenging due to complex anatomical deformities. The deformities may involve pseudoherniated fat (eye bags), skin laxity (wrinkles), and soft tissue deflation at the nasojugal groove (tear trough), lid–cheek junction, and mid-face (V deformity). Treatment should be tailored appropriately because a single deformity does not represent the overall problem [1, 2].

It has been difficult to classify lower eyelid deformities because of the complexity of defining their location and severity. Barton et al. graded preoperative and postoperative results into three degrees based on the severity and extension of the lid–cheek junction, from the tear trough to the lateral orbital rim [3]. Meanwhile, Hirmands characterized lower lid deformities according to periorbital volume loss [4]. Sadick's scoring system summed the scores

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derived from the depth of the tear trough, hyperpigmentation, lower lid rhytidosis, and prolapse of nasal fat pads, to represent the overall severity [5]. Classifications can also serve to differentiate the morphology and may extend to therapeutic guidance. Turkmani's classification directs filler injections based on the morphology of the tear trough as five types of "hill–valley" combinations [6]. However, none of the studies classifying the severity or therapeutic approaches have been widely accepted.

The current practice emphasizes homogenizing periorbital congruency and minimizing adverse outcomes by performing periorbital fat grafting, release of ligamentous structures, limited resection of orbital fat, and pinch skin excision. Rohrich further comprehended the paradigm with the five-step method and subsequently added fractionated fat injection and simplified orbital retaining ligament (ORL) release by a blunt cannula [7–9]. Some Asian surgeons also adopted and modified the concept. Integrating structural fat grafting has largely increased in Asian lower blepharoplasty [10–14]. Huang et al. demonstrated three-step lower blepharoplasty via a transcutaneous approach following microautologous fat transplantation (MAFT) [11]. Larsson et al. highlighted fat grafting to the lid–cheek junction and mid-cheek during periorbital rejuvenation in the Asian population [13]. Furthermore, the bi-lamellar approach of transconjunctival fat removal plus skin excision has become popular among some Asian surgeons, and yields great safety and optimal results [15, 16]. On the other hand, Asian surgeons tend to overlook additional lateral canthal supports because Asians are less likely to develop involutional ectropion and lower lid retraction due to disparity in soft tissue nature when compared to Caucasians [17, 18]. Thus, ethnicity is an indispensable issue at initial assessment and for therapeutic approaches.

This study aimed to propose a novel four-type deformity and treatment-oriented classification of the lower eyelids that directs the therapeutic combination of three-step lower blepharoplasty for Asian populations. We also provide detailed and quantitative measurements of each procedure and demonstrate safe and reproducible surgical nuances.

Methods

Patient Demographics

We reviewed 183 patients who underwent three steps of lower blepharoplasty after being diagnosed with a novel four-type deformity and treatment-oriented classification of the lower eyelids. The three steps of lower blepharoplasty include: (1) mid-face and lower eyelid fat augmentation, (2) transconjunctival removal of lower eyelid fat, and (3) pinch skin removal. Each step or combination of the steps aims to resolve the following deformities: soft tissue deflation, eye bag protrusion, skin laxity, and the presence of festoons. This study was approved by the institutional review board of our institute and was prospectively designed and retrospectively reviewed. Patients were recruited between July 2018 and April 2020. Patients who underwent lower blepharoplasty within 3 months or had lower eyelid malposition were excluded. Data collection included age, sex, classification of lower eyelid deformities, volume of fat graft at four subunits, amount of eye bag excised, width of skin excised, and associated surgical procedures. All complications and secondary procedures were also documented.

Aesthetic Results Evaluation

The evaluation was performed at a similar time and usually at two months after the surgery. Patients scored their satisfaction on a visual analogue scale (0 to 100). As for the external validation, four board-certified plastic surgeons and four lay people evaluated the aesthetic improvement based on pre- and postoperative photographs on a vertical 100-mm visual analogue scale (0 to 100) [19].

Classifications

The patients were classified into four types based on their deformities and the therapies performed. Patients with type I deformity have only lower eyelid volume deficiency and require only fat augmentation treatment; patients with type II deformity have both volume deficiency and eye bags, which require two approaches for treatment: fat augmentation and transconjunctival eye bag removal; patients with type III deformity have volume deficiency, eye bags, and skin laxity, which require three approaches for correction: fat augmentation, transconjunctival eye bag removal, and pinch skin excision; and patients with type IV deformity (festoon) have severe skin laxity and volume deficiency, which require fat augmentation and pinch skin excision (Figure 1).

Type I deformity (one deformity, one approach).

Patients had only a volume deficiency of the lower eyelid without eye bags and skin laxity. The treatment includes only one approach: mid-face and lower eyelid fat augmentation (Figure 2).

Type II deformity (two deformities, two approaches).

Patients presented with both volume deficiency and eye bags, without skin laxity. Treatments include two approaches: mid-face and lower eyelid fat augmentation and transconjunctival removal of lower lid fat (Figure 3).

Type III deformity (three deformities, three approaches).

Patients have volume deficiency, eye bags, and skin laxity, which is more likely related to the ageing process. Treatments include three approaches: mid-face and lower

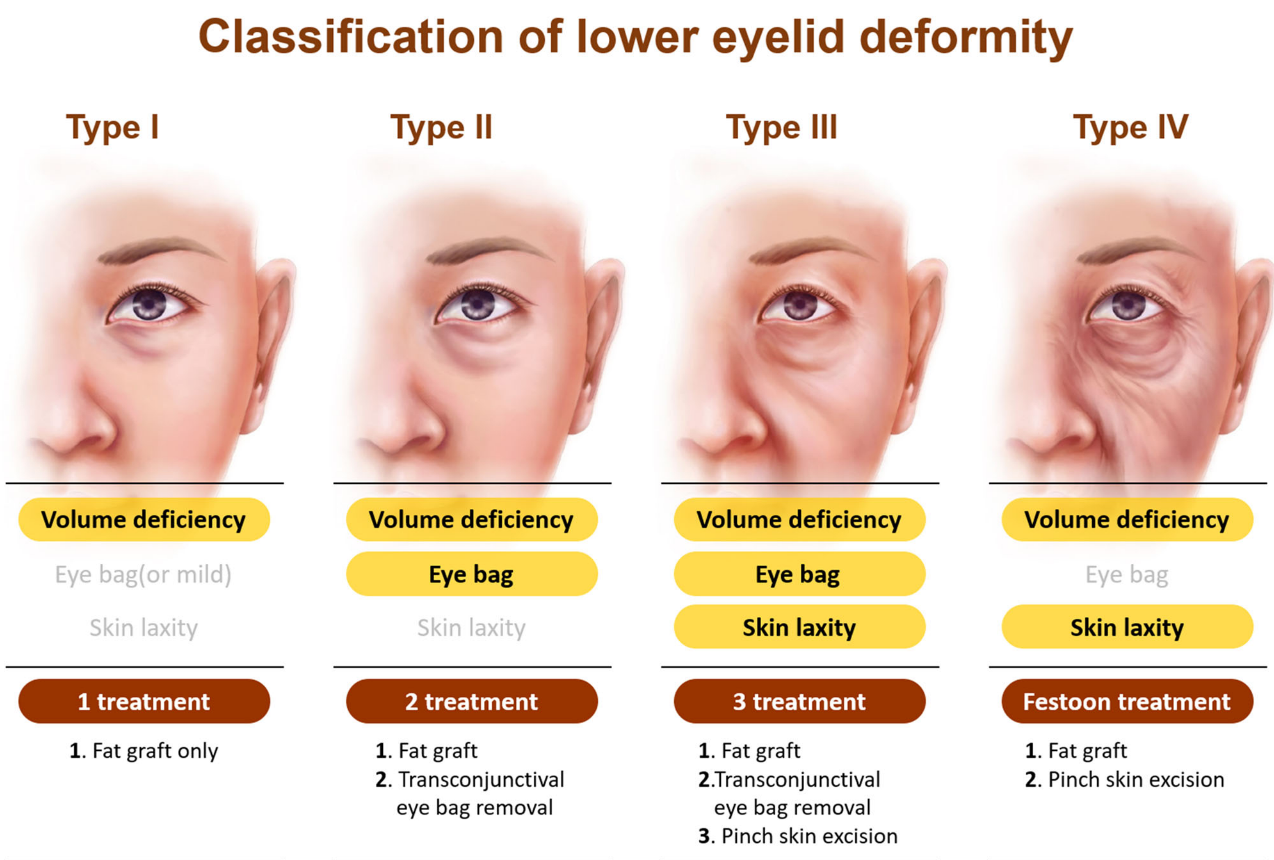


Fig. 1 Therapeutic algorithm along with classification of lower lid deformities

eyelid fat augmentation, transconjunctival removal of lower lid fat, and pinch skin excision (Figure 4).

Type IV deformity (festoon type).

We characterized festoon deformity as type IV, which includes severe skin laxity and volume deficiency but without significant eye bags. Treatments include pinch skin excision and volume correction using fat grafts. Eye bag removal is unnecessary (Figure 5).

Surgical Nuances

All procedures were performed by the senior author (H.-C. C.). Each surgery is a combination of the following three procedures: (1) lower eyelid augmentation by fat graft; (2) transconjunctival removal of orbital fat and ORL release; and (3) pinch skin excision (Video 1).

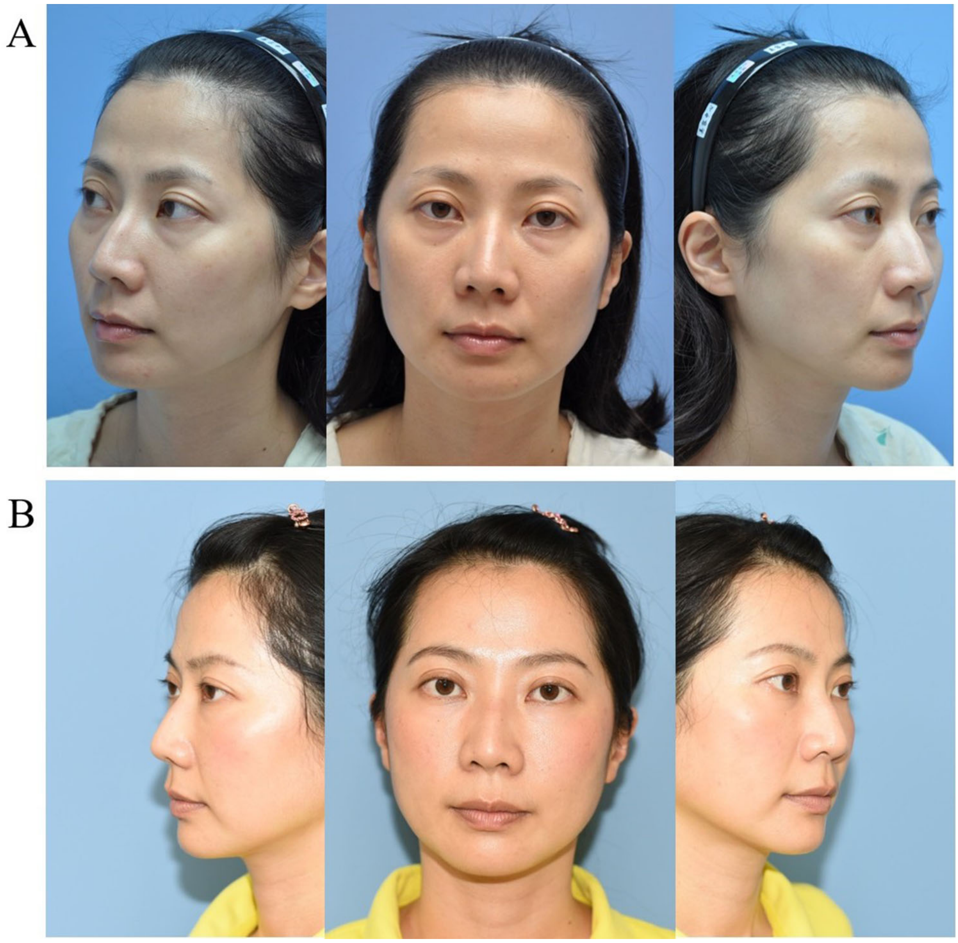
Lower Eyelid Augmentation by Fat Grafting

All four types of deformities require fat grafting, which is variably affected by periorbital deflation. First, the four subunits for augmentation, including the palpebral area, nasojugal groove (tear trough), lid–cheek junction, and mid-face including zygomatic cutaneous groove, were marked preoperatively (Figure 6). Liposuction was performed by initially using a tumescent solution (20 mL of 2% lidocaine [20 mg/mL]:80 mL of normal saline solution:0.25 mL of epinephrine [1:400000]) for infiltrating the donor site at either the abdomen or thigh and then suctioning with 20-mL Luer-Lock syringe. The lipoaspirate was filtered through a fine silicon mesh surrounded by dry gauze and then transferred from a 10-mL syringe to 1-mL syringes. We injected the fat graft using a microautologous fat transplantation (MAFT) gun (DermatoPlastica Beauty Co., Kaohsiung, Taiwan), which allows smaller and more controlled fat parcel delivery [11]. The fat graft was injected using an 18-gauge blunt tip cannula, and the size of each fat parcel delivered was set at 1/90 mL. The fat graft was injected in different planes and was completed upon disappearance of the upper sulcus hollow and smooth transition of the lid–cheek junction. The amount of fat graft in four subunits was recorded (Figure 7).

Transconjunctival Removal of Orbital Fat and Orbital Retaining Ligament Release

Lidocaine (2% xylocaine with 1:100,000 epinephrine) was infiltrated into the conjunctiva. A 15-mm excision was

Fig. 2 Type I deformity **A** pre- and **B** postoperative (3 months) view



made using either Bovie cautery or CO2 laser (UltraPulse® carbon dioxide laser delivery system). We used a cotton tip to bluntly dissect the pre-septal space down to the arcus marginalis then release the ORL and tear trough following the route. The orbital septum was then identified, and three excisions were made along the medial, central, and lateral compartments. The amount of fat removal was determined by the extrusion of orbital fat while applying gentle pressure to the orbit. Excessive removal was unnecessary. Fat was excised by either Bovie cautery or a CO2 laser. The amount of orbital fat removal was recorded (Figure 8).

Pinch Skin Excision

The definite area for skin excision was preoperatively pinched and determined in the upright position. We did not change our planning intra-operatively because any manipulation might have interfered with the judgement of the lower eyelid position. The procedure was inspired by that of Rosenfield [20]. Briefly, lidocaine (2% xylocaine with 1:100,000 epinephrine) was infiltrated before excision. Excision was performed using a surgical blade above the orbicularis oculi muscle. Minimal ectropion was anticipated as the end point, which would resolve within a week (Figure 9).

Postoperative Care

Patients were given an ice pack over the surgical field for 30 min immediately after surgery, and no additional ice pack is recommended. Regular postoperative care was provided for 3 days, including the administration of oral antibiotics, oral antifibrinolytic agents, oral nonsteroidal anti-inflammatory medications (NSAIDs), and antibiotic eye ointment for wound care twice a day.

Statistics

Statistical analyses and data processing were performed using R software (version 4.0.4). One-way ANOVA was performed for continuous variables in multigroup analysis, and statistical significance was evaluated by Tukey's post hoc analysis. Unpaired Student's t-test was used for continuous variables. Statistical significance was set at $p < 0.05$.

Fig. 3 Type II deformity **A** pre- and **B** postoperative (11 months) view

Results

Patient Demographics

From July 2018 to April 2021, 183 consecutive patients (36 men and 147 women) were retrospectively reviewed. There were 15 type I cases, 15 type II cases, 142 type III cases, and 11 type IV cases. The average follow-up time was 6 ± 5.4 months. Demographic and statistical data are summarized in Table 1. The type II patients were statistically younger than the other three types, but we did not find a direct correlation between deformity type and age. Fifty-five type III patients underwent additional procedures concomitant to lower blepharoplasty, including 36 upper blepharoplasties and 19 fat grafts in other regions of the face.

Aesthetic Results

Most patients satisfied with the procedures with an overall score 91.0 on the visual analogue scale (Table 1). On external review, type III achieved the most aesthetic improvement, scoring 88.5 ± 11.8 and 85.0 ± 12.8 among experts and lay persons, respectively. However, the score was lowest in type I, with 72.5 ± 10.8 and 70.5 ± 11.1 in experts and lay persons, respectively. Type I comprises the least deformity; thus, postoperative changes can be subtle to raters and reflect the least aesthetic improvement in scores. Regardless, type I patients were satisfied with the results and subjectively scored 90.0 by the end of follow-up.

Volume of Fat Graft

The volume of the fat graft ranges from 2 to 3 mL per orbit according to the severity of the deformity. The detailed volume of fat graft at four subunits (palpebral area, tear trough, lid–cheek junction, and mid-face) of the lower eyelid is shown in Table 1. The amount of total fat grafting was highest in type III and lowest in type I, with 3.07 ± 0.90 mL and 2.01 ± 1.19 mL per orbit, respectively ($p < 0.005$) (Table 1). Type I required statistically lower fat amounts than the other three types on post hoc analysis, indicating the least degree of volume deficiency requiring correction ($p < 0.005$). This discrepancy was likely attributed to the palpable region. The amount of fat

Fig. 4 Type III deformity **A** pre- and **B** postoperative (3 months) view

injection at the palpable region was higher in type III (0.96 ± 0.38 mL per orbit, $p < 0.005$), type II (0.88 ± 0.33 mL per orbit, $p < 0.005$), and type IV (0.67 ± 0.26 mL per orbit, $p = 0.068$) compared to type I (0.29 ± 0.31 mL per orbit), whereas the amount of fat injection did not differ in the tear trough ($p = 0.482$), lid–cheek junction ($p = 0.218$), or mid-face ($p = 0.092$) across each type (Table 1).

Amount of Eye Bag Excised

The amount of fat removed was 0.53 ± 0.36 mL and 0.61 ± 0.40 mL per orbit in types II and III patients, respectively. Table 1 shows the detailed amount of eye bags removed from the lower eyelid (medial, central, and lateral parts of the eye bag). The presence of an eye bag in types II and III required subconjunctival orbital fat removal. The amount of fat removed was 0.53 ± 0.36 mL and 0.61 ± 0.40 mL per orbit in types II and III, respectively ($p = 0.393$). Protrusion of orbital fat in the lateral compartment was significantly higher in type III than in type II (0.30 ± 0.23 mL per orbit, $p < 0.005$). Insufficient removal might result in a higher revision rate and dissatisfaction, based on our previous experience.

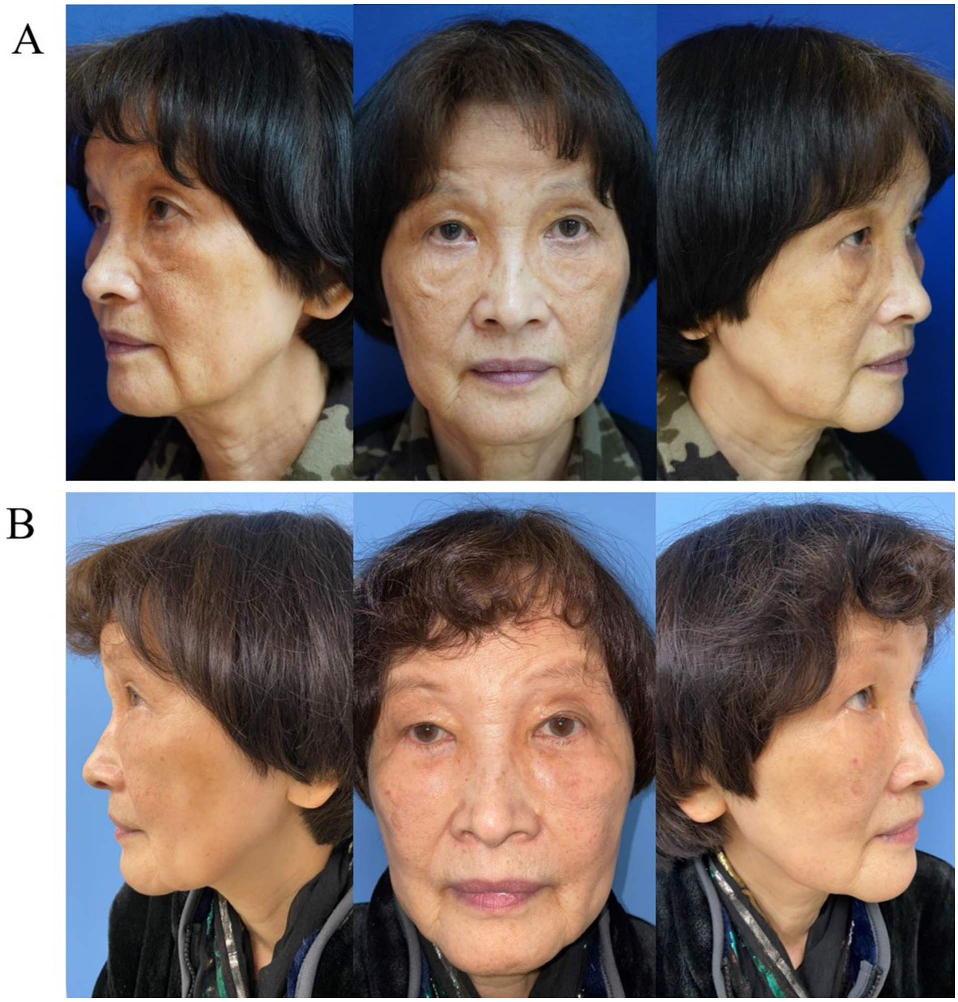
Width of Skin Excision

Skin redundancy was present in type III and type IV patients. The lax skin can be safely removed with a width of 5.00 ± 1.31 mm and 5.50 ± 2.46 mm in types III and IV, respectively. Although we did not experience any lower lid malposition, nine patients required secondary skin excision, in which 4.17 ± 1.20 mm of skin was excised. At the initial operation, the amount of excised skin was not different between patients with and without secondary excision (5.44 ± 2.18 mm and 4.97 ± 1.23 mm, respectively, $p = 0.141$).

Complications

Lower eyelid malposition was not reported in this study, either ectropion or entropion. Touch-up for sequalae of fat grafting was the predominant secondary procedures in 11 and 20 patients with over- and under-correction of fat grafting, respectively. Under-correction of fat grafting usually occurs at the palpebral subunit. These patients underwent secondary fat grafting with an average volume of 0.84 ± 0.37 mL. Over-correction of fat grafting always

Fig. 5 Type IV deformity **A** pre- and **B** postoperative (20 months) view



occurs at the tear trough subunit. Over-corrected patients received steroid injection (triamcinolone acetonide, 40 mg/mL diluted 1:1 with saline solution). Granuloma at the conjunctival wound was found in three patients and managed with direct excision. Four patients experienced postoperative infection which resolved after antibiotic treatment, while three patients had transient diplopia.

Discussion

Understanding the fundamental cause of an issue can lead adequate solutions. Although lower blepharoplasty is complex, we classified patients into four types according to deformities (presence of tear trough/lid–cheek deformity, eye bags, skin laxity, and festoon), and created a three-step therapeutic combination (Figure 1). Similar to Rohrich's five-step method [7–9] herein, we condensed the process into the three most essential procedures: structural fat grafting augments the periorbital deflation and blends the junction; the transconjunctival route allows resurfacing the eye bags and releasing the orbital retaining ligament simultaneously; and the pinch skin method excises crepe-like and lax skin.

The causes of lower eyelid malposition following lower blepharoplasty are multifactorial, including lid laxity, excessive skin removal, denervation of the orbicularis oculi muscles, and scarring at the anterior or middle lamellae. In our series, there was no case of lower eyelid malposition requiring a secondary procedure. We believe that malposition can be avoided effectively, without lateral canthopexy, by the cumulative effects of periorbital fat augmentation, orbicularis oculi muscle preservation using a bi-lamellar approach, and precise skin excision.

Asian lower blepharoplasty regards lateral canthal support, canthopexy, or canthoplasty, as optional procedures [11, 13, 21], whereas Western experts highlight the importance of lateral canthal supports to avoid lower lid malposition [22–25]. The disparity in tissue nature across ethnicities can be one of the fundamental causes of this. Caucasians are more susceptible to involutional ectropion and lower lid retraction [17, 18]. We previously quantified skin tones and resistance to lower eyelid retraction by using a force gauge across ethnicities, and the results suggested

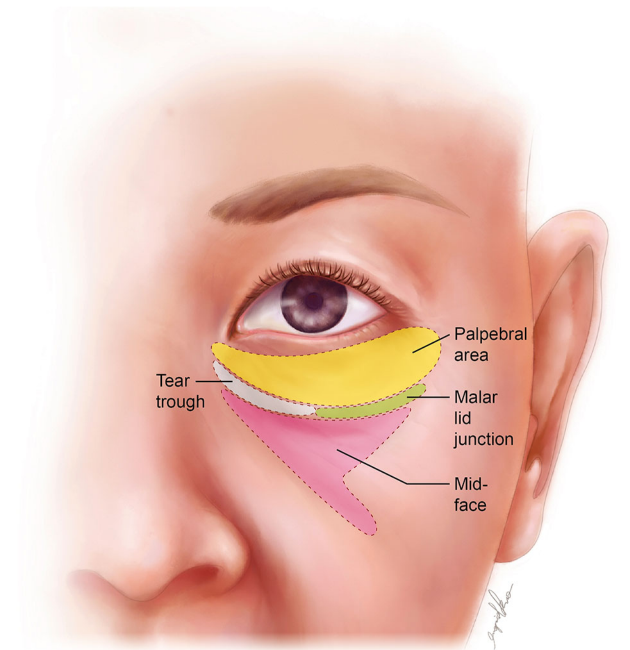


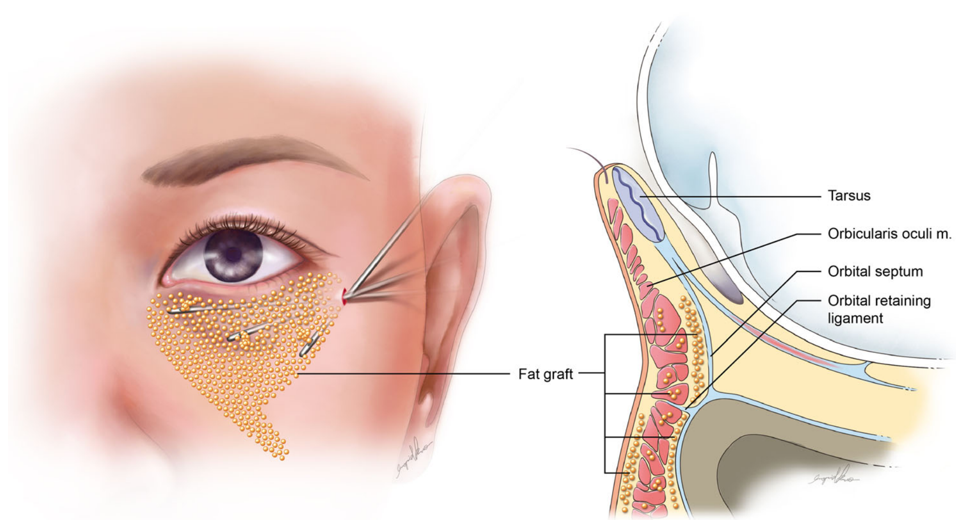
Fig. 6 Subunits of fat augmentation: palpebral area, nasojugal groove (tear trough), lid–cheek junction, and mid-face including zygomatic cutaneous groove.

that Hispanics and Asians were more resilient to traction on the lower eyelids [18]. Despite a general consensus towards performing routine lateral canthopexy in Caucasians, Maffi suggested that lateral canthal support is only necessary if lid laxity is present. He retrospectively reviewed 2007 patients who underwent lower blepharoplasty without lateral canthopexy in his 30-year cohort and found only 0.4% symptomatic lower eyelid malposition [26]. Lateral canthopexy need not necessarily be performed routinely with lower blepharoplasty, especially in Asia, and it might increase complications and cannot completely eliminate the risk of malposition [22, 23].

The orbicularis oculi muscle contributes to the principal lower lid tone, and preservation minimizes lower lid malposition. Traditional skin–muscle flap resection increases the risk of middle lamellar scarring and denervation of the orbicularis oculi muscle as the branches of the zygomatic nerve run perpendicular to the surgical incision [27]. Histologically, Lessa et al. [28] reinforced that myotomy increased collagen deposition and decreased nerve distribution, thus emphasizing the advantages of muscle preservation. Still, some regard the transcutaneous approach as safe and minimally denervate the muscles if the medial portion of the orbicularis oculi muscle is not violated [11, 29]. Although the transcutaneous approach yields comparable results when used cautiously [22[3], 30], orbicularis oculi muscle preservation via the bi-lamellar approach is regarded as a safer and more reliable option [9, 15, 16, 31].

Aggressive skin removal leads to lid malposition, while insufficiency yields suboptimal aesthetics and secondary excision. We marked the definite skin for excision preoperatively in the upright position, as it offers more accurate judgement for determining the desired lower eyelid position and avoiding tissue distortion by deciding the procedures in advance. The width of skin excision can vary according to factors such as the route of approach, ethnicity, and supplementary procedures. In Western patients, Rosenfield excised 8-12 mm of lower lid skin [20], while Innocenti excised 1.3-4.3 mm; [29] in Asians, Huang et al. suggested a conservative 3-4 mm excision via the transcutaneous approach [11]. In our practice, approximately 5 mm of skin can be safely excised without supplementary procedures; however, secondary revision is sometimes

Fig. 7 The fat graft was injected by a 18-gauge blunt tip cannula and the size of each fat parcel delivered was set at 1/90 mL. The fat graft was injected in different planes.



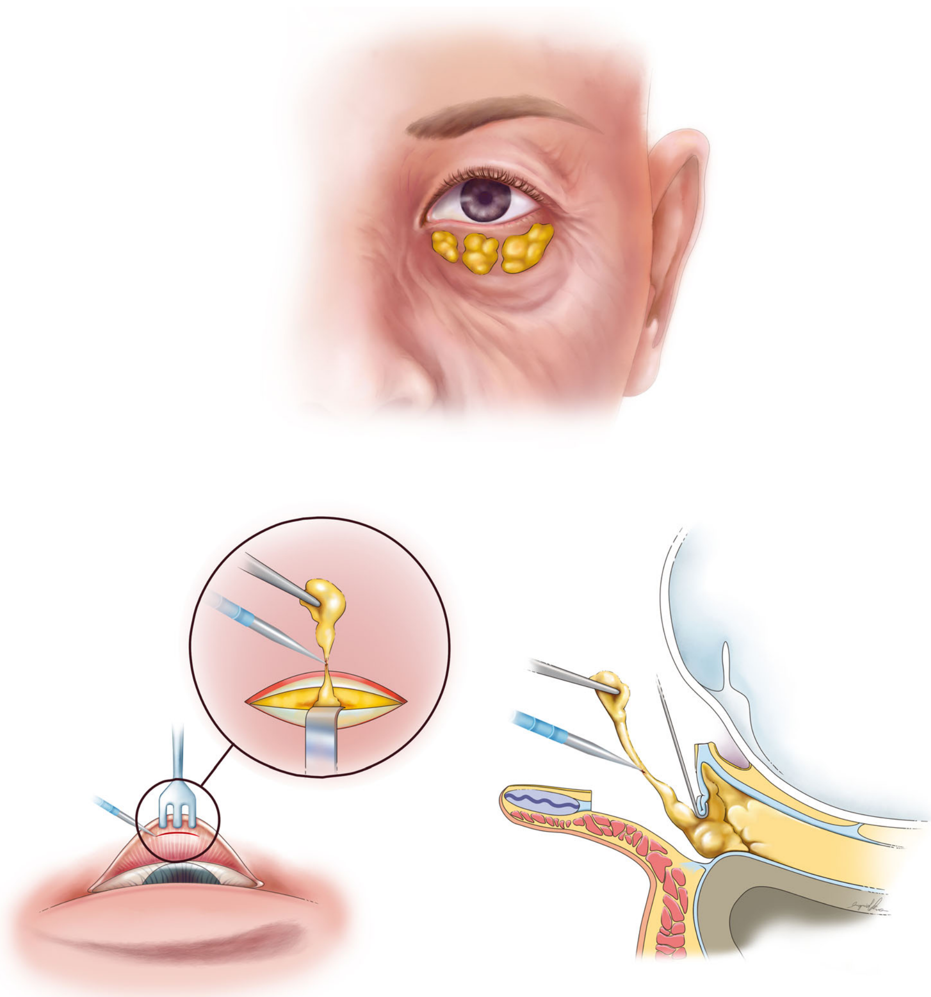


Fig. 8 Transconjunctival eye bag removal

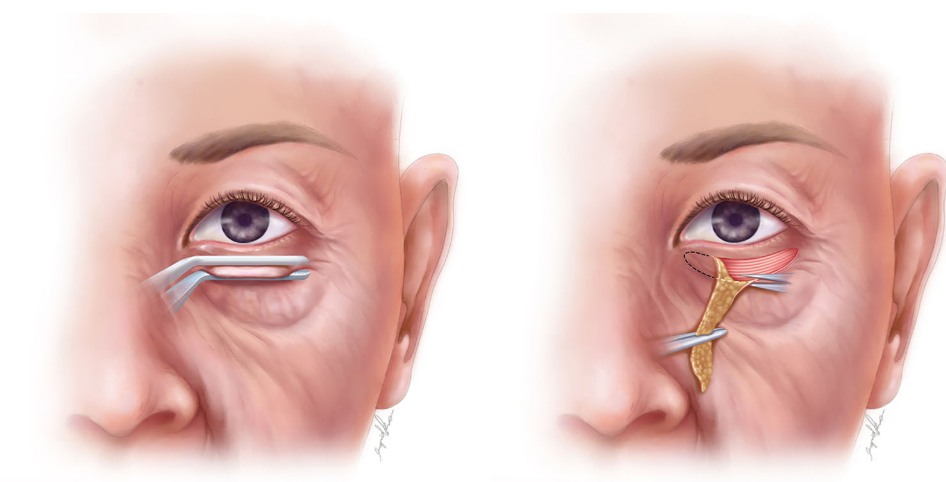


Fig. 9 Pinch skin excision

inevitable. Minimal ectropion is anticipated immediately postoperatively, which usually resolves in one week.

Periorbital volumnization is indispensable in the rejuvenation and homogenization of periorbital aesthetics. We specify the lower periorbital area into four subunits: the palpebral area, nasojugal groove (tear trough), lid–cheek junction, and the mid-face; with amounts ranging from 2 to 3 mL per orbit according to the deformity's severity

Table 1 Patient demographic data of four types and intra-operative statistics

	Type I n = 15	Type II n = 15	Type III n = 142	Type IV n = 11	Total n = 183	*P-value*
Age (years) (mean ± SD)	52.4 ± 12.3	39.1 ± 12.6	56.0 ± 9.1	55.1 ± 11.7	54.2± 10.8	**< 0.005**
Female	14	12	112	9	147	–
Surgical procedures						
Total fat graft (mL) (mean ± SD)	2.01 ± 1.19	2.76 ± 0.62	3.07 ± 0.90	2.91 ± 1.02		**< 0.005**
Palpable region	0.29 ± 0.31	0.88 ± 0.33	0.96 ± 0.38	0.67 ± 0.26	–	**< 0.005**
Tear trough	0.63 ± 0.17	0.63 ± 0.16	0.70 ± 0.25	0.66 ± 0.32	–	0.482
Lid–cheek junction	0.24 ± 0.26	0.29 ± 0.21	0.34 ± 0.19	0.27 ± 0.07	–	0.218
Mid-face	1.18 ± 0.57	1.06 ± 0.34	1.30 ± 0.53	1.08 ± 0.43	–	0.092
Orbital fat removal, total (g) (mean ± SD)	–	0.53 ± 0.36	0.61 ± 0.40	–		0.393
Medial	–	0.15 ± 0.15	0.15 ± 0.12	–	–	0.917
Central	–	0.24 ± 0.22	0.17 ± 0.17	–	–	0.158
Lateral	–	0.14 ± 0.07	0.30 ± 0.23	–	–	**< 0.005**
Pinch skin excision width (mm) (mean ± SD)	–		5.00 ± 1.31	5.50 ± 2.46		0.360
Results (0–100)						
Patients' satisfaction (mean)	90.0	87.5	91.1	94.0	91.0	–
Lay person (mean ± SD)	70.5 ± 11.1	78.8± 11.2	85.0 ± 12.8	75.0 ± 14.7	80.2 ± 13.5	–
Plastic surgeons (mean ± SD)	72.5 ± 10.8	83.3± 11.9	88.5 ± 11.8	75.0 ± 12.2	83.3 ± 13.3	–
Complications (%)						
Fat over-correction	1 (6.7)	2 (13)	8 (5.6)	0	11 (6)	–
Fat under-correction	2 (13)	1 (6.7)	17 (11.9)	0	20 (10.9)	–
Second skin pinch excision	0	1 (6.7)	9 (6.3)	0	10 (5.5)	–
Granuloma	0	0	3(2.1)	0	3 (1.6)	–
Infection	0	0	4 (2.8)	0	4 (2)	–
Diplopia (transient)	0	0	3 (2)	0	3 (1.6)	–

(Table 1). The palpable region corresponds to the inferior orbital fat compartment, which is confined between the area from the inferior lid tarsus, the orbicularis retaining ligament, and the medial and lateral canthi [32]. Under-correction of fat grafting usually occurs at the palpebral subunit. Types III and IV patients required more augmentation in this area, suggesting greater deflation during the ageing process than type I patients (Table 1). The fat graft was injected submuscularly in palpable region, which decreased the risk of irregularity if placed subcutaneously.

The tear trough deformity results from atrophy of superficial tissues over the muscular junction between the palpebral and orbital portions of the orbicularis oculi muscle. Submuscularly, the orbicularis oculi muscle directly attaches to the bone with minimal space for expansion by fat grafting at this layer [33]. Fat grafts can be delivered into intra-muscular/submuscular, or subcutaneous planes. However, the space in the submuscular plane of the tear trough is limited owing to its tight attachment. Therefore, fat grafts are predominantly delivered in the subcutaneous plane, which increases the risk of irregularity. Over-correction of fat grafting has always occurred at the tear trough subunit. Precise measurements and cautious injection are warranted in this area. We suggest that fat injection be limited to around 0.6 mL to 0.7 mL at the tear trough subunit, which is similar to the suggestion from a previous review (average of 0.65 mL per orbit at the tear trough) [34]. Despite the anatomical similarity between the lid–cheek junction and the tear trough, the ORL in the lid–cheek junction represents a loose attachment that allows more effective release and volumization in the submuscular plane [33]. Still, a cautious approach in the subcutaneous plane is warranted.

Although the interposition or microfat grafting from orbital fat to the tear trough to amend volume deficits yields satisfactory outcomes, the volume might not be sufficient in advanced deformities [35–37]. The amount of fat removed in our study was 0.53 ± 0.36 mL and 0.61 ± 0.40 mL per orbit, compared to the 0.63 ± 0.16 mL and 0.70 ± 0.25 mL required for augmentation at the tear trough in types II and III patients, respectively. Our results suggest that either interposition or microfat grafting from orbital fat is likely to match the deficiency in the tear trough deformity in type II patients. However, the resected volume might be insufficient in some type II patients, highlighting the necessity for additional fat grafting. Moreover, orbital fat transfer is not recommended for volume replacement in type III patients because the volume of deficit usually exceeds the resected volume.

A variety of valuable classifications based on anatomy, volume loss, and morphology had been offered in previous investigations. None of these classifications, however, have been widely used because they are difficult to memorize and inconvenient to employ in clinical settings. We proposed a novel classification in this study that defines the severity with corresponding therapeutic approaches. A treatment plan accompanies each lower eyelid deformity. It is easier to memorize and more practical in therapeutic settings.

The complication rate was low in the present study. Conjunctival wound granulomas may be a side effect of lateral thermal injury during transconjunctival eye bag removal. According to Mullins et al., conjunctival granulomas developed in 8 of 400 (2%) patients who underwent transconjunctival blepharoplasty [38]. In this study, 3 of 158 (1.9%) patients underwent transconjunctival eye bag removal and developed conjunctival granulomas. The incidence of conjunctival granuloma was similar to that reported in a previous study. Injuries to the inferior oblique muscle following lower blepharoplasty may cause diplopia. In our study, three (1.6%) patients who developed transient diplopia, which might be due to postoperative oedema, spontaneously recovered. Myotoxicity caused by local anaesthetics has also been considered as a cause of transient diplopia [39]. Postoperative eyelid infections are uncommon, and the infection rate after blepharoplasty has been reported to be 0.2%. In this study, four (2%) patients who developed lower eyelid erythema and swelling were considered to have postoperative infections and were successfully treated with oral broad-spectrum antibiotic therapy. It may be difficult to distinguish infection from an allergy, which could explain why the infection rate in this study was higher than that in previous studies.

This study provides one of the largest cohorts in Asian lower blepharoplasty with 183 consecutive patients, of which type III patients constituted the most dominant population. Although we retrospectively collected the data, the protocol was designed in a prospective manner. There are limitations in our study. The 55 type III patients received concomitant procedures that could affect the overall evaluation. The patients were followed up in the clinic with average 6 months, but a longer longitudinal follow-up is warranted to elucidate long-term outcomes. The lack of comparison with other techniques is one of the limitations of this study. A precise comparison of the methods across studies is difficult because of the high variability in the classification and outcome measurements. The orbital vector may influence the treatment decisions for lower blepharoplasty. One of the disadvantages of our study is that we did not collect data on the orbit vector. The lower lid and mid-face tissues droop and sag because of gravity. For severe laxity, skin pinch excision alone is insufficient for lifting. We did not discuss the mid-face lift, which can improve the dropping and sagging of the lower lid and mid-face tissues. This is another limitation of the present study.

Conclusion

The novel four-type treatment and deformity-based classification directs the combination of the three-step therapeutic approach and achieves high satisfaction in 183 consecutive patients with low complication rates. We also demonstrate the detailed volume of fat graft at four lower eyelid subunits, amount of excised eye bag, and width of pinch skin removal to provide a safe and reproducible experience in Asian lower blepharoplasty.

Declarations

Conflict of interest None of the authors has a financial interest in any of the products, devices, or drugs mentioned in this manuscript.

Consent for publication This study was approved by the institutional review board of our institute and was prospectively designed and retrospectively reviewed.

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