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Corneal Topographic Changes after Trabeculectomy and Deep Sclerectomy in Patients with Primary Open Angle Glaucoma

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ABSTRACT

Background: The The refractive outcomes of glaucoma surgeries particularly their effect on astigmatism, are incompletely understood.
Aim of The Work: To evaluate corneal topographic changes following subscleral trabeculectomy (SST) versus non penetrating deep sclerectomy (NPDS) in patients with primary open angle glaucoma (POAG).
Patients and Methods: 30 eyes of 30 patients were divided into two equal groups: (Group A) included patients who had SST with Mitomycin C (MMC) 0.2mg/ml for 2 min, and (Group B) included patients who had NPDS with Mitomycin C (MMC) 0.2mg/ml for 2 min. Complete ophthalmic examination and computerized topography were performed before surgery, then 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 & axis) and apical keratometry front (AKf).
This prospective comparative study was done at Ophthalmology Department of Al Azhar university hospitals during the period from March 2021 to Sept 2021.
Results: Highly statistical significant (p-value < 0.001) increased Δ K1(0.47 ± 0.09) , Δ K2(0.86 ± 0.18) and Δ astigmatism (1.32 ± 0.13) in group A when compared with Δ K1 (0.22 ± 0.09), Δ K2 (0.46 ± 0.08), Δ astigmatism (0.69 ± 0.1) in group B. Non significant change was found among groups A & B regarding Δ (Avg K and AKF).
Conclusion: Induced astigmatism may account for a reduction in unaided visual acuity in the early postoperative period following glaucoma surgeries. SST induce more astigmatism than NPDS.

Keywords: *glaucoma; topography; trabeculectomy; deep sclerctomy.*

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INTRODUCTION

Glaucoma is the second most common cause of worldwide blindness following cataract, and is the main reason of non-reversible visual disability ,mainly because of POAG.[1] Elevated intra-ocular pressure (IOP) is the main risk factor of glaucoma and present glaucoma treatments are entirely pointed to decreasing IOP. [2]

Surgery is offered in POAG if there is advanced glaucoma at presentations, especially in younger patients, or if glaucoma is progressing despite 2-3 classes of drugs or after laser trabeculoplasty. Surgery may be offered earlier in the developing world because of lack of availability or affordability of medications, and lack of regular long term access medical care as in remote communities. [3]

The golden standard in glaucoma operation still the *SST*. It is a penetrating filtration operation that efficiently decrease IOP by permitting aqueous drainages via a sclerostomy, with complete penetrations of the anterior chamber creating a linking with the sub-conjunctival space.[4] Following decrease in IOP as well depend on sub-conjunctival bleb formation.[5] Non penetrating deep sclererectomy (NPDS) is another, nonpenetrating filtration operation, that preserve the trabeculo-Descemet membrane.[6] The former is conventionally accompanied with an elevated rate of complications.[7]

The influence of glaucoma operations on refraction, predominantly astigmatism, aren't entirely explained. It is frequent for cases experiencing glaucoma operations to have a shorter time of decreased visual acuity in the earlier post-operative time, and for some cases, this may persevere longstanding. While the variation in vision may be because of the reduction in IOP, numerous reports have investigated the direct impact of glaucoma surgeries on astigmatism, signifying that variations in corneal topography and refractive conditions may have a function. [8]

PATIENTS AND METHODS

A randomized prospective observational study was carried out from March 2021 to Sept 2021.The study was conducted on 30 eyes of 30 patients suffering from POAG with uncontrolled IOP by maximum tolerable antiglaucoma therapy and operations has been done in the departments of ophthalmology at Al- Azhar University hospitals.

All patients had normal corneal topographic parameters before operation. The research excepted cases with neo-vascular glaucoma, congenital and juvenile glaucoma, ocular pathology rather than glaucoma such as (corneal dystrophies and uveitis), history of ocular trauma, history of intraocular surgeries, or any systemic diseases that could affect the eye such as uncontrolled diabetes and hypertension. Patients who failed to complete the follow-up examinations after the surgery were also excluded.

Informed agreement was attained from all cases pre any operation. The dangers, profits, substitutes and restrictions of the intervention were explained to them .

Patients were allocated into 2 similar groups:

Group A:15-eye of 15 cases who had SST with adjuvant intra-operative usage of 0.2 mg/ml (MMC) for 2 mins.

Group B:15 eyes of 15 cases who had NPDS with adjuvant intra-operative usage of 0.2 mg/ml (MMC) for 2 mins.

Preoperative Assessment

A detailed medical and surgical history,including: history of prior ocular inflammation ,trauma or infection and history of bleeding disorders and medications.

Complete ophthalmological examination, including: measurement of BCVA, slit-lamp bio-microscopy , IOP measurements with Goldman applanation tono-metry, dilated fundoscopy and corneal topography by SIRIUS Topographer® (CSO, Firenze, Italy).

Surgical Techniques

All operations have been done underneath Peri bulbar anesthesia. The site of the operation, whether for trabeculectomy or deep sclerectomy was be at superior half of the globe for all eyes. A corneal traction suture was taken using a silk 8/0 and a conjunctival fornical based flap was made .

In SST with MMC: a superficial scleral flap (6x4mm) half thickness of the sclera was shaped. Afterward, MMC (0.2 mg/mL) has been utilized underneath the scleral flap and the conjunctiva for 2 mins, and then it was cleaned. A sclerostomy and marginal iridectomy was created then suturing the scleral flap by 10/0 nylon sutures. Lastly, conjunctival closure with a 8/0 virgin silk sutures.

In NPDS with MMC: a superficial scleral flap (5x5mm) one-third of the sclera was shaped. Afterward, MMC (0.2 mg/mL) was utilized underneath the scleral flap and the conjunctiva for 2 mins, and then it was cleaned. The deep flap (4x4mm) was shaped after that it was excised. Schlemm's canal was unroofed followed by removal of juxtacanalicular trabeculum. Suturing the scleral flap by 10/0 nylon sutures then conjunctival closure with a 8/0 virgin silk sutures.

Post-operative Follow Up

All cases were inspected on the 1st day post-operatively, 7 days and then once-a-month for 3-mths. Examinations involved measuring the BCVA, slit-lamp examinations and IOP measurements with Goldman applanation tonometry. Furthermore, corneal topography was obtained using SIRIUS Topographer® (CSO, Firenze, Italy) 3 months post-operatively.

Topical corticosteroid was given heavily then reduced gradually as the clinical course dictated. Topical anti-biotics and cycloplegic agents were as well be utilized.

Statistical Analysis:

Collected data analysis was done via SPSS-24. Quantitative data have been introduced as mean ±SD (data with normal distribution) and median (IQR) (data with abnormal distribution).Qualitative data have been introduced as frequency and percentages.

The next tests were performed:

Independent-samples t-testing: was utilized for comparison among 2 means (normal distribution).
Mann–Whitney U testing: was utilized for comparison among 2 means (abnormal distribution).
A one-way analysis of variance (ANOVA): was utilized for comparison among more than 2 means (normal distribution).
Kruskal Willis test (KW): was utilized for comparison among more than 2 means (abnormal distribution).
Chi-square test: was utilized for comparison among non-parametric data..
Probability (P-value)

$P < 0.05$ result has significance.
$P < 0.001$ result has high significance.
$P > 0.05$ result has no significance.

RESULTS

This prospective observational study was carried out from March 2021 to Sept 2021, patients were admitted to Ophthalmology department of Al-Azhar university hospitals at Cairo through the outpatient clinic scheduled for glaucoma filteration surgery.

In this study, 30 patients (with 30 eyes) were allocated into 2 similar groups: (Group A) comprised cases who had SST with adjuvant intra-operative usage of 0.2 mg/ml Mito-mycin C (MMC) for 2-min, and (Group B) comprised cases who had NPDS with adjuvant intra-operative usage of 0.2 mg/ml MMC for 2 mins.

Corneal topography was obtained using SIRIUS Topographer® (CSO, Firenze, Italy) preoperatively and 3 months post-operatively.

Demographic data:

		Group A (N = 15)		Group B (N = 15)		Stat. test	P-value
Age (years)	Mean	53.4		52.4		T = 0.32	0.751 NS
	±SD	9.06		8.01			
Sex	Male	8	53.3%	8	53.3%	$X^2 = 0.0$	1.0 NS
	Female	7	46.7%	7	46.7%		

T: independent sample T testing.

X2: Chi-square testing.

Table 1: comparing among the study groups regarding Age and Sex

This table shows nonsignificant change among the study groups regarding demographic data (age and sex).

Clinical data:

1. BCVA:

		Group A (N = 15)	Group B (N = 15)
Pre-BCVA (Log MAR)	Mean	0.66	0.59
	±SD	0.29	0.28
Post-BCVA (Log MAR)	Mean	0.54	0.49
	±SD	0.26	0.26
Stat. test	T	1.18	1.08
	p-value	0.244 NS	0.289 NS

T: independent sample T test.

Table 2: comparison of BCVA (pre & post) in studied groups.

This table shows nonsignificant change among Pre-BCVA and Post-BCVA in group A and group B. (p-value > 0.05)

2. Intraocular Pressure (IOP):

		Group A (N = 15)	Group B (N = 15)
Pre IOP	Mean	28.13	26.93
	±SD	4.26	3.95
Post IOP	Mean	14.07	13.33
	±SD	2.91	2.89
Stat. test	T	**10.5**	**10.7**
	p-value	**< 0.001 HS**	**< 0.001 HS**

T: independent sample T test.

Table 3: comparison of IOP (pre & post) in studied groups

This table shows:

Highly statistical significant (p< 0.001) decreased post IOP (14.07 ± 2.91) when compared with pre IOP (28.13 ± 4.26) in group A.

Highly significant (p< 0.001) decreased post IOP (13.33 ± 2.89) when compared with pre IOP (26.9 ± 3.95) in group B.

Corneal parameters:

1.Flat K (K1) :

		Group A (N = 15)	Group B (N = 15)
Pre K1	Mean	42.38	41.20
	±SD	1.10	1.30
Post K1	Mean	41.91	40.98
	±SD	1.10	1.29
Stat. test	T	1.17	0.47
	p-value	0.248 NS	0.640 NS

T: independent sample T test.

Table 4: comparison of K1 (pre & post) in studied groups.

This table shows nonsignificant change (p > 0.05) among (pre) K1 and (post) K1 in group A and group B.

2.Steep K (K2):

		Group A (N = 15)	Group B (N = 15)
Pre K2	**Mean**	43.43	42.81
	±SD	0.46	0.95
Post K2	**Mean**	44.29	43.27
	±SD	0.57	0.95
Stat. test	**T**	**4.5**	0.92
	p-value	**< 0.001 HS**	0.192 NS

T: independent sample T test.

Table 5: comparison of K2 (pre & post) in studied groups.

This table shows:

Highly significant increased post K2 (44.29 ± 0.57) when compared with pre K2 (43.43 ± 0.46) in group A.

Nonsignificant change among K2 (pre) and K2 (post) in group B.

3. Average Keratometry (Avg K):

		Group A (N = 15)	Group B (N = 15)
Pre Avg K	**Mean**	42.90	42.00
	±SD	0.75	1.10
Post Avg K	**Mean**	43.10	42.12
	±SD	0.80	1.09
Stat. test	**T**	0.69	0.3
	p-value	0.495 NS	0.763 NS

T: independent sample T test.

Table 6: comparison of Avg K (pre & post) in studied groups.

This table shows nonsignificant difference among AVG K (pre) and AVG K (post) in group A and group B.

4.Apical Keratometry Front (AKF):

		Group A (N = 15)	Group B (N = 15)
Pre AKF	**Mean**	44.41	43.42
	±SD	0.53	0.93
Post AKF	**Mean**	44.41	43.51
	±SD	0.47	0.92
Stat. test	**T**	0.0	0.26
	p-value	1.0 NS	0.792 NS

T: independent sample T test.

Table 7: comparison of AKF (pre & post) in studied groups.

This table shows nonsignificant difference among AKF (pre) and AKF (post) in groups A and B.

5.Corneal Astigmatism :

		Group A (N = 15)	Group B (N = 15)
Pre Astigmatism	**Mean**	1.06	1.61
	±SD	0.75	0.62
Post Astigmatism	**Mean**	2.38	2.30
	±SD	0.70	0.61
Stat. test	**T**	**4.96**	**3.06**
	p-value	**< 0.001 HS**	**0.005 S**

T: independent sample T test.

Table (8): comparison of astigmatism (pre & post) in studied groups.

This table shows:

Highly significant increased astigmatism post (2.38 ± 0.7) when compared with astigmatism pre (1.06 ± 0.75) in group A.

Statistically significant (p-value = 0.005) increased astigmatism post (2.3 ± 0.61) when compared with astigmatism pre (1.61 ± 0.62) in group B.

6.Axis Of Flat k:

		Group A (N = 15)	Group B (N = 15)
Axis Pre	**Mean**	66.40	105.53
	±SD	75.89	79.16
Axis Post	**Mean**	66.33	106.73
	±SD	76.44	77.86
Stat. test	**T**	0.002	0.042
	p-value	0.998 NS	0.967 NS

T: independent sample T test.

Table 9: comparison of axis (pre & post) in studied groups.

This table shows nonsignificant change among axis (pre) and axis (post) in group A and group B.
Amount of Changes in studied parameters (Δ):

		Group A (N = 15)	Group B (N = 15)	MW	p-value
Δ BCVA	**Mean**	0.12	0.11	91.5	0.389 NS
	±SD	0.05	0.06		
Δ IOP	**Mean**	14.07	13.60	101	0.653 NS
	±SD	1.91	1.88		
Δ K1	**Mean**	0.47	0.22	**10**	**< 0.001**
	±SD	0.09	0.09		**HS**
Δ K2	**Mean**	0.86	0.46	**1**	**< 0.001**
	±SD	0.18	0.08		**HS**
Δ AVG K	**Mean**	0.20	0.12	71.5	0.089 NS
	±SD	0.12	0.07		
Δ Astigmatism	**Mean**	1.32	0.69	**0.0**	**< 0.001**
	±SD	0.13	0.10		**HS**
Δ AKF	**Mean**	0.00	0.09	81.5	0.202 NS
	±SD	0.25	0.05		

MW: Mann Whitney U testing.

Table 10: comparing among the study groups regarding changes in studied parameters.

This table shows:

Highly statistical significant increased Δ K1 (0.47 ± 0.09) in group A when compared with Δ K1 (0.22 ± 0.09) in group B.

Highly statistical significant (p-value < 0.001) increased Δ K2 (0.86 ± 0.18) in group A when compared with Δ K2 (0.46 ± 0.08) in group B.

Highly statistical significant (p-value < 0.001) increased Δ astigmatism (1.32 ± 0.13) in group A when compared with Δ astigmatism (0.69 ± 0.1) in group B.

Nonsignificant change among group A and group B regarding Δ (BCVA, IOP, AVG K and AKF).

DISCUSSION

Surgery-induced astigmatism is one of the factors behind patients' complaints of decrease of vision after uneventful glaucoma operation.[9]Various reports introduced dissimilar patterns of post-glaucoma operations induced-astigmatism.When studies defined those corneal topographic variations in few cases may last around 12 months, others defined that the persuaded variations vanish in 6 - 12 months.[10] Moreover, other reports showed that keratometric readings has been stable after 2-3 months.[11]

As regard post SST persuaded astigmatism, Cunliffe et al.[12], performed a study measuring refraction and kerato-metry in 16 cases having SST. Vertical radius of the cornea has been decreased from a pre-operative mean of 7.69 to7.56 mm at 1stwk . This with the rule (WTR) shift in corneal astigmatism persevered at 3rd wk and 8th wk of following-up but had resumed to pre-operative values at ultimate following-up at 10 mths. Horizontal radius of the cornea was increased at 1stwks and 3rd wk but, had normalized from 8th-wk onward. They stated no change in the axis of the vertical curvature of the cornea . Rosen et al. [13] protracted these results when compared corneal topo-graphy and kerato-metry in 8 eyes from 6 cases having SST.They established aWTR shift of 1.5 to 2.5 D of cylinder up to the 12th wks postoperatively. They as well revealed that the quantity of persuaded steepening was under-estimated via keratometry in comparison with topo-graphy. Kook et al.[14] inspected 18 eyes of 16 cases having SST with 0.4 mg/mL MMC for 2-5 min at 1, 3, 6,and 12 mths.. Approving preceding reports, they revealed a mean WTR shift in corneal astigmatism of 1.23 D at 3rd-mth post-operatively, trailed by a period of against the rule (ATR) shift .Strangely , persuaded astigmatism were still existing at 6th and 12th month (0.94 D and 0.65D resp), very longer than formerly documented without usage of MMC.

In our study,we measuered corneal topographic changes 3 months post-operatively in 15 eyes of 15 patients having SST with 0.2mg/ml MMC for 2 mins (group A),we found:

No statistical significant difference in K1.
Highly statistical significant increased post K2 (44.29 ± 0.57) when compared with pre K2 (43.43 ± 0.46).
Highly statistical significant increased post astigmatism (2.38 ± 0.7) when compared with pre astigmatism (1.06 ± 0.75)
WTR shift in corneal astigmatism of 1.32 ± 0.13 .
Nonsignificant change in axis.

In a larger report measuring corneal topography in 29 cases having SST, Claridge and colleagues found more multifaceted variations. While they established an general tendency to vertical steepening and WTR astigmatism, they recognized 3 sub-groups characterized by a) superior corneal steepening, b) superior corneal flattening, and c)irregular changes . They as well confirmed that in some cases, the topographic variations persuaded by operation last for up to 12 mths.[9]
Egrilmez et al. [15] inspected 10 eyes having NPDS with a nonabsorbable implants. In comparison to SST controls, NPDS group had lesser persuaded WTR shift followed by lesser ATR shift (0.62 D vs. 1.06 D at 3 mths; 0.62 D vs. 1.24 D at 6 mths).. This was in line with results in the current work we compared

15 eyes having SST with MMC to 15 eyes having NPDS with MMC. We found the two groups showed a significant WTR shift in astigmatism of (1.32 ± 0.13) in SST group and (0.69 ± 0.1) in NPDS group at 3 months post-operatively.

While, a larger report proposed that both NPDS and SST persuaded substantial and comparable post-operative astigmatism. El Saied et al.[16] matched 60 eyes having NPDS with MMC to 60 eyes having SST with MMC. They concluded that the two groups showed a significant and comparable WTR shift in astigmatism of 0.67 D in the NPDS group and 0.82 D in the SST group at the 6th month post-operatively.
The cause of the surgical persuaded postoperative astigmatism succeeding glaucoma operation still non identified. Maybe when a tissue piece is excised from under the scleral flap permits the unsubstantiated corneal edge of the trabeculectomy to slightly sink causing a reduction in vertical radius of the cornea. [12] In deep scelerectomy, the thin layer of trabeculo-Descemet membrane that is left intact in nonpenetrating operation can aid to decrease the quantity of persuaded reduction in vertical radius of the cornea.[15]

CONCLUSION

Both SST and NPDS induced a significant post-operative astigmatism**.**

An indicated glaucoma surgery, is recommended to be done first prior to an intended refractive or cataract surgery to avoid refractive surprises; particularly in cases of multifocal or toric interaocular lens (IOLs).

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