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Measurement of Contrast Sensitivity Using the M&S Smart System II Compared with the Standard Pelli–Robson Chart in Patients with Primary Pterygium

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Abstract

Background: Contrast sensitivity (CS) is widely used as a measure of visual function in research and clinical settings. CS is regarded as an important visual parameter, detecting subtle reductions in vision prior to significant reduction in visual acuity. **Methods**: We examined the agreement between the gold-standard Pelli–Robson chart and a computerized test termed the M&S Smart System II (MSSS-II) in patients with primary pterygium. Ninety-three patients (93 primary pterygium eyes) who visited an ophthalmology clinic were selected. The patients were randomly assessed for CS using the MSSS-II or Pelli–Robson chart. The primary outcome was agreement in log units between these two tests in the assessment of CS in patients with primary pterygium. **Results**: The mean and standard deviation of CS measurement in the two tests were comparable (1.22 ± 0.56 vs. 1.21 ± 0.57 log units, respectively, p = 0.083). The Bland–Altman plot revealed that the mean difference between the two charts was 0.0016 log units (standard deviation: 0.009 log units) with narrow limits of agreement of −0.0186 to 0.0186. **Conclusions**: MSSS-II provides an alternative for the clinical assessment of CS using a computerized method that describes the status of visual function in patients with primary pterygium.

Keywords: contrast sensitivity, Pelli–Robson chart, M&S Smart System II, pterygium

Introduction

Pterygium is a disorder characterized by abnormal fibrovascular growth, originating from the bulbar conjunctiva and progressing towards the central cornea. It is estimated that the prevalence of pterygium is higher in geographical locations near the equator. Although standard clinical techniques, such as best-corrected visual acuity (BCVA), are widely used for the assessment of visual performance in patients with pterygium, the use of a clinical parameter – contrast sensitivity (CS) – has rarely been addressed. Previous research has shown that BCVA alone may be inadequate in assessing visual impairment in patients with pterygium, as the effect of CS on visual performance occurs prior to reduction in the BCVA.[1,2]

CS refers to a measurement of visual function – specifically based on variation in luminance (i.e., brightness) – used to distinguish between visible and invisible increments of luminance from the background.[3,4] Assessment of CS provides valuable information for the early detection and monitoring of certain ocular diseases such as amblyopia,[5,6] cataract,[7,8] glaucoma,[9-12] macular degeneration,[11] diabetic retinopathy,[13,14,15] as well as the evaluation of therapeutic outcomes.[16] In addition, CS is often considered a better indicator for functional disabilities[17,18] and predictive of performance impairment compared with standard acuity measurements.[19-22] Clinically, CS has commonly been assessed using the established Pelli–Robson chart (Clement Clarke Inter-national, Essex, UK).[23] However, there is a limitation in logistic and chart fades over time that makes this chart portable due to its specific requirements such as illumination.

The M&S Smart System II (MSSS-II; M&S Technologies Inc., Niles, IL, USA) comprises a combination of computer-generated, letter-based CS tests. The luminance of the liquid crystal display screen can be adjusted to the recommended level of luminance (85 candelas/m^2)

using its built-in control. The testable contrast of the MSSS-II ranges from 0.0 to 2.3 log units (comparable with the Pelli–Robson chart), with each level corresponding to a change of 0.1 log units. This system offers several advantages over the Pelli–Robson chart such as conducting the test in dark illumination, calibrating the test at various distances, and using random letters that prevent patients from memorizing their position. Previous studies had reported that the measurement of CS using the MSSS-II is comparable with that of the Pelli–Robson chart in healthy adults and children[24] and in glaucoma patients.[11,12] However, to the best of our knowledge, there is no evidence on the reliability of CS testing using the MSSS-II in patients with primary pterygium. Therefore, we aimed to determine the reliability of the MSSS-II in comparison with the Pelli–Robson chart for measuring CS in such patients.

Methods

A total of 93 patients with primary pterygium were selected to participate in this study. All patients in this study were selected on the basis of specific criteria. The inclusion criteria involved an established diagnosis of primary pterygium by a consultant ophthalmologist (KMK). The study included male and female patients aged 20 to 70 years and free from a history of ocular trauma, ocular surgery, use of a contact lens, or any ocular anterior segment disease other than pterygium that may affect vision, as previously described.[25] The sample size was calculated using the mean difference between preoperative and postoperative (3 months after for the treatment of pterygium) corneal astigmatism, as previously reported.[26] The Power and Sample Size Calculation software (Version 3.1.2) (PS software, Nashville, TN, USA) was used for this purpose.[27]

The study was conducted in accordance with the tenets of the Declaration of Helsinki and approved by the ethical research committee (IIUM/310/G13/4/4-125) of the International Islamic University Malaysia. Written informed consent was provided by all patients prior to their participation in this study. The CS function and BCVA were measured using the M&S Technologies Smart System II (SSII, Park Ridge, IL, USA). The setting of this system was similar to that described in previous studies.[24,28] The patients were randomized using a randomization software[29] prior to undergoing testing using the Pelli–Robson chart or the MSSS-II.

The size of the MSSS-II optotype was set at 1.5 logarithms of the minimum angle of resolution at a distance of 4 m, to ensure it is comparable with the visual angle subtended by letters presented on the Pelli–Robson chart at 1 m, hence representing a spatial frequency of one cycle per degree for both distances. The patients assessed via the Pelli–Robson chart were scored individually for each letter, with an assigned score of 0.05 for each correct response.[30] For the MSSS-II, patients were requested to identify the letter displayed in the center of the screen. Subsequently, the operator adjusted the contrast level based on the previous response. A single Sloan letter with 100% contrast level was set as the baseline. Once the patient approached the threshold, determined by hesitation in response or error in identifying the letter, the operator randomly selected two Sloan letters at the same contrast level to be correctly identified by each patient prior to determining the contrast threshold.[24]

Statistical analyses were performed using IBM SPSS (Predictive analytics software) (Version 24, SPSS Inc., Chicago, IL, USA). The primary outcome of this study was the agreement between the MSSS-II and the Pelli–Robson chart in patients with primary pterygium. The agreement between these two tests was assessed via the paired t-test and the Bland–Altman plot.[31,32]

Results

Of the 93 patients in the analysis, 50.5% (n = 47) were male. The mean ± standard deviation for age, CS (MSSS-II), and CS (Pelli–Robson chart) were 57.42 ± 11.55 years, 1.22 ± 0.56 log units, and 1.21 ± 0.57 log units, respectively. The results of the paired t-test showed that the difference between the MSSS-II and the Pelli–Robson chart were not statistically significant (p = 0.083). The Bland–Altman analysis showed excellent agreement between the tests with a mean difference in CS of 0.0016 log units and narrow limits of agreement of 0.037. Figure 1 illustrates the agreement between the two tests using the Bland–Altman plot.

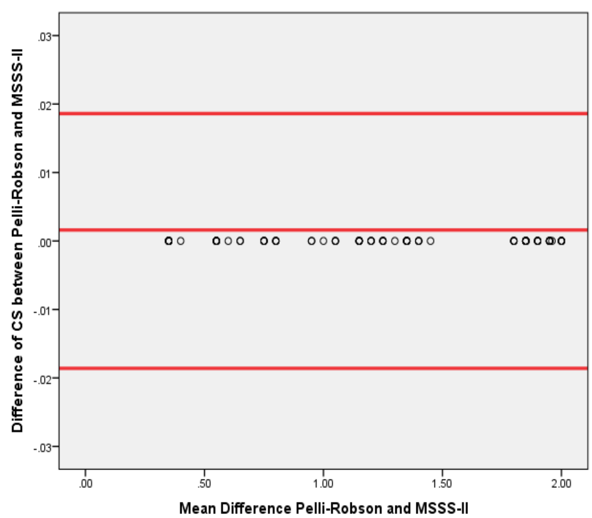

Figure 1. Bland–Altman plots of the difference in CS between the Pelli–Robson chart and MSSS-II to their mean. Mean difference of CS between the tests was 0.0016 (SD: 0.008), and the 95% limits of agreement were 0.0186 to −0.0186. SD = standard deviation; CS = contrast sensitivity; MSSS-II = M&S Smart System II

Discussion

The importance of assessing CS in patients with primary pterygium has rarely been addressed. Moreover, the impact of pterygium on oculo-visual function cannot be easily described. This is attributed to an association between visual quality and changes in visual acuity and corneal curvature (known as k-reading). Although visual acuity has been extensively investigated, CS is rarely discussed as a component of visual quality assessment in patients with primary pterygium. In 1997, Tan *et al*.[33] proposed a clinical grading system based on the translucent appearance of the pterygium tissue, corresponding to an increase of fleshiness of the fibrovascular components of the pterygium. Previous studies demonstrated that translucency (fleshiness) of the pterygium exerts various effects on visual performance.[25] This is important as a reduction of CS may occur, irrespective of visual acuity impairment.[22,25,34–38]

Different types of pterygia exert different effects in CS due to variations in their fleshiness. However, based on the Pelli–Robson chart, the simultaneous assessment of BCVA and CS is challenging. Hence, it is inconvenient for patients to undergo assessment of both components. Our study demonstrated that the MSSS-II provides comparable measurements of CS and BCVA with those obtained using the Pelli–Robson chart, when measured simultaneously. In addition, this was supported by the narrow limits of agreement observed in this analysis. Previous studies[32] have shown that limits of agreement <1.0 are indicative of good agreement between two tests.

It is postulated that these variations may be due to the difference in log progression between these two charts. The log progressions were smaller with the MSSS-II compared with those observed with the Pelli–Robson chart (0.10 vs. 0.15 log units, respectively). Moreover, the testing time for the MSSS-II system was shorter compared with that of the Pelli–Robson chart, which further minimizes variations in measurement. The shorter testing time observed with MSSS-II is attributed to its requirement of only one letter for each contrast level. In contrast, the Pelli–Robson chart requires all three letters in a triplet for each contrast level.

The present findings showed lower value for CS function compared with that reported in previous studies.[39] This may be due to two reasons. Firstly, the present study included patients with primary pterygium, whereas the previous study[24] involved healthy young adults. It is expected that young and healthy adults may exhibit better CS compared with that observed in patients with a visible anterior eye lesion (e.g., pterygium). Any obstacle on the cornea would result in an abnormal CS. Secondly, the approximately equal distribution of patients in this study may have resulted in a lower CS as different types of pterygium may affect the measurement due to their fleshy appearance, which indirectly affects visual performance.

The MSSS-II offers several advantages over the Pelli–Robson chart. There are several factors that may affect the measurement of the CS threshold using the Pelli–Robson chart. Firstly, the recommended luminance of 85 candelas/m^2 (range: 60–120 candelas/m^2) for the Pelli–Robson chart is difficult to be used in a clinical setting as the illumination in the lower portion of the chart decreases in parallel with the overhead lighting compared with that in the top portion. Moreover, different rooms with different light fixtures may cause variations in the measurement of the threshold. Secondly, the Pelli–Robson chart fades over time with exposure. According to the recommendations of the manufacturer, the chart should be replaced every 7 years. Thus, the use of the Pelli–Robson chart would be an issue regarding its variations and accuracy when comparing measurements of different ages. A lack of standardization in CS measurements may occur because of faded chart. Thirdly, the Pelli–Robson chart includes only two versions with different triplets of optotypes. Hence, repetitive testing may lead to memorizing of frequently used letters, especially those that are tested approximately at their threshold.

Conclusions

The present findings showed that the MSSS-II may be used as a clinical alternative to the Pelli–Robson chart for the measurement of CS, during the assessment of visual function in patients with primary pterygium.

Acknowledgements

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Conflict of interest

The author report no conflict of interest.

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