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Contour Symmetry of the Upper Eyelid Following Bilateral Conjunctival-Müller's Muscle Resection

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Abstract

Background: Conjunctiva-Müller muscle resection (CMMR) is a simple, effective, and predictable procedure for internal treatment of ptosis.

Objectives: The authors determined contour symmetry of the upper eyelid following bilateral CMMR.

Methods: Thirty control participants (ie, without ptosis) and 44 patients with acquired bilateral blepharoptosis who underwent CMMR were evaluated in a prospective study. To assess symmetry of lid contour, distances from midpupil to the upper eyelid (ie, MPLDs) were determined radially at intervals of 15° (total, 180°) along the palpebral fissure, and MPLDs at each angle were compared for right and left eyes.

Results: For control participants, the mean marginal reflex distance (MRD_1; ie, MPLD at 90°) ± standard error (SE) was 4.05 mm ± 0.75 mm, and small contour asymmetries (<10%) were measured for all angles. Medial (9.4% ± 4.7%) and lateral (8.1% ± 4.9 %) asymmetries were not significantly different for these participants. For patients with ptosis, the mean preoperative MRD_1 was 2.56 ± 0.1 mm, and mean medial and lateral lid asymmetries (14.3% ± 8.4% and 16.7% ± 9.7%, respectively) were significantly higher than those of controls. Medial and lateral asymmetries correlated significantly with the extent of ptosis and were more pronounced laterally than medially. One month after CMMR, the lateral-medial discrepancy in lid asymmetry was resolved, and mean medial and lateral MPLDs (9.9% ± 7.5% and 8.5% ± 5.3%, respectively) were similar to those of controls.

Conclusions: For patients with involutional ptosis, CMMR enables elevation of the lid margin and correction of contour anomalies.

Level of Evidence: 2

Therapeutic

Editorial Decision date: November 11, 2016.

Resection of conjunctiva and Müller's muscle through a posterior approach (CMMR) has become popular among oculoplastic surgeons for treatment of mild involutional ptosis.[1,2] There is consensus that CMMR is fast, simple, and predictable, whether the traditional closed technique[3-5] or the open-sky variant is performed; the latter enables direct visualization of Müller's muscle.[6-8] Moreover, CMMR does not require intraoperative adjustments.[3] Attaining symmetric eyelid contour is essential for satisfactory treatment of bilateral or unilateral ptosis. However, most proponents of CMMR regard changes in the marginal reflex distance (MRD_1) as the only criterion of success.[9-12] To test the assumption that CMMR consistently yields symmetric eyelid contour, we measured

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pre- and postoperative distances from the midpupil to the upper lid (MPLDs) for patients with involutional ptosis who underwent bilateral CMMR.

METHODS

Study Design

Thirty participants without ptosis (ie, control group) and 44 consecutive patients who underwent CMMR for bilateral involutional ptosis from January 2015 to November 2015 were evaluated in a prospective study. The study was approved by the Research Ethics Committee of the School of Medicine at the Hospital das Clínicas de Ribeirão Preto (São Paulo, Brazil). Exclusion criteria for the control group were any pathologies or surgeries that affected eyelid shape or function. Control participants were colleagues of the authors or hospital employees who agreed to be photographed. Included in the patient group were individuals with bilateral ptosis of at least 1 lid with an MRD1 <3.0 mm. All patients underwent CMMR; most patients (42 of 44; 95.5%) also received blepharoplasty of the upper eyelid.

All individuals were photographed in the primary gaze position to obtain images of the palpebral fissure. Care was taken to avoid chin elevation, which is common among patients with ptosis. Patient photographs were obtained preoperatively and 1 month postoperatively.

Surgical Procedures

Patients underwent CMMR by means of the closed technique, described by Putterman[13] and by Putterman and Urist[14] and modified by others.[3,5] Briefly, 1 to 2 mL of 2% lidocaine with epinephrine (1:100,000) was injected transcutaneously in the midpoint of the pretarsal portion of the lid to anesthetize the lid margin. A 4-0 silk suture was placed in the central portion of the lid margin to assist lid eversion over a Desmarres (Desmarres lid retractor—size 0, Storz Ophthalmics, St. Louis, MO) retractor. Subsequently, 0.5 to 1 mL of the same anesthetic solution was injected transconjunctivally, superior to the upper border of the tarsal plate.[3,5] The desired amount of resection (usually 8 mm) was marked and grasped with a Putterman ptosis clamp (Putterman Mullers muscle-conjunctival resection ptosis clamp, Storz Ophthalmics, St. Louis, MO). The Desmarres retractor was removed, and the clamp was elevated, allowing for placement of a double-armed 6-0 polyglactin 910 sutures (Vicryl; Ethicon, Inc, Somerville, NJ) suture in running horizontal mattress fashion in the lateral-to-medial direction and then in the medial-to-lateral direction. Grasped tissue then was resected with a no. 15 blade. After surgery patients used lubricants and antibiotics eyedrops 4 times per day for 1 week.

Analysis of Lid Contour

Patient and control photographs were evaluated for asymmetry of upper-lid contour. Images were manually reviewed to ensure that horizontal head tilt had been avoided. Subsequently, ImageJ software (National Institutes of Health, Bethesda, MD) was applied to align medial canthi, thereby correcting any left or right head tilt. Contours of the upper lid were analyzed from aligned images by custom software developed by 1 of the authors (D.M.G.), in C# (Microsoft, Redmond, WA), which was described previously.[15] The pupil center was identified manually, and a vertical line, denoting the central MPLD, was set by the program. This line was equivalent to MRD_1, which typically is measured clinically with a millimeter ruler. In addition, the software drew 12 oblique MPLDs at intervals of 15° medially (75°, 60°, 45°, 30°, 15°, 0°) and laterally (105°, 120°, 135°, 150°, 165°, 180°) from MRD_1 along the palpebral fissure (Figure 1).[15] Next, the intersections of the radial lines were marked manually on the eyelid margin. No image showed severe dermatochalasis, which would have prevented clear visualization of the lid margin. The extent of contour asymmetry was computed as the difference in same-angle MPLDs for the right and left eyes (higher value minus lower value) divided by the higher value and expressed as a percentage (ie, multiplied by 100).

Statistical Analysis

Statistical analyses were performed with JMP SAS 10.0 software (SAS Institute, Cary, NC). Data were reported as mean ± standard error (SE) or with the 95% confidence interval. Between-group differences in MRD_1 were ascertained with paired (pre- vs postoperative) and independent

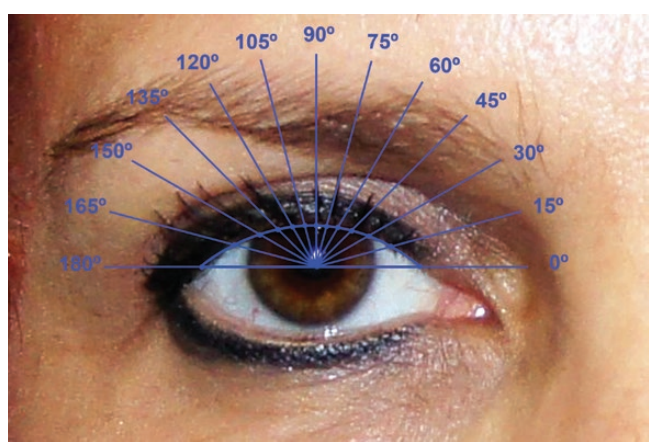

Figure 1. Representative photograph of a 46-year-old woman from the control group, showing computer-generated midpupil-to-lid lines spaced at 15° intervals.

(controls vs patients) t tests. Graphs were generated with Origin Pro 9.0 software (OriginLab, Northampton, MA).

RESULTS

The control group comprised 23 women and 7 men; their mean age was 55.2 years (standard deviation [SD], 8.8 years; range, 42-74 years). The patient group included 37 women and 7 men; mean age was 59.9 years (SD, 7.8 years; range, 44-74 years).

Table 1 summarizes mean (95% confidence interval) MPLDs measured radially along the palpebral fissure for control participants and for patients before and after CMMR. For control participants, the mean MRD_1 was 4.05 mm ± 0.75 mm, and small asymmetries in MPLDs (0.62 mm; 5.7% ± 1.5% at 180° to 0.41 mm; 9.8% ± 6.0% at 90°) were detected for all angles along the palpebral fissure. Mean asymmetries for medial MPLDs (0.56 mm; 9.4% ± 4.7%) and lateral MPLDs (0.50 mm; 8.1% ± 4.9%) were similar (t = 0.169).

Preoperatively, mean MPLDs were more asymmetric for patients than for controls along the medial (14.3% ± 8.4%, t = 3.18; P = .0022) and lateral (16.7% ± 9.7%, t = 5.00; P < .0001) aspects of the lid. The extents of lateral and medial MPLD asymmetries correlated linearly with the degree of ptosis asymmetry (lateral, r = 0.78, P < .0001; medial, r = 0.86, P < .0001) (Figure 2). Moreover, the extents of MPLD asymmetry along the lateral and medial portions of the lid were significantly different, with more pronounced asymmetry noted laterally (lateral, 16.7% ± 9.7%; medial, 14.3% ± 8.4%; P = .049) (Figure 3).

Postoperatively, contour asymmetries for patient eyelids were indistinguishable from those of controls (Figure 3). The mean patient MRD_1 increased from 2.56 ± 0.1 mm preoperatively (right eye, 2.6 mm; left eye, 2.5 mm) to 3.8 ± 0.1 mm postoperatively (t = 18.3; P < .0001). The mean postoperative MRD_1 for patients did not differ from that of controls (t = 1.78; P = .0813. Differences in asymmetry along the lateral and medial aspects of the lid, observed preoperatively, were nullified after CMMR. Moreover, mean postoperative lateral and medial asymmetries were similar to those of controls (lateral, 8.5% ± 5.3%, t = 0.375, P = .709; medial, 9.9% ± 7.5%, t = 0.386,P = .703).Representative clinical photographs depicting the effects of CMMR on lid contour are presented in Figures 4-6.

DISCUSSION

The contour line of the upper eyelid can be fitted to a second-degree polynomial function.[16] The shape of this line is determined by the resting position of the upper lid on the globe of the eye, which is approximately spherical.[17]

Table 1. Right/Left Asymmetries of Eyelid Contour

Angle	Control group (N = 30)			Patient group, preoperatively (N = 44)			Patient group, postoperatively (N = 44)		
	Right-eye MPLD, mm	Left-eye MPLD, mm	Difference, %	Right-eye MPLD, mm	Left-eye MPLD, mm	Difference, %	Right-eye MPLD, mm	Left-eye MPLD, mm	Difference, %
0°	8.7 (8.3; 9.1)	8.8 (8.3; 9.3)	8.9 (6.8; 11.0)	7.1 (6.7; 7.5)	7.3 (6.9; 7.7)	5.9 (3.4; 8.4)	8.2 (7.9; 8.5)	8.4 (8.1; 8.7)	7.8 (5.8; 9.8)
15°	6.7 (6.4; 7.0)	6.8 (6.5; 7.1)	9.3 (7.3; 11.3)	5.1 (4.8; 5.4)	5.1 (4.8; 5.4)	10.3 (7.5; 13.1)	6.4 (6.1; 6.7)	6.6 (6.3; 6.9)	9.7 (7.3; 12.1)
30°	5.5 (5.2; 5.8)	5.4 (5.1; 5.7)	9.4 (7.4; 11.4)	3.9 (3.6; 4.2)	3.9 (3.7; 4.1)	12.8 (9.5; 16.1)	5.3 (5.0; 5.6)	5.3 (5.0; 5.6)	10.6 (8.0; 13.2)
45°	4.7 (4.4; 5.0)	4.7 (4.4; 5.0)	9.8 (7.7; 11.9)	3.2 (3.0; 3.4)	3.2 (3.0; 3.4)	14.5 (11.5; 17.5)	4.5 (4.3; 4.7)	4.5 (4.3; 4.7)	10.2 (7.5; 12.9)
60°	4.3 (4.0; 4.6)	4.3 (4.0; 4.6)	9.3 (7.0; 11.6)	2.8 (2.6; 3.0)	2.8 (2.6; 3.0)	15.9 (12.8; 19.0)	4.1 (3.9; 4.3)	4.1 (3.9; 4.3)	10.0 (7.4; 12.6)
75°	4.1 (3.8; 4.4)	4.1 (3.8; 4.4)	9.6 (7.0; 12.2)	2.6 (2.4; 2.8)	2.6 (2.4; 2.8)	15.8 (12.6; 19.0)	3.9 (3.7; 4.1)	3.9 (3.7; 4.1)	11.2 (8.9; 13.5)
90°	4.1 (3.8; 4.4)	4.0 (3.7; 4.3)	9.8 (7.6; 12.0)	2.6 (2.4; 2.8)	2.5 (2.3; 2.7)	16.2 (12.9; 19.5)	3.8 (3.6; 4.0)	3.8 (3.6; 4.0)	9.8 (7.7; 11.9)
105°	4.2 (3.9; 4.5)	4.2 (3.9; 4.5)	9.3 (6.9; 11.7)	2.7 (2.5; 2.9)	2.6 (2.4; 2.8)	17.3 (14.1; 20.5)	4.0 (3.8; 4.2)	4.0 (3.8; 4.2)	10.1 (8.0; 12.2)
120°	4.6 (4.3; 4.9)	4.5 (4.2; 4.8)	9.1 (6.6; 11.6)	3.0 (2.8; 3.2)	2.9 (2.7; 3.1)	17.5 (14.1; 20.9)	4.4 (4.2; 4.6)	4.3 (4.1; 4.5)	9.2 (7.1; 11.3)
135°	5.3 (4.9; 5.7)	5.1 (4.7; 5.4)	8.9 (6.7; 11.1)	3.5 (3.3; 3.7)	3.3 (3.1; 3.5)	18.0 (14.8; 21.2)	5.0 (4.8; 5.2)	5.0 (4.7; 5.3)	9.3 (7.3; 11.3)
150°	6.4 (5.9; 6.9)	6.3 (5.9; 6.7)	8.3 (6.0; 10.6)	4.3 (4.0; 4.6)	4.2 (4.0; 4.4)	18.6 (15.1; 22.1)	6.1 (5.8; 6.4)	6.1 (5.8; 6.4)	8.8 (6.7; 10.9)
165°	8.1 (7.6; 8.6)	8.0 (7.5; 8.5)	7.2 (5.2; 9.2)	6.0 (5.6; 6.4)	5.6 (5.3; 5.9)	16.8 (12.7; 20.9)	7.8 (7.5; 8.1)	7.7 (7.4; 8.0)	7.9 (6.1; 9.7)
180°	10.7 (10.2; 11.2)	10.5 (10.0; 11.0)	5.7 (4.2; 7.2)	9.1 (8.8; 9.4)	8.8 (8.4; 9.2)	17.9 (15.2; 20.6)	10.3 (10.0; 10.6)	8.4 (8.1; 8.7)	7.8 (6.3; 9.3)

Data are represented as mean (95% confidence interval). MPLDs were measured at intervals of 15° along the palpebral fissure. MPLD, distance from midpupil to the upper eyelid.

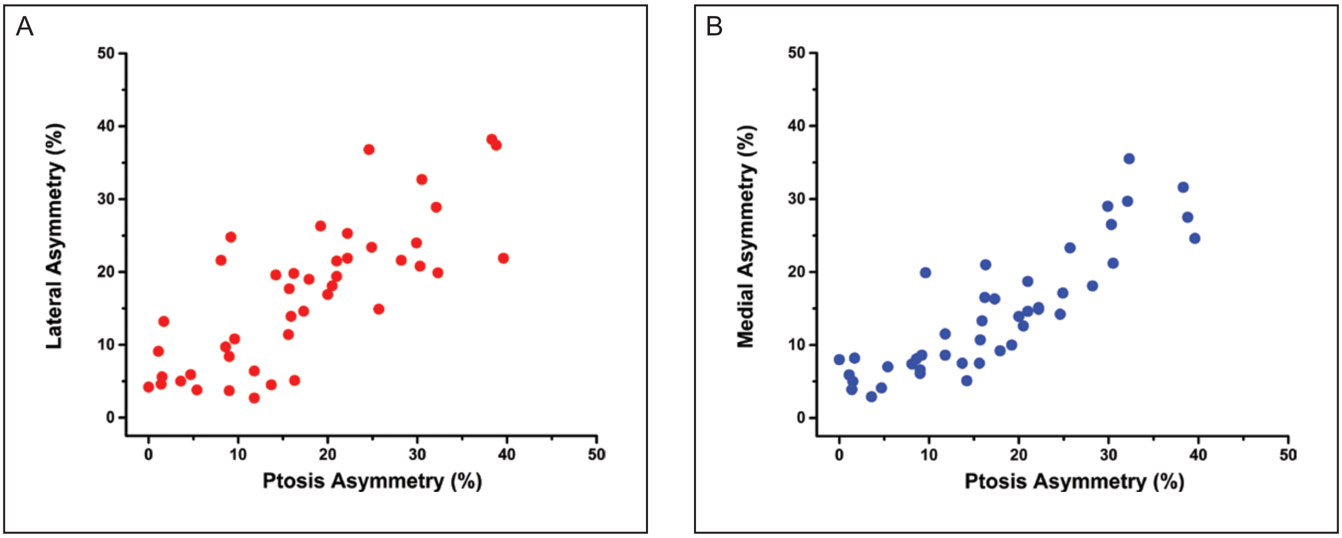

Figure 2. Linear correlations between ptosis asymmetry and contour asymmetry, in terms of radial midpupil-lid distances (MPLDs) for the (A) lateral and (B) medial portions of the lid. Each data point represents preoperative values for a patient with bilateral ptosis. Contour asymmetry was computed as the difference in same-angle MPLDs for the right and left eyes (higher value minus lower value) divided by the higher value and expressed as a percentage (ie, multiplied by 100).

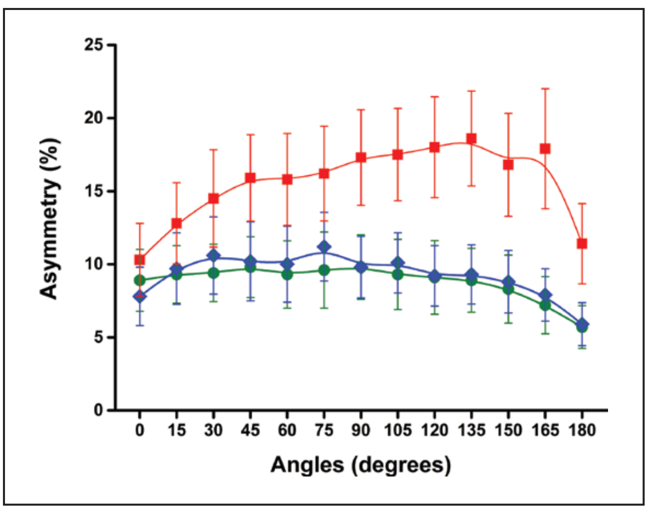

Figure 3. Lid contour asymmetries for both study groups before and after conjunctiva-Müller muscle resection (CMMR). Each error bar indicates the 95% confidence interval of the mean. Pronounced lateral asymmetry of lid contour among patients resolved after correction of ptosis with CMMR. Green circles, control group; red squares, preoperative patient group; blue diamonds, patient group after CMMR. Postoperative images were obtained 1 month after CMMR.

The contour of the ptotic lid tends to be flattened and may be deformed, especially laterally.[18] Therefore, the aim of ptosis surgery is to create or maintain a smooth, curved contour in addition to lifting the lid.

Abnormalities of lid contour are common complications of ptosis surgery. Before image processing, postoperative contour deformities were described only pictorially, with accompanying terms such as Gothic arch, peak, and notch.[19-22] Even with computerized image processing, the quantification and precise localization of contour abnormalities remain challenging because these deformities are variable and do not follow amathematic pattern.[15]

Herein, we described a straightforward method of analyzing lid contour for patients with ptosis. Other investigators have measured radially distributed MPLDs to assess contour changes that occur with aging[23] and thyroid eye disease.[24] Choudhary et al[25] measured pre- and postoperative MPLDs for 20 patients who underwent unilateral CMMR with or without tarsectomy. These authors expressed their results as ratios of oblique MPLD pairs reflected on either side of MRD_1 (ie, 105°/75°, 120°/60°, 135°/45°, 150°/30°,165°/15°, 180°/0°) for operated (ptotic) and nonoperated (nonptotic) eyes.[25] They concluded that CMMR restored lid contour because the operated and fellow eyes had similar ratios postoperatively.[25] We suggest that symmetry of lid contour cannot be analyzed adequately in terms of MPLD-pair ratios because similar ratios could be computed from different MPLD values. We found that contour asymmetries correlated linearly with the degree of ptosis and were more pronounced laterally than medially. We also demonstrated that in bilateral ptosis, CMMR eliminates preoperative contour deformities.

Although intraoperative adjustment is not possible with CMMR, this procedure reliably yields a symmetric lid shape. We suggest that the excellent outcomes associated with CMMR can be attributed to physiologic, anatomic, and procedural factors. CMMR appears to advance the levator aponeurosis indirectly,[1] and this advancement does not correlate with the amount of Müller's muscle resected.[11] In

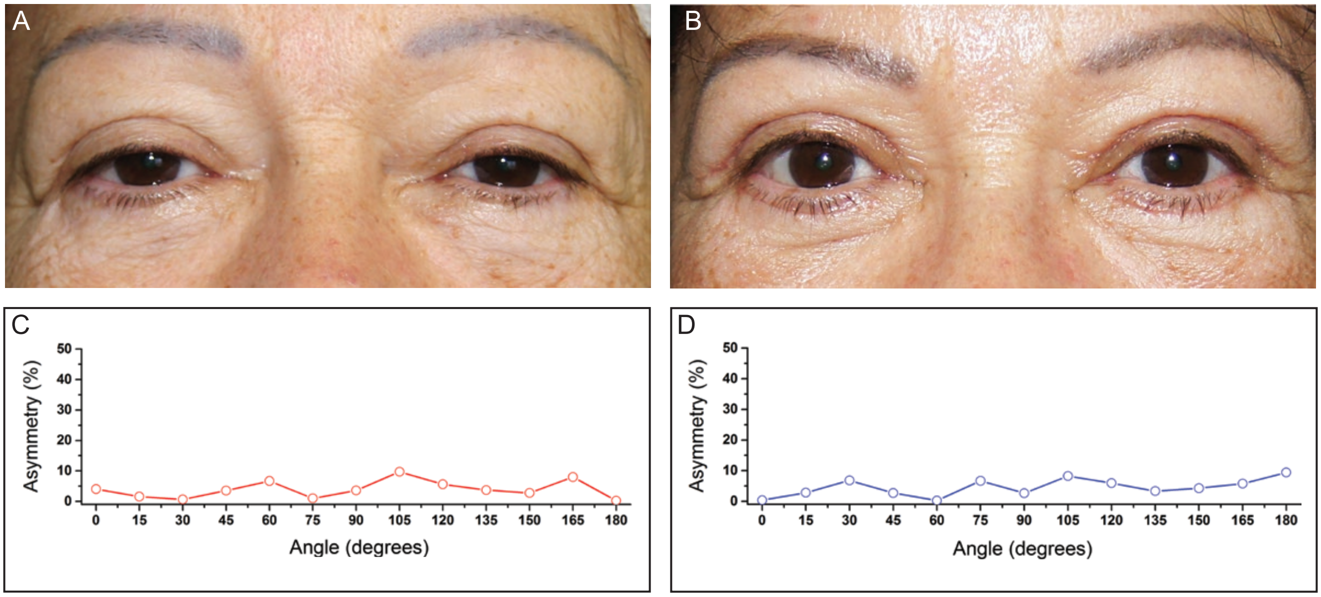

Figure 4. (A) Preoperative view of a 68-year-old woman with nearly symmetric ptosis. (B) One month after CMMR, ptosis had been mitigated. Contour asymmetries (C) preoperatively and (D) 1-month postoperatively also are depicted graphically, confirming that no contour deformity was induced by CMMR.

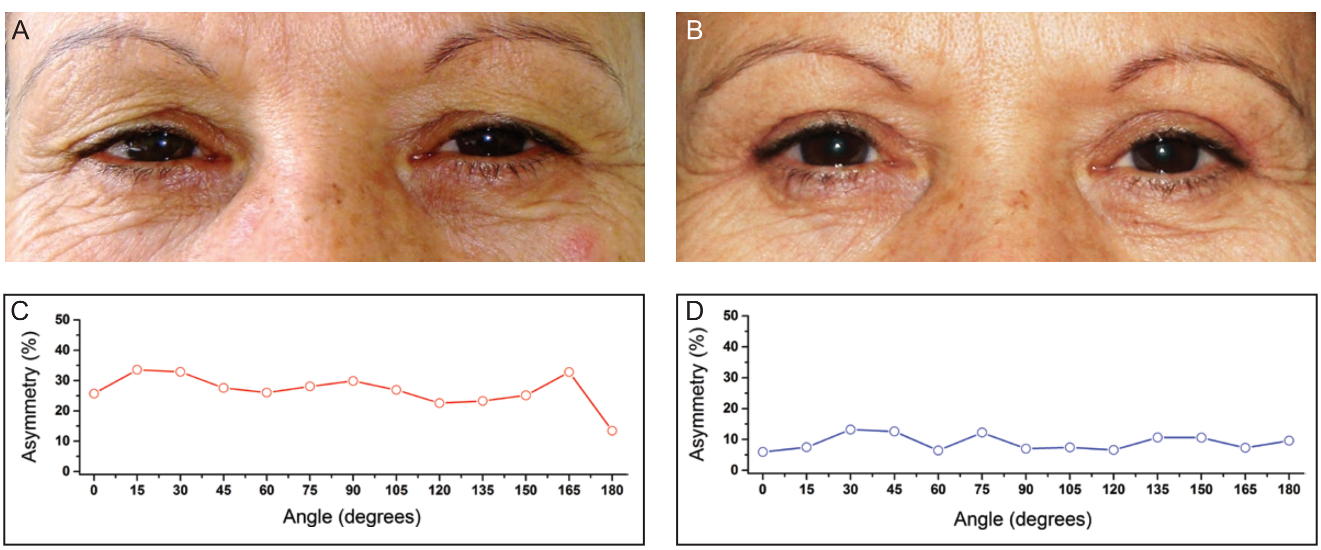

Figure 5. (A) Preoperative view of a 58-year-old woman with asymmetric ptosis medially and laterally. (B) One month after CMMR, no contour abnormality was present. Contour asymmetries (C) preoperatively and (D) 1-month postoperatively also are depicted graphically. Note the association between treatment of ptosis and resolution of lid contour asymmetry.

a cadaver study, Marcet et al[26] found that CMMR resulted in advancement of the levator aponeurosis and its plication to the superior tarsal border. We did not perform histologic analyses in the current study, so we cannot verify whether the lifting effect of CMMR correlate with the amount of Müller's muscle removed. Nevertheless, Müller's muscle is regarded as a strong transmitter of tension on the tarsal plate;[27] therefore, it is conceivable that scarring the posterior lamella of the lid would produce lid elevation. The results of anatomic and surgical studies indicate that Müller's muscle originates from the underside of the levator muscle, approximately 8 mm from the upper border of the tarsal plate.[28,29]

Nonadjustable levator plication alone would not be expected to produce a smooth lid contour. Unlike the anterior approach, which contours the lid by means of 1 or 3 stiches, CMMR routinely is closed with a running suture. We posit that the running suture places curvilinear tension on the levator aponeurosis, thereby correcting the shape of the lid margin. The shape of tissue resection also

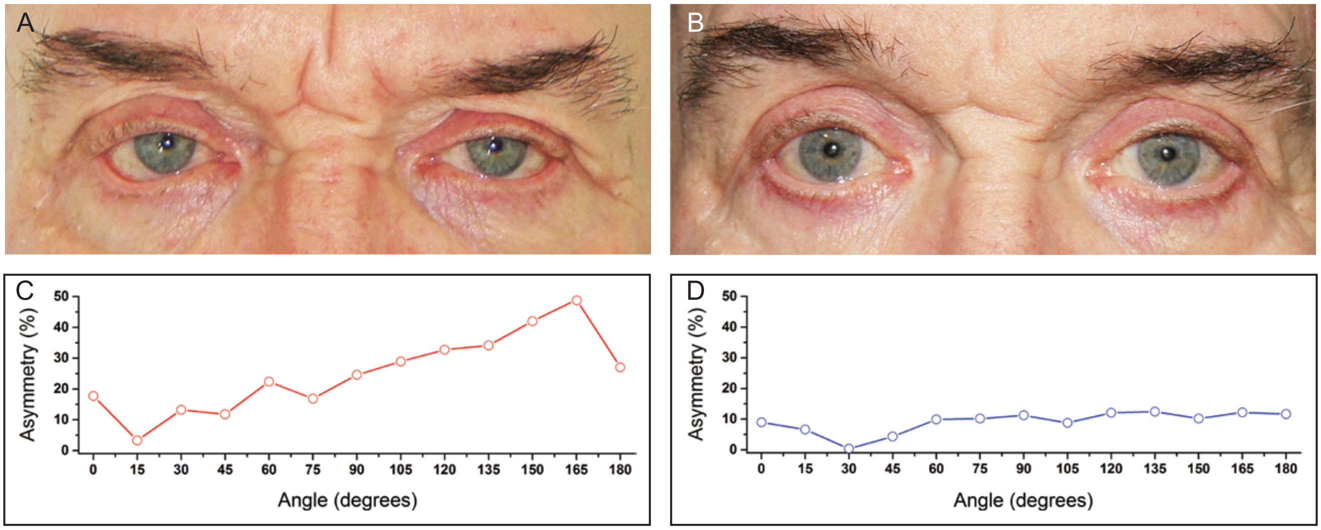

Figure 6. (A) Preoperative view of a 74-year-old man with lateral asymmetric ptosis. (B) One month after CMMR, the lateral deformity was not present. Contour asymmetries (C) preoperatively and (D) 1-month postoperatively also are depicted graphically.

may contribute to smooth lid contour. The resection shape is determined by the method of grasping the posterior lamella. The design of the popular Putterman[30] clamp was influenced by results from the Fasanella-Servat procedure with 2 curved hemostats, in which patients experienced a centrally peaked eyelid contour. Putterman[30] attributed this contour abnormality to excessive resection of the central portion of the lid. To our knowledge, no study has entailed comparing the lid contour achieved by different instruments after excision of the posterior lamella. Our data indicate that uniform excision of tissue along the entire lid, as advocated by Putterman,[30] yields excellent contour symmetry.

To our knowledge, this study is the first to confirm mathematically that CMMR can produce symmetric contour for the right and left eyelids. Although the study is limited to 1 surgeon's experience with CMMR, the procedures were performed in a consistent manner. A study in which postoperative lid contours are compared among several centers may be warranted, especially because CMMR can be performed as a closed or open technique and may result in different overall lid shapes.

CONCLUSIONS

For patients with involutional ptosis, CMMR not only elevates the lid margin but also normalizes preoperative contour anomalies.

Disclosures

The authors declared no potential conflicts of interest with respect to the research, authorship, and publication of this article.

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