

## The Role of Muller's Muscle-Conjunctiva Resection (MCR) in the Treatment of Ptosis

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### Abstract

**Introduction:** Muller's muscle-conjunctival resection (MCR) is a form of posterior approach surgery for the treatment of ptosis. The phenylephrine test is commonly used preoperatively to predict the treatment response of MCR and to guide the amount of Muller's muscle resection needed. **Methods:** Literature search for this topic is done with PubMed using the words "Muller's muscle", "conjunctival", "resection", "mullerectomy", "ptosis" and "blepharoptosis". Additional articles on this subject were traced when indicated from the list of literature obtained by the PubMed search engine. **Results:** The original surgical technique of MCR reported by Putterman and other modifications of this surgical technique are described. Various treatment algorithms on the quantity of Muller's muscle to be resected for a desired level of ptosis correction and the surgical success rates are reviewed. As compared to other common ptosis surgeries, it offers the advantages of tarsal preservation, avoiding skin incisions, non-violation of the orbital septum and orbital fat. The disadvantages of MCR include non-preservation of conjunctiva (with goblet cells) and damage to the accessory lacrimal glands (glands of Krause and Wolfring). **Conclusions:** MCR is an acceptable alternative treatment modality for mild and moderate ptosis with good levator function. It offers the benefits of short surgical time, being less invasive, obviating the need for intraoperative adjustment, predictability and less re-operation. The potential risks of conjunctival fornical shortening and dry eye after surgery seem to be low.

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### Introduction

The Muller's muscle (MM) is a sympathetically innervated upper eyelid muscle that elevates the eyelid besides the levator palpebral superioris. The MM resembles smooth muscle and originates from the levator aponeurosis about 15 mm above the superior tarsus.<sup>1</sup> The MM is adherent to the conjunctiva but easily separable from the levator aponeurosis and is enclosed in a vascular sheath. The lifting effect of the MM is best demonstrated clinically by the improvement of some ptotic eyelids upon stimulation with phenylephrine eye drops (phenylephrine test, Fig. 1).

Conventionally, the levator aponeurosis is considered as the major elevator and determinant of the upper eyelid height.<sup>1,2</sup> The commonly used levator advancement and resection surgery is based on this concept to lift the upper eyelid. Nonetheless, other authors have postulated that the levator aponeurosis terminates 2 to 3 mm above the upper

tarsal border and merely supports the anterior lamella (skin and orbicularis). These authors believe that the major pull on the upper tarsus is relayed via the MM and hence the efficacy of ptosis correction with muscle-conjunctival resection (MCR) with or without tarsal resection.<sup>3-5</sup> Kiyoshi<sup>6</sup> reported MM acting as a spindle in a stretch reflex involving involuntary contraction of the levator muscle to control the upper eyelid height.

### Muller's Muscle-Conjunctiva Resection

How does MCR work to lift up the eyelid? The simple concept of MM shortening may not be sufficient explanation. Buckman et al<sup>7</sup> reported that 88% of their 40 surgical specimens (from Fasanella-Servat procedure involving tarsus, MM and conjunctiva resection) had absent or minimal MM resection, yet the surgeries were equally successful in comparison to those with moderate or large amounts of

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MM resection. The other postulated mechanisms include advancement of the anterior extensions of the levator aponeurosis to the tarsus to enhance its pull on the eyelid,<sup>8</sup> vertical posterior lamellar shortening, wound cicatrisation and contraction.<sup>7</sup> The possibility of advancement of the levator aponeurosis-MM complex may be supported by the lowering or normalisation of the high upper eyelid crease observed postoperatively.

### **Surgical Techniques of Muller's Muscle-Conjunctival Resection**

Muller's Muscle-Conjunctival Resection, first described by Putterman in 1975, is a modality of treatment for mild to moderate ptosis.<sup>9,10</sup> The surgery is commonly performed under local anaesthesia with sedation. In Putterman's original technique, the upper eyelids are injected subcutaneously with local anaesthetic containing epinephrine and a 4/0 silk traction suture is placed central through skin, orbicularis oculi and superficial tarsus. The eyelid is then everted over a Demarres retractor to expose the palpebral conjunctiva and topical anaesthetic is applied.

Three 6/0 marking sutures are placed 8.25 mm (6.5 to 9.0 mm depending on the phenylephrine test response) above the superior tarsal border at the centre, 7 mm medial and lateral to the central mark. A toothed forceps is used to grasp the conjunctiva and the adherent MM between the superior tarsal border and the marking sutures, while a T shaped clamp is applied (with the tooth of clamp blade engaging the marking suture). A double armed 5/0 catgut suture is then passed 1.5 mm below the clamp from temporal to nasal direction taking bites of the conjunctiva and MM. A no. 15 surgical blade is used to excise the tissue grasped within the clamp by cutting below it. The nasal end of the suture is now run in the opposite direction. The 2 suture ends temporally are then passed through conjunctiva and MM and tied to be buried sub-conjunctivally.

In a 10-year analysis of the surgical results of Putterman's technique of MCR, 90% of the acquired ptosis (213 lids) and all of the congenital ptosis (19 lids) cases were within 1.5 mm of the level of the opposite eyelid postoperatively.<sup>11</sup> The re-operation rate was low with only 2 eyelids having residual ptosis requiring additional surgery because of cosmetically unacceptable results. However, the severity of ptosis in Putterman's series was not reported.

### **Modifications of Muller's Muscle-Conjunctival Resection**

Other modifications of MCR have been used to treat ptosis, each using different algorithms of MM resection for similar degrees of ptosis. Weinstein and Buerger<sup>12</sup> proposed a linear relationship between the amount of MM resection and ptosis correction. Their technique used 8 mm of MCR to correct 2 mm of ptosis, then added or subtracted 1 mm

of resection to adjust the eyelid position by 0.25 mm. Eighteen (95%) of 19 eyelids treated with this modification were cosmetically acceptable.

Dresner<sup>8</sup> described an algorithm of 4 mm of MCR for 1 mm of ptosis, 6 mm of MCR for 1.5 mm ptosis, 10 mm of MCR for 2 mm ptosis and 11 or 12 mm MCR for more than 3 mm of ptosis. Dresner also reported a strong linear correlation in between the quantity of MM resected and postoperative correction but a poor linear correlation was noted between the response to phenylephrine testing and the magnitude of ptosis correction.<sup>10</sup> Eyelid height symmetry was achievable in 68% of cases with this algorithm.

Perry et al<sup>13</sup> suggested another algorithm based on the hypothesis that maximal stimulation of MM with 10% phenylephrine eye drops can be achieved by near-complete 9 mm of MM excision; any residual undercorrection during the phenylephrine testing can corrected with additional tarsal resection in a 1:1 ratio of eyelid elevation, up to a maximum of 2.5 mm (to avoid tarsal instability). For example, if there is 1 mm of undercorrection, 1 mm of tarsectomy will correct 1 mm of ptosis not corrected by 9 mm of MM resection. Postoperative eyelid symmetry was achieved in 58 of 67 patients (87%) after 1 surgery with no overcorrection.

Guyuron and Davies<sup>14</sup> reported a modification to the Putterman's technique of MCR that involved resection of 6 to 9 mm of tissue within the T shaped clamp (with no tarsal resection) followed by wound closure with a 6/0 running horizontal mattress suture. The suture ends were brought out through the skin and tied externally. With the exception of 1 overcorrection, the majority of the 43 eyelids in this study had satisfactory elevation of the ptotic eyelid. The author (CC Yip) adopts a similar surgical technique as Guyuron by passing a 6/0 non-absorbable suture full-thickness through the nasal eyelid skin, running it in a horizontal mattress manner under the clamp and exiting full thickness back into the temporal eyelid skin. The suture is then passed back full thickness through the eyelid adjacent to the temporal skin puncture mark into the conjunctival side, run in a reverse horizontal mattress fashion under the clamp and exited full-thickness back into the nasal eyelid skin adjacent to the first skin puncture mark. The suture ends at the nasal and temporal aspects are tied externally on the skin so as not to abrade the ocular surface. A no. 15 blade is then used to cut below the clamp to excise the conjunctiva and Muller's muscle grasped within it (Fig. 2).

Lake et al<sup>15</sup> used an open-sky method of MCR for the correction of ptosis with moderate to good levator function without the use of the T shaped clamp specially designed by Putterman.<sup>9</sup> A sub-total resection of MM and conjunctiva is performed under direct visualisation. A 1-mm strip of



Fig. 1. A patient with bilateral aponeurotic ptosis showing good response to 2.5% phenylephrine upon instillation on the right side with significant elevation of the eyelid.



Fig. 2. The T shaped clamp grasped a pre-determined amount of Muller's muscle and conjunctiva to be resected by a No. 15 surgical blade. A double running horizontal mattress suture is passed below the clamp to appose the wound after resection



Fig. 3a. Preoperative photograph showing bilateral aponeurotic ptosis with high upper eyelid creases.



Fig. 3b. Sixth postoperative week photograph showing symmetrical elevation of both upper eyelids with natural contours after bilateral Muller's muscle-conjunctival resections.

tarsus is excised if the phenylephrine test yielded under-correction. The resected MM is reattached to the tarsus with 3 double-armed 5/0 silk sutures passed full thickness through the eyelid crease and tied externally on the skin over small cotton bolsters. This technique has a good success rate of 92% within 0.5 mm of desired target correction (in 61 eyelids). In addition, the surgery was evaluated on 20 eyelids and was found to be effective in treating ptosis with negative phenylephrine test without the need for revision surgery.<sup>16</sup>

A further improvement to the open-sky technique of MCR was reported by Khooshabeh et al.<sup>17</sup> The conjunctiva is preserved in this technique that requires extensive dissection of the MM from the conjunctiva up to the level of the fornix. A sub-total resection of MM is done followed by suturing of the residual stump to the superior tarsus with the 3 double-armed sutures passed through the skin crease. This surgery was effective with 96% of the study patients (34 eyelids) having a final eyelid height at or 1 mm below the limbus and symmetry to within 0.5 mm of the fellow eyelid.

Foster et al<sup>18</sup> reported a novel technique of MCR using fibrin sealant instead of suture for wound closure. The surgical success was good with a postoperative symmetry rate of 97% in 33 patients. No keratopathy, wound

dehiscence or other complication was encountered with this technique that saves the surgical time incurred with traditional suturing methods.

### The Importance of the Phenylephrine Test

In Putterman's original description of his surgical technique of MCR, 10% phenylephrine eye drops was instilled preoperatively into the upper conjunctiva fornix to elicit the response of Muller's muscle contraction to lift up the eyelid.<sup>9,10</sup> The phenylephrine test functions as a guide to the amount of MM and conjunctiva resection required based on the treatment algorithm adopted by the surgeon.

The systemic absorption of phenylephrine despite punctal occlusion may result in rare but undesirable cardiac complications.<sup>19</sup> Although Putterman and Fett<sup>11</sup> reported no adverse events in over 500 patients during clinical evaluation, many have used a lower dosage of 2.5% phenylephrine for this testing to minimise adverse systemic effects. Glatt et al<sup>20</sup> reported that although the 10% dosage resulted in a statistically significant upper eyelid elevation of 0.2 mm higher than the 2.5% dosage, the small magnitude might not be of clinical importance in influencing the decision to perform MCR or the amount of tissue resection.

### The Advantages of Muller's Muscle-Conjunctival Resection

External levator advancement or resection has been the gold standard for the treatment of ptosis with moderate to good levator function. This procedure has high success rates of 70% to 95% or more<sup>21-23</sup> but re-operation rates of 2.5% to 8.7% have been reported.<sup>21,24</sup> In contrast, MCR seems more predictable and rarely requires re-operation.<sup>9-17</sup> Ben Simon et al<sup>25</sup> compared the 2 procedures and reported a significantly lower re-operation rate of 3% in the MCR group versus 8% in the external ptosis surgery group. However, the interpretation of success rates between these 2 procedures should be done with caution as the more severe cases of ptosis with poorer levator function may be managed in general more frequently with external ptosis surgery, a trend also noted in the paper by Ben Simon.

Different from the Fasanella-Servat operation,<sup>26</sup> another posterior approach ptosis surgery, the tarsus is preserved in MCR with less risk of suture keratopathy since the sutures are placed at the superior tarsal border and at a higher level away from the cornea. In addition, the risk of dry eye (aggravated by the widened palpebral fissure height) due to meibomian gland destruction may be lower with tarsal preservation. Eyelid contour abnormality and the potential risk of tarsal instability are additional disadvantages that can be avoided with MCR (Fig. 3). Nonetheless, some of the modifications of MCR<sup>13,15</sup> incorporated small amounts of tarsectomy to augment the ptosis repair in cases of under-correction during phenylephrine testing.

Even patients with Horner's syndrome and neurogenic ptosis may be effectively treated with MCR.<sup>27</sup> In Glatt's series of 6 patients with unilateral Horner's syndrome, 5 patients attained perfect symmetry and the eyelid of 1 patient was only 0.5 mm higher than the contralateral eyelid. In the presence of a possibly non-functioning MM, the surgery works most likely via indirect mechanisms of advancement of the levator aponeurosis (terminal end) on the tarsus and posterior lamellar shortening. There was only 1 case report of myogenic ptosis with poor levator function (but good phenylephrine test response) effectively treated by MCR thus avoiding a frontalis suspension procedure.<sup>28</sup> But the findings of this study need further validation.

MCR may be performed alone or in combination with upper blepharoplasty. However, the anticipated postoperative eyelid elevation may be reduced by up to 1 mm.<sup>29</sup> A larger MCR may be required to attain the desired postoperative ptosis correction.

MCR also has the advantages of less tissue dissection, avoidance of a potential cutaneous incision scar, a shorter operation time (approximately 20 minutes per eyelid) and obviating the need for intraoperative adjustment and patient

cooperation.<sup>27</sup> The patient comfort level may be improved with a faster surgery and deeper sedation feasible with this surgery. The less invasive nature of MCR without the need to breach the orbital septum and dissect around the pre-aponeurotic fat is particularly beneficial in cases of orbital fat atrophy and deep superior sulcus. With less tissue manipulation, faster patient recovery and lower risk of orbital haemorrhage may be more conceivable.

### The Disadvantages of Muller's Muscle-Conjunctival Resection

One of the arguments against MCR is the risk of conjunctival fornical shortening due to conjunctival resection. This problem has especially more impact on disease states with conjunctival deficiency such as anophthalmic socket, cicatrising conjunctival diseases such as Steven Johnson syndrome and ocular cicatricial pemphigoid.

However, caution should be exercised in patients with glaucoma filtration surgery such as trabeculectomy and filtration tubes although suture keratopathy is very rare. The suture used in MCR may potentially abrade on these filtration sites at superior aspect globe to cause injury and infection (blebitis and even endophthalmitis). It is therefore not advisable to perform MCR in these glaucoma patients in view of the potentially serious visual consequences.

Ptosis is not uncommonly associated with the anophthalmic socket. Karesh et al<sup>30</sup> reported the safety and efficacy of MCR in the management of 35 eyelids with anophthalmic ptosis. There was no compromise of the superior conjunctival fornix, socket dryness or inability to retain a prosthesis on evaluation by an experienced ophthalmologist postoperatively.

Dry eye is another concern with MCR especially with an increased surface area of tear evaporation due to a widened palpebral fissure postoperatively. Conjunctiva contains goblet cells and the accessory lacrimal glands (glands of Krause and Wolfring). The gland of Krause is located at the superior conjunctival fornix, while the gland of Wolfring is found at the superior tarsal border often within the tarsus.<sup>31</sup> A properly performed MCR would be unlikely to compromise these accessory glands which probably only plays a contributory role to the overall tear production. The problem of dry eye does not seem to be encountered in the many studies on MCR.<sup>9-17</sup> Dailey et al<sup>32</sup> reported no effect on tear production (as measured by Schirmer's test) after MCR, although subjective dry eye symptoms were transiently increased in the immediate postoperative period.

### Conclusion

Muller's MCR is a safe and effective treatment alternative for ptosis with moderate to good levator function. Different

modifications of the surgical technique and treatment algorithms have been used with varying success. Pre-operative phenylephrine test is a useful test to evaluate the suitability for MCR and to guide the amount of MM resection. Small amounts of tarsectomy may be performed concomitantly with MCR to increase the amount of ptosis correction in cases of inadequate eyelid elevation during phenylephrine testing.

As compared to external levator surgery, it has the advantages of simplicity, quicker surgery, requiring less tissue dissection, predictability and less re-operation. Postoperative complications such as dry eye and conjunctival shortening are rare and generally do not compromise the ocular surface.

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