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Research Article

An Attempt of Subjective Refraction Test Maintaining Everyday Pupil Diameter Using Ground Glass Lens

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Abstract

Purpose: To investigated the effects of pupil dilation on subjective refraction by using ground glass lens.

Methods: Forty-two subjects (22.1 ± 1.2 years) participated in the study. We measured the change in pupil diameter during binocular and monocular vision (using an occluder and a ground glass lens). And we conducted subjective refraction test using an occluder and a ground glass lens. Paired t-test was used for statistical analysis of pupil diameter and subjective refraction. Pearson's rank correlation test was performed to assess the relationship between subjective refraction change and pupil diameter change. The p-value of < 0.01 was considered statistically significant.

Results: The average pupil diameter measured before and after covering with an occluder was 4.35 ± 0.55 mm and 5.77 ± 0.75 mm ($P < 0.0001$). The average pupil diameter measured before and after covering with ground glass lens was 4.38 ± 0.65 mm and 4.39 ± 0.68 mm ($P = 0.78$). The average spherical equivalent subjective refraction using an occluder and a ground glass lens was -3.89 ± 2.15D, -3.67 ± 2.02D. Using an occluder resulted in significantly more myopia than using a ground glass lens ($P < 0.0001$). The bigger the change in pupil diameter, the bigger was the change in subjective refraction ($P = 0.0005$; $R^2 = 0.25$).

Conclusions: Our results indicate using a ground glass lens is effective method for measuring the exact refraction value.

Keywords: *Subjective Refraction; Pupil Diameter; Pupil Dilation; Refractive Error*

Introduction

In clinical ophthalmology, a refraction test is very frequently conducted, and plays an important role in the prescription of glasses or contact lenses, and in pre- and post-examination of refractive surgery. However, refractive error or complaints of patients after the refractive correction is frequently seen. Refractive error after refractive correction induces patient's eye strain [1,2], and greatly affect the patient's quality of vision. Therefore, measuring the exact refraction value of the patient is very important. It is necessary to inspect the patient's everyday condition in order to estimate the patient's precise visual function. In clinical ophthalmology, subjective refraction test is conducted with one eye covered. In this case, binocular function is blocked from a functional perspective, and pupil dilation from an optic perspective has been reported [3,4]. The depth of focus decreases because of pupil dilation due to the covering of one eye, and the retinal image became blurred [5,6]. As a result, it has been reported that subjective and objective refraction leads to myopia, and introducing myopia by covering one eye with an occluder is therefore a problem in clinical ophthalmology [7-9]. In a previous report, binocular

open subjective refraction tests were conducted without one eye covered, by using a 3D monitor and polarized glasses [7,8]. This report indicate that monocular subjective refraction test (using an occluder) become myopic compared with binocular open subjective refraction tests which maintains the pupil diameter under everyday condition. However, it is difficult to introduce such equipment. Therefore, there is a need for a method by which subjective refraction can be tested more easily without causing changes in pupil diameter. In this study, we examined the subjective refraction tests that employ ground glass lenses, which may be expected not to result in a change in the pupil diameter.

Materials and Methods

We investigate 42 right eyes from 42 subjects (mean age ± standard deviation: 22.1 ± 1.2 years). The results of their ophthalmic examinations were unremarkable, except for refractive errors in several patients. The patients had distance and near vision of at least -0.08 (logMAR) in the best-corrected eye. If patients felt fatigued during the procedure, the experiment was stopped immediately.

We conducted pupil diameter measurement and performed a subjective refraction test using an occluder and ground glass lens (TOKAI OPTICAL CO., LTD., Okazaki, Japan). The occluder and ground glass lens are shown in figure 1. Pupil diameter was measured using a binocular open-type electronic pupil diameter ViewShot (T.M.I. CO., LTD., Saitama, Japan). Patients were instructed to fixate on a fixation target at a distance of 5 m. We measured changes in the pupil diameter under binocular and monocular (using an occluder and ground glass lens) vision. We conducted a subjective refraction test using a cortical vision visual acuity chart. In this test, one eye was covered using an occluder and ground glass lens and a test distance of 5 m was implemented. Room luminance was 270lx. All measurements were performed by a single experienced examiner.

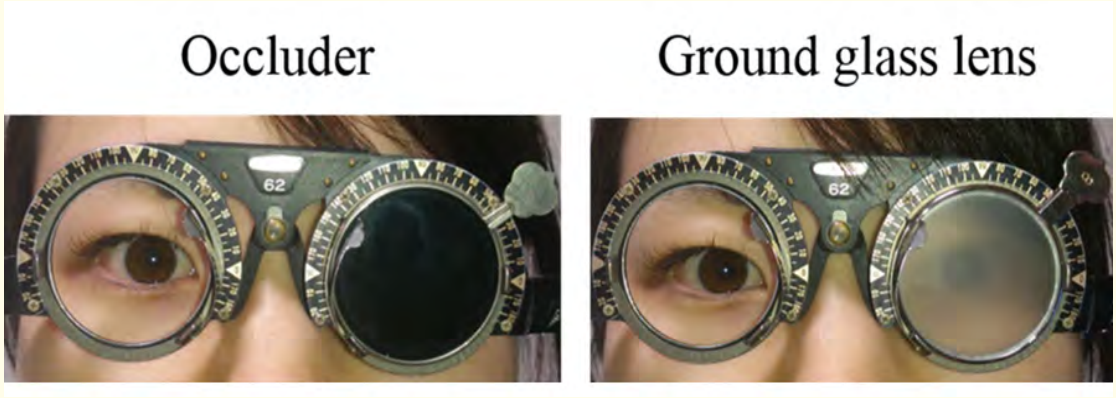

Figure 1: *Occluder and ground glass lens.*

The Paired t-test was used for statistical comparisons of pupil diameter and subjective refraction. Pearson's rank correlation test was used to assess the relationships between subjective refraction change and pupil diameter change. The results are expressed as mean ± standard deviation, and a p-value of < 0.01 was considered statistically significant.

This research conformed to the tenets of the Declaration of Helsinki and was approved by the Kitasato University Human Sciences Ethics Committee. The methods were carried out in accordance with approved guidelines. Potential subjects gave written consent after being given detailed information about the study and their role as a participant. Informed consent was obtained from all subjects after an explanation of the study.

Result

When one eye was covered using an occluder, the pupil dilated. The average pupil diameter before and after covering with an occluder

was 4.35 ± 0.55 mm and 5.77 ± 0.75 mm, respectively (Table 1). The pupil diameter was significantly larger with one eye covered than it was without covering (P < 0.0001).

Conversely, when one eye was covered with a ground glass lens, the pupil diameter did not change markedly. The average pupil diameter using a ground glass lens before covering and after covering was 4.38 ± 0.65 mm and 4.39 ± 0.68 mm, respectively (Table 1). There was no significant difference in the pupil diameter before and after covering with a ground glass lens (P = 0.78).

The average subjective spherical equivalent refraction using an occluder and a ground glass lens are shown in table 1, and were -3.89 ± 2.15 D and -3.67 ± 2.02 D, respectively. Using an occluder resulted in a significantly more myopic refraction than in using a ground glass lens (P < 0.0001). The average cylindrical subjective refraction using an occluder and a ground glass lens are shown in table 1, and were -0.46D ± 0.39 D and -0.44D ± 0.36 D, respectively. There was no significant difference between using an occluder and a ground glass lens in measuring cylindrical subjective refraction (P = 0.22).

		Pupil diameter (mm)	Spherical equivalent subjective refraction (D)	Cylindrical subjective refraction (D)
Occluder	Binocular Vision	4.35 ± 0.55	-3.89 ± 2.15	-0.46 ± 0.39
	Monocular Vision	5.77 ± 0.75		
Ground Glass Lens	Binocular Vision	4.38 ± 0.65	-3.67 ± 2.02	-0.44 ± 0.36
	Monocular Vision	4.39 ± 0.68		

Table 1: *Pupil diameter and subjective refraction using occluder and ground glass lens.*

The correlation between change in pupil size and subjective refraction is shown in figure 2. The bigger the change in pupil diameter, the bigger was the change in subjective refraction (P = 0.0005; R^2 = 0.25).

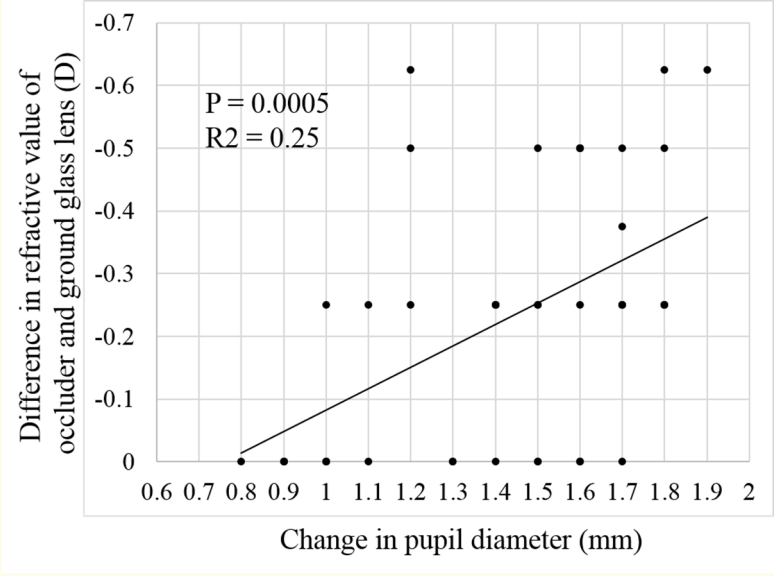

Figure 2: *Correlation between pupil size and subjective refraction.*

Discussion

In this study, we concluded that when using an occluder, the pupil is dilated because the amount of light entering the pupil is decreased, but that when using a ground glass lens, the pupil size did not change because the ground glass lens can transmit light. As with the previous report [7,8], we could conduct subjective refraction test without changing the pupil diameter. When using an occluder, the depth of focus is decreased compared with using a ground glass lens [5,6]. A stronger lens is therefore required due to decrease of depth of focus. Furthermore, the bigger the change in the pupil diameter from before to after covering, the more the subjects had a tendency to become myopic. We believe that this indicates that the bigger the change in the pupil diameter, the bigger is the decrease in the depth of focus. Although the previous study reported that there was no correlation between the variation in the subjective refraction value and the amount of change in the pupil diameter [8], we found a weak correlation in the present study.

This study showed that there is a possibility of overcorrection when covering one eye during the subjective refraction test. A refractive value change of 0.22 D was observed in this study; however, we consider that this cannot be ignored as a refractive correction for glasses, contact lenses, or refractive surgery, and refractive error after refractive correction induces eye strain [1,2].

In recent years, not only adults, but also children complained of eye strain [10]; therefore it is important to correct refraction, but an objective refraction test should be conducted while maintaining the patient's typical daily pupil diameter. Our results indicate that using a ground glass lens is an effective method for measuring the exact refraction value. The average age of cases in our study was 22.1 ± 1.2 years. Comparison of young children, with a big pupil diameter, with elderly persons, with a small pupil diameter [11,12], is expected to result in marked differences, but this requires further examination.

Conclusion

When objective refraction test is conducted, we need to consider the pupil diameter.

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