THE EVALUATION OF PINHOLE GLASSES AS VISUAL THERAPY IN IMPROVING REFRACTIVE ERROR

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ABSTRACT

Introduction: Visual therapy or eye exercise, which is widely used in behavioral optometry, has been successfully helping some visual disorders, especially binocular vision problem. In Bates System of Eye Exercise, it is claimed that eye exercise can restore vision with refractive error by completely relaxing the eyes. One of the ways to relax the eyes is by wearing the pinhole glasses as the pinhole placed before the eyes will help to relax accommodation and temporarily improving vision by reducing the size of blur circle. Pinhole glasses have been marketed as a visual therapy device, with the claim that continuous use of these glasses will improve refractive error. Although only anecdotal evidences have been provided on the efficacy of this product, the society are still interested to use the pinhole glasses and believe that their vision could be improved by simply wearing this device. **Aim:** The purpose of this study was to compare the refractive error of myopic participants before and after wearing the pinhole glasses for 3 weeks. **Methodology:** Fifteen participants were recruited in this study and all of the participants wore the pinhole glasses while performing near works for 20 minutes/day, anytime from 9 p.m. to 11 p.m. everyday for 3 weeks. **Results:** The refractive error before and after the intervention was then being compared and the results showed that there was no significant difference in refractive error of both right (p= 0.08) and left eyes (p= 0.09) of myopic participants before and after wearing the pinhole glasses. **Conclusion:** Our results suggest that pinhole glasses did not improve the refractive error of myopic participants.

KEYWORDS: Visual therapy, eye exercise, pinhole glasses, refractive error

INTRODUCTION

In the presence of uncorrected refractive error, pinhole aperture can make the image clearer by reducing the diameter of blur circle, hence improving the vision of ametropic eyes (Kim, Park, & Chun, 2014). Clinically, pinhole itself is one of the diagnostic tools in which the optometrist used in order to predict the potential improvement of vision after refraction and also to determine either reduction in visual acuity is due to refractive error or visual pathologies (Eagan, Jacobs & Derners-Turco, 1999).

Theoretically, pinhole placed before the eyes will minimise the size of blur retinal image by limiting the rays of light entering the eyes and increasing the depth of focus (Yanoff & Duker, 2008). However, in order to get a maximum sharpness when viewing through a pinhole, there is an optimum size for the opening of the pinhole itself in which according to Tunnacliffe and Hirst (1996), the optimum hole diameter is proportional to the distance between the pinhole and the image screen. In the case where the hole diameter is too small, it will result in blurring of the image due to the effect of diffraction.

With the basis of pinhole optics, the pinhole glasses have been created for multiple purposes. Pinhole glasses, which are also known as stenopaeic glasses, are glasses without lenses. Instead, they are made of opaque plastic disk. Pinhole glasses come with many little holes which act as small apertures and allowing the light to pass through, hence producing a clearer image by reducing the size of blur circle (Carlson, 2014).

Nowadays, there are many advertisements from the pinhole glasses' companies, in which they claimed that continuous wearing of these glasses can exercise and relax the eye muscles, hence restoring the vision for an ametropic eye (IbnuSina Eyewear, n.d.; Terapi D' Mata, 2011; Trayner Pinhole Glasses, n.d.). However, up to our knowledge, there is no clinical study that can prove the claim that these low-tech glasses are able to restore visual function in person with uncorrected refractive error. Thus, this study was conducted to validate the claims that pinhole glasses can improve vision by training and exercising the eye's muscles to focus in order to make the object clearer.

MATERIALS AND METHODS

The study complied with Tenets of Declaration of Helsinki involving human subjects. Ethical approval for this study had been acquired from IIUM Research Ethics Committee (IREC).Fifteen participants were recruited in this study, in which two of them were male and 13 were female. The participants' spherical refractive error ranged from -0.75D to -3.50D and the maximum cylindrical power was -1.00D.

The inclusion criteria for this study were healthy (free from any disease), range of age between 20- 25 years, correctable distance visual acuity by glasses up to 6/6, having spherical refractive error between -0.75DS to -3.50DS and maximum cylindrical error of -1.00DC. Participants were excluded if they had cataract or any ocular pathologies, amblyopia, abnormal amplitude of accommodation or using systemic or topical medication that might affect accommodation (Kim et al., 2014).

As the participants agreed to participate in this study, they were explained about this study and asked to sign a consent form. Next, history taking was conducted and the participants were required to answer the questionnaire in order to exclude those who did not meet the inclusion criteria. As normal amplitude of accommodation (AA) was one of the inclusion criteria in this study, the participant's AA was measured by using Royal Air Force (RAF) Rule. The technique used was Push-up Test, in which the target was moved towards the participant's eye. When the first sustained blur was achieved, the value of accommodation was recorded. The recovery point, at which the target became clear as it was moved away from the participant's eye was also recorded. These steps were repeated for three times and the average of three measurements will be compared to normal values of AA. If the AA was within normal range for both eyes, the refractive error was then objectively measured using EyeNetra (Figure 1).

Figure 1 EyeNetra (Source: EyeNetra Inc. Somerville, Massachusetts, USA)

The refractive error of the participants measured using EyeNetra was analyzed by simply allowing them to align the red and green targets that being projected from the smartphone. The average time taken for the participants to complete the task was approximately 6 to 10 minutes. In order to measure the refractive error by using EyeNetra, the tutorial on how to perform the test was presented to the participant. The participant was seated in the chair with both elbows rested on the table, and EyeNetra was gripped with both hands. The test started as the participants began to turn the brightness knob to locate the red and green umbrellas' image seen through the smartphone (Samsung S4) that was attached to EyeNetra. The participant needed to adjust the alignment knob until the two stems of the umbrellas overlapped as close as possible with each other. The test was repeated eight times per eye and the result was displayed on the smartphone after the test completed.

Next, subjective refraction was also performed in order to know the participant's refractive error for both eyes. Snellen Chart at 6 meters was used throughout the procedures. In order to refine the spherical component, Duochrome and +1.00D test have been performed. The cylindrical component was refined by using Jackson Cross-Cyl lens. At the end of the refraction, binocular balancing using Alternate Occlusion technique was performed in order to balance the state of accommodation of the eyes. The subjective refraction was done by a certified optometrist.

A set of diaries with a pair of pinhole glasses were given to the participants and they needed to wear the pinhole glasses for at least 20 minutes/day, anytime from 9 p.m. to 11 p.m. every day without fail for 3 weeks. They also needed to record or log in the diary for 3 weeks of wearing the pinhole glasses.

Three weeks later, the participants submitted the diary and pinhole glasses. The refractive error was measured again by using EyeNetra and subjective refraction, using the same techniques. In order to analyze the data, the participants' refractive error was converted to spherical equivalent refraction (SER) by using the equation below:

$$\text{SER} = \text{Sphere power} + \frac{\text{Cylindrical power}}{2}$$

RESULTS

All the data obtained was analyzed using Statistical Package for Social Science Software (SPSS) (version 12 for Windows, SPSS, Inc., Chicago, IL, USA). The normality of the data was analyzed using Shapiro-Wilk normality test. As all the data were normally distributed, paired sample *t*-test was used in order to compare the refractive error measured before and after wearing the pinhole glasses.

Comparing means of refractive error before and after wearing pinhole glasses

The measurement of refractive error was done on both eyes, by using two different techniques, which were subjective refraction and EyeNetra. Thus, for each visit, there would be two measurements of refractive error taken for each eye and the comparison of the mean of refractive error before and after wearing the pinhole glasses was made specifically for each eye and each technique.

Figure 2 illustrate the comparison of the refractive error between before and after using pinhole glasses as measured using subjective refraction for the right and left eyes respectively. Refractive error was also estimated using EyeNetra and the results of the comparison between before and after intervention with pinhole glasses are shown in Figure 3.

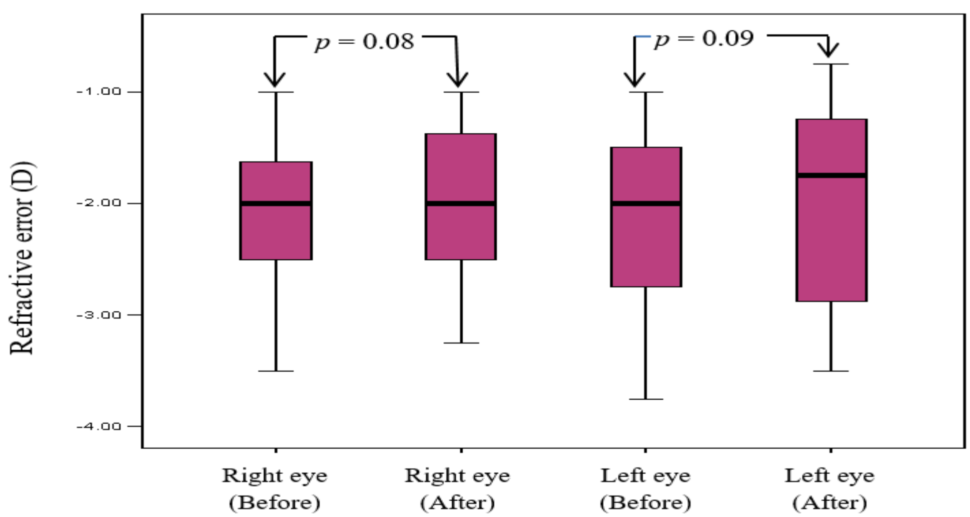

Figure 2 Boxplot of refractive error measured using subjective refraction before and after 3 weeks of intervention.

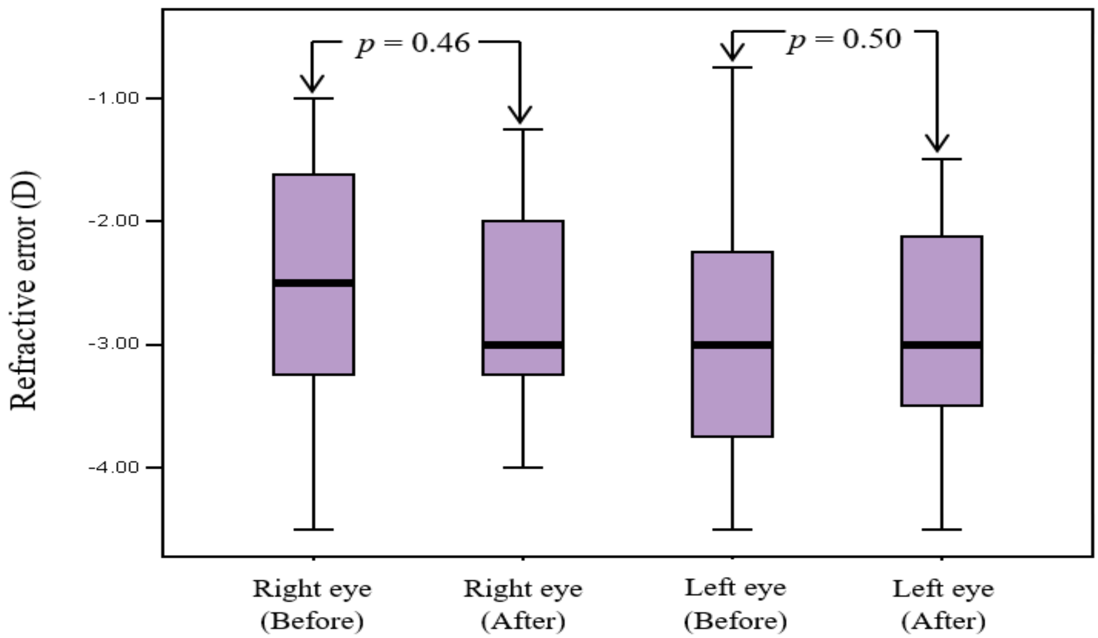

Figure 3 Boxplot of refractive error measured using EyeNETRA before and after 3 weeks of intervention.

The significance levels and the difference pre- and post-intervention with pinhole glasses

Paired *t*-test analysis showed that all the *p*-values for refractive error of both eyes were >0.05, indicated that there was no significant difference in refractive error of myopic participants before and after wearing the pinhole glasses. As for the mean difference, all parameters showed reduction in the range of -0.10D to -0.13D, except for the refractive error of the right eye (measured using EyeNetra), which showed increment in -0.10D. However, the reduction in refractive error was not statistically significant as all the *p*-values were >0.05. Table 1 shows the significance levels and the difference pre- and post-intervention from this study.

Table 1 Comparison of refractive error before and after 3 weeks of wearing pinhole glasses

Technique used	Measured eye	Time of measurement	Refractive error (D) Mean ± SD	*p*-value
Subjective refraction	Right	Pre-intervention	-2.07 ± 0.80	0.08
		Post- intervention	-1.97 ± 0.77	
	Left	Pre-intervention	-2.10 ± 0.86	0.09
		Post- intervention	-1.97 ± 0.96	
EyeNetra	Right	Pre-intervention	-2.58 ± 0.99	0.46
		Post- intervention	-2.68 ± 0.88	
	Left	Pre-intervention	-2.93 ± 1.02	0.50
		Post- intervention	-2.83 ± 0.90	

DISCUSSION

Effect of pinhole glasses on refractive error (myopia)

In this study, we compared the refractive error of the participants before and after wearing the pinhole glasses for 3 weeks in order to evaluate the effect of pinhole glasses on myopic participants. Our findings showed that the refractive error of myopic participants did not show significant decrement after wearing the pinhole glasses for 3 weeks. Although there was low decrement of refractive error in some participants, the decrement was not clinically significant.

Meta-analysis and evidence based medicine as opposed to anecdotal evidence

Anecdotal evidence has become controversies over science and technology as it exists prior to public opinion of performance data, in ignorance to scientific validations. Anecdotal evidence by definition is the evidence used based on subjective report and interpretation of an individual in which it is also an indicator of expert ignorance (Moore & Stilgoe, 2009). Being collected in informal manners and improper scientific methodologies, anecdotal evidence provides questionable and weak evidences with many flaws regarding certain issues especially the issues involving clinical intervention.

In contradiction with anecdotal evidence, meta-analysis placed in the highest level of research design in providing the evidence of the effect of clinical intervention (Thomsen, 2014). By definition, meta-analysis is one of the methods used in order to establish the causality by combining the previous research studies and draw a general conclusion regarding that specific topic (Haidich, 2010). On the other hand, evidence based medicine, which is considered as the most complete paradigm in clinical intervention can provide strong evidences regarding therapeutic product such as pinhole glasses as it integrates individual clinical expertise with clinical evidences from systematic research (Naudet, Falissard, Boussageon, & Healy, 2015).

Although only anecdotal evidences have been provided on the efficacy of pinhole glasses, the society are still interested to use this product and believe that their vision can be improved by simply wearing the glasses. In order to draw a conclusion regarding the effect of pinhole glasses on refractive error, meta-analysis can be used as a tool for evidence based medicine as it has the potential to provide reliable evidences to support the clinical intervention and opposed the weaker level of evidences (Erin, McNamara, Charles, & Scales, 2011).

Recommendations and suggestions for future research

Future research should increase the period of intervention as the manufacturer of pinhole glasses claimed that the longer the time of wearing the pinhole glasses, the more effective the glasses in correcting the refractive error (Terapi D' Mata, 2011; IbnuSina Eyewear, n.d.). It would be better if the participants can wear the pinhole glasses for a longer period (more than 3 weeks) without fail to observe for the outcome of interest. Besides, other brands of pinhole glasses for example IbnuSina Eyewear, Cermin Mata Terapi 2020 and Terapi D' Mata can be used to observe if there is any changes in refractive error by wearing these different brands of pinhole glasses.

As for this study, we only recruited the participants with low to moderate myopia. Thus, for future research, it is suggested to include high myopic participants and increase the number of participants involved in order to evaluate if there is any changes in refractive error of high myopic participants after wearing the pinhole glasses. Other than that, the future research may also investigate the effect of pinhole glasses against hyperopic and high astigmatism participants. Assigning only one optometrist to refine the subjective refraction in order to minimize the variation in result of refractive error can also be considered in future research.

CONCLUSION

Results of this study showed that the pinhole glasses did not improve the refractive error of myopic participants. However, it is undeniable that by wearing the pinhole glasses, person with refractive error will see the image clearer as compared to when they are seeing it without their spectacles due to the effect of the pinhole itself, in which it limit the amount of light entering the eye and minimize the size of blur retinal image. Because of this effect, pinhole glasses manufacturers have manipulated the function of the pinhole, by claiming that it can reduce or improve the refractive error if being worn continuously and some of them even sold the pinhole glasses with a high price, as if it can replace the prescription glasses. Thus, with this finding, we hoped that it can assist the society to make a wise decision before using any optical devices which are widely available in the market, other than being prescribed by the eye care professionals.

Declaration of Interest

The study has no conflict of interest and no financial gained from the manufacturer of the pinhole glasses (Daiso Industries Co., Ltd.) and also EyeNetra (EyeNetra Inc.).

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