Original Article

The Effect of Soft Contact Lenses on Optic Nerve Head Measurements Using Optical Coherence Tomography

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Abstract

Purpose: To evaluate the effect of soft contact lens induced myopia and hyperopia on optic nerve head measurements of normal eyes using spectral domain optical coherence tomography (SD-OCT).
Methods: This cross sectional study was performed on 114 emmetropic eyes of 57 participants. Each participant underwent a complete ophthalmic examination including determination of best-corrected visual acuity, intraocular pressure, dry and cycloplegic refraction as well as axial length measurement. SD-OCT measurement was performed in all ayes while different levels of refraction strength were induced by wearing soft contact lenses of five different diopters (- 10.00, - 5.00, Plano, + 5.00, + 10.00).
Results: The mean measured thicknesses of retinal nerve fiber layer was 123.29 ± 10.56 micrometer, 123.17 ± 11.61 micrometer, 122.77 ± 11.61 micrometer, 123.37 ± 11.15 micrometer and 123.42 ± 11.45 micrometer in contact lens induced high myopia, moderate myopia, emmetropic, moderate hyperopia, and high hyperopia groups, respectively ($P = 0.721$). Also, corresponding evaluations for mean rim area ($P = 0.781$), mean optic disc area ($P = 0.601$), mean cup area ($P = 0.53$), and mean cup to disc area ratio ($P = 0.414$) showed no statistically significant difference.
Conclusion: Our findings indicate that refractive error variation at the corneal plane caused by contact lens wear has no significant effect on thickness of retinal nerve fiber layer, disc area, cup area, rim area and mean cup to disc area ratio measured by SD-OCT in normal eyes.

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Introduction

Optical coherence tomography (OCT) is a new imaging technology that works by low coherence interferometry and reflectometry and allows a practitioner to obtain cross sectional images of the eye [1-3].

Thicknesses of the retinal nerve fiber layer (RNFL), as well as the size of the rim area and disc area, are the important parameters for assessment of optic nerve disease [3]. However there are many factors that affect OCT measurements of these parameters such as glaucoma, dry eye, and type of instrument, race and refractive errors [4-8]. Therefore, it is important to determine whether variation in optical power may induce changes that should be accounted for by a clinician prior to interpreting OCT derived data.

Although some studies have reported that refractive error affects measurements taken with OCT, it is not clear weather these changes are caused by corneal thickness or other factors that affect accuracy of OCT measurement [9, 10]. In theory, the optical system of OCT could be affected by magnification factor and such changes may affect measurement of the retinal plane [10-14]. It is essential to achieve accurate OCT measurement for users of soft contact lenses and patients undergoing cataract/refractive surgery, especially for monitoring changes in glaucoma in follow up scans. The aim of the present study was to determine the effect of soft contact lens induced myopia and hyperopia on optic nerve head measurement of normal eyes using spectral domain optical coherence tomography (SD-OCT).

Methods

This cross sectional study was approved by the Ethics Committee of Shahid Beheshti University of Medical Sciences. The study followed the principles of the Declaration of Helsinki and all participants gave their written consent before entering the study.

The sample size calculated based on instrument normative database was 114 eyes. The inclusion criteria were age of 18 to 45 years; IOP of less than 21 mm Hg, BCVA of 20/20, and equivalent refractive error of less than 0.5 diopter. Exclusion criteria included any vitreoretinal diseases and RNFL problems, a history of systemic disease such as hypertension or diabetes, ocular media opacities, history of eye surgery, history of intolerance to local anesthesia, contraindication for pupil dilation or evidence of glaucoma.

Each participant underwent a complete ophthalmic evaluation including refraction and BCVA measurements, IOP assessment (Goldmann Applanation Tonometry) and eye axial length measurement using A-scan ultrasonography (Sonomed Inc; California, USA). The pupils were dilated using Cyclopentolate 1 % applied twice within 5 minutes and fundus examination was performed after 45 minutes using a + 78 D lens. Refraction measurement was repeated at this time to ensure the accommodation would not affect the findings. To investigate the effect of contact lens on images; optic nerve pictures were first taken without contact lenses. In the next step, subjects wore + 5.00, + 10.00, - 5.00 and - 10.00 D soft contact lenses and were allowed to feel relatively comfortable with soft contact lenses without tearing. At this time images were taken from the optic nerve head using OptoVue RTVue (OptoVue Inc, Fremont, CA, USA) while patients wore each of contact lenses. For this purpose, the first step was to take a 3 D image reference then optic nerve head images were captured and calculations were made for optic disc area, cup area, rim area and thickness of RNFL. All measurements were taken by an experienced optometrist and accuracy of the landmarks was approved in all cases. Only scans with signal strength above 50 were accepted.

We used SPSS version 20 (Armonk, NY: IBM Corp) to analyze the data. Kolmogorov Smirnov test was used to check the normal distribution of data. Comparison of measurements with and without contact lenses was performed using paired t-test and ANOVA test.

Results

The present study was performed on 114 eyes of 57 normal emmetropic participants including 30 males (52.63 %) and 27 females (47.36 %) with mean age of 25.78 ± 6.50 years (Table 1). The mean spherical equivalent refractive error and axial length for all participants were -0.27 ± 0.20 Diopter and 23.31 ± 0.56 mm respectively. The mean intraocular pressure was 14.53 ± 1.94 mmHg. No statistically significant difference for the mean thickness of RNFL, cup area, rim area, optic disc area and cup to disc area ratio was observed (P = 0.272, 0.189, 0.218, 0.607 and 0.536 respectively) when patients wore either no contact lens or Plano contact lenses (Table 2). Also no statistically significant difference for the mean thickness of RNFL, cup area, rim area, optic disc area and cup to disc area ratio was observed (P = 0.721, 0.530, 0.781, 0.601 and 0.414 respectively) when patients wore different power contact lenses (Table 3, Figure 1).

Discussion

The variation in scan parameters might have a considerable impact on outcome of RNFL thickness measurement [15-22]. As imaging technology and RNFL segmentation algorithms improve, it is necessary to incorporate the optical properties of patients' eyes to achieve more accurate measurements [14].

In the present study, RNFL thickness was measured in emmetropia condition and while subjects wore different soft contact lenses to induce non axial high myopia, moderate myopia, moderate hyperopia and high hyperopia. Our results suggest that different levels of induced refractive error had no significant effect on measurement of RNFL thickness (P = 0.721). Similar to our findings Salchow et al., [23] found no effect on OCT measurements of RNFL

Table 1: Demographic characteristics of participants including age, refractive error and axial length

Variable		Mean	Standard deviation	Range	
				Minimum	Maximum
Age	Male	24.90	5.59	18	42
	Female	26.75	7.28	18	42
	Total	25.78	6.50	18	42
Refractive error(spherical equivalent)	Male	0.00	0.20	-0.50	+0.50
	Female	+0.08	0.20	-0.50	+0.50
	Total	+0.03	0.20	-0.50	+0.50
Eye axial length (mm^2)	Male	23.48	0.65	22.11	24.81
	Female	23.12	0.55	21.38	24.12
	Total	23.31	0.62	21.38	24.81

Table 2: Optic nerve head parameters with and without Plano soft contact lens, measured by OCT

Measurement	With plano soft contact lens	Without plano soft contact lens	P value*
Mean retinal nerve fiber Layer thickness (μm)	122.77 ± 11.61	122.33 ± 10.27	0.272
Mean cup area (mm^2)	0.63 ± 0.52	0.64 ± 0.53	0.189
Mean rim area (mm^2)	1.62 ± 0.47	1.64 ± 0.44	0.218
Mean disc area (mm^2)	2.26 ± 0.44	2.27 ± 0.39	0.607
Mean cup to disc ratio	0.26 ± 0.19	0.26 ± 0.19	0.536

*Paired t-test

thickness in 15 healthy subjects after inducing refractive errors of - 4.00, + 4.00, - 10.00 and +10.00 Diopters using contact lenses. Also Bhandari et al., [19] have reported that patients' contact lens (including rigid and soft contact lenses) did not affect OCT measurements of RNFL thickness. In another study Carpineto et al.,[20] evaluated the effect of photorefractive keratectomy on thickness of the RNFL and axial length measured by OCT. Six months after surgery when the cornea was clear; the mean RNFL thickness and axial length measurements did not show a change compared to presurgical measurements [20]. In contrast in a study by Lee et al.,[9] and in another study by Patel et al.,[14] the authors reported that induced

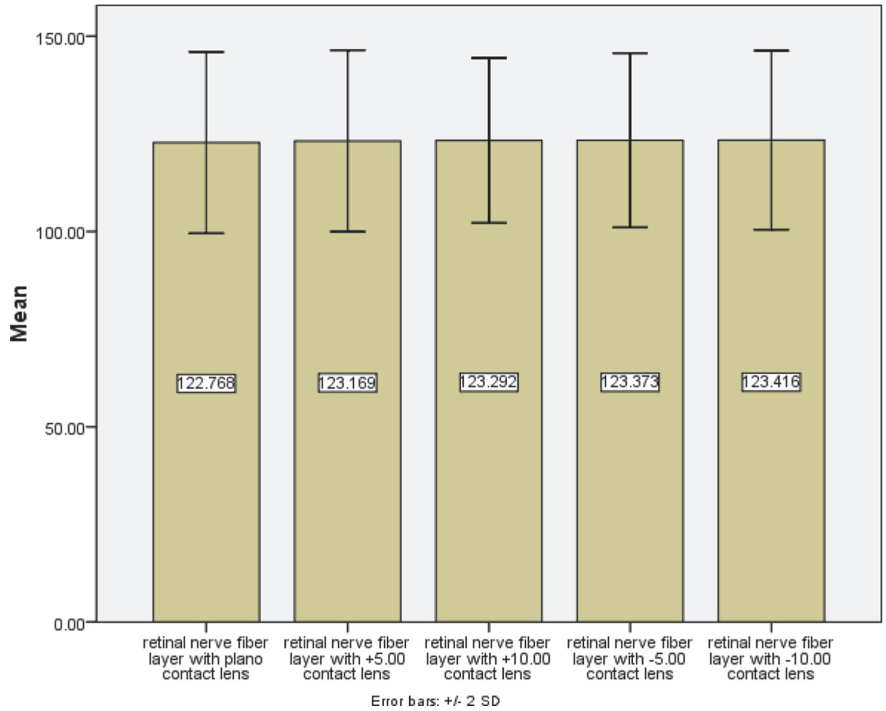

Figure 1: Comparison of the mean retinal nerve fiber layer thickness (RNFLT) in different induced refractive errors (μm); no statistical effect of contact lens induced mild and high myopia or hyperopia on RNFL thickness readings by OCT was observed

Table 3: Comparison of optic nerve measurements in different contact lens induced refractive errors

Measurement	Contact lens power: -10.00 diopter	Contact lens power: -5.00 diopter	Contact lens power: plano	Contact lens power: +10.00 diopter	Contact lens power: +5.00 diopter	P value*
Mean retinal nerve fiber layer thickness (μm)	123.42 ± 1.45	123.37 ± 11.15	122.77 ± 11.61	123.29 ± 10.56	123.17 ± 11.61	0.721
Mean cup area (mm^2)	0.64 ± 0.54	0.64 ± 0.56	0.63 ± 0.52	0.65 ± 0.53	0.63 ± 0.53	0.530
Mean rim area (mm^2)	1.64 ± 0.45	1.64 ± 0.47	1.62 ± 0.47	1.62 ± 0.45	1.63 ± 0.45	0.781
Mean disc area (mm^2)	2.28 ± 0.42	2.27 ± 0.40	2.26 ± 0.44	2.28 ± 0.39	2.26 ± 0.40	0.601
Mean cup to disc ratio	0.26 ± 0.19	0.26 ± 0.20	0.26 ± 0.19	0.27 ± 0.19	0.26 ± 0.20	0.414

*Repeated measure ANOVA

myopia and hyperopia cause underestimation and overestimation in measurement of RNFL thickness respectively. Rauscher et al., [21] reported that RNFL thickness measured by OCT decreases as axial length and equivalent sphere increase, for which the impact of axial length was more than that of refractive error. They reported that the mean RNFL thickness decreases by 7 μm for each 1mm increase in eye axial length and decreases by 3 μm for each 1 diopter increase in refractive error. Parvaresh et al., [22] measured thickness of RNFL and found that eyes with high hyperopia had a thicker RNFL than myopic and emmetropic eyes and emmetropes had thicker retinal nerve fiber layer than highly myopic eyes.

In the present study, there was no statistically significant difference between groups in mean cup area measurement (P = 0.530). Similar to our findings Salchow et al., [23] reported that induced refractive error using - 4.00, + 4.00, + 10.00 and - 10.00 diopter soft contact lenses did not affect cup area measurements.

Measurement of optic nerve head rim area in the present study showed no significant difference among groups (P = 0.781). Gurses-Ozden et al., [24] have reported that rim area measured using OCT did not change one and four weeks after LASIK surgery. Also, in another study, Varma et al., [25] using an image analyzer (Topcon Image Analyzer) found no relationship between equivalent sphere refractive error and measured rim area among different refractive error groups.

In the present study, the difference in optic disc area measurements using OCT when wearing different power contact lenses was not statistically significant (P = 0.601). Similar to our findings a study by Enrique et al., [26] found no significant difference between groups with different refractive errors when measuring disc area using OCT. In contrast Leung et al., [13] have reported optic disc area increase with increased eye axial length. Ramrattan et al., [27] using an image analyzer, reported that optic disc area increases by 0.33 mm^2 per one diopter of myopia, but results were not different in eyes with refractive error of between -4.00

and + 4.00 diopter.

According to our findings the difference in cup to disc ratio measurements using OCT in different contact lens groups was not statistically significant ($P = 0.414$). Similarly Salchow et al., [23] reported no statistically significant difference in OCT cup to disc ratio measurements when using soft contact lenses at various strengths. In contrast several studies have reported that a change in magnification resulting from refractive error can affect transverse parameters such as optic disc measurements and in effect the cup to disc ratio measurements [11, 14, 28].

As researchers have shown, the difference in magnification between the eye being scanned and the standard eye is strongly correlated to axial factor rather than optical power so the effect of optical power alone might not be strong enough to produce considerable RNFL thickness measurement changes when using OCT [12].

Although some studies [9,14] have found differences in this measurements after using contact lenses the difference has not been clinically significant. For example 8 diopters of refractive error in real myopia have been reported to cause 23 µm of variation in RNFL thickness measurements while the corresponding measure for contact lens induced myopia was just 3.5 micrometer [14, 22].

Conclusion

Our findings indicate that refractive error variation at the corneal plane caused by contact lens wear has no significant effect on thickness of RNFL, disc area, cup area, rim area and mean cup to disc area ratio measured by SD-OCT in normal eyes.

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Footnotes and Financial Disclosures

Conflict of interest:

The authors have no conflict of interest with the content matter of the present manuscript.