

# Adjunctive Techniques to Traditional Advancement Procedures for Treating Severe Blepharoptosis

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**Background:** To create a more physiologic eyelid opening in patients with severe blepharoptosis, the authors used lamina propria mucosa of conjunctiva, which continues to the check ligament of the superior fornix, in addition to levator aponeurosis and Müller's muscle as a composite flap. In patients with epicanthal folds with associated telecanthus, the authors also performed epicanthoplasty with medial canthal tendon shortening.

**Methods:** Fifty blepharoptosis patients (85 eyelids) with a degree of ptosis of greater than 4 mm underwent the advancement technique using the levator aponeurosis–Müller's muscle–lamina propria mucosa of conjunctiva as a composite flap. Twenty-one (42 percent) of those patients also underwent split V-W epicanthoplasty and plication of the medial canthal tendon for epicanthal folds with associated telecanthus. Degree of ptosis and levator function were measured preoperatively and postoperatively.

**Results:** Complete or near-complete correction of ptosis (degree of ptosis, <1 mm) was achieved in 54 eyelids (63.5 percent) and mild residual ptosis (degree of ptosis, 1 to 2 mm) was observed in 22 eyelids (25.9 percent) in postoperative follow-up after 6 months. The most common complication was reoperation, which was done in 15 eyelids (17.6 percent) because of incomplete correction.

**Conclusions:** The advancement technique using the levator aponeurosis–Müller's muscle–lamina propria mucosa of conjunctiva composite was effective in the treatment of severe blepharoptosis with levator function of 2 to 7 mm. The technique produced elevating motion of the physiologic eyelid in a superior-posterior direction. There were no serious complications, such as long-term lagophthalmos or lid lag. (*Plast. Reconstr. Surg.* 133: 887, 2014.)

**CLINICAL QUESTION/LEVEL OF EVIDENCE:** Therapeutic, IV.

Various operative techniques have been recommended for mild and moderate blepharoptosis.<sup>1-4</sup> Severe ptosis presents a difficult condition because a significant amount of eyelid excursion is required to correct it. In addition, in congenital ptosis, levator muscle function is often

poor. We define *severe ptosis* as the degree of ptosis greater than 4 mm, as described by Isaksson.<sup>5</sup> Frontalis suspension is commonly performed to bypass the issue of poor levator muscle function. However, there are many drawbacks associated with frontalis suspension, such as lagophthalmos, lid lag, lid distortion, and unnatural eyelid movement in a superior direction following overaction of the frontalis muscle.

Holmström and Santanelli<sup>6</sup> reported on suspension of the eyelid to the check ligament of the superior fornix in congenital blepharoptosis. The check ligament of the superior fornix, which emanates from the sheaths of the levator and superior rectus muscles and from Tenon's

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capsule, contains collagen fibers, elastin fibers, and smooth muscle fibers.<sup>7</sup> Superficial and deep extensions of the check ligament continue to the superior conjunctival fornix and conjunctiva. This check ligament was confirmed by Lukas and colleagues<sup>8</sup> and Hwang and colleagues<sup>9</sup> as the intermuscular transverse ligament and conjoint fascial sheath, respectively.

Kakizaki and colleagues<sup>10</sup> classified the conjunctiva into lamina propria mucosa of conjunctiva and conjunctival epithelium. The lamina propria mucosa of conjunctiva is located just posterior to the Müller's muscle and has a rich vascular plexus. The lamina is as thick as Müller's muscle and inserts onto the posterior half of the superior tarsal border. The lamina continues proximally to the check ligament and is thought to have a suspensory effect on the upper eyelid.

Mustardé<sup>11</sup> classified epicanthal folds into simple epicanthal folds, epicanthal folds with associated ptosis, and epicanthal folds (with or without ptosis) with associated telecanthus. He defined telecanthus (increased breadth between the inner canthi) as inner canthal distance greater than 55 percent of the interpupillary distance.

We used the levator aponeurosis, Müller's muscle, and lamina propria mucosa of conjunctiva in the treatment of severe blepharoptosis. In cases of epicanthal folds with associated telecanthus, epicanthoplasty and medial canthal tendon shortening were performed simultaneously to enlarge the palpebral opening and to release the tension of the upper medial eyelid skin and tethering fold, which impedes the action of eyelid elevation.

## PATIENTS AND METHODS

Between January of 2004 and September of 2012, we recruited 50 Korean patients with severe blepharoptosis (degree of ptosis, >4 mm) for this study. The 50 patients (85 eyelids) underwent the advancement technique using the levator aponeurosis–Müller's muscle–lamina propria mucosa of conjunctiva composite flap. Twenty-one of 50 patients (42 percent, 42 eyelids) had epicanthal folds with associated telecanthus and therefore underwent epicanthoplasty and shortening of the medial canthal tendon.

### Operative Technique

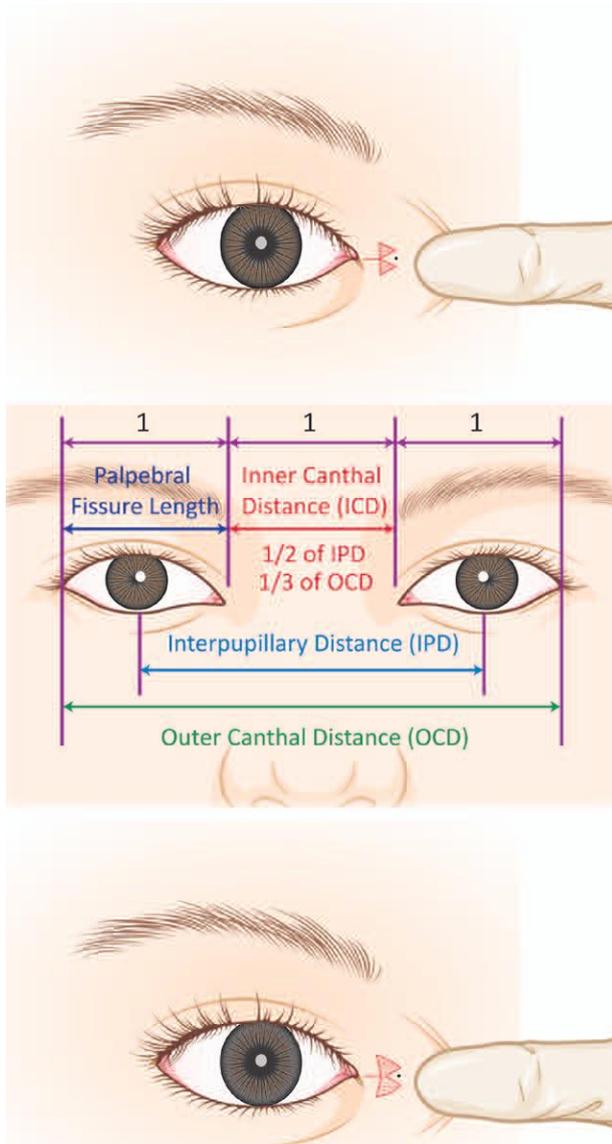
The double eyelid incision line is marked on the upper eyelid 6 to 9 mm above the lid margin, depending on the personal preference of patients without double eyelids. Modified V-W plasty<sup>12,13</sup> is designed on the skin medial to the epicanthal

folds of patients with blepharoptosis and epicanthal folds with associated telecanthus. Epicanthal folds with associated telecanthus are corrected before ptosis correction is performed. The operation is usually performed with the patient under local anesthesia with intravenous or oral sedation.

### Correction of Epicanthal Folds with Associated Telecanthus

In the design of Flowers' modification of Uchida's split V-W epicanthoplasty for simple epicanthal folds, a mark is made on the skin medial to the epicanthal fold at the projected site of the actual medial canthus. On this mark at the flap base, a V-shaped triangular flap (V flap) with a 60-degree angle and sides of the same length (3 to 5 mm) is designed. A straight vertical line is drawn along the margin of the epicanthal fold. The tip of the V flap is at the vertical line and is directed to the ipsilateral pupil. From each base of the V flap, two straight lines are drawn to touch the vertical line, forming the outer lines of a W-shaped configuration. Then, a new line with the same length as a side of the V flap is drawn from the center of the vertical line toward the actual canthus to split the tight epicanthal fold and to transpose the V flap (Fig. 1, *above*). In cases of epicanthal folds with telecanthus, two marks are made on the bilateral medial palpebral skin at points half the distance of the interpupillary distance or one-third of the outer canthal distance in patients in whom interpupillary distance cannot be checked (Fig. 1, *center*). The straight vertical line is curved along the epicanthal fold and does not touch the tip of the V flap. The lines that formed the outer lines of the W-shaped configuration should be longer than normal letter W to touch the curved vertical line (Fig. 1, *below*).

Incisions are made on the designs after subcutaneous infiltration with 1% lidocaine with 1:100,000 epinephrine. Any surplus skin between the straight or curved vertical line and the W-shaped configuration is excised. Two more triangular flaps are developed by making an incision along the horizontal line starting from the midpoint of the vertical line toward the medial canthus. The triangular flaps and the original V flap are elevated, and the soft tissue under the flaps is excised to expose the medial canthal tendon. The medial canthal tendon is plicated by suturing the most lateral part of the tendon to its bony insertion with 6-0 nylon to shorten the inner canthal distance in patients with associated telecanthus. The triangular flaps are then advanced and sutured with 7-0 nylon to make a new W-shaped closure.



**Fig. 1.** Preoperative designs of epicanthoplasty for patients with epicanthal folds with associated telecanthus. (Above) Preoperative design of Flowers' modification of Uchida's split V-W plasty procedure for simple epicanthal folds. (Center) Normal distance ratio of four standard measurements around the eyes. (Below) Preoperative design of modification of Flowers' V-W plasty for epicanthal folds with associated telecanthus. Red triangles mark the skin to be excised.

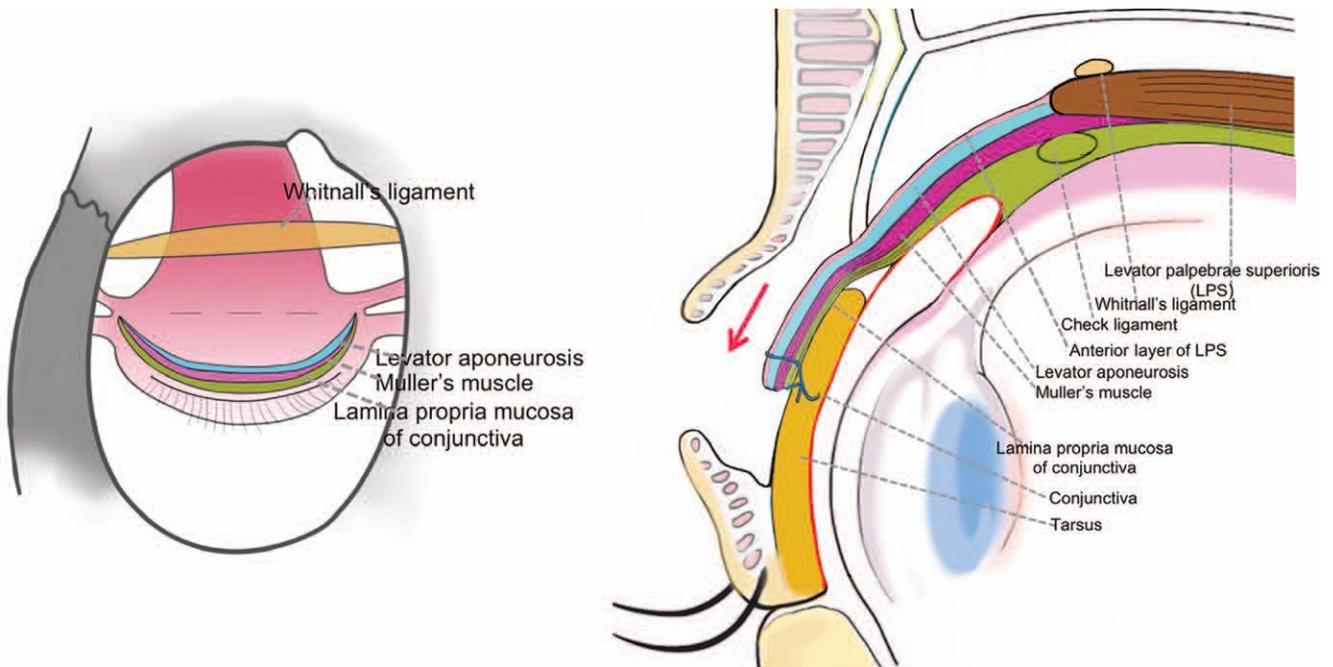
### Correction of Severe Blepharoptosis

An incision is made along the double eyelid mark after subcutaneous infiltration with 1% lidocaine with 1:100,000 epinephrine. Epinephrine is omitted during deeper injection to prevent stimulation of the Müller's muscle. The

upper anterior surface of the tarsal plate and the orbital septum are exposed after excision of pretarsal soft tissue. The orbital septum is cut at its lowest part and the protruding orbital fat is partly excised to expose the levator aponeurosis. Tetracaine eye drops are applied to the cornea, and corneal eye protectors are applied to the globe. Three traction sutures are placed in the distal levator aponeurosis or orbital septum and the distal Müller's muscle. The levator aponeurosis, Müller's muscle, and lamina propria mucosa of conjunctiva are then detached carefully from the superior tarsal border and underlying conjunctival epithelium with sharp iris scissors with the help of these three traction sutures. Injection of pure lidocaine into the superior portion of the tarsus facilitates the detachment of the Müller's muscle and the lamina from the superior tarsal border and the conjunctival epithelium by causing the tissues to balloon up slightly. In some cases, dark cornea is visible through the conjunctival epithelium (Fig. 2, left). The detached levator aponeurosis–Müller's muscle–lamina propria mucosa composite flap is advanced onto the anterior surface of the tarsus. To check the level of the upper eyelid margin with eye opening, a temporary central mattress suture is placed with 7-0 nylon 2 to 3 mm inferior to the superior margin of the tarsus. When the level of the eyelid margin is satisfactory during primary gaze in a sitting position, a temporary knot is tied and two additional mattress sutures are placed medially and laterally 5 to 7 mm from the central stitch (Fig. 2, right). The knots can be located on the anterior surface of the tarsus or on the levator aponeurosis. The distal redundant portion of the advanced composite flap is trimmed, but 2 to 3 mm of the flap stump is maintained. The length of trimmed composite flap is usually 2 to 3 mm; it does not exceed 5 mm in order to preserve more function of the levator complex. A 5-mm excision of the flap stump advances the composite flap more than 10 mm because the flap is fixed 2 to 3 mm inferior from the superior margin of the tarsal with 2 to 3 mm of the stump remnant. The double eyelid is made with five or six stitches of 7-0 nylon or 6-0 Vicryl between the dermomuscular portion of the inferior skin flap margin and the distal edge of the advanced levator aponeurosis. The skin is closed with 7-0 nylon in three-way suturing of the lower flap skin edge, distal end of the levator aponeurosis, and upper flap skin edge for a definite double eyelid. Schematic views of the advanced composite flap procedure are shown in Figure 3.



**Fig. 2.** Intraoperative sequence of the advancement technique using the levator aponeurosis–Müller’s muscle–lamina propria mucosa of conjunctiva composite flap. (Left) The composite flap was dissected from the conjunctival epithelium. The dark cornea was visible underneath the conjunctival epithelium. (Right) Three mattress sutures were placed between the tarsal plate and the composite flap. The distal end of the composite flap was trimmed, maintaining 2 to 3 mm of the flap stump.



**Fig. 3.** Schematic view of advanced composite flap. (Left) Anterior view. (Right) Lateral view.

### RESULTS

Fifty patients (85 eyelids) with ptosis greater than 4 mm were operated on (Table 1). Of these patients, 38 (76 percent) had congenital ptosis and 35 (70 percent) had bilateral ptosis. Of the 35 patients who had bilateral ptosis, eight exhibited eyelid asymmetry of more than 1 mm. Patient ages ranged from 12 to 89 years (mean age, 35.7 years).

The degree of ptosis among the 85 eyelids ranged from 4 to 8 mm. Seventy-seven eyelids (90.6 percent) had 4 to 5 mm of ptosis, and eight

(9.4 percent) had more than 6 mm. Levator function among the 85 eyelids ranged from 7 to 2 mm. Fifty-five eyelids (64.7 percent) had fair levator function (7 to 5 mm).

In primary cases, the advanced composite flap was resected at less than 5 mm (mean, 3 mm). In revision cases caused by incomplete correction of ptosis, the composite flap was further advanced and resected by about 3 mm.

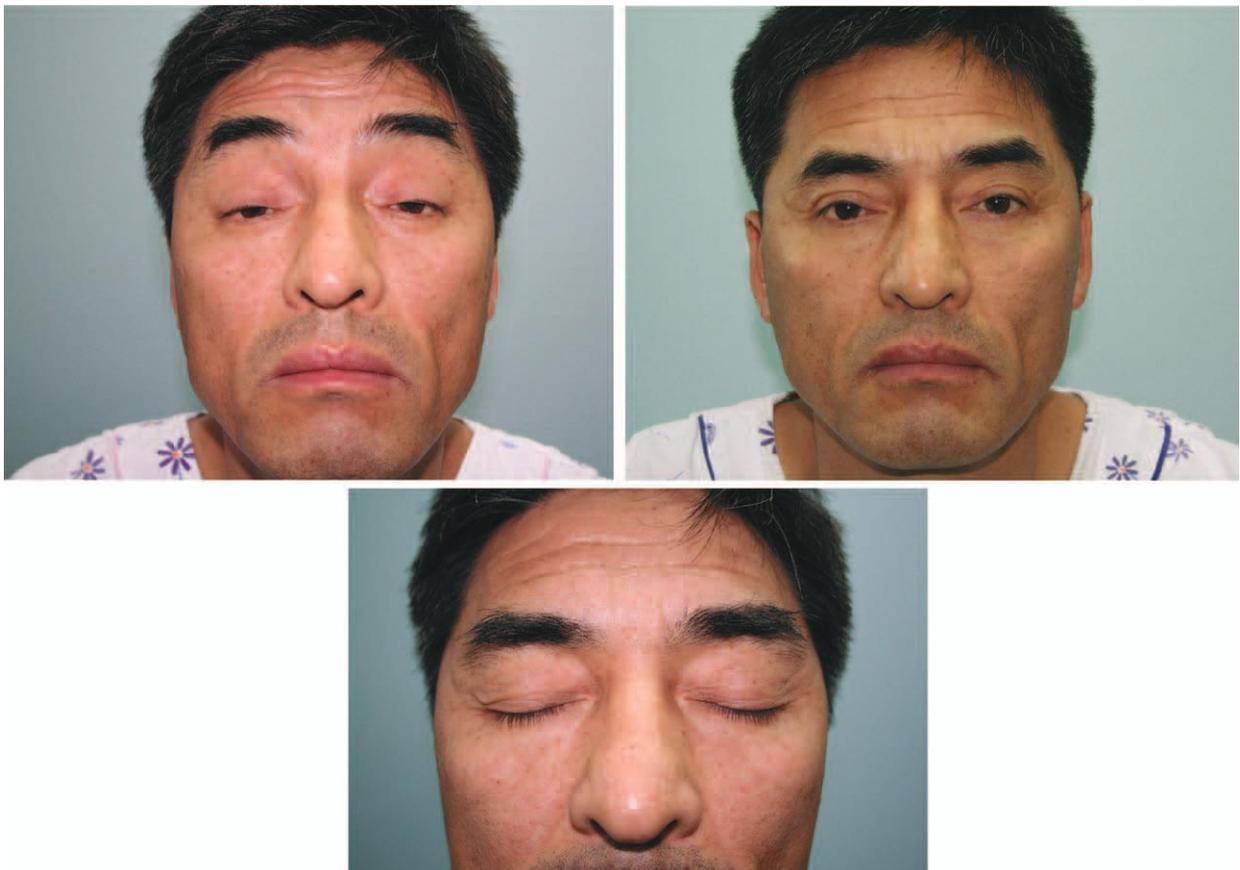
All patients were followed postoperatively for 6 months to 9 years (Table 2). Complete correction of ptosis (degree of ptosis, <1 mm) was

**Table 1. Preoperative Characteristics of Patients**

	Congenital (%)	Acquired (%)	Total (%)
Etiology	38 (76)	12 (24)	50 (100)
Involved eyes ( <i>n</i> = 50 cases)			
Unilateral	12 (24)	3 (6)	15 (30)
Bilateral	26 (52)	9 (18)	35 (70)
Degree of ptosis ( <i>n</i> = 85 eyelids)			
4~5 mm	61 (71.8)	16 (18.8)	77 (90.6)
>6 mm	3 (3.5)	5 (5.9)	8 (9.4)
Levator function ( <i>n</i> = 85 eyelids)			
Fair (7~5 mm)	38 (44.7)	17 (20.0)	55 (64.7)
Poor (4~2 mm)	26 (30.6)	4 (4.7)	30 (35.3)

**Table 2. Postoperative Data of Patients**

	Congenital (%)	Acquired (%)	Total (%)
Degree of ptosis			
Complete correction	36 (42.3)	18 (21.1)	54 (63.5)
Mild residual ptosis	19 (22.3)	3 (3.5)	22 (25.9)
Moderate residual ptosis	9 (10.6)		9 (10.6)
Levator function			
Good (>8 mm)	35 (41.2)	12 (14.1)	47 (55.3)
Fair (7~5 mm)	25 (29.4)	9 (10.6)	34 (40.0)
Poor (<4 mm)	4 (4.7)		4 (4.7)



**Fig. 4.** A 49-year-old man presented with bilateral congenital blepharoptosis. (Above, left) Preoperative straight-ahead gaze. (Above, right) One-year postoperative results after advancement of the composite flap. (Below) Closure of eyes.

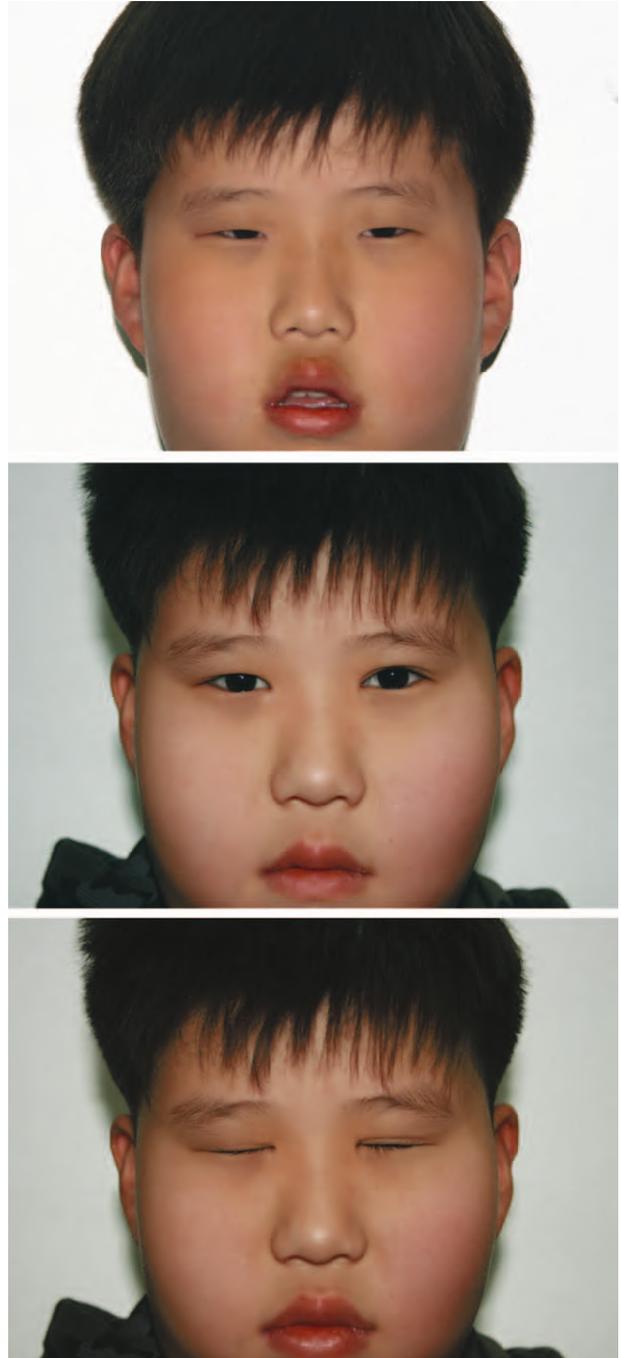
obtained in 54 eyelids (63.5 percent), and mild residual ptosis (degree of ptosis, <2 mm) was seen in 22 eyelids (25.9 percent). In the nine eyelids with moderate residual ptosis (degree of ptosis, 3 mm), two patients (four eyelids) underwent autogenous fascia lata suspension to the frontalis muscle because of poor levator function. The remaining patients refused the procedure.

The most common complication was incomplete correction of ptosis. Reoperation was performed in 15 eyelids, with further advancement of the composite flap. In 41 eyelids (48 percent), lagophthalmos of 1 to 2 mm and mild lid lag were present for the first few months postoperatively but were seen to resolve after 6 months, except in three patients who were lost to follow-up. Minor complications, such as chemosis, ecchymosis, and corneal irritation, were well recovered by conservative treatments such as eye lubricants.

### DISCUSSION

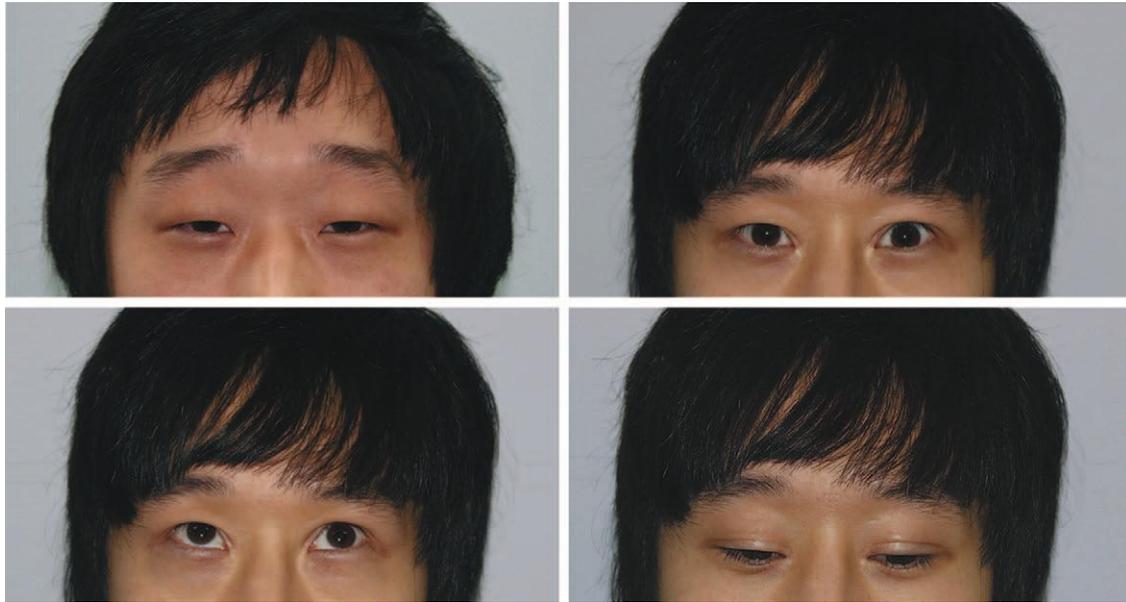
Frontalis suspension has been advocated for the treatment of severe congenital ptosis,<sup>14</sup> although the procedure is associated with complications such as lagophthalmos in closing eyelid and lid lag during downward gaze (Figs. 4 through 6).

We have been interested in the advancement technique of using the levator aponeurosis–Müller’s muscle composite as a flap in the correction of blepharoptosis, and have reported the results.<sup>15–17</sup> We found that eyelid elevation was still deficient for using this technique in patients with severe ptosis. After gaining a further understanding of the deeper connection between the lamina propria mucosa of conjunctiva and the check ligament of the superior fornix, we incorporated the lamina into the composite flap. We postulated that simultaneous advancement of the levator aponeurosis–Müller’s muscle–lamina propria mucosa of conjunctiva composite as a flap produces stronger power to correct severe ptosis. The levator aponeurosis is connected superiorly to the levator palpebrae superioris muscle and the Whitnall’s ligament, and has firm osseous insertion at the medial and lateral horns. Advancement of the distal levator aponeurotic margin downward on the tarsal plate raises the tarsus dynamically by increasing levator function and statically by pulling on the elastic Whitnall’s ligament and shortened levator aponeurosis itself. Müller’s muscle has normal function even in severe ptosis and has 2 to 3 mm of eyelid lifting power. Müller’s muscle is an important terminal attachment of the levator muscle to the superior tarsal border, and shortening the



**Fig. 5.** A 12-year-old boy presented with bilateral congenital blepharoptosis and epicanthal folds associated with mild telecanthus. (Above) Preoperative straight-ahead gaze. (Center) One-year postoperative straight-ahead gaze after advancement of the composite flap and Flowers’ split V-W plasty with shortening of the medial canthal tendon. (Below) Closure of eyes. Double eyelid asymmetry is seen postoperatively.

Müller’s muscle may augment its physiologic role by increasing the tensile strength of the muscle.<sup>18–20</sup> The lamina propria mucosa of the conjunctiva is continuous with the elastic check ligament of the



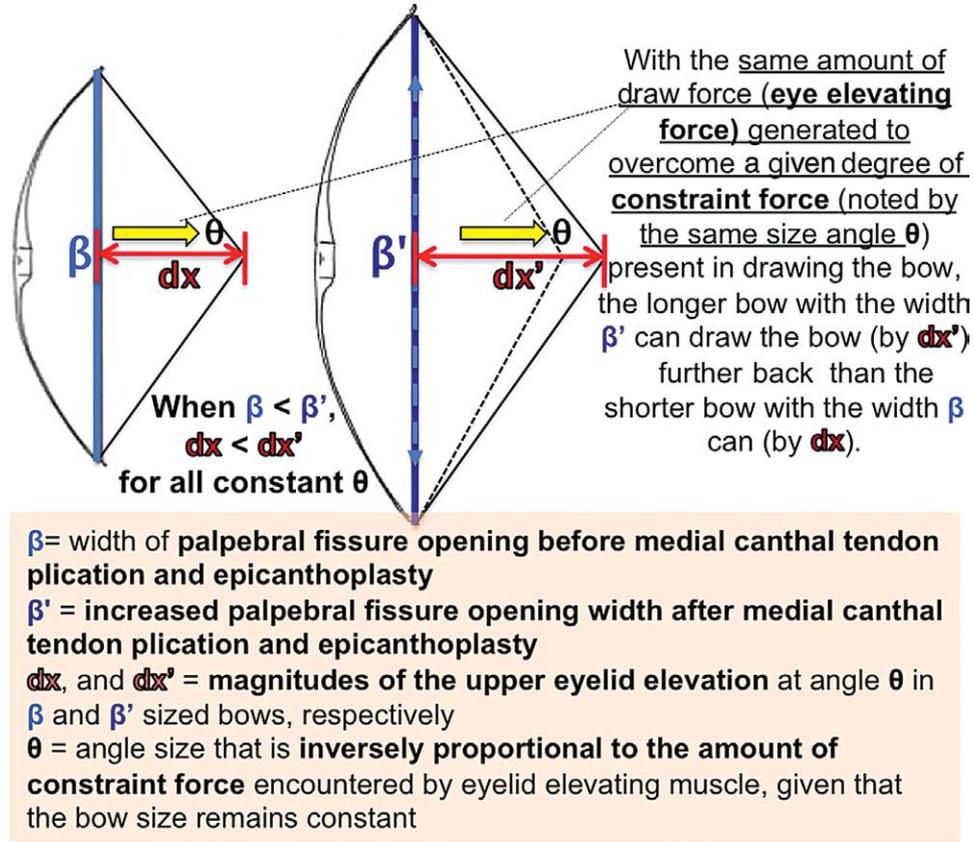
**Fig. 6.** A 26-year-old man presented with bilateral congenital blepharoptosis and epicanthal folds associated with moderate telecanthus. (Above, left) Preoperative straight-ahead gaze. (Above, right) Two-year postoperative straight-ahead gaze after advancement of the composite flap and modification of Flowers' V-W epicanthoplasty with shortening of the medial canthal tendon. (Below, left) Upward gaze. (Below, right) Downward gaze.

superior fornix, and shortening the lamina propria mucosa pulls on the check ligament.<sup>8-10</sup> Therefore, advancement of these three distinct anatomic structures simultaneously to the tarsal plate produces integrated power to raise the upper eyelid in a natural superior-posterior vector. In addition, compared with other techniques in which the levator aponeurosis is separated from Müller's muscle (levator advancement) or Müller's muscle is separated from the lamina (levator-Müller advancement), our technique induces less tissue injury and hence increases the relative effectiveness of these components.

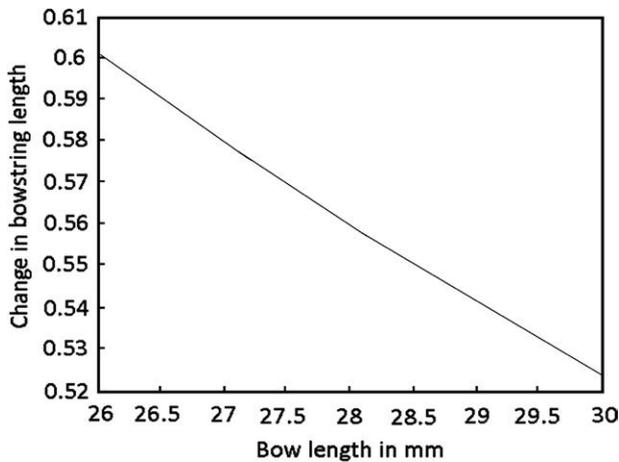
Patients with severe eyelid ptosis attempt to use three muscles to maximize eyelid opening. The initial attempt is by the primary component of eyelid elevation—the levator muscle. The next phase of eyelid opening that patients attempt involves use of the superior rectus muscle to look upward. The third phase is the use of the frontalis muscle. In our current technique, we were able to gain additional eyelid elevation power by incorporating the lamina propria mucosa of conjunctiva compared with using only the levator aponeurosis and Müller's muscle. Shortening the lamina pulls the elastic check ligament of the superior fornix. This, in turn, pulls on not only the levator palpebrae superioris muscle but also the superior rectus muscle, because the check ligament is connected anteriorly to the levator palpebrae superioris muscle and posteriorly to the superior

rectus muscle. The ligament is supposed to act as a hypomochlion in assisting the levator palpebrae superioris muscle with its contracting motion and as a barrier to the underlying superior rectus muscle in providing mechanical interference of the contracting levator palpebrae superioris muscle. Therefore, pulling the check ligament pulls the levator palpebrae superioris muscle and the superior rectus muscle. One can postulate that the check ligament pulls the superior rectus muscle more directly since the connection between the check ligament and the levator palpebrae superioris muscle allows some gliding motion, while the connection between the check ligament and the superior rectus muscle is relatively firm.<sup>8</sup> We believe that coupling the superior rectus muscle to the main eyelid opening mechanism improves the overall excursion of the eyelid. We extrapolated the additive effect of the superior rectus muscle in eyelid elevation from our prior published studies. When we advanced the levator and Müller's muscle as a composite flap without incorporating the underlying lamina propria mucosa of conjunctiva,<sup>15-17</sup> we were unable to generate enough eyelid elevating power to correct severe ptosis. We believe that coupling the lamina enhances eyelid function when patients with severe ptosis attempt to look upward.

One theory concerning the morphogenesis of the extraocular muscles suggests that mesenchymal cells differentiate to become mesodermal



**Fig. 7.** Mechanical advantage of wider horizontal palpebral fissure. The *bow* represents the palpebral fissure.

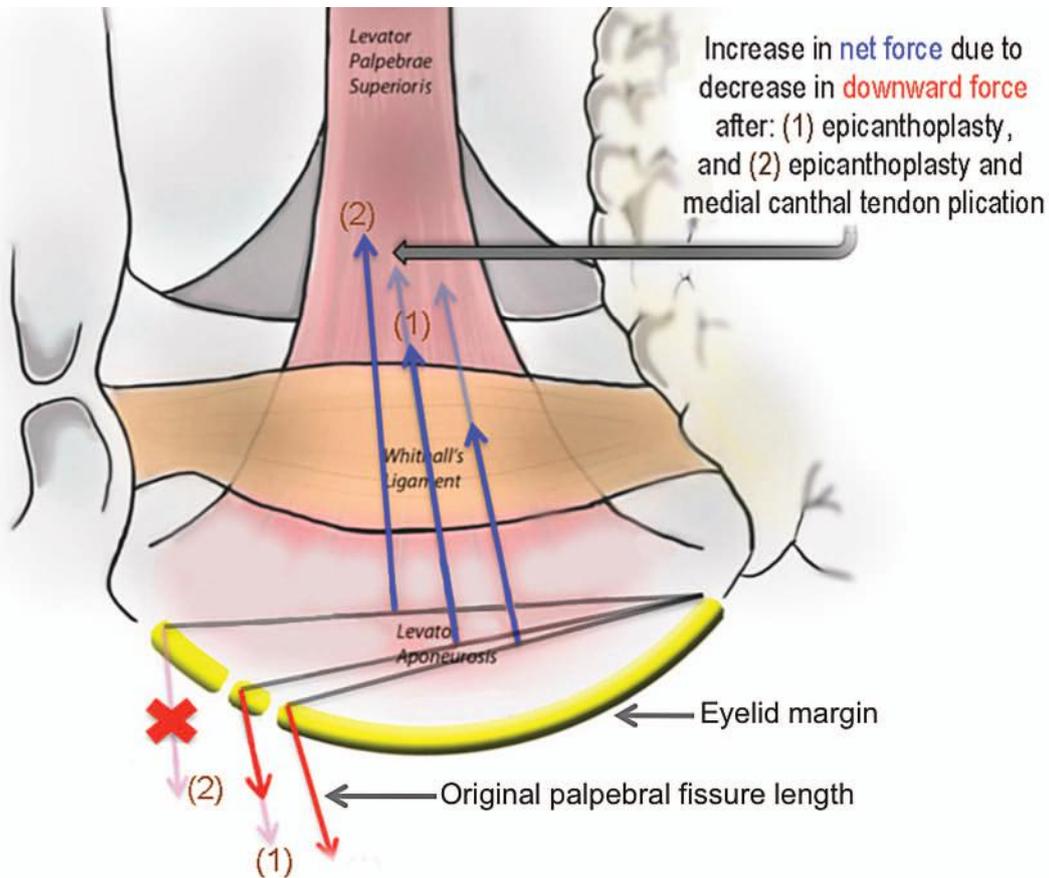


**Fig. 8.** Changes in bowstring length when the bow is drawn by 4 mm for bows of different lengths (26 to 30 mm). Normal horizontal palpebral fissure opening ranges from 26 to 30 mm, and the vertical palpebral fissure opening is approximately 8 mm. Considering that the bow is meant to represent the upper eye lid elevating system, we hypothetically set the bow length to be the horizontal palpebral fissure and that the bow was drawn by 4 mm (half of vertical palpebral fissure).

tissues, which later divide into superior and inferior mesodermal complexes. The levator palpebrae superioris muscle and the superior rectus muscle are considered to develop from superior mesodermal complexes.<sup>21</sup> Vertical lid and vertical eye movements are tightly linked because the levator palpebrae superioris muscle is developmentally derived from the superior rectus muscle. Premotor saccadic signals to the levator palpebrae superioris muscle and the superior rectus muscle come from a common source.<sup>22</sup>

Another advantage of using the levator palpebrae superioris muscle, Müller’s muscle, and superior rectus muscle, compared with using just one muscle, is the reduced shortening of one particular muscle. Distributing the shortening to other eye elevating muscles and augmenting the physiologic component of eyelid elevation allows decreased eyelid shortening to gain the same lifting effect. In theory, this should induce less lagophthalmos and lid lag, as noticed in our results.

In patients with epicanthal folds with associated telecanthus, palpebral openings are small with tightened upper eyelid margins, as in blepharophimosis. Epicanthal folds with associated



**Fig. 9.** Eliminating downward traction force of lower eyelid connection by epicanthoplasty and medial canthal tendon plication.

telecanthus are uncommon in the general population, yet in our study, 42 percent of our severe ptosis patients presented with the concomitant finding. Correction of the epicanthal folds with telecanthus releases the tight upper medial eyelid margin tethered to the medial lower lid and enlarges the palpebral opening.

We applied an analogy of archery bow lengths to sizes of palpebral openings to demonstrate the mechanical advantage seen with larger palpebral openings. When an equal amount of force is used to pull a long archery bow as used to pull a short archery bow, the bowstring of the longer archery bow will be pulled farther back. Similarly, with equal amounts of force generated by eyelid elevating muscles, the upper eyelid margins of larger palpebral openings after epicanthoplasty and medial canthal plication will be pulled farther to increase eyelid excursion, compared with those of smaller palpebral openings as in epicanthal folds with associated telecanthus (Figs. 7 and 8).

Besides the mechanical advantage of the elongated palpebral fissure, epicanthoplasty with

medial canthal tendon plication eliminates or reduces the opposing downward force of the epicanthal fold caused by tethering to the lower eyelid. In patients with epicanthal folds without telecanthus, epicanthoplasty alone can separate the tethering connection of the upper eyelid with the lower lid. However, in patients with epicanthal folds with associated telecanthus, the wide skin excisional epicanthoplasty with medial canthal plication (Figs. 1 through 3) can separate more widely the lower lid from the upper lid. Therefore, these additive procedures further improve eyelid excursion (Fig. 9).

Correction of severe ptosis in Asian patients often involves simultaneous creation of a double eyelid. Double eyelid surgery is performed because the original double eyelid no longer remains after correction of severe ptosis, and to camouflage the incisional scar. In severe ptosis correction, there is an increased chance of postoperative double eyelid asymmetry, since a significant change in the positioning of the levator aponeurosis is made during ptosis correction (Figs. 4 and 5). These patients often need revisional surgery for fold asymmetry.

In extreme cases of severe ptosis with very poor levator function, we recommend the frontalis sling method. For our technique to be effective, we believe that some levator function should exist.

## CONCLUSIONS

The technique of advancement of the levator aponeurosis–Müller’s muscle–lamina propria mucosa of conjunctiva composite as a flap was effective in the treatment of severe ptosis with preexisting levator function of greater than 2 mm. In patients with epicanthal folds with associated telecanthus, epicanthoplasty and medial canthal tendon shortening enlarged the palpebral fissure opening and eliminated the constricting factors that hinder upper eyelid elevation. Our technique produced physiological eyelid excursion in a superior-posterior direction. The amount of resected advanced composite tissue stump was less than 5 mm, and there were no serious complications, such as long-term lagophthalmos or lid lag.

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## PATIENT CONSENT

*Patients or parents or guardians provided written consent for use of patients’ images.*

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