

Outcomes After Müller Muscle Conjunctival Resection Versus External Levator Advancement in Severe Involutional Blepharoptosis



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- **PURPOSE:** To compare outcomes between Müller muscle conjunctival resection (MMCR) ptosis repair and external levator resection (ELR) in patients with severe involutional blepharoptosis.
- **DESIGN:** Retrospective, interventional, comparative case series.
- **METHODS:** A retrospective review was performed of patients who underwent ptosis repair between 2012 and 2019. Inclusion criteria were patients who underwent MMCR or ELR ptosis repair, patients with complete documentation of preoperative eyelid measurements, and patients with documentation of postoperative outcome. The main outcome measure was surgical failure, defined as patient-reported or physician-reported dissatisfaction with postoperative eyelid height or postoperative upper margin reflex distance (MRD1) of less than 2 mm. Severe ptosis was described as an MRD1 of 0 or worse. Outcome analysis was also performed after stratification for concomitant blepharoplasty performed at the time of ptosis repair.
- **RESULTS:** A total of 231 patients (372 eyelids) met the study criteria, of which 142 eyelids had severe ptosis. Comparing outcomes of MMCR vs ELR in patients with severe ptosis, there was a statistically significant higher rate of success after MMCR ($P = .0143$). The rate of ptosis repair success in eyelids that underwent MMCR was 97.2% and 90.9% in patients with severe ptosis and mild/moderate ptosis, respectively ($P = .42$). In eyelids that underwent ELR, the rate of ptosis repair success was 77.4% and 85% in eyelids with severe ptosis and mild/moderate ptosis, respectively ($P = .15$). Concomitant blepharoplasty did not affect ptosis repair outcomes in any group.
- **CONCLUSIONS:** MMCR ptosis repair is an effective approach in treating patients with severe ptosis, and it may offer superior outcomes to ELR. In patients with good responses to phenylephrine, MMCR may offer an efficient and highly efficacious surgery regardless of

presenting MRD1. (Am J Ophthalmol 2020;217:182–188. © 2020 Elsevier Inc. All rights reserved.)

MÜLLER MUSCLE CONJUNCTIVAL RESECTION (MMCR) ptosis repair is an effective procedure, introduced in the 1970s. The patient population classically deemed to be good candidates for MMCR are those with mild-to-moderate ptosis with good levator function and a favorable response to phenylephrine topical drops.^{1,2} At present, MMCR is not widely accepted as an appropriate treatment for severe ptosis, as defined as an upper eyelid margin reflex distance (MRD1) of 0 or less.^{3–5} The dismissal of MMCR in this setting may stem from previously published guidelines reporting on suggested nomograms for length of resected Müller muscle/conjunctiva and millimeters of resultant eyelid lift.² Several authors have reported evidence for the limitations of such nomograms.^{6,7} Such discrepancy in outcomes of lid lift based on algorithms raises interest in the upper limits of lid lift with MMCR ptosis repair, such as in the setting of severe ptosis.

The purpose of this study is to compare outcomes of patients with severe ptosis who underwent MMCR vs external levator resection (ELR) ptosis repair. Additionally, this study seeks to report on the outcomes of MMCR ptosis repair in patients with severe ptosis compared to patients with mild or moderate ptosis.

METHODS

APPROVAL WAS GRANTED PRIOR TO INITIATING PATIENT data collection from the Baylor College of Medicine Institutional Review Board. A retrospective chart review was performed of all patients who underwent ptosis repair between 2012 and 2019 by 4 surgeons at a tertiary referral center.

Inclusion criteria were patients who underwent MMCR or ELR ptosis repair, patients with complete documentation of preoperative eyelid measurements, and patients with documentation of postoperative outcome. Patients were excluded if they were less than 18 years of age, had a diagnosis other than involutional ptosis, underwent

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TABLE 1. Patient Demographics

	Total	MMCR	ELR	P
Number of patients (eyelids)	231 (372)	73 (102)	158 (270)	
Mean age (years) (range)	69.5 (19 to 91)	69.1 (19 to 91)	69.7 (25 to 88)	.62
Sex (F/M)	251/121	92/10	159/111	<.01
Preoperative MRD1 (mm) (SD; range)	0.56 (0.84; -3 to 3)	0.63 (0.79; -1 to 2)	0.53 (0.86; -3 to 3)	.29
Preoperative levator function (mm)	10.35 (1.40; 6 to 15)	10.4 (1.29; 6 to 16)	10.3 (1.64; 6 to 18)	.70
Length of tissue taken (mm) (SD; range)		9.13 (1.08; 6 to 11)		
Previous intraocular surgery	184 (49%)	53 (52%)	131 (49%)	.56
Concomitant blepharoplasty	70 (19%)	4 (4%)	66 (24%)	<.01
Postoperative follow-up time (months) (SD; range)	10.5 (12.51; 3 to 74)	9.4 (13.4; 3 to 74)	11.0 (12.1; 3 to 67)	.28

ELR = external levator resection; MMCR = Müller muscle conjunctival resection; MRD1 = upper margin reflex distance.

TABLE 2. Demographics of Patients With Severe Ptosis

	Total	MMCR	ELR	P
Number of eyelids	142	36 (25%)	106 (75%)	
Mean age (years) (range)	70.2 (25 to 91)	70.6 (43 to 91)	70.0 (25 to 88)	.82
Sex (F/M)	92/50	32/4	60/46	<.01
Preoperative MRD1 (mm) (SD; range)	-0.23 (0.58; -3 to 0)	-0.11 (0.32; -1 to 0)	-0.28 (0.64; -3 to 0)	.14
Preoperative levator function (mm) (SD; range)	10.0 (1.53; 6 to 16)	10.0 (1.97; 6 to 16)	10.0 (1.36; 6 to 15)	.89
Previous intraocular surgery	76 (54%)	19 (53%)	57 (54%)	1.00
Concomitant blepharoplasty	22 (15%)	0 (0%)	22 (21%)	<.01
Postoperative follow-up time (months) (SD; range)	11.4 (13.8; 3 to 74)	9.9 (12.6; 3 to 74)	11.9 (14.2; 3 to 67)	.46

ELR = external levator resection; MMCR = Müller muscle conjunctival resection; MRD1 = upper margin reflex distance.

frontalis suspension, or did not have at least 3 months of postoperative follow-up. Patients were not excluded if they underwent concurrent eyelid surgery, if they had prior eyelid surgeries, or if they had ptosis repair prior to the study inclusion date. Patients with a levator function of 5 mm or less were not offered MMCR or ELR, but rather frontalis sling.

Patients were considered candidates for MMCR if they had elevation of the lid to a desirable height after instillation of 2.5% phenylephrine. Surgical failure was defined as patient-reported or physician-reported dissatisfaction with postoperative eyelid height or postoperative MRD1 of less than 2 mm. Patient satisfaction was routinely queried and documented by both the technician and surgeon at every visit. Patients who met the study parameters were stratified based on presenting MRD1 and surgical approach/technique. Outcome analysis was also performed after stratification for concomitant blepharoplasty performed at the time of ptosis repair.

The preoperative and postoperative MRD1 was measured by the surgeon characterizing the distance from the corneal light reflex to the upper eyelid margin. Severe ptosis was described as eyelids bisecting the pupil—an MRD1 of 0 or worse. The determination of the surgical approach selected and the technique used among all surgeons was similar and comparable to those reported elsewhere for both MMCR and ELR.^{8,9} The amount of Müller muscle resection performed was based on phenylephrine testing results, as previously described.¹⁰

Comparative statistical analyses were performed among patient groups before and after ptosis repair. Longitudinal analysis of failure over time was performed using a Kaplan-Meier estimator. Statistical analysis, including statistical summaries and 2-sample *t* tests assuming equal variance, were performed using Microsoft Excel for Mac 2011 (Microsoft Corporation, Redmond, Washington, USA). R Console 3.6.0 was used for Kaplan-Meier analysis. Statistical significance was set at a *P* value of <.05.

TABLE 3. Preoperative Characteristics in Müller Muscle Conjunctival Resection: Mild/Moderate vs Severe Ptosis

	Mild/Moderate	Severe	P
Number of eyelids	66 (65%)	36 (35%)	
Mean age (years)	68.3 (19 to 87)	70.6 (43 to 91)	.44
Sex (F/M)	60/6	32/4	.74
Preoperative MRD1 (mm) (SD; range)	1.04 (0.66, 0.5 to 4)	-0.11 (0.32, -1 to 0)	<.01
Preoperative levator function (mm)	10.5 (1.43; 9 to 18)	10.0 (1.97; 6 to 16)	.70
Length of tissue taken (mm) (SD; range)	8.99 (1.05; 6 to 10)	9.38 (1.11; 6 to 11)	.09
Previous intraocular surgery	34 (52%)	19 (53%)	1.00
Concomitant blepharoplasty	4 (4%)	0 (0%)	.57
Postoperative follow-up time (months) (SD; range)	9.1 (13.9; 3 to 74)	9.9 (12.6; 3 to 74)	.78

MRD1 = upper margin reflex distance.

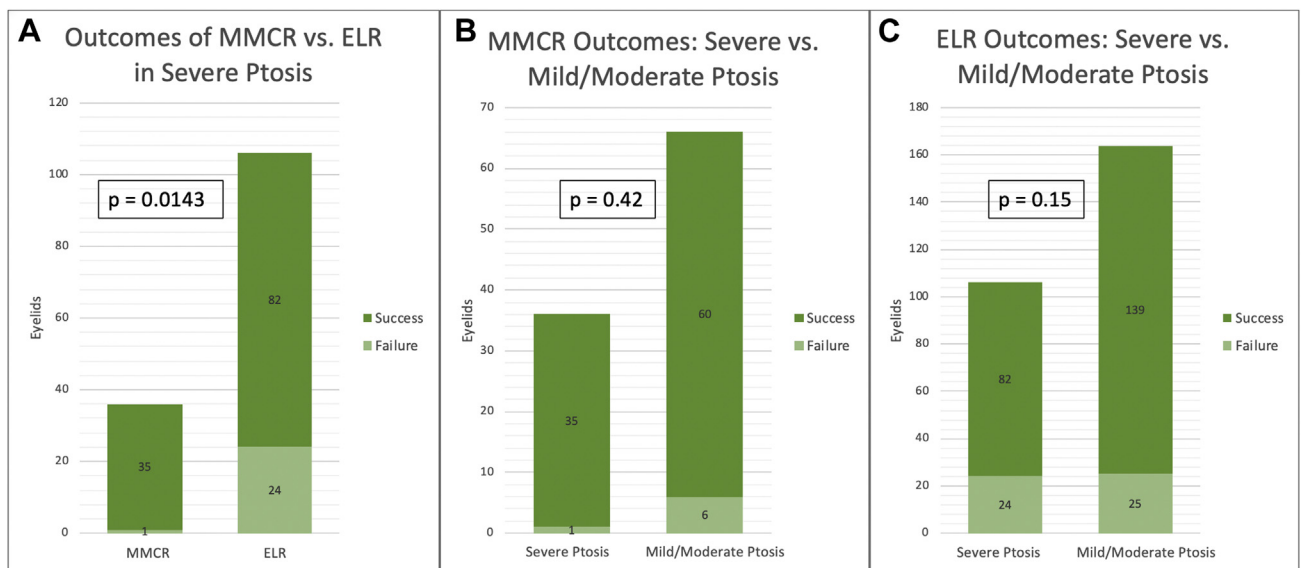


FIGURE 1. Outcomes following Müller muscle conjunctival resection (MMCR) or external levator resection (ELR). (A) MMCR vs ELR in severe ptosis. (B) MMCR outcomes: severe vs mild/moderate ptosis. (C and B) ELR outcomes: severe vs mild/moderate ptosis.

RESULTS

A TOTAL OF 231 PATIENTS (372 EYELIDS) MET THE STUDY criteria. Patient demographics are shown in Table 1. Mean age of patients was 69.1 in patients who underwent MMCR and 69.7 in patients who underwent ELR ($P = .62$). Preoperative MRD1 was 0.63 (standard deviation [SD] 0.79; range -1 to 2) mm in patients who underwent MMCR and 0.53 (SD 0.86; range -3 to 3) mm in patients who underwent ELR ($P = .29$). Preoperative levator function was 10.4 (SD 1.29; range 6-16) mm in patients who underwent MMCR and 10.3 (SD 1.64; range 6-18) mm in patients who underwent ELR. Follow-up averaged 10.53 (range 3-74) months and was not statistically different between groups (Table 1).

Of the study population, 142 of 372 (38.2%) eyelids had severe ptosis. Of eyelids with severe ptosis, 36 underwent MMCR and 106 underwent ELR. Mean preoperative MRD1 was -0.11 (SD 0.32; range -1 to 0) mm and -0.28 (SD 0.64; range -3 to 0) mm for patients who underwent MMCR vs ELR, respectively ($P = .14$). Levator function averaged 10.0 mm for both patients who underwent MMCR and those who underwent ELR ($P = 1.00$). Average follow-up was 9.9 months following MMCR and 11.9 months following ELR (Table 2).

After stratification by ptosis severity of patients who underwent MMCR, there was no statistical difference in age, sex, preoperative levator function, previous intraocular surgery, or follow-up (Table 3). Of patients who underwent MMCR, mean preoperative MRD1 in the mild/moderate ptosis group

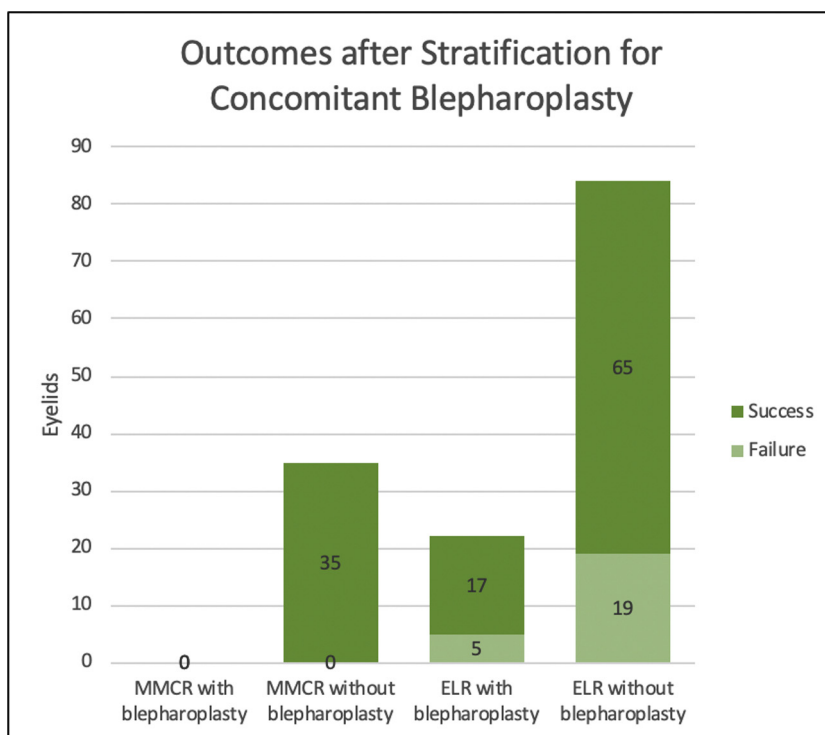


FIGURE 2. Outcomes after stratification for concomitant blepharoplasty. ELR = external levator resection; MMCR = Müller muscle conjunctival resection.

was 1.04 (SD 0.66) mm and in the severe ptosis group was -0.11 (SD 0.32) mm ($P < .01$). In patients who underwent MMCR, the mean length of tissue resected was 8.99 (range 6-10) mm in patients with mild/moderate ptosis and 9.38 (range 6-11) mm in patients with severe ptosis ($P = .09$).

Comparing ELR vs MMCR in severe ptosis, there was a statistically significant higher rate of success following MMCR: 97.2% (35/36) compared to ELR 77.4% (82/106) ($P = .0143$; Figure 1A). After MMCR, the rate of ptosis repair success was 97.2% (35/36) in eyelids with severe ptosis and 90.9% (60/66) in patients with mild-to-moderate ptosis ($P = .42$; Figure 1B). After ELR, the rate of ptosis repair success was 77.4% (82/106) in eyelids with severe ptosis and 85% (139/164) in eyelids with mild-to-moderate ptosis ($P = .15$; Figure 1C).

Concomitant blepharoplasty at the time of ptosis repair was performed for 4% (4/102) of eyelids undergoing MMCR and 24% (66/270) of eyelids undergoing ELR. In the setting of severe ptosis, no eyelids undergoing MMCR received concomitant blepharoplasty and 21% (22/106) of eyelids undergoing ELR received concomitant blepharoplasty. Comparing outcomes of ptosis repair among eyelids that received concomitant blepharoplasty found no difference in success rates following MMCR with blepharoplasty (100%; 4/4) compared to MMCR without blepharoplasty (93%; 91/98) ($P = 1.00$) or in success rates following ELR with blepharoplasty (85%; 56/66) compared to ELR without blepharoplasty (81%; 165/204)

($P = .58$). This was similarly true among eyelids with severe presenting ptosis with no difference in success rates following ELR with blepharoplasty (77%; 17/22) compared to ELR without blepharoplasty (77%; 65/84) ($P = 1.00$). Comparison of MMCR outcomes in severe ptosis was not possible, as no patients received concomitant blepharoplasty in this setting. Outcomes after stratification for blepharoplasty are shown in Figure 2.

The mean time of ptosis recurrence was 27 months ($n = 1$) after MMCR for severe ptosis, 6 (range 4-15; SD 4.43) months after MMCR for mild/moderate ptosis, 16.8 (range 1-27; SD 18.8) months after ELR for severe ptosis, and 9.6 (range 3-24; SD 6.44) months after ELR for mild/moderate ptosis. A Kaplan-Meier survival estimator of the time until failure for eyelids comparing MMCR vs ELR in patients with severe ptosis vs mild/moderate ptosis demonstrates longer survival times in patients with MMCR compared to ELR (Figure 3).

DISCUSSION

MMCR IS A SAFE AND EFFICIENT SURGERY OFFERING PREDICTABLE and quantitative results. The nomogram originally proposed by Putterman is using an 8 mm resection to obtain results coinciding with a preoperative phenylephrine drop test.¹⁰ However, since that time, experience with the

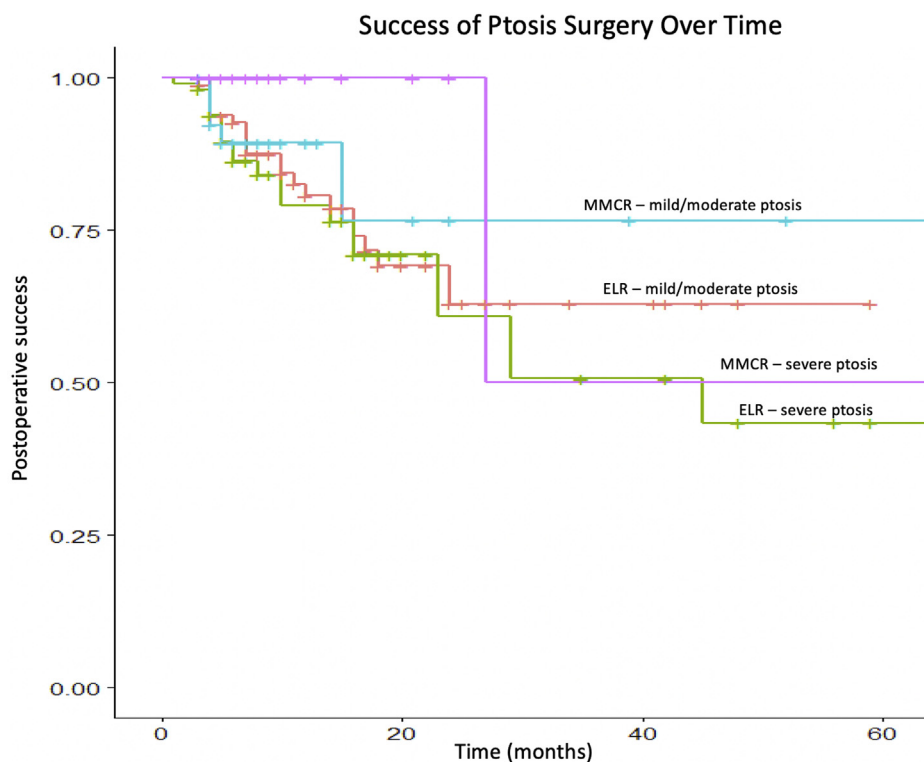


FIGURE 3. Success of ptosis surgery over time. ELR = external levator resection; MMCR = Müller muscle conjunctival resection.

surgery has led to use of a variety of algorithms relating to amount of tissue resected with or without respect to a phenylephrine response.^{3,11,12} Additionally, there is significant debate regarding the correlation of the amount of tissue resected and amount of resultant eyelid lift.^{1,2,7,13} It therefore becomes clear that the mechanism for a successful outcome following MMCR is still not fully understood.

Recently, Patel and associates reported on MMCR in the setting of severe ptosis with and without tarsus resection, demonstrating favorable outcomes in patients with MRD1 of zero or less.⁵ A comparison to patients who underwent ELR was not performed in this study.

Georgescu and associates reported achieving successful postoperative eyelid heights in patients who underwent MMCR in the setting of poor-to-fair levator function, including patients presenting with severe preoperative ptosis.¹⁴ From these recent reports involving MMCR used in patients with severe ptosis, there may be an expanding role for MMCR.^{5,15}

Our results suggest MMCR is an effective surgical approach in patients with severe ptosis, as defined by an MRD1 of 0 or less. Our results suggest the degree of ptosis is not associated with the surgical outcomes. Additionally, our results suggest MMCR may actually be a more successful procedure when performed in patients with severe ptosis responsive to phenylephrine testing, when compared to patients who underwent ELR. In patients with severe involu-

tional ptosis, the levator aponeurosis is commonly found to be more rarefied or fatty infiltrated.^{16,17} Given that Müller muscle is less prone to muscle fat infiltration,¹⁸ we hypothesize that correction of eyelids with severe ptosis and a good response to phenylephrine may be better provided with MMCR. For this study, we categorized success as patient- and physician-reported approval of the postoperative eyelid height in addition to a postoperative MRD1 of at least 2 mm. The authors, however, concede that it is possible that patients with more severe ptosis may be more likely to approve of the postoperative eyelid height because of simply a greater absolute value of eyelid lift obtained.

Limitations of this study include that it is a retrospective study in nature. Additionally, this study excludes patients who underwent tarsectomy. The authors are hesitant to remove tarsus, and rarely do so, as the authors feel it may complicate further repair. Given the minimal elasticity of tarsus, tarsectomy may predictably augment the lifts MMCR and ELR provide.^{19,20} Other limitations to the study include the lack of comprehensive reporting of the numerous factors known to influence the surgical outcome of ptosis repair, including subsequent intraocular surgery,²¹ preoperative eyelid asymmetry,²² chronic prostaglandin analogue use,²³ contact lens use,²⁴ and older age,⁶ among others.

There is no universally accepted definition of success following ptosis surgery. Ideal eyelid height is certainly variable among race, sex, and age. A ptosis repair outcome

criteria suggesting “1 size fits all” may not represent clinical goals for patients and physicians. Moreover, ocular comorbidities, such as a low bleb, should limit the ptosis surgeon from performing an aggressive eyelid lift, so as to avoid bleb exposure. While some studies use solely MRD1 and/or inter-eyelid symmetry to gauge success, more recently patient satisfaction has been recognized as equally or more important to postoperative measurements or physician-reported satisfaction.^{23,25} For these reasons, we chose to require both patient and physician satisfaction of the eyelid height in addition to a postoperative MRD1 minimum of 2 mm to define surgical success.

In conclusion, our results demonstrate that MMCR can be an effective technique in patients with severe ptosis in the setting of good levator function. Our results suggest that MMCR offers superior outcomes to ELR in the setting of patients responsive to phenylephrine testing with an MRD1 of less than 0. In patients with significant dermatochalasis, ELR may still be preferred to MMCR to aid in efficiency of skin excision. Additional prospective studies are needed to evaluate MMCR vs ELR in patients with severe ptosis. Based on these findings, we recommend consideration of performing MMCR in patients with good responses to phenylephrine regardless of presenting MRD1.

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