

Visual Field Parameters and Pupil Size Measured through and Compared between Colored Contact Lenses and Clear Contact Lenses: A Prospective Comparative Pilot Study in Asian Population

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ABSTRACT

Objective: To compare visual field (VF) parameters and pupil size as measured through colored and clear contact lenses (CL) in Asian population.

Materials and Methods: Demographic data and CL prescription data were recorded during the baseline visit. Visual acuity and autorefractometry were evaluated while patients wore clear CL, followed by slit-lamp examination and intraocular pressure measurements after CL removal. During the second visit, subjects were given dark brown-colored CL with their same prescription. Visual acuity and autorefractometry were measured. Pupil size and VF tests were measured twice with the clear CL and the colored CL. Measurements through colored and clear CL were compared.

Results: Twenty-one volunteers (mean age: 31 years) were recruited. Refractive error varied from 0.00 to -7.00 diopters. Mean horizontal meridian measured through clear and colored CL was $134.8 \pm 7.8^\circ$ and $133.3 \pm 4.7^\circ$, respectively. Mean vertical meridian measured through clear and colored CL was $100.1 \pm 3.8^\circ$ and $100.4 \pm 2.5^\circ$. Mean total VF area measured through clear and colored contact lenses was $9,890.9 \pm 822.8^\circ$ and $9,882.7 \pm 528.1^\circ$. There was no significant difference between clear and colored CL groups for horizontal meridian, vertical meridian, total VF area, or pupil size.

Conclusion: There was no significant difference in any evaluated parameters between clear and colored CL.

Keywords: Visual field parameters; pupil size; colored contact lenses; clear contact lenses; Asian population (Siriraj Med J 2022; 74: 600-603)

INTRODUCTION

Contact lenses (CL) are a commonly used method for correcting refractive error, and they are positioned directly on the cornea to improve light refraction. Since soft CL can cover the entire cornea, some people who do not require refractive error correction use colored CL to temporarily enhance or change their eye color. The use of colored CL for cosmetic purpose is becoming increasingly popular among Asian youths. According to the Study of the International Market for Contact

Lenses conducted by Multi-Sponsor Surveys International LLC in 2010, the use of cosmetic tinted lenses among all CL wearers ranged from 24% in Taiwan to 39% in Singapore.¹ In the United Kingdom, cosmetic tinted CL are generally prescribed at the request of younger people (mean age: 27 years).² A 5 millimeter (mm) clear optical zone and a circumpupillary matrix of opaque colored dots are features of colored CL. These opaque colored dots may obscure peripheral vision or the visual field

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(VF), particularly when the pupil dilates in dim light and extends beyond the clear optical zone. Previous studies that evaluated this effect reported different results.³⁻⁷ Accordingly, aim of this study was to measure visual field parameters and pupil size through both colored contact lenses and clear contact lenses and then to compare the results among Thai CL wearers. To clarify our concern about peripheral visual field that will obscure by these opaque colored dots especially in some situation such as driving at night that pupil size may get larger beyond clear optical zone.

MATERIALS AND METHODS

This prospective comparative study was conducted at the Department of Ophthalmology of the Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand during February 2020 to May 2021. We enrolled healthy Thai CL wearers aged 18 – 39 years old with best-corrected visual acuity (BCVA) of 6/6 and spherical equivalent of less than 0.5 diopters. Patients with any ocular disease that could adversely affect peripheral vision or BCVA were excluded. Patients who had unavailable colored CL prescription were excluded. The protocol for this study was approved by the Siriraj Institutional Review Board (SIRB) [Si 892/2019 (IRB3)], and informed consent was provides by all study participants before joining the study.

All study participants were evaluated over the course of two visits. During the first visit, demographic data and detailed CL prescription data were recorded. Visual acuity (VA) and autorefraction were evaluated while the CL were on the patient's eyes, followed by slit-lamp examination and intraocular pressure (IOP) measurements after the CL were removed. During the second visit, study subjects were given dark brown-colored contact lenses (Maxim® cocoa-colored contact lenses; Maxim Inter-Corporation LTD, Bangkok, Thailand) with the same prescription as that obtained from the patient at the first visit. VA and autorefraction were then reevaluated with the patient wearing the newly provided brown-colored CL.

In order to compare pupil diameter and VF parameters between clear and colored CL, patients were first randomly allocated to 1 of 4 testing sequence groups, as shown in Table 1. All measurements were made while CL were being worn. In all patients, pupil diameter was measured before performing VF measurements in each eye. In all patients and for all measurements, a colored CL was worn in one eye, and a clear CL was worn in the other eye. To control for carry-over effects, such as learning and sequencing, two rounds of VF measurement were performed with a 5-minute break between the two measurement rounds. The clear and colored CL were

switched to the opposite eyes for the second round of measurements. All VF measurements were performed using an autokinetic Humphrey Field Analyzer (HFA; Carl Zeiss Meditec, Dublin, CA, USA). The HFA was set at standard illumination (III 4 e white) to measure the peripheral VF in 8 meridians (0, 45, 90, 135, 180, 225, and 270 degrees) in automatic pattern, and to give a kinetic 90-degree report. The means of all measured parameters were compared between the clear CL group and the colored CL group. The size of the pupil was measured by HFA before the visual field measurement was performed. The mean of the pupil size was compared between the clear CL group and the colored CL group.

Statistical analysis

SPSS Statistics (SPSS, Inc., Chicago, IL, USA) was used to perform all statistical analyses. Paired *t*-test was used to compare all evaluated parameters between the clear and colored CL groups. Within group data are presented as mean plus/minus standard deviation. The result of the comparison between groups for each evaluated parameter is shown as mean difference between groups and 95% confidence interval. A *p*-value less than 0.05 was considered statistically significant for all tests.

RESULTS

Twenty-one volunteers (42 eyes) with an age range of 21 to 39 years (mean age: 31 years) were enrolled in this study. There were 20 females and 1 male. The refractive error among all patients varied from 0.00 to -7.00 diopters. There were 6 subjects in VF sequence group 1, and 5 subjects in each of the other 3 VF sequence groups. Only the VF and pupil measurement data collected during the second round of measurement were used for analyzed. VF and pupil measurement data are shown in Table 2 and Figs 1 - 4. The mean horizontal meridian measured through clear and colored CL was $134.8 \pm 7.8^\circ$ and $133.3 \pm 4.7^\circ$, respectively. The mean vertical meridian measured through clear and colored CL was $100.1 \pm 3.8^\circ$ and $100.4 \pm 2.5^\circ$, respectively. The mean total VF area measured through clear and colored contact lenses was $9,890.9 \pm 822.8^\circ$ and $9,882.7 \pm 528.1^\circ$, respectively. The mean difference in the horizontal meridian, the vertical meridian, and the total VF area measured through clear and colored CL was 1.52 ($p=0.372$), -0.33 ($p=0.648$), and 8.25 ($p=0.951$), respectively. The mean pupil size measured through clear and colored CL was 4.53 ± 0.80 mm and 4.72 ± 0.75 mm, respectively. The mean difference in pupil size measured through clear and colored CL was -0.19 ($p=0.136$). There was no significant difference between the clear and colored CL groups for horizontal meridian, vertical meridian, total VF area, or pupil size.

TABLE 1. Sequences of visual field testing randomly assigned for each subject.

Visual field 1		Rest 5 minutes	Visual field 2	
Group 1	OD: Colored CL → OS: Clear CL		OD: Clear CL → OS: Colored CL	
Group 2	OS: Clear CL → OD: Colored CL		OS: Colored CL → OD: Clear CL	
Group 3	OD: Clear CL → OS: Colored CL		OD: Colored CL → OS: Clear CL	
Group 4	OS: Colored CL → OD: Clear CL		OS: Clear CL → OD: Colored CL	

TABLE 2. The horizontal meridian, vertical meridian, total area of visual field (VF) and pupil diameter measuring through clear and colored contact lenses (CL).

	VF Mean± SD		Clear CL – Colored CL	
	Clear CL	Colored CL	Mean difference (95% CI)	P -value
Horizontal meridian (degrees)	134.8 ± 7.8	133.3 ± 4.7	1.52 (-1.95, 5.00)	0.372
Vertical meridian (degrees)	100.1 ± 3.8	100.4 ± 2.5	-0.33 (-1.83, 1.17)	0.648
Total area of VF (degrees ²)	9890.9 ± 822.8	9882.7 ± 528.1	8.25 (-270.95, 287.45)	0.951
Pupil diameter (millimeters)	4.53 ± 0.80	4.72 ± 0.75	-0.19 (-0.46, 0.07)	0.136

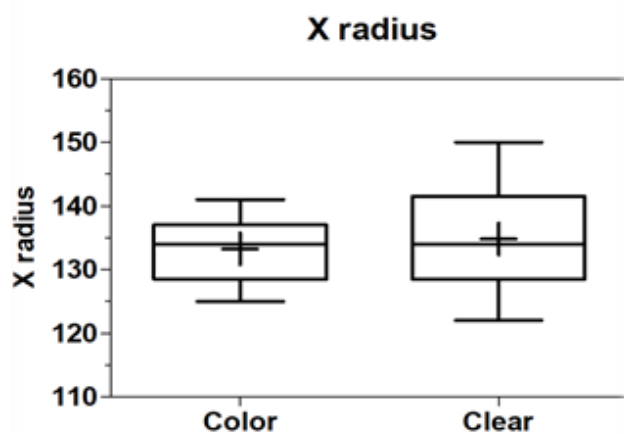


Fig 1. Comparing horizontal meridian of visual field between clear contact lenses and colored contact lenses (degrees).

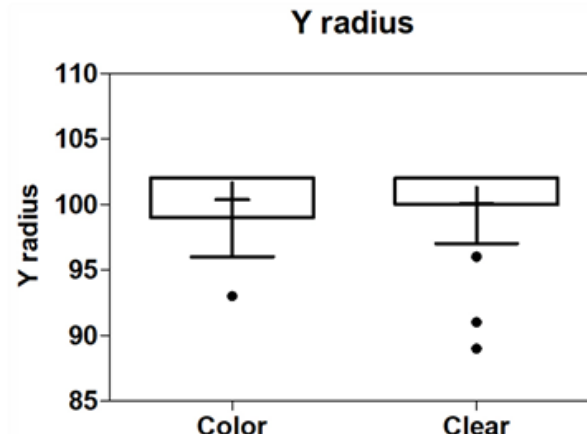


Fig 2. Comparing vertical meridian of visual field between clear contact lenses and colored contact lenses (degrees).

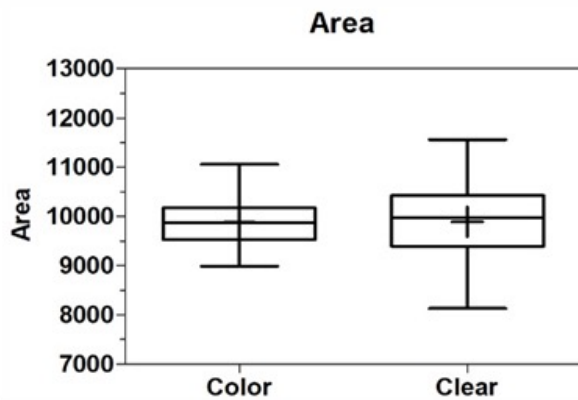


Fig 3. Comparing total area of visual field between clear contact lenses and colored contact lenses (degrees).

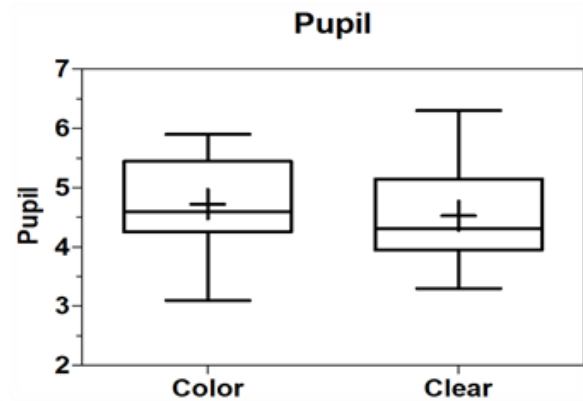


Fig 4. Comparing pupil diameter between clear contact lenses and colored contact lenses (mm).

DISCUSSION

Colored CL can temporarily change or enhance eye color using a matrix of opaque colored dots that surround a clear optical zone. Gauthier, *et al.* studied comfort, VA, and VF parameters in opaque tinted soft CL wearers, and they found no alteration of these parameters while wearing the evaluated the opaque tinted soft CL.⁵ Trick, *et al.* found no significant effect of opaque tinted CL on VF using the 30-2 VF test.⁶ In contrast, Insler, *et al.* reported that dot matrix CL could constrict both central and peripheral VF isopters by as much as 5 to 20 degrees as evaluated by Goldmann kinetic perimetry.³ Josephson, *et al.* tested the 30-80 degree peripheral field of 10 patients and found at least 10 degrees constriction during colored CL wear.⁴ In the present study, we used Maxim® cocoa-colored CL with a 5-mm clear optical zone and dark brown color at the circumpupillary area. We assumed these CL to have the darkest color available on the Thai market. We found the pupil diameter to be larger when wearing colored CL compared to that when wearing clear CL, the difference in pupil diameter between groups was not statistically significant. We also found no significant difference in any of the evaluated VF parameters between the colored and clear CL groups.

CONCLUSION

There was no significant difference in horizontal meridian, vertical meridian, total VF area, or pupil size as measured through and compared between clear and colored CL in Thai population. So the colored CL may not effect both on peripheral visual field and size of the pupil.

The main limitations of this study were its small sample size, the enrollment disparity between genders, and the fact that there is a difference in the design and

diameter of the clear optical zone among different brands of colored CL.

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Conflict of interest declaration

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