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ORIGINAL ARTICLE
Reconstructive

Closed Posterior Levator Advancement in Severe Ptosis

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Background: Repair of blepharoptosis from the posterior eyelid approach has usually been done utilizing a Müller's muscle-conjuctival resection (MMCR) or an "open sky" technique. We present a new technique to advance the levator muscle from the posterior-approach in a closed fashion that can be used in patients with severe involutional ptosis.

Methods: A retrospective chart review was performed for consecutive patients with severe involutional blepharoptosis during a 6-year period treated by a single surgeon with a Closed Posterior Levator Advancement. The inclusion criteria were good levator function (≥ 10 mm), graded response to phenylephrine (change in lid height, 0–5 mm), and no concomitant procedures. Severe involutional blepharoptosis was defined as a margin-to-reflex-distance-1 (MRD1) of ≤ 1.5 mm. Follow-up for all patients was a minimum of 9 months. The main outcome variables were MRD1, upper eyelid contour, intereye symmetry, and reoperation rates.

Results: Three hundred three eyes from 192 patients, with severe ptosis were identified. The average age was 65 years, and the mean preoperative MRD1 was 0.3 mm. Postoperatively, mean MRD1 was 3.5 mm with a median improvement of 3.2 mm. The upper eyelid contour was deemed to be satisfactory by patient and surgeon in 98.3% of eyes. Intereye symmetry was excellent in 96% of our cohort. An overall revision rate of 1.8% was found.

Conclusions: We present a new technique that involves an advancement of the levator muscle in a closed posterior eyelid approach. The technique has produced satisfactory outcomes in our cohort of patients with severe ptosis with a low revision rate.
(Plast Reconstr Surg Glob Open 2018;6:e1781; doi: 10.1097/GOX.0000000000001781; Published online 15 May 2018.)

INTRODUCTION

Müller's Muscle-Conjunctiva Resection (MMCR), first described by Putterman and Urist[1] in 1975, has been shown to be an effective surgery for mild-to-moderate ptosis with moderate-to-good levator function and a positive phenylephrine response.[2–6]

Traditionally, external levator resection and advancement has been the gold standard for the treatment of severe ptosis with moderate-to-good levator function. This external approach involves a lid crease incision and intraoperative manipulation of the lid height with a cooperative, conscious patient under minimal sedation.

Success rates of this traditional external approach have been variably quoted from 70% to 90%.[6–8] Rates of cosmetically unsatisfactory eyelid crease and contour abnormalities along with comparatively higher reoperation rates of up to 11% to 30% have been reported with external levator resection surgery.[6–8]

MMCR on the other hand has consistently demonstrated a high success rate of 80–97% with low reoperation rates (0–3%),[2–6] requires shorter operation time (approximately 20 minutes per eyelid), involves less tissue dissection, and requires no intraoperative adjustment or patient cooperation. Another distinct advantage is the absence of an external scar and maintenance of an unaltered eyelid

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Received for publication May 19, 2017; accepted March 20, 2018.

DOI: 10.1097/GOX.0000000000001781

Disclosure: *The authors have no financial interest to declare in relation to the content of this article. The Article Processing Charge was paid for by the authors.*

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contour.[9] However, it has only been advocated for mild ptosis and has not been used for severe ptosis patients.

The anatomical basis of the success of MMCR surgery is still debated but most surgeons advocate its use in only mild ptosis of 1–2 mm or an MRD1 (Margin reflex distance-1) of 3 or better.

Müller's muscle is believed to control upper eyelid position by acting as a muscle spindle generating a stretch reflex regulating levator muscle tone.[10] Müller's muscle shortening alone may not explain the effect of MMCR on eyelid elevation. Histopathological analysis of Fasanella-Servat procedures show predominantly minimal or no Müller's muscle excision despite successful repair of (mild) ptosis.[11] Other postulated mechanisms for the success of MMCR include advancement of the anterior extensions of the levator aponeurosis to the tarsus, vertical posterior lamellar shortening, and wound cicatrisation.

Although most studies of MMCR surgery include patients with predominantly mild ptosis, it has only been presumed that the procedure is not effective in patients with more significant ptosis.[12] Some recent data suggest that it may be helpful in a wider array of ptosis severity.[5,13,14]

To try and amalgamate the low complication and revision rates seen with posterior eyelid ptosis repair with the increased power of external approach ptosis surgery, we developed a new technique that advances the levator aponeurosis in a closed fashion from the posterior eyelid aspect [(Closed Posterior Levator Advancement (CPLA)].

This study examines the efficacy of CPLA surgery for severe ptosis via retrospective analysis of operations in 303 eyes with 1 surgeon.

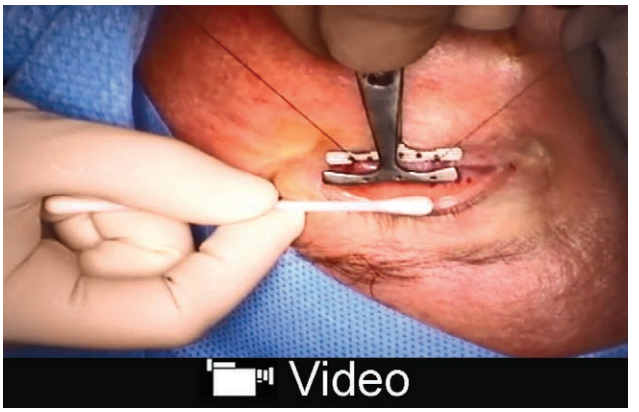
METHODS

Study Design

Patients who underwent a CPLA procedure for acquired upper eyelid ptosis were retrospectively extracted from a clinical database held by a single oculoplastic surgeon (coauthor AT) working in multiple private metropolitan hospitals. Patients were included if they had a CPLA procedure at any time between June 1, 2010, and June 1, 2016, and had a preoperative Marginal Reflex Distance 1 of 1.5 mm or less (defining this as severe ptosis). Postoperative follow-up was performed up to a minimum of 9 months up to 24 months. Patients with classically described involutional ptosis and an isolated surgical repair with no concomitant surgery were included. Other inclusion criteria were good levator function (≥ 10 mm) and graded response to phenylephrine (change in lid height, 0–5 mm).

The surgeon (A.T.) assessed each eye independently for suitability of the CPLA procedure. A number of variables regarding preoperative demographics and clinical data for each individual patient was kept in the clinical database and extracted for our study. Pre- and postoperative physical examination parameters, including the MRD1, levator function, ocular surface dryness, phenylephrine response to 10% NSE (neosynephrine drops) were collected.

Pre- and postoperative standardized photographs were used to measure MRD1 and assess eyelid contour. The standardized technique involved photographing in a frontal position with eyelids open and facial muscles relaxed. The use of photographs for the measurement of MRD1 and lid eyelid contour has been established. Photographic analysis was performed with ImageJ with calibration done for each individual image assuming a horizontal corneal diameter of 11.7 mm. We then measured the distance between the upper eyelid margin and the corneal light reflex.



Video Graphic 1. See video, Supplemental Digital Content 1, which displays closed posterior levator approach. This video is available in the "Related Videos" section of the Full-Text article on PRSGlobalOpen.com or available at ***http://links.lww.com/PRSGO/A774***.

Preoperatively, 10% phenylephrine was instilled into the upper fornix to determine the ability and degree of Müller's muscle contraction and the amount of lid elevation. The degree of eyelid elevation with phenylephrine was used to guide the amount of tissue resection required. A number of different algorithms exist for the amount of tissue resection required based on the response to phenylephrine and the degree of ptosis being repaired.[2–5] The author (Dr A Tsirbas) uses a complex algorithm that involves variable advancement of the levator depending on severity of ptosis, response to NSE 10%, ocular surface dryness and patient preference.

Surgical Technique

The surgery is usually performed with local anesthesia (2% lignocaine with 1:80,000 adrenaline) and IV sedation. No patient cooperation is required. Approximately 2 ml of local anesthetic is administered in the tissue plane between Müller's muscle and the conjunctiva with 0.5 ml to the lateral edges of the skin crease where the suture will be externalized (Fig. 1; **See video, Supplemental Digital Content 1**, which displays closed posterior levator approach. This video is available in the "Related Videos" section of the Full-Text article on PRSGlobalOpen.com or available at ***http://links.lww.com/PRSGO/A774***).

The lid is marked for the lid crease and the exit positions of the suture (Fig. 2A). The lid is then everted over a Desmarres retractor, and the highest point of the tarsus is marked. Lateral to this marks are placed at the medial one-third and lateral one-third of the lid. This is 6 mm either side of the central mark. The palpebral conjunctiva is marked to a predetermined height (3.5–5 mm) above

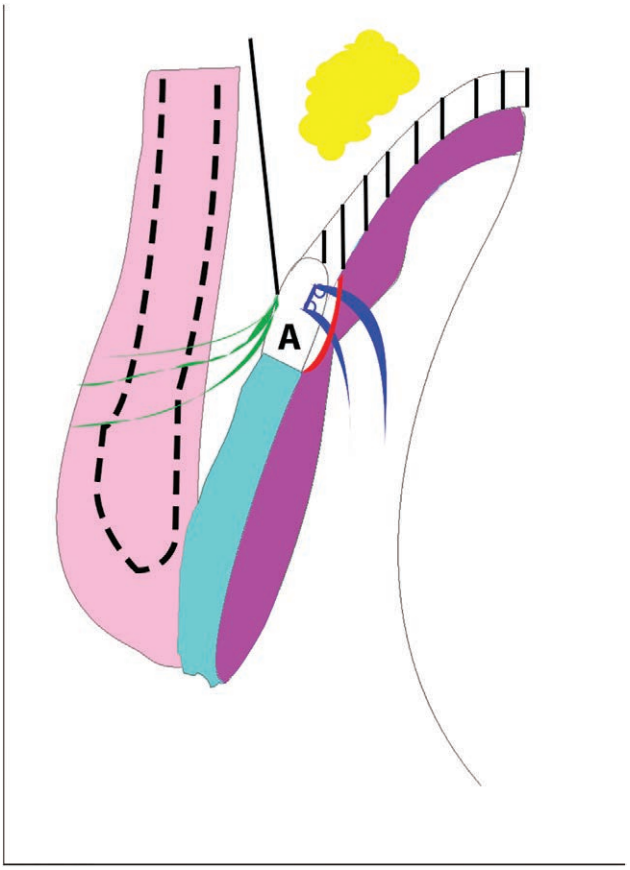


Fig. 1. The green lines are representative of the levator attachment to the skin, and the blue lines are representative of the suture advancement of the LPS (striated, and "A" represents the levator aponeurosis). The other structures are highlighted as follows: pink, skin; dotted outline, orbicularis muscle; thick black line, septum; Yellow, pre aponeurosis fat pad; teal, tarsal plate; red, Müller's muscle; magenta, conjunctiva.

the superior tarsal border at the lateral and medial tarsal marks.

A 4/0 silk traction suture on an FS2 needle is placed at this mark (Fig. 2B). The placement of this suture is a critical step in the surgery. It is placed through the conjunctiva and Müller's muscle to engage the underside of the levator aponeurosis complex. This step involves the "closed" advancement of the Levator Palpebrae Superioris (LPS) complex. This step is critical and is the complete opposite of the classically described Putterman Procedure. It also mimics the techniques involving "open sky" levator surgery. At this point, the sutures are tied and the desmarres is removed and the lid is returned to the anatomical position. At this stage, traction on both sutures should cause traction on the skin of the anterior lid and the underlying Levator aponeurosis. Again, this is opposite to a Putterman procedure where the skin is pulled away to ensure there is no traction on the levator.

The lid is everted over the retractor again and while the surgeon and assistant place traction on the sutures a curved T-shaped clamp is applied (Fig. 2C) between the superior tarsal border and previously marked site 4.5–5 mm above. Again, this will show a line of traction on the anterior skin surface that demonstrates traction on the levator complex.

A 6/0 prolene suture on a reverse cutting needle is inserted at the previously marked lid crease externally and exits at the edge of the clamp. The suture is used in a running fashion below the clamp in 1.5 mm steps. It is important that the suture is placed flush with the clamp while there is no traction on the clamp. After suturing all the way across the tarsus, the suture exits from the conjunctiva to the second external lid crease mark.

A number 15 scalpel blade is used to resect the tissue below the clamp and above the running suture (Fig. 2D). It is critical that traction is applied at this step to ensure the suture is not cut. Pressure is then applied for 2 minutes with no cautery required.

The patients are seen at 10 days, and the suture is removed.

Other data points collected at the postoperative follow-up appointment included the complication profile of each eye, specifically of eye lagophthalmos, subjective and objective dryness, corneal abrasions, bleeding (requiring patching or active management) and infection (requiring oral antibiotics), and an overall assessment of cosmesis, including the brow position and eyelid contour. All eyes requiring revision procedures, either due to initial under or overcorrection, was also recorded.

Statistical Analysis

Basic descriptive statistics were used to assess the cohort using the Statistical Analysis Software version 9.3 (SAS Institute, Cary N.C.).

Ethics Approval

Ethics approval was obtained from the institutional review board. This study was performed according to the tenets of the declaration of Helsinki.

RESULTS

Patient Demographics

We identified a total of 303 eyes from 192 patients who underwent a CPLA procedure to at least 1 eye with severe upper eyelid ptosis, as defined by an MRD1 distance of 1.5 mm or less.

We found that this cohort had a mean age of approximately 65 years of age, and 52.7% of procedures were performed on female patients (159). In total, 47.4% of procedures were noted to be performed on the left eye (143), and 83 cases were unilateral.

At the preoperative assessment, we noted that of the 303 eyes, 98.7% had a positive phenylephrine response (299). The preoperative MRD1 had a mean of 0.3 mm, median of 0.5 mm, and range of 6.5 mm (from -5.0 mm to 1.5 mm).

Postoperative MRD1 and Cosmetic Outcome

At a mean follow-up of 6.1 months from the date of surgery, the postoperative MRD1 measurement had a mean

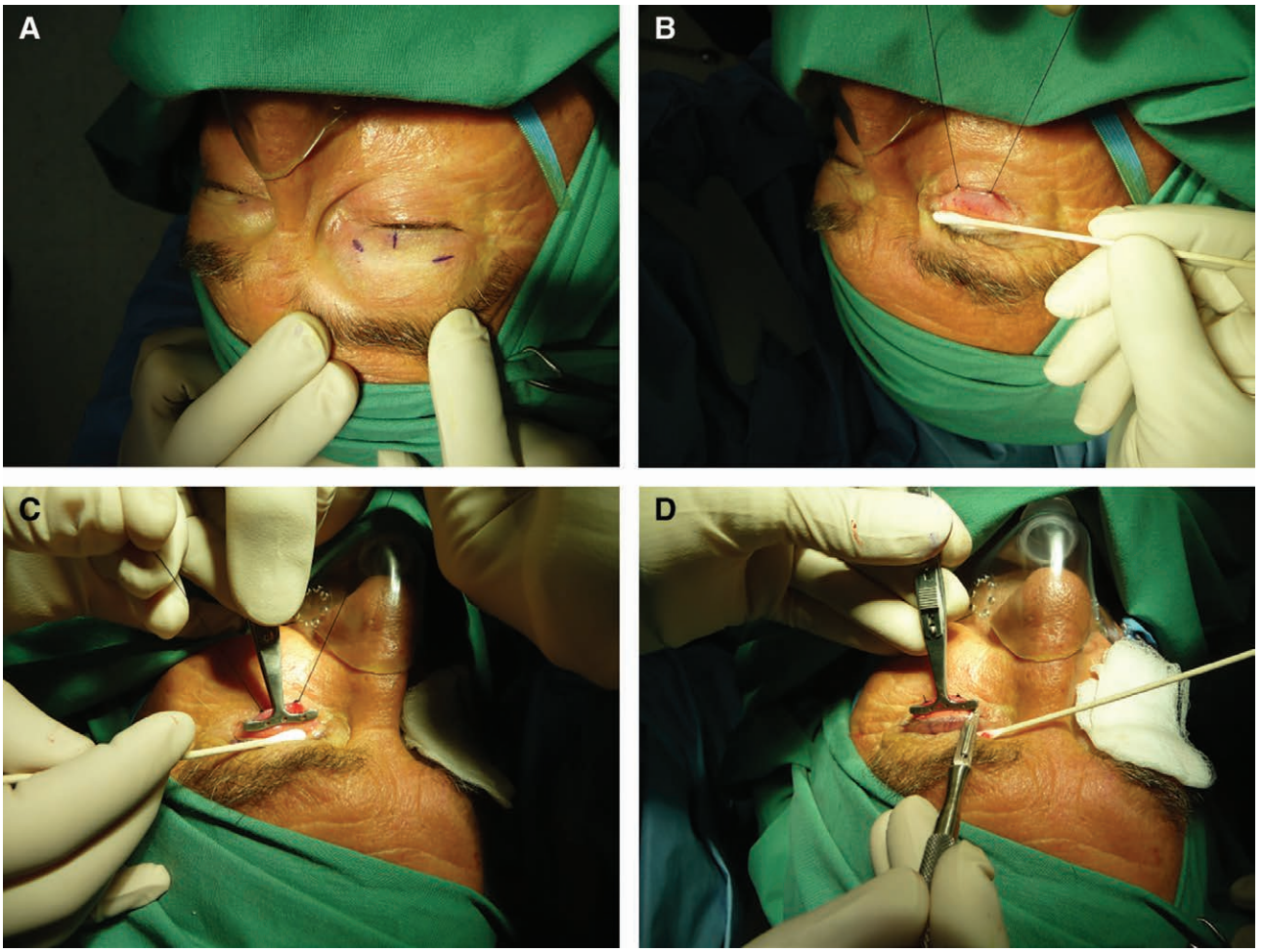


Fig. 2. A, Lid marked for pupil position and lid crease. B, Traction suture placed through conjunctiva and Müller's muscle to engage the levator palpebrae superioris. C, Curved T-shaped clamp is applied. D, Resection of conjunctiva and Müller's muscle contained within the clamp to advance the levator palpebrae superioris.

of 3.5 mm, median of 3.4 mm, and a range of 4.5 mm (1.1–5.6 mm). This represented a mean MRD1 improvement of 3.2 mm (median, 3.1 mm; range, 0.2–8.8 mm).

Intereye symmetry within 1 mm was found in 96% of patients (291 eyes).

Cosmesis and the contour of the upper lid were found to be normal in 98.3% of eyes (290/295). This was graded by the surgeon. Normal contour is defined when there is an absence of peaking, lateral flare, or flattening. No patient noted an abnormality of the contour themselves.

Demonstration of the outcome of CPLA is evident in Figures 3, 4.

Fig. 3. Before (A) and after (B). Closed posterior levator advancement.

Complication Profiles and Revision Rates

In total, 9.6% of patients (29 eyes) were noted to have had at least 1 complication by the latest follow-up review. Ten patients complained of subjective eye dryness (10, 3.3%) but had no signs of ocular surface epitheliopathy or increased use of lubricants. This was followed by eye lag-ophthalmos noted at 1-month follow-up but improving at 3-month follow-up (6, 2.0%), superficial redness and mild skin infection requiring antibiotics (4, 1.3%), and finally bleeding was described by the patient at the 1-month visit that required cold compresses to settle but no other active management (3, 1.0%). We also report no cases of corneal abrasions in our technique.

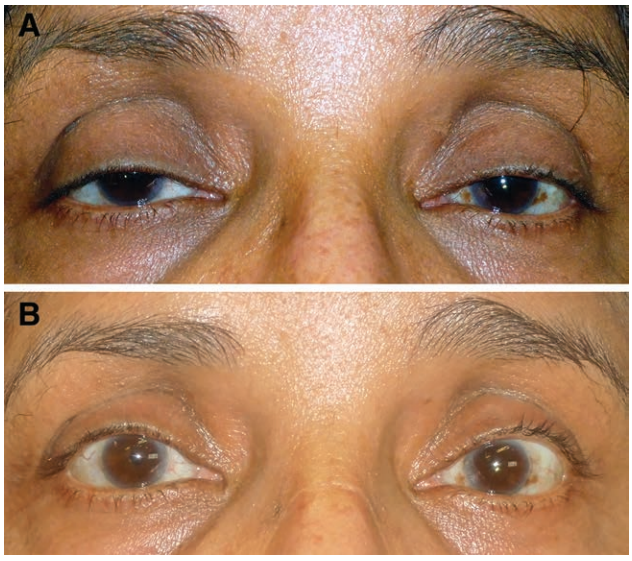


Fig. 4. Before (A) and after (B). Closed posterior levator advancement.

The overall revision rate was 1.8% (6 eyes), the majority due to initial undercorrection (95.4%, 21 eyes; Tables 1–3).

DISCUSSION

MMCR is a commonly used first-line treatment for mild-to-moderate ptosis with a functional levator muscle and response to phenylephrine.[15–19] Its traditionally described weakness is that it is not suitable for use in severe ptosis cases.

An original study of MMCR surgery by Putterman and Urist[2] reported a 94% success rate within 1 mm of desired height. In a subsequent 10-year analysis published by Putterman and Fett,[19] a 90% success rate within 1.5 mm was reported. Perry et al.[3] achieved an 87% success rate, whereas Guyuron and Davies[4] reported a success rate of 98% for MMCR surgery in patients with mild-to-moderate ptosis. In comparison, our CPLA technique achieved a 96% success rate of symmetry within 1 mm of the fellow eye but in patients with severe ptosis.

The results also compare favorably to studies of external levator surgery, the current favored technique for repair of severe ptosis. A large review of 828 patients by McCulley et al.[8] showed 77% of patients undergoing external levator surgery for varying degrees of ptosis achieved lid height within 1 mm of desired height. A reoperation rate of 8.7% was reported. Their mean preoperative MRD1 ranged from 1.0 to 1.1 mm, whereas our cohort had a mean MRD1 of 0.3 mm.

Simon et al.[6] retrospectively compared external levator surgery with an original MMCR showed similar results between the 2 cohorts with a mean MRD1 increase of 1.6 mm. The cohort undergoing external levator surgery had more severe ptosis with an average MRD1 of 0.5 mm preoperatively, improving to 2.0 mm postoperatively with a revision rate of 1.8%.

Table 1. Demographic Data on the Cohort

Demographic Variable	
Total number of eyes	303
Total number of patients	192
Average age (y) (range)	65 (7–90)
Female sex, n (%)	159 (52.7)
Left eye operations, n (%)	143 (47.4)
Unilateral operations, n (%)	81 (26.7)

Table 2. Preoperative Assessment of the Cohort

Assessment Criteria Number, (%)	
Phenylephrine response	
Positive	299 (98.7)
Nil response	4 (1.3)
Degree of response	
Poor response (minimal effect)	15 (5.0)
Mild response (only 1–2 mm response)	22 (7.3)
Moderate response (to slight undercorrection 1 mm)	133 (42.9)
Good response (correct lid height achieved)	92 (30.5)
Very good response (overcorrected)	41 (13.6)
Preoperative MRD1 score	
Mean MRD1 score (mm)	0.3 (range, -5.0 to 1.5)

Table 3. Complication Profile on the Cohort

Complication Number, (%)	
Corneal abrasion	0 (0.0)
Subjective dry eye	10 (3.3)
Secondary hemorrhage	3 (1.0)
Infection	4 (1.3)
Lagophthalmos	6 (2.0)
Revision procedure performed	6 (1.8)
For initial undercorrection	5 (83.3)
For initial overcorrection	1 (16.7)

The relatively high rate of revision surgery and contour irregularities seen with anterior ptosis surgery approach encouraged us to investigate whether a posterior approach could be devised that was useful in severe ptosis but had the major benefit of a decreased risk of eyelid contour irregularity and a lower revision rate. Both of these attributes are critical to managing patient expecations especially in younger patients. The approach we devised that we term CPLA has similarities with the "white line" advancement described by Malhotra/patel but has the advantage of being a closed procedure. Lake et al.[5] also described an open approach to the levator from the posterior lid aspect.

Our cohort had a lower preoperative MRD1 of 0.3 mm corrected to 3.5 mm; furthermore, our revision rate was only 1.8%. This depicts a favorable outcome with our CPLA technique. Perhaps the greatest test of whether ptosis surgery is successful or not is if it needs to be revised. This study shows CPLA is a viable treatment option for severe ptosis with similar characteristics. Our cohort had a mean preoperative MRD1 of 0.3 mm and a mean postoperative MRD1 of 3.5 mm. This translates to a 3.22 mm average increase in the MRD1.

Our technique is comparable with the recent study by Patel et al.,[13] who used the original MCR ± tarsectomy for 100 eye-

lids with severe ptosis. They had a mean preoperative MRD1 of -0.65 mm and a mean postoperative value of 3.00 mm. Patel et al.[13] did not exclude any patients who had other concurrent procedures while all our 303 cases had the CPLA and no toher confounding procedures. The critical difference lies in our technique. CPLA involves engaging the underside of the levator with the traction suture, which we believe is the essential step in increasing the success of the operation and its predictability. The amount of levator advancement can be titrated preoperatively using several variables including LPS function, severity of ptosis, graded response to 10% phenylephrine, and patient eyelid height preference.

The most common complication in our cohort was subjective dry eye (3.3%). Dry eye may be exacerbated by ptosis repair due to increased tear evaporation secondary to a widened palpebral fissure. Preoperative assessment of dry eye symptoms is required, especially in repair of severe ptosis, where widening of the palpebral fissure is greatest.

It has also been postulated that tear production may be affected due to damage and removal of conjunctival goblet cells and accessory lacrimal glands. However, the incidence of dry eye appears minimal in many studies of MMCR surgery. Dailey et al.[20] reported no effect on tear production (Schirmer's test) after MMCR, with subjective dry eye symptoms only transiently increased in the immediate postoperative period.

It is important to note that none of the patients in the study group reported worsening of any dry eye symptoms after the surgery.

The chief modifications in the current author technique that allow the correction of moderate and severe ptosis relate to the placement of the traction sutures through the levator from the posterior aspect in a closed approach. Ensuring inclusion of some LPS fibers in the resection and suturing in 2 mm steps helps improve the power of the posterior approach surgery.

While no cases of corneal abrasion occurred, the reported incidence of postoperative corneal abrasion with MMCR surgery appears low (< 2%) and easily treatable. With CPLA, all eye lid contours were deemed satisfactory, which is an advantage over external levator surgery where eyelid contour abnormalities such as the presence of a peaked contour postoperatively.[21] All 6 cases of lagophthalmos spontaneously resolved by the 3-week follow-up and were treated conservatively with lubricating eyedrops until further review.

The limitations in our study include its retrospective design, without a masked observer; however, all procedures were performed by a single surgeon (A.T.). In the future, there may be benefits from having a prospective randomized control trial comparing our CPLA with external levator surgery in patients with severe ptosis.

CPLA is an effective and safe surgery for the repair of severe ptosis. Preoperative testing with phenylephrine can guide the amount of levator palpebrae superioris advancement required in PCLA using a unique and surgeon-specific nomogram. CPLA for severe ptosis appears comparable to external levator surgery. It has the advantages of high success with low revision rates, shorter operation times, improved cosmesis, and minimal incidence of postoperative complications.

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