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Corneal Topographic Changes after Eyelid Ptosis Surgery

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ABSTRACT

Background: Modifications in eyelid position change pressure exerted on the corneal anterior surface and produce topographic changes that may affect the quality of vision and corneal refractive power and related measurements.
Aim of work: The aim of the current study is to evaluate corneal topographic changes after ptosis surgery.
Patient and Methods: 30 eyes of 30 patients of ptosis underwent surgical correction. Complete ophthalmic examination and computerized topography were performed before surgery, then 1-month and 3-months after surgery. The pre-operative and post-operative data were subtracted and statistically analyzed. Data included K1, K2, average keratometry (avgK), corneal astigmatism (value & type), apical keratometry front (AKf) and symmetry index front (SIf). The effect of surgery on BCVA was also evaluated.
Results: 1-month postoperative, none of the measured parameters did show any significant change. 3-months postoperative, corneal astigmatism demonstrated a significant reduction from baseline 1.2 ± 0.3 D to 0.7 ± 0.3 D ($p = 0.007$). (avgK) also demonstrated a significant reduction from baseline 43.1 ± 1.3 D to 42.2 ± 1.5 D ($p = 0.011$). Another significant difference was also reported in (AKf) which decreased from baseline 46.21 ± 1.81 to 44.22 ± 2.04 ($p = 0.033$). (SIf) decreased from baseline -1.23 ± 1.61 to -1.05 ± 1.39, difference was insignificant ($p = 0.308$). The BCVA improved from baseline 0.54 ± 0.22 to 0.61 ± 0.18 ($p = 0.285$), improvement was statistically insignificant.
Conclusion: The surgical correction of eyelid urges the modification of the anterior corneal surface, restoration of symmetry of the cornea and regular corneal astigmatism.

Keywords: *Ptosis; corneal topography; levator resection; frontalis sling.*

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INTRODUCTION

Ptosis is one of the most common eyelid disorders encountered in ophthalmology. It refers to abnormal drooping of the upper eyelid which may be unilateral or bilateral.[1]

Ptosis can be classified as congenital or acquired. Ptosis can also be classified according to the etiology into myogenic, aponeurotic, neurogenic, mechanical, neuromuscular,neurotoxic,pseudoptotic andtraumatic.In children it may interfere with the normal development of vision, resulting in amblyopia if the ptotic lid obstruct the pupil.[2]

In adults it may impair the field of vision and interfere with activities of daily living.[3]

The incidence of ptosis has increased in the elderly, especially after cataract extraction or lens replacement. This is probably due to the stretching or disruption of the levator muscle or its aponeurosis when the eyelids retracted with a speculum during surgery.[4]

The droopy eyelids may “compress” the eyeball leading to astigmatism.[5]

Altering the normal eyelid position has also been shown to cause changes in corneal topography and astigmatism.[6]

Ptosis and its surgery have additionally been found to cause changes in corneal topography and astigmatism.[7]

Corneal topography is a non-invasive imaging technique for mapping the surface curvature of the cornea.The refractive power of the cornea represents 70% of the refractive power of the eye, so its topography is important in determining the quality of vision.[8]

Assuming that pressure plays a role in the development of corneal astigmatism, it is needed to investigate whether there are links between the morphology of the eyelids and the topography of the cornea.[9]

PATIENT AND MATERIALS

Design: Prospective & interventional study.
Methods: 30 eyelids with congenital or acquired ptosis, assigned for levator resection/ frontalis sling surgeries, were included in the study. All patients were examined, operated upon and followed up at Al-Azhar university hospitalsin the period from 1/11/2018 to 31/1/2020.
This study was approved by Al-Azhar Medical Research Ethical Committee. Informed consent was obtained from all patients or their guardians before surgery.
Inclusion criteria: Patient diagnosed with moderate or severe ptosis (either congenital or acquired) that need surgical correction, Age > 4 years of both sexes and completed 3 months of follow up were included.
Exclusion criteria: Patients who had Previous intraocular, refractive surgery,Corneal scars, dystrophies, hypoesthesia,Corneal surface–altering diseases such as pterygium and keratoconus,Contact lens wearers,Patients with severe dry eye,Poor Bell's phenomenon,Patients with mild ptosis (MRD1 ≥ 3 mm),Patients uncooperative for topographic imaging,Significant postoperative undercorrection (MRD1 < 3mm).
Preoperative Examinations: All patients had complete ophthalmic examination including: cycloplegic refraction, BCVA (Snellen chart, Decimal nomination), Extraocular muscles motility, Slit-lamp biomicroscopy, palpebral fissure height, the upper eyelid margin reflex distance (MRD1), levator function. Jaw-winking phenomenon, Bell's phenomenon, pupils, and corneal sensation were also evaluated.
Computerized tomography (using Sirius® 3D rotating Scheimpflug & topography system) was performed preoperatively. We recorded power readings in the flat and steep axes from the anterior surface of the cornea for the central 3 mm zone (K1 and K2, respectively), corneal astigmatism, (SIf) and (AKf). All patients were photographed preoperatively.
Procedure: Patients with good levator function were assigned for levator resection, Patient with poor levator function were assigned for frontalis sling operationWe used extended Polytetrafluoroethylene (Gortex®) sling, placedin the suborbicularis plane, in a pentagonal fashion.
Postoperative Evaluations: BCVA and cycloplegic refraction were done. Corneal topography was performed one and three months post-operatively, data was subtracted digitally for quantitative evaluation. Photography and documentation.
Analysis of the data was done by SPSS (V. 25.0, IBM Corp., USA, 2017-2018). Quantitative parametric data were expressed as a Mean ± SD. Categorized data were expressed as numbers and percentages. The (P) probability of error value >0.05 was regarded insignificant, values of 0.05-0.01 was regarded significant, values ≤ 0.01 was regarded highly significant.

RESULTS

The study included 30 patients with ptosis, 17 males (56.7%) and 13 females (43.3%), the mean age of patients was 24.7 ± 7.9 years (6-63 years). Ptosis was congenital in 24 patients (80%) and Aponeurotic in 6 patients (20%); 17 patients (56.7%) had moderate ptosis and 13 patients (43.3%) had severe ptosis. Sling operation was done for 7 patients (23.3%) with poor Levator function, while Levator resection was done for 23 patients (76.7%), 6 patients (20%) with fair levator function and 17 patients (56.7%) with good levator function.

Demographic data		**Studied patients (N = 30)**	
Age	**Mean ±SD**	24.7 ± 7.9	
	Min - Max	6 – 63	
Sex	**Male**	17	56.7%
	Female	13	43.3%
Laterality	**Right side**	13	43.3%
	Left Side	17	56.7%
Ptosis type	**Congenital**	24	80%
	Aponeurotic	6	20%
Ptosis degree	**Moderate**	17	56.7%
	Severe	13	43.3%
Levator function	**Poor**	7	23.3%
	Fair	6	20%
	Good	17	56.7%
Type of operation	**Sling**	7	23.3%
	Levator resection	23	76.7%

Table 1: demographic data and ptosis details of patients.

At 1 month postoperatively, none of the studied corneal parameters did show a statistically significant change. In comparison to results at 1 month postoperatively, changes at 3 months in avgK & astigmatism were statistically significant (p-value: 0.028 and 0.014 respectively). By comparing preoperative results and results at 3 months postoperatively, changes in avgK, astigmatism & AKf were statistically significant (p-value: 0.011, 0.007 & 0.013 respectively), Table (2).

		Baseline (N = 30)	1st month (N = 30)	3rd month (N = 30)	P_1-value	P_2-value	P_3-value
K1 (D)	Mean	42.5	42.5	41.8	0.864 NS	0.731 NS	0.652 NS
	±SD	1.2	1.7	1.5			
K2 (D)	Mean	43.7	43.4	42.5	0.703 NS	0.802 NS	0.909 NS
	±SD	1.4	1.7	1.8			
avg K (D)	Mean	43.1	42.9	42.2	0.8 NS	0.028 S	0.011 S
	±SD	1.3	1.6	1.5			
Sph (D)	Mean	0.9	0.9	0.8	1.0 NS	0.664 NS	0.660 NS
	±SD	0.7	0.6	0.6			
AST (D)	Mean	1.2	0.9	0.7	0.855 NS	0.014 S	0.007 S
	±SD	0.3	0.2	0.3			
AST (type)	OBL	5 16.7%	6 20%	5 16.7%	0.920 NS	0.592 NS	0.697 NS
	WTR	21 70%	18 60%	18 60%			
	ATR	4 13.3%	6 20%	723.3%			
AKf (D)	Mean	46.21	45.9	44,22	0.361 NS	0.227 NS	0.033 S
	±SD	1.81	1.92	2.04			
SIf	Mean	-1.23	-1.17	-1.05	0.528 NS	0.418 NS	0.308 NS
	±SD	1.61	1.45	1.39			
BCVA	Mean	0.54	0.57	0.61	0.512 NS	0.391 NS	0.285 NS
	±SD	0.22	0.23	0.18			

Table 2: corneal parameters: preoperative ,1-month postoperative &1-month postoperativemeasurements. NS: non-significant, D: diopters, avgK: average simulated keratometry, Sph: spherical error, AST: astigmatism, AKf: apical keratometry front, SIf: symmetry index front, BCVA: best corrected visual acuity ,OPL: oblique astigmatism ,WTR: with rule astigmatism , ATR:against the rule astigmatism ,P1:is a comparison between preoperative & 1-month postoperative,P2: is a comparison between 1-month postoperative& 3-months postoperative, P3:is a comparison between preoperative &3-month postoperative.

	Post-operative (1m) No %	Post-operative (3m) No %
Increased astigmatism	7 23·4	4 13.4
Decreased astigmatism	17 56.6	21 70
No changes	6 20	5 16.6

Table 3: Number & percentage distribution of post-operative changes of astigmatism.

Table 3 summarizes changes in astigmatism after surgery: at 1 month of follow up, 23.4% of patients showed increase of astigmatism, 56.6% of patients showed decrease of astigmatism 20 %of patient showed no change. At 3 months of follow up, 13.4% of patient showed increase of astigmatism, 70% of patients showed decrease of astigmatism 16.6 %of patient showed no change.

DISCUSSION

Eyelid ptosis is a commonly encountered problem. The effect of ptosis and ptosis correction procedures on the cornea have been documented by many authors.

Ptosis may be associated with visual and functional impairment and cosmetic problems. Treatment of ptosis is indicated where vision is impaired or where there is an undesired appearance. The vision can be impaired not only when the upper eyelid covers the pupil but even for refractive reasons. Previous studies indeed suggest that the eyelid pressure, in ptotic eyes, can modify corneal shape.[10]

Upper eyelid ptosis can cause refractive errors leading to amblyopia in childhood and persistently blurred vision in adult patients.[11]

On contrary to this popular conclusion, Vihlen & Wilson.[12] evaluated corneal toricity by keratometry in 195 eyes and reported no correlation between corneal toricity and lid tension. Authors in that study evaluated the effect of the dynamic force of lid movements on corneal toricity; a force that is momentary and temporary. We think that this conclusion does not interfere with the concept that long-standing abnormal lid position does affect corneal topography and power.

In our study we have investigated the effects of eyelid ptosis surgery on corneal topographic parameters that were measured by Sirius® 3D rotating Scheimpflug & topography system. Detailed study of corneal parameters included K1, K2, avgK, corneal astigmatism (value & type), (AKf) and (SIf). The effect of surgery on BCVA was also evaluated. Many investigators have studied changes in various corneal parameters after ptosis surgeries using different instruments.

In our work, we used the following astigmatism classification: With-the-rule astigmatism was defined by the steeper axes in the range of 90°±20°, against-the-rule astigmatism by the steeper axes in the range of 0°±20°, steeper axes falling outside of these ranges were defined as an oblique astigmatism. We considered the same definitions that were used by authors of similar work, as Brown et al.[13] and Savino et al.[14] to get more accurate comparisons.

Preoperatively, 70% of the patients in our study had with-the-rule astigmatism, 13.3% of the patients had against-the-rule astigmatism and 16.7% of the patients had oblique astigmatism. After 3 months of the operation, percentage of with-the-rule astigmatism decreased to 60%, percentage of against-the-rule astigmatism increased to 23.3%, while the percentage of Oblique astigmatism remained unchanged 16.7%.

Brown et al.[13]reported that 42% had with-the-role change and 50% of patients had against-the-role astigmatism as a final result. Zinkernagel et al.[15] documented that between 1 month and 3 months after ptosis repair, rotation in with-the-rule direction was equally as frequent as rotation in against-the-rule direction. They documented a rotation of astigmatic axis more than 10° in 8 of 15 (53% of eyes with astigmatism change, 33.3% of total number of cases) eyes. The mean axis rotation reported by Savino et al.[14] was about 10.3±4.8 degrees (range 0–15°) but was not systematic or predictable.

After 3-months of ptosis repair, most of our patients, 70%, showed decrease of astigmatism, 13.4% of the patients showed increase of astigmatism and 16.6% patients showed no changes (table 3).

Similar results were reported by Zinkernagel et.[15] who reported astigmatism changes (0.2 D or more) in 88% of eyes, while 12% of eyes showed no changes. While, Kim et al.[16] reported 50% of the patients with decrease of astigmatism, 19.2% of the patients with increase of astigmatism and 30.8 % patients with no changes. Brown et al.[13] reported that the number of patients with increased astigmatism was approximately equal to the number of patients with decreased astigmatism between 1 and 3 months after surgery.

On the contrary to these studies, Cadera et al.[17] assessed 88 eyes postoperatively at 3, 6, and 12 months and reported that there was an overall increase in average astigmatic refractive error by 0.3 D and 36% of study eyes changed by more than 0.75 D. They explained their results that, ptosis surgery tightens the upper eyelid vertically leading to increase curvature of the anterior cornea in the vertical meridian. Despite different results, they copied a common conclusion that modifications in eyelid position induce pressure on the anterior corneal surface, modifying corneal surface and leading to topographic changes that may affect the quality of vision and corneal refractive power.

Similar but temporary results were reported by Holck et al.[18] where 86% of their patients showed a measurable increase in corneal astigmatism and central corneal power by topographic analysis 6 weeks after surgical correction. These changes tended to regress toward the preoperative level by 12 months after surgery.

In the present study, the mean measured corneal astigmatism progressively decreased from pre-operative 1.2±0.3 D to 0.9±0.2 D after 1-month, then to 0.7±0.3 D after 3 months post-operatively (table 2); the mean change between preoperative and 3 months postoperative measurements was 0.5±0.4D. Corneal astigmatic changes at 3 months were statistically significant comparison to preoperative and 1 month postoperative measurements [p=0.007, 0.014 respectively].

Many authors reported less changes in corneal astigmatism after ptosis surgery. Kim et al.[16] reported a mean change of 0.22D, Savino et al.[14] got close results, reporting a mean change of 0.26D. Zinkernagel et al.[15] reported a median change of 0.3D, that was a statistically significant change ($P<0.05$).

Mean Keratometric values for the flattest (K1) and the steepest (K2) meridians of the studied subjects in the present study decreased 1 month after ptosis surgery, then further decreased 3 months after ptosis surgery, but none of these changes was statistically significant throughout the study. On the other hand, despite decrease in mean avgK values was also insignificant at 1-month, Mean avgK values significantly decreased at 3 months in comparison to preoperative and 1-month postoperative measurements [p=0.011, 0.028 respectively] (Table 2). Mean pre-operative avgK of 43.1 D dropped to 42.2 D after 3 months post-operative, with a mean decrease of about 0.9±0.18 D.

Minimal and insignificant changes of 0.07 D in the average corneal power were reported by Kim et al.[16], while Savino et al.[14] reported a higher but also insignificant (p=0.411) reduction in avgK of 0.15 ± 0.47 D. Zinkernagel et al.[15] reported that, the mean overall change in simulated keratometry in the 3-mm zone was 0.25 ±25D.

Greater changes were previously reported by other authors; Brown et al.[13]reported an average dioptric change of 0.6D by both keratometry and CVK 3 months after ptosis repair. They added that almost 30% of patients showed more than 1D change 1month after ptosis repair. Holck et al.[18] reported that, the average change in the central power was 1.11D in cases with increased with-the-role astigmatism (84%), and he average change in the central power was 0.79% in cases with increased against-the-role astigmatism (16%).

Values of mean AKf showed significant decrease 3 months postoperatively while reduction in mean SIf values was statistically insignificant throughout the study. These results mean that the steepest point of the anterior corneal surface flattens significantly after ptosis surgery, with insignificant difference between superior and inferior hemispheres.

Savino et al.[14] got similar results with significant reduction in AKf and detectable but statistically insignificant reduction in SIf.

Our results showed no significant topographic changes after 1month of ptosis surgery, but after 3 months changes in corneal astigmatism, avgK and AKf were significant. We could conclude that, topographic corneal changes are slow, and time is required for ptosis surgery to induce significant changes. Aforementioned conclusion of Vihlen & Wilson.[12] that there was no correlation between corneal toricity and lid tension, implies that momentary lid movements don't affect corneal toricity and may partially support our conclusion.

Shao et al.[19] reported a total of 6 patients (5.7%) with persistent visual acuity change at least 1 year after surgery; 4 of the 6 patients with visual acuity changes had a combined blepharoplasty and ptosis repair. Zinkernagel et al.[15] reported only 1 patient (4.1%) with blurred vision at 3 months after surgery. This patient showed an astigmatic change of 1.0 D after ptosis surgery.

Savino et al.[14] reported that mean BCVA significantly improved to 0.18 ±0.06 logMAR in all patients after the ptosis surgery ($P < 0.001$). They added, our experience shows that refractive changes of 0.2D or more may be noted by patients, whereas smaller changes usually do not affect visual acuity.

Despite significant decrease in mean corneal astigmatism (0.5D) and mean avgK (0.9D) in our study, improvement in BCVA (0.54 preoperatively to 0.61 three months postoperatively, table 2) were statistically insignificant.

Zinkernagel et al.[15] recommended ptosis surgery to be performed at least 3 months after cataract surgery, because cataract surgery can induce further levator detachment. However, blepharoplasty (in contrast to ptosis repair, especially when large fat pads are to be resected) should be performed at least 3 months before cataract surgery or refractive procedures. This sequence allows assessment of the correct lens power after corneal shape change.

Ptosis is a well-known complication of anterior segment surgery; cataract, corneal transplantation, and glaucoma filtering surgery. Baroody et al.[20] reported an incidence of 1–2%, while Altieri et al.[21] reported an incidence of 6.7%.

The mechanism of ptosis after anterior segment surgery is controversial. The presence or absence of the superior rectus bridle suture and the site of the ocular wound do not significantly contribute to the incidence of postoperative ptosis.[21]

Clinical and laboratory-based study has shown that in postoperative blepharoptosis there is disinsertion of the levator aponeurosis complex caused by eyelid edema. This eyelid edema could be induced by a multiple of pre- and peri-operative factors. Peribulbar anesthesia with its initial myotoxic effect and the eyelid speculum, which would compress the upper lid against the orbital bones and thereby reduce the blood flow to the levator muscle and so induce inflammation, would contribute to this edema. Such a combination of factors would inherently damage an already weakened levator complex due to involutional changes.[22]

Based on our research, we do recommend an indicated ptosis surgery, to be done first prior to an intended cataract or refractive surgery to avoid refractive surprises that may occur due to corneal shape changes. The fore mentioned mechanisms attribute postoperative ptosis to the added weakness to an already compromised levator-aponeurosis complex. Through ptosis repair surgery, the levator-aponeurosis complex is either strengthened through levator resection or totally bypassed through frontalis sling operation. So, the possibility of recurrence of a repaired ptosis after an anterior segment surgery is unlikely to occur.

Moreover, the era of multifocal IOLs and toric IOLs adds burden to the necessity for accurate biometry. Such cases may be very sensitive for even subtle changes in corneal measurements that may follow ptosis surgery.

CONCLUSION

Many corneal topographic parameters showed significant changes after ptosis surgery. Visual acuity changes and contact lenses intolerability may be encountered after ptosis surgery. An indicated ptosis surgery, is recommended to be done first prior to an intended cataract or refractive surgery to avoid refractive surprises; especially in cases of toric or multifocal IOLs.

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