ECRONICON OPEN ACCESS

EC OPHTHALMOLOGY

Research Article

Preoperative Values of Higher Order Aberrations in Myopic Candidates for Laser Refractive Surgery

Bojan Kozomara[1]*, Tamara Bojanic-Baric[1], Ernesta Potkonjak[1] and Nikica Gabric[2]

[1]*Special Eye Hospital "Svjetlost", Banja Luka, Bosnia-Herzegovina*

[2]*Special Eye Hospital "Svjetlost", Zagreb, Croatia*

***Corresponding Author**: Bojan Kozomara, Special Eye Hospital "Svjetlost", Banja Luka, Bosnia-Herzegovina.

Received: May 25, 2020; **Published:** June 30, 2020

Abstract

Purpose: To evaluate corneal higher-order aberrations (HOA) values in myopic patients who are candidates for laser refractive surgery.

Methods: Preoperative exam data of myopic laser refractive surgery candidates are evaluated. The preoperative exam consists of uncorrected (UCDVA) and best spectacle-corrected (BSCVA) distance visual acuity, intraocular pressure, and biomicroscopy of the anterior and posterior segment. Keratometry, corneal pachymetry, and HOA measurements are gathered through Scheimpflug imaging. Higher-order aberrations were measured at 4 mm pupil diameter. All candidates were divided into four groups according to their refractive error: Group I (-0.50 to -2.00), Group II (-2.25 to -4.00), Group III (-4.25 to -6.00), and Group IV (-6.25 to -8.00).

Results: A total of 1630 myopic patients (3060 eyes) were enrolled in this study. Mean spherical equivalent (SE) for all groups was -3.91 ± 1.95. The mean value of RMS Coma was 0.29 ± 0.15 and RMS spherical aberration (SA) was 0.23 ± 0.06. Two groups showed a statistically significant increase in RMS coma and only one group in RMS SA.

Conclusion: There was no overall statistically significant increase in corneal HOA between the groups. The focus of future studies could be on the evaluation of corneal and ocular HOA in myopic patients.

Keywords: *Higher-Order Aberration; Myopia; Value*

Introduction

Myopia is one of the leading causes of visual impairment in the world. The etiology of myopia is multifactorial and includes both genetic and environmental factors [1]. Its prevalence has risen in the past five decades, particularly in developed countries. Some regions in the world consider this rise to be a major public healthcare problem [2-4].

Higher-order aberrations (HOA) are visual imperfections caused by the irregularity of the light rays as they pass through the optical system of the eye. Almost 80% of HOA are corneal, and the rest 20% are caused by changes in other parts of the eye [5,6]. HOA can cause retinal image deterioration, and they cannot be corrected with spectacles or contact lenses.

Purpose of the Study

The purpose of this study is to show the values of corneal higher-order aberrations in myopic candidates for laser refractive surgery.

Materials and Methods

This study is designed as a prospective, longitudinal, monocentric, and cross-sectional.

Inclusion criteria:

- Myopic candidates for laser refractive surgery who were referred to our hospital starting January 2017.
- Older than 18 and younger than 50 years of age.
- No change in refractive error stable for at least a year.
- The corneal thickness of 500 microns and more.
- No ocular pathology.

Exclusion criteria:

- Patients who have myopic astigmatism or any other refractive error.
- Younger than 18 years of age or older than 50 years of age.
- Refractive error is still unstable.
- Corneal thickness is less than 500 microns.
- Cataract or other ocular pathologies are present.

Research groups

Participants were organized into four groups according to their preoperative refractive error: group I (-0.50 D to -2.00 D), group II (-2.25 D to -4.00 D), group III (-4.25 D to -6.00 D), and group IV (-6.25 D to -8.00 D).

Preoperative assessment

A preoperative eye exam was mandatory for all candidates. Uncorrected (UCDVA) and best spectacle-corrected (BSCVA) distance visual acuity was determined using the Snellen chart. For patients with presbyopia, uncorrected near visual acuity (UCNVA) was assessed using the Jaeger chart. Intraocular pressure values were evaluated with Goldmann contact tonometer, while the slit lamp examination evaluated anterior and posterior eye segments.

Keratometry, corneal pachymetry, and higher-order aberration measurement were measured using Oculus Pentacam II (Oculus Optikgerate, GmbH, Wetzlar, Germany). For the purpose of this study, RMS coma and spherical aberrations values were used.

Statistical analysis

Mean, and the standard deviation was calculated using continuous variables, while significance was tested with paired two-tailed student t-test. A p-value of less than 0.05 was considered statistically significant.

Consent

Before obtaining the results, every participant was informed about the research aims and goals. Each of them had to give their written consent by which they approve their results to be used and presented in the study.

Results

A total of 1630 candidates (3060 eyes) for laser refractive surgery are enrolled in this study. The demographics of the patients are shown in table 1.

Demographic data	
No. of participants (eyes)	1630 (3060)
Male/Female ratio	736/894
Surgical procedure: both eyes/right eye/left eye	2670/185/205
Mean spherical equivalent (SE)	-3.91 ± 1.95
Mean pachymetry values	557.54 ± 10.67

Table 1: *Demographic data for all participants.*

Mean spherical equivalent (SE) is -3.91 ± 1.95, mean pachymetry value is 557.54 ± 10.67, and mean K1/K2 values are 43.29 ± 7.94/44.57 ± 1.64. Table 2 shows the mean SE, pachymetry, and K1/K2 values between groups.

	Groups			
	Group I	**Group II**	**Group III**	**Group IV**
Mean ref. error	-1.41 ± 0.41	-2.91 ± 0.53	-4.74 ± 0.63	-6.61 ± 0.97
Pachymetry	543.79 ± 30.76	556.50 ± 26.43	560.33 ± 21.18	569.54 ± 20.12
Keratometry	43.10 ± 14.10	43.32 ± 21.20	43.60 ± 18.71	44.41 ± 19.21
RMS coma	0.309 ± 1.14	0.308 ± 1.16	0.339 ± 0.17	0.381 ± 0.13
RMS SA	0.31 ± 2.28	0.15 ± 0.40	0.24 ± 1.11	0.25 ± 0.13

Table 2: *Distribution of the results between groups.*

Overall root mean square (RMS) value for third-order coma is 0.29 ± 0.15, and for forth order, spherical aberration is 0.23 ± 0.06.

There is a statistically significant increase in HOA between groups I and II and groups II and III in RMS coma ($p = 0.003215$; $p = 0.004369$). An increase in HOA between groups III and IV was statistically insignificant ($p = 0.11346$). In HOA SA, statistically significant change is seen between groups I and II ($p = 0.0026$), while statistically insignificant changes are noticed between groups II and III ($p = 0.2894$), as well as III and IV ($p = 0.7808$).

Discussion

Corneal HOA accounts for 80% of total HOA in the eye, and they can affect the visual quality in all patients [5,6]. Out of all HOA, third-order coma and fourth-order spherical aberration are found to create most of the photic phenomena [7,8]. Others found no noticeable effect on haloes and glare with HOA values of less than 1.0 µm, while blur could be seen with HOA values between 1.0 µm and 1.5 µm [9].

Many authors compared preoperative values of HOA in their myopic patients and had similar results. In their study on preoperative and postoperative HOA values with different laser refractive surgical techniques, Zhang J., *et al*. [10] found total preoperative HOA values of 0.24 ± 0.06 and 0.25 ± 0.08 with the SE of -5.18 ± 1.90 and -5.68 ± 2.29 respectively. Similar results were found in 148 eyes with SE of -4.23 ± 1.58 and RMS HOA of 0.38 ± 0.12 [11]. However, all these studies have shown similar values in third-order and fourth-order HOA preoperatively. Comparing this to our results, the RMS coma shows no statistically significant difference (0.29 ± 0.15 for coma, and 0.23 ± 0.06 for spherical aberration).

The question remains whether there is a direct relationship between HOA and myopia. Collins., *et al.* [12] compared myopic and emmetropic HOA levels and found that individuals with progressive myopia have higher HOA. Paquin., *et al*. [13] also found that HOA increases in a myopic eye, while other authors pointed out the correlation between SE and spherical aberration and horizontal coma [14,15]. Furthermore, some reports also show a significant increase of HOA in fast-developing myopia compared to slow-developing myopia [16-18].

If we look at the results of this study between groups, there is a statistically significant increase of HOA with a rise in myopia in both RMS coma and RMS SA between some groups, but not all of them. Furthermore, we cannot be sure what is the exact cause of this change. We can only hypothesize that a more significant increase of axial length anatomically changes iris and pupil as well, which then shows the difference in the RMS coma. On the other hand, a statistically significant change in RMS SA change was noticed between groups I and II. Again, the reason for this may be the small change in peripheral corneal power with an increase of myopia.

Many studies pointed out a direct correlation between the pupil diameter, age, and increase in HOA [19-21]. For this study, age-related change in HOA was not included, while all measurements of HOA were taken at 4 mm pupil diameter.

Conclusion

In conclusion, we can say that there is no direct correlation between the increase in myopia and an increase in corneal RMS coma and spherical aberration values. However, a new study that measures ocular and compares them to corneal higher-order aberrations could be useful to determine if ocular aberrations change with an increase in axial length.

Bibliography

1. Flitcroft DI. “The complex interactions of retinal, optical and environmental factors in myopia aetiology”. *Progress in Retinal and Eye Research* 31 (2012): 622-660.
2. Morgan IG., *et al*. “Myopia”. *Lancet* 379 (2012): 1739-1748.
3. Pan CW., *et al*. “Worldwide prevalence and risk factors for myopia”. *Ophthalmic and Physiological Optics* 32 (2012): 3-16.
4. Vitale S., *et al*. “Increased prevalence of myopia in the United States between 1971-1972 and 1999-2004”. *Archives of Ophthalmology* 127 (2009): 1632-1639.
5. Atchinson DA., *et al*. “Anterior corneal, posterior corneal, and lenticular contributions to ocular aberrations”. *Investigative Ophthalmology and Visual Science* 57 (2016): 5263-5270.
6. Wan XH., *et al*. “Ocular monochromatic aberrations in a rural Chinese adult population”. *Optometry and Vision Science* 91 (2014): 68-75.
7. Yamane N., *et al*. “Ocular higher-order aberrations and contrast sensitivity after conventional laser in situ keratomileusis”. *Investigative Ophthalmology and Visual Science* 45 (2004): 3986-3990.
8. Moshirfar M., *et al*. “Visual outcomes after wavefront-guided photorefractive keratectomy and wavefront-guided laser in situ keratomileusis prospective comparison”. *Journal of Cataract and Refractive Surgery* 36 (2010): 1336-1343.
9. He JC., *et al*. “Wavefront aberrations in eyes of emmetropic and moderately myopic school children and young adults”. *Vision Research* 42 (2002): 1063-1070.
10. Zhang J., *et al*. “Corneal aberrations after small-incision lenticule extraction versus Q value-guided laser-assisted in situ keratomileusis”. *Medicine* 98 (2019): e14210.

11. Zhang, N., *et al*. "Relationship between higher-order aberrations and myopia progression in schoolchildren: a retrospective study". *International Journal of Ophthalmology* 6 (2013): 295-299.

12. Collins MJ., *et al*. "Retinal image quality, reading and myopia". *Vision Research* 46 (2006): 196-215.

13. Paquin MP., *et al*. "Objective measurement of optical aberrations in myopic Eyes". *Optometry and Vision Science* 79 (2002): 285-291.

14. Karimian F., *et al*. "Higher-order aberrations in myopic eyes". *Journal of Ophthalmic and Vision Research (JOVR)* 5 (2010): 3-9.

15. Kwan WC., *et al*. "Monochromatic aberrations of the human eye and myopia". *Clinical and Experimental Optometry* 92 (2009): 304-312.

16. Kirwan C., *et al*. "Higher-order aberrations in children". *American Journal of Ophthalmology* 141 (2006): 67-70.

17. He JC., *et al*. "Wavefront aberrations in eyes of emmetropic and moderately myopic school children and young adults". *Vision Research* 42 (2002): 1063-1070.

18. Yazar S., *et al*. "Comparison of monochromatic aberrations in young adults with different visual acuity and refractive errors". *Journal of Cataract and Refractive Surgery* 40 (2014): 441-449.

19. Applegate RA. "Three-dimensional relationship between high-order root-mean-square wavefront error, pupil diameter, and aging". *Journal Of The Optical Society Of America A, Optics, Image Science, And Vision* 24 (2007): 578-587.

20. Wu WJ., *et al*. "Changes in monochromatic higher-order aberrations in different pupil sizes with accommodation in young emmetropes". *Zhonghua Yanke Zazhi* 44 (2008): 603-608.

21. Bisneto OS., *et al*. "Relationship between high-order aberrations and age and between high-order aberrations and refractive errors". *Arquivos Brasileiros De Oftalmologia* 70 (2007): 290-297.

Volume 11 Issue 7 July 2020