The Effect of Hering’s Law on Different Ptosis Repair Methods

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Abstract

**Background:** The Hering’s law effect has significant importance in surgical planning and outcomes of eyelid surgery.

**Objectives:** The current study examined the preoperative and intraoperative effect of Hering’s law in Mullerectomy and levator aponeurosis advancement.

**Methods:** A retrospective analysis was conducted of 52 patients with unilateral ptosis who underwent surgical repair from January 2011 through June 2013. Patients underwent levator aponeurosis advancement or Mullerectomy with or without tarsectomy. Preoperative and postoperative clinical documentation and photographs were evaluated. Preoperative Hering’s dependency and postoperative changes in positioning of the non-operated eyelid were measured. The decision to operate on the ptotic eye alone or on both eyelids was based on preoperative Hering’s dependence and intraoperative changes in the contralateral eyelid.

**Results:** Fifty-two patients with unilateral ptosis were included. Average age was 63.3 ± 20.1 years (range, 22–88 years; median, 61 years); 34 (65.4%) were female. The 14 cases that were not aponeurotic (either congenital, secondary to trauma, or due to postoperative ptosis) did not need contralateral repair \( (p = .000) \). In 4 (19%) cases of Mullerectomy and in 9 (52.9%) cases of levator advancement, both eyelids required surgery \( (p = .029) \). Hering’s law effect was significantly more apparent in the levator advancement approach than in Mullerectomy.

**Conclusions:** Levator surgery resulted in a higher incidence of combined intraoperative and postoperative Hering’s law effect than did Mullerectomy. Cases with poor levator function or congenital ptosis can be repaired unilaterally with no need for contralateral surgery. The fibrotic levator palpebrae muscle and its special innervations probably explain this phenomenon. This should be considered in surgical planning.

**Level of Evidence:** 3

Outcomes of ptosis surgery are less predictable than those of blepharoplasty and other types of eyelid surgery. In most cases of asymmetric eyelid ptosis, the level of the contralateral eyelid is at least partially dependent on both the preoperative and postoperative positions of the ptotic eyelid.\(^1\)

Hering originally described the phenomenon of equal innervations for dependent extraocular eye muscles.\(^2\) Walsh\(^3\) was the first to describe Hering’s law for eyelids, which is the compensatory retraction of the contralateral upper eyelid in cases of unilateral ptosis. The Hering’s law phenomenon is explained by the special innervations of the levator palpebra (LP). Phylogenetically, it evolves by separating from the superior rectus muscle and differentiates from it only late in embryogenesis.\(^4\) Therefore, the LP would be expected to obey neurophysiologic rules that apply to the superior rectus. The motor neuronal pool for the elevators lies in a single, unpaired central caudal nucleus of the oculomotor complex. Single motor neurons innervate the LP bilaterally.\(^5,6\) Clinically, according to Hering’s law, a patient’s attempt to overcome ptosis in one eye will induce

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an increase in innervation in both levators, resulting in contralateral lid retraction.\textsuperscript{7,8} The development of ptosis in the contralateral upper eyelid after successful repair of unilateral ptosis was demonstrated in 9.6\% to 17\% of patients.\textsuperscript{7,9} The postoperative effect might be suppressed at different levels by mechanisms including, but not limited to, frontalis muscle action.\textsuperscript{7}

Hence, it is important to consider Hering’s law when planning blepharoptosis repair, bearing in mind every specific condition. In cases of bilateral ptosis, even with different levels in each eye, both eyelids are repaired. However, in unilateral cases, the repair of one eyelid may result in contralateral eyelid drooping due to Hering’s law phenomena. Likewise, Hering’s law effect may be influenced either by the etiology of the ptosis or by the method of surgical repair. It does not manifest in some circumstances, for example with congenital ptosis.\textsuperscript{1,10,11} Thus, the Hering’s law effect for different ptosis etiologies has not yet been investigated.

Another unanswered question is whether Hering’s law presents similarly when different surgical approaches are used. Anterior repair by levator advancement and posterior repair by Mullerectomy are two entirely different techniques. In Mullerectomy, Muller’s muscle still regulates the position of the upper eyelid. However, when the levator aponeurosis is sutured directly to the tarsal plate, it bypasses this mechanism. Muller’s muscle no longer affects the eyelid level; rather, the levator aponeurosis performs this function.\textsuperscript{1}

The current study examined the effect of Hering’s law on Mullerectomy and levator aponeurosis advancement repair methods for cases of unilateral ptosis. Based on our clinical impression, each surgical repair creates a different Hering’s dependence.

**METHODS**

**Study Population**

This study reports a retrospective analysis of patients who had surgical repair for unilateral ptosis performed by a single surgeon (A.Y.N.), from January 2011 through June 2013. In this study, patients with bilateral ptosis were excluded. When performing the surgery, the decision to operate only on the ptotic eye or also on the contralateral eyelid was based on the preoperative Hering’s dependence and on the intraoperative result of the contralateral eyelid, in all cases.

**Patient Evaluation**

The preoperative evaluation included a full-slit lamp examination, visual acuity test, and ptosis workup. Medical and general histories were taken. Patients were photographed preoperatively and 1 and 6 months postoperatively.

The ptosis workup includes measurements of the marginal reflex distance (MRD), levator function (LF), the palpebral fissure, and the presence of Bells’ phenomena. We traditionally classify ptosis as mild (2 mm), moderate (3 mm), or severe (4 mm). Here, only cases with a MRD difference of more than 1 mm between eyes were operated. Hering’s dependence was tested by manually elevating the ptotic eyelid with a single finger to the desired position during the patient’s initial assessment, and the contralateral MRD was remeasured.\textsuperscript{12} The 2.5\% phenylephrine test was also performed for patients on whom a Mueller muscle resection procedure was considered, which also helps determine the effect of Hering’s law. The test is performed by instilling 2 drops of 2.5\% phenylephrine into the eye. The phenylephrine test is more physiologic than the manual lift; however, it influences the lower eyelid position and dilates the pupil diameter, so both tests were performed. After 5 minutes, the MRD1 was reassessed. An increase of 2 mm or more in the MRD1 is considered a positive test. Based on these results, Mullerectomy was performed when the test was positive and when no significant dermatochalasis was present. In the presence of significant dermatochalasis, the anterior approach was chosen (although some surgeons use a posterior approach with skin excision). When it was negative, levator advancement was performed. Intraoperatively, if the contralateral eyelid drooped, it was also corrected using the same surgical technique performed on the first side.

**Surgical Procedures**

All surgeries were performed under local anesthesia with 2\% lidocaine and 1/100,000 epinephrine, administered by local infiltration. No sedation was used, in order to prevent eyelid drooping from the sedation effect.

For Mullerectomy, the surgical procedure was based on the Hering’s dependence (if positive, the contralateral eyelid was operated simultaneously). The amount of resection was adjusted slightly as needed to achieve small differences in the degree of elevation. Usually, a 2 mm ptosis requires an 8 mm resection of Muller’s muscle and conjunctiva. In cases needing more than 2 mm of elevation, additional tarsectomy of 1 to 2 mm was performed, depending on the amount of ptosis (Figure 1).\textsuperscript{13}

The anterior levator aponeurosis advancement approach was performed in cases with a negative phenylephrine test or when significant dermatochalasis was present. The lid crease was cut and the levator aponeurosis and the anterior margin of the tarsal plate was exposed. The levator was advanced to the tarsus using 3 Vicryl 5-0 stitches. The eyelid contours and heights were compared and evaluated with the patient in a sitting position (Figure 2). Excess muscle
and skin were excised and the skin sutured with single, deep Vicryl 6-0 stitches. Supratarsal fixation to aponeurosis was used to recreate the lid crease. Following repair of one eyelid, the patient was again examined in a sitting position and the lid height of both eyes measured. If the contralateral eye was ptotic, it was also repaired surgically.

Postoperatively, an eyelid position of less than 1 mm difference from the contralateral eyelid position, with a symmetrical contour was considered a good result. Otherwise, a contralateral repair was performed on a second occasion.

The medical documentation was evaluated 6 months postoperatively, along with clinical examination of the preoperative and postoperative photographs. The study was approved by the Meir Medical Center Institutional Review Board.

### Statistical Analysis

Categorical variables were analyzed using Fisher’s exact test. Results were considered statistically significant when \( p < .05 \). Data were analyzed using SPSS-12 Statistical Software SPSS (SPSS Inc. Chicago, IL).

### RESULTS

A total of 52 adult patients (range, 22–88 years; median, 61 years) with unilateral ptosis were included in the study. There were 34 females (65.4%). Mullerectomy was performed on 27 patients (52%), with an average follow-up of 15 months (range, 9–22 months), and levator advancement was performed on 25 (48%), with an average follow-up of 16 months (range, 11–24 months). Patient demographics and preoperative measurements are presented in Table 1. A summary of the surgical procedures is presented in Table 2. The results of cases with aponeurosis ptosis were evaluated separately.

Unilateral ptosis in those with Hering’s is actually bilateral ptosis (latent) that is masked by the Hering’s in the retracted eyelid. Hering’s law effect was encountered less frequently with the posterior surgical approach. Both
eyelids required surgery in 10 (37%) cases of Mullerectomy and in 17 (68.0%) cases of levator advancement. For both surgical methods, the 14 cases that were not aponeurotic (congenital, post-trauma, or post-ocular operative ptosis) did not need contralateral ptosis repair ($p = .000, \text{Pearson Chi-Square} = 26.580$).

Among the cases of Mullerectomy, eight (29.6%) had a Hering’s effect on the contralateral eyelid that was lifted during the first operation, while two cases (7.4%) with residual ptosis of more than 1 mm had ptosis repair on a second occasion. The same surgical procedure was performed with good results. The etiology of ptosis was aponeurotic in 21 cases (77.8%). The etiologies of the remaining six cases were congenital ptosis in four (16.7%) and post-intraocular surgery in two (8.3%).

Among patients who underwent levator advancement, 15 (60%) needed lifting of the contralateral eyelid during the first operation (Figure 3) and two (8%) needed ptosis repair on a second occasion (Figure 4). The etiology of ptosis was aponeurotic in 17 cases (68%), congenital in three (12%), mechanical (post-trauma or postoperative) in four (16%), and neurological (third cranial nerve paresis) in one (4%).

We further evaluated the ptosis repair for aponeurotic ptosis only. In 19% of Mullerectomy cases and in 53% cases of levator advancement, both eyelids needed surgery (Pearson chi-square = 4.795, DF = 1, $p = .029$). Hering’s law was significantly more common with the levator advancement approach than with posterior surgical approach (Mullerectomy).

**DISCUSSION**

This series shows that levator surgery results in a higher incidence of combined intraoperative and postoperative Hering’s law than the Mullerectomy procedure. Hering’s law effect was not present in patients with post-traumatic, post-intraocular surgery, or in congenital ptosis (even with good LF). Retraction of the contralateral eyelid depends on multiple factors that affect eyelid height, including the frontalis muscle, the orbicularis oculi, sympathetic reaction by Muller’s muscle, and coexisting mild ptosis in the opposite eye. In addition, a compensatory retraction may not be visible if the patient uses the fellow eye for fixation.14 Ocular dominance probably has a strong influence on the surgical results, as well.7

In order to predict contralateral ptosis, preoperative evaluation of Hering’s dependency is based on various studies, including digital lift, closure, and pharmacologic stimulation tests.12,15,16 Corrective surgery for Hering’s dependency is reported to give predictable results and excellent symmetry.17

Cetinkaya et al7 recently showed that bilateral ptosis cases with documented Hering’s dependency yield better results when both eyes are operated in the same session, rather than delaying surgery for the second eyelid. However, Hering’s dependency is not documented in all

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**Table 1. The Result of Ptosis Repair of the Contralateral Eye in Patients With Unilateral Ptosis**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mullerectomy (n = 27)</th>
<th>Levator Advancement (n = 25)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender, female</td>
<td>20 (74.5%)</td>
<td>14 (56.0%)</td>
</tr>
<tr>
<td>Mean age (years)</td>
<td>63.5 ± 18.9</td>
<td>62.9 ± 21.2</td>
</tr>
<tr>
<td>Side (right)</td>
<td>10 (37.0%)</td>
<td>10 (40%)</td>
</tr>
<tr>
<td>Bilateral</td>
<td>8</td>
<td>15</td>
</tr>
<tr>
<td>Secondary contralateral surgery</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Average follow-up, months (range)</td>
<td>15 (9-22)</td>
<td>16 (11-24)</td>
</tr>
<tr>
<td>Ptotic eye MRD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preoperative</td>
<td>0.64 ± 0.59</td>
<td>0.813 ± 1.05</td>
</tr>
<tr>
<td>Postoperative</td>
<td>3.18 ± 0.76</td>
<td>3.33 ± 0.76</td>
</tr>
<tr>
<td>Difference</td>
<td>2.54</td>
<td>2.52</td>
</tr>
<tr>
<td>Contralateral eye MRD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preoperative</td>
<td>3.03 ± 0.92</td>
<td>3.18 ± 1.13</td>
</tr>
<tr>
<td>Postoperative</td>
<td>3.24 ± 0.77</td>
<td>3.28 ± 0.2</td>
</tr>
<tr>
<td>Difference</td>
<td>−0.21</td>
<td>−0.1</td>
</tr>
<tr>
<td>Preoperative to postoperative MRD change</td>
<td>−0.15 ± 0.8</td>
<td>−0.12 ± 0.65</td>
</tr>
</tbody>
</table>

MRD, marginal reflex distance.

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**Table 2. Summary of Cases With Unilateral and Bilateral Ptosis Repair**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mullerectomy (n = 27)</th>
<th>Levator advancement (n = 25)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Etiology</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aponeurotic</td>
<td>21</td>
<td>17</td>
</tr>
<tr>
<td>Other</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>Primary surgery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unilateral</td>
<td>19</td>
<td>10</td>
</tr>
<tr>
<td>Bilateral</td>
<td>8</td>
<td>15</td>
</tr>
<tr>
<td>Secondary contralateral surgery</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Total contralateral surgeries</td>
<td>10 (37%)</td>
<td>17 (68%)</td>
</tr>
<tr>
<td>Aponeurosis ptosis contralateral repair</td>
<td>4/21 (19%)</td>
<td>9/17 (52.9%)</td>
</tr>
</tbody>
</table>

*Excluding cases with congenital, poor levator function, or post-traumatic/surgical ptosis.
cases of unilateral ptosis. Lepore et al\textsuperscript{18} initially suggested that Hering’s law applies only to patients with ptosis resulting from neuromuscular junction or more distal dysfunction. However, Averbuch-Heller et al\textsuperscript{10} showed that some cases were due to third nerve palsy proximal to the neuromuscular junction, so the effect was not restricted to neuromuscular junction dysfunction.\textsuperscript{1} Mehta\textsuperscript{19} reported that Hering’s law also occurs in mechanical ptosis.

While McCulley et al\textsuperscript{9} reported that reoperation was more than twice as likely in patients undergoing bilateral versus unilateral procedures (13\% and 5.2\%, respectively), the success rates for unilateral ptosis repair reported by other studies have varied from 27\% to 72\%.\textsuperscript{20-22}

The postoperative effect on the contralateral eyelid apparently continues to evolve a long time after surgery (Figure 4). Erb et al\textsuperscript{23} noted that 17\% of patients undergoing unilateral ptosis repair developed a decrease in contralateral eyelid height of at least 1 mm over the course of a year, resulting in a 5\% rate of contralateral surgery. Interestingly, this effect was not correlated with preoperative Hering’s law interdependence. In one study, a week after unilateral blepharoptosis repair, 64\% of patients had decreased MRD on the contralateral eyelid, whereas it was present in only 36\% after 6 months.\textsuperscript{24}

It has recently been shown that Hering’s law does not occur in congenital ptosis when addressed with either levator resection or frontalis sling procedures.\textsuperscript{11} In the current study, Hering’s law did not manifest in cases of poor levator function, post-trauma, or in congenital ptosis (even with good LF). A possible explanation for these
findings is that the LP muscle is fibrotic and not elastic in cases of traumatic or congenital ptosis.\textsuperscript{25,26} Thus, in contrast to the normal elastic eyelid (also in aponeurotic ptosis cases), if one pulls up the ptotic eyelid in cases of fibrotic muscle, sensory input is diminished and the unpaired motor central caudal nucleus of the oculomotor complex does not respond.\textsuperscript{5,26} The contralateral eyelid will not retract preoperatively.

This study compared the results of two surgical methods for unilateral ptosis repair (Figures 1–7). The preferred method for ptosis repair is controversial. Some physicians prefer Mullerectomy with or without tarsectomy over levator advancement, even when performed in conjunction with blepharoplasty. Many consider this method more predictable, shorter, and easier for the patient.\textsuperscript{27,28} In addition, it eliminates the need for patient cooperation. The orbicularis plane can be preserved\textsuperscript{29} and it reduces the chance of postoperative lagophthalmos, as well.\textsuperscript{29} Others advocate aponeurotic approaches as more predictable, simple to reverse, and more logical and anatomical.\textsuperscript{30}

The anterior and posterior approaches involve significantly different mechanisms. Hence, it is reasonable that the Hering’s law effects vary between these approaches. The actual eyelid level is regulated from moment to moment by Muller’s muscle, which attaches directly from the levator muscle to the upper edge of the tarsal plate. A delicate mechanism and power balance are present in every normal eyelid and account for some of the unusual manifestations of various presentations of ptosis. For example, the aponeurosis acts as a “check” ligament only, preventing too much eyelid descent.\textsuperscript{1} If a ptotic eyelid is corrected with the usual technique of aponeurosis to tarsectomy reinsertion, the contralateral lid is still dependent on Muller’s muscle and the elastic aponeurosis. There will, in fact, be a difference between the lifting mechanisms of the previously ptotic (operated) eyelid and the contralateral (unoperated) eyelid, which might drop.\textsuperscript{1} However, after Mullerectomy, the length of the muscle does not affect LP activity, as the length is decreased, but not the muscle tension. Hence, Hering’s law effect is less significant than in levator advancement, where the muscle tension is more significant. Another possible difference of Hering’s law on various ptosis approaches is that the eyelid lift in Mullerectomy stems from the conjunctival shortening and plication or scarring of the posterior lamella and not the amount of resected Muller muscle.\textsuperscript{31} As such, there is no influence on the LP nucleus (which innervates the LP bilaterally) and the LP of other eye does not stretch.

More Hering’s effect was found in levator repair of combined intraoperative and postoperative cases, but not with pure postoperative cases. A staged, second surgery on the contralateral lid was required in only 20% and 12% of Mullerectomy and levator surgery patients, respectively. So while Hering’s effect was seen more often with levator surgery, most manifested on the table with less need for a second surgery. Intraoperative Hering’s testing is not accurate and might lead to an inaccurate MRD1 assessment. Injection and surgery usually cause swelling and bruising, making such intraoperative evaluations inaccurate for assessing Hering’s law on the un-operated side. The author uses about 1 cc of local anesthesia for the posterior approach and about 2 cc for the anterior approach for each eyelid, so the swelling and bruising is different between these methods.

The findings presented here are limited by possible confounding factors. It is possible that a second surgery was required less often with Mullerectomy because these patients responded to a physiologic phenylephrine test to lift the lid with a similar physiologic lowering of the other lid (an accurate evaluation of Hering’s). In patients who had levator advancement, the lid was lifted manually, which may be a less accurate assessment of Hering’s effect. In addition, for these cases a posterior approach was chosen when the phenylephrine test was positive. It is possible that it is not necessarily the surgical approach that causes the difference detected, but rather the physiology of the eyelid as to whether or not it respond to pheynylephrine.

Figure 5. (A) A 61-year-old woman with left aponeurotic ptosis (marginal reflex distance 4 mm in right and 1 mm in the left eye). She had Mullerectomy with tarsectomy on the left eye, in December 2011. (B) 12 months postoperatively, she had symmetric results of 4 mm, bilaterally.
Despite the fact that there was no significant difference preoperatively in MRD1 between both methods in the current study, it is possible that the likelihood of a Hering’s dependence and contralateral ptosis following surgery would be higher with levator surgery since it is often performed in cases with more severe initial ptosis. In addition, the results may be related to the parameters dictated (ie, at least 2 mm ptosis). For patients with smaller degree of ptosis, as is often the case with aesthetic patients, the situation may differ.

The study includes a relatively small number of patients. Moreover, they have a heterogeneous ptosis etiology, which we attempted to differentiate. Hence, each parameter might change the statistical interpretation. Likewise, many factors can influence ptosis repair, including etiology, preoperative values (LF, MRD, etc.), and measurement errors by the examiner, among others. Palpebral fissure height and diurnal variation can also change the surgical outcome.

**CONCLUSION**

In the current study, the Hering’s law effect was not found in cases with poor levator function, post-trauma, or congenital ptosis (even with good LF). These cases can be performed unilaterally, with no need to repair the contralateral side. We also found that the Hering’s law effect was more common with the levator advancement approach than Mullerectomy.

This information has broad clinical applicability. In some cases of unilateral ptosis, as in congenital ptosis, there is no need to examine for Hering’s law phenomena preoperatively or to operate on the contralateral eyelid. A thorough patient history and preoperative assessment, including specific inquiry regarding poor levator function and trauma, are needed, as well as early childhood photographs and a clinical examination. If indeed Hering’s law effects occur less often with a posterior surgical approach, this should be considered in the surgical plan for cases where a second surgery is less desired (such as with elderly patients). Despite the mentioned limitations, we believe that the current results can assist surgical planning and intraoperative management of ptosis repair. To investigate this phenomenon more thoroughly, a prospective study should be conducted with preoperative videos, additional photographs, and long-term follow-ups.

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REFERENCES
12. Schechter RJ. Ptosis with contralateral lid retraction due to excessive innervation of the levator palpebrae superio-
13. Samimi DB, Erb MH, Lane CJ, Dresner SC. The modified fasanello-servat procedure: description and quanti-