Comparison of Blepharoptosis Correction Using Müller-aponeurosis Composite Flap Advancement and Frontalis Muscle Transfer

David Dae Hawan Park, MD, PhD*
Anwar Ramadhan, BDS†
Dong Gil Han, MD*
Jeong Su Shim, MD, PhD* Yong Jig Lee, MD, PhD* Won Ho Ha, MD* Byung Kwon Lee, MD*

Background: Treatments for severe blepharoptosis are well documented and include the most common operations for restoring upper eyelid ptosis, which are levator surgery and frontal muscle transfers; however, the choice of treatment is still controversial. There are different approaches to the restoration of upper eyelid ptosis, and the choice will be based on ptosis severity and the surgeon’s skill and experience.

Methods: Two hundred and fourteen patients presenting with a levator function of between 2 and 4 mm received ptosis correction between 1991 and 2010 at our clinic. Of these, 71 patients underwent Müller aponeurosis composite flap advancement for correction of 89 eyelids, and frontalis muscle transfer was performed on 143 patients (217 eyelids). Postoperative results were evaluated with an average follow-up period of 23 months.

Results: The preoperative average for marginal reflex distance (MRD₁) in the Müller aponeurosis composite flap advancement group was 1.25 mm, and in the frontal muscle transfer group, it was 0.59 mm. The area of corneal exposure (ACE) was 57.2% in the Müller aponeurosis composite flap advancement group and 53.6% in the frontal muscle transfer group. The postoperative average distance was not significantly different for the 2 techniques. In the Müller aponeurosis composite flap advancement group, MRD₁ was 2.7 mm and ACE was improved to 73.5%. In the frontal muscle transfer group, MRD₁ was 2.3 mm and ACE was 71.2%. Undercorrection and eyelid asymmetry were the most frequently observed postoperative complications for both techniques.

Conclusions: In our study, we confirmed that Müller aponeurosis composite flap advancement and the frontalis transfer technique are both effective in the correction of severe blepharoptosis; our results showed no significant differences between the 2 techniques. (Plast Reconstr Surg Glob Open 2014;2:e200; doi: 10.1097/GOX.0000000000000094; Published online 12 August 2014.)

Blepharoptosis is defined as drooping of the upper eyelid due to impairment of levator muscle function.

Ptosis can be classified as congenital or acquired, whereby 70% of congenital diagnoses present as unilateral or bilateral disorders of the upper eyelids.¹

Treatments of blepharoptosis have been under development for more than 100 years and are still being refined. Management is still challenging for the oculoplastic surgeon as there are different circumstances and guidelines relevant to the repair of upper eyelid ptosis.¹-⁶

From the *Department of Medicine, Catholic University of Daegu, Daegu, Korea; and †Amiri Hospital, Kuwait City, Kuwait.

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In essence, the selection method of blepharoptosis treatment is based on the severity of ptosis, its etiology, and the surgeon’s skill and experience. There are multiple ways to restore upper eyelid function, such as shortening the length of the levator palpebrae superioris, Müller’s muscle resection, or frontal muscle transfer and suspension procedures. Payman et al. chose levator resection in cases where levator function was more than 4 mm, and Mustarde performed frontal muscle suspension only in cases in which the levator function was less than 1 mm and performed levator resection in the other eyelids. Fox concluded that levator resection could be performed in cases where levator function was more than 2 mm, and frontal muscle suspension could be performed in eyelids where levator function was less than 1 mm. As seen earlier, there are different ways to manage severe blepharoptosis.

Some authors perform resection of the levator muscle when levator muscle function is more than 2 mm, and others agree with frontal muscle transfer or suspension procedures. Park et al. published a comparison of levator resection and frontal muscle transfer in the treatment of severe ptosis, whereby both procedures were performed when levator muscle function was between 2 and 4 mm.

We studied 306 blepharoptoses that were operated on by 2 different procedures to compare outcomes for Müller aponeurosis composite flap advancement and frontal transfer at 23 months follow-up.

### MATERIALS AND METHODS

#### Patients

This prospective study is based on 214 patients with levator function (2–4 mm); they were operated on by 1 senior consultant from 1991 to 2010. Seventy-one patients (89 eyelids) received Müller aponeurosis composite flap advancement procedures, and frontal muscle transfer techniques were performed on 143 patients (217 eyelids) (Tables 1 and 2).

Preoperatively, the ptosis degree of severity and levator and frontal muscle functions were measured. Marginal reflex distance (MRD) and eyebrow height were recorded. Ancillary tests were performed on the patient, such as serial external photograph, corneal sensitivity, Bell’s phenomenon, jaw-winking phenomenon, myasthenia, and Schirmer test.

In this study, we aimed to obtain accurate measurements in 2-dimensional views by measuring the area of corneal exposure (ACE) to record the blepharoptosis degree of severity (Table 3).

The selection of surgical procedures depends on the patient’s age and also levator function (Table 4). The authors performed Müller aponeurosis composite flap advancement procedure as first line of treatment to treat severe ptosis of between 2 and 4 mm and also for patients younger than 15 years old (Table 4).

### Table 1. The Distribution of Patients by Age, Sex, and Etiology

| Age  | Male | Female | Unilateral | Bilateral | Cause | Total No. Patients |
|------|------|--------|------------|-----------|-------|-------------------|
|      |      |        | Right      | Left      |       |                   |
| 0-10 | 7    | 8      | 5          | 4         |       | 11                |
| 11-20| 8    | 12     | 5          | 3         |       | 18                |
| 21-30| 7    | 10     | 7          | 3         |       | 10                |
| 31-40| 8    | 18     | 5          | 6         |       | 15                |
| 41-50| 30   | 31     | 18         | 9         |       | 39                |
| 51-60| 16   | 26     | 8          | 14        |       | 22                |
| >61  | 14   | 19     | 6          | 9         |       | 23                |
| Total| 90   | 124    | 54         | 48        |       | 214               |

### Table 2. The Distribution of Operation Method

| Methods of Operation | Etiology | No. Eyelids | Total |
|----------------------|----------|-------------|-------|
| Müller aponeurosis   | Congenital| (57) 67     | (71) 89 |
| composite flap        | Acquired | (14) 22     |       |
| advancement           |          |             |       |
| Frontal muscle        | Congenital| (126) 195   | (143) 217 |
| transfer              | Acquired | (17) 22     |       |
| Total                 |          | (214) 306   |       |
Frontal muscle transfer can be the second choice in cases where the patient has relapsed after levator resection or Müller aponeurosis composite flap advancement. Frontal muscle transfer is also appropriate if levator function is less than 2 mm or the patient is more than 15 years old (Table 4).

**Surgical Methods**

*Müller Aponeurosis Composite Flap Advancement Procedure*

La (Lidoicain/Adrenalin 2%) is administered, the skin crease is marked, and upper eyelid crease incision is performed, followed by dissection through the orbicularis, then identification of the preaponeurotic fat as a guide to the levator muscle. Local anesthesia is applied to the conjunctiva to achieve a hydrodissection effect, followed by vertical incision through the upper transconjunctiva, the Müller muscle was separated from the conjunctiva using blunt scissors, then the Müller muscle was carefully detached from the superior portion of the tarsus.

After that, the Müller muscle-levator aponeurosis flap was dissected and advanced with resection if needed. The elevated flap was fixed to the tarsal plate.

**Table 3. The Preoperative MRD₁ of Ptosis**

| Degree of MRD₁ | Müller Aponeurosis Composite Flap Advancement | Frontal Muscle Transfer |
|----------------|---------------------------------------------|-------------------------|
| 1–2 mm         | 49                                          | 40                      |
| 0–1 mm         | 35                                          | 90                      |
| −1 to 0 mm     | 5                                           | 70                      |
| <−1 mm         | 17                                          |                         |
| Average        | 1.25 mm                                     | 0.59 mm                 |

**Table 4. Indication of Using Müller Aponeurosis Composite Flap and Frontal Transfer According to Authors’ Experience**

| Patient’s Characteristic | Müller Aponeurosis Composite Flap Advancement | Frontal Muscle Transfer |
|-------------------------|---------------------------------------------|-------------------------|
| Levator muscle function | 2–4 mm                                      | 2–4 mm                  |
| Age preference          | Children/adult                              | Usually adult (>15 y)   |
| Ptosis etiology         | Acquired/congenital                         | Usually congenital Oculomotor nerve palsy Blepharophimosis |

![Fig. 1. Both levator aponeurosis and Müller muscle are elevated. The flap was advanced and fixed to tarsus at appropriate level on 2–3 points.](image-url)
at the appropriate level by 5-0 polydioxanone suture at 2–3 points (Figs. 1 and 2). (See Video 1, Supplemental Digital Content 1, which demonstrates the Müller aponeurosis composite flap advancement procedure. This video is available in the “Related Videos” section of the full-text article at http://www.PRS-GO.com or available at http://links.lww.com/PRSGO/A37.)

**Frontal Muscle Transfer Procedure**

La (Lidocain/Adrenalin 2%) was administered. First, 2 incisions were made at the inferior margin of the eyebrow and in the supratarsal region. The frontal muscle was delineated by a 2-cm horizontal cut and 1-cm vertical cuts bilaterally (lateral border of the frontal muscle) and then the frontal muscle was mobilized and elevated. The frontal muscle flap must include soft tissue for thickness. A tunnel was then created as a link between the inferior margin of the eyebrow and the supratarsal area. The tunnel must be as small as possible to avoid entropion. The muscle flap was drawn downward through a small tunnel beneath the orbital septum to the tarsal plate and was fixed to the tarsal plate by 5-0 PDS for fixation of the muscle flap and the tarsal plate at 2–3 points. To prevent loosening of knots, a tight knot was made at least 5 times. After flap fixation, skin to tarsus fixation was done with 7-0 Nylon suture (Figs. 3 and 4). (See Video 2, Supplemental Digital Content 2, demonstrating the frontal muscle transfer procedure. This video is available in the “Related Videos” section of the full-text article at http://www.PRS-GO.com or available at http://links.lww.com/PRSGO/A38.)

**Evaluation**

**Anthropometry and Photograph Analysis**

We measured the MRD, ACE, and eyebrow height to estimate ptosis severity and pre- and postoperative change using the qualitatively analyzed software (Adobe photoshopp 7.0) and the Java-based image processing program (Image J 1. 40; National Institutes of Health, Bethesda, Md.).

**Statistical Analysis**

This study was analyzed using the SPSS program. The paired-samples t test and independent-samples
Fig. 3. Frontal muscle flap was drawn downward through a small tunnel beneath the orbital septum to the tarsal plate and was fixed to the tarsal plate for fixation between the muscle flap and the tarsal plate on 2–3 points.

Fig. 4. A, Expose and elevate the frontalis muscle. B, Grasp the tarsal plate and mark the fixation point 2 mm from the lower upper margin of tarsus. C, Tunneling from supratarsal incision to the inferior margin of the eyebrow, the metzemaum scissors passing between orbicularis oculi and orbital septum. D, Frontalis muscle flap passed through a small tunnel beneath the orbital septum to the 2 mm lower than upper margin of tarsus and then fixed to the tarsal plate by PDS 5-0.
Statistical significance level was set at $P < 0.05$ without control group.

**RESULTS**

Of the blepharoptosis patients with less than 2 mm of MRD$_1$, 214 people could be traced and 306 eyelids were researched. The sample group's gender ratio showed more men, and more unilateral cases, and the average age was 30.7 years old. The average follow-up period was 23 months (Table 1).

Müller aponeurosis composite flap advancement was performed on 71 patients and 89 eyelids. The frontal muscle transfer method was performed on 143 patients and 217 eyelids (Table 2).

The average value of MRD$_1$ before the operation was 1.25 mm for patients who received Müller aponeurosis composite flap advancement and 0.59 mm for patients who underwent frontal muscle transfer (Table 3).

The postoperative average value of MRD$_1$ was 2.73 mm in the Müller aponeurosis composite flap advancement group and 2.38 mm in the frontal muscle group (Tables 5 and 6).

However, the improvement value for MRD$_1$ and ACE was slightly different for the 2 techniques; the degree of improvement was greater for the frontal muscle transfer technique than for the Müller aponeurosis composite flap advancement technique (Figs. 5–7). The improvement of MRD$_1$ was 1.8 mm in the frontal muscle technique and 1.5 mm for the Müller aponeurosis composite flap. The ACE increased by 16.3% for the Müller aponeurosis composite flap and 17.6% in frontal muscle transfer (Table 7).

The outcome in terms of esthetics was that eyebrow height improvement was greater for the Müller aponeurosis composite flap advancement technique and gives the patient a more natural appearance compared with frontal muscle transfer (Tables 8 and 9).

Outcomes for Müller aponeurosis composite flap advancement were considered excellent in 37.1% of cases, good in 32.6%, fair in 16.9%, and poor in 13.4% (Table 6).

Outcomes for frontal muscle transfer were excellent in 39.2%, good in 27.7%, fair in 25.7%, and poor in 7.4% (Table 6).

Undercorrection and eyelid asymmetry were the most common postoperative complications seen in both techniques.

Undercorrection was observed for the Müller aponeurosis composite flap advancement procedure in 13.4% and for frontal muscle transfer procedure in 7.4%, followed by asymmetry complications in 10.1% for the Müller aponeurosis composite flap advancement procedure and in 7.4% for frontal muscle transfer procedure.

Moreover, 10 patients (4.6%) had overcorrection after the frontal muscle transfer procedure compared with only 2 patients (2.2%) with overcorrection in the Müller aponeurosis composite flap advancement group (Table 10).

**DISCUSSION**

The selection method for correction of blepharoptosis depends on the severity of the ptosis and its etiology and the surgeon’s experience.

Mark et al. performed Müller muscle conjunctival resection to treat mild ptosis cases, and their results
Fig. 5. Anthropometry tool and photograph analysis. A, Measurement of MRD, in Adobe photoshop 7.0.1 program, the distance between the center of pupil to the center of upper eyelid margin. B, Measurement of ACE: (a) total surface of corneal area and (b) representation of area corneal exposure. C, Measurement of the eyebrow height: first, horizontal line was drawn from lateral canthus to the medial canthus of the eye, followed by 3 vertical lines. H1: From lateral canthus to the lateral upper margin of eyebrow. H2: From central of pupil to the central of the upper margin of eyebrow. H3: From medial canthus to the medial upper margin of eyebrow.

Fig. 6. Müller aponeurosis composite flap advancement procedure. A, Preoperative view. A 21-year-old man with congenital severe unilateral blepharoptosis. Preoperative evaluation (right eye: MRD1, 0.1 mm; ACE, 54%; eyebrow height: H1, 29.1 mm; H2, 29.2 mm; H3, 27.5 mm; levator function: 4 mm). B, Three-month postoperative evaluation (right eye: MRD1, 2.49 mm; ACE, 74%; eyebrow height: H1, 26.1 mm; H2, 26.3 mm; H3, 25.7 mm).
showed an MRD₁ improvement of up to 2 mm postoperatively with an increasing palpebral fissure height of 2.4 mm. They concluded that Müller muscle–conjunctival resection using this method is not recommended for patients with poor levator function.¹⁵

In 2010, Shimizu et al¹⁶ discovered a new method for correction of mild and moderate ptosis using a nonincisional technique. They achieved improvements in 97.5% (406 eyelids) in mild cases and in 88.9% (185 eyelids) in moderate cases.

This technique has the advantages of nonvisible scar and fast procedures and creates the double eyelid fold that is defined as a desirable esthetic result in Asian countries such as Japan, Korea, and China where orientals constitute an ethnic majority.¹⁶

Nevertheless, the methods mentioned above yielded excellent outcomes for correction of mild or moderate ptosis.

Either frontal muscle suspension or frontal muscle transfer can be used for the correction of severe blepharoptosis. However, it is quite difficult to achieve good results in cases of severe blepharoptosis because the direction of traction in this method is anatomically different from that of levator resection. Frontal muscle suspension needs a lot of materials and is also associated with some problems, such as unnatural shape of eyelids after surgery, need for a donor site, and the possibility of recurring blepharoptosis due to stretched fascia or partial absorption of the tissue used for suspension. The L-shape of frontal muscle transfer by Song and Song⁵ resulted in a more natural and more dynamic shape of the eyelids and a more normal location of the eyebrow than frontal muscle suspension. Furthermore, it is associated with a lower rate of recurrence and does not need fascia. However, there is a risk of hematoma, paresthesia of the forehead due to supraorbital nerve injury, loss of wrinkles in the forehead, depression of the forehead, and requires 2 incision lines. Another disadvantage is that deformity may occur if the area of frontal flap fixation is pulled too tightly. To this end, different methods

Table 7. The Improvement ACE after Surgery (Average)

|                         | Müller Aponeurosis Composite Flap Advancement, n = 30 (45) | Frontal muscle transfer, n = 30 (45) |
|-------------------------|------------------------------------------------------------|-------------------------------------|
| Preoperative degree of ACE | 57.24%                                                      | 53.65%                              |
| Postoperative degree of ACE | 73.54%                                                      | 71.27%                              |
| Degree of improvement (%)   | 16.3%                                                       | 17.62%                              |

Table 8. Amount of Changes of Postoperative Eyebrow Height of Severe Blepharoptosis Patients and Depends on Operative Methods

|                         | H1     | H2     | H3     |
|-------------------------|--------|--------|--------|
| Eyebrow height of normal Asian person [n = 15 (30)] Average (mm) | 26.44  | 28.3   | 25.71  |
| Eyebrow height of blepharoptosis patient (in severe case) [n = 60 (90)] Average (mm) | 32.84  | 35.96  | 31.32  |
| Amount of difference between operation (mm) | −3.64  | −3.31  | −2.79  |
| Ratio of difference between operation (%) | 11.1   | 9.2    | 8.9    |
| Amount of eyebrow height changes depend on operative method [n = 60 (90)] | Frontalis transfer (mm) | −5.5   | −6.9   | −10.7  |
| Müller aponeurosis composite flap advancement (mm) | −12.2  | −10.4  | −14.2  |
are being introduced to ensure that the tensile forces are evenly distributed by dividing the lower end of the frontal flap into 3 sections and resection of the frontal flap in an arch-shaped way with subsequent fixation to the tarsal plate. Holds et al are in favor of Whitnall’s sling with superior tarsectomy for the correction of severe unilateral blepharoptosis.

However, all the measurements used in ptosis surgery whether preoperatively or postoperatively (MRD, marginal limbal distance, and vertical height of the palpebral fissure) are 1-dimensional figures that measure the distance between 2 points and have the limitation that they are measuring a 3-dimensional ocular surface. It is difficult to obtain precise results because the use of a graduated ruler to measure may make the patient nervous.

In this study, we also obtained the ACE, a 2-dimensional area that helps quantify the change between the sizes of the eyes.

This study is a review of outcomes after Müller aponeurosis composite flap advancement versus frontal muscle transfer in severe ptosis.

The author performs Müller aponeurosis composite flap advancement when the levator muscle function is between 2 and 4 mm.

The postoperative MRD after conducting Müller aponeurosis composite flap advancement was 1.5 mm; frontal transfer showed an improvement of 1.8 mm.

The results of ACE showed improvement in 73.5% in the Müller aponeurosis composite flap advancement group and 71.2% in the frontal muscle transfer group.

In addition, eyebrow height results showed greater improvement in the Müller aponeurosis composite flap advancement group than in the frontal muscle transfer group, whereby the latter offers an esthetic advantage and produces a more natural appearance compared with the frontal muscle transfer technique.

The result showed no significant difference between the 2 surgical techniques; both techniques are effective for the correction of severe ptosis.

To end this discussion, in our study, the authors were able to significantly refine the indications for Müller aponeurosis composite flap advancement and frontal transfer for the correction of severe blepharoptosis (Table 4).

In severe ptosis, Müller aponeurosis composite flap advancement can be used for acquired and congenital disorders in children older than 8 years and in adults. Frontal transfer is usually used in congenital as well as oculomotor nerve palsy and blepharophimosis and is appropriate in adults older than 15 years only (Table 4).

Nevertheless, the surgical technique of frontal muscle transfer should be performed with great surgical care to avoid postoperative complications. In terms of the author’s own experience, it is appropriate to perform Müller aponeurosis composite flap advancement as a first line of severe ptosis treatment with the advantage of avoiding the postoperative complications that can occur when using frontal muscle transfer such as exposure keratitis and entropion, which are more commonly observed after frontal transfer. It is also valuable to preserve the frontal transfer technique as a second option in the future in cases of relapse.

**CONCLUSIONS**

Müller aponeurosis composite flap advancement and frontal muscle transfer techniques are both effective in severe blepharoptosis correction.
Müller aponeurosis composite flap advancement can be the first choice as first line of treatment for correction of the upper eyelid in severe ptosis when the levator function is between 2 and 4 mm, thus helping the surgeon to avoid the postoperative complications associated with frontal muscle transfer as the first line of treatment and also preserve this latter technique as a second choice if the Müller aponeurosis composite flap should relapse in the future.

**Fig. 8.** Frontal muscle transfer procedure. A, Preoperative view. A 22-year-old man with congenital severe bilateral blepharoptosis. Preoperative evaluation (right eye: MRD1, 1.8 mm; ACE, 71%; eyebrow height: H1, 30.1 mm; H2, 30.2 mm; H3, 28.7 mm; levator function: 6 mm. Left eye: MRD1, –1.8 mm; ACE, 33%; eyebrow height: H1, 33.1 mm; H2, 33.2 mm; H3, 29.7 mm; levator function: 2 mm). B, Three-month postoperative evaluation (right eye: MRD1, 2.75 mm; ACE, 75%; eyebrow height: H1, 26.3 mm; H2, 28.1 mm; H3, 28.1 mm. Left eye: MRD1, 2.45 mm; ACE, 72%; eyebrow height: H1, 27.3 mm; H2, 28.4 mm; H3, 28.5 mm).

**Fig. 9.** Frontal muscle transfer procedure. A, Preoperative view. A 18-year-old man with congenital bilateral severe blepharoptosis. Preoperative evaluation (right eye: MRD1, 1.1 mm; ACE, 59%; eyebrow height: H1, 31.5 mm; H2, 31.4 mm; H3, 29.3 mm; levator function: 2 mm. Left eye: MRD1, 1.0 mm; ACE, 55%; eyebrow height: H1, 31.1 mm; H2, 31.3 mm; H3, 29.5 mm; levator function: 2 mm). B, Six-month postoperative evaluation (right eye: MRD1, 2.31 mm; ACE, 71%; eyebrow height: H1, 27.9 mm; H2, 27.7 mm; H3, 26.3 mm. Left eye: MRD1, 2.39 mm; ACE, 72%; eyebrow height: H1, 27.7 mm; H2, 27.4 mm; H3, 26.1 mm).

**PATIENT CONSENT**

Patients provided written consent for the use of their images.

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