ANALYSIS

23(100), November - December, 2019

ISSN
2321–7359
EISSN
2321–7367

Medical Science

Early postoperative total corneal Wavefront aberrations, higher order coma, trefoil and spherical aberrations following successful Photorefractive keratectomy using optimized ablation with Mitomycin C application for mild to high myopia

Tamer Adel Refai

Ophthalmology Department, Research Institute of ophthalmology,
Giza, Egypt
E-mail: tamerrefai@hotmail.com

Article History
Received: 12 July 2019
Reviewed: 16/July/2019 *to* 23/August/2019
Accepted: 25 August 2019
Prepared: 30 August 2019
Published: November - December 2019

Citation
Tamer Adel Refai. Early postoperative total corneal Wavefront aberrations, higher order coma, trefoil and spherical aberrations following successful Photorefractive keratectomy using optimized ablation with Mitomycin C application for mild to high myopia. *Medical Science*, 2019, 23(100), 876-884

ABSTRACT

Objective: To study early post-operative variation in total corneal aberration, higher order Coma, spherical and trefoil aberrations induced by Photorefractive keratectomy (PRK) using optimized ablation profile with mitomycin C application for myopic eyes. *Design:* Retrospective, consecutive case series. Participants: twenty –five eyes (of 14 myopic patients) in which photorefractive keratectomy (PRK) with mitomycin C application were examined preoperatively and early postoperatively for induced total corneal aberrations as well as for higher order Coma, trefoil and spherical aberrations to evaluate the early post operative stabilization. *Methods:* Patients were examined preoperatively as well as one to three months postoperatively after stabilization of the refractive status. Examination included Uncorrected visual acuity (UCVA), refractive error evaluation by Topcon autorefractometer (and confirmation by trial), Best corrected visual acuity (BCVA), Scheimflug imaging (i.e., Pentacam, (ALLEGRO Oculyzer Version 1074; Allergo, Germany) to detect Keratometric readings, central pachymetry, higher order spherical, Coma, trefoil aberration coefficients, total aberration coefficient for the corneal front surface (from Zernike values at 6.0 mm optical zone) and Ocular response analyzer (ORA) for Corneal hysteresis (CH) ,Corneal resistance factor (CRF) to detect case suitability for refractive ablation. Tabulation of the collected data as well as well as analyses by suitable statistical methods was done. For each studied item, mean value, standard deviation, minimum as well as maximal values were provided. Comparison tests and correlation tests are also performed. *Results: In this study,* a post-PRK statistically significant increase ($p<0.05$) occurs in the mean values of higher order coma aberration coefficient (from 0.12±0.07μ preoperatively to 0.24±0.15 μ postoperatively), higher order trefoil aberration coefficient, (0.09±0.05μ preoperatively to 0.15±0.11μ postoperatively), higher order spherical aberration coefficient , (from 0.08±0.07μ preoperatively to 0.21±0.18 postoperatively) as well as in the Total aberration coefficient (ABR), (increased 1.04±0.55μ preoperatively to 1.64±0.31 postoperatively). Also, a highly significant correlation ($p<0.01$) existed between post-PRK decrease in the average keratometric readings and the post-PRK increase in higher order coma aberration coefficient ($r=0.58$) and a statistically significant ($p<0.05$) correlation existed between post-PRK decrease in the average keratometric readings and the post-PRK increase in the total aberration coefficient ($r=0.22$). Similarly, a highly significant correlation ($p<0.01$) existed between post-PRK decrease in the central pachymetrty readings and the post-PRK increase in the higher order coma ($r=0.41$), while a statistically significant correlation ($p<0.05$) existed between post-PRK decrease in the central pachymetrty readings and the post-PRK increase in higher order trefoil ($r=0.21$) and spherical aberration coefficients ($r=0.28$) as well as the total aberration coefficients ($r=0.20$). Also, a highly significant correlation ($p<0.01$) existed between the corrected spherical error and the post-PRK increase in the higher order coma($r=0.44$). Similarly, a highly significant correlation ($p<0.01$) existed between the corrected cylinderical error and the post-PRK increase in the higher order trefoil aberration ($r=0.46$) as well as in the total aberration coefficients ($r=0.49$). Also, a statistically significant correlation ($p<0.05$) existed between total corrected sphero-cylinderical error and the post-PRK increase in the higher order coma ($r=0.27$) and trefoil aberration coefficients ($r=0.22$). *Conclusion:* Following successful PRK with mitomycin for mild to high myopia with astigmatism using optimized ablation profile, a statistically significant increase occurred in the higher order coma, trefoil, and spherical aberration as well as for the total aberration coefficient values which was largely related to the extent of spherocylinderical correction. The higher order trefoil aberration as well as the total aberration coefficient increase was particularly related to the extent of cylinder corrected.

Keywords: PRK optimized ablation with mitomycin C, total aberration coefficient, higher order coma, trefoil and spherical aberration.

1. INTRODUCTION

Background and statement of the problem

LASIK had become the technique of choice for treatment of wide range of myopia, offering quicker visual recovery and relatively pain-free experience (Schmack et al., 2010). However, biochemical corneal failure, caused by flap creation in addition to laser ablation can result in progressive ectasia (Randleman 2006). Surface ablation in which the lamellar corneal cut is abolished has been considered as an alternative procedure that could decrease the risk of ectasia but with increased possibility of postoperative haze and slower visual recovery as principal disadvantages (Hatch et al., 2011). The adjunctive use of Mitomycin C (is an alkylating agent for DNA, derived from Streptomyces caespitosus), is capable of inhibiting DNA/RNA replication mainly in rapidly dividing cells, like fibroblasts, thus suppressing wound healing (Talamo et al., 1991) and so decreasing the risk of corneal haze (Wallau et al., 2009). In this study, total corneal aberration coefficient as well as higher order coma, trefoil and spherical aberration coefficients were studied both preoperatively as well as one to three months (i.e. after refractive stability) after photorefractive keratectomy for myopia and

myopic astigmatism to have a better understanding of visual function. Wave front aberrations are optical imperfections resulting from improper light focusing on the retina; these aberrations may originate from the cornea or from other optical elements of the eye (Schwiegerling 2000). Wave front aberrations may be lower order aberrations which can be corrected by glasses (defocus and regular astigmatism) and higher order astigmatism which cannot be corrected by glasses) (Porter et al., 2001, Charman 2005, Lombardo et al., 2010, Bühren et al., 2007 and Kuroda et al., 2002). Zernike polynomials are commonly used to classify and represent optical aberrations, using terms of the same form as the types of aberrations, expression the aberrations in the form of pyramid (fig 1) (Lombardo et al., 2010). Among the high order aberrations, only spherical, coma and trefoil aberrations are of clinical interest. The spherical aberration is the cause of night myopia and it increases after LASIK and surface ablation. It results in haloes around point images. It exacerbates myopia in low light (night myopia) (Lombardo et al., 2010). Coma is the distortion in image formation that occurs when a bundle of light rays enters an optical system not parallel to the optic axis resulting in off-axis point sources such as stars appearing distorted, with a comet-like tail causing some sort of double vision (Resan et al., 2012). Trefoil aberration causes a point of light to smear in three directions, like a Mercedes-Benz symbol (Lombardo et al., 2010).

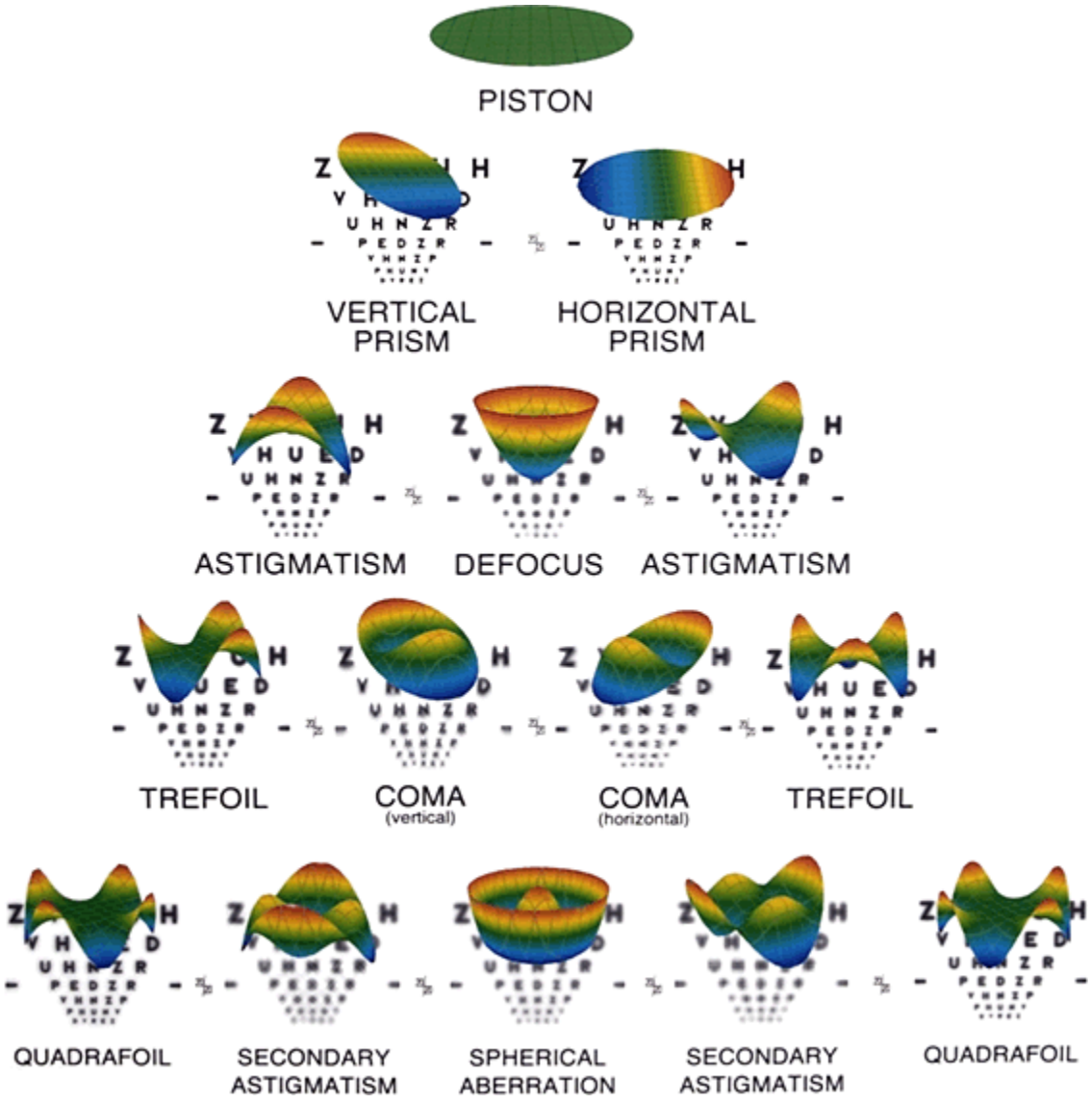

Figure 1 Zernicke polynomials represented in pyramidal form (12).

Objective

In this work, I will focus on studying higher order spherical, Coma, trefoil aberration coefficients as well as total aberration coefficients both before and again after photorefractive keratectomy (PRK) using optimized ablation with mitomycin C application after stabilization of refractive status in myopia with or without astigmatism aiming to achieve reasonable refractive results.

Design

Retrospective, consecutive case series

Participants

Twenty –five eyes (of 14 myopic patients with or without astigmatism) arriving at the refractive unit in the Research Institute Of Ophthalmology Giza (Egypt) seeking for refractive correction in the interval between August 2018 and July 2019 in which photorefractive keratectomy (PRK) using optimized ablation with mitomycin C application was done were included in the study. These patients were considered not suitable for Lasik for a variety of reasons; including extremely thin corneas, abnormal biomechanical corneal properties, high risk corneas for flap creation and cases that carries a high risk from suction ring application like eyes with extreme retinal degenerations with anterior tiny holes. Among the exclusion criteria; patients with previous corneal and intraocular surgery, patients with abnormal tomography, patients with corneal thickness below 475 microns, pregnant and lactating women, patients with active ocular or systemic diseases that can impair healing, cases in which there is under correction of more than 1 diopter and cases with any clinically significant postoperative haze that decreased (BCVA) more than one Snellen line.

2. METHODS

Twenty-five eyes of fourteen myopic patients (with or without stigmatism) seeking for excimer laser ablation, were included in the study; the age ranged from 18-39 years (mean age 28.35±5.51years) , and preoperative total sphero-cylinderical corrected error (T.Sph-Cyl.) ranged from -1.75 to -11.25 diopters (D) (mean value -6.67±2.39D).

PRK with mitomycin C application technique

Topical anaesthesia (Proparacaine hydrochloride 0.4%) is applied twice, followed by mechanical debridement for the central 8mm diameter epithelium with a blunt end of spatula keeping the cornea w*et* all the time to enable smooth debridement. Excimer laser ablation by the ALLEGRETTO WAVE EYE-Q 1010 using a nomogram where 10% undercorrection was used (to avoid overcorrection associated with mitomycin C usage). Mitomycin C 0.02% is applied for 1.5-2 minutes to the ablation site following laser ablation and then washed thoroughly with cold BSS with meticulous washing of the corneal bed, fornices, the lid margins and the puncti to remove any traces of mitomycin C to avoid endothelial toxicity and limbal stem cells toxicity followed by application of a drop of antibiotic –steroid combination and the applying a bandage contact lens for 4 days.

Post-operatively, antibiotics (moxifloxacin hydrochloride 0.5%), Corticosteroid eye drops (prednisolone acetate 1%), topical NSAIDs (Nepafenac 0.3%) and preservative free artificial tears were used for approximately one month, in addition to a GABA analog (gabapentin 300-mg tablets) twice daily for 2 days as a pain killer.

Patients were examined preoperatively as well as one to three months postoperatively after stabilization of the refractive status. Examination included Uncorrected visual acuity (UCVA), refractive error evaluation by Topcon RM 8800 autorefractometer (and confirmation by trial), Best corrected visual acuity (BCVA), Scheimflug imaging (i.e. Pentacam, (ALLEGRO Oculyzer Version 1074; Allergo, Germany) to detect Keratometric readings, central pachymetry, higher order spherical (Z 6.0), Coma (Z 5, ± 1), trefoil aberration (Z 5, ± 3) coefficients, total aberration coefficient for the corneal front surface (from Zernike values at 6.0 mm optical zone) and Ocular response analyzer (ORA) for Corneal hysteresis (CH) ,Corneal resistance factor (CRF) to detect case suitability for refractive ablation. Tabulation of the collected data as well as well as analyses by suitable statistical methods was done. For each studied item, mean value, standard deviation, minimum as well as maximal values were provided. Comparison tests and correlation tests are also performed.

3. RESULTS

Preoperatively, the average keratometric readings (Km) ranged from 41.2 to 46 Diopters (mean value 43.73±1.25). The central pachymetry (Cent.Pachy) readings ranged from 510 to 660µ (mean value 552.44±42.21). The sphere (Sph.) ranged from -0.75 to -10D (mean value -5.17±2.36). The cylinder (Cyl.) ranged from -0.5 to -4.75 Diopters (mean value -2.25±1.25). The total sphero-cylinderical correction (T.Sph-Cyl.) ranged from -1.75 to -11.25 diopters (mean value -6.67±2.39). The best-corrected visual acuity

(BCVA) in Snellen lines ranged from 0.3 to 1.0 (mean value 0.69±0.24). The corneal hysteresis (CH) ranged from 7.5 to 16.8 (mean value 11.00±2.00). The corneal resistance factor (CRF) ranged from 9 to 15.8 (mean value 10.70±1.66).

Postoperatively, the average keratometric readings (Km) ranged from 33.05 to 43.45 Diopters (mean value 38.26±3.04). The central pachymetry (Cent.Pachy) readings ranged from 354 to 600μ (mean value 435.76±74.51). The uncorrected visual acuity (UCVA) in Snellen lines ranged from 0.3 to 1.0 (mean value 0.72±0.19).

The mean decrease in the average keratometric readings (Km) ranged from 1.4 to 8.8 diopters (mean value 4.92±2.07). The mean decrease in the central pachymetry (Cent.Pachy) ranged from 27 to 190 μ (mean value 116.68±40.86μ).

Regarding the higher order aberrations of the front corneal surface for cases under study, the coma aberration coefficient, increased from a mean value of 0.12±0.07μ preoperatively to a mean value of 0.24±0.15 μ postoperatively with t-test showing a value of 3.29 ($p<0.05$) denoting a statistically significant increase. The trefoil aberration coefficient, increased from a mean value of 0.09±0.05μ preoperatively to a mean value of 0.15±0.11 μ postoperatively with t-test showing a value of 2.29 ($p<0.05$) denoting a statistically significant increase. The spherical aberration coefficient, increased from a mean value of 0.08±0.07μ preoperatively to a mean value of 0.21±0.18 μ postoperatively with t-test showing a value of 3.27 ($p<0.05$) denoting a statistically significant increase. The Total aberration coefficient (ABR), increased from a mean value of 1.04±0.55μ preoperatively to a mean value of 1.64±0.31 postoperatively with t-test showing a value of 4.86($p<0.05$) denoting a statistically significant increase (table 1 and chart 1).

Table 1 Showing the mean values of higher order coma, trefoil and Spherical aberration coefficients as well as total aberration coefficient both preoperatively and 1-3 months postoperatively for cases under the study.

Item	Preoperative mean value and standard deviation	Post-operative mean value and standard deviation	t-test	P-value	Significance
Coma aberration	0.12±0.07μ	0.24±0.15 μ	3.29	*<0.05*	*Statistically significant*
Trefoil aberration	0.09±0.05μ	0.15±0.11 μ	2.29	*<0.05*	*Statistically significant*
Spherical aberration	0.08±0.07μ	0.21±0.18 μ	3.27	*<0.05*	*Statistically significant*
Total Aberration coefficient (ABR)	1.04±0.55μ	1.64±0.31	4.86	*<0.05*	*Statistically significant*

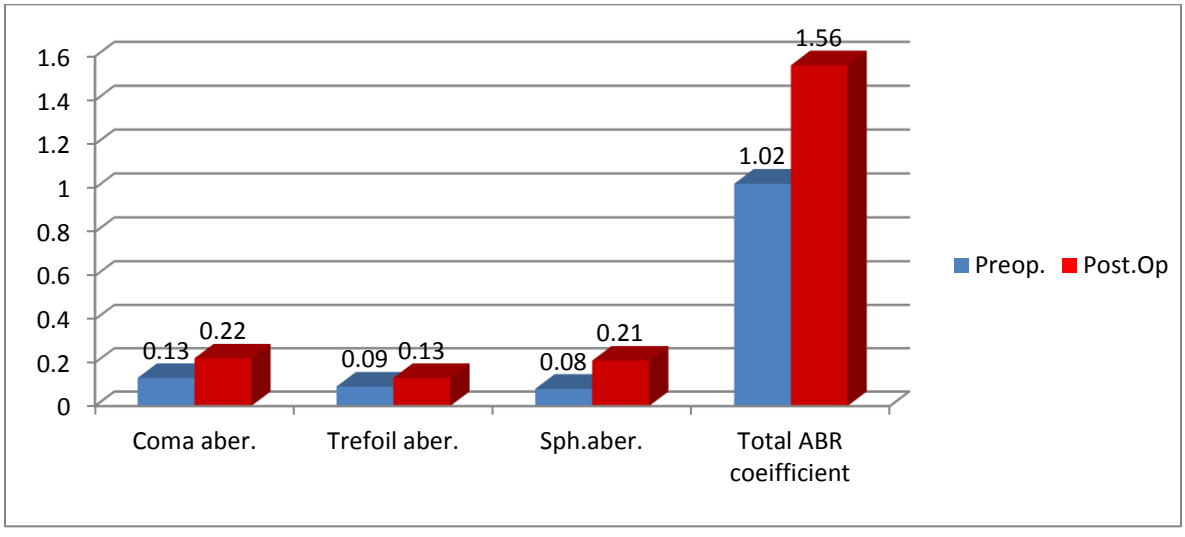

Chart 1 showing the mean values of higher order coma, trefoil and Spherical aberration coefficients as well as total aberration coefficient both preoperatively and 1-3 months postoperatively for cases under the study.

To study the effect of mean keratometry change post-PRK with mitomycin on changes in studied aberration coefficients Pearson correlation test was done

A highly significant correlation (p<0.01) existed between post-PRK change (i.e. decrease) in the average keratometric readings and the post-PRK increase in higher order trefoil (r=0.15), Spherical aberration coefficients(r=0.07), and coma aberration coefficient (r=0.58), a statistically significant (p<0.05) correlation existed between post-PRK change (i.e. decrease) in the average keratometric readings and the post-PRK increase in the total aberration coefficient (r=0.22), but a non significant correlation (p>0.05) existed between post-PRK change (i.e. decrease) in the average keratometric readings and the post-PRK increase in higher order trefoil (r=0.15) and Spherical aberration coefficients (r=0.07) (table 2).

Table 2 showing correlations between post-PRK with mitomycin change in average keratometric readings and the post-PRK change in the various studied aberrations among cases under study.

Correlation between items	Pearson correlation "r"	P-value	Significance
Coma.aberr.change *Vs* mean keratometry change	0.58	*<0.01*	*Highly Significant*
Trefoil.aberr.change *Vs* mean keratometry change	0.15	>0.05	Non significant
Spherical.aberr.change *Vs* mean keratometry change	0.07	>0.05	Non significant
Total.aberr.change *Vs* mean keratometry change	0.22	*<0.05*	*Significant*

To study the effect of mean central pachymetry decrease post-PRK with mitomycin on changes in studied aberration coefficients, Pearson correlation test was done

A highly significant correlation (p<0.01) existed between post-PRK change (i:e; decrease) in the central pachymetrty readings and the post-PRK increase in the higher order coma (r=0.41), while a statistically significant correlation (p<0.05) existed between post-PRK decrease in the central pachymetrty readings and the post-PRK increase in higher order trefoil (r=0.21) and spherical aberration coefficients (r=0.28) as well as the total aberration coefficients (r=0.20) (table 3).

Table 3 showing correlations between post-PRK with mitomycin change in central pachymetry readings and the post-PRK change in the various studied aberrations among cases under study.

Correlation between items	Pearson correlation"r"	P-value	Significance
Coma.aberr.change *Vs* Cent.pachym change	0.41	*<0.01*	*Highly Significant*
Trefoil.aberr.change *Vs* Cent.pachym change	0.21	*<0.05*	*Significant*
Spherical.aberr.change *Vs* Cent.pachym change	0.28	*<0.05*	*Significant*
Total.aberr.change *Vs* Cent.pachym change	0.20	*<0.05*	*Significant*

To study the effect of the corrected spherical error on changes in studied aberration coefficients, Pearson correlation test was done

A highly significant correlation (p<0.01) existed between the corrected spherical error and the post-PRK increase in the higher order coma (r=0.44), but a non significant correlation (p>0.05) existed between the corrected spherical error and the post-PRK increase in the higher order trefoil (r=0.08), spherical aberration (r=0.05) as well as the total aberration coefficients (r=0.12) (table 4).

Table 4 Showing correlations between the corrected spherical error and the post-PRK change in the various studied aberrations among cases under study.

Correlation between items	Pearson correlation"r"	P-value	Significance
Coma.aberr.change *Vs* Spherical error corrected	0.44	*<0.01*	*Highly Significant*
Trefoil.aberr.change *Vs* Spherical error corrected	0.08	>0.05	Non significant
Spherical.aberr.change *Vs* Spherical error corrected	0.05	>0.05	Non significant
Total.aberr.change *Vs* Spherical error corrected	0.12	>0.05	Non significant

To study the effect of the corrected cylinderical error on changes in studied aberration coefficients, Pearson correlation test was done

A highly significant correlation (p<0.01) existed between the corrected cylinderical error and the post-PRK increase in the higher order trefoil aberration (r=0.46) as well as in the total aberration coefficients (r=0.49), but a non significant correlation (p>0.05) existed between the corrected cylinderical error and the post-PRK increase in the higher order coma(r=0.13) and spherical aberration coefficients (0.17) (table 5).

Table 5 showing correlations between the corrected cylinderical error and the post-PRK change in the various studied aberrations among cases under study.

Correlation between items	Pearson correlation "r"	P-value	Significance
Coma.aberr.change *Vs* cylinderical error corrected	0.13	>0.05	Non significant
Trefoil.aberr.change *Vs* cylinderical error corrected	0.46	*<0.01*	*Highly significant*
Spherical.aberr.change *Vs* cylinderical error corrected	0.17	>0.05	Non significant
Total.aberr.change *Vs* cylinderical error corrected	0.49	*<0.01*	*Highly significant*

To study the effect of the total corrected sphero-cylinderical error on changes in studied aberration coefficients, Pearson correlation test was done

A statistically significant correlation (p<0.05) existed between total corrected sphero-cylinderical error and the post-PRK increase in the higher order coma(r=0.27), trefoil aberration coefficients (r=0.22), but a non significant correlation (p>0.05) existed between the total corrected sphero-cylinderical error and the post-PRK increase in the higher order spherical aberration coefficients (0.19) as well as the total aberration coefficients (r=0.18) (table 6).

Table 6 showing correlations between the total corrected sphero-cylinderical error and the post-PRK change in the various studied aberrations among cases under study.

Correlation between items	Pearson correlation"r"	P-value	Significance
Coma.aberr.change *Vs* total corrected sphero-cylinderical error	0.27	*<0.05*	*Significant*
Trefoil.aberr.change *Vs* total corrected sphero-cylinderical error	0.22	*<0.05*	*Significant*
Spherical.aberr.change *Vs* total corrected sphero-cylinderical error	0.19	>0.05	Non significant

Total.aberr.change *Vs* total corrected sphero-cylinderical error	0.18	>0.05	Non significant

4. DISCUSSION

Photorefractive keratectomy (PRK) with mitomycin was proven in many studies to achieve reasonable refractive results comparable to lasik in many cases of myopia and astigmatism (Wallau et al., 2009 and Gambato et al., 2005). However some investigators found that using photorefractive keratectomy for correcting intermediate to high levels of myopia may result in strong wound healing reaction, leading to haze formation and suboptimal refractive outcomes (Wallau et al., 2009). Also some investigators have reported that the wave front aberrations were significantly increased after Photorefractive keratectomy in which mitomycin C application was not applied in all cases (Hosseini et al., 2016 and Yan et al., 2007). Others report that photorefractive keratectomy with mitomycin did not induce significant post-operative changes in the higher order aberrations (Randleman et al., 2009). In this study which included low to high myopes with or without astigmatism, in which photorefractive keratectomy using optimized excimer laser ablation with mitomycin C was applied, wavefront aberrations were studied after early stabilization of refractive errors.

Hosseini et al., 2016, studied 50 eyes in which PRK with mitomycin was performed using wavefront-guided treatment with Technolas 217z (Bausch & Lomb/Technolas, Munich, Germany), and the wavefront aberrations were measured using a Hartmann-Shack wavefront sensor (Zywave II aberrometer, Bausch & Lomb/Technolas, Munich, Germany), the total higher order aberrations (HOA) RMS increased from 0.35±0.13 preoperatively to 0.43±0.21 postoperatively at 6 mm pupil denoting a statistically significant increase (P<0.02), the horizontal coma showed a statistically significant increase (<0.001) but neither the higher order spherical aberration nor the vertical coma showed any statistically significant change after the PRK with mitomycin (Hosseini et al., 2016); but they worked on much lower mean values for the spherical (-3.26±1.43), cylinderical error (-0.72±0.60) as well as for the spherical equivalents (-3.61±1.51) that in my study.

Yan et al., 2007, studied 16 eyes (between -5 to -6.0 diopters of myopia and with less than -1.0 D cylinder with mean spherical equivalent of -5.41±0.41) in which photorefractive keratectomy was applied in which excimer laser ablation was performed using NIDK EC-5000 (NIDEK, Gamagori, Japan), and the Wave aberrations were measured by means of a subjective aberrometer (Su Zhou BriteEye Model WFA 1000, China) that has been described and based on the principle of laser ray tracing that has been changed to a computer-monitor version, they found that post-PRK, the mean RMS for the higher aberrations had significantly increased (Yan et al., 2007).

Randleman et al., 2009, studied 100 eyes in which PRK with mitomycin was performed using Wave Light Allegretto Wave excimer laser (WaveLight AG)-optimized technology and the Higher-order aberrations were measured with the OPD-Scan ARK-10000 corneal analyzer (Nidek Technologies) they did not found any significant change in the total higher order aberrations as well as in the spherical, coma, trefoil or tetrafoil aberrations.

In this study, a post-PRK statistically significant increase (p<0.05) occurs in the higher order coma aberration coefficient (from a mean value of 0.12±0.07μ preoperatively to a mean value of 0.24±0.15 μ postoperatively), higher order trefoil aberration coefficient, (from a mean value of 0.09±0.05μ preoperatively to a mean value of 0.15±0.11μ), higher order spherical aberration coefficient, (from a mean value of 0.08±0.07μ preoperatively to a mean value of 0.21±0.18 μ postoperatively as well as in the Total aberration coefficient (ABR), (increased from a mean value of 1.04±0.55μ preoperatively to a mean value of 1.64±0.31 postoperatively) and these findings agreed with the results found by Yan W et al., 2007, and agreed partially with results found by Hosseini et al., 2016, in which neither the higher order spherical aberration nor the vertical coma showed any statistically significant change after the PRK with mitomycin; but they worked on much lower mean values for the spherical (-3.26±1.43 Vs -5.17±2.36 in my study), cylinderical error (-0.72±0.60 Vs -2.25 ±1.25 in my study) as well as for the spherical equivalents (-3.61±1.51 Vs -6.67±2.39 in my study) that in my study.

In this study, a highly significant correlation (p<0.01) existed between post-PRK decrease in the average keratometric readings and the post-PRK increase in higher order coma aberration coefficient (r=0.58) and a statistically significant(p<0.05) correlation existed between post-PRK decrease in the average keratometric readings and the post-PRK increase in the total aberration coefficient (r=0.22) , but a non significant correlation (p>0.05) existed between post-PRK change (i.e. decrease) in the average keratometric readings and the post-PRK increase in higher Similarly, a highly significant correlation (p<0.01) existed between post-PRK change (i.e. decrease) in the central pachymetrty readings and the post-PRK increase in the higher order coma (r=0.41), while a statistically significant correlation (p<0.05) existed between post-PRK decrease in the central pachymetrty readings and the post-PRK increase in higher order trefoil (r=0.21) and spherical aberration coefficients (r=0.28) as well as the total aberration coefficients (r=0.20). Also, a highly significant correlation (p<0.01) existed between the corrected spherical error and the post-PRK increase in

the higher order coma (r=0.44). Similarly, a highly significant correlation (p<0.01) existed between the corrected cylinderical error and the post-PRK increase in the higher order trefoil aberration (r=0.46) as well as in the total aberration coefficients (r=0.49). Also, a statistically significant correlation (p<0.05) existed between total corrected sphero-cylinderical error and the post-PRK increase in the higher order coma (r=0.27) and trefoil aberration coefficients (r=0.22) and these correlations were not included in the studies made by Hosseini et al., 2016, Yan W et al., 2007, nor by Randleman et al., 2009.

5. CONCLUSION

Following successful PRK with mitomycin for mild to high myopia with astigmatism using optimized ablation profile, a statistically significant increase occurred in the higher order coma, trefoil, and spherical aberration as well as for the total aberration values which was largely related to the extent of spherocylinderical correction. The higher order trefoil aberration as well as the total aberration increase was particularly related to the extent of cylinder corrected.

Financial disclosure

The author has no proprietary or commercial interest in any of the materials discussed in this article.

REFERENCE

1. Bühren J, Kühne C, Kohnen T. Defining subclinical keratoconus using corneal first-surface higher-order aberrations. Am J Ophthalmol. 2007; 143:381–389.
2. Charman WN. Wavefront technology: past, present and future.Cont Lens Anterior Eye. 2005; 28:75–92.
3. Gambato C, Ghirlando A, Moretto E, Busato F,Midena E. Mitomycin C modulation of corneal wound healing after photorefractive keratectomy in highly myopic eyes. Ophthalmology, 2005; 112:208-18.
4. Hatch BB, Moshirfar M, Ollerton AJ, Sikder S, Mifflin MD. A prospective, contralateral comparison of photorefractive keratectomy (PRK) versus thin flap LASIK: assessment of visual function. Clin Ophthalmol 2011; 5:451–457.
5. Jahadi Hosseini SH, Abtahi SM, Khalili MR. Comparison of Higher Order Aberrations after Wavefront-guided LASIK and PRK: One Year Follow-Up Results. J Ophthalmic Vis Res 2016; 11 (4): 350–357.
6. Kuroda T, Fujikado T, Maeda N, Oshika T, Hirohara Y, Mihashi T. Wavefront analysis in eyes with nuclear or cortical cataract. Am J Ophthalmol. 2002; 134:1–9.
7. Lombardo M, Lombardo G. Wave aberration of human eyes and new descriptors of image optical quality and visual performance. J Cataract Refract Surg. 2010; 36:313–331.
8. Porter J, Guirao A, Cox IG, Williams DR. Monochromatic aberrations of the human eye in a large population. J Opt Soc Am A Opt Image Sci Vis. 2001; 18:1793–1803.
9. Randleman J.B. Post-laser in-situ keratomileusis ectasia: current understanding and future directions. Curr Opin Ophthalmol. 2006; 17(4): 406-412.
10. Randleman JB, Perez-Straziota CE, Hu MH, White AJ, Loft ES, Stulting RD. Higher-order aberrations after wavefront-optimized photorefractive keratectomy and laser in situ keratomileusis. J Cataract Refract Surg. 2009 February; 35(2): 260–264.
11. Resan M, Miroslav Vukosavljević M and Milivojević M. Wavefont Aberrations. Advances In Ophthalmology 2012:192-204.
12. Schmack I, Auffarth GU, Epstein D, Holzer MP. Refractive surgery trends and practice style changes in Germany over a 3-year period. J Refract Surg. 2010; 26(3): 202-8.
13. Schwiegerling J. Theoretical limits to visual performance. Surv Ophthalmol 2000; 45:139–146.
14. Talamo JH, Gollamudi S, Green WR, De La Cruz Z, Filatov V, Stark WJ.Modulation of corneal wound healing after excimer laser keratomileusis using topical mitomycin C and steroids. Arch Ophthalmol 1991; 109:1141–1146.
15. Wallau AD, Campos M. One-year outcomes of a bilateral randomized prospective clinical trial comparing PRK with mitomycin C and LASIK.Br J Ophthalmol 2009; 93:1634–1638.
16. Yan W, Kan-xing Z, Ji-chang H, Ying J, Tong Z. Ocular higher-order aberrations features analysis after corneal refractive surgery. Chin Med J 2007; 120(4):269-273.