Comparison of Percent Tissue altered in Topography Guided and Wavefront Optimized Laser-assisted in situ Keratomileusis using Zeiss MEL 80 Excimer Laser

Shwetambari Singh[1], Neha Shilpy[2], Dipali Purohit[1], Zalak Shah[1]
[1]C. H. Nagri Eye Hospital, Ahmedabad, India
[2]Regional Institute of Ophthalmology, RIMS, Ranchi, India

ABSTRACT

Introduction: Laser-assisted in situ Keratomileusis (LASIK) is the most commonly performed refractive surgical procedure. The amount of tissue ablated in LASIK affects the safety and long-term outcome. The objective of this study was to compare the percent tissue altered (PTA) in topography guided (TG) and wavefront optimized (WFO) LASIK using Zeiss MEL 80 excimer laser.

Materials and methods: This retrospective observational study was conducted at a tertiary eye center. Patients with moderate myopia who underwent LASIK between June 2016 and January 2019 were divided into two groups (Group I: TG LASIK, 69 eyes; Group II: WFO LASIK, 70 eyes). The groups were compared for preoperative parameters [spherical equivalent (SE), keratometry and pachymetry], intraoperative parameters [ablation depth (AD), PTA and residual stromal bed thickness (RSBT)] and postoperative parameters (vision, SE).

Results: Among preoperative parameters, SE and keratometry were similar while thinnest pachymetry was significantly less in group I. Among the intraoperative parameters, PTA ($P < 0.01$) and AD ($P < 0.01$) were significantly less in group I while RSBT ($P = 0.54$) was not significantly different. Postoperatively at 6 months, 92.75% (64) eyes in group I and 90% (63) eyes in group II had visual acuity of 6/6 or better ($P = 0.57$). 98.55% (68) and 97.14% (68) eyes in group I and group II respectively had SE refraction within ± 0.5 dioptres.

Conclusion: TG LASIK induces less tissue alteration for given refractive error with similar visual outcome as compared to WFO LASIK which makes TG apparently safer and is the preferred technique for borderline thin corneas.

Key words: Percent tissue altered, Topography-guided LASIK, Wavefront optimized LASIK.

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Corresponding Author
Dr. Neha Shilpy
Regional Institute of Ophthalmology, RIMS,
Ranchi, India.
E-mail: nehashilpy@gmail.com
Contact: +91 8709483744

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INTRODUCTION

The field of refractive surgery has seen significant advancement in the past few decades. Despite a large number of surgical options, still, the refractive procedure most commonly performed worldwide is Laser-assisted in situ keratomileusis (LASIK).(Pillar et al, 2016) Apart from the conventional LASIK surgery, various types of LASIK procedures have been developed that include wavefront guided (WFG), wavefront optimized (WFO) and topography guided (TG).(Krueger et al, 2008) All these procedures were additionally aimed at correcting or reducing the higher order aberrations, so as to reduce the chances of glare and halos post-operatively. WFG LASIK decreases aberrations using the individual aberration profile while the WFO LASIK is based on a pre-calculated treatment algorithm to reduce surgically-induced spherical aberration. (Schallhorn et al, 2008; El Awady et al, 2011) However, WFO LASIK does not remove the pre-existing higher order aberrations.(Tan et al, 2012) TG LASIK is based on individual topography of each eye and thereby maintains the asphericity of cornea which leads to less higher order aberrations postoperatively.(El Awady et al, 2011; Stulting et al, 2016)

The safety of any refractive procedure depends on the postoperative visual outcome and the rate of complications. One of the most feared complications of LASIK surgery is post LASIK ectasia. Percent tissue altered (PTA) is a significant risk factor along with other variables like age, residual stromal bed thickness (RSBT) and ectasia risk score for the development of post LASIK ectasia.(Santhiago et al, 2016; Santhiago et al, 2014; Ambrosio et al, 2014) PTA is calculated as [PTA=(FT+AD)/CCT] where FT=flap thickness, AD=ablation depth, and CCT=preoperative central corneal thickness. PTA ≥40 is significantly associated with the risk of ectasia even in eyes with normal preoperative topography.(Santhiago et al, 2016; Santhiago et al, 2014; Ambrosio et al, 2014) Therefore, lesser the PTA, lesser is the risk of ectasia and more is the safety of the procedure.

Studies have been done to compare the visual outcome and higher order aberrations following various types of LASIK procedures.(El Awady et al, 2011; Jain et al, 2016; Tiwari et al, 2018; Shetty et al, 2017; Padmanabhan et al, 2008) However, there are only a few studies that have compared the amount of tissue ablated following these procedures. So, here we conducted a study to compare the percent tissue altered (PTA) along with postoperative visual outcome in TG and WFO LASIK.

MATERIALS AND METHODS

This retrospective observational study was conducted in the refractive department of a tertiary eye care center in Western India. The study protocol was ethically approved by the institutional review board and followed the declaration of Helsinki. Records of patients who had undergone LASIK from June 2016 to January 2019 were reviewed. We included patients aged

18 years or older with stable refraction for at least a year. Only those patients who had best-corrected visual acuity (BCVA) of 6/9 or better and spherical equivalent (SE) between -4.0D to -6.0D, with/ without astigmatism <1.5D and who had discontinued soft contact lens for at least 2 weeks were included. Patients with any ocular or systemic pathology, pre-existing ocular surgery, pregnant and lactating females, patients with thinnest corneal pachymetry < 490 microns, estimated residual stromal bed thickness (RSBT) < 300 microns or topography suggestive of any ectatic corneal condition were excluded from our study.

Detail history and clinical examination data of the patients were reviewed and noted. Final subjective correction, keratometry, preoperative topography and thinnest pachymetry were also recorded. Review of treatment received was done with the type of LASIK procedure undergone, ablation depth, RSBT and PTA. Postoperative visual acuity and SE after 3 months of the procedure along with complications, if any, were also noted.

Patients were grouped on the basis of the type of LASIK procedure done (group I: TG LASIK; group II: WFO LASIK). Comparison was done between the groups in terms of demographic profile, preoperative parameters, treatment profile and postoperative parameters.

Keratometry values were collected from the Atlas 9000 corneal topography system, a placido-based topographer (software version 3.0.0.39. Carl Zeiss Meditec AG, Jena, Germany). Pachymetry values were collected from the Galilei dual Scheimpflug system (G4, Ziemer Ophthalmic System AG, Port, Switzerland). Treatment review was done by CRS master (Custom Refractive Surgery software, Carl Zeiss Meditec) which exported the data for MEL 80 excimer laser (Carl Zeiss Meditec AG, Jena, Germany).

CRS-Master Software

The CRS-Master has a topography supported customized ablation (TOSCA) system which takes care of both the lower order aberrations as well as higher order aberrations by correcting irregular corneal topographies. The corneal elevation data as well as wavefront data both are used to derive the ablation profile. Elevation data is used for regularization of the cornea while wavefront data and manifest refraction are used for determining the target corneal surface. The software is able to discriminate that component of manifest refraction which compensates for higher order aberrations and considers that during treatment. In short, the software aims to regularize cornea and correct refractive error while inducing fewer higher order aberrations.

Before treatment, the ablation profile was generated using the CRS-master software. Informed consent was taken from all the patients. Moria SA microkeratome (Moria, Antony, France) was used to create a 90 μm LASIK flap and the treatment was done with MEL 80 excimer laser.

Statistical Analysis: The collected data was entered into the SPSS software (version 20.0, SPSS Inc. Armonk, NY: IBM corp.). Continuous data was expressed in terms of Mean ± Standard Deviation. The Shapiro Wilk test for normality was used to examine continuous variables. Continuous data included both parametric and non-parametric data. Independent t-test and Mann Whitney U-test were used for calculating P value. P value < 0.05 was considered to be a statistically significant difference.

RESULTS

There were 69 eyes of 42 patients in the TG LASIK group (group I) and 70 eyes of 43 patients in the WFO LASIK group (group II). The mean age of patients in group I was 22.33 ± 2.86 years while in group II was 22.80 ± 3.85 years (P = 0.27). There were 23 males (54.76%) and 19 females (45.24%) in group I and 18 males (41.86%) and 25 females (58.14%) in group II (P = 0.13).

The preoperative and intraoperative parameters assessed in both the groups are shown in Table 1. Among the preoperative parameters, there was no significant difference between the two groups in all except the thinnest pachymetry. The thinnest pachymetry was significantly less in group I (P < 0.01).Among the intraoperative parameters, PTA (P < 0.01) and AD (P < 0.01) were significantly less in group I while RSBT (P = 0.54) was not significantly different.

Table 1: Comparison of TG and WFO LASIK group for age, preoperative and intraoperative parameters.

Variables	Group I (TG LASIK) (n=69) (mean±sd)	Group II (WFO LASIK) (n=70) (mean±sd)	P value
Age (in years)	22.33±2.86	22.80±3.85	0.42[a]
Spherical error	-4.80±0.51 D	-4.75±0.64 D	0.60[a]
Cylindrical error	-0.73±0.39 D	-0.59±0.44 D	0.07[b]
Spherical equivalent	-5.16±0.48 D	-5.04±0.63 D	0.21[a]
Flat keratometry	43.60±1.26 D	43.39±1.27 D	0.32[a]
Steep keratometry	44.60±1.32 D	44.17±1.39 D	0.06[a]
Mean keratometry	44.10±1.26 D	43.78±1.31 D	0.14[a]
Thinnest pachymetry (in µm)	518.06±23.96	548.0±23.32	<0.0001[b]*
RSBT (in µm)	331.35±24.28	328.96±21.16	0.537[b]
PTA	33.10±1.99	36.04±2.07	<0.0001[b]*
AD (in µm)	81.47±11.09	107.47±11.24	<0.0001[b]*

(TG = topography guided; WFO = wavefront optimized; LASIK = laser-assisted in situ keratomileusis; n = number of patients; RSBT = residual stromal bed thickness; PTA = percent tissue altered; AD = ablation depth; D = dioptre; [a] = Student's t-test; [b] = Mann-Whitney U-test; * = P<0.05)

Table 2: Comparison of postoperative visual acuity in TG and WFO LASIK.

Visual acuity (Snellen)	Group I (TG LASIK) (n=69)		Group II (WFO LASIK) (n=70)		P value for cumulative number of patients
	Number of patients	Cumulative number of patients with visual acuity equal or better	Number of patients	Cumulative number of patients with visual acuity equal or better	
6/5	34	34	32	32	0.67
6/6	30	64 (92.75%)	31	63 (90%)	0.57
6/7.5	4	68 (98.55%)	4	67 (95.71%)	0.32
6/9	1	69 (100%)	2	69 (98.57%)	0.32
6/12	0		1	70 (100%)	

(Abbreviations: TG = topography guided; WFO = wavefront optimized; LASIK = laser-assisted in situ keratomileusis; n = total number of patients)

Table 3: Comparison of postoperative spherical equivalent in TG and WFO LASIK.

Spherical equivalent (in Dioptre)	Group I (TG LASIK) (n=69) Number of patients	Group II (WFO LASIK) (n=70) Number of patients	P value
< -1	0	0	
-1 to -0.51	1 (1.45%)	2 (2.86%)	0.57
-0.50 to -0.26	12 (17.39%)	15 (21.43%)	0.55
-0.25 to + 0.25	56 (81.16%)	53 (75.71%)	0.44
0.26 to 0.50	0	0	
0.51 to 1	0	0	

(Abbreviations: TG = topography guided; WFO = wavefront optimized; LASIK = laser-assisted in situ keratomileusis; n = total number of patients)

Postoperatively at 6 months, 92.75% (64) eyes in group I and 90% (63) eyes in group II had visual acuity of 6/6 or better (P = 0.57) while in total, 98.55% (68) eyes in group I and 95.71% (67) eyes in group II had visual acuity of 6/9 or better (Table 2).

81.16% (56) eyes in group I and 75.71% (53) eyes in group II had SE refraction within ± 0.25 dioptres (P = 0.44) while 98.55% (68) and 97.14% (68) eyes in group I and group II respectively had SE within ±0.5 dioptres (Table 3). None of the eyes had any complication till 3 months postoperatively.

DISCUSSION

TG treatment was initially done for irregular and highly aberrated corneas like in post keratoplasty cases, post radial keratectomy or

post LASIK flap complications.(Holland et al, 2013; Pasquali et al, 2012) It was effective with good predictability in correction of irregular astigmatism in these cases. Later, the procedure was extended to normal corneas as well because of the less higher order aberrations. We aimed at comparing TG with WFO LASIK in terms of PTA and postoperative visual outcome.

The two groups were demographically similar in age and gender profile. Preoperative parameters like SE and mean keratometry were also similar in the two groups indicating that the two groups were comparable and both the groups had regular cornea. The thinnest pachymetry was significantly less in group I. This was because patients with borderline thinnest pachymetry were preferably corrected using TG LASIK.

PTA and AD were significantly less in group I. This implies that less tissue is ablated in TG compared to WFO LASIK for correction of a given refractive error. Therefore it can be interpreted that TG is less tissue hungry compared to WFO and is better in cases of borderline thin cornea. Jain et al (2016) have also found that TG LASIK leads to less tissue ablation compared to WFO LASIK.

In our study, as discussed above, group I had significantly less preoperative thinnest pachymetry compared to group II. Despite that, RSBT was not significantly different in the two groups. This can be explained due to the fact that in TG LASIK, less tissue was ablated and eventually, the RSBT was similar in the two groups postoperatively. WFO LASIK treatment aims to maintain the aspheric profile of cornea and, in order to do that, an additional amount of tissue needs to be ablated apart from that needed to correct the refractive error.(Meyer et al, 2015) However, in TG treatment, ablation depends on the individual topography and so the treatment is customized and overall ablation depth is less.(El Awady et al, 2011; Stulting et al, 2016)

The postoperative visual acuity and SE were statistically similar in the two groups with TG LASIK showing slightly better outcome clinically than WFO LASIK (92.75% vs 90% respectively with visual acuity of 6/6 or better). Our results are similar to previous studies.(El Awady et al, 2011; Jain et al, 2016; Tiwari et al, 2018; Shetty et al, 2017) Though we didn't compare the impact on contrast sensitivity and aberrations in the two procedures, there are other studies that have done so. El Awady et al (2011) and Jain et al (2016) concluded in their studies that topography guided LASIK induced fewer higher order aberrations as compared to WFO LASIK. In addition, Jain et al (2016) found that postoperative contrast sensitivity was also better with topography guided LASIK. Tiwari et al (2018) mentioned that there was greater gain of visual acuity with topography-guided LASIK compared to WFO LASIK, but they did not find any difference in higher order aberrations.

CONCLUSION

In this study, we found that TG induces less tissue alteration for given refractive error with similar visual outcome as compared to WFO

LASIK which makes TG apparently safer and the preferred technique for borderline thin corneas. Further studies can be done with larger sample size and longer follow up duration to evaluate early as well as long term postoperative outcome and thus better compare the two procedures in safety profile.

REFERENCES

Ambrosia R Jr, Dawson DG, Belin MW (2014). Association between the percent tissue altered and post-laser in situ keratomileusis ectasia in eyes with normal preoperative topography. Am J Ophthalmol;158(6):1358-9. doi: 10.1016/j.ajo.2014.09.016; PMid:25457710

El Awady HE, Ghanem AA, Saleh SM (2011). Wavefront-optimized ablation versus topography-guided customized ablation in myopic LASIK: Comparative study of higher order aberrations. Ophthalmic Surg Lasers Imaging;42:314-20. doi: 10.3928/15428877-20110421-01; PMid:21534496

Holland S, Lin DT, Tan JC (2013). Topography-guided laser refractive surgery. Curr Opin Ophthalmol;24(4):302-9. doi: 10.1097/ICU.0b013e3283622a59; PMid:23680760

Jain AK, Malhotra C, Pasari A, Kumar P, Moshirfar M (2016). Outcomes of topography-guided versus wavefront-optimized laser in situ keratomileusis for myopia in virgin eyes. J Cataract Refract Surg;42(9):1302-11. doi: 10.1016/j.jcrs.2016.06.035; PMid:27697248

Krueger RR, Rocha KM (2008). Introduction to wavefront-optimized, wavefront -guided, and topography-guided customized ablation: fifth year in review. J Refract Surg;24(4):S417-8. doi: 10.3928/1081597X-20080401-18; PMid:18500095

Meyer B, Sluyterman van Langeweyde G, Wottke M (2015). Refractive outcomes of an advanced aspherically optimized profile for myopia corrections by LASIK: a retrospective comparison with the standard aspherically optimized profile. Clin Ophthalmol;9:379-92. doi: 10.2147/OPTH.S75812; PMid:25750516

Padmanabhan P, Mrochen M, Basuthkar S, Viswanathan D, Joseph R (2008). Wavefront-guided versus wavefront-optimized laser in situ keratomileusis: contralateral comparative study. J Cataract Refract Surg;34(3):389-97. doi: 10.1016/j.jcrs.2007.10.028; PMid:18299062

Pasquali T, Krueger R (2012). Topography-guided laser refractive surgery. Curr Opin Ophthalmol;23(4):264-8. doi: 10.1097/ICU.0b013e328354adf0; PMid:22569472

Pillar A, Krueger R (2016). Advances in Refractive Surgery: June 2014 to July 2015. Asia Pac J Ophthalmol (Phila);5(3):212-22. doi: 10.1097/APO.0000000000000200; PMid:27183291

Santhiago MR (2016). Percent tissue altered and corneal ectasia. Curr Opin Ophthalmol;27(4):311-5. doi: 10.1097/ICU.0000000000000276; PMid:27096376

Santhiago MR, Smadja D, Gomes BF, Mello GR, Monteiro ML, Wilson SE, Randleman JB (2014). Association between the percent tissue altered and post-laser in situ keratomileusis ectasia in eyes with normal preoperative topography. Am J Ophthalmol;158(1):87-95. doi: 10.1016/j.ajo.2014.04.002; PMid:24727263

Schallhorn SC, Farjo AA, Huang D, Wachler B, Trattler WB, Tanzer DJ, et al (2008). Wavefront-guided LASIK for the correction of primary myopia and astigmatism a report by the American Academy of Ophthalmology. Ophthalmology;115:1249-61. doi: 10.1016/j.ophtha.2008.04.010; PMid:18598819

Shetty R, Shroff R, Deshpande K, Gowda R, Lahane S, Jayadev C (2017). A Prospective Study to Compare Visual Outcomes Between Wavefront-optimized and Topography-guided Ablation Profiles in Contralateral Eyes With Myopia. J Refract Surg;33(1):6-10. doi: 10.3928/1081597X-20161006-01; PMid:28068440

Stulting D, Fant BS, T-CAT Study Group (2016). Results of topography-guided laser in situ keratomileusis custom ablation treatment with refractive excimer laser. J Cataract Refract Surg;42:11-8. doi: 10.1016/j.jcrs.2015.08.016; PMid:26948773

Tan J, Simon D, Mrochen M, Por YM (2012). Clinical results of topography-based customized ablations for myopia and myopic astigmatism. J Refract Surg;28:S829-S836. doi: 10.3928/1081597X-20121005-04

Tiwari NN, Sachdev GS, Ramamurthy S, Dandapani R (2018). Comparative analysis of visual outcomes and ocular aberrations following wavefront optimized and topography-guided customized femtosecond laser in situ keratomileusis for myopia and myopic astigmatism: A contralateral eye study. Indian J Ophthalmol;66(11):1558-61. doi: 10.4103/ijo.IJO_507_18; PMid:30355860