ORIGINAL ARTICLE

Patterns of Visual Field Defects in Malay Population with Myopic Eyes

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ABSTRACT

Introduction: Myopia is an emerging vision problem that causes public health and economic burden worldwide and associated with increased risk to many ocular conditions leading to blindness. This study aimed to evaluate patterns of visual field defects in Malay population with myopia. **Methods:** A retrospective study was conducted between January 2018 until June 2018 at MSU Eye Centre and data was obtained from patient records of Malay subjects with myopia and free from any ocular and systemic diseases. The spherical equivalent (SE) of the refractive errors and the global indices (mean deviation, MD and pattern of standard deviation, PSD) of OCULUS Twinfield® 2 with SPARK strategy were recorded for this study. **Results:** A total of 90 eyes with the mean age of 29.16 (SD: 10.27) years old and SE (M= -2.92 D, SD:2.94 D) were selected. The mean of MD was -1.71 dB (SD 3.95 dB) and PSD was 1.81 dB (SD:1.82 dB) respectively. Significant differences was found in MD (p=0.012) and PSD (p=0.01) between the three groups. The localised field defect was observed in the moderate to high myopic eyes in all quadrants (p=0.01) for PP2, and also more prevalent pattern found in all quadrants for PP1 except at superior quadrant (p=0.08). **Conclusions:** There is a localised visual field defect found in a higher degree of myopia particularly at temporal, nasal and inferior quadrants. Thus, the visual field test is recommended as a routine procedure in moderate to high myopic eyes and need to be interpreted with caution.

Keywords: High myopia, RNFL, MD, PSD, Field defect, Glaucoma

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INTRODUCTION

Myopia is a condition in which the visual images fall in front of the retina of the eye resulting defective vision of distant objects. Individual suffering myopia is likely having difficulties to see clearly at far. Prevalence of myopia has been tremendously increasing in East Asia which contributed to the high cost of public health and economic burden (1). The prevalence is estimated a significant increased globally, and by the year 2020, one-third of the world's population will be affected by myopia (2-3). And, the prevalence of high myopia is expected to increase from 15% to 45% in young age and school children (4). Students with high myopic may have amblyopia, academic problem, lifestyle and active daily life activities if left untreated. High myopia can cause several ocular abnormalities which could lead to irreversible blindness. Studies have shown that an increase in myopia prevalence increased the prevalence of Open-Angle Glaucoma (OAG) (5), bilateral retinal detachment (6) and myopic macular degeneration (7). In addition, High myopia has been linked to reduced retinal and contrast sensitivity (8).

Besides that, the most prominent findings on myopic morphological changes were the retinal nerve fibre layer (RNFL) thinning. Myopic has significantly thin of RNFL compared to non-myopic. Furthermore, reducing in RNFL thickness was found with the increase in degree of myopia, primarily at inferior quadrant which highly susceptibility to glaucoma disease (9). The direction of optic disc torsion predicts the location of glaucomatous damage in patients with myopic normal-tension glaucoma. The nerve fibre bundle located in the direction of optic disc torsion may get higher chances to be damaged particularly at the inferior quadrant because inferior torsion could place stress on the inferior nerve axons, resulting in inferior RNFL damage that presents with superior visual field (VF) defects (10). However, the RNFL defect was located in the same direction of the optic disc torsion in 60.2% cases of primary open-angle glaucoma (5).

A recent study by Heo et al., (2017) on VF has shown that as the glaucoma advances, the depression of the

visual field has becoming more diffuse which represent by decreasing value in the mean deviation (MD) and pattern of standard deviation (PSD) (11). The decreasing in visual field indices somehow suggests that the pattern of visual field defect is different between glaucoma and myopia. Although studies have suggested the increased risk of glaucoma in myopic patients, they did not specify the exact pattern of visual field defect differences between the glaucomatous visual field defect in high myopic patient and non-glaucomatous visual field defect of high myopic patients. However, there was a limited study on visual field defect in relation to high myopia and compared with low myopia and emmetropic. Thus, this study is to investigate the pattern of visual field defects in moderate to high myopia patients.

MATERIALS AND METHODS

Samples

The patient records at MSU Eye Centre, Shah Alam, Selangor dated January 2018 to June 2018 from MSU Rapid database were examined retrospectively. The selected patient records comprised of information of the comprehensive eye examination done at MSU Eye Centre which included patient history, objective and subjective refractive assessment, fundus evaluation via Nidek-600 Fundus Camera, anterior ocular health evaluated with slit-lamp and anterior chamber depth with Van-Herrick technique and IOP with Huvith Charops CRK 7000 Autorefractor-Keratometer with Tonometer. The records then classified further into the emmetropic eye (EE) (SE is between +0.50 diopter (D) and –0.50 D), moderate myopia (MM)(SE is defined as <-3.00 to -6.00D), and high myopia (HM) (SE is defined as more than -6.00D). The classifications of the groups were based on the studies done on high myopia and glaucoma susceptibility and between myopia severity groups and controls (12-13). The inclusion criteria of the sample included patients with a refractive error less than and equal to +0.50 D, aged 18 to 39 years old. Intraocular pressure (IOP), anterior chamber depth (ACD) and cup to disc ratio (C/D) data obtained following standard guidelines by Asia Pasific Glaucoma Society (APGS) to determine normal and abnormal IOP, ACD and C/D ratio (14). The exclusion criteria of the sample include SE of more than +0.50D, have any form of ocular diseases, trauma or surgery. The study was approved by the Management and Science University Ethics Committee and the conduct of the study followed the tenets of the Declaration of Helsinki.

Visual Field Test

The visual field test results of OCULUS Twinfield® 2 Perimeter using SPARK strategy were used in this study. The printout of visual field results consists of Mean Deviation (MD), Pattern of Standard Deviation (PSD) and Probability Plot 2% (PP2) and Probability Plot 1% (PP1) were recorded and analysed. The classifications of the groups were based on the studies done on high myopia and glaucoma susceptibility and between myopia severity groups and controls (12-13).

Statistical analysis

Descriptive analysis was performed for all variables. Comparisons for all pairs were performed by Kruskal-Wallis H and the correlation by Spearman's Correlation. For all tests, statistical significance was defined by a $p \leq 0.05$. All data were analysed using SPSS VERSION 21. Values for measurements were presented as mean ± SD.

RESULTS

A total of 90 eyes comprised of the emmetropic to myopic patients in MSU Eye Centre with the mean age was 29.16 (SD: 10.27) ranged from 18 to 39 years old. Out of 90 eyes data obtained, 55.6% (n=50) was females and 44.4%(n=40) was males. From the refractive error's distribution, EE subjects constituted 41.1% (n=37), followed by MM, 31.1% (n=28) and HM, 27.8% (n=25) subjects respectively. The mean of MD was -1.71 (SD 3.95) dB and PSD was 1.81 (SD: 1.82) dB respectively. There was a significant decreasing in mean MD observed in myopic groups compared to emmetropic eyes [$\chi^2(2) = 8.892$, $p = 0.012$]. A similar pattern was observed in PSD [$\chi^2(2) = 42.057$, $p = 0.01$] between myopic groups and EE (Table I).

Table I: Relationship between visual field defect and degree of myopia for p<2%

	Groups	Mean rank	Chi-Square	p- value
P<2% Inferior	Emmetrope	28.31	66.96	<0.01
	Moderate Myopia	40.05		
	High Myopia	77.04		
P<2% Superior	Emmetrope	39.68	8.81	0.01
	Moderate Myopia	45.14		
	High Myopia	54.52		
P<2% Temporal	Emmetrope	37.38	17.93	<0.01
	Moderate Myopia	44.04		
	High Myopia	59.16		
P<2% Nasal	Emmetrope	39.68	8.81	0.01
	Moderate Myopia	45.14		
	High Myopia	54.52		

Among the probability plots, PP2 inferior quadrant has the highest mean of 0.03 (SD: 0.60). There was significance inter-group differences found in PP2 for all quadrants and PP1 except at superior quadrant (p=0.08). Significant inter-group differences in PP1 was observed at inferior quadrant $\chi^2(2) = 11.89$, p=0.01; superior quadrant was $\chi^2(2) = 5.00$, p =0.08; temporal quadrant was $\chi^2(2) = 9.47$; and nasal quadrant was $\chi^2(2) = 66.96$, p =0.01 respectively (Table II). There was weak positive correlation between myopia degrees and MD (r= 0.253, p = 0.02) and good negative correlation with PSD (r= -0.703, p < 0.01) (Figure 1 and Figure 2).

Table II: Relationship between visual field defect and degree of myopia for p<1%

	Groups	Mean rank	Chi-Square	p- value
P<1% Inferior	Emmetrope	38.65	11.89	<0.01
	Moderate Myopia	45.27		
	High Myopia	55.90		
P<1% Superior	Emmetrope	41.30	5.00	0.08
	Moderate Myopia	46.77		
	High Myopia	50.30		
P<1% Temporal	Emmetrope	38.97	9.47	<0.01
	Moderate Myopia	47.27		
	High Myopia	53.18		
P<1% Nasal	Emmetrope	39.92	11.33	<0.01
	Moderate Myopia	43.88		
	High Myopia	55.58		

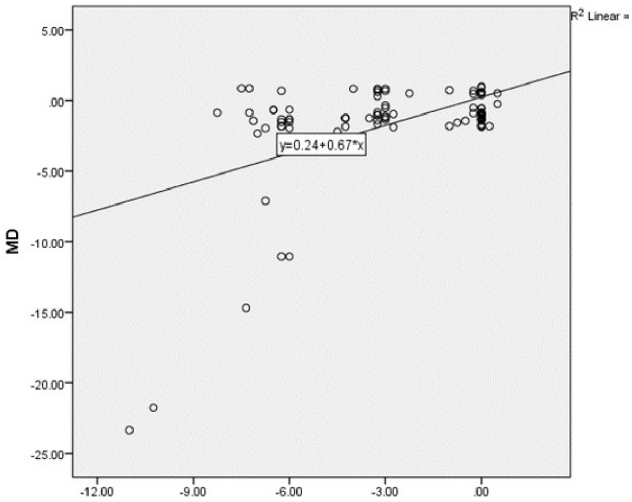

Figure 1: Graph showing the positive correlation between MD and SE. The mean deviation (MD) of retinal sensitivity loss plot against the degree of myopia. A weak relationship indicates that the mean MD will increase with increasing of the degree of myopia. The significant correlation value of MD shows that the reduction of -4dB (decibel) of retinal sensitivity loss from average normal.

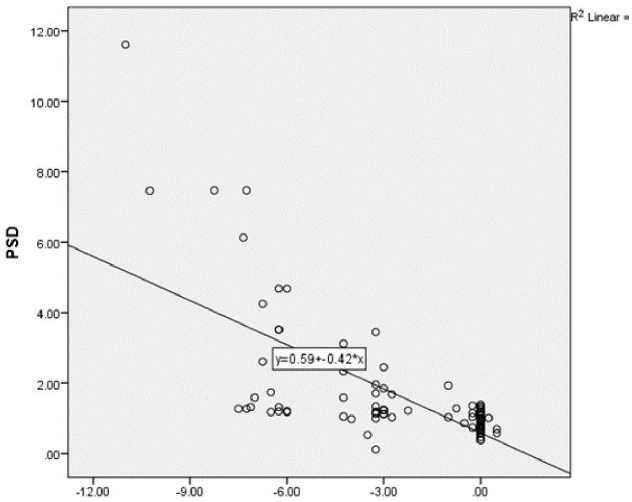

Figure 2: Graph showing the negative correlation between PSD and SE. A moderate negative correlation shows that the higher the degree of myopia will increase the PSD value. PSD value represents the localised field defects. The significant correlation value of PSD shows that the reduction of more than -8dB(decibel) of retinal sensitivity loss at localised RNFL from average normal.

DISCUSSION

Myopia has been established as a risk factor of glaucoma diseases and associated with numerous morphological changes (5,6,10-11) but visual field defect in myopia particularly in moderate to high myopia need to dealt with precaution (13). In the current study, we identified variations in visual field defects associated with categories of myopia. The MD result for all myopia degrees was lower than -4dB. MD and PSD results showed significantly increased in moderate to high myopia. Our study suggests that a significant relationship between the degrees of myopia with a specific reduction in retinal sensitivity loss (MD) and general retinal sensitivity loss (PSD). The retinal sensitivity losses found at all quadrants, horizontal and vertical of RNFL at PP2. This significant value represents at PP2 showing the deviation reduction variance in pattern deviation probability plot is more than average could suggest local retinal sensitivity loss at a specific location within RNFL. Supported by the negative value of MD in moderate to high myopia, the significant value of PP2 is strongly correlated to RNFL defect. The similar pattern was observed at PP1 at all quadrants except at superior quadrants suggested that the depth of RNFL defect are more prevalent in high myopia (Table2). These findings are supported by OCT study on RNFL profiles suggested that decreasing in RNFL at pericentral and peripheral regions (15). Thinning of this RNFL may results abnormalities of choroid layers and disturbing

the blood flow in moderate to high myopic eyes (16,17) subsequently lead to cell apoptosis of photoreceptors layers (15). This damage to RNFL in particularly at photoreceptors layers could explain the visual field defects found in our study on significant losses of retinal sensitivity at all quadrants of RNFL as showed by PP2 and PP1.

Apart of evaluating the pattern on the relationship between global indices (MD and PSD) and probability plot with the degrees of myopia, the significant inter-groups difference found for general and localised defects in visual fields. Thus, our study shows that there is an effect of myopia on the value of MD and PSD. However, the analysis of the probability plot at PP2 and PP1 need to evaluate further considering Anderson's criteria to justify glaucomatous defects in moderate to high myopia (13). Since, our results reveal specific pattern of significant differences at each quadrant, the probability plot for PP2 and PP1 for all of the quadrant ($p \leq 0.01$) except, superior quadrant for PP1 ($p=0.08$), PP1 signifies a worse defect compared to PP2 shows the depth of focal defect at a specific location of RNFL. Thus, the degree of myopia affects all quadrants of the visual field, and the area of defects seems to be more focused towards the inferior, temporal and nasal visual field. Furthermore, our result shows a weak correlation between global indices of field defects with spherical equivalent ($r= 0.253$, $p= 0.02$) which with the spherical equivalent increases, the general retinal sensitivity losses increases. Our findings are supported with other studies that field defects were observed in high myopic eyes and was suggested as early glaucomatous field defects associated with high myopia (6-7, 9-10). Although we cannot specify the mechanism of the field defects in this retrospective study, our findings on field defects may aid understanding of the functional and pathophysiology of myopic progression.

Although there are significant losses of retinal sensitivity at all quadrants of RNFL as showed by PP2 and PP1, extensive studies are required to decide whether myopia is only a risk factor for glaucomatous visual field changes or a separate entity that on its own can cause visual field defect (18,19). If the latter is to be proven in the future, changes in the routine examination including additional examination regarding high myopic patients must include visual field perimetry analysis. Additional further studies are needed to comprehend the impact of moderate and high myopia on the thickness of RNFL and visual field defects. More studies also needed to show a comparison between the glaucomatous visual field defect in high myopic eyes and non-glaucomatous visual field defect of high myopic eyes as well as comparison of visual field defect on normal tension glaucoma with moderate and high myopia.

Our study has some limitations. This study was conducted without comprehensively examined patients and it is a preliminary study to investigate visual field defects in various degrees in myopic eyes. Other diagnostic characteristics of retinal pathology related to myopia were not evaluated. The study was also limited to a young age group, as well as by the retrospective design. Longitudinal studies with a broader range of age group, using an Ultra-high resolution Optical Coherence Tomography for RNFL evaluation and a standard protocol for static perimetry test may be useful in overcoming these limitation.

CONCLUSION

The study shows that there are visual field changes at all quadrants except superior quadrant and suggests focal defects occur in moderate to high myopia. A static visual field test may be useful in monitoring myopic progression and also could be useful to predict subtle changes in the status of visual function associated with pathophysiological changes in moderate to high myopic eyes. However, to incorporate static visual field test as routine eye examination for moderate to high myopia and to the interpretation of visual field defects link to glaucomatous defects particularly the risk to normal-tension glaucoma should be dealt with precaution.

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