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Ophthalmology

Corneal Topographic Changes after Subscleral Trabeculectomy

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Abstract

Background: Glaucoma is a cause of permanent blindness and occurs most often in older adults. Although glaucoma can be initially managed by conservative treatments, trabeculectomy, initially described by has traditionally been considered the “gold standard” for filtration surgery.
Objective: To investigate the effect of trabeculectomy on corneal topography, anterior chamber depth, and aberrations by a SIRIUS topography.
Patients and Methods: The present study was a prospective cohort study including 30 eyes of patients who were scheduled to undergo trabeculectomy at Ophthalmology Department of Al Azhar university hospital during the period from January 2018 to August 2019.
Results: In the present study, we compared included eyes according to site of flap midway (between K1&K2) versus vertical flap (on K). We found no statistically significant differences between studied groups in terms of K1 ($p = 0.29$), K2 ($p = 0.33$), and astigmatism values ($p = 0.38$).In our study, there was statistically significant difference between pre and postoperative values of ACD ($p < 0.001$). Eyes showed statistically significant decrease in ACD postoperatively.
Conclusions: Trabeculectomy surgery can cause changes in keratometry values, aberrations and ACD. These changes can be significant enough to affect visual acuity, the accuracy of IOL power calculation, and refractive outcomes after combined or future cataract surgery.

Keywords: *Glaucoma; Corneal Topographic Changes; Subscleral Trabeculectomy*

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INTRODUCTION

Intraocular pressure (IOP) is the major risk factor of glaucoma and existing glaucoma therapies are exclusively aimed at lowering IOP. In one large population cohort, 1 in 6 people with OAG (open angle glaucoma) became bilaterally blind.[1]

The only proven way to prevent vision loss is to reduce the pressure inside the eye (intraocular pressure) over the long term. Approaches to reducing intraocular pressure (IOP) include medical therapy, laser treatments, and surgery. As commercially available eye drop preparations have a short-lasting effect, medical therapy requires eye drops to be instilled one or more times daily for life. Trabeculectomy marked a major advance in glaucoma surgery.[2]

Trabeculectomy remains the standard surgical procedure for glaucoma when medical and laser treatments fail to control intraocular pressure (IOP).

This involved the removal of a partial thickness block of limbal tissue containing trabecular meshwork, sclera, and cornea under a lamellar scleral flap. Closure of the scleral flap controlled the egress of aqueous humor and reduced the major early postoperative complications.[3]

The change in astigmatism after trabeculectomy can lead to a decrease in the visual acuity in some patients and it would be useful to know when refraction stabilize. Over the last few years several studies have suggested that early trabeculectomy may be superior to medical therapy in the treatment of primary open angle glaucoma.[4]

Topographic assessment of corneal changes after trabeculectomy showed that the majority of the post-operative changes are found in the superior semimeridian.[5]

It was stated that the trabeculectomy operation induces changes in corneal keratometry, astigmatism and topography that results in visual acuity decline as well as corneal aberrations influences the visual function such as reading and driving, especially at night that affect the quality of life.[6]

Hence, assessment of corneal topography following trabeculectomy in order to investigate the changes of these factors. The results might be helpful in postsurgical management of patients with open angle glaucoma particularly in early stages following trabeculectomy.

The aim of the study is to investigate the effect of trabeculectomy on corneal topography, anterior chamber depth, and aberrations by a SIRIUS topography.

PATIENTS AND METHODS

Ethical Statement:

A written informed consent was obtained from each eligible patients prior to study's enrollment. The study's protocol was reviewed and approved by ethics committee or audit department of ophthalmology department, Faculty of Medicine, Al Azhar University.

Study Design and Setting:

The present study was a prospective cohort study including 30eyes of patients who were scheduled to undergo trabeculectomy at Ophthalmology Department of Al Azhar university hospital during the period from January 2018 to August 2019.

Sample Size and Sampling:

The predetermined sample size was 30eyes. We used non-probability consecutive sampling technique to collect the data from eligible patients; the patients were recruited consecutively from Ophthalmology Department of Al Azhar university hospital.

Preoperative Assessment:

In the present study, all eligible patients were subjected to: Details history of previous of systemic or ocular diseases / surgery, Complete ophthalmological examination, including: (Best corrected visual acuity (BCVA), Slit-lamp examination, Fundus examination with optic disc evaluation, Intraocular pressure recording (using the Goldmann'sapplanation tonometry and Measurement of Corneal k reading, coma, high order and spherical abberations and anterior chamber depth were taken by SIRIUS Topographer® (CSO, Firenze, Italy). Itis a Scheimpflug-Placido device integrating a Placido topographer with a dual and single rotating Scheimpflug camera, respectively.The Sirius provides measurements of ACD, anterior chamber volume (ACV),central corneal thickness(CCT), pupil size, corneal volume,keratometry and abberations.[7]

Steps of the Operation:

Preoperatively, patient's IOP was controlled medically by ocular hypotensive agents. If not controlled, a general anaesthetic was recommended.Eyelashes were kept away off the field by a guarded speculum or sticky drape In addition, patients underwent routine preoperative laboratory investigations including complete blood profile, blood glucose profile, and cardiac investigations.

Intraoperatively, local anaestheticwas used in the form ofperibulbar lignocaine 2%.

Then, a superior corneal traction suture was done followed by fornix-based incisions.The Tenon'swas attached about 0.5 mm behind the conjunctiva at the limbus. A cytotoxic agent (mitomycin C) was applied. This step was followed by focal cauterization of vessels.

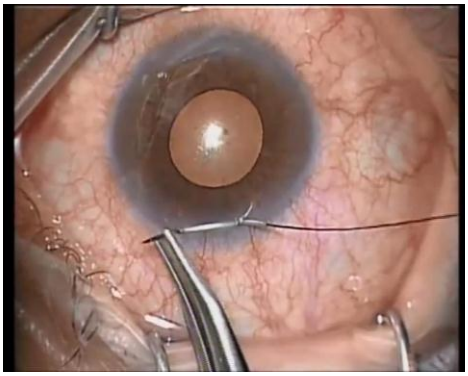

Fig. 1: Traction suture.

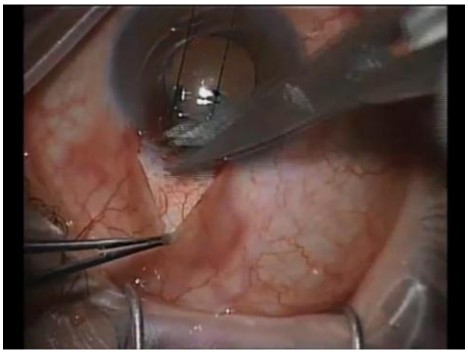

Fig. 2: Conjunctival incision

Square 4x4 scleral flap was used, followed by straight dissection of the flap at the base, right where dissection was occurring. An infero-temporally placed paracentesis was then placed to allow anterior chamber access both at surgery and post-operatively. Sclerostomy was performed by direct, half-thickness cuts.

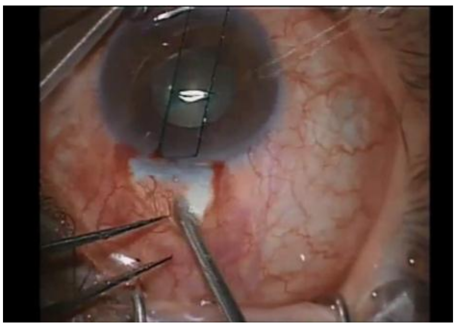

Fig.3: Cutarizations of bleeding vessels.

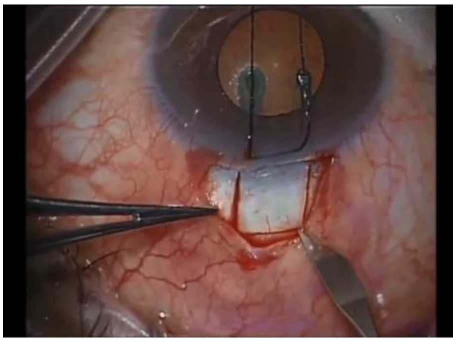

Fig.4: Sclera flap and dissection of the flap.

This step was followed by peripheral iridectomy peripherally and parallel to the limbus. Sutures to sclera were done by prolen 10/0 and conjunctival sutures were done.

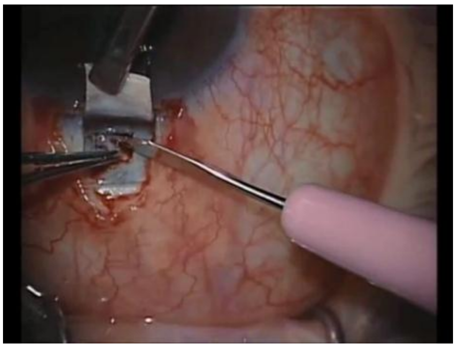

Fig. 5: Trabeculectomy.

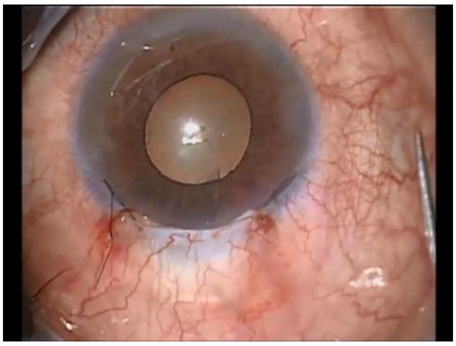

Fig. 6: Conjunctival sutures were done.

Finally subconjunctival injection of appropriate steroid and antibiotic was done.

Postoperative Follow-up:

Patients were follow-up at day 1, week 1, and 1st month after the surgery to record the following parameters :IOP using a calibrated applanation tonometer, Number of IOP lowering medications if required and Measurement of Corneal k reading, corneal abberations and anterior chamber depth by SIRIUS after subscleraltrabeculectomy surgery at 1 month follow up visit.

Statistical Analysis:

An Excel spreadsheet was established for the entry of data. We used validation checks on numerical variables and option-based data entry method for categorical variables to reduce potential errors. The analyses were carried with SPSS software (Statistical Package for the Social Sciences, version 24, SSPS Inc, Chicago, IL, USA). The normality of the data were assessed using Shapiro-Wilk Test. Numerical data were described as mean ±SD if normally distributed; or median and interquartile range [IQR] if not normally distributed. Frequency tables with percentages were used for categorical variables. Independent Student t-test and paired t-test were used to compare parametric quantitative variables; while Mann-Whitney tests and Wilcoxon matched pairs test were used to compare non-parametric quantitative variables. Chi-square test or McNemar-Bowker tests were used to analyze categorical variables. A p-value < 0.05 is considered statistically significant.

RESULTS

The present study was a prospective cohort study including 30 eyes of patients who were scheduled to undergo trabeculectomy at Ophthalmology Department of Al Azhar university hospital during the period from January 2018 to August 2019.

Variables	Eye (N =30)
Age in years	
• Mean ±SD	47.13 ±13.7
• Median (range)	49 (26 -72)
Diabetes Mellitus, No. (%)	
• Yes	14 (46.7%)
• No	16 (53.3%)
Hypertension, No. (%)	
• Yes	16 (53.3%)
• No	14 (46.7%)
History of cardiac diseases, No. (%)	
• Yes	6 (20%)
• No	24 (80%)

* Data are presented as mean ±SD, median (Range), or number (%)

Table 1: Thedemographic characteristics of the included patients.

The age of the included patients ranged from 26-72 years old with a mean age of 47.13 ±13.7years old. Fourteen (46.7%) patients had diabetes, 53.3% had hypertension, and 20% had history of cardiac diseases.

Variables, mean ±SD	Eye (N =30)	
	mean ±SD	Median (range)
K1 in D	42.96 ±1.47	43 (40.5 -45)
K2 in D	43.73 ±2.1	42.95 (41.3 – 48.68)
Anterior chamber depth in mL	3.468 ±0.62	3.65 (2.24 – 4.85)

* Data are presented as mean ±SD and median (range)

Table 2: Preoperative Keratometry and Biometry Findings.

Preoperatively, the mean IOP was 23.87 ±1.3mmHg and the mean best corrected visual acuity was 0.313 ±0.12.

Variables, mean ±SD	Eye (N =30)	
	mean ±SD	Median (range)
High Order Aberration	0.467 ±0.23	0.37 (0.2 - 0.91)
Coma Aberration	0.268 ±0.17	0.24 (0.5 – 0.75)
Spherical Aberration	0.149 ±0.104	0.14 (0.01 - 0.42)
Astigmatism	1.1 ±0.36	0.93 (0.49 – 1.53)

* Data are presented as mean ±SD and median (range)

Table 3: Preoperative Aberrations Findings.

Preoperatively, the mean high order aberration was 0.467 ±0.23 and the mean coma aberration was 0.268 ±0.17. The mean astigmatism was1.1 ±0.36.

Variables	Preoperative		rative		P-value^T
	mean ±SD	Median (range)	mean ±SD	Median (range)	
IOP in mmHg	23.87 ±1.3	24 (22 - 26)	13.73 ±2.8	13 (10 -20)	<0.001
BCVA	0.313 ±0.12	0.3 (0.13 -0.5)	0.239 ±0.077	0.3 (0.1 - 0.3)	<0.001

* Data are presented as mean ±SD, median (Range). T Using paired-t-test.

Table 4: The changes in IOP and BCVA among the included patients.

There were statistically significant differences between pre and postoperative values of IOP (p <0.001) and BCVA (p < 0.001). Eyes showed statistically significant reductions in IOP and increase in BCVA.

Variables, mean ±SD	Preoperative		Postoperative		P-value^T
	mean ±SD	Median (range)	mean ±SD	Median (range)	
K1 in D	42.96 ±1.47	43 (40.5 -45)	43.96 ±1.4	44 (41.5 -46.1)	0.019
K2 in D	43.73 ±2.1	42.95 (41.3 – 48.68)	43.34 ±2.2	43 (40.2 – 47.5)	0.2
Astigmatism	1.1 ±0.36	0.93 (0.49 – 1.53)	1.66 ±0.24	1.1 (0.56 – 1.49)	0.033^K
Anterior chamber depth in mL	3.468 ±0.62	3.65 (2.24 – 4.85)	3.036 ±0.43	2.9 (2.17 – 3.7)	<0.001

*Data are presented as mean ±SD and median (range).^{TU}singpaired-t-test. ^{K}UsingKruskal-Wallis test

Table 5: The Changes in Keratometry and Biometry Findings of the included patients

There were statistically significant differences between pre and postoperative values ofK1 (p =0.019), astigmatism (p =0.033), and ACD (p <0.001). Eyes showed statistically significant increase in K1, astigmatism values, and decrease in ACD. In contrary, there was no statistically significant difference between pre and postoperative values of K2 (p =0.2).

Variables, mean ±SD	Preoperative		Postoperative		P-value^k
	mean ±SD	Median (range)	mean ±SD	Median (range)	
High Order Aberration	0.467 ±0.23	0.37 (0.2 -0.91)	0.692 ±0.22	0.6 (0.43 -1.15)	<0.001
Coma Aberration	0.268 ±0.17	0.24 (0.1 – 0.75)	0.482 ±0.18	0.46 (0.26 – 0.92)	<0.001
Spherical Aberration	0.149 ±0.104	0.14 (0.01 - 0.42)	0.34 ±0.08	0.31 (0.19 -0.53)	<0.001

*Data are presented as mean ±SD and median (range).^{K}Using Kruskal-Wallis test

Table 6: The changes in Aberrations Findings of the included patients

There were statistically significant differences between pre and postoperative values of high order aberration (p <0.001), coma aberration, and spherical aberration (p <0.001). Eyes showed statistically significant increase in the three parameters.

Variables, mean ±SD	Group I		Group II		P-value[w]
	mean ±SD	Median (range)	mean ±SD	Median (range)	
K1 in D	43.68±1.01	43(40.5 -45)	42.34±15	42(40.5 -45)	0.1
K2 in D	43.8±1.8	44 (41.3 – 48.86)	43.67±2.4	44 (41.3 – 48.86)	0.68
Anterior chamber depth in mL	3.38±0.49	3.1(2.24 – 4.85)	3.54±0.73	3.4(2.24 – 4.85)	0.49

*Data are presented as mean ±SD and median (range). [w]Using Mann-Whitney test

Table 7: The association between studied groups and preoperative Keratometry and Biometry Findings

Variables, mean ±SD	Group I		Group II		P-value[w]
	mean ±SD	Median (range)	mean ±SD	Median (range)	
K1 in D	44.2 ±1.6	44 (41.5 -46.1)	43.7 ±1.2	44 (41.5 -46.1)	0.29
K2 in D	42.7 ±1.8	43 (40.2 – 47.5)	43.8 ±2.4	43 (40.2 – 47.5)	0.33
Anterior chamber depth in mL	2.9 ±0.36	2.9 (2.17 – 3.7)	3.2 ±0.47	2.9 (2.17 – 3.7)	0.38

*Data are presented as mean ±SD and median (range). [w]Using Mann-Whitney test

Table 8: The association between studied groups and postoperative Keratometry and Biometry Findings.

There were no statistically significant differences between studied groups in terms of preoperative K1 (p =0.1), K2 (p =0.68), and ACD (p =0.49). Similarly, there were no statistically significant differences between studied groups in terms of postoperative K1 (p =0.29), K2 (p =0.33), and ACD (p =0.38).

DISCUSSION

The present study was a prospective cohort study including 30 eyes of patients who were scheduled to undergo trabeculectomy at the Ophthalmology Department of Al Azhar university hospital during the period from January 2018 to August 2019. The age of the included patients ranged from 26-72 years old with a mean age of 47.13 ±13.7 years old. Fourteen (46.7%) patients had diabetes, 53.3% had hypertension, and 20% had history of cardiac diseases.

In line with our findings, Eldaly et al.[8] performed across- sectional observational study that included 68 glaucomatous patients who were attending the outpatient clinics of Cairo University Hospitals. The age of patients ranged between 8 and 75 years with mean of 47.75 years± 15.4.

Similarly, Latifet al. [9] performed a prospective study on 110 adult patients previously diagnosed with POAG. They were asked to participate in this study during their usual follow-up visit to the outpatient clinic of the Nile Health Insurance Hospital during the period from November 2009 to May 2010. The age of the majority of the patients was between 40-60 years old. Sixty patients were suffering from another chronic illness.The reported chronic diseases were diabetes mellitus, hypertension, ischemic heart disease, renal failure, hepatitis C virus, and chronic obstructive pulmonary disease.

Abu Hussein et al. [10] studied the factors affecting patient's compliance with antiglaucoma medications in Egypt.Four hundred and forty patients wereenrolled in the study. The mean age of compliant group of patients was 49.77 years ±8.92. 51% of compliant patients had no coexisting morbidity as opposed to 24.6% of noncompliant patients. High percentages of noncompliant patients had hypertension (31.4%), diabetes with hypertension (16.5%), and ischemic heart disease (13.1%).

In the present study, There were statistically significant differences between pre and postoperative values of high order aberration (p <0.001), coma aberration, and spherical aberration (p < 0.001). Eyes showed statistically significant increase in the three parameters.

Similarly, Fardet al. [11], performed a prospective study of A total of 20 eyes from 20 patients. There was a significant decrease in intraocular pressure following surgery at 1 month and 3 months postoperatively. One month after surgery, a significant change in coma-like, spherical-like, and total higher-order aberrations of the eyes was observed. However, the repeated measurements performed 3 months after procedure revealed no significant difference compared to the baseline values.

There is no difference between our present study and Fard et al. [11] ,study due to similar period of follow up after one month and close number of study group patients , however their study results were followed up after one and three months at which returned to baseline.

In the present study, there were statistically significant differences between pre and postoperative values of IOP ($p < 0.001$) and best-corrected visual acuity (BCVA) ($p < 0.001$). Eyes showed statistically significant reductions in IOP and increase in BCVA.

In line with our findings, Radcliffe et al. [12] conducted a prospective, multicenter, randomized clinical trial on 300 patients with newly diagnosed open-angle glaucoma enrolled at 14 centers in the United States who were randomized to initial trabeculectomy. The IOP in the treated eyes was lower than baseline at 3, 6, 12, 18 and 24 months after trabeculectomy.

In the present study, there were statistically significant differences between pre and postoperative values of flat keratometry (K1) ($p = 0.019$) and astigmatism ($p = 0.033$). Eyes showed statistically significant increase in K1 and astigmatism values.

In agreement with our findings, EL-Saied et al. [13] evaluatedthe surgically induced astigmatism following trabeculectomy. In a prospective interventional comparative study, patients with primary open-angle glaucoma underwent trabeculectomy with mitomycin C; 60 eyes of 42 patients were enrolled for vector analysis. There was a statistically significant difference between pre and postoperative values of WTR astigmatism.

In the present study, we compared included eyes according to site of flap midway (between K1&K2) versus vertical flaps (on K). We found no statistically significant differences between studied groups in terms of K1 ($p = 0.29$), K2 ($p = 0.33$), and astigmatism values ($p = 0.38$).

In concordance with our findings, Claridgeet al. [14] performed a pilot study measuring, pre- and post-operative corneal topography. Twenty-nine patients admitted for trabeculectomy had pre-operative assessment of subjective and automated refraction. Similar patterns of corneal topographic change to those found in our pilot study were noted. In both the superior steepening and superior flattening groups there was an increase in vertical keratometry and a shift towards 'with-the-rule' astigmatism.

In our study, there was statistically significant difference between pre and postoperative values of ACD ($p < 0.001$). Eyes showed statistically significant decrease in ACD postoperatively.

Similarly, Husain et al. [15] investigated longitudinal changes in ACD over 5 years after trabeculectomy surgery in Asian patients with primary glaucoma, In this prospective cohort study, 122 subjects were analysed. ACD was shallower compared with baseline at all postoperative visits, with a mean decrease of 0.11 mm.

Man et al. [16] documented the anatomical effects of clear lens extraction by phacoemulsification versus trabeculectomy on anterior chamber angle in patients with PACG. Fifty PACG eyes of 50 patients were included. The mean ACD decreased from 2,000.2 ± 214.5 microns to 1975.8 ± 218.2 microns ($p = 0.001$) by trabeculectomy.

CONCLUSION

In conclusion, The present study showed There were statistically significant differences between pre and postoperative values of high order aberration, coma aberration, and spherical aberration and There were no significant difference in topographic changes between site of the sclera flab which were between k1& k2 (group 1) or on K (group 2).

So, Trabeculectomy surgery can cause changes in keratometry values, aberrations and ACD. These changes can be significant enough to affect visual acuity, the accuracy of IOL power calculation, and refractive outcomes after combined or future cataract surgery. These unpredictable changes may affect the accuracy of intraocular lens IOL power calculation in cases who need cataract surgery and IOL implantation combined with glaucoma surgery.

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