Objective Comparison of Eyebrow Position after Internal and External Browpexy

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Background: Several brow-lift techniques have been used to prevent brow ptosis after blepharoplasty. For example, both internal and external browpexies have been adopted worldwide. However, few studies have compared these two methods. The authors compared postoperative eyebrow position changes between upper eyelid skin excision, internal browpexy, and external browpexy.
Methods: The authors retrospectively reviewed the cases of 87 patients who underwent upper blepharoplasty performed by a single clinician at their institute between April of 2018 and June of 2020. Patients with routine outpatient photographs taken before and after surgery were enrolled in the study. ImageJ was used to measure brow height at eight points in each eye. Brow height changes were compared among the three groups.
Results: Routine photographs were available for 68 patients (133 eyes). Thirty-nine patients underwent internal browpexy (78 eyes), nine underwent external browpexy (17 eyes), and 20 underwent upper eyelid skin excisions (38 eyes). Three months after surgery, significant elevation was noted on the lateral side of the brow in the internal browpexy group and across the whole brow in the external browpexy group. In the upper eyelid skin excision group, whole brow ptosis was observed. Brow-lift outcomes were better in the external than in the internal browpexy group, whereas both browpexy groups showed better outcomes than the upper eyelid skin excision group.
Conclusions: Within 3 months of surgery, both internal and external browpexy provided significant brow-lift effects, preventing brow ptosis caused by blepharoplasty with skin excision. External browpexy had better brow-lift outcomes than did internal browpexy. *(Plast. Reconstr. Surg.* 152: 414e, 2023.)
CLINICAL QUESTION/LEVEL OF EVIDENCE: Therapeutic, III.

Increasing emphasis has been placed on facial aesthetics, especially in the eyes and periorbital area, which are essential features for first impressions.[1,2] In patients with dermatochalasis, false impressions about age, sadness, hostility, fatigue, or absence of spirit can lead to misunderstandings, and the condition can even result in visual field limitation.[3–7] The incidence of dermatochalasis is 16.3% in individuals older than 45 years in the Netherlands and is more frequent in men.[8,9]

Blepharoplasty has been used to improve the appearance of patients with dermatochalasis. However, it can cause postoperative brow ptosis, particularly in the lateral part of the eyebrow. This adverse effect is more common in men, older patients, and obese patients.[10–13] Many older patients present with concomitant brow ptosis and dermatochalasis.[14–17] Brow height alterations may lead to concerns about general appearance, with the lateral part of the eyebrow communicating sadness, and the lower eyebrows indicating fatigue.[2] To address these issues, several browpexy techniques have been developed.

Internal browpexy is a traditional method for achieving brow suspension. It uses an eyelid crease incision made during blepharoplasty and can result in a favorable aesthetic outcome.[13,18,19]

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It provides an elevation of 0.49 to 1.47 mm at the medial side of the brow and of 1.10 to 3.19 mm at the lateral side.[13,19–25] External browpexy with suprabrow excision is known as the direct brow lift[5,6] and is said to be more reliable because it involves lifting from above with the orbicularis muscle and brow fat pad secured. It provides an elevation of 1.90 to 2.66 mm at the medial side of the brow and 2.97 to 3.03 mm at the lateral side.[19,23,24,26] However, it results in obvious scarring that may limit patient satisfaction.[25,26]

Few studies have compared these two techniques. Kaderli et al. conducted a retrospective study of 35 patients to evaluate the efficacy of internal and external browpexy. They showed that the two methods resulted in similar elevations in the central and lateral regions of the brows 24 months after surgery.[24] Mokhtarzadeh et al. investigated the outcomes of internal and external browpexy in a retrospective review of 98 patients. They found no significant differences between the two groups after an average follow-up of 4 to 5 months.[23] There were many discrepancies in study design between these articles, including the method of measurement, analysis of brow height data, and follow-up duration. In these studies, only two points of the eyebrows were measured at a single time after surgery.

The purpose of the present study was to investigate the efficacy and outcomes of upper blepharoplasty with internal browpexy (referred to as internal browpexy), upper blepharoplasty with external browpexy and suprabrow excision (referred to as external browpexy), and upper blepharoplasty with eyelid skin excision without browpexy (referred to as upper eyelid skin excision). The outcomes were measured at different time points and at eight different points in one brow.

PATIENTS AND METHODS

The study included 87 patients who underwent upper blepharoplasty performed by a single surgeon (H.C.C.) at Chang Gung Memorial Hospital, Linkou main branch, between April of 2018 and June of 2020. The patients were categorized into three groups according to the surgical procedures: internal browpexy, external browpexy, and upper eyelid skin excision. The following patient characteristics were recorded by reviewing medical charts: diagnosis, surgical techniques, intraoperative findings, duration of operation, and follow-up duration. Brow ptosis was observed in all patients; thus, brow suspension was recommended. Both internal and external browpexy were described thoroughly to patients, including their effectiveness and scar conditions. The degree of brow ptosis was not worse in either group. Patients who had brow ptosis but refused to have brow suspension were classified into the upper eyelid skin excision group. The patients' photographs taken at the outpatient department were used to evaluate the outcomes of eyebrow position before and after surgery. The photographs were standardized using the same camera, lighting conditions, and photographer. Patients whose photographs were not available were excluded from the study. Patients' outcomes were recorded at the following time points: before and immediately after, and 1 week, 1 to 3 months, 4 to 6 months, and 7 to 12 months after surgery. The ImageJ biological measuring program was used to measure brow height at the following eight points of each eye: medial brow, medial canthus, medial limbus, pupil center, lateral limbus, lateral canthus, brow ridge, and lateral brow. All measurements were taken by the same assessor to avoid interexaminer variation. The brow height was defined as the length from the horizontal diameter of the cornea to the upper margin of the brow at the site of the corresponding point, and the length was standardized to the diameter of each patient's right cornea in every photograph (Fig. 1). Statistical analyses were performed to evaluate and compare the outcomes of each group. This study was approved by the institutional review board of the Chang Gung Medical Foundation. Photographs were taken after each patient provided informed consent, and data were kept in anonymized form.

Surgical Procedures

Internal Browpexy

Before the operation, the upper margin of the eyebrow was marked, and the patient was placed in the upright position with a mirror held in their hands facing their face. The brow was manually lifted to the desired position, which could improve lateral hooding of the upper eyelid. A marker pen was maintained at the same level as the upper brow margin. The brow was allowed to drop to normal position, and the forehead skin was marked where the pen was positioned (Fig. 2). The patient was placed in supine position during the operation. Upper blepharoplasty procedures were performed for every patient following a standardized method, which included skin excision, conservative to no removal of fat, and supratarsal eyelid crease creation (horizontal

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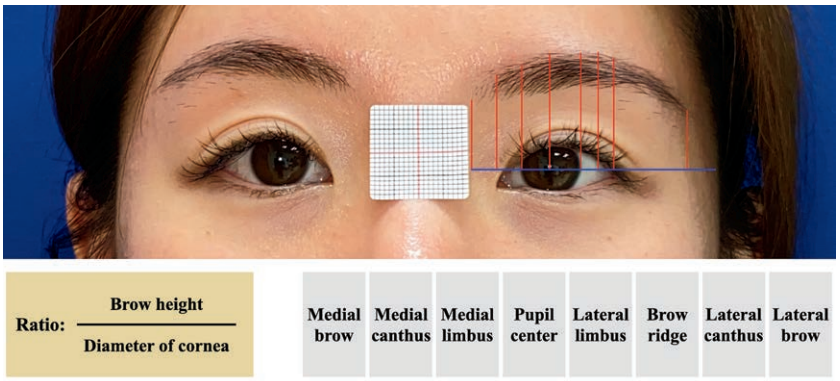

Fig. 1. Example measurement of patients' eyebrows using ImageJ.

Fig. 2. Deciding the desired position of the brow in internal and external browpexy. (*Left*) Before the operation, the patient is placed in the upright position, and the upper margin of the eyebrow (brow ridge) is marked first. (*Center*) The brow is manually lifted to the desired position, which could improve lateral hooding of the upper eyelid, and is agreed on by both surgeon and patient, with a marker pen moved to the same level of the upper brow margin. (*Right*) The brow is allowed to drop to normal status, and the marker pen is maintained at the same level. Then, the forehead skin is marked where the marker pen was positioned.

suture levator aponeurosis to the subdermis or muscle of the lower flap margin using 6-0 nylon sutures). The orbicularis oculi muscle was not routinely removed. The upper blepharoplasty wound was repaired using 7-0 nylon sutures. The amount of eyelid skin removed was then recorded.

Dissection was performed through the incision in the preseptal plane to the orbital rim until the retro-orbicularis oculi fat (ROOF) was exposed. The dissection pocket was then extended approximately 2 cm superolaterally in the supraperiosteal plane to the orbital rim in approximately the lateral two-thirds of the eyebrow to avoid damage to the supraorbital and supratrochlear nerves. When performing the browpexy, a sterile cotton swab was used to press vertically on the forehead skin mark of the desired position. The operator marked the same point at the periosteum, and the ROOF beneath the eyebrow within the dissection pocket. Two 4-0 Prolene sutures were used to capture the ROOF and orbicularis oculi muscle beneath the eyebrow at the brow ridge and tie them to the underlying periosteum at the temporal ligamentous adhesion and supraorbital ligamentous adhesion matching the forehead skin–marked point in the pocket.

External Browpexy

Before the operation, the upper margin of the eyebrow was marked with the patient in the upright position. The brow was held at the desired height; then, the forehead skin was marked. The patient was placed in the supine position during the operation. The width of the suprabrow skin removal was

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between the upper margin of the eyebrow and the designated desirable point on the forehead. The skin on the lateral two-thirds of the suprabrow was excised. There was no removal of the orbicularis oculi or frontalis muscles. The amount of removed suprabrow skin was recorded. Dissection through the upper margin of the suprabrow excision was then performed to expose the orbicularis muscle and ROOF. It was then continued to the frontal periosteum approximately lateral two-thirds of the eyebrow. The stabilizing sutures were placed at the brow ridge of the eyebrow. Two 4-0 Prolene sutures were passed through the orbicularis muscle and ROOF beneath the eyebrow corresponding to the brow ridge and tied to the underlying periosteum at the temporal ligamentous adhesion and supraorbital ligamentous adhesion matching the forehead skin–marked point in the pocket. The orbicularis oculi muscle was repaired using 5-0 Vicryl sutures, and the suprabrow skin excision wound was repaired using 5-0 Vicryl sutures and 7-0 nylon sutures. Upper blepharoplasty procedures were identical to the internal browpexy procedures.

Statistical Analysis

Analysis of variance was used to compare the widths of eyelid skin excision, and the Scheffé test was then applied to correction of the significance level and pairwise comparisons between the three groups. The chi-square test of independence was used to analyze the differences of patient numbers followed up through time among the three groups. The paired *t* test was used to evaluate differences in absolute brow alteration between each pair of groups after the operation. The independent *t* test was used to compare the ratios of postoperative brow height change to determine the outcomes of the different techniques. Statistical analyses were performed using R version 4.0.3. Statistical significance was set at $P < 0.05$.

RESULTS

Of the 87 patients, 68 had routine photographs available (mean follow-up, 3.59 months; range, 1 to 14 months); 39 had undergone internal browpexy (mean follow-up, 3.26 months; range, 1 to 11 months), nine had undergone external browpexy (mean follow-up, 5.22 months; range, 2 to 12 months), and 20 had undergone upper eyelid skin excision (mean follow-up, 3.5 months; range, 1 to 12 months). A total of 133 eyes were included, of which 78 had undergone internal browpexy, 17 had undergone external browpexy, and 38 had undergone skin excision. Among the 68 patients, 60 were women and eight were men. The average width of eyelid excision was 5.79 mm in the internal browpexy group, 4.87 mm in the external browpexy group, and 4.82 mm in the skin excision group. There were no significant changes in the width of eyelid skin excision among the three groups ($P = 0.0888$). Pairwise comparison of eyelid skin excision between the groups revealed no statistically significant differences. The desired point on the forehead, and suprabrow width excision varied. The average width of suprabrow skin excision was 7.88 mm in the external browpexy group (Table 1). Patient and eye numbers followed over time are presented in Table 2. There were no significant differences of loss of follow-up numbers among the three groups at postoperative

Table 1. Patient Demographics

	Internal Browpexy	External Browpexy	Upper Eyelid Skin Excision
No. of patients	39	9	20
No. of eyes	78	17	38
Age, yr			
Mean ± SD	59.26 ± 11.91	57.41 ± 6.46	44 ± 17.44
Range	26–81	49–67	19–80
Sex ratio, F:M	34:5	8:1	18:2
Mean operation time ± SD, min	159 ± 60	162 ± 61	112 ± 43
Mean width of eyelid skin excision ± SD, mm[a]	5.79 ± 2.61	4.56 ± 1.86	4.82 ± 2.65
Mean width of suprabrow skin excision ± SD, mm	NA	7.88 ± 2.36	NA
Follow-up, mo			
Mean ± SD	3.26 ± 3.06	5.22 ± 4.09	3.5 ± 3.05
Range	1–11	2–12	1–12

F, female; M, male; NA, not applicable.
[a]The *P* value was 0.0888 comparing width of eyelid skin excision among the three groups, 0.3924 between the internal and the external browpexy group, 0.1329 between the internal browpexy and the upper eyelid skin excision group, and 0.9976 between the external browpexy and the upper eyelid skin excision group.

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Table 2. Patient Numbers (Eye Numbers)

	Internal Browpexy	External Browpexy	Upper Eyelid Skin Excision	*P*
Preoperative	39 (78)	9 (17)	20 (38)	
Operative day	38 (76)	9 (17)	20 (38)	
Postoperative week 1	38 (76)	7 (13)	19 (36)	
1–3 mo	29 (58)	9 (17)	16 (31)	0.2292[a]

[a]The χ^2 test of independence was used to examine the ratio of patient numbers followed up through time among the three groups, which showed no significant differences ($P = 0.2292$). Pairwise comparison was also performed. The *P* value was 0.2106 between the internal and the external browpexy group, 0.8738 between the internal browpexy and the upper eyelid skin excision group, and 0.3882 between the external browpexy and the upper eyelid skin excision group.

months 1 to 3 ($P = 0.2292$). In the internal browpexy group, 10, 27, and 35 patients were lost to follow-up at 1 to 3, 4 to 6, and 7 to 12 months postoperatively, respectively; in the external browpexy group, six and six patients were lost to follow-up at 4 to 6 and 7 to 12 months postoperatively, respectively; in the skin excision group, 4, 12, and 18 patients were lost to follow-up at 1 to 3, 4 to 6, and 7 to 12 months postoperatively, respectively. Because several patients were lost to follow-up after 3 months, late data are shown in supplemental tables and figures. (**See Table, Supplemental Digital Content 1**, which shows patient numbers and eye numbers followed over time, ***http://links.lww.com/PRS/G18***.)

In the internal browpexy group, significant differences in brow elevation were noted at the lateral limbus, brow ridge, lateral canthus, and lateral brow on the day of surgery and after 1 week. One to 3 months after the operation, significant differences were noted at the lateral canthus and lateral brow (Fig. 3). [**See Table, Supplemental Digital Content 2**, which shows absolute value of brow height (ratio: brow height/diameter of cornea), ***http://links.lww.com/PRS/G19***.] Internal browpexy provided brow elevation at the lateral side of the eyebrow within 3 months of surgery, but there were no significant differences in brow height after 3 months.

In the external browpexy group, significant differences in brow elevation were noted at several points on the day of surgery and after 1 week (ie, the medial canthus, medial limbus, pupil center, lateral limbus, brow ridge, lateral canthus, and lateral brow) and 1 to 3 months after the operation (ie, the medial limbus, pupil center, lateral limbus, brow ridge, lateral canthus, and lateral brow) (Fig. 3). Almost all brow elevation was found within 3 months after external browpexy, except at the medial point of the brow.

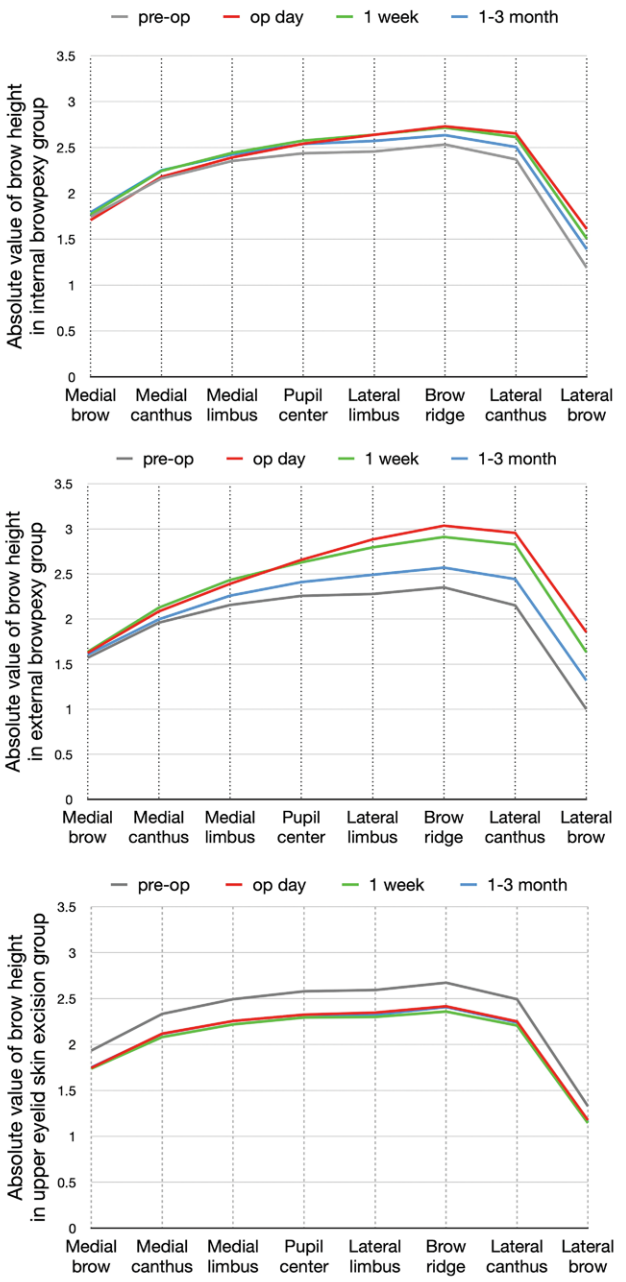

Fig. 3. Brow height at eight points at different times in (*above*) the internal browpexy group, (*center*) the external browpexy group, and (*below*) the upper eyelid skin excision group.

In the upper eyelid skin excision group, whole brow ptosis at all eight points was observed on the operation day and at 1 week and 1 to 3 months after the operation. No significant differences in brow height were found after 3 months (Fig. 3). [**See Figure, Supplemental Digital Content 3**, which shows brow height at eight points at different times in (*left*) the internal browpexy group, (*center*) the external browpexy group, and (*right*)

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the upper eyelid skin excision group, ***http://links.lww.com/PRS/G20***.] Changes in brow height for all groups (postoperative minus preoperative value of brow height) are shown. [**See Table, Supplemental Digital Content 4**, which shows alteration of brow height value (postoperative minus preoperative value of brow height), ***http://links.lww.com/PRS/G21***.]

To eliminate variability among the different patient components, the ratio of postoperative to preoperative brow height values was compared among the groups (Fig. 4). [**See Figure, Supplemental Digital Content 5**, which shows the ratio of brow height change at eight points at different times in (*left*) the internal browpexy group, (*center*) the external browpexy group, and (*right*) the upper eyelid skin excision group, ***http://links.lww.com/PRS/G22***.] We found that external browpexy had better brow lift outcomes than internal browpexy on the operation day at the medial canthus, medial limbus, pupil center, lateral limbus, brow ridge, lateral canthus, and lateral brow; 1 week after the operation at the medial limbus, pupil center, lateral limbus, brow ridge, lateral canthus, and lateral brow; 1 to 3 months after the operation at the pupil center, lateral limbus, brow ridge, lateral canthus, and lateral brow; 4 to 6 months after the operation at the lateral canthus; and 7 to 12 months after the operation at the lateral limbus, brow ridge, and lateral canthus. (**See Table, Supplemental Digital Content 6**, which shows the ratio of postoperative compared with preoperative brow height, comparison of the internal browpexy and the external browpexy groups, ***http://links.lww.com/PRS/G23***.) In Figure 5, we exhibited the points of the eyebrow that revealed significant differences between the two groups as follows: red, operation day; green, 1 week after surgery; blue, 1 to 3 months after surgery; pink, 4 to 6 months after surgery; and purple, 7 to 12 months after surgery. External browpexy had a better brow lift effect than internal browpexy across almost the entire brow within 3 months of the operation.

The internal and external browpexy groups were compared with those of the eyelid skin excision group. The two comparisons showed significant differences at almost every point of the eyebrow from the operation day to 12 months after surgery (Figs. 6 and 7). (**See Table, Supplemental Digital Content 7**, which shows the ratio of postoperative compared with preoperative brow height, comparison of the internal browpexy and the upper eyelid skin excision group, ***http://links.lww.com/PRS/G24***. **See Table, Supplemental Digital Content 8**, which shows the ratio of postoperative compared with preoperative brow height comparison of the external browpexy and the upper eyelid skin excision group, ***http://links.lww.com/PRS/G25***.) Both internal and external browpexy provide superior brow lift outcomes compared

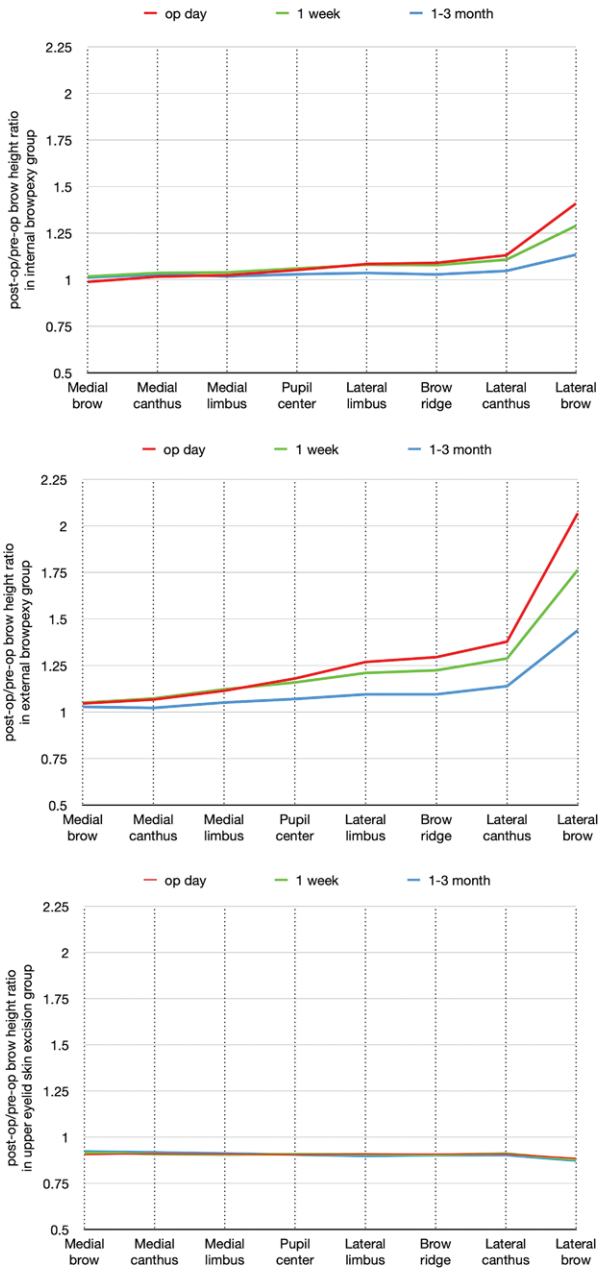

Fig. 4. (*Above*) Ratio of brow height change at eight points at different times in the internal browpexy group. (*Center*) Ratio of brow height change at eight points at different times in the external browpexy group. (*Below*) Ratio of brow height change at eight points at different times in the upper eyelid skin excision group.

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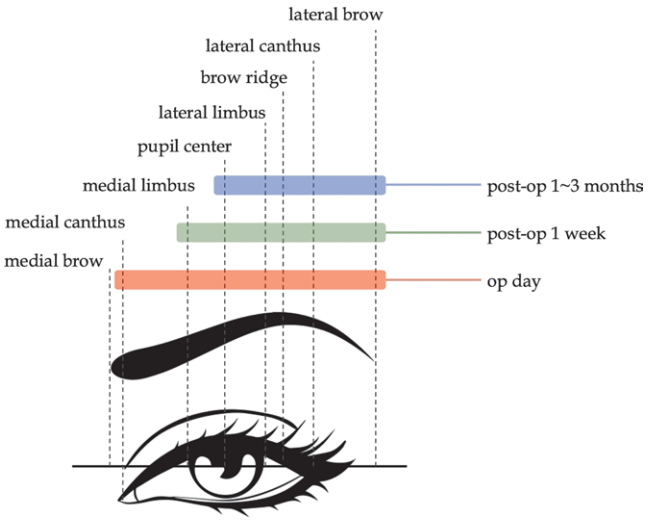

Fig. 5. Comparison of brow height change between internal and external browpexy groups. The *horizontal color bar* exhibited the eyebrow points that revealed significant differences between the two groups: *red*, operation day; *green*, 1 week after surgery; *blue*, 1 to 3 months after surgery.

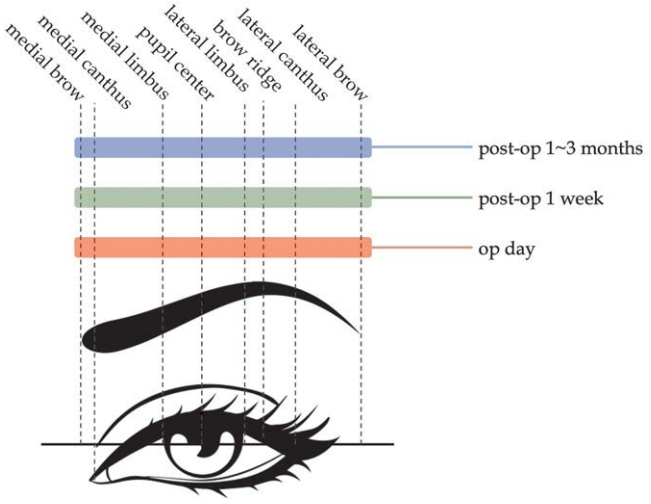

Fig. 6. Comparison of brow height change between internal browpexy and upper eyelid skin excision groups. The *horizontal color bar* exhibited the eyebrow points that revealed significant differences between the two groups: *red*, operation day; *green*, 1 week after surgery; *blue*, 1 to 3 months after surgery.

with upper eyelid skin excision alone. Clinical examples of each procedure and time point are shown in Figure 8.

DISCUSSION

With aging, loss of elastin and collagen in the upper eyelid skin and preserved function of the orbicularis muscle can lead to sagging of

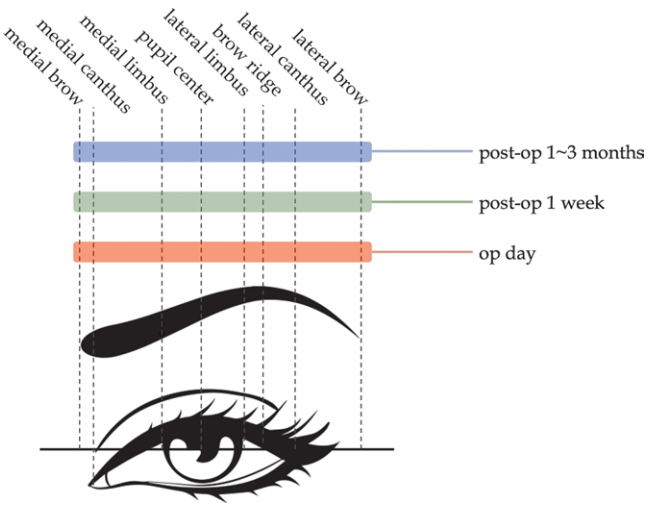

Fig. 7. Comparison of brow height change between external browpexy and upper eyelid skin excision groups. The *horizontal color bar* exhibited the eyebrow points that revealed significant differences between the two groups: *red*, operation day; *green*, 1 week after surgery; *blue*, 1 to 3 months after surgery.

anatomical structures and brow ptosis with dermatochalasis, bringing about aesthetic issues and visual obstacles.[17,27,28] The main sag tends to occur at the lateral one-third of the eyebrows, because the only brow elevator, the frontalis, is not attached at this area.[17] Morley et al. described the upper eyelid area in terms of the distance between the eyelid margin and the upper eyelid skinfold, termed the pretarsal show, and the distance between the skinfold and relaxed brow, termed the preseptal show. In female patients, the ratio of pretarsal show to preseptal show was approximately 1:1.5 on the medial side and 1:3 on the lateral side of the brow, and the ratio increased gradually with age.[15,29] Brow ptosis gave rise to an aged appearance. According to our results, internal and external browpexy, performed along with upper eyelid skin excision, could contribute to rejuvenation by resolving dermatochalasis and providing significant brow lift.

Mokhtarzadeh et al.[23] and Kaderli et al.[24] conducted studies and found similar results: the brow lift did not differ significantly between internal and external browpexy. Neither of these studies involved data from Asian populations, and the limited measurements used were insufficient to represent the postoperative change in brow position. We recorded eight points based on the anatomical structure of each eye to describe brow shape accurately, rather than just using the terms "medial" or "lateral." We found that external browpexy could elevate the brow at the medial

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Fig. 8. Clinical examples of (*above*) external browpexy preoperatively, immediately postoperatively, 1 week postoperatively, and 3 months postoperatively; (*center*) internal browpexy preoperatively, immediately postoperatively, 1 week postoperatively, and 4 months postoperatively; and (*below*) upper eyelid skin excision preoperatively, immediately postoperatively, 1 week postoperatively, and 3 months postoperatively.

canthus and medial limbus, which are located more medially than the "medial brow" of the two previous articles. External browpexy could yield a brow-lift effect on the medial side of the brow as a sequela of suprabrow skin excision, which produced tension and pulled up the eyebrow. The present study was the first to analyze brow height immediately after surgery.

Internal browpexy is more suitable for relatively small degrees of brow ptosis; it is a minimally invasive method that provides stabilization and possibly subtle elevation of the lateral two-thirds of the brow in any age group. However, patients with significant ptosis, heavy brows, and medial greater than lateral ptosis, and post–facial palsy patients may not be ideal candidates.[13,19,26,30–32] In contrast, external browpexy can be used to treat any degree and pattern of brow ptosis, showing the greatest elevation per millimeter of excised tissue.[30,31,33] Experts have suggested that external browpexy is more reliable because it involves lifting from above rather than below with the orbicularis muscle secured with a fat pad, and superior fixation that prevents the brow from pivoting over the anchor point, which could provide surgeons with better control over the brow position and contour.[26,33,34] The greatest disadvantage of external browpexy is postoperative scarring above the brow.[31,33]

According to our results, both internal and external browpexy provided brow-lift effects within 3 months of surgery and can prevent brow ptosis caused by blepharoplasty afterward. External browpexy had better brow-lift outcomes than internal browpexy across almost the entire brow within 3 months of surgery. This corroborated previous literature findings. For older patients with brow ptosis, endoscopic forehead lift is the procedure of choice. However, several patients declined it; thus, external or internal browpexy was recommended, wherein they can prevent brow ptosis after upper eyelid skin excision. External browpexy was recommended for patients with significant whole brow ptosis, concern about postoperative brow height, and access to eyebrow tattoos that could conceal the suprabrow excision scar. In contrast, internal browpexy was recommended for patients with mild brow ptosis, ptosis at the lateral side of the brow, or concern about surgical scars. Both external and internal browpexy were combined with open upper blepharoplasty, and only corrected the eyebrow area, not the entire forehead region. These might be the potential causes of a fast relapse in both procedures.

Open blepharoplasty with eyelid skin excision can develop brow ptosis after surgery,

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especially in the lateral region of the brow.[10–13] Decrease in frontalis hyperactivity is most likely the cause of brow descent after skin/muscle resection during blepharoplasty,[21] which is consistent with our results. The length of upper eyelid skin excision usually ranged from 1 to 2 mm medial to the medial canthus to 3 to 4 mm lateral to the lateral canthus, with an average width of 4.82 mm. Although removing and repairing the upper eyelid skin does not appear to be excessive, it can nonetheless pull the brow down and cause brow ptosis. Most of our patients had supratarsal eyelid crease creation (usually 6- to 8-mm height) during open upper blepharoplasty. The supratarsal eyelid crease creation had little effect on the brow position because it only established a horizontal connection between the eyelid skin and levator muscle, but not vertical traction.

The limitations of our study are similar to those of previous studies. Patients who were satisfied with the recovery and pleased with the outcomes of the surgery did not need to return for follow-up. Most of our patients were lost to follow-up in the outpatient center, so we lacked long-term data.[23] This may have caused a bias in data analysis and explains why there were no significant differences in brow height in the upper eyelid skin excision group 3 months after surgery, and may explain why the average brow height was higher in the 4- to 6-month group than in the 7- to 12-month group. For data analysis, two independent assessors are usually necessary to eliminate data bias; however, in this study, we had only one assessor. The distribution of surgical procedures and sex was uneven, making it a bias and limitation of this study. More Asian women than men received brow tattoos that could hide the scar of external browpexy, which may be why external browpexy was chosen more frequently in female patients. In addition, this was a retrospective study, and the selection of patients for each technique was not randomized. Further research is required for evaluation and investigation.

CONCLUSIONS

Internal and external browpexy can both provide significant brow lift effects within 3 months of surgery, serving as effective techniques to prevent brow ptosis caused by subsequent blepharoplasty. External browpexy had superior brow-lift outcomes compared with internal browpexy within 3 months of the operation.

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DISCLOSURE

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PATIENT CONSENT

Patients provided written informed consent for the use of their images.

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