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High Double Eyelid Fold Correction Using Wide Dual-Plane Dissection

Kenneth K. Kim, MD, FACS, Woo-Seok Kim, PhD,† Se Kwang Oh, MD, PhD,‡ and Hong Seok Kim, MD, PhD‡*

Background: The ability to correct unnatural-appearing, high, and deep double eyelid folds has been limited by the lack of redundant upper eyelid skin and the presence of prior incision line scars in patients.

Methods: From January 2000 to September 2011, 256 patients with high and deep double eyelid folds underwent our fold-lowering procedure. The first dissection was made at the superficial layer between the orbicularis oculi muscle and orbital septum/retroorbicularis oculi fat. The second dissection was at a deeper layer between the preaponeurotic fat and levator aponeurosis. The dissection proceeded 7 to 8 mm farther cephalad to the prior fold line to separate the upper flap and the floor from the prior fold line. The lower flap was undermined caudally to obtain normal skin tension, and the lower flap was secured to the septoaponeurosis junctional thickening or pretarsal tissue. Six months after surgery, the correction of the high fold scar and change in fold height (with eyes closed) was documented.

Results: Using the authors' technique, unnatural-appearing, high, and deep double eyelid folds were converted to lower nondepressed folds. Although prior high fold incision scars could be seen postoperatively on close examination, they were not easily visible. Complications included fold height asymmetry in 10 cases, persistence of the prior fold in 5 cases, and redundant upper flap skin that needed further excision in 25 cases.

Conclusions: Using a wide double-layer dissection, high folds were lowered successfully even in situations where there was no redundant upper eyelid skin for excision.

Key Words: high double eyelid fold, secondary blepharoplasty, double eyelid revision, eyelid ptosis, dual-plane dissection

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After double eyelid surgery, the resultant fold can be too low (small) or too high (large). A fold that is too low can be easily corrected by making a higher fold, but correcting a higher fold can be difficult, especially if the upper eyelid does not have excess skin.[1,2]

Asian upper eyelid skin gets thicker in a cephalic direction toward the brow. In cases of a high fold, the lower flap and upper flap immediately adjacent to the fold are thick. Therefore, any fold that occurs in this upper region of skin near the brow appears unnatural, because the fold depth is significant.

These are the characteristics of high folds in Asians: (1) The fold is deep. (2) The lower flap below the fold is puffy. (3) The presence of eyelid ptosis. (4) The presence of an outfold. (5) The double eyelid fold appears unnatural (Fig. 1).

If septal area skin is used to create the double eyelid fold rather than the pretarsal skin, the attachment to the levator aponeurosis creates a deep and high fold that burdens the levator aponeurosis. The extra weight loaded by the fold creation induces iatrogenic eyelid ptosis. In addition, because periorbital skin is thicker than pretarsal skin, the surrounding area of the fold may look puffy due to fold penetration and the discrepancy in depth of the surrounding skin. In patients with prominent epicanthal folds, the high fold creates an outfold at the medial region that appears as if the double eyelid fold has been forcefully created. All these factors lead to a harsh or tired appearance of the eyes.

An earlier technique of lowering a high fold involved excising the old high fold and creating a new lower fold.[3] However, this technique is only applicable when there is excess skin to be removed. In addition, the original fold shape cannot be changed because the upper margin of the skin excision is the prior high fold.

The authors developed a technique where the high fold is released and a new lower fold is created to give a more natural-appearing double eyelid fold. By releasing the high fold that was exerting excess weight on the levator aponeurosis, the eyelid is able to lift up more easily. However, even with this lysis of adhesion of the high fold, in patients with persistent eyelid ptosis, the levator function has to be improved by levator-muller advancement technique.

In most cases, outfolds were changed to infolds. If a patient had epicanthal folds, then epicanthoplasty was performed at the time of correction surgery to create a more natural curve medially.

PATIENTS AND METHODS

From January 2000 to September 2011, 256 patients (227 women, 29 men) underwent high double eyelid fold-lowering revision surgery. There were no primary cases. The average age was 39 years. Although the patient was seated, the fold height was measured by lifting the brow until the upper eyelashes started to evert. The average fold height which was measured from the gray line of the eyelash margin to the double eyelid fold at the midpupillary line was on average 13.5 mm.

Design and Anesthesia

The desired lower fold height was determined based on the patient's preferred height and shape. The new fold typically started below the epicanthal fold medially as an inward fold. The point 7 to 8 mm cephalad to the patient's prior high fold was marked for anticipated dissection. The incision site was injected with 2% lidocaine with 1:100,000 epinephrine up to the area marked for dissection.

Upper Flap Dissection (Dual-Plane Dissection)

On the newly designed lower fold line, an incision was made through the skin and the orbicularis oculi muscle. The dissection was

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From the *Division of Plastic and Reconstructive Surgery, David Geffen School of Medicine at University of California, Los Angeles, Los Angeles, CA; †Department of Energy and Electrical Engineering, Korea Polytechnic University, Siheung; and ‡Ohkims Plastic Surgical Clinic, Ilsan, South Korea.

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Reprints: Hong Seok Kim, MD, PhD, Hyosan Building, 5th Floor, 861 Janghang-dong, Ilsan-dong-gu, Gokyang City, Kyung-gi-do, South Korea. E-mail: ohkims743@naver.com.

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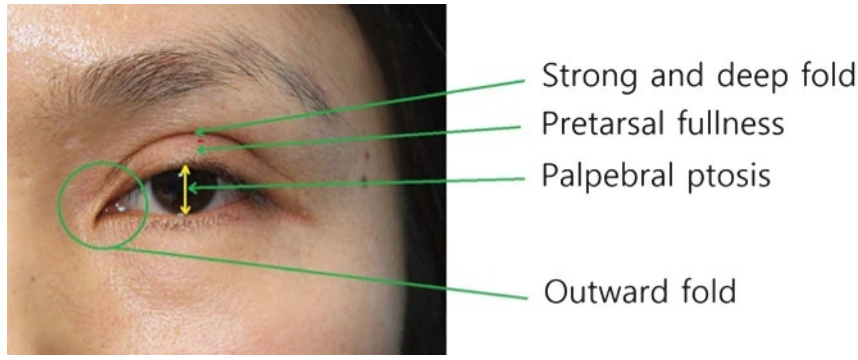

FIGURE 1. Appearance of a high double eyelid fold. The surgically created high fold starts above the medial epicanthal fold. Pretarsal fullness can be seen. A deep and puffy fold with eyelid ptosis gives a harsh or tired appearance to the eyes.

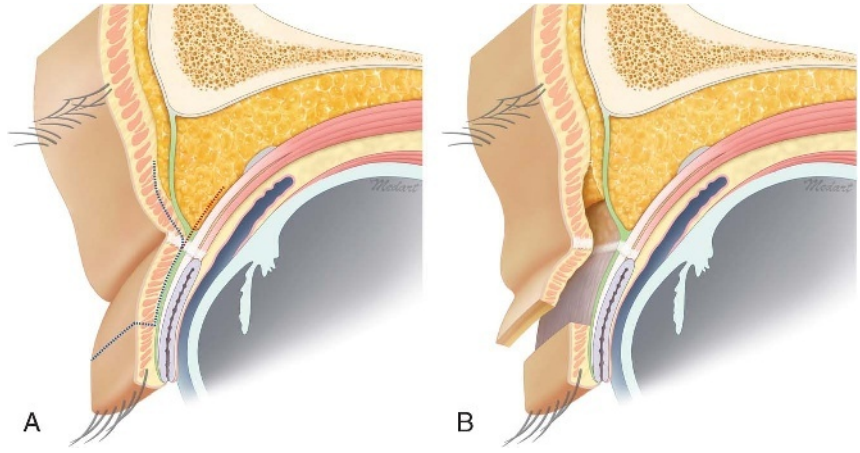

FIGURE 2. (Left) Illustration of high double eyelid fold before revision surgery. (Right) Initial dissection at the plane under the orbicularis oculi muscle but above the orbital septum.

made in a cephalic direction under the orbicularis oculi muscle but above the orbital septum (Fig. 2). The dissection released the anterior portion of the prior fold scar and the dissection proceeded 7 to 8 mm farther cephalad, anterior to the retroorbicularis oculi fat. The second posterior dissection started at the caudal orbital septum and raised a plane between the preaponeurotic fat and levator aponeurosis (Fig. 3). Thus, this dual-plane dissection fully separated the prior upper fold incision from the prior levator aponeurosis attachment site (see Video, Supplemental Digital Content 1, http://links.lww.com/SAP/A201). Furthermore, the adhesion of the prior fold to the prior levator aponeurosis site was also buffered by the new nonscarred region of the orbital septum and fat, thus hindering readhesion (Fig. 4).

Lower Flap Dissection

When a high fold is converted to a low fold, often, the lower fold flap is under tension. To reduce this tension of the fold, the lower flap was released from the tarsal plate in a caudal direction until no tension was seen on the lower flap. Specifically, the plane of dissection was between the orbicularis muscle and the pretarsal fascia. The maximal caudal dissection proceeded until the follicle of the eyelash was seen. Maximal caudal dissection was reserved for severely contracted lower flaps.

Levator Manipulation

In some patients, eyelid ptosis was still evident even with the release of the attachment of the high fold to the levator aponeurosis. In

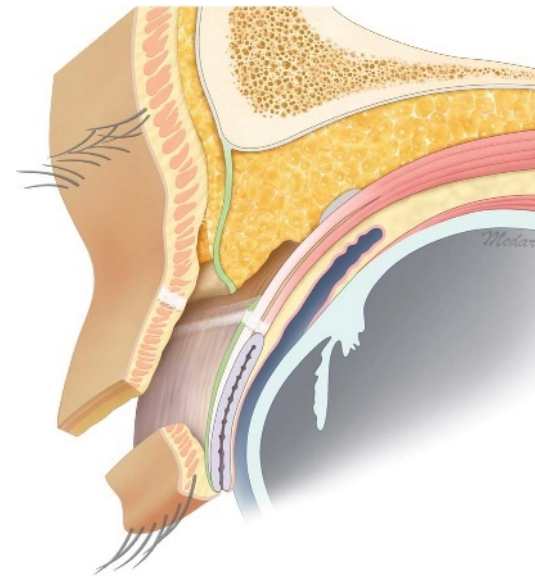

FIGURE 3. Illustration of the second component of the dual-plane dissection. The dissection starts at the caudal orbital septum, and a plane between the preaponeurotic fat and levator aponeurosis is raised.

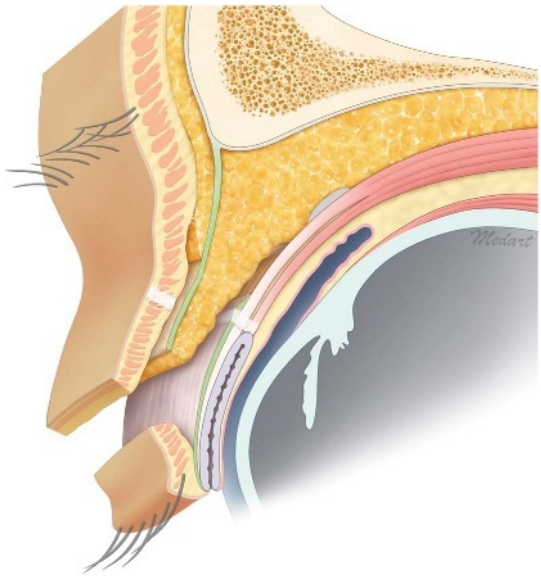

FIGURE 4. Separation of the anterior and posterior lamella scarring is buffered by the fresh edges of the nonscarred middle lamella.

cases of residual eyelid ptosis, the levator apeonuerosis was separated from the Müller muscle. The tarsal plate was sutured to the levator aponeurosis and the Müller muscle with 6-0 nylon. To advance the eyelid by 1 mm, the levator aponeurosis needed to be advanced 3 mm.

Fixation and Skin Suturing

The upper end of the dermis of the lower flap was sutured to the septoaponeurosis junctional thickening (SAJT) with 7-0 white nylon.[4] In cases where the SAJT was excised during a prior surgery, the fixation was made to the pretarsal tissue. On average, 5 to 7 sites were connected from the lower flap to either the SAJT or pretarsal tissue. Skin suturing was performed with 8-0 nylon in a continuous running fashion.

Taping and Forced Folding Suturing

To prevent the prior dermal incision scar from readhering to the prior fold site on the levator aponeurosis, a 3M skin tape was applied on the skin. The tape kept the skin taut and helped avoid the prior fold from reoccuring. The tape was used for 2 weeks. In addition, horizontal

FIGURE 6. (Above) Before high double eyelid fold reduction surgery with eyes open and closed. (Below) Two months after high fold reduction surgery.

mattress sutures were placed at the incision sites using 7-0 nylon. This increased the downward, depressive force of the new incision site and helped the new fold to occur over the prior incision fold. The sutures were in place for 3 to 4 days.

RESULTS

From January 2000 until September 2011, 256 patients underwent correction of high double eyelid folds. There were 227 women and 29 men. The average age was 39 years.

For at least 6 months, height of the new double eyelid folds, recurrence of prior eyelid folds, and asymmetry of the eyelid folds were measured and monitored. Average follow-up was 1.3 years. On average, the newly created double eyelid fold height was 7.8 mm. This was a 57.7% reduction from the average preoperative fold height of 13.5 mm (Figs. 5, 6). 83.24% of patients were satisfied with the results, and there was minimal visibility of the prior high fold (Fig. 7). Complications included fold asymmetry in 10 cases, persistence or recurrence of prior folds in 5 cases, and excess upper eyelid skin needing further skin excision in 25 cases. The recurrence of prior folds occurred within 2 weeks. There were 127 cases of mild to moderate eyelid ptosis that needed concomitant ptosis correction surgery (Table 1).

DISCUSSION

Double eyelid revision surgery is highly common in Asian patients. Common reasons for revision surgery are high fold, low fold, and weakened fold (loosening of the fold). Among these revision surgeries, high fold correction is the most difficult. High folds can occur for 2 reasons. One reason is excessively high placement of the fold during initial surgery. The other reason is underlying or borderline eyelid ptosis.

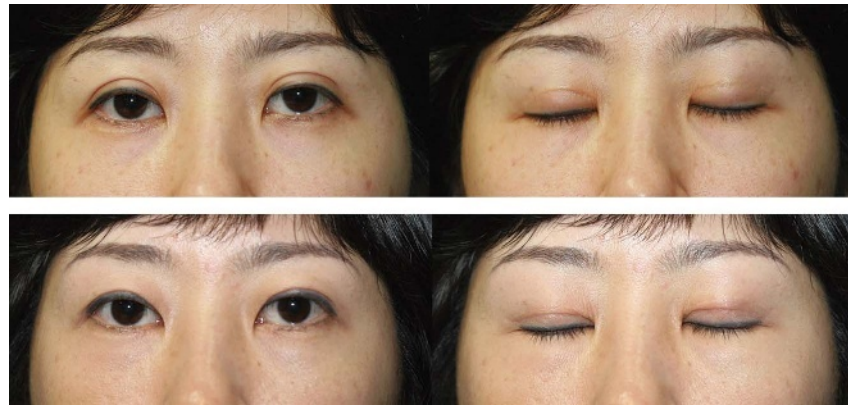

FIGURE 5. (Above) Before high double eyelid fold reduction surgery with eyes open and closed. (Below) Six months after high fold reduction surgery.

FIGURE 7. (Left) Before high double eyelid fold revision surgery with eyes closed. (Right) After high fold reduction surgery with minimal visibility of the prior high fold incision site. There is no contour deformity.

In cases where the upper eyelid skin has redundant skin, prior high folds can be excised, and a lower fold can be made. In cases where there is minimal or no excess upper eyelid skin, the amount a fold could be lowered was limited when prior techniques were used. The excision of the high fold creates greater tightening of the upper eyelid skin and leads to upper eyelid ectropion or lagophthalmos. Relying on the principle that only scar excision can eliminate prior folds created a limitation to fold reduction in upper eyelids that lack redundant skin. Simply releasing the upper fold adhesion during creation of a lower fold leads to recurrence of the upper fold in addition to development of a new lower fold scar. This creates a triple fold.[5–7] A triple fold occurs when the original high double eyelid fold and the newly created lower double eyelid fold form simultaneously.

To solve the problem of having an insufficient amount of skin in patients with an undesired high fold, we made an incision at the desired lower fold height. The dissection then proceeded in cephalic direction to release the adhesions. We performed a dual-plane dissection to interrupt the levator aponeurosis connection to the prior fold at 2 separate layers (between the orbicularis oculi muscle and orbital fat and between the orbital fat and levator aponeurosis). Another key point is the need to make a wide dissection to allow sufficient mobility of the anterior, middle, and posterior lamellae. Thus, the contact point of the prior scar from the posterior orbicularis muscle separates from the anterior orbital septum. Also, the contact point of the prior scar from the posterior orbital septum/fat separates from the anterior levator aponeurosis. Wide, dual-plane dissection and the unique mobility of the upper eyelid prevent the scars from readhering at the same contact points (Fig. 4).

Rather than fully releasing the prior adhesions, Kim and Youn[2] corrected high folds by placing a fibromuscular flap or graft in the region of the prior fold after resecting the entire depth of the prior fold scar. Other techniques relied on using fat or dermal fat grafts as a buffer to prevent prior folds from reattaching to the levator aponeurosis.[1,5,8] Fat grafting has a negative effect of unpredictable resorption. In addition, fat grafting can lead to prolonged swelling, graft necrosis, clumping, migration, or an unnatural appearance. We did not excise the prior fold scar or apply grafts. Because we used the preexisting scar, there was no volume deficit so we did not need additional tissue. In addition, contour irregularity was minimized. Another disadvantage of using prior techniques that resect scar tissue to lower the fold is that the shape or design of the double eyelid fold cannot be changed. Because our technique is not limited by the prior fold scar, we can design a new lower fold that best matches the patient's face and overall eye shape. Also with eyes open and closed, the resultant scarring from the prior high fold is minimal.

In cases where there is concomitant eyelid ptosis, ptosis correction brings the levator aponeurosis down to the tarsus.[9–11] Therefore, there is a greater shift in tissue planes between the middle lamella and the posterior lamella. This increased movement of the tissue aids in preventing a prior fold from reoccurring as the scar edges of the upper and lower layers are further separated. In addition, we placed the tarsal fixation lower than that in typical tarsal fixation (2 mm below the upper border of the tarsal plate).[12] By bringing the levator aponeurosis farther down (caudal) to the level of the new fold height, the double eyelid fixation point was at the same level as the height of the new low fold. If the levator was fixated 2 mm below the upper border of the tarsus, then a deep double eyelid fold and eyelash ectropion could occur as the skin of the lower flap gets pulled cephalad by the cephalically located levator aponeurosis.

In terms of the causes of high fold occurrence, besides placing the fold excessively high, the other reason is underlying or borderline eyelid ptosis. During consultation, some patients bring photographs of high folds and express their desire for their double eyelid folds to look like the photos. These pictures often reveal patients with excellent levator function and thin eyelids. However, some patients desiring double eyelid surgery present with underlying or borderline eyelid ptosis. Borderline eyelid ptosis refers to cases when eyelid ptosis is not present but likely to occur when any additional weight is loaded onto the levator aponeurosis (by connecting the high fold to the levator aponeurosis). The diagnosis of eyelid ptosis can be missed at the time of consultation because patients tend to open their eyes fully when looking at the mirror with the surgeon. In addition, the excitement or nervousness of being in a doctor's office induces a sympathetic response that activates the Müller muscle, thus masking borderline eyelid ptosis.[13,14] When a high

TABLE 1. Patient Satisfaction With Surgery Outcomes (Of 256 Patients, 197 Responded to the Survey, 83.24% Patient Satisfaction)

Satisfaction Score	Very Unsatisfied (1)	Unsatisfied (2)	Neutral (3)	Satisfied (4)	Very Satisfied (5)
N (%)	3 (1.52)	5 (2.53)	25 (12.69)	132 (67.00)	32 (16.24)

Ptosis surgery was performed in 127 patients (49.6%).

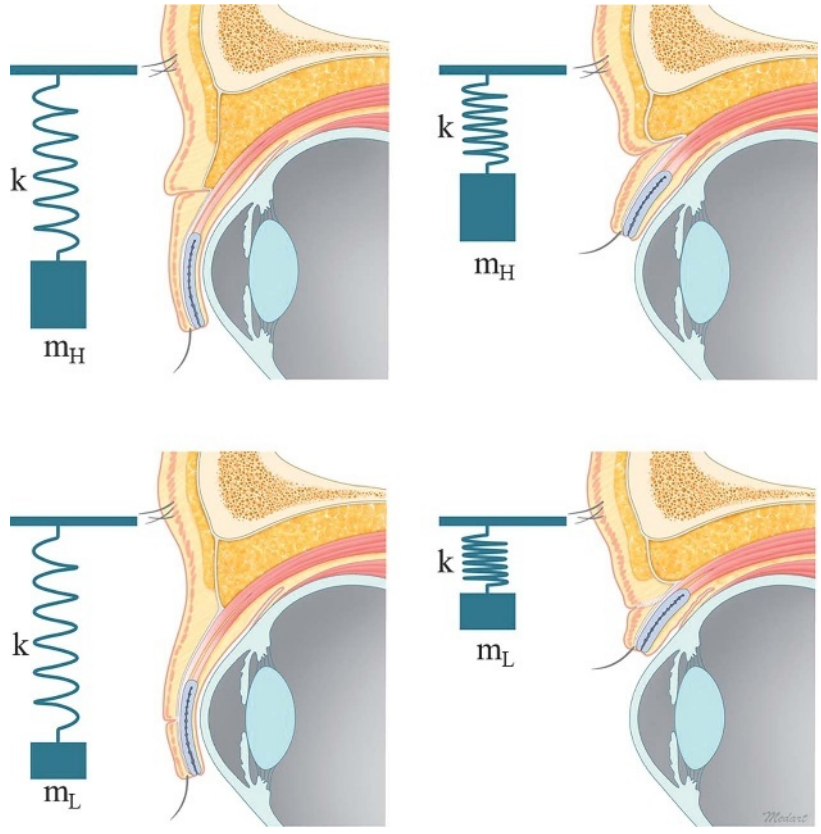

FIGURE 8. A spring dynamics model for a high fold and a low double eyelid fold in typical Asian eyelid structures. A mechanical model based on spring dynamics was used to analyze the movement of the eyelid. The spring constant k in the equations (X1) to (X6) (below) signifies stiffness of the spring which corresponds to the upper eyelid skin. (Above) Illustration reflects a high fold with eyes closed and open. (Below) Illustration reflects a low fold with eyes closed and open. Neglecting the damping constant of the spring, the force equilibrium equations of each system for the high fold and the low fold can be expressed as (X1) and (X2) respectively,

$$\sum F_x = F - kx = m_H g + m_H \frac{d^2x}{dt^2} \tag{X1}$$

$$\sum F_x = F - kx = m_L g + m_L \frac{d^2x}{dt^2} \tag{X2}$$

where m_H and m_L are the mass of the eyelid in a high fold and low fold respectively, g means gravitational acceleration, and F is the force that lifts the eyelid by the levator muscle.[15] When the velocity becomes zero when the eye opens most widely, the second order time derivatives of the displacements in (X1) and (X2) become zero. Equation (X3) and (X4) show the relation between the maximum displacement of the eyelid and force. Therefore, the maximum displacement of the eyelid in cases of a high fold and a low fold can be derived as shown in (X5) and (X6).

$$\sum F_x = F - kx_{H,\max} = m_H g \tag{X3}$$

$$\sum F_x = F - kx_{L,\max} = m_L g \tag{X4}$$

$$x_{H,\max} = \frac{F - m_H g}{k} \tag{X5}$$

$$x_{L,\max} = \frac{F - m_L g}{k} \tag{X6}$$

The equations (X5) and (X6) say that the maximum displacement should be inversely proportional to the mass of the eyelid. Therefore, the maximum displacement in the case of a high fold (above right) should always be less than that in case of a low fold (above left) as shown in the illustrations. Consequentially, the spring model can explain why eyelid ptosis can occur just from the creation of a high double eyelid fold without any direct effect from the levator muscle. Conversely, Figure 8 demonstrates clinically how eyelid elevation increases (resolution of eyelid ptosis) with correction of a high fold to a lower double eyelid fold.

double eyelid fold is created in these patients, the levator muscle has to lift the extra weight that is attached to the levator aponeurosis (Fig. 8).

We created a spring model to demonstrate the effect of a high fold *vs* a low fold on levator muscle weight load. The physics calculation based on the spring model equation reveals that a high fold induces a greater weight load on the levator muscle compared to a low fold. Therefore, high double eyelid folds can induce eyelid ptosis without any intrinsic effect from the levator muscle. By contrast, eyelid elevation increases (resolution of eyelid ptosis) with lowered double eyelid folds (Figs. 5 and 6). Incision in itself and excessive use of cautery can induce scarring on eyelid soft tissue. In addition, when a firm anchoring fixation of the skin to the levator aponeurosis is performed to create the fold, it obstructs the lymphatic flow of the lower flap.[1,16] Increased fibrosis and swelling from the lymphatic obstruction adds to the weight the levator muscle has to lift, compared to the motion of the prior non-fettered levator. This can induce iatrogenic eyelid ptosis. Therefore, it is imperative that eyelid ptosis correction be performed at the time of double eyelid surgery in patients with eyelid ptosis or borderline eyelid ptosis, who wish to have a high double eyelid fold.

CONCLUSIONS

Excessively high double eyelid folds can create deep folds and an unnatural appearance. The 3 lamellar structures of the upper eyelid and the mobile component of the posterior lamella allow for a dual-plane dissection method to effectively correct a high fold without contour irregularity of the lid. Converting a high fold to a low fold reduces the weight load on the levator aponeurosis. This in turn can resolve iatrogenic ptosis occurring from high double eyelid folds that burden the eye-elevating mechanism in patients without preexisting ptosis. The technique is applicable to patients without redundant skin, and a lower double eyelid fold can be created without being limited by prior high fold design. Scarring of the prior high fold is minimally noticeable with eyes open and closed.

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