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Original Article

The Effect of Lower Eyelid Malposition Repair on Palpebral Fissure Size Changes

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Abstract

Objectives: The aim of the study was to evaluate the effect of changes in the horizontal and vertical palpebral fissure dimensions on surgical success performed due to entropion and ectropion of the lower eyelid.

Methods: The present research was conducted as a retrospective and interventional case series who had undergone involutional lower eyelid malposition repair with a lateral tarsal strip (LTS) alone, LTS with a medial spindle, and LTS with the advancement of the lower eyelid retractors. The subjects' medical records, including demographic and clinic characteristics, pre-operative assessment of horizontal eyelid laxity, and surgical outcomes, were reviewed. The distance between the pupillary light reflex and the lower-eyelid margin marginal reflex distance 2 (MRD-2) and the horizontal palpebral aperture (HPA) width were measured using the Image J program in the pre-operative and post-operative 6-month follow-up. The correlation between surgical success, changes in pre-operative and post-operative MRD-2, and HPA width was assessed by the Spearman rank correlation test.

Results: A total of 66 eyelids of 48 patients were included in the study. This cohort comprised of 41 males (86.4%) and 7 females (13.6%), 18 of whom underwent bilateral surgery. The pre-operative mean MRD-2 was 7.13 ± 1.98 mm, and the post-operative 6-month mean MRD-2 was 6.21±1.19 mm ($p<0.01$). The mean post-operative HPA width was statistically significantly higher in comparison with the mean pre-operative HPA width (27.35±2.41, 26.89±2.39, $p=0.02$, respectively). There was no correlation between success rate and changes in horizontal and vertical palpebral fissure dimensions.

Conclusion: LTS surgery is a method that turns the shortened HPA width to normal and enables the successful correction of the lower eyelid malpositions.

Keywords: Horizontal lower eyelid laxity, horizontal palpebral aperture width, lower eyelid malpositions, vertical eyelid instability

Introduction

Entropion and ectropion are among the most common eyelid problems in the elderly population where many factors play a role in the development of their mechanism. The laxity of the medial and lateral canthal tendons, the disinsertion of the lower eyelid retractors, and orbicularis muscle degeneration represent the main factors for involutional lower lid ectropion. Furthermore, horizontal eyelid laxity, tarsus instability induced by lower eyelid retractor dehiscence, the override of the preseptal orbicularis muscle onto pretarsal orbicularis, and involutional enophthalmos induced by or-

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bital soft-tissue atrophy are notable changes in involutional lower lid entropion (1-4). Among multiple predisposing factors, horizontal eyelid laxity is the common factor which plays a role in both entropion and ectropion and may occur due to many reasons. A number of researchers have suggested that aging leads to a lateral canthal ligament elongation, the downward displacement of the lateral canthus, and of the eyeball proper. Accordingly, aging has been found to cause gradual shortening of the horizontal palpebral aperture (HPA) of approximately 2.5 mm (5,6).

Since lateral canthal tendon laxity represents the main issue in a significant part of lax eyelids, the lateral tarsal strip (LTS), which is an operation to tighten the lateral canthal tendon, is a widely used method to correct involutional entropion and ectropion (7). LTS can be applied alone or in combination with a medial spindle for punctal ectropion and advancement of the lower eyelid retractors for vertical eyelid instability causing entropion. In all these surgeries, it is aimed to increase lower eyelid stability, to normalize the relationship of the lower eyelid with the globe, and to prevent the inward or outward rotation of the eyelid. The purpose of this study was to evaluate the effect of changes in the horizontal and vertical palpebral fissure dimensions on surgical success performed for entropion and ectropion of the lower eyelid.

Methods

The present research was carried out as a retrospective and interventional consecutive case series including 72 eyelids of 54 subjects who had undergone age-related lower eyelid malposition repair with LTS alone, LTS with a medial spindle, and LTS with an advancement of the lower eyelid retractors. Ethical approval was waived by the Local Ethics Committee of Okmeydanı Training and Research Hospital Ethics in view of the retrospective nature of the study and all the procedures being performed were part of the routine care. The research was conducted within the scope of the principles of the Declaration of Helsinki. The medical records of all subjects who were treated and followed up for at least 6 months at the Ophthalmic Plastic and Reconstructive Surgery Department of the authors' hospital between May 2018 and December 2019 were reviewed retrospectively. The patients who have lower eyelid malposition due to a cicatricial, paralytic, mechanic, and congenital problems, and who have a history of any kind of lower eyelid surgery were excluded from the study. Anterior, medial, and lateral distraction tests and also the snapback test were conducted to assess the horizontal lower eyelid laxity. In the distraction test, the lower eyelid is pulled away from the globe, and the measurement of the distance between the globe and the lower eyelid is measured in millimeters. Eyelid distraction above 8 mm is considered abnormal. In the snapback test, the lower eyelid is pulled down, and it is monitored at what time the eyelid returns to the initial position after the release. In case of a delay of the snapback or requiring a blink for resetting the lower eyelid, there is considerable lower eyelid laxity. The severity of the disease was defined as the fourth grade in terms of the laxity. Grade 0, no lid margin eversion and no detectable deformity; Grade I, a minimal scleral show without of the loss of lower eyelid tarsal ligamentous tone; Grade II, mild lower eyelid laxity; Grade III, moderate lower lid laxity; and Grade IV, frank entropion or ectropion (8).

Data collection was performed from the medical records of every subject, including their age, sex, type of procedure, the period of follow-up, pre-operative assessment of horizontal eyelid laxity, peri-operative complications, and surgical success. All subjects were photographed frontally by a digital camera (Canon G3X, Canon Inc., Tokyo, Japan) under the same light conditions with the eyes in the primary position before and after the surgery. A self-adhesive dot sticker with a 10 mm diameter in the glabellar area was used to set the mm/pixel scale. The HPA width (the distance between the medial and lateral canthus) and the marginal reflex distance 2 (MRD-2, the distance between the pupillary light reflex and the lower-eyelid margin) were measured using the Image J (U.S. National Institutes of Health, Bethesda, Maryland, USA) program on the pre-operative and post-operative 1-month photographs (Fig. 1).

Functional success was defined as the recovery of symptoms. The punctal position in the tear lake, the absence of ectropion, the lack of contact of cilia with the globe, and the absence of entropion recurrence were judged for the anatomical success.

Surgical Technique

The patients were operated under local anesthesia and intravenous sedation. The conjunctiva and the lateral orbital rim were infiltrated with 2 mL 1% lidocaine with 1:200.000 epinephrine. A lateral canthal incision was performed through the skin and orbicularis. After dissection of orbicularis and exposing the periosteum of lateral orbital rim, lateral canthotomy and a lower limb cantholysis were carried out. After measuring the horizontal lid excess, anterior lamella and conjunctiva were removed from the tarsus and a tarsal strip was created. 6.0 Prolene was used to fashion and secure the tarsal strip to the zygomatic periosteum right inside the orbital rim at the Whitnall tubercle above the horizontal canthal line. The reformation of the lateral canthal angle was performed and the closure of the orbicularis and skin in two layers was ensured. In case of punctal ectropion, as described for medial spindle surgical technique by Nowinski and Anderson, (9) the eversion of the lower eyelid and

Figure 1. Photographs of pre-operative measurement of palpebral dimensions with Image J program after using a 10 mm diameter dot to set the mm/pixel scale, marginal reflex distance 2 (MRD-2) **(a)**, and Horizontal palpebral aperture (HPA) width measurement **(b)**. Photographs of post-operative measurement of MRD-2 **(c)** and HPA width measurement **(d)**. The red ellipses show the lengths of MRD-2 and HPA in millimeters.

the insertion of a lacrimal probe into the inferior canaliculus were made. The excision of a diamond shape of the conjunctiva and lower eyelid retractors located inferior to the lacrimal punctum was performed by Westcott scissors. Thus, the superior apex of the diamond was located just below the lacrimal ampulla. The closure of the incision was performed using 6.0 Vicryl, during which the retractors' cut edge was retracted in such a way that it was included on the same needle pass, involving the conjunctiva at the lower apex of the diamond. For severe entropion where LTS was not enough, advancement of lower eyelid retractors was added to the procedure. After local anesthesia, a horizontal skin incision was made at approximately 3–4 mm below the line of the lower eyelash. After the incision of the skin, the orbicularis muscle was dissected; the anterior surface of the eyelid retractors can be observed after the removal of septum and fat pads. The portion of the eyelid retractors attached to the tarsus was separated. The eyelid retractors were dissected from conjunctiva downward. The posterior of the lower eyelid retractor is created and advanced, and then is fixed to tarsus with three 6.0 Vicryl suture. The closure of the skin incision was performed using 6.0 Prolene suture.

Statistical Analysis

The Shapiro–Wilk test was employed to determine the distribution of the data. Categorical results were compared by Pearson's Chi-squared test (Exact 2- sided). Paired t-test was used for statistical evaluation at baseline and at 6 months mean MRD-2 and the HPA width. The Spearman rank correlation was used to evaluate the correlation between surgical success, changes in pre-operative and post-operative MRD-2 (ΔMRD-2), changes in pre-operative and post-operative HPA (ΔHPA) width, the age and the sex of the patient, diagnosis, severity of the disease, and type of the surgery. $P<0.05$ was considered statistically significant. The SPSS 17.0 program was used for all statistical analyses.

Results

A total of 72 eyelids of 54 patients were included in the study. This cohort comprised of 45 males (83.3%) and 9 females (16.7%), 18 of whom underwent bilateral surgery. Of the 51 eyes with ectropion, LTS only was applied to 38 patients, and LTS with a medial spindle was applied to 13 patients. Of the 21 eyes with entropion, 20 patients underwent LTS with a lower lid retractor advancement, and one patient underwent LTS alone. No peri-operative or post-operative complication was observed. The demographics and clinical characteristics of the cases, type of surgery, and surgical success rate are shown in Table 1. The mean pre-operative MRD-2 was 6.99±1.91 mm, and the mean post-operative 1-month MRD-2 was 5.67±1.29 mm ($p<0.01$). A statistically significantly higher mean post-operative HPA width compared to

Table 1. The demographics and clinical characteristics of patients

	Involutional ectropion n=48	Involutional entropion n=18
Age (mean±SD) year	71.81±9.79	69.78±9.00
Gender		
Male	43 (65%)	14 (7.6%)
Female	5 (21.2%)	4 (6.2%)
Follow up (mean±SD) mo	11.29±3.50	12.16±2.50
Severity of disease		
Grade 0	16 (33.3%)	0
Grade 1	15 (31.3%)	5 (27.8%)
Grade 2	9 (18.8%)	10 (55.6%)
Grade 3	8 (16.7%)	3 (16.7%)
Type of surgery		
LTS	36(75%)	1 (5.6%)
LTS with a medial spindle	12 (25%)	0
LTS with LER advancement	0	17 (94.4%)
Functional success	46 (95.8%)	18 (100%)
Anatomic success	46 (95.8%)	18 (100%)
Overall success	44 (91.7%)	18 (100%)

LTS: lateral tarsal strip; LER: lower eyelid retractor.

the mean pre-operative HPA width was found (27.27±2.28, 26.82±2.43, p<0.01, respectively) (Table 2). There was a mild correlation between surgical success and ΔMRD-2. No significant relationship was determined between surgical success and, ΔHPA width measurements in the eyes that underwent surgery, the subject's age or sex, diagnosis, the severity of the disease, and type of the surgery. On the other hand, there is a weak positive correlation between the severity of the disease and age, and a mild positive correlation between the severity of the disease, ΔHPA width measurements, diagnosis, and type of the surgery (Table 3). In addition, ΔMRD-2 was also found a significant predicting value of the surgical in logistic regression analysis (OR 7.17, 95 % CI, 1.15–44.69, p=0.035), (Table 4).

Discussion

Various surgical methods have been described with variable success rates in the literature to address the involutional lower eyelid malposition (10-13). Although horizontal lower eyelid laxity is the crucial pathology to be addressed, combined surgery is inevitable in some cases for a successful outcome. Complete surgical success was found in subjects with entropion and ectropion, who had undergone the combination surgery in this study. On the contrary, a lower success rate (92.2%) was determined in subjects with ectropion who had undergone LTS alone. Anatomical recurrence was shown in two patients and functional recurrence was shown in the other two patients. This was comparable with other studies in which the functional and anatomic success rates were range between 87% and 100% (10-12).

Bosch et al. demonstrated that aging caused a gradual shortening of the horizontal eyelid fissure of approximately 2.5 mm. At the same time, a decrease of about 1.5 mm occurred in the distance from the lateral canthal angle to the anterior corneal surface (6). This caused horizontal lower eyelid laxity. Horizontal laxity and the disinsertion of the lid retractors may lead to general tarsal instability, which can cause entropion or ectropion (14,15). Treatment is generally planned to overcome the horizontal laxity. The LTS surgery represents a beneficial technique to correct ectropion or entropion with the aim of tensing the horizontal laxity (10,16,17). The above-mentioned procedure shortens the eyelid in the horizontal direction at the point of attachment of the lateral canthal ligament, the laxity of which represents the main pathological characteristic of the aging eyelid (10,16). In another study, the researchers stated that the midtarsal lower lid shortening procedure performed for entropion caused the iatrogenic phimosis of the palpebral fissure, but this was not observed in patients undergoing LTS (17). In the present study, it was evaluated how the HPA width was affected after LTS alone and combined surgery and found a statistically significantly longer post-operative mean palpebral horizontal aperture width in comparison with the mean pre-operative palpebral aperture width.

Thaller et al. (18) investigated the impacts of the direct closure of full-thickness eyelid margin defects under tension

Table 2. Comparison of pre-operative and post-operative palpebral fissure dimensions

Mean	Pre-operative	Post-operative month 6	P*
MRD-2 (mm±SD)	7.13±1.98	6.21±1.19	<0.01*
HPA width (mm±SD)	26.89±2.39	27.35±2.41	0.02*

MRD-2: The pupillary light reflex and the lower-eyelid margin; HPA: Horizontal palpebral aperture; *Paired sample t-test; P<0.05 statistically significant.

Table 3. Correlations between variable factors and surgical outcome

	Age	Gender	Severity of the disease	ΔMRD-2	ΔHPA width	Type of surgery	Diagnosis
Surgical success							
r	-0.08	0.10	-0.03	0.24	0.14	0.20	0.15
P*	0.48	0.42	0.81	0.10	0.33	0.10	0.21
Severity of the disease							
r	0.29	-0.10	1	0.36	0.44	0.39	0.31
P*	0.01*	0.38		0.01*	0.01*	<0.01*	<0.01*

MRD-2: The pupillary light reflex and the lower-eyelid margin, ΔMRD-2: Changes in pre-operative and post-operative MRD-2, ΔHPA: Changes in pre-operative and post-operative horizontal palpebral aperture, *Spearman rank correlation, r: Correlation coefficient, P<0.05, statistically significant.

Table 4. Logistic regression analysis independent predictors of surgical outcomes

	P*	Exp(B)	95% C.I.for EXP(B)	
			Lower	Upper
Age	0.723	1.040	0.836	1.295
MRD-2	0.399	0.624	0.209	1.866
HPA width	0.907	1.037	0.562	1.914
ΔMRD-2	0.068	5.842	0.878	38.888
ΔHPA width	0.276	2.290	0.516	10.165

MRD-2: The pupillary light reflex and the lower-eyelid marginm, HPA: Horizontal palpebral aperture, ΔMRD-2: Changes in pre-operative and post-operative MRD-2, ΔHPA: Changes in pre-operative and post-operative horizontal palpebral aperture, *P<0.05 statistically significant.

on the palpebral aperture dimensions. They suggested that it was possible to resect a significant amount of lid tissue without considerable changes in the ultimate palpebral dimensions. They detected no difference in the HPA width measurements before and after surgery (18). In the present study, unlike the above-mentioned research, the horizontal eyelid shortening was performed for the horizontal laxity with LTS thereby anchoring the elongated lateral canthal ligament to the orbital-rim periosteum may lead to palpebral fissure lengthening. In contrary our results Georgescu et al. (13) showed a more dramatic lengthening in the HPA in the cases with lateral canthal resuspension when compared with LTS. Since they started to elevate lateral canthus to a higher position from Whitnall's tubercle. In a recent study, it was mentioned that aging could cause an increased distance from the pupil center to the lower eyelid in both males and females (6). The advancement of the lower eyelid retractor and/or medial spindle procedures can be combined with the LTS for the vertical laxity of the lower eyelid (10,11). Georgescu et al. (13) found that a mean decrease in MRD-2 was 0.86±0.1 mm in patients undergoing LTS. The mean decrease in MRD-2 was 1.31±1.56 mm in the present study. Decreasing the MRD-2 was slightly more effective in our study since we have done LTS as well as medial spindle or lower eyelid retractor advancement in severe cases. Therefore, the lower scleral show improved without the development of palpebral phimosis and tarsus instability was prevented by improving the contact of the lower eyelid with the globe. There was a positive correlation between surgical success and change of MRD-2 in our study. Lower eyelid contact with the eyeball may increase with decreased MRD-2. In addition, we found that the mean change of MRD-2 was a predictive factor of surgical success. The severity of the disease was also increased with age, entropion diagnosis, and ΔHPA width measurements in this study. We used Image J software to measure the biometric parameters of the eyelids quantitatively. Measuring the biometric parameters with a ruler has some limitations such as observer variables, need to sitting at the eye level of the patient, and standard illumination (19). Furthermore, it is not possible to accurately measure decimal values with millimeter ruler. Image J program is more objective than conventional method. Some other advantages of the using this program are that the digital images can be stored in computers and can be recalled and analyzed at follow-up visits (20).

Retrospective and non-randomized design and the shorter mean follow-up time were the limitations of this study. It is possible to obtain more beneficial information to analyze the findings by measuring the distance between the lateral orbital rim and the lateral commissure.

Conclusion

The LTS surgery may achieve successful results by increasing the HPA width and by ensuring the lateral canthus approaches the lateral orbital rim alone or in combination surgeries in lower eyelid malpositions. MRD-2 difference with surgeries was a predictive factor for surgical success. The anatomical and functional results may be improved by restoring the vertical instability of the lower eyelid and involutional horizontal eyelid fissure shortening.

Disclosures

Ethics Committee Approval: Okmeydanı Training and Research Hospital Ethic Commite, 19.02.2020/48670771-514.10 E.3902.

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