Prospective Analysis of Changes in Corneal Topography After Upper Eyelid Surgery

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Purpose: Some patients note a decrease in visual acuity in the operated eye after eyelid surgery. Although, the most common cause for this change is dry eye syndrome, it has been hypothesized that the symptom of blurred vision may result from a change in the corneal curvature. The study was conducted to determine if there is a change in corneal curvature after upper eyelid surgery.

Methods: Standard keratometry and corneal videokeratography (CVK) were performed 1 and 3 months after blepharoplasty (18 lids) and ptosis repair (24 lids). Pre- and postoperative images from CVK data were digitally subtracted for quantitative evaluation.

Results: After ptosis repair, the average dioptric change as measured by keratometry and by CVK was approximately 0.60 diopters (D); of note, nearly 30% of these patients showed transient astigmatic changes greater than 1.00 D; After blepharoplasty, the average dioptric change as measured by keratometry and by CVK was approximately 0.55 D; of note, only 11% of patients showed astigmatic changes greater than 1.00 D.

Conclusion: Repositioning of the upper eyelid after ptosis repair or blepharoplasty may result in visually significant astigmatic changes in the central and peripheral cornea and may alter the patient's spectacle or contact lens correction.

Patients who have undergone ptosis surgery occasionally complain of blurred vision in the operated eye (1). A limited number of causes have been found to account for these subjective symptoms. It has been theorized that patients without the more common causes of blurred vision—dry eye, diminution of the blink reflex, and eyelid notching or contour changes—may have a change in the refractive error from a change in corneal curvature. Clinical evidence for this alteration, however, has not been previously demonstrated (1,2). The association between eyelid abnormalities (i.e., hemangiomas of the eyelids and orbit) and astigmatism has been documented (3). In both ptosis and dermatochalasis the upper eyelid is abnormal. After ptosis, upper eyelid blepharoplasty, or both, the upper eyelid shape and contour has been altered. Patients with ptosis have an upper eyelid that is displaced down over the corneal surface to varying degrees (Fig. 1A–D); with dermatochalasis, excess skin and prolapsed fat can cause eyelid hooding (Fig. 1E, F). Raising the eyelid or removal of any excess skin repositions the eyelid and may alter corneal curvature and affect the patient's refraction. This may be the cause of blurring seen after surgery in these patients whose visual loss cannot be explained on the basis of dry eye syndrome.

Although corneal curvature and changes of curvature usually are measured with a keratometer, the instrument only assays the central 3 mm of the cornea. Corneal videokeratography (CVK) has greatly

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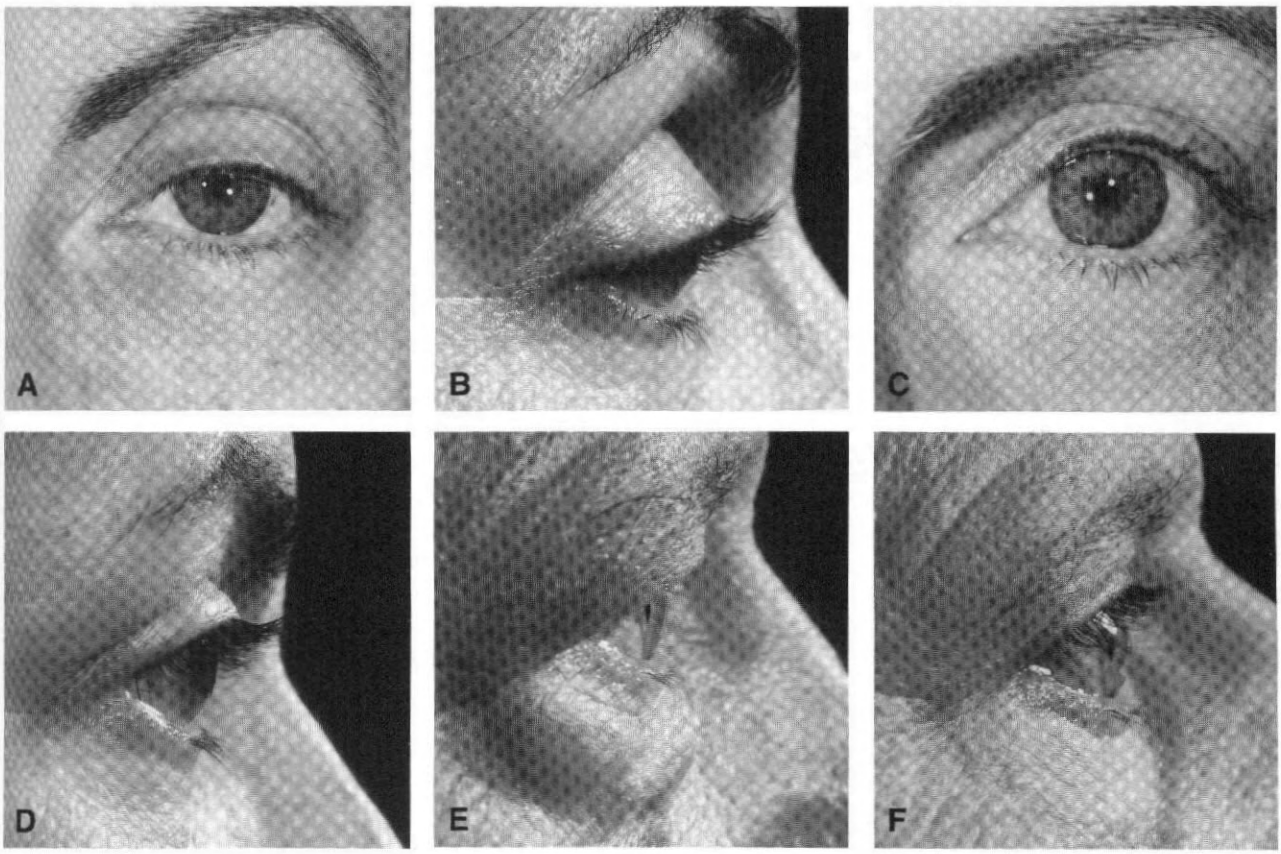

FIG. 1. **A, B.** Preoperative photographs of a patient with ptosis demonstrating the upper eyelid resting lower on the cornea. **C, D.** After surgical correction the upper eyelid rests higher on the cornea producing relative steepening at 12 o'clock. **E.** Preoperative photograph of a blepharoplasty patient demonstrating excessive upper eyelid tissue pressing on the cornea. **F.** Postoperatively, with a reduction in upper eyelid tissue the palpebral aperture is widened, steepening the corneal surface in a more superior position (new with-the-rule astigmatism).

enlarged the measurable area. Although CVK is an established method to examine changes in the cornea after ocular surgery (4,5), to date no study using this technique has described an effect on the corneal curvature after ptosis repair or blepharoplasty. Because both procedures effect upper eyelid height and contour and the degree of eyelid–cornea contact, it seems plausible that both procedures might subsequently alter the corneal curvature.

Our study prospectively examined changes in corneal curvature as determined by corneal topography at multiple points in time after surgery to determine: 1) if changes in corneal topography occur soon after upper eyelid surgery; and 2) if changes in corneal topography are documented, which corneal meridians are affected, and when they stabilize.

TABLE 1. *Patient characteristics*

	Blepharoplasty	Ptosis
Male	14	21
Female	4	3
Total	18	24
Average age (y)	69.7	52.9

METHODS

Our study represents a nonrandomized prospective cohort of patients who underwent repair of ptosis or dermatochalasis. Patients were recruited from the Manhattan Veterans Hospital and Bellevue Hospital from January through May 1995. Patients with other ocular or orbital surgery, repeat surgical procedures, and unsuccessful results were excluded. Our study group included 24 eyelids in 13 patents who underwent repair of ptosis, and 18 eyelids in 9 patients who underwent blepharoplasty. Patients ranged in age from 13 to 80 years (Table 1). Refraction and CVK were performed preoper-

atively. The surgical technique for patients undergoing ptosis repair included: 1) anterior levator surgery (nine patients); 2) tarsomyectomy (two patients); 3) conjunctiva-mullerectomy (nine patients); and, 4) frontalis sling (four patients).

Measurements were also taken 1 and 3 months after surgery. Astigmatism was classified "with-the-rule" if the steep meridian was at 90° ± 20° or "against-the-rule" if the steep axis was at 180° ± 20°.

Change in corneal curvature was measured by keratometry and CVK. Keratometry measurements after surgery were subtracted from keratometry measurements before surgery to determine the magnitude and orientation of change, which was categorized as with-the-rule, against-the-rule, or no change. Similarly, digital subtraction using the CVK postoperative corneal values were subtracted from preoperative values to create a difference map, which demonstrated the magnitude, location, and direction (e.g., steepening or flattening) in corneal curvature.

RESULTS

Ptosis

The average preoperative astigmatism of the study group was 1.50 diopters (D), an error that usually reduces vision to about 20/40. Approximately 70% of these patients had with-the-rule astigmatism (Table 2). As measured by keratometry, the average dioptric change at 1 and 3 months after surgery was 0.60 D. Between 1 and 3 months the number of eyes that increased in change was approximately equal to the number of eyes that decreased. Almost 30% of patients showed astigmatic changes greater than 1.00 D one month after ptosis repair (see Fig. 2). Similar changes were found by CVK; the average dioptric changes at 1 month and 3 months after surgery were 0.68 D and 0.61 D, respectively.

TABLE 2. *Average cylinder in preoperative group measured by both keratometry and corneal videokeratography*

	Blepharoplasty	Ptosis
Cylinder by keratometry	1.0 D	1.5 D
% of patients with WTR astigmatism before surgery	22	70

D, diopter; WTR, with-the-rule.

The average dioptric change, as measured by keratometry, was not statistically different for any procedure for repair of ptosis (Table 3). By keratometry, 29% and 42% of patients had a with-the-rule change at 1 and 3 months, respectively (Fig. 3). Approximately 20% of patients had a 90° shift of the steeper meridian, but of these, half became with-the-rule. Corneal videokeratography showed that at 1 month and 3 months after ptosis repair, slightly more than 50% of patients had a vertical steepening (Fig. 4).

Blepharoplasty

The average preoperative cylinder of the study group was 1.0 D; approximately 22% of these patients had with-the-rule astigmatism (Table 2). As measured by keratometry, the average dioptric change at 1 and 3 months after surgery was 0.49 D and 0.57 D, respectively. Between 1 and 3 months, astigmatism increased in 10 eyes and decreased in 8 eyes. One month after blepharoplasty only 11% of patients showed astigmatic changes greater than 1.00 D (Fig. 5). Similar changes were found by CVK; the average dioptric change at 1 month and

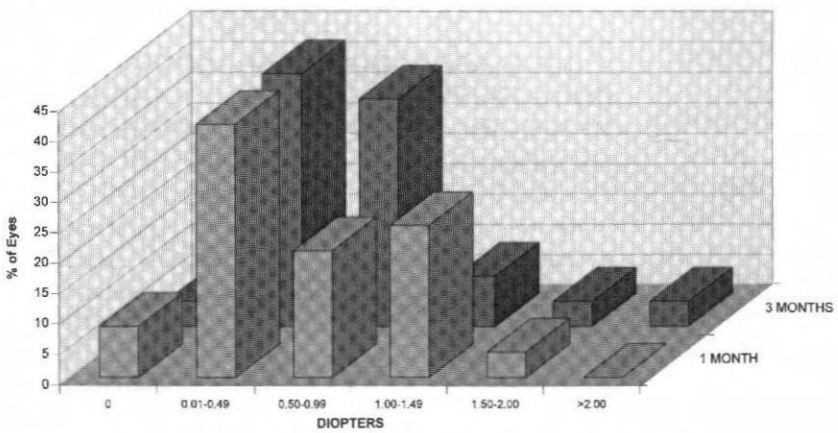

FIG. 2. The bar graphs show the distribution of dioptric change in corneal curvature after ptosis repair as measured by keratometry. Note that the changes in curvature do not specify a steepening or a flattening, nor do they indicate which meridian(s) are responsible for the change.

TABLE 3. *Average change as measured by keratometry, according to surgical technique*

	n	1 mo	3 mo
Müller muscle conjunctival resection	7	0.29	0.67
Tarsomyectomy	2	0.60	0.48
Anterior levator advancement	9	0.74	0.52
Frontalis silicone sling	4	0.86	0.80

3 months after surgery were 0.62 D and 0.45 D, respectively. Similar to the keratometry measurements, CVK data revealed that 1 month after blepharoplasty only 16% of patients showed astigmatic changes greater than 1.00 D (Fig. 6). As measured by keratometry, 50% and 67% of patients had a with-the-rule change at 1 and 3 months, respectively (Fig. 7). Approximately 35% of patients had a 90° shift of the steeper meridian, but of these, at 3 months all became with-the-rule changes. Corneal videokeratography data showed that, at 1 and 3 months after blepharoplasty, 65% of patients had a steepening in the vertical meridian.

DISCUSSION

It may appear paradoxical at first that procedures performed on eyelids should induce changes in the refractive state of the eye. However, considering the eyelid–cornea interaction and that even minuscule surface alterations of the cornea can result in significant visual change, it is less surprising that our study demonstrated corneal curvature changes after repair of ptosis and blepharoplasty. After ptosis repair, repositioning of the upper eyelid resulted in astigmatic changes in the central and peripheral cornea. In fact, nearly 30% of our patients showed transient changes greater than 1.00 D. The average change in diopters was not statistically different among the various surgical methods. Of those whose steepest corneal meridian changed, slightly more than half became with-the-rule changes, i.e., the steepest curvature occurring in the vertical meridian.

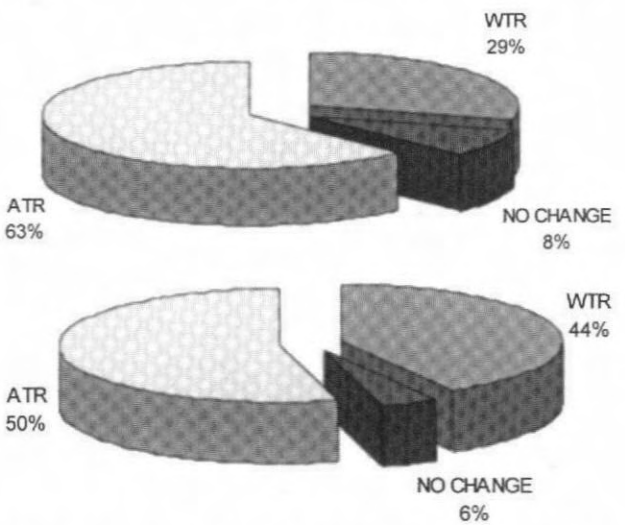

FIG. 3. Changes in topography as measured by keratometry at 1 month (top) and 3 months (bottom) (percentage of eyes with a with-the-rule [WTR] change at 1 and 3 months after ptosis repair). Note that there are 50% more eyes at 3 months that demonstrate a with-the-rule change as compared with 1 month. ATR, against-the-rule.

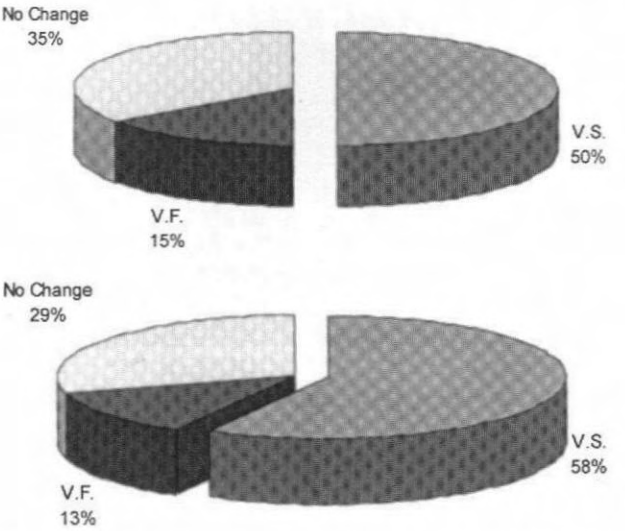

FIG. 4. Changes in topography as measured by corneal videokeratography at 1 month (top) and 3 months (bottom). The percentages of eyes that have a steepening along the vertical meridian (V.S.) after repair of ptosis are shown in this set of pie charts. Note that the data do not specify if the change is the result of vertical steepening, horizontal flattening, or both. V.F., vertical flattening.

Persistent astigmatic changes in the central and peripheral cornea were found more commonly after blepharoplasty. Indeed, approximately 90% of patients had only a small degree of astigmatic change (less than 1.00 D) in the central and the peripheral cornea. Approximately two thirds showed a steepening in the vertical meridian. Of the patients whose steep axis changed, all changed to become with-the-rule changes at 3 months.

In both ptosis and blepharoplasty procedures, the corneal changes were the result of a change in the way the eyelid apposed the cornea after surgery. Eyelid abnormalities and induced astigmatism have been previously reported. For example, Robb (3) reported the association between hemangiomas and astigmatism; in his study the pressure of the tumor

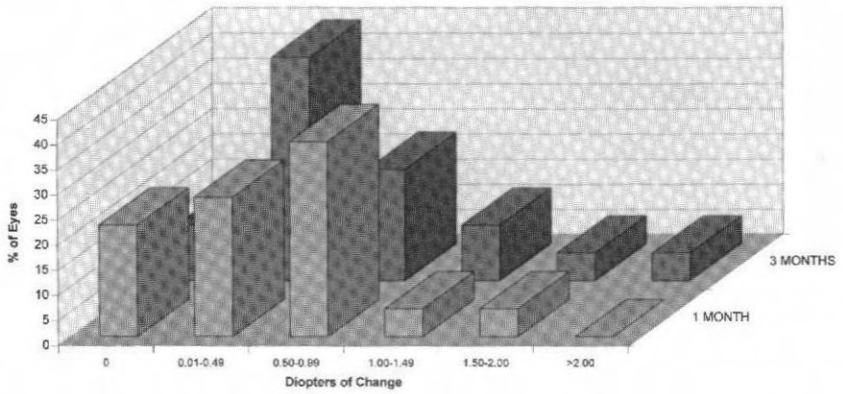

FIG. 5. The bar graphs show the distribution of dioptric change in corneal curvature after blepharoplasty as measured by keratometry. Note that the changes in curvature do not specify a steepening or a flattening, nor do they indicate which meridian(s) are responsible for the change.

seems to have produced a relative steepening in the cornea in one meridian. In a series of patients with congenital ptosis, Merriam et al. (6) noted a high incidence of astigmatic errors after surgery; 15% of the patients developed an increase in corneal steepening along the 90° meridian after surgery. They theorized that surgically elevating the eyelid may apply pressure on the globe superiorly that might create a steepness in that meridian, or a with-the-rule change.

Two studies have been published that specifically examined the effect of ptosis surgery on astigmatic refractive error. The first, by Cadera et al. (2) reported changes in astigmatism after surgery for congenital ptosis in children using both fascia lata slings and levator resections. They examined 88 eyes at 3, 6, and 12 months after surgery. They noted an overall increase in average astigmatic increase of 0.30 D; 36% of the eyes changed by more the 0.75 D.

The second study, by Gingold et al. (1) reported no statistical change in refractive error after surgery for acquired ptosis. In their 6-month retrospective study they examined refraction and keratometry on 47 eyelids in 26 patients after surgery at 6 months after levator resection. Although patients noted a subjective change in vision after surgery, no statistical changes in corneal curvature were found. It should be noted, however, that it is unclear whether combining data on corneal flattening and corneal steepening may have masked a change.

It should be noted that both of the above studies used standard keratometry to examine the cornea. However, keratometry measures only the curvature around a small central area of the cornea; it does not measure beyond the central area and does not assess the corneal apex itself. In constrast, corneal topographic analysis yields information about virtually the entire corneal surface. In our study, the number of patients who had a with-the-rule change was underestimated by keratometry compared with CVK. For example, at 1 month after repair of ptosis, keratometry data demonstrated that only 29% of patients had a with-the-rule change versus 50% as measured by CVK. In contrast, magnitude of corneal curvature change was not underestimated by keratometric data.

Given the substantial number of patients whose corneal shape is altered after ptosis repair or blepharoplasty, surgeons who perform these procedures should be aware that attendant changes in the patient's refractive status may occur. It may rea-

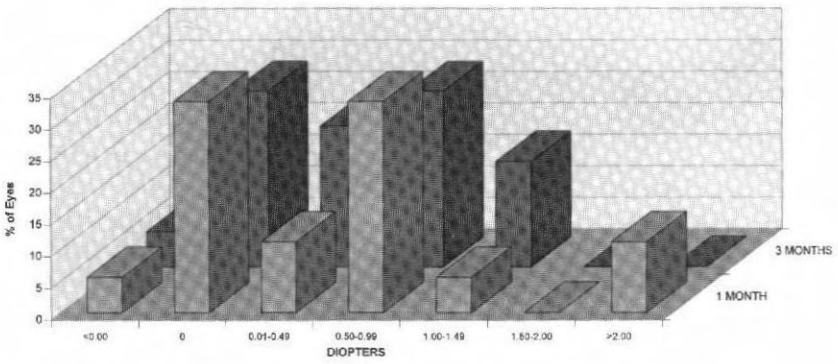

FIG. 6. The bar graphs show the distribution of dioptric change in corneal curvature as measured by corneal videokeratography proximal to the vertical meridian after blepharoplasty. Negative numbers indicate a flattening and positive numbers reflect a steepening in the vertical meridian(s).

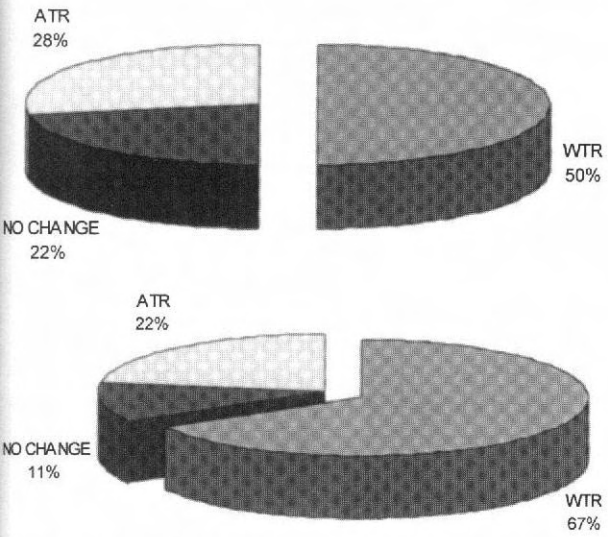

FIG. 7. Changes in topography as measured by keratometry at 1 month (top) and 3 months (bottom) (percentage of eyes that showed a with-the-rule [WTR] change at 1 and 3 months after blepharoplasty). ATR, against-the-rule.

sonably be asked why these findings are not clinically evident to a greater number of patients. Visual changes of 0.50 D or less usually are noted only by patients whose normal activities of daily living require a higher standard in their visual acuity. Patients who are sensitive to such changes in refractive error may require changes in their spectacle prescription or contact lenses. Although the aesthetic plastic surgeons may not be held to the same legal clinical standards as an ophthalmologist, it behooves the plastic surgical community to remember that any complaints of visual alterations after eyelid surgery may be the result of induced or altered astigmatism and that patients may require a change in their spectacle and contact lens prescription.

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