

IJMA



INTERNATIONAL JOURNAL OF MEDICAL ARTS

Volume 7, Issue 10 (October 2025)



<http://ijma.journals.ekb.eg/>

P-ISSN: 2636-4174

E-ISSN: 2682-3780



Available online on Journal Website
<https://ijma.journals.ekb.eg/>
 Main Subject [Ophthalmology]



Original Article

Anterior Segment Optical Coherence Topography [AS-OCT] and Corneal Topography Changes after Trabeculectomy in Patients Presenting with Primary Open Angle Glaucoma

Elsayed Ali Gomaa*, Mahmoud Abd Elhaleim Rabea; Ibraheem Hasan Mohammad

Department of Ophthalmology, Faculty of Medicine, Al-Azhar University, Cairo, Egypt.

Abstract

Article information

Received: 09-07-2023

Accepted: 18-04-2025

DOI: [10.21608/ijma.2024.222065.1733](https://doi.org/10.21608/ijma.2024.222065.1733).

*Corresponding author

Email: aboseedali2018@gmail.com

Citation: Gomaa EA, Rabea MAE, Mohammad IH. Anterior Segment Optical Coherence Topography [AS-OCT] and Corneal Topography Changes after Trabeculectomy in Patients Presenting with Primary Open Angle Glaucoma. IJMA 2025 October; 7[10]: 6213-6216. doi: [10.21608/ijma.2024.222065.1733](https://doi.org/10.21608/ijma.2024.222065.1733).

Background: Primary open-angle glaucoma [POAG] is a progressive optic neuropathy characterized by elevated intraocular pressure [IOP] and damage to the optic nerve. Trabeculectomy is a common surgical intervention aimed at reducing IOP and preserving vision in patients with POAG.

The aim of the work: This study aimed to investigate the changes in anterior segment optical coherence topography [AS-OCT] and corneal topography following trabeculectomy in patients diagnosed with primary open-angle glaucoma.

Patients and Methods: A prospective study was conducted on twenty eyes of twenty patients with POAG undergoing trabeculectomy. AS-OCT and corneal topography measurements were obtained preoperatively and then three months post-operative to assess changes in the anterior segment and corneal parameters.

Results: A statistically significant increase was observed in $\Delta K2$ [median = 44.41, IQR = 43.86-44.57], Δ astigmatism [median = 2.44, IQR = 1.7-3.11], Δ ACD-OCT [2.11 $\pm$ 0.38], and Δ ACA-OCT [20.8 $\pm$ 5.01] when compared with $\Delta K2$ [median = 43.47, IQR = 43.01-43.69], Δ astigmatism [median = 1.11, IQR = 0.47-1.97], Δ ACD-OCT [2.62 $\pm$ 0.39], and Δ ACA-OCT [30.9 $\pm$ 7.8] pre-operatively. No statistically significant changes were found regarding $\Delta K1$, Avg K, and A.

Conclusion: Astigmatism is the main reason for the diminution of visual acuity [VA] that is detected in the early weeks after operations. Decreases in anterior chamber [AC] depth and AC angle occur in the first week after trabeculectomy, reaching baseline levels before surgery after one month.

Keywords: Astigmatism; Corneal Topography; Open-Angle Glaucoma; Optical Coherence Tomography; Trabeculectomy.



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INTRODUCTION

Glaucoma syndrome includes group of disorders with chronic progressive optic nerve neuropathy and progressive visual field [VF] defect. Intraocular pressure is difficult to define glaucoma syndrome as it is a significant modifiable factor. Glaucoma in each form and presentations is the main cause of permanent loss of vision all over the world [1]. Increased intra-ocular pressure [IOP], is the important variable risk factor of glaucoma syndrome and the target point of glaucoma treatments is lowering and controlling of IOP [2].

TRAB is preferred in patients of POAG, if they have advanced glaucoma at first examination, particularly in younger patients, or if patient on 2-3 classes of drugs with progressive glaucoma, or post trabeculoplasty by laser. TRAB may be the choice in the remote and developing areas because of loss of, health care availability or affordability of drugs [3]. In addition, TRAB is still the gold standard in treatment of patient presenting with POAG and it is a penetrating filtration surgery that lowers IOP by permits drainage of aqueous through the sclerotomy with complete penetration of the AC and create track with the sub-conjunctival space and blood vessels [4].

Formation of sub-conjunctival blebs is important for lowering and controlling IOP and detecting successful glaucoma surgery [5].

Astigmatism is the main refractive error after glaucoma surgery that isn't clearly explained. Many cases of glaucoma surgery have a short period of diminution of VA in the early weeks after surgery, and some of patient have long time of diminution and deterioration of VA. While the variation in VA may be because of the decrease in IOP and stability of AC depth. Different reports and studies have many investigations to detect the impact and effect of successful glaucoma surgeries on astigmatism [6].

Corneal topography is a non-contact procedure for mapping corneal curvature. The main refractive power of eyes is dioptric power of cornea, so corneal topography is main factor in detecting the quality of VA [7]. Anterior segment OCT [AS OCT] is a non-contact procedure for imaging and visualizing the ocular surfaces structures as corneal thickness, AC structures [AC depth and angle], aqueous humor outflow system [8].

THE AIM OF THE WORK

This study aimed to investigate the changes in anterior segment optical coherence topography [AS-OCT] and corneal topography following trabeculectomy in patients diagnosed with primary open-angle glaucoma.

PATIENTS AND METHODS

A prospective cohort study was done from March 2022 to March 2023. The study included twenty phakic globe of twenty patients presenting with uncontrolled IOP of POAG on anti-glaucomatous drugs, and surgery has been performed in the Departments of Ophthalmology at Al-Azhar University Hospitals. Corneal topographic parameters were done before operation and found normal parameters in all patients.

In this study, we excluded patients with eye insults other than glaucoma syndrome like as [degeneration of cornea and different type of uveitis and choroiditis], history of traumatic, refractive operations, or other systemic defects that affect the eye like uncontrolled diabetes mellitus and hypertension. If it is difficult to complete investigation and

examinations of patients after operation, we exclude them. Informed agreement of All cases was attained on informed consent before any procedure. Complications and benefits of the surgery were explained to all patients

Preoperative Assessment: Medical and surgical history was obtained including inflammatory eye diseases, trauma and history of drugs or bleeding disorders. Ocular examination and investigations which included determined Corrected VA, slit lamp bio-microscopy, ocular pressure [IOP] by Goldman applanation tonometry, AS-OCT [DRI OCT Tritonplus, Topcon, Japan], topography performing by SIRIUS Topographer [CSO, Firenze, Italy].

Techniques of operation: Every surgery of patients was done under effect of Peri bulbar anesthesia. TRAB was done at upper half of the eyeball for all of patients. Traction suture of cornea was done by non-absorbable [8/0] and made a conjunctival fornical based flap. In TRAB with MMC, the superficial scleral flap, [4x5 mm] half scleral thickness was shaved after utilizing MMC [0.20 mg/mL] under the scleral flap, and conjunctiva for two mins, and then clean scleral flap. Marginal iridectomy after sclerotomy was done then the scleral flap suturing by non-absorbable sutures [10/0 nylon]. Finally, conjunctival closure by absorbable sutures as [8/0 virgin silk].

Follow Up post-operative: Patients were examined after 24 h post-operative, one week and then every one-month for three months by measuring ocular hypertension [IOP] by Goldman tonometry, slit-lamp examinations. Performing AS-OCT [DRI OCT, Triton plus, Topcon, Japan] and corneal topography was done by a SIRIUS Topographer machine, [CSO, Firenze, Italy] three months after operative day.

Statistical analysis: Results were analyzed by Statistics Package for Social Sciences [SPSS] V 24. Normality tests [Kolmogorov-Smirnov & Shapiro-Wilk test] were performed and data [ACA-OCT and ACD-OCT] were normally distributed. In contrast, data for [IOP, K1, K2 and Astigmatism] were not normally distributed. Continuous data were expressed as mean $\pm$ standard deviation [Mean $\pm$ SD] for normally distributed data. For comparing two non-normally distributed variables at different time points, The Wilcoxon signed-rank test was used. For comparing more than two variables, the Friedman test was used. P value < 0.05 is considered significant.

RESULTS

Table [1] shows demographic data in all examined patients. Regarding age, the mean age was 52.5 ± 7.6 years. There were 9 males [45%] and 11 females [55%]. Regarding the affected side, there were 10 patients [50%] with right side affection and 10 patients [50%] with left side affection.

Regarding IOP, there was a significant [p-value < 0.001] decrease of post-operative IOP [median = 13.5, IQR = 11.25 – 16 mmHg] when compared with pre-operative IOP [median = 26, IQR = 24 – 29.75 mmHg] [table 2]. No statistically significant difference was detected [p-value = 0.068] between pre-operative K1 [median = 42.61, IQR = 41.16 – 43.33 D] and post-operative K1 [median = 42.23, IQR = 40.71 – 42.83 D]. There was a statistically significant [p-value < 0.001] increase in post-operative K2 [median = 44.41, IQR = 43.86 – 44.75 D] when compared with pre-operative K2, [median = 43.47, IQR = 43.01 – 43.69 D] [table 3]. There was a statistically significant [p-value < 0.001] increased post-operative astigmatism [median = 2.44, IQR = 1.7 – 3.11 D] when compared with pre-operative astigmatism, [median = 1.11, IQR = 0.47 – 1.97 D]. No statistically significant difference [p-value =

0.758] between pre-operative AXIS [median = 26, IQR = 10.5 – 170 °] and post-operative AXIS [median = 28.5, IQR = 8.5 – 170.25 °] [table 4]. There was a statistically significant difference [p-value < 0.001] of ACA-OCT throughout the study. Pre-operatively it was 30.9 ± 7.8 , one week post-operatively it was 20.8 ± 5.01 , 1 month post-operatively it was 29.3 ± 4.8 while 3 months post-operatively it was 28.3 ± 3.5 [table 5].

Table [6] shows a statistically significant difference [p-value < 0.001] of ACD-OCT throughout the study. Pre-operatively it was 2.62 ± 0.39 , one week post-operatively it was 2.11 ± 0.38 , 1 month post-operatively it was 2.57 ± 0.38 while 3 months post-operatively it was 2.61 ± 0.34 .

Table [1]: Demographic data in the studied patients

Studied patients [n = 20]			
Age [years]	Mean $\pm$ SD	52.5 $\pm$ 7.6	
	Min – Max	43 – 68	
Sex	Male	9	45%
	Female	11	55%
Affected side	Right side	10	50%
	Left side	10	50%

Table [2]: Comparison of IOP among studied cases

		Pre-op	3 mo. Post-op	Test	P-value
IOP [mmHg]	Median	26	13.5	0.0	< 0.001*
	IQR	24 – 29.75	11.25 – 16		

Wilcoxon signed-rank

Table [3]: Comparison of K1 and K2 in the studied patients

		Pre-op	3 mo. Post-op	Test	P-value
K1 [D]	Median	42.61	42.23	132	0.068
	IQR	41.16 – 43.33	40.71 – 42.83		
K2 [D]	Median	43.47	44.41	38	< 0.001
	IQR	43.09 – 43.69	43.86 – 44.75		

Table [4]: Comparison of astigmatism and AXIS in the studied patients

		Pre-op	3 mo. Post-op	Test	P-value
Astigmatism [D]	Median	1.11	2.44	48.5	< 0.001
	IQR	0.47 – 1.97	1.7 – 3.11		
AXIS [°]	Median	26	28.5	188.5	0.758
	IQR	10.5 – 170	8.5 – 170.25		

Table [5]: Comparison of ACA-OCT in the studied patients

		ACA-OCT	Test	P-value
Follow	Pre-op	30.9 $\pm$ 7.8	F = 13.01	< 0.001*
	1 st W post-op	20.8 $\pm$ 5.01		
	1 st M post-op	29.3 $\pm$ 4.8		
	3 rd Mns. Post-op	28.3 $\pm$ 3.5		

Friedman test.

Table [6]: Comparison of ACD-OCT in the studied patients

		ACD-OCT	Test	P-value
Follow-up	Pre-op	2.62 $\pm$ 0.39	F = 8.4	< 0.001
	1-week post-op	2.11 $\pm$ 0.38		
	1-month post-op	2.57 $\pm$ 0.38		
	3 months post-op	2.61 $\pm$ 0.34		

Friedman test.

DISCUSSION

In this prospective cohort study, patients' ages ranged from 43-68 years old with a mean of 52.5 ± 7.6 . We measured anterior chamber [Angle and depth] by performing AS-OCT one week, one month and 3 months after surgery. TRAB had induced changes in the values of AC

parameters [AC angle and depth] in the first postoperative week and these changes of regained their pre-operative baseline after one month from surgery. The anterior chamber angle and depth were persisting stable after the first month with no significant difference in the first and third postoperative months. Simsek et al.^[9] conducted a prospective study included thirty-eight phakic eyes presenting with POAG, who underwent TRAB. Significant changes were detected in all the

parameters of anterior chamber through time of postoperative [P, <0.001 for ACA and AC depth], in comparison with pre-operative values. But no significant differences were detected between the pre-operative and first month after surgery values of anterior segment. **Cunliffe et al.** [10] found that AC depth returned to baseline values at the third week after operation. **Karasheva et al.** [11] measured values of ACD in forty-four patients and found no significant differences between pre and post TRAB surgery.

Sudden decrease in IOP after surgery, due to rapid filtration, may affect anterior chamber parameters early after operation. Stabilization of IOP was reached after the 1st week after operation, but the stabilization of anterior chamber parameters was obtained after one month. However, **Simsek et al.** [9] found that there was no relation between the decreasing in IOP and different values and measurements in the ACD or ACA.

In the present study, we found a statistically significant [p-value <0.001] lowering of IOP after TRAB [median= 13.5, IQR= 11.25-16 mmHg] when compared with baseline IOP [median= 26, IQR= 24-29.75]. **Fard et al.** [12] reported a significant decrease in IOP after operation in 1st month and 3rd months post-operatively. Repeated measurements done after three months found no significant difference compared to the preoperative values.

Refractive error, especially astigmatism, is the main factor to cause diminution of VA after surgical history [13]. **Nawar et al.** [14] measured corneal topographic changes three months after surgery in fifteen eyes of fifteen patients having TRAB with [0.20mg/ml, MMC, for two mins]; they found a statistically significant increase of $\Delta K1$, [0.47±0.09], $\Delta K2$ [0.86±0.18] and Δ astigmatism, [1.3±0.13].

In this research, we detected changes of corneal topographic three months post-operatively. No statistically significant changes of K1, in contrast to the significant increase of post-operative K2. Also, a statistically significant upgrading of post-operative astigmatism was noticed, but there were no significant changes in the axis of astigmatism. **Claridge et al.** [13] conducted a study to measure corneal topography of 29 patients undergoing TRAB. They confirmed that the topographic changes caused by operation [SST] lasted for up to twelve months in some cases. Surgical astigmatism which occur after TRAB is still undefined and unclear. It may be due to piece of tissue which is shaved from beneath the flap of sclera allowing unstable corneal edge of the TRAB to slightly sliding causing a diminution in vertical radius of the corneal curvature [10].

Conclusion: Results of the present study detected that the first month following trabeculectomy is important for return to baseline and stabilization of anterior segment parameters [AC depth and angle]. The simplest investigation to detect and measure the changes in the AC parameters following TRAB from first day is AS-OCT as a noncontact method.

Due to the TRAB-induced refractive error especially post-operative astigmatism, it's preferred to do early glaucoma surgery before refractive or cataract surgeries to avoid IOL miscalculation or residual astigmatism; especially in cases of patients seeking bifocal, trifocal or multifocal IOLS.

Financial and non-financial activities and relationships of interest: None

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IJMA



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<http://ijma.journals.ekb.eg/>

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E-ISSN: 2682-3780