The Performance of Red Tinted Contact Lenses of Various Tones on Colour Deficient Subjects

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Introduction:

Colour vision is an important element in our daily tasks. Without normal colour perception, humans will face many challenges in life such as difficulty in determining the traffic light signals, distinguishing the ripeness of fruit, distinguishing the colour codes designed for safety purposes and index labels as well as limitation in the selection of critical occupation such as in the police force, military, pilots, commercial drivers and many more.[1,2,3.]

Colour vision deficiency (CVD) is an ocular disorder when one type of the cones has defect or lack in density. This leads to weaknesses in perceiving colours as each type of cone corresponds to different wavelengths. Congenital colour deficiency is commonly exhibited as red-green colour defect. Most of the time, colour deficient conditions occur since birth due to hereditary factors and it is often inherited as an X-linked recessive trait. This is evident when comparing the prevalence of colour deficiency in male and female. According to Birch (2012) study, congenital colour deficiency affects 4.20-6.50% in male and 0.20-1.70% in female among the Asian populations including China, Taiwan, Korea and Singapore.[4] In Malaysia, the prevalence of congenital colour deficiency in male and female are 4.80% and 0.20%, respectively.[5] The prevalence of colour deficiency is expected to rise with population growth.

Currently, there is still no treatment for colour deficiency condition. However, many researchers are striving to invent colour vision aids to help the colour deficient subjects in improving colour perception. Currently, there are many types of aids available in the market such as the tinted eyeglasses, special tinted contact lenses and opto-electronic glasses.[6] Most of these aids use the concept of red filter to enhance colour perception. This is because red filter can increase the transmission of long wavelength by absorbing the short and medium wavelengths. Therefore, the differentiation between red and green colour can be appreciated.[7]

Even so, different colour vision aids show different results on colour deficient subjects. This is likely due to the inconsistency in red colour tone during the manufacturing process of red-tinted contact lenses. Diaconu et al. (2010) also reported an increase in the perception of red colour which in line with the loss of green and yellow colour perception when red filters were used on protan subjects.[8]

To date, the guidelines in purchasing colour vision aids still do not exist. Therefore, this study is proposed to determine the effectiveness of red-tinted lenses which have specific spectral transmittance and to relate it with the total error score (TES) value. This is to assist the colour deficient subject to select suitable colour vision aids that can provide optimum effectiveness.

Methods: This clinical trial was conducted on 6 congenital colour deficient subjects who failed the Ishihara test during a colour vision screening session done in the Optometry clinic of National University of Malaysia. A sample size of 6 people was calculated using Gpower calculator for Wilcoxon Signed-Rank test at effect size 0.5, alpha value 0.05 and power value 0.25. Judgement sampling was used to obtain the subject. The colour deficient subjects selected for this study were aged between 18 and 40 and were free from ocular and systemic diseases.

The colour vision tests included in this study were Ishihara 38-plate Edition (Kanehara & Co., Ltd 1999) and Farnsworth-Munsell 100 Hue (FM 100 Hue) test. Four different types of red-tinted contact lenses (labelled as Type A, B, C and D) which varied in its tone were used. The spectral transmittance of all the contact lenses was measured using a spectrophotometer (PRIM Light Model, SECOMAM®) in a private contact lens laboratory.

The room illumination was set at 360 lux for the Ishihara test and 780 lux for Farnsworth-Munsell 100 Hue test. This illuminance was measured using a lux meter each time before data collection. The illuminance of the Ishihara test was set up in the range of 100-650 lux as suggested in Ram et al. and Bowman et al.[9,10] It is important to ensure consistent illumination for the colour vision tests so that the accuracy of the results is not disturbed by external factors.[11]

After giving informed consent and measuring visual acuity, the subjects were assessed with Ishihara test and FM 100 Hue test to obtain the error score before the intervention of colour vision aids. The red-tinted contact lenses were inserted into the non-dominant eye after determining it through the Miles Test. The Ishihara test was conducted again after the insertion of all four types of red tinted contact lenses. The error score after the wearing of red-tinted contact lenses was recorded. The plate was considered correct if the subject reported a correct number despite an unclear edge of number was seen on the Ishihara plates. The subjects were also asked to choose the most comfortable contact lenses subjectively.

SPSS version 25 was used to analyze the data. Descriptive statistics was used to report demographic data and the improvement of error score in Ishihara test for each red-tinted contact lens. Due to small sample size, non-parametric tests such as the Spearman's rho test, One-Sample Wilcoxon Signed-Rank test and Wilcoxon Signed-Rank test were used for data analysis.

This study had been approved by the Research Ethics Committee of UKM with a reference number of UKM PPI/111/8/JEP-2021-145. This study was conducted according to the principles of Declaration of Helsinki. All the subjects were adults and written consent were all granted by them before the start of the trial.

Declaration of Competing Interest

The authors declare that there is no conflict of interest.

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